

Part VIII: SQL programming



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SQL programming

You can use the implementation of the SQL language to develop applications for database servers.

Quick reference cards that are suitable for printing

- [SQL quick reference card: SET ENVIRONMENT](#) (PDF)
- [Quick reference card: SQL administration API arguments](#) (PDF)

Portals that list reference information by functional area and include links

- [SQL administration API portal](#)
- [Environment variable portal](#)

Tools

- [DB-Access User's Guide](#)

External resources

- [An insider's guide to star join optimization in Server](#) ()
Get an introduction to a star join optimization, which can significantly increase query performance for queries on star schemas and snowflake schemas.
- [Take advantage of fragment-level statistics and smarter statistics in](#) ()
Learn how to improve efficiency by determining when you really need to run update statistics and how to gather fragment-level statistics for fragmented tables.
- [SYSDBOPEN: A flexible way to change session behavior in](#) ()
Learn how to use the SYSDBOPEN() and SYSDBCLOSE() procedures to set environments to activate user tracing, handle short-lasting locks on data records, or change the reading behavior of sessions. This article shows how to create a SYSDBOPEN() procedure that can be dynamically changed without re-creating the procedure to avoid downtime if session environments must be adjusted.
- [Perform case-insensitive queries in](#) ()
Learn how to create a not case-sensitive database and explore considerations for implementing check constraints, running distinct searches, running group-by aggregate queries, implementing distributed queries, and more, in a not case-sensitive database environment.

Main resources

- [Guide to SQL: Syntax](#)
These topics describe the syntax of the statements, data types, expressions, operators, and built-in functions of the dialect of the SQL language, as implemented in 14.10.
- [Guide to SQL: Reference](#)
These topics contain the reference information for the system catalog tables, data types, and environment variables of the dialect of the SQL language, as implemented in . These topics also include information about the stores_demo, sales_demo, and superstore_demo databases that are included with .
- [Guide to SQL: Tutorial](#)
This publication shows how to use basic and advanced structured query language (SQL) to access and manipulate the data in your databases. It discusses the data manipulation language (DML) statements as well as triggers and stored procedure language (SPL) routines, which DML statements often use.

Guide to SQL: Syntax

These topics describe the syntax of the statements, data types, expressions, operators, and built-in functions of the Informix® dialect of the SQL language.

This information is intended for the following users:

- Database users
- Database administrators
- Database security administrators
- Database application programmers.

This information assumes that you have the following background:

- A working knowledge of your computer, your operating system, and the utilities that your operating system provides
- Some experience working with relational databases or exposure to database concepts
- Some experience with computer programming.

These topics are taken from the *IBM® Informix Guide to SQL: Syntax*.

- [Overview of SQL syntax](#)
These topics provide an overview about how to use the SQL statements, SPL statements, and syntax segments.
- [SQL statements](#)
This chapter describes the syntax and semantics of SQL statements that are recognized by .
- [SPL statements](#)
These topics describe Stored Procedure Language (SPL) statements, which you use to write SPL routines. You can store these routines in the database as user-defined routines (UDRs).
- [Data types and expressions](#)
These topics describe the data types and expressions that Informix supports.

- [Other syntax segments](#)
These topics describe *syntax segments*, which are language elements, such as database object names or optimizer directives, that appear as a subdiagram reference in the syntax diagrams of some SQL or SPL statements.
- [Built-in routines](#)
Use build-in routines in SQL statements to perform specialized tasks.
- [Appendixes](#)

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Overview of SQL syntax

These topics provide an overview about how to use the SQL statements, SPL statements, and syntax segments.

The topics in this chapter are organized into the following sections.

Section	Scope
How to Enter SQL Statements	How to use syntax diagrams and descriptions to enter SQL statements correctly
How to Enter SQL Comments	How to enter comments in SQL statements
Categories of SQL Statements	The SQL statements, listed by functional category
ANSI/ISO Compliance and Extensions	The SQL statements, listed by degree of ANSI/ISO compliance

- [How to Enter SQL Statements](#)
- [How to Enter SQL Comments](#)
- [Categories of SQL Statements](#)
- [ANSI/ISO Compliance and Extensions](#)

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How to Enter SQL Statements

SQL is a free-form language, like C or PASCAL, that generally ignores white-space characters like TAB, LINEFEED, and extra blank spaces between statements or statement elements. At least one blank character or other delimiter, however, must separate keywords and identifiers from other syntax tokens.

SQL is lettercase insensitive, except within quoted strings; see also [Identifier](#). In an ANSI-compliant database, if you do not delimit the *owner* of an object by double (") quotation marks, and the **ANSIOWNER** environment variable was not set to 1 when the database server was initialized, the database server stores the *owner* name in uppercase letters.

Statement descriptions are provided in this publication to help you to enter SQL statements successfully. A statement description includes this information:

- A brief introduction that explains what the statement does
- A syntax diagram that shows how to enter the statement correctly
- A syntax table that explains each input parameter in the syntax diagram
- Rules of usage, typically with examples that illustrate these rules

For some statements, this information is provided for individual clauses.

Most statement descriptions conclude with references to related information in this publication and in other publications.

[SQL statements](#) provides descriptions of each SQL statement, arranged in alphabetical order. [SPL statements](#) describes each of the SPL statements, using the same format.

The major aids for entering SQL statements include:

- The combination of the syntax diagram and syntax table
- The examples of syntax that appear in the rules of usage
- The references to related information
- [Using Syntax Diagrams and Syntax Tables](#)
- [Using Examples](#)
- [Using Related Information](#)

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Using Syntax Diagrams and Syntax Tables

Before you try to use the syntax diagrams in this chapter, it is helpful to read the syntax diagram section of the Introduction. This section is the key to understanding the syntax diagrams and explains the elements that can appear in a syntax diagram and the paths that connect the elements to each other. This

section also includes an example that illustrates the elements of typical syntax diagrams. The narrative that follows the example diagram shows how to read the diagram in order to enter the statement successfully.

Notes to the diagram can reference other syntax segments or can specify various restrictions. If you are using an application programming interface, such as ESQL/C, only the SQL syntax rules that both your client application and the database server support are valid.

When a syntax diagram includes input specifications that are not keywords, syntax segments, nor punctuation symbols, such as identifiers, expressions, filenames, or host variables, the syntax diagram is followed by a table that describes how to enter the term without generating errors. Each syntax table includes four columns:

- The **Element** column lists each variable term in the syntax diagram.
- The **Description** column briefly describes the term and identifies the default value, if the term has one.
- The **Restrictions** column summarizes the restrictions on the term, such as acceptable ranges of values. (For some diagrams, restrictions that cannot be tersely summarized appear in the **Usage** notes, rather than in this column.)
- The **Syntax** column points to the SQL segment that gives the detailed syntax for the term. For a few terms, such as the names of host variables, pathnames, or literal characters, no page reference is provided.

The diagrams generally provide an intuitive notation for what is valid in a given SQL statement, but for some statements, dependencies or restrictions among syntax elements are identified only in the text of the Usage section.

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Using Examples

To understand the main syntax diagram and subdiagrams for a statement, study the examples of syntax that appear in the rules of usage for each statement. These examples have two purposes:

- To show how to accomplish specific tasks with the statement or its clauses
- To show how to use syntax of the statement or its clauses in a concrete way

Tip: An efficient way to understand a syntax diagram is to find an example of the syntax and compare it with the keywords and parameters in the syntax diagram. By mapping the concrete elements of the example to the abstract elements of the syntax diagram, you can understand the syntax diagram and use it more effectively. For an explanation of the conventions used in the examples in this publication, see the syntax diagram section of the Introduction.

These code examples are program fragments to illustrate valid syntax, rather than complete SQL programs. In some code examples, ellipsis (...) symbols indicate that additional code has been omitted. To save space, however, ellipses are not shown at the beginning or end of the program fragments.

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Using Related Information

For help in understanding concepts and terms in the SQL statement description, check the “Related Information” section at the end of each statement.

This section points to related information in this publication and other publications to help you understand the statement in question. The section provides some or all of the following information:

- The names of related statements that might contain a fuller discussion of topics in this statement
- The titles of other publications that provide extended discussions of topics in this statement

Tip: If you do not have extensive knowledge and experience with SQL, the *IBM® Informix® Guide to SQL: Tutorial* gives you the basic SQL knowledge that you need to understand and use the statement descriptions in this document.

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How to Enter SQL Comments

You can add comments to clarify the purpose or effect of particular SQL statements. You can also use comment symbols during program development to disable individual statements without deleting them from your source code.

Your comments can help you or others to understand the role of the statement within a program, SPL routine, or command file. The code examples in this document sometimes include comments that clarify the role of an SQL statement within the code, but your own SQL programs will be easier to read and to maintain if you document them with frequent comments.

The following table shows the SQL comment indicators that you can enter in your code. Here a Y in a column signifies that you can use the symbol with the product or with the type of database identified in the column heading. An N in a column signifies that you cannot use the symbol with the indicated product or with a database of the indicated ANSI-compliance status.

Comment Symbol	ESQL/C	SPL Routine	DB-Access	ANSI-Compliant Databases	Databases Not ANSI Compliant	Description
----------------	--------	-------------	-----------	--------------------------	------------------------------	-------------

Comment Symbol	ESQL/C	SPL Routine	DB-Access	ANSI-Compliant Databases	Databases Not ANSI Compliant	Description
double hyphen (--)	Y	Y	Y	Y	Y	The double hyphen precedes a comment within a single line. To comment more than one line, put double hyphen symbols at the beginning of each comment line.
braces ({ ... })	N	Y	Y	Y	Y	Braces enclose the comment. The { precedes the comment, and the } follows it. Braces can delimit single- or multiple-line comments, but comments cannot be nested.
slash and asterisk (/* ... */)	Y	Y	Y	Y	Y	C-language style slash and asterisk (/* */) paired delimiters enclose the comment. The /* precedes the comment, and the */ follows it. These can delimit single-line or multiple-line comments, but comments cannot be nested.

Characters within the comment are ignored by the database server.

The section [Optimizer Directives](#) describes a context where information within comments can influence query plans of Informix®.

If the product that you use supports all of these comment symbols, your choice of a comment symbol depends on requirements for ANSI/ISO compliance:

- Double hyphen (--) complies with the ANSI/ISO standard for SQL.
- Braces ({ }) are the Informix extension to the ANSI/ISO standard.
- C-style slash-and-asterisk (/* ... */) comply with the SQL-99 standard.

If ANSI/ISO compliance is not an issue, your choice of comment symbols is a matter of personal preference.

In DB-Access, you can use any of these comment symbols when you enter SQL statements with the SQL editor and when you create SQL command files with the SQL editor or with a system editor.

An SQL command file is an operating-system file that contains one or more SQL statements. Command files are also known as command scripts. For more information about command files, see the discussion of command scripts in the *IBM® Informix Guide to SQL: Tutorial*. For information on how to create and modify command files with the SQL editor or a system editor in DB-Access, see the *IBM Informix DB-Access User's Guide*.

You can use any of these comment symbols in any line of an SPL routine. See the discussion of how to comment and document an SPL routine in the *IBM Informix Guide to SQL: Tutorial*.

In Informix ESQL/C, the double hyphen (--) can begin a comment that extends to the end of the same line. For information on language-specific comment symbols in Informix ESQL/C programs, see the *IBM Informix ESQL/C Programmer's Manual*.

- [Examples of SQL Comments](#)
- [Non-ASCII Characters in SQL Comments](#)

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Examples of SQL Comments

These examples illustrate different ways to use the SQL comment indicators.

The following examples use each style of comment indicator, including the double hyphen (--), braces ({ }), and C-style (/* ... */) comment delimiters to include a comment after an SQL statement. The comment appears on the same line as the statement.

```
SELECT * FROM customer; -- Selects all columns and rows

SELECT * FROM customer; {Selects all columns and rows}

SELECT * FROM customer; /*Selects all columns and rows*/
```

The next three examples use the same SQL statement and the same comments as in the preceding examples, but place the comment on a separate line:

```
SELECT * FROM customer;
-- Selects all columns and rows

SELECT * FROM customer;
{Selects all columns and rows}

SELECT * FROM customer;
/*Selects all columns and rows*/
```

In the following examples, the user enters the same SQL statement as in the preceding example but now a multiple-line comment (or for the double-hyphen indicator, two comments) follows each statement:

```
SELECT * FROM customer;
-- Selects all columns and rows
```

```
-- from the customer table

SELECT * FROM customer;
{Selects all columns and rows
 from the customer table}

SELECT * FROM customer;
/*Selects all columns and rows
 from the customer table*/
```

Comments in any of these styles can also appear within an SQL statement:

```
SELECT *          -- Selects all columns and rows
FROM customer;   -- from the customer table

SELECT *          {Selects all columns and rows}
FROM customer;   {from the customer table}

SELECT *          /*Selects all columns and rows*/
FROM customer;   /*from the customer table*/
```

If you use braces or C-style comments that are delimited by paired opening and closing indicators, the closing comment indicator must be in the same style as the opening comment indicator.

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Non-ASCII Characters in SQL Comments

You can enter non-ASCII characters (including multibyte characters) in SQL comments if the database locale supports the non-ASCII characters. For further information on the GLS aspects of SQL comments, see the *IBM® Informix® GLS User's Guide*.

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Categories of SQL Statements

SQL statements are traditionally divided into the following logical categories:

Data definition statements

These data definition language (DDL) statements can declare, rename, modify, or destroy objects in the local database.

Data manipulation statements

These data manipulation language (DML) statements can retrieve, insert, delete, or modify data values.

Cursor manipulation statements

These statements can declare, open, and close cursors, which are data structures for operations on multiple rows of data.

Dynamic management statements

These statements support memory management and allow users to specify at runtime the details of DML operations.

Data access statements

These statements specify discretionary access privileges and support concurrent access to the database by multiple users.

Data integrity statements

These implement transaction logging and support the referential integrity of the database.

Optimization statements

These can be used to improve the performance of operations on the database.

Routine definition statements

These can declare, define, modify, execute, or destroy user-defined routines that the database stores.

Client/server connection statements

These can open or close a connection between a database and a client application.

Auxiliary statements

These can provide information about the database. (This is also a residual category for statements that are not closely related to the other statement categories.)

- [Data Definition Language Statements](#)
The data definition language (DDL) statements of SQL create, modify, rename, or destroy database objects, and make corresponding changes to rows in the system catalog tables of the database.
- [Data Manipulation Language Statements](#)
- [Data Integrity Statements](#)
- [Cursor Manipulation Statements](#)
- [Dynamic Management Statements](#)
- [Data Access Statements](#)
- [Optimization Statements](#)
- [Routine Definition Statements](#)
- [Auxiliary Statements](#)
- [Client/Server Connection Statements](#)

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Data Definition Language Statements

The data definition language (DDL) statements of SQL create, modify, rename, or destroy database objects, and make corresponding changes to rows in the system catalog tables of the database.

- ALTER ACCESS_METHOD
- ALTER FRAGMENT
- ALTER FUNCTION
- ALTER INDEX
- ALTER PROCEDURE
- ALTER ROUTINE
- ALTER SECURITY LABEL COMPONENT
- ALTER SEQUENCE
- ALTER TABLE
- ALTER TRUSTED CONTEXT
- ALTER USER
- CLOSE DATABASE
- CREATE ACCESS_METHOD
- CREATE AGGREGATE
- CREATE CAST
- CREATE DATABASE
- CREATE DEFAULT USER
- CREATE DISTINCT TYPE
- CREATE EXTERNAL TABLE
- CREATE FUNCTION
- CREATE FUNCTION FROM
- CREATE INDEX
- CREATE OPAQUE TYPE
- CREATE OPCLASS
- CREATE PROCEDURE
- CREATE PROCEDURE FROM
- CREATE ROLE
- CREATE ROUTINE FROM
- CREATE ROW TYPE
- CREATE SCHEMA
- CREATE SECURITY LABEL
- CREATE SECURITY LABEL COMPONENT
- CREATE SECURITY POLICY
- CREATE SEQUENCE
- CREATE SYNONYM
- CREATE TABLE
- CREATE TEMP TABLE
- CREATE TRIGGER
- CREATE TRUSTED CONTEXT
- CREATE USER
- CREATE VIEW
- CREATE XDATASOURCE
- CREATE XDATASOURCE TYPE
- DROP ACCESS_METHOD
- DROP AGGREGATE
- DROP CAST
- DROP DATABASE
- DROP FUNCTION
- DROP INDEX
- DROP OPCLASS
- DROP PROCEDURE
- DROP ROLE
- DROP ROUTINE
- DROP ROW TYPE
- DROP SECURITY
- DROP SEQUENCE
- DROP SYNONYM
- DROP TABLE
- DROP TRIGGER
- DROP TRUSTED CONTEXT
- DROP TYPE
- DROP USER
- DROP VIEW
- DROP XDATASOURCE
- DROP XDATASOURCE TYPE
- RENAME COLUMN
- RENAME DATABASE
- RENAME INDEX
- RENAME SECURITY

- RENAME SEQUENCE
- RENAME TABLE
- RENAME TRUSTED CONTEXT
- RENAME USER
- TRUNCATE
- UPDATE STATISTICS

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Data Manipulation Language Statements

- DELETE
- INSERT
- LOAD
- MERGE
- SELECT
- UNLOAD
- UPDATE

Note: DELETE, INSERT, MERGE, SELECT, and UPDATE are DML statements in the ANSI/ISO standard for SQL, where MERGE can emulate INSERT and DELETE or UPDATE. Although LOAD and UNLOAD resemble DML in their functionality, these DB-Access macros are out-of-scope for most references in this document to "DML statements."

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Data Integrity Statements

- BEGIN WORK
- COMMIT WORK
- SAVEPOINT
- RELEASE SAVEPOINT
- ROLLBACK WORK
- SET Database Object Mode
- SET LOG
- SET Transaction Mode
- START VIOLATIONS TABLE
- STOP VIOLATIONS TABLE

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Cursor Manipulation Statements

- CLOSE
- DECLARE
- FETCH
- FLUSH
- FREE
- OPEN
- PUT
- SET AUTOFREE

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Dynamic Management Statements

- ALLOCATE COLLECTION
- ALLOCATE DESCRIPTOR
- ALLOCATE ROW
- DEALLOCATE COLLECTION
- DEALLOCATE DESCRIPTOR
- DEALLOCATE ROW
- DESCRIBE
- DESCRIBE INPUT
- EXECUTE
- EXECUTE IMMEDIATE

- FREE
- GET DESCRIPTOR
- INFO
- PREPARE
- SET DEFERRED_PREPARE
- SET DESCRIPTOR

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Data Access Statements

- GRANT
- GRANT FRAGMENT
- LOCK TABLE
- REVOKE
- REVOKE FRAGMENT
- SET ISOLATION
- SET LOCK MODE
- SET ROLE
- SET SESSION AUTHORIZATION
- SET TRANSACTION
- SET Transaction Mode
- UNLOCK TABLE

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Optimization Statements

- SAVE EXTERNAL DIRECTIVES
- SET ENVIRONMENT
- SET EXPLAIN
- SET OPTIMIZATION
- SET PDQPRIORITY
- SET STATEMENT CACHE

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Routine Definition Statements

- ALTER FUNCTION
- ALTER PROCEDURE
- ALTER ROUTINE
- CREATE FUNCTION
- CREATE FUNCTION FROM
- CREATE PROCEDURE
- CREATE PROCEDURE FROM
- CREATE ROUTINE FROM
- DROP FUNCTION
- DROP PROCEDURE
- DROP ROUTINE
- EXECUTE FUNCTION
- EXECUTE PROCEDURE
- SET DEBUG FILE TO

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Auxiliary Statements

- GET DIAGNOSTICS
- INFO
- OUTPUT
- SET COLLATION
- SET DATASKIP
- SET ENCRYPTION PASSWORD
- SET USER PASSWORD

- WHENEVER

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Client/Server Connection Statements

- CONNECT
- DATABASE
- DISCONNECT
- SET CONNECTION

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ANSI/ISO Compliance and Extensions

Lists that follow show statements that match the ANSI SQL-92 standard at the entry level, statements that are ANSI compliant but include Informix® extensions, and statements that are Informix extensions to the ANSI/ISO standard.

- [ANSI/ISO-Compliant Statements](#)
- [ANSI/ISO-Compliant Statements with Informix Extensions](#)
- [Statements that are Extensions to the ANSI/ISO Standard](#)

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ANSI/ISO-Compliant Statements

- CLOSE
- COMMIT WORK
- RELEASE SAVEPOINT
- SET CONSTRAINTS (See [SET Transaction Mode statement](#))
- SET SESSION AUTHORIZATION
- SET TRANSACTION

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ANSI/ISO-Compliant Statements with Informix® Extensions

- ALLOCATE DESCRIPTOR
- ALTER TABLE
- CONNECT
- CREATE FUNCTION
- CREATE PROCEDURE
- CREATE TRIGGER
- CREATE SCHEMA
- CREATE TABLE
- CREATE TEMP TABLE
- CREATE VIEW
- DEALLOCATE DESCRIPTOR
- DECLARE
- DELETE
- DESCRIBE
- DESCRIBE INPUT
- DISCONNECT
- EXECUTE
- EXECUTE IMMEDIATE
- FETCH
- GET DESCRIPTOR
- GET DIAGNOSTICS
- GRANT
- INSERT
- MERGE
- OPEN
- PREPARE
- REVOKE
- ROLLBACK WORK

- SAVEPOINT
- SELECT
- SET CONNECTION
- SET DESCRIPTOR
- UPDATE STATISTICS
- WHENEVER

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Statements that are Extensions to the ANSI/ISO Standard

- ALLOCATE COLLECTION
- ALLOCATE ROW
- ALTER ACCESS_METHOD
- ALTER FRAGMENT
- ALTER FUNCTION
- ALTER INDEX
- ALTER PROCEDURE
- ALTER ROUTINE
- ALTER SECURITY LABEL COMPONENT
- ALTER SEQUENCE
- ALTER TRUSTED CONTEXT
- ALTER USER
- BEGIN WORK
- CLOSE DATABASE
- CREATE ACCESS_METHOD
- CREATE AGGREGATE
- CREATE CAST
- CREATE DATABASE
- CREATE DEFAULT USER
- CREATE DISTINCT TYPE
- CREATE EXTERNAL TABLE
- CREATE FUNCTION
- CREATE FUNCTION FROM
- CREATE INDEX
- CREATE OPAQUE TYPE
- CREATE OPCLASS
- CREATE PROCEDURE
- CREATE PROCEDURE FROM
- CREATE ROLE
- CREATE ROUTINE FROM
- CREATE ROW TYPE
- CREATE SECURITY LABEL
- CREATE SECURITY LABEL COMPONENT
- CREATE SECURITY POLICY
- CREATE SEQUENCE
- CREATE SYNONYM
- CREATE TRIGGER
- CREATE TRUSTED CONTEXT
- CREATE USER
- CREATE XDATASOURCE
- CREATE XDATASOURCE TYPE
- DATABASE
- DEALLOCATE COLLECTION
- DEALLOCATE ROW
- DROP ACCESS_METHOD
- DROP AGGREGATE
- DROP CAST
- DROP DATABASE
- DROP FUNCTION
- DROP INDEX
- DROP OPCLASS
- DROP PROCEDURE
- DROP ROLE
- DROP ROUTINE
- DROP ROW TYPE
- DROP SECURITY LABEL
- DROP SECURITY LABEL COMPONENT
- DROP SECURITY POLICY
- DROP SEQUENCE
- DROP SYNONYM
- DROP TABLE
- DROP TRIGGER

- DROP TRUSTED CONTEXT
- DROP TYPE
- DROP USER
- DROP VIEW
- DROP XADATASOURCE
- DROP XADATASOURCE TYPE
- EXECUTE FUNCTION
- EXECUTE PROCEDURE
- FLUSH
- FREE
- GRANT FRAGMENT
- LOAD
- LOCK TABLE
- OUTPUT
- PUT
- RELEASE SAVEPOINT
- RENAME COLUMN
- RENAME DATABASE
- RENAME INDEX
- RENAME SECURITY LABEL
- RENAME SECURITY LABEL COMPONENT
- RENAME SECURITY POLICY
- RENAME SEQUENCE
- RENAME TABLE
- RENAME TRUSTED CONTEXT
- RENAME USER
- REVOKE FRAGMENT
- SAVE EXTERNAL DIRECTIVES
- SET AUTOFREE
- SET COLLATION
- SET CONSTRAINTS (See [SET Database Object Mode statement.](#))
- SET Database Object Mode
- SET DATASKIP
- SET DEBUG FILE TO
- SET DEFERRED_PREPARE
- SET ENCRYPTION PASSWORD
- SET ENVIRONMENT
- SET EXPLAIN
- SET INDEXES (See [SET Database Object Mode statement.](#))
- SET ISOLATION
- SET LOCK MODE
- SET LOG
- SET OPTIMIZATION
- SET PDQPRIORITY
- SET ROLE
- SET STATEMENT CACHE
- SET TRIGGERS (See [SET Database Object Mode statement.](#))
- SET USER PASSWORD
- START VIOLATIONS TABLE
- STOP VIOLATIONS TABLE
- TRUNCATE
- UNLOAD
- UNLOCK TABLE
- UPDATE STATISTICS

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SQL statements

This chapter describes the syntax and semantics of SQL statements that are recognized by .

The SQL statement names that appear as the title to each statement description in this chapter are listed in alphabetical order.

For some statements, important details of the semantics appear in other volumes of this documentation set, as indicated by cross-references.

For many statements, the syntax diagram, or the table of terms immediately following the diagram, or both, includes references to syntax segments in [Data types and expressions](#) or in [Other syntax segments](#).

When the name of an SQL statement includes lowercase characters, such as "SET Database Object Mode," it means that the first mixed-lettercase string in the statement name is not an SQL keyword, but that two or more different SQL keywords can follow the preceding uppercase keyword.

For an explanation of the structure of statement descriptions, see [Overview of SQL syntax](#).

- [ALLOCATE COLLECTION statement](#)
Use the ALLOCATE COLLECTION statement to allocate memory for a variable of a collection data type (such as LIST, MULTISSET, or SET) or for an untyped

collection variable.

- [ALLOCATE DESCRIPTOR statement](#)
Use the ALLOCATE DESCRIPTOR statement to declare the name and allocate memory for a system-descriptor area (SDA). Use this statement with ESQL/C.
- [ALLOCATE ROW statement](#)
Use the ALLOCATE ROW statement to allocate memory for a *row* variable. This statement is an extension to the ANSI/ISO standard for SQL. Use this statement with ESQL/C.
- [ALTER ACCESS_METHOD statement](#)
Use the ALTER ACCESS_METHOD statement to change one or more attributes of a user-defined primary or secondary access method in the **sysams** system catalog table.
- [ALTER FRAGMENT statement](#)
Use the ALTER FRAGMENT statement to change the distribution strategy or the storage location of an existing table or index. This statement is an extension to the ANSI/ISO standard for the SQL language.
- [ALTER FUNCTION statement](#)
Use the ALTER FUNCTION statement to change the routine modifiers or pathname of a user-defined function. This statement is an extension to the ANSI/ISO standard for SQL.
- [ALTER INDEX statement](#)
Use the ALTER INDEX statement to change the clustering attribute of an existing index. This statement is an extension to the ANSI/ISO standard for SQL.
- [ALTER PROCEDURE statement](#)
Use the ALTER PROCEDURE statement to change the routine modifiers or pathname of a previously defined external procedure. This statement is an extension to the ANSI/ISO standard for SQL.
- [ALTER ROUTINE statement](#)
Use the ALTER ROUTINE statement to change the routine modifiers or pathname of a previously defined user-defined routine (UDR). This statement is an extension to the ANSI/ISO standard for SQL.
- [ALTER SECURITY LABEL COMPONENT statement](#)
Use the ALTER SECURITY LABEL COMPONENT statement to add one or more new elements to an existing security label component in the current database. This statement is an extension to the ANSI/ISO standard for SQL.
- [ALTER SEQUENCE statement](#)
Use the ALTER SEQUENCE statement to modify the definition of a sequence object. This statement is an extension to the ANSI/ISO standard for SQL.
- [ALTER TABLE statement](#)
Use the ALTER TABLE statement to modify the schema of an existing table.
- [ALTER TRUSTED CONTEXT statement](#)
Use the ALTER TRUSTED CONTEXT statement to modify the current options and attributes (including the ENABLED or DISABLED mode) of a trusted-context object.
- [ALTER USER statement \(UNIX, Linux\)](#)
Use the ALTER USER statement to change one or more of the properties, including the password, user ID, surrogate group, administrative authorization, and home directory, and to enable or disable the account of an internally authenticated user, or of the default internally authenticated user.
- [BEGIN WORK statement](#)
Use the BEGIN WORK statement to start a *transaction*, which is a series of database operations that the COMMIT WORK or ROLLBACK WORK statement terminates, and that the database server treats as a single unit of work. This statement is an extension to the ANSI/ISO standard for SQL.
- [CLOSE statement](#)
Use the CLOSE statement when you no longer need to refer to the set of rows associated with a Select cursor or with a Function cursor. With ESQL/C, this statement can also flush and close an Insert cursor. Use this statement with Informix ESQL/C or SPL.
- [CLOSE DATABASE statement](#)
Use the CLOSE DATABASE statement to close the implicit connection to the current database. This statement is an extension to the ANSI/ISO standard for SQL.
- [COMMIT WORK statement](#)
Use the COMMIT WORK statement to commit all modifications made to the database from the beginning of a transaction.
- [CONNECT statement](#)
Use the CONNECT statement to connect to a database environment. This statement is an extension to the ANSI/ISO standard for SQL.
- [CREATE ACCESS_METHOD statement](#)
Use the CREATE ACCESS_METHOD statement to register a new primary or secondary access method in the **sysams** system catalog table.
- [CREATE AGGREGATE statement](#)
Use the CREATE AGGREGATE statement to create a new aggregate function and register it in the **sysaggregates** system catalog table.
- [CREATE CAST statement](#)
Use the CREATE CAST statement to register a cast that converts data from one data type to another.
- [CREATE DATABASE statement](#)
Use the CREATE DATABASE statement to create a new database.
- [CREATE DEFAULT USER statement \(UNIX, Linux\)](#)
Use the CREATE DEFAULT USER statement to define the properties set of the default internally authenticated user. This statement is an extension to the ANSI/ISO standard for the SQL language.
- [CREATE DISTINCT TYPE statement](#)
Use the CREATE DISTINCT TYPE statement to create a new distinct data type.
- [CREATE EXTERNAL TABLE Statement](#)
Use the CREATE EXTERNAL TABLE statement to define an external source that is not part of your database to load and unload data for your database.
- [CREATE FUNCTION statement](#)
Use the CREATE FUNCTION statement to create a user-defined function, to register an external function, or to write and register an SPL function.
- [CREATE FUNCTION FROM statement](#)
Use the CREATE FUNCTION FROM statement to access a user-defined function whose CREATE FUNCTION statement resides in a separate file.
- [CREATE INDEX statement](#)
Use the CREATE INDEX statement to create an index for one or more columns in a table, or on values returned by a UDR that uses column values as arguments.
- [CREATE OPAQUE TYPE statement](#)
Use the CREATE OPAQUE TYPE statement to create an opaque data type.
- [CREATE OPCLASS statement](#)
Use the CREATE OPCLASS statement to create an *operator class* for a *secondary-access method*.

- [CREATE PROCEDURE statement](#)
Use the CREATE PROCEDURE statement to create a user-defined procedure. (To create a procedure from text of source code that is in a separate file, use the CREATE PROCEDURE FROM statement.)
- [CREATE PROCEDURE FROM statement](#)
Use the CREATE PROCEDURE FROM statement to access a user-defined procedure. The actual text of the CREATE PROCEDURE statement resides in a separate file.
- [CREATE ROLE statement](#)
Use the CREATE ROLE statement to declare and register a new role.
- [CREATE ROUTINE FROM statement](#)
Use the CREATE ROUTINE FROM statement to register a UDR by referencing the text of a CREATE FUNCTION statement or CREATE PROCEDURE statement that resides in a separate file.
- [CREATE ROW TYPE statement](#)
Use the CREATE ROW TYPE statement to create a named ROW type.
- [CREATE SCHEMA statement](#)
Use the CREATE SCHEMA statement to issue a block of data definition language (DDL) and GRANT statements as a unit.
- [CREATE SECURITY LABEL statement](#)
Use the CREATE SECURITY LABEL statement to define a new security label for a specified security policy in the current database and to identify its components and the elements of its components.
- [CREATE SECURITY LABEL COMPONENT statement](#)
Use the CREATE SECURITY LABEL COMPONENT statement to define a new security label component in the current database and to define the elements the component.
- [CREATE SECURITY POLICY statement](#)
Use the CREATE SECURITY POLICY statement to define a new security policy in the current database and to identify its security label components and access rules.
- [CREATE SEQUENCE statement](#)
Use the CREATE SEQUENCE statement to create a sequence database object from which multiple users can generate unique integers.
- [CREATE SYNONYM statement](#)
Use the CREATE SYNONYM statement to declare and register an alternative name for an existing table, view, or sequence object.
- [CREATE TABLE statement](#)
Use the CREATE TABLE statement to create a new permanent table in the current database.
- [CREATE TEMP TABLE statement](#)
Use the CREATE TEMP TABLE statement to create a temporary table in the current database.
- [CREATE TRIGGER statement](#)
Use the CREATE TRIGGER statement to define a trigger on a table. You can also use CREATE TRIGGER to define an INSTEAD OF trigger on a view.
- [CREATE TRUSTED CONTEXT statement](#)
Use the CREATE TRUSTED CONTEXT statement to define a new trusted-context object. This statement is an extension to the ANSI/ISO standard for the SQL language.
- [CREATE USER statement \(UNIX, Linux\)](#)
Use the CREATE USER statement to define internally authenticated users, or to map externally authenticated users to surrogate user properties required for access to resources.
- [CREATE VIEW statement](#)
Use the CREATE VIEW statement to create a new view that is based on one or more existing tables and views that reside in the database, or in another database of the local database server or of a different database server.
- [CREATE XDATASOURCE statement](#)
Use the CREATE XDATASOURCE statement to create a new XA-compliant data source and create an entry for it in the **sysxdatasources** system catalog table. This statement is an extension to the ANSI/ISO standard for SQL.
- [CREATE XDATASOURCE TYPE statement](#)
Use the CREATE XDATASOURCE TYPE statement to create a new XA-compliant data source type and create an entry for it in the **sysxasourcetypes** system catalog table. This statement is an extension to the ANSI/ISO standard for SQL.
- [DATABASE statement](#)
Use the DATABASE statement to open an accessible database as the current database. This statement is an extension to the ANSI/ISO standard for SQL.
- [DEALLOCATE COLLECTION statement](#)
Use the DEALLOCATE COLLECTION statement to release memory for a collection variable that was previously allocated with the ALLOCATE COLLECTION statement.
- [DEALLOCATE DESCRIPTOR statement](#)
Use the DEALLOCATE DESCRIPTOR statement to free a previously allocated, system-descriptor area. Use this statement with Informix ESQL/C.
- [DEALLOCATE ROW statement](#)
Use the DEALLOCATE ROW statement to release memory for a ROW variable.
- [DECLARE statement](#)
Use the DECLARE statement of dynamic SQL to declare a cursor and to associate it with an SQL statement that returns a set of rows to an SPL or IBM® Informix ESQL/C or routine.
- [DELETE statement](#)
Use the DELETE statement to delete one or more rows from a table, or to delete one or more elements from a collection variable of SPL or of Informix ESQL/C.
- [DESCRIBE statement](#)
Use the DESCRIBE statement to obtain information about output parameters and other features of a prepared object before you execute it.
- [DESCRIBE INPUT statement](#)
Use the DESCRIBE INPUT statement to return input parameter information before a prepared statement is executed.
- [DISCONNECT statement](#)
Use the DISCONNECT statement to terminate a connection between an application and a database server.
- [DROP ACCESS_METHOD statement](#)
Use the DROP ACCESS_METHOD statement to remove a previously defined primary or secondary access method from the database.
- [DROP AGGREGATE statement](#)
Use the DROP AGGREGATE statement to drop a user-defined aggregate that you created with the CREATE AGGREGATE statement.
- [DROP CAST statement](#)
Use the DROP CAST statement to remove an existing cast from the database.

- [DROP DATABASE statement](#)
Use the DROP DATABASE statement to delete an entire database, including all system catalog tables, objects, and data.
- [DROP FUNCTION statement](#)
Use the DROP FUNCTION statement to remove a user-defined function from the database. This statement is an extension to the ANSI/ISO standard for SQL.
- [DROP INDEX statement](#)
Use the DROP INDEX statement to remove an index.
- [DROP OPCLASS statement](#)
Use the DROP OPCLASS statement to remove an existing operator class from the database.
- [DROP PROCEDURE statement](#)
Use the DROP PROCEDURE statement to drop a user-defined procedure from the database. This statement is an extension to the ANSI/ISO standard for SQL.
- [DROP ROLE statement](#)
Use the DROP ROLE statement to remove a user-defined role from the database.
- [DROP ROUTINE statement](#)
Use the DROP ROUTINE statement to remove a user-defined routine (UDR) from the database.
- [DROP ROW TYPE statement](#)
Use the DROP ROW TYPE statement to remove an existing named ROW data type from the database.
- [DROP SECURITY statement](#)
Use the DROP SECURITY statement to remove an existing security object from the current database. The object can be a security policy, security label, or a security label component.
- [DROP SEQUENCE statement](#)
Use the DROP SEQUENCE statement to remove a sequence object from the database.
- [DROP SYNONYM statement](#)
Use the DROP SYNONYM statement to unregister an existing synonym.
- [DROP TABLE statement](#)
Use the DROP TABLE statement to remove a table with its associated indexes and data. This statement is an extension to the ANSI/ISO standard for SQL.
- [DROP TRIGGER statement](#)
Use the DROP TRIGGER statement to remove a trigger definition from the database.
- [DROP TRUSTED CONTEXT statement](#)
Use the DROP TRUSTED CONTEXT statement to destroy a trusted-context object.
- [DROP TYPE statement](#)
Use the DROP TYPE statement to remove a user-defined distinct or opaque data type from the database. (You cannot use this statement to remove a built-in data type or a ROW data type.)
- [DROP USER statement \(UNIX, Linux\)](#)
Use the DROP USER statement to remove an internal user.
- [DROP VIEW statement](#)
Use the DROP VIEW statement to remove a view from the database.
- [DROP XADATASOURCE statement](#)
Use the DROP XADATASOURCE statement to drop a previously defined XA-compliant data source from the system catalog of the database.
- [DROP XADATASOURCE TYPE statement](#)
Use the DROP XADATASOURCE TYPE statement to drop a previously defined XA-compliant data source type from the database.
- [EXECUTE statement](#)
Use the EXECUTE statement to run a previously prepared statement or a multiple-statement prepared object.
- [EXECUTE FUNCTION statement](#)
Use the EXECUTE FUNCTION statement to invoke a user-defined function or a built-in routine that returns a value.
- [EXECUTE IMMEDIATE statement](#)
Use the EXECUTE IMMEDIATE statement to perform tasks equivalent to what the PREPARE, EXECUTE, and FREE statements accomplish, but as a single operation.
- [EXECUTE PROCEDURE statement](#)
Use the EXECUTE PROCEDURE statement to invoke a user-defined procedure or a built-in routine. This statement is an extension to the ANSI/ISO standard for SQL.
- [FETCH statement](#)
Use the FETCH statement to move a cursor to a new row in the active set and to retrieve the row values from memory.
- [FLUSH statement](#)
Use the FLUSH statement to force rows that a PUT statement buffered to be written to the database.
- [FREE statement](#)
Use the FREE statement to release resources that are allocated to a prepared statement or to a cursor.
- [GET DESCRIPTOR statement](#)
Use the GET DESCRIPTOR statement to read from a system descriptor area.
- [GET DIAGNOSTICS statement](#)
Use the GET DIAGNOSTICS statement to return diagnostic information about the most recently executed SQL statement.
- [GRANT statement](#)
Use the GRANT statement to assign access privileges and roles to users and to other roles. Users who hold the DBSECADM role can use this statement to assign user security labels and exemptions from label-based access control (LBAC) security rules.
- [GRANT FRAGMENT statement](#)
Use the GRANT FRAGMENT statement to assign privileges on table fragments in the local database if the table is fragmented by expression.
- [INFO statement](#)
Use the INFO statement to list the names of all the user-defined tables in the current database, or to display information about a specific table.
- [INSERT statement](#)
Use the INSERT statement to insert one or more new rows into a table or view, or to insert one or more elements into an SQL or Informix ESQL/C collection variable.
- [LOAD statement](#)
Use the LOAD statement to insert data from an operating-system file into an existing table or view.
- [LOCK TABLE statement](#)
Use the LOCK TABLE statement to control access to a table by other processes.

- [MERGE statement](#)
Use the MERGE statement to transfer data from a source table into a target table by combining UPDATE or DELETE operations with INSERT operations in a single SQL statement. You can also use this statement to join the source and target tables, and then perform only UPDATE operations, only DELETE operations, or only INSERT operations on the target table.
- [OPEN statement](#)
Use the OPEN statement to activate a cursor.
- [OUTPUT statement](#)
Use the OUTPUT statement to send the results of a query to an operating-system file or to a program.
- [PREPARE statement](#)
Use the PREPARE statement to parse, validate, and generate an execution plan for one or more SQL statements at runtime.
- [PUT statement](#)
Use the PUT statement to store a row in an insert buffer for later insertion into the database.
- [RELEASE SAVEPOINT statement](#)
Use the RELEASE SAVEPOINT statement to destroy a specified savepoint. The RELEASE SAVEPOINT statement is compliant with the ANSI/ISO standard for SQL.
- [RENAME COLUMN statement](#)
Use the RENAME COLUMN statement to change the name of a column. The RENAME COLUMN statement is an extension to the ANSI/ISO standard for SQL.
- [RENAME CONSTRAINT statement](#)
Use the RENAME CONSTRAINT statement to rename the constraint. This statement is an extension to the ANSI/ISO standard for SQL.
- [RENAME DATABASE statement](#)
Use the RENAME DATABASE statement to change the name of a database. This statement is an extension to the ANSI/ISO standard for SQL.
- [RENAME INDEX statement](#)
Use the RENAME INDEX statement to change the name of an existing index. This statement is an extension to the ANSI/ISO standard for SQL.
- [RENAME SECURITY statement](#)
Use the RENAME SECURITY statement to change the name of an existing security object. The object can be a security policy, or a security label, or a security label component.
- [RENAME SEQUENCE statement](#)
Use the RENAME SEQUENCE statement to change the name of a sequence. This statement is an extension to the ANSI/ISO standard for SQL.
- [RENAME TABLE statement](#)
Use the RENAME TABLE statement to change the name of a table. The RENAME TABLE statement is an extension to the ANSI/ISO standard for SQL.
- [RENAME TRUSTED CONTEXT statement](#)
Use the RENAME TRUSTED CONTEXT statement to change the name of a trusted-context object.
- [RENAME USER statement \(UNIX, Linux\)](#)
Use the RENAME USER statement to change the name of an internal user of a non-root installation of the database server.
- [REVOKE statement](#)
Use the REVOKE statement to cancel access privileges or roles that are held by users, by roles, or by PUBLIC, or to cancel user security labels or exemptions from the rules of security policies.
- [REVOKE FRAGMENT statement](#)
Use the REVOKE FRAGMENT statement to revoke from one or more users or roles the Insert, Update, or Delete fragment-level privileges that were granted on individual fragments of a table that has been fragmented by expression. This statement is an extension to the ANSI/ISO standard for SQL.
- [ROLLBACK WORK statement](#)
Use the ROLLBACK WORK statement to cancel all or part of the current transaction intentionally, undoing any changes that occurred since the beginning of the transaction, or between the ROLLBACK WORK statement and a specified or default savepoint.
- [SAVE EXTERNAL DIRECTIVES statement](#)
Use the SAVE EXTERNAL DIRECTIVES statement to create external optimizer directives for a specified query, and save the directives in the database. These directives are applied automatically to subsequent instances of the same query. This statement is an extension to the ANSI/ISO standard for SQL.
- [SAVEPOINT statement](#)
Use the SAVEPOINT statement to declare the name of a new savepoint within the current SQL transaction, and to set the position of the new savepoint within the lexical order of SQL statements within the transaction. The SAVEPOINT statement is compliant with the ANSI/ISO standard for SQL.
- [SELECT statement](#)
Use the SELECT statement to retrieve values from a database or from an SPL or Informix ESQ/C collection variable. A SELECT operation is called a *query*.
- [SET AUTOFREE statement](#)
Use the SET AUTOFREE statement to instruct the database server to enable or disable a memory-management feature that can free the memory allocated for a cursor automatically, as soon as the cursor is closed.
- [SET COLLATION statement](#)
Use the SET COLLATION statement to specify a new collating order for the session, superseding the collation implied by the DB_LOCALE environment variable setting. SET NO COLLATION restores the default collation.
- [SET CONNECTION statement](#)
Use the SET CONNECTION statement to reestablish a connection between an application and a database environment and to make the connection current. You can also use this statement with the DORMANT option to put the current connection in a dormant state. Use this statement with Informix ESQ/C.
- [SET CONSTRAINTS statement](#)
Use the SET CONSTRAINTS statements to change how some or all of the existing constraints on a table are processed.
- [SET Database Object Mode statement](#)
Use the SET Database Object Mode statement to change the filtering mode of constraints and of unique indexes, or to enable or disable constraints, indexes, and triggers, or to bypass referential-integrity checking of constraints while this statement is resetting the constraint mode.
- [SET DATASKIP statement](#)
Use the SET DATASKIP statement to control whether the database server skips a dbspace that is unavailable during the processing of a transaction.
- [SET DEBUG FILE statement](#)
Use the SET DEBUG FILE statement to identify the file that is to receive the runtime trace output of an SPL routine.
- [SET DEFERRED PREPARE statement](#)
Use the SET DEFERRED PREPARE statement to control whether a client process postpones sending a PREPARE statement to the database server until the OPEN or EXECUTE statement is sent.
- [SET DESCRIPTOR statement](#)
Use the SET DESCRIPTOR statement to set values in a system-descriptor area (SDA).
- [SET ENCRYPTION PASSWORD statement](#)
Use the SET ENCRYPTION PASSWORD statement to define or reset a *session password* for the encryption and decryption of character, BLOB, or CLOB values.

- [SET ENVIRONMENT statement](#)
Use the SET ENVIRONMENT statement to specify settings for session environment variables that can affect how queries are executed in the same routine, or other operations in the current user session. For some options, the session variable overrides default behavior that is set by a configuration parameter or by an environment variable of the client or of the database server.
- [SET EXPLAIN statement](#)
Use the SET EXPLAIN statement to enable or disable the recording measurements of queries in the current session, including the plan of the query optimizer, an estimate of the number of rows returned, and the relative cost of the query.
- [SET INDEXES statement](#)
Use the SET INDEXES statement to enable or disable a user-defined index, or to change the filtering mode of a unique index.
- [SET ISOLATION statement](#)
Use the SET ISOLATION statement to define the degree of concurrency among processes that attempt to access the same rows simultaneously.
- [SET LOCK MODE statement](#)
Use the SET LOCK MODE statement to define how the database server handles a process that tries to access a locked row or table.
- [SET LOG statement](#)
Use the SET LOG statement to change your database logging mode from buffered transaction logging to unbuffered transaction logging or vice versa.
- [SET OPTIMIZATION statement](#)
Use the SET OPTIMIZATION statement to specify how much time the query execution optimizer spends developing a query plan or specifying optimization goals. The SET OPTIMIZATION statement is an extension to the ANSI/ISO standard for SQL.
- [SET PDQPRIORITY statement](#)
The SET PDQPRIORITY statement enables an application to set the query priority level dynamically within a routine. The SET PDQPRIORITY statement is an extension to the ANSI/ISO standard for SQL.
- [SET ROLE statement](#)
Use the SET ROLE statement to enable the privileges of a user-defined role. This statement is an extension to the ANSI/ISO standard for SQL.
- [SET SESSION AUTHORIZATION statement](#)
The SET SESSION AUTHORIZATION statement lets you change the user name under which database operations are performed in the current session.
- [SET STATEMENT CACHE statement](#)
Use the SET STATEMENT CACHE statement to turn on caching or turn off caching for the current session. This statement is an extension to the ANSI/ISO standard for SQL.
- [SET TRANSACTION statement](#)
Use the SET TRANSACTION statement to define the isolation level and to specify whether the access mode of a transaction is read-only or read-write.
- [SET Transaction Mode statement](#)
Use the SET Transaction Mode statement to specify whether constraints are checked at the statement level or at the transaction level during the current transaction.
- [SET TRIGGERS statement](#)
Use the SET TRIGGERS statement to enable or disable all or some of the triggers on a table, or all or some of the INSTEAD OF triggers on a view.
- [SET USER PASSWORD statement \(UNIX, Linux\)](#)
Use the SET USER PASSWORD statement to change your password for database server access if you are an internally authenticated user. This statement is an extension to the ANSI/ISO standard for the SQL language.
- [START VIOLATIONS TABLE statement](#)
Use the START VIOLATIONS TABLE statement to create a violations table and a diagnostics table for a specified target table. The START VIOLATIONS TABLE statement is an extension to the ANSI/ISO standard for SQL.
- [STOP VIOLATIONS TABLE statement](#)
Use the STOP VIOLATIONS TABLE statement to drop the association between a target table, its violations table, and its diagnostics table. This statement is an extension to the ANSI/ISO standard for SQL.
- [TRUNCATE statement](#)
Use the TRUNCATE statement to quickly delete all rows from a local table and free the associated storage space. You can optionally reserve the space for the same table and its indexes. Only Informix supports this implementation of the TRUNCATE statement, which is an extension to the ANSI/ISO standard for SQL.
- [UNLOAD statement](#)
Use the UNLOAD statement to write the rows retrieved by a SELECT statement to an operating-system file. The UNLOAD statement is an extension to the ANSI/ISO standard for SQL.
- [UNLOCK TABLE statement](#)
Use the UNLOCK TABLE statement in a database that does not support transaction logging to unlock a table that you previously locked with the LOCK TABLE statement. The UNLOCK TABLE statement is an extension to the ANSI/ISO standard for SQL.
- [UPDATE statement](#)
Use the UPDATE statement to change the values in one or more columns of one or more existing rows in a table or view.
- [UPDATE STATISTICS statement](#)
Use the UPDATE STATISTICS statement to update system catalog information that the query optimizer uses for operations on objects in the local database. The UPDATE STATISTICS statement is an extension to the ANSI/ISO standard for SQL.
- [WHENEVER statement](#)
Use the WHENEVER statement to trap exceptions that occur during the execution of SQL statements. The WHENEVER statement is equivalent to placing an exception-checking routine after every SQL statement.
- [WITH statement \(Common Table Expressions\)](#)
A common table expression (CTE) is a named temporary result set that exists within the scope of a single statement and that can be referred to later within that statement, possibly multiple times. The following discussion describes how to write statements that use CTEs.

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ALLOCATE COLLECTION statement

Use the ALLOCATE COLLECTION statement to allocate memory for a variable of a collection data type (such as LIST, MULTISSET, or SET) or for an untyped collection variable.

Syntax

```
>>-ALLOCATE COLLECTION--variable-----><
```

Element	Description	Restrictions	Syntax
<i>variable</i>	Name of the typed or untyped collection variable to allocate	Must be an unallocated Informix® ESQL/C collection-type host variable	Language-specific rules for names

Usage

This statement is an extension to the ANSI/ISO standard for SQL. Use this statement with ESQL/C.

The ALLOCATE COLLECTION statement allocates memory for an ESQL/C variable that can store the value of a collection data type.

To create a collection variable for Informix ESQL/C programs:

1. Declare the collection variable as a client collection variable in the Informix ESQL/C program.
The collection variable can be a typed or untyped collection variable.
2. Allocate memory for the collection variable with the ALLOCATE COLLECTION statement.

The ALLOCATE COLLECTION statement sets **SQLCODE** (that is, **sqlca.sqlcode**) to zero (0) if the memory allocation was successful, or to a negative error code if the allocation failed.

When you no longer need the collection variable, you must explicitly release the memory that it occupies with the DEALLOCATE COLLECTION statement. After the DEALLOCATE COLLECTION statement executes successfully, you can reuse the collection variable.

Tip: The ALLOCATE COLLECTION statement allocates memory for Informix ESQL/C collection variables only. To allocate memory for Informix ESQL/C row variables, use the ALLOCATE ROW statement.

Examples

The following example shows how to allocate resources with the ALLOCATE COLLECTION statement for the untyped collection variable, **a_set**:

```
EXEC SQL BEGIN DECLARE SECTION;  
    client collection a_set;  
EXEC SQL END DECLARE SECTION;  
...  
EXEC SQL allocate collection :a_set;
```

The following example uses ALLOCATE COLLECTION to allocate resources for a typed collection variable, **a_typed_set**:

```
EXEC SQL BEGIN DECLARE SECTION;  
    client collection set(integer not null) a_typed_set;  
EXEC SQL END DECLARE SECTION;  
...  
EXEC SQL allocate collection :a_typed_set;
```

Related concepts:

[Inserting into a Collection Cursor](#)

Related reference:

[ALLOCATE ROW statement](#)

[DEALLOCATE COLLECTION statement](#)

Related information:

[Access a collection](#)

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ALLOCATE DESCRIPTOR statement

Use the ALLOCATE DESCRIPTOR statement to declare the name and allocate memory for a system-descriptor area (SDA). Use this statement with ESQL/C.

Syntax

```
>>-ALLOCATE DESCRIPTOR--+-'descriptor'--+----->  
                        '-descriptor_var-'  
  
>--+-----+-----><  
    '-WITH MAX--+items-----+'  
                        '-items_var-'
```

Element	Description	Restrictions	Syntax
---------	-------------	--------------	--------

Element	Description	Restrictions	Syntax
<i>descriptor</i>	Name that you declare here for an unallocated system-descriptor area	Enclose in single (') quotation marks. Must be unique among SDA names	Quoted String .
<i>descriptor_var</i>	Host variable that stores the name of a system-descriptor area	Must contain name of unallocated system-descriptor area	Language specific
<i>items</i>	Number of item descriptors in <i>descriptor</i> . Default value is 100.	Must be an unsigned INTEGER greater than zero	Literal Number
<i>items_var</i>	Host variable that contains the number of items	Data type must be INTEGER or SMALLINT	Language specific

Usage

The ALLOCATE DESCRIPTOR statement creates a new *system-descriptor area*, which is a location in memory that holds information that the DESCRIBE statement can display, or that holds information about the WHERE clause of a query.

A system-descriptor area (SDA) contains one or more fields called *item descriptors*. Each item descriptor holds a data value that the database server can receive or send. The item descriptors also contain information about the data, such as data type, length, scale, precision, and support for NULL values.

A system-descriptor area holds information that a DESCRIBE ... USING SQL DESCRIPTOR statement obtains or that holds information about the WHERE clause of a dynamically executed query.

If the name that ALLOCATE DESCRIPTOR declares for a system-descriptor area matches the name of an existing system-descriptor area, the database server returns an error. After you free the specified descriptor with the DEALLOCATE DESCRIPTOR statement, however, the ALLOCATE DESCRIPTOR statement can reuse the same descriptor name.

- [WITH MAX Clause](#)

You can use the WITH MAX clause to indicate the maximum number of item descriptors that the new system-descriptor area can include.

Related reference:

[GET DESCRIPTOR statement](#)

[SET DESCRIPTOR statement](#)

[DEALLOCATE DESCRIPTOR statement](#)

[DECLARE statement](#)

[DESCRIBE statement](#)

[EXECUTE statement](#)

[FETCH statement](#)

[OPEN statement](#)

[PREPARE statement](#)

[PUT statement](#)

[DESCRIBE INPUT statement](#)

Related information:

[A system-descriptor area](#)

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WITH MAX Clause

You can use the WITH MAX clause to indicate the maximum number of item descriptors that the new system-descriptor area can include.

When you use this clause, the COUNT field value of the system-descriptor area is set to the number of *items* that you specify here. If you do not specify the WITH MAX clause, the default value of the COUNT field is 100 items. You can use the SET DESCRIPTOR statement to change the value of the COUNT field.

Examples of ALLOCATE DESCRIPTOR statements

The following examples show valid ALLOCATE DESCRIPTOR statements that include the WITH MAX clause. This example uses embedded variable names to identify the system-descriptor area and to specify the maximum number of item descriptors:

```
EXEC SQL allocate descriptor :descname with max :occ;
```

The next example uses a quoted string to declare **desc1** as the identifier of the system-descriptor area, and uses an unsigned integer to specify 3 as the maximum number of item descriptors in the **desc1** area:

```
EXEC SQL allocate descriptor 'desc1' with max 3;
```

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ALLOCATE ROW statement

Use the ALLOCATE ROW statement to allocate memory for a *row* variable. This statement is an extension to the ANSI/ISO standard for SQL. Use this statement with ESQL/C.

Syntax

```
>>-ALLOCATE ROW--variable-----><
```

Element	Description	Restrictions	Syntax
<i>variable</i>	Name of a typed or untyped <i>row</i> variable to allocate	Must be an unallocated Informix® ESQL/C row-type host variable	Language specific

Usage

The ALLOCATE ROW statement allocates memory for a host variable that stores row-type data. To create a **row** variable, an ESQL/C program must do the following:

1. Declare the *row* variable. The row variable can be a typed or untyped *row* variable.
2. Allocate memory for the *row* variable with the ALLOCATE ROW statement.

The following example shows how to allocate resources with the ALLOCATE ROW statement for the typed *row* variable, *a_row*:

```
EXEC SQL BEGIN DECLARE SECTION;  
    row (a int, b int) a_row;  
EXEC SQL END DECLARE SECTION;  
.  
.  
EXEC SQL allocate row :a_row;
```

The ALLOCATE ROW statement sets **SQLCODE** (the contents of **sqlca.sqlcode**) to zero (0) if the memory allocation operation was successful, or to a negative error code if the allocation failed.

You must explicitly release memory with the DEALLOCATE ROW statement. Once you free the *row* variable with the DEALLOCATE ROW statement, you can reuse the *row* variable.

Tip: The ALLOCATE ROW statement allocates memory for the Informix ESQL/C *row* variable only. To allocate memory for the Informix ESQL/C *collection* variable, use the ALLOCATE COLLECTION statement.

When you use the same *row* variable in multiple function calls without deallocating it, a memory leak on the client computer results. Because there is no way to determine if a pointer is valid when it is passed, Informix ESQL/C assumes that the pointer is not valid and assigns it to a new memory location.

Related reference:

[ALLOCATE COLLECTION statement](#)

[DEALLOCATE ROW statement](#)

Related information:

[Complex data types](#)

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ALTER ACCESS_METHOD statement

Use the ALTER ACCESS_METHOD statement to change one or more attributes of a user-defined primary or secondary access method in the **sysams** system catalog table.

Syntax

```
>>-ALTER ACCESS_METHOD--+-+-----+-+access_method----->  
                        '- owner -- . '  
  
    .,-----  
    v      (1) |  
>-----+-MODIFY+---| Purpose Option |-----+><  
    | '-ADD-----|  
    '-DROP--purpose_keyword-----'
```

Notes:

1. See [Purpose Options](#)

Element	Description	Restrictions	Syntax
<i>access_method</i>	Name of the access method to modify	Access method must be registered in the sysams system catalog table by a previous CREATE ACCESS_METHOD statement	Identifier
<i>owner</i>	Name of the owner of the access method	Must own the access method	Owner name
<i>purpose_keyword</i>	A keyword that indicates which attribute to change	Keyword must be associated with the access method by a previous CREATE or ALTER ACCESS_METHOD statement	Purpose Functions, Flags, and Values

Usage

This statement is an extension to the ANSI/ISO standard for SQL. This statement cannot modify a built-in access method.

Use ALTER ACCESS_METHOD to modify the definition of a user-defined access method. You cannot modify a built-in access method.

You must own the access method or hold the DBA privilege to alter a user-defined access method. In an ANSI-compliant database, the DBA must qualify the name of the access method with the *owner* name if another user is the owner of the access method.

When you alter an access method, you change the purpose-option specifications (purpose functions, purpose methods, purpose flags, or purpose values) that define the access method. For example, you might alter an access method to declare a new user-defined function or method name, or to provide a multiplier for the scan cost on a table.

If a transaction is in progress, the database server waits to modify the access method until after the transaction is committed or rolled back. No other users can execute the access method until the transaction has completed.

Examples

The following statement alters the **remote** user-defined access method:

```
ALTER ACCESS_METHOD remote
  ADD am_scancost = FS_scancost,
  ADD am_rowids,
  DROP am_getbyid,
  MODIFY am_costfactor = 0.9;
```

The preceding example makes the following changes to the access method:

- Adds a user-defined function or method named **FS_scancost()**, which is associated in the **sysams** table with the **am_scancost** keyword
- Sets (adds) the **am_rowids** flag
- Drops the user-defined function or method associated with the **am_getbyid** keyword
- Modifies the **am_costfactor** value

Related reference:

[DROP ACCESS_METHOD statement](#)

[CREATE ACCESS_METHOD statement](#)

[Purpose Options](#)

[GRANT statement](#)

Related information:

[SYSAMS](#)

[Access methods](#)

[Access methods](#)

[Secondary-access methods](#)

[Grant privileges](#)

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ALTER FRAGMENT statement

Use the ALTER FRAGMENT statement to change the distribution strategy or the storage location of an existing table or index. This statement is an extension to the ANSI/ISO standard for the SQL language.

Syntax

```
>>-ALTER FRAGMENT--+-+-----+----->
      | (1) |
      |-----ONLINE-|

>--+--ON TABLE--surviving_table--+| ATTACH Clause |-----+--+<
      |                                     | (2) | | |
      |                                     | (3) |
      | +--| DETACH Clause |-----+ |
      | |                                     | (4) |
      | | +--| INIT Clause |-----+ |
      | | |                                     | (5) |
      | | +--| ADD Clause |-----+ |
      | | |                                     | (6) |
      | | +--| DROP Clause |-----+ |
      | | |                                     | (7) |
      | | +--| MODIFY Clause |-----+ |
      | | |                                     | (4) |
      | | +--| INIT Clause |-----+ |
      | | |                                     | (5) |
      | | +--| ADD Clause |-----+ |
      | | |                                     | (6) |
      | | +--| DROP Clause |-----+ |
      | | |                                     | (7) |
      | | +--| MODIFY Clause |-----+ |
```

Notes:

1. Only with ATTACH, DETACH, or MODIFY on tables fragmented by interval
2. See [ATTACH Clause](#)
3. See [DETACH Clause](#)
4. See [INIT Clause](#)
5. See [ADD Clause](#)
6. See [DROP Clause](#)
7. See [MODIFY Clause](#)

Element	Description	Restrictions	Syntax
<i>surviving_index</i>	Index on which to modify the distribution or storage	Must exist when the statement executes	Identifier
<i>surviving_table</i>	Table on which to modify the distribution or storage	Must exist. See Restrictions on the ALTER FRAGMENT Statement .	Identifier

Usage

The ALTER FRAGMENT statement applies only to table fragments or index fragments that are located at the current site. No remote information is accessed or updated.

You must have the Alter privilege or the DBA privilege to change the fragmentation strategy of a table. You must have the Index privilege or the DBA privilege to alter the fragmentation strategy of an index.

Attention: This statement can cause indexes to be dropped and rebuilt. Before undertaking alter operations, check corresponding sections in your *IBM® Informix® Performance Guide* to review effects and strategies.

Clauses of the ALTER FRAGMENT statement support the following tasks.

Clause

Effect

ATTACH

Combines two or more tables that have the same schema into a single fragmented table

DETACH

Detaches one fragment from a fragmented table, and creates a new nonfragmented table to store the rows in the fragment.

INIT

Provides the following options:

- Defines and initializes a fragmentation strategy on a nonfragmented table
- Changes the order of evaluation of fragment expressions
- Changes the fragmentation strategy of a fragmented table or index
- Changes the storage location of an existing table
- Moves data from an existing table fragment into a new nonfragmented table
- Changes the storage location of fragments that the database generates for a table or index
- Changes the fragmentation key or fragmentation expression for a table or index

ADD

Adds an additional fragment to an existing fragmentation list

DROP

Drops an existing fragment from a fragmentation list

Remove one or more dbspaces from the list of dbspaces where interval fragments are created.

MODIFY

Changes an existing interval, list, or expression-based fragmentation expression

Moves an existing fragment to a different dbspace

Replaces with a new list the current list of dbspaces where interval fragments are created.

Enables or disables automatic creation of interval fragments

Use the CREATE TABLE statement or the INIT clause of the ALTER FRAGMENT statement to create fragmented tables.

After a dbspace has been renamed successfully by the **onspaces** utility, only the new name can reference the renamed dbspace. The database server automatically updates existing fragmentation strategies for tables or indexes in the system catalog, however, to replace the old dbspace name with the new name. You do not need to take any additional action to update a distribution strategy or storage location that was defined using the old dbspace name, but you must use the new name if you reference the dbspace in an ALTER FRAGMENT or ALTER TABLE statement.

If you omit the optional ONLINE keyword, the ALTER FRAGMENT operation requires exclusive access and exclusive locks on all of the tables involved in the operation. If you enable the FORCE_DDL_EXEC session environment option, you can force out other transactions that have opened a table involved in an ALTER FRAGMENT ON TABLE operation, or that have placed locks on any of those tables. If the server is unable to get exclusive access and exclusive locks on the table, the server starts rolling back the transactions that are open or that have locks on the table, until the value specified with the FORCE_DDL_EXEC option is reached. (For more information, see [FORCE_DDL_EXEC session environment option](#).)

- [Restrictions on the ALTER FRAGMENT Statement](#)
- [ALTER FRAGMENT and Transaction Logging](#)
- [Determining the Number of Rows in the Fragment](#)
- [The ONLINE keyword in ALTER FRAGMENT operations](#)

The ONLINE keyword instructs the database server to modify the storage of the table in the background, while other concurrent users can continue to access the table.

- [ATTACH Clause](#)

Use the ATTACH clause of the ALTER FRAGMENT ON TABLE statement to combine tables that have identical structures into a table with the same fragmentation strategy.

- [DETACH Clause](#)

Use the DETACH clause of the ALTER FRAGMENT ON TABLE statement to detach a table fragment from a storage distribution scheme and place the contents

into a new nonfragmented table.

- [INIT Clause](#)
The INIT clause of the ALTER FRAGMENT statement can define or modify the fragmentation strategy or the storage location of an existing table or an existing index.
- [ADD Clause](#)
Use the ADD clause to add another fragment to a list of fragments of an existing table or index.
- [DROP Clause](#)
Use the DROP clause to remove an existing fragment from the fragmentation list of a table or index that is fragmented by round-robin. For a table or index that is fragmented by range interval, you can use this clause to drop one or more dbspaces from the list of dbspaces that store system-generated interval fragments.
- [MODIFY Clause](#)
Use the MODIFY clause to change the fragmentation list or the fragment key of a table or of an index that is fragmented by list or by expression, or to define, modify, or disable a range-interval or rolling window fragmentation scheme.
- [Examples of ALTER FRAGMENT ON INDEX statements](#)
The following series of examples illustrate the use of ALTER FRAGMENT ON INDEX with the INIT, ADD, DROP, and MODIFY options.

Related reference:

[CREATE TABLE statement](#)

[CREATE INDEX statement](#)

[ALTER TABLE statement](#)

Related information:

[Table fragmentation strategies](#)

[Fragmentation guidelines](#)

[Improve the performance of operations that attach and detach fragments](#)

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Restrictions on the ALTER FRAGMENT Statement

You cannot use the ALTER FRAGMENT statement on a view, on a temporary table, or on a table that is not registered in the current database.

If your table or index is not already fragmented, the only clauses available to you are ATTACH and INIT.

You cannot use ALTER FRAGMENT on a typed table that is part of a table hierarchy.

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ALTER FRAGMENT and Transaction Logging

If your database supports transaction logging, ALTER FRAGMENT is executed within a single transaction. If the fragmentation strategy uses large numbers of records, you might run out of log space or disk space. (To alter a fragmentation strategy, the database server requires extra disk space that it later frees.)

If you run out of log space or disk space, try one of the following procedures to reduce your log-space or disk-space requirements:

- Turn off logging and turn it back on again at the end of the operation. This procedure indirectly requires a backup of the **root** dbspace.
- Split the operations into multiple ALTER FRAGMENT statements, moving a smaller portion of records each time.

For information about log-space requirements and disk-space requirements, see your *IBM® Informix® Administrator's Guide*. That guide also contains detailed instructions about how to turn off logging. For information about backups, refer to your *IBM Informix Backup and Restore Guide*.

Related information:

[Overview of backup and restore](#)

[Logging and log administration](#)

[Disk, memory, and process management](#)

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Determining the Number of Rows in the Fragment

You can place as many rows into a fragment as the available space in the dbspace allows.

To find out how many rows are in a fragment:

1. Run the UPDATE STATISTICS FORCED statement on the table. This step fills the **sysfragments** system catalog table with the current table information.
2. Query the **sysfragments** system catalog table to examine the **npused** and **nrows** values. The **npused** column shows the number of data pages used in the fragment, and the **nrows** column shows the number of rows in the fragment.

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The ONLINE keyword in ALTER FRAGMENT operations

The ONLINE keyword instructs the database server to modify the storage of the table in the background, while other concurrent users can continue to access the table.

The DBA can reduce the risk of nonexclusive access errors, and can increase the availability of the fragmented table, by including the ONLINE keyword in the ALTER FRAGMENT statement. This instructs the database server to commit the work in ATTACH, DETACH, and MODIFY operations internally, if there are no errors, and to apply an intent exclusive lock to the table, rather than an exclusive lock.

In DETACH and MODIFY operations, the ONLINE keyword can reduce the risk of -710 errors when either of the following is true:

- the AUTO_REPREPARE configuration parameter is set to 1,
- the IFX_AUTO_REPREPARE session environment variable is set to 1.

The following restrictions apply to the ALTER FRAGMENT ONLINE FOR TABLE statement:

- Only the ATTACH, DETACH, and MODIFY options to ALTER FRAGMENT ONLINE are valid.
- The FOR TABLE clause must specify a table that is fragmented by a range interval scheme.
- The table that is being altered cannot be locked explicitly by the LOCK TABLE statement.
- The ALTER FRAGMENT ONLINE operation must be the first statement in the transaction that modifies any database object or table.
- No other operation that modifies an object in the database can follow the ALTER FRAGMENT ONLINE statement in the same transaction.

For additional information, see the following topics:

- [Using the ONLINE keyword in ATTACH operations](#)
- [Using the ONLINE keyword in DETACH operations](#)
- [Using the ONLINE keyword in MODIFY operations](#)

- [Automatic renaming of interval fragment identifiers](#)

Some ALTER FRAGMENT operations can change the positional order of existing interval fragments within the fragment list. In these cases, the database server automatically updates the system-defined names of the affected interval fragments.

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Automatic renaming of interval fragment identifiers

Some ALTER FRAGMENT operations can change the positional order of existing interval fragments within the fragment list. In these cases, the database server automatically updates the system-defined names of the affected interval fragments.

For tables partitioned by an interval fragmentation scheme, ALTER FRAGMENT operations that add, drop, attach, or detach fragments, or that modify the transition value of the table, can change the **sysfragments.evalpos** values for existing interval fragments, or can change an interval fragment to a range fragment. To avoid creating new interval fragments with the same system-generated name as an interval fragment that the ALTER FRAGMENT statement has repositioned within the fragment list, the database server automatically replaces the original system-defined names with new identifiers that will not match the names of subsequently created interval fragments of the same table.

The general rules used for system generated range and interval fragment names are as follows:

- For interval fragments: **sys_evalpos**
- For range fragments: **sys_evalposrg**

Here **evalpos** is the numeric (ordinal) value of **sysfragments.evalpos**, where 0 is the **evalpos** value for the first fragment in the fragment list.

During a fragment renaming operation, an exclusive lock is placed on the fragment while the **sysfragments** system catalog is being updated with the new **partition** names, and with new **evalpos** values for any fragments whose ordinal positions within the fragment list changed during the ALTER FRAGMENT operation.

To avoid declaring non-unique fragment names when new interval fragments are created, the database server renames only system-generated identifiers of interval fragment that are repositioned during ALTER FRAGMENT operations. Automatic renaming does not occur for user-defined identifiers of repositioned fragments.

If you wish to avoid having existing fragments automatically renamed during ALTER FRAGMENT ONLINE ATTACH statements, or during other ALTER FRAGMENT operations on tables that use interval partitioning, you can first use the ALTER FRAGMENT MODIFY statement to rename with user-defined names the interval fragments whose system-generated names might otherwise be changed by the ALTER FRAGMENT operation. User-defined fragment names cannot begin with the string **sys_**.

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ATTACH Clause

Use the ATTACH clause of the ALTER FRAGMENT ON TABLE statement to combine tables that have identical structures into a table with the same fragmentation strategy.

You can use this syntax, for example, to combine a fragment that has been detached from a table with an archival table that has the same distributed storage scheme.

```

      .------.
      V      (1)
|--ATTACH-----surviving_table-----+-----+
      '-consumed_table-----'      '-| AS Clause |-'
```

```

|--AS--+-----+-----+----->
      |   (2)                                     |
      +-----PARTITION--new_frag-'
<-+-+--+expr-----+--+-----+--+-----|
    | '-' List Expression '-' | | .-AFTER-. | |
    |                         | |           | |
    |                         | | '+-----old_frag-' | |
    |                         | | '-BEFORE-' | |
    | +-+ Range Interval Expression +-+-----+'
    |   (1)   (3)                   |
    |-----REMAINDER -----'

```

```

|---+VALUES < range_expr+-----|
|   (1)                   |
|'-----VALUES IS NULL-'|

```

```

      .------.
      |         |
      v         |
|--VALUES +-+-(const_expr)---+-+-----+
      |   (1)                |
      +-----+--NULL-----'
              '-TS-'

```

1. Use path no more than once
2. Required if another *surviving_table* fragment has the same name as *dbspace*
3. Required for fragmentation by expression; optional for round-robin and list fragmentation; not valid for range interval fragmentation

When a new expression fragment is attached to table that is fragmented by list or by range interval, the data from the consumed table and the affected fragments in the surviving table are scanned and moved into appropriate partitions, because these strategies are not overlapping.

To use this clause, you must have the DBA privilege or else be the owner of the specified tables. The ATTACH clause supports the following tasks:

- Creates a single fragmented table by combining two or more identically-structured, nonfragmented tables (See [Combining Nonfragmented Tables to Create a Fragmented Table.](#))
- Attaches one or more tables to a fragmented table (See [Attaching a Table to a Fragmented Table.](#))
- [General Restrictions for the ATTACH Clause](#)

- [Using the BEFORE, AFTER, and REMAINDER options](#)
- [Combining Nonfragmented Tables to Create a Fragmented Table](#)
- [Attaching a Table to a Fragmented Table](#)
- [Using the ONLINE keyword in ATTACH operations](#)

The ONLINE keyword instructs the database server to commit the ALTER FRAGMENT ATTACH work internally, if there are no errors, and to apply an intent exclusive lock to the surviving table, rather than an exclusive lock. An exclusive lock is applied to the consumed table, which must be a nonfragmented table.

- [Effect of the ATTACH Clause](#)

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General Restrictions for the ATTACH Clause

This clause is not valid in ALTER FRAGMENT ON INDEX statements.

Any tables that you attach must have been created previously in separate partitions. You cannot attach the same table more than once.

All consumed tables listed in the ATTACH clause must have the same structure as the surviving table. The number, names, data types, and relative position of the columns must be identical.

The *expression* cannot include aggregates, subqueries, or variant functions.

- [Additional Restrictions on the ATTACH Clause](#)

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Additional Restrictions on the ATTACH Clause

User-defined routines and references to fields of a ROW-type column are not valid. You cannot attach a fragmented table to another fragmented table.

All of the dbspaces that store the fragments must have the same page size.

An ATTACH operation on two nonfragmented tables cannot produce a surviving table that is fragmented by interval or by list. (If you want to attach two nonfragmented tables, use the INIT option of ALTER FRAGMENT to define an interval or list fragmentation scheme for one of the nonfragmented tables, and then use the ATTACH option to attach the second table to it.)

For surviving tables that are fragmented by interval, the following restrictions apply:

- Because the database server determines the ordinal position of interval fragments, BEFORE and AFTER specifications are not valid.
- You cannot attach a fragment whose expression matches an existing interval fragment expression.
- While you attach fragments above the transition value, the upper limit of the fragment being attached must align at an interval fragment boundary. That is, the upper limit of the fragment must equal the transition value plus an integer multiple of the interval value.

For fragmented tables that are protected by a security policy, attaching a fragment to the table fails if any of the following conditions are not satisfied:

- The source table and the target table are both protected by the same security policy;
- Both tables have the same protection granularity (either row-level, or column-level, or both row-level and column-level);
- In both tables, the same set of protected columns is protected by the same security labels. If there is more than one protected column, there can be more than one security label in each table, but the same label must protect the same column in both tables.

If the ATTACH operation fails because one or more of these conditions are not satisfied, you can use the ALTER TABLE statement to make the schemas of the two tables identical, and then repeat the ALTER FRAGMENT ATTACH statement on the modified tables

Only a user who holds the DBSECADM role can reference a protected table in the ALTER FRAGMENT statement.

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Using the BEFORE, AFTER, and REMAINDER options

The BEFORE and AFTER options allow you to place a new fragment either before or after an existing fragment. You cannot use the BEFORE and AFTER options when the distribution scheme is round-robin or range interval..

When you attach a new list or expression fragment without specifying an explicit BEFORE or AFTER keyword option, the database server places the added fragment at the end of the fragment list, unless a remainder fragment exists. If a remainder fragment exists, the new fragment, by default, is placed just before the remainder fragment. You cannot attach a new fragment after the remainder fragment.

You cannot define a remainder fragment when the distribution scheme is round-robin or range interval.

If you omit the AS PARTITION *fragment* specification, the default name of the fragment is the name of the dbspace where it is stored. If another fragment of the same table already has the same name as the dbspace, the database server issues an exception, and the ALTER FRAGMENT ATTACH operation fails.

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Combining Nonfragmented Tables to Create a Fragmented Table

When you transform tables with identical table structures into fragments into a single table, you allow the database server to manage the fragmentation instead of allowing the application to manage the fragmentation. The distribution scheme can be round-robin or expression based.

To make a single, fragmented table from two or more identically-structured, nonfragmented tables, the ATTACH clause must include the surviving table in the *attach list*. The attach list is the specified list of tables in the ATTACH clause.

To include a **rowid** column in the newly-created single, fragmented table, attach all tables first and then add the **rowid** with the ALTER TABLE statement.

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Attaching a Table to a Fragmented Table

To attach a nonfragmented table to an already fragmented table, the nonfragmented table must have been created in a separate dbspace and must have the same table structure as the fragmented table. In the following example, a round-robin distribution scheme fragments the table **cur_acct**, and the table **old_acct** is a nonfragmented table that resides in a separate dbspace. The following example shows how to attach (as the consumed table) **old_acct** to **cur_acct** (as the surviving table):

```
ALTER FRAGMENT ON TABLE cur_acct ATTACH old_acct;
```

When you attach one or more tables to a fragmented table, a *consumed_table* must be nonfragmented.

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Using the ONLINE keyword in ATTACH operations

The ONLINE keyword instructs the database server to commit the ALTER FRAGMENT ATTACH work internally, if there are no errors, and to apply an intent exclusive lock to the surviving table, rather than an exclusive lock. An exclusive lock is applied to the consumed table, which must be a nonfragmented table.

Requirements for ONLINE ATTACH operations

You can use the ATTACH option to the ALTER FRAGMENT ONLINE ON TABLE statement only if the *surviving table* is fragmented by an interval fragmentation scheme. The consumed table must be nonfragmented.

All indexes on the surviving table must have the same fragmentation scheme as the table. (That is, any indexes must be attached.) For this reason, if there is a primary key constraint or other referential constraints on the table, it is recommended that you first create an attached index for the constraint, and then use the ALTER TABLE statement to add the constraint. (By default, system-created indexes for primary key constraints and for other referential constraints are detached.)

For each index on the surviving table, there must be a matching index on the same set of columns of the consumed table. The matching indexes on the consumed table will be recycled as index fragments on the surviving table during the ATTACH operation. Any additional indexes on the consumed table are dropped during the ATTACH operation. The indexes on the consumed table that will be recycled must each be detached in a single dbspace, and the dbspace that stores the recycled index must be same dbspace that stores the consumed table.

If the index on the surviving table is unique, the corresponding matching index on the consumed table must also be unique.

The consumed table must have a check constraint that satisfies the following two conditions:

- It must exactly match the expression for the fragment that is being attached.
- It must span a single interval only.

This last requirement, that rows in the consumed table span only a single interval within the range interval fragmentation scheme of the surviving table, is necessary to prevent data movement. Data movement is not allowed in ALTER FRAGMENT ATTACH operations that include the ONLINE keyword.

Only one consumed table can be specified in the ONLINE ATTACH operation.

All other restrictions that apply to the ATTACH option also apply to ONLINE ATTACH operations. For those restrictions, see [General Restrictions for the ATTACH Clause](#) and [Additional Restrictions on the ATTACH Clause](#).

Example of ALTER FRAGMENT ONLINE ATTACH

The following SQL statements define a fragmented **employee** table that uses a range-interval storage distribution scheme, with a unique index **employee_id_idx** on the column **emp_id** (that is also the fragmentation key) and another index **employee_dept_idx** on the column **dept_id**.

```
CREATE TABLE employee
  (emp_id INTEGER, name CHAR(32),
   dept_id CHAR(2), mgr_id INTEGER, ssn CHAR(12))
FRAGMENT BY RANGE (emp_id)
  INTERVAL (100) STORE IN (dbs1, dbs2, dbs3, dbs4)
  PARTITION p0 VALUES < 200 IN dbs1,
  PARTITION p1 VALUES < 400 IN dbs2;
```

```
CREATE UNIQUE INDEX employee_id_idx ON employee(emp_id);
CREATE INDEX employee_dept_idx ON employee(dept_id);
```

The last two statements insert rows with fragment key values above the upper limit of the transition fragment, causing the database server to generate two new interval fragments, so that the resulting fragment list consists of four fragments:

```
Fragments in surviving table before ALTER FRAGMENT ONLINE:
p0    VALUES < 200          - range fragment
p1    VALUES < 400          - range fragment (transition fragment)
sys_p2 VALUES >= 400 AND VALUES < 500 - interval fragment
sys_p4 VALUES >= 600 AND VALUES < 700 - interval fragment
```

The next SQL statements define a nonfragmented **employee2** table with the same column schema as the **employee** table, and with single-column indexes on the two corresponding columns (**emp_id** and **dept_id**) that were indexed in the **employee** table, but also defines a unique index **employee2_ssn_idx** on the column **emp_ssn** and another index **employee_dept_idx** on the column **name**. All four of these indexes are stored in the dbspace **dbs4**. The **CREATE TABLE** statement also specifies a check constraint ((**emp_id** >=500 AND **emp_id** <600)) that exactly matches the fragment expression for a consumed table that will be attached, and that exactly spans a single interval of the range interval fragmentation scheme for the **employee** table.

```
CREATE TABLE employee2
(emp_id INTEGER, name CHAR(32),
 dept_id CHAR(2), mgr_id INTEGER, ssn CHAR(12),
 CHECK (emp_id >=500 AND emp_id <600)) in dbs4;
CREATE UNIQUE INDEX employee2_id_idx ON employee2(emp_id) in dbs4;
CREATE INDEX employee2_dept_idx ON employee2(dept_id) in dbs4;
CREATE UNIQUE INDEX employee2_ssn_idx ON employee2(ssn) in dbs4;
CREATE INDEX employee2_name_idx ON employee2(name) in dbs4;
```

The following statement returns an error because the fragment being attached is a range fragment (a fragment that stores rows with fragmentation key values below the transition value of 400 for the **employee** table). Only interval fragments can be attached online.

```
ALTER FRAGMENT ONLINE ON TABLE employee
ATTACH employee2 AS PARTITION p3 VALUES < 300;
```

The following statement runs successfully, and creates a new **p3** interval fragment:

```
ALTER FRAGMENT ONLINE ON TABLE employee
ATTACH employee2 AS PARTITION p3 VALUES < 600;
```

```
Fragments in surviving table after ALTER FRAGMENT ONLINE:
p0    VALUES < 200          - range fragment
p1    VALUES < 400          - range fragment
sys_p2 VALUES >= 400 AND VALUES < 500 - interval fragment
sys_p3 VALUES >= 500 AND VALUES < 600 - interval fragment
sys_p4 VALUES >= 600 AND VALUES < 700 - interval fragment
```

Note that the successful **ALTER FRAGMENT ONLINE . . . ATTACH** operation above required multiple correspondences among specifications in the DDL statements that defined the surviving and consumed tables, including their columns, indexes, constraints, index storage location, and the interval fragmentation strategy of the surviving table:

- The check constraint on the consumed table spans a single interval only. The interval value is 100 for the surviving table, and the check constraint is >= 500 and < 600.
- The conditional expression being attached (< 600) is internally converted to the interval fragment expression format (>= 500 and < 600) which matches the check constraint.
- The indexes on the surviving table are attached (that is, they are fragmented by the same fragmentation scheme as the table) because no fragmentation strategy was specified explicitly in their **CREATE INDEX** statements.
- The indexes on the consumed table are detached in a single dbspace (**dbs4**), which is the same dbspace that stored the consumed table.
- For each index on the surviving table, there is a matching index on the consumed table.
- The extra indexes on the consumed table (**employee2_ssn_idx** and **employee2_name_idx**) that do not correspond to indexes on the surviving **employee** table are dropped during the **ONLINE ATTACH** operation.

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Effect of the ATTACH Clause

After an **ATTACH** operation, all consumed tables no longer exist. Any **CHECK** constraints or **NOT NULL** constraints on the consumed tables also no longer exist. You must reference the records that were in the consumed tables through the surviving table.

- [What Happens to Indexes?](#)
- [What Happens to BYTE and TEXT Columns?](#)
- [What Happens to Triggers and Views?](#)
- [What Happens with the Distribution Scheme?](#)
- [Round-Robin Distribution Scheme](#)
- [Expression Distribution Scheme](#)

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What Happens to Indexes?

A detached index on the surviving table retains its same fragmentation strategy. That is, a detached index does not automatically adjust to accommodate the new fragmentation of the surviving table. For more information on what happens to indexes, see the discussion about altering table fragments in your *IBM® Informix Performance Guide*.

In a database that supports transaction logging, an ATTACH operation extends any attached index on the surviving table according to the new fragmentation strategy of the surviving table. All rows in the consumed table are subject to these automatically adjusted indexes. For information on whether the database server completely rebuilds the index on the surviving table or reuses an index that was on the consumed table, see your *IBM Informix Performance Guide*.

In a nonlogging database of Informix®, an ATTACH operation does not extend indexes on the surviving table according to the new fragmentation strategy of the surviving table. To extend the fragmentation strategy of an attached index according to the new fragmentation strategy of the surviving table, you must drop the index and re-create it on the surviving table.

Some ALTER FRAGMENT ... ATTACH operations to attach a fragment can cause the database server to update the index structure. When an index is rebuilt in those cases, the associated column distribution is automatically recalculated, and is available to the query optimizer when it designs query plans for the table on which the fragment was attached.

- For an indexed column (or a set of columns) on which ALTER FRAGMENT ... ATTACH automatically rebuilds a B-tree index, the recalculated column distribution statistics are equivalent to distributions created by the UPDATE STATISTICS statement in HIGH mode.
- If the rebuilt index is not a B-tree index, the automatically recalculated statistics correspond to distributions created by the UPDATE STATISTICS statement in LOW mode.

See also the section [Automatic Calculation of Distribution Statistics](#) in the description of the CREATE INDEX statement for additional information about statistical distributions that are produced automatically when an index or constraint is created on an existing table.

Related information:

[Improve the performance of operations that attach and detach fragments](#)

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What Happens to BYTE and TEXT Columns?

When an ATTACH occurs, BYTE and TEXT fragments of the consumed table become part of the surviving table and continue to be associated with the same rows and data fragments as they were before the ATTACH operation.

Each BYTE and TEXT column in every table that is specified in the ATTACH clause must have the same storage type, either blobspace or tblspace. If the BYTE or TEXT column is stored in a blobspace, the same column in all tables must be in the same blobspace. If the BYTE or TEXT column is stored in a tblspace, the same column must be stored in a tblspace in all tables.

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What Happens to Triggers and Views?

When you attach tables, triggers on the surviving table survive the ATTACH, but triggers on the consumed table are automatically dropped. No triggers are activated by the ATTACH clause, but subsequent data-manipulation operations on the new rows can activate triggers.

Views on the surviving table survive the ATTACH operation, but views on the consumed table are automatically dropped.

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What Happens with the Distribution Scheme?

You can attach a nonfragmented table to a table with any type of supported distribution scheme. In general, the resulting table has the same fragmentation strategy as the prior fragmentation strategy of the surviving table.

When you attach two or more nonfragmented tables, however, the distribution scheme can either be based on expression or round-robin.

Only the following distribution schemes can result from combining the distribution schemes of the tables in the ATTACH clause.

Prior Distribution Scheme of Surviving Table	Prior Distribution Scheme of Consumed Table	Resulting Distribution Scheme
None	None	Round-robin or expression
Round-robin	None	Round-robin
Expression	None	Expression

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Round-Robin Distribution Scheme

The following example combines nonfragmented tables **pen_types** and **pen_makers** into a single, fragmented table, **pen_types**. Table **pen_types** resides in dbspace **dbsp1**, and table **pen_makers** resides in dbspace **dbsp2**. Table structures are identical in each table.

```
ALTER FRAGMENT ON TABLE pen_types ATTACH pen_types, pen_makers;
```

After you execute the ATTACH clause, the database server fragments the table **pen_types** using a round-robin scheme into two dbspaces: the dbspace that contained **pen_types** and the dbspace that contained **pen_makers**. Table **pen_makers** is consumed and no longer exists; all rows that were in table **pen_makers** are now in table **pen_types**.

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Expression Distribution Scheme

Consider the following example that combines tables **cur_acct** and **new_acct** and uses an expression-based distribution scheme. Table **cur_acct** was originally created as a fragmented table and has fragments in dbspaces **dbsp1** and **dbsp2**. The first statement of the example shows that table **cur_acct** was created with an expression-based distribution scheme. The second statement of the example creates table **new_acct** in **dbsp3** without a fragmentation strategy. The third statement combines the tables **cur_acct** and **new_acct**. Table structures (columns) are identical in each table.

```
CREATE TABLE cur_acct (a int) FRAGMENT BY EXPRESSION
  a < 5 in dbsp1, a >= 5 and a < 10 in dbsp2;
CREATE TABLE new_acct (a int) IN dbsp3;
ALTER FRAGMENT ON TABLE cur_acct ATTACH new_acct AS a>=10;
```

When you examine the **sysfragments** system catalog table after you alter the fragment, you see that table **cur_acct** is fragmented by expression into three dbspaces. For additional information about the **sysfragments** system catalog table, see the *IBM® Informix® Guide to SQL: Reference*.

In addition to simple range rules, you can use the ATTACH clause to fragment by expression with hash or arbitrary rules. For a discussion of all types of expressions that you can use in an expression-based distribution scheme, see [Expression Fragment Clause](#).

Warning: When you specify a date value as the default value for a parameter, make sure to specify 4 digits instead of 2 digits for the year. If you specify a 2-digit year, the setting of the **DBCENTURY** environment variable can affect how the database server interprets the date value. For more information, see the *IBM Informix Guide to SQL: Reference*.

Related information:

[SYSFRAGMENTS](#)

[DBCENTURY environment variable](#)

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DETACH Clause

Use the DETACH clause of the ALTER FRAGMENT ON TABLE statement to detach a table fragment from a storage distribution scheme and place the contents into a new nonfragmented table.

This clause is not valid in ALTER FRAGMENT ON INDEX statements.

For an explanation of distribution schemes, see [FRAGMENT BY clause](#).

DETACH Clause

```
--DETACH-----+--fragment--new_table-----|
'-PARTITION-'
```

Element	Description	Restrictions	Syntax
<i>fragment</i>	Named fragment or dbspace that contains the table fragment to be detached.	Must exist at the time of execution. For list or range-interval fragments, the PARTITION keyword must precede <i>fragment</i> .	Identifier
<i>new_table</i>	Name that you declare here for a nonfragmented table that results after you execute the ALTER FRAGMENT statement.	Must not exist before execution	Identifier

Usage

The new table that results from executing the DETACH clause does not inherit any indexes or constraints from the original table. Only data values remain.

Similarly, the new table does not inherit any access privileges from the original table. Instead, the new table has the default privileges of any new table. For further information on default table-level privileges, see the description in the GRANT statement of [Table-Level Privileges](#).

The DETACH clause cannot be applied to a table that has any of the following attributes:

- a ROWID column

- a column or columns defined as the primary key of a referential constraint
- an Enterprise Replication replicate is defined on the table
- a detached index (that is, an index whose storage distribution scheme is not identical to the fragmentation strategy of the table).

If you omit the **PARTITION** keyword, the name of the fragment must be the name of the dbspace where the fragment is stored.

In the following example, a system-generated range interval fragment **sys_pt1** is detached from table **T1** and placed in a new unfragmented table **detacht1**:

```
ALTER FRAGMENT ON TABLE T1 DETACH PARTITION sys_pt1 detacht1;
```

The next example detaches a list fragment **part2** from table **T2** and places its data in a new unfragmented table **detacht2**:

```
ALTER FRAGMENT ON TABLE T2 DETACH PARTITION part2 detacht2;
```

Distribution statistics after DETACH operations

Some **ALTER FRAGMENT . . . DETACH** operations can cause the database server to update the index structure of the original table. When an index is rebuilt in those cases, the database server also recalculates the associated column distributions, and these statistics are available to the query optimizer when it designs query plans for the table from which the fragment was detached:

- For an indexed column (or for a set of columns) on which **ALTER FRAGMENT . . . DETACH** automatically rebuilds a B-tree index, the recalculated column distribution statistics are equivalent to distributions created by the **UPDATE STATISTICS** statement in **HIGH** mode.
- If the rebuilt index is not a B-tree index, the automatically recalculated statistics correspond to distributions created by the **UPDATE STATISTICS** statement in **LOW** mode.

If the automatic mode for updating column-distribution statistics is enabled, and the table from which the fragment is being detached has fragment-level distribution statistics, the database server uses the statistics of the detached fragment as distribution statistics for the new table. The database server also merges the data distribution statistics of the remaining fragments to calculate new table distribution statistics for the original table, and stores these results in the **sysdistrib** system catalog table. This registration of distribution statistics for the new table and recalculation of table distribution statistics for the old table runs in the background.

See also the section [Automatic Calculation of Distribution Statistics](#) in the description of the **CREATE INDEX** statement for additional information about statistical distributions that are produced automatically when an index or constraint is created on an existing table.

- [Using the ONLINE keyword in DETACH operations](#)
The **ONLINE** keyword instructs the database server to commit the **ALTER FRAGMENT . . . DETACH** work internally, if there are no errors, and to apply an intent exclusive lock to the table from which the fragment was detached, rather than an exclusive lock. An exclusive lock is applied to the table that is created from the detached fragment.
- [Detach with BYTE and TEXT Columns](#)
- [Detach from a Protected Table](#)
If a successfully executed **DETACH** clause specifies a table that is protected by a security policy, the database server creates a new table that is protected by the same security policy.
- [Detach That Results in a Nonfragmented Table](#)

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Using the ONLINE keyword in DETACH operations

The **ONLINE** keyword instructs the database server to commit the **ALTER FRAGMENT . . . DETACH** work internally, if there are no errors, and to apply an intent exclusive lock to the table from which the fragment was detached, rather than an exclusive lock. An exclusive lock is applied to the table that is created from the detached fragment.

You can use the **DETACH** option to the **ALTER FRAGMENT ONLINE ON TABLE** statement only for a table that uses a range interval fragmentation scheme.

A table that uses a range interval storage distribution scheme can have two types of fragments:

- *range* fragments, which are defined by the user in the **FRAGMENT BY** or **PARTITION BY** clause of the **CREATE TABLE** or **ALTER TABLE** statement, and
- *interval* fragments, which are generated automatically by the database server during **INSERT** and **UPDATE** operations, if a row has a fragment key values above the upper limit of the transition fragment (the last range fragment).

Only an interval fragment can be detached in an **ONLINE DETACH** operation.

If the detached interval fragment that is not the last fragment, the database server modifies the fragment names for any system-generated interval fragments that follow the detached fragment in the fragment list to match their new **sysfragments.evalpos** values in the surviving table. During this fragment renaming operation, an exclusive lock is placed on the fragments while the **sysfragments** system catalog is being updated with the new **partition** names (and with new **evalpos** values for any fragments whose ordinal positions within the fragment list changed during the **ALTER FRAGMENT DETACH** operation).

All indexes on the surviving table must have the same fragmentation scheme as the table. (That is, any indexes must be attached.) For this reason, if there is a primary key constraint or other referential constraints on the table, it is recommended that you first create an attached index for the constraint, and then use the **ALTER TABLE** statement to add the constraint. (By default, system-created indexes for primary key constraint and for other referential constraints are detached.)

If there are sessions accessing the same partition that is being detached, it is recommended that you issue the **SET LOCK MODE TO WAIT** statement for enough seconds to prevent nonexclusive access errors.

All other restrictions that apply to the **DETACH** option also apply to **ONLINE DETACH** operations. For those restrictions, see [Restrictions on the ALTER FRAGMENT Statement](#) and [DROP Clause](#).

Example of ALTER FRAGMENT ONLINE ... DETACH

The following SQL statements define a fragmented **employee** table that uses a range-interval storage distribution scheme, with a unique index **employee_id_idx** on the column **emp_id** (that is also the fragmentation key) and another index **employee_dept_idx** on the column **dept_id**.

```
CREATE TABLE employee (emp_id INTEGER, name CHAR(32), dept_id CHAR(2),
                        mgr_id INTEGER, ssn CHAR(12))
  FRAGMENT BY RANGE (emp_id)
    INTERVAL (100) STORE IN (dbs1, dbs2, dbs3, dbs4)
    PARTITION p0 VALUES < 200 IN dbs1,
    PARTITION p1 VALUES < 400 IN dbs2;
CREATE UNIQUE INDEX employee_id_idx ON employee(emp_id);
CREATE INDEX employee_dept_idx ON employee(dept_id);

INSERT INTO employee VALUES (401, "Susan", "DV", 101, "123-45-6789");
INSERT INTO employee VALUES (601, "David", "QA", 104, "987-65-4321");
```

The last two statements insert rows with fragment key values above the upper limit of the transition fragment, causing the database server to generate two new interval fragments, so that the resulting fragment list consists of four fragments:

```
Fragments in surviving table before ALTER FRAGMENT ONLINE:
p0    VALUES < 200                - range fragment
p1    VALUES < 400                - range fragment (transition fragment)
sys_p2 VALUES >= 400 AND VALUES < 500 - interval fragment
sys_p4 VALUES >= 600 AND VALUES < 700 - interval fragment
```

The following statement returns an error, because the specified fragment to be detached is a range fragment (a fragment that stores rows with fragmentation key values below the transition value of 400). Only interval fragments can be detached online.

```
ALTER FRAGMENT ONLINE ON TABLE employee
  DETACH PARTITION p0 employee3;
```

The following statement runs successfully, and creates a new **employee3** table to store the data in the detached fragment.

```
ALTER FRAGMENT ONLINE ON TABLE employee
  DETACH PARTITION sys_p2 employee3;
```

If there are concurrent sessions accessing **sys_p2**, set the lock mode to WAIT (for a number of seconds sufficient for the ONLINE DETACH operation to be committed) to prevent nonexclusive access errors:

```
SET LOCK MODE TO WAIT 300;
ALTER FRAGMENT ONLINE ON TABLE employee DETACH PARTITION sys_p2 employee3;
```

```
Fragments in surviving table after ALTER FRAGMENT ONLINE:
p0    VALUES < 200                - range fragment
p1    VALUES < 400                - range fragment
sys_p4 VALUES >= 600 AND VALUES < 700 - interval fragment.
```

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Detach with BYTE and TEXT Columns

If the DETACH clause specifies the first fragment of a table that includes simple large objects of data type BYTE or TEXT, the database server applies locks on the blobspaces of every fragment of the table. To detach any other fragment of the table locks only the blobspaces of the specified fragment, rather than the blobspaces of all fragments, so fewer locks are required if the fragment is not the first.

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Detach from a Protected Table

If a successfully executed DETACH clause specifies a table that is protected by a security policy, the database server creates a new table that is protected by the same security policy.

If the original table has both row-level and column-level protection,

- the new table has the same IDSSecurityLabel column, and the same label, for row-level security,
- and the same set of protected columns secured by the same labels as the original table for column-level protection.

For tables with row-level protection, the IDSSecurityLabel column has a NOT NULL constraint by default. Only a user who holds the DBSECADM role can reference a protected table in the ALTER FRAGMENT statement.

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Detach That Results in a Nonfragmented Table

The following example uses the table **cur_acct** fragmented into two dbspaces, **dbsp1** and **dbsp2**:

```
ALTER FRAGMENT ON TABLE cur_acct DETACH dbsp2 accounts;
```

This example detaches **dbsp2** from the distribution scheme for **cur_acct** and places the rows in a new table, **accounts**. Table **accounts** now has the same structure (column names, number of columns, data types, and so on) as table **cur_acct**, but the table **accounts** does not contain any indexes or constraints from the table **cur_acct**. Both tables are now nonfragmented. The following example shows a table that contains three fragments:

```
ALTER FRAGMENT ON TABLE bus_acct DETACH dbsp3 cli_acct;
```

This statement detaches **dbsp3** from the distribution scheme for **bus_acct** and places the rows in a new table, **cli_acct**. Table **cli_acct** now has the same structure (column names, number of columns, data types, and so on) as **bus_acct**, but the table **cli_acct** does not contain any indexes or constraints from the table **bus_acct**. Table **cli_acct** is a nonfragmented table, but table **bus_acct** remains fragmented.

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INIT Clause

The INIT clause of the ALTER FRAGMENT statement can define or modify the fragmentation strategy or the storage location of an existing table or an existing index.

The INIT clause has the following syntax.

INIT Clause

```
|--INIT-----+----->
      '-WITH ROWIDS-'

(1)
>--+| FRAGMENT BY Clause for Tables |-----+-----|
  +-+-----+-----+-- IN -dbspace--+
  | '-PARTITION--fragment-' |
  |                           (2) |
  '-| FRAGMENT BY Clause for Indexes |-----'
```

Notes:

1. See [FRAGMENT BY Clause for Tables](#)
2. See [FRAGMENT BY clause for indexes](#)

Element	Description	Restrictions	Syntax
<i>dbspace</i>	Dspace storing fragmented data	Must exist at time of execution	Identifier
<i>fragment</i>	Name of fragment	No more than 2048 for same table	Identifier

The INIT clause can accomplish tasks that include the following:

- Move a nonfragmented table from one dspace to a named fragment or to another dspace.
- Convert a fragmented table to a nonfragmented table.
- Fragment an existing non-fragmented table without redefining it.
- Convert a fragmentation strategy to another fragmentation strategy.
- Fragment an existing index that is not fragmented without redefining the index.
- Convert a fragmented index to a nonfragmented index.
- Add a new **rowid** column to the table definition.

When you use the INIT clause to modify a table, the **tabid** value in the system catalog tables changes for the affected table. The **constrid** value of all unique and referential constraints on the table also changes.

For more information about the storage spaces in which you can store a table, see [Using the IN Clause](#).

Attention: When you execute the ALTER FRAGMENT statement with this clause, it results in data movement if the table contains any data. If data values move, the potential exists for significant logging, for the transaction being aborted as a long transaction, and for a relatively long exclusive lock being held on the affected tables. Use this statement when it does not interfere with day-to-day operations.

- [WITH ROWIDS Option](#)
Nonfragmented tables contain a hidden column called **rowid**. Its integer value defines the physical location of a row. To include a **rowid** column in a fragmented table, you must explicitly request it by using the WITH ROWIDS clause in CREATE TABLE (or ADD ROWIDS in ALTER TABLE, or WITH ROWIDS in ALTER FRAGMENT INIT).
- [Converting a Fragmented Table to a Nonfragmented Table](#)
- [FRAGMENT BY Clause for Tables](#)
Use the FRAGMENT BY option of the INIT clause of the ALTER FRAGMENT statement to fragment an existing nonfragmented table, or to convert one table fragmentation strategy to another.
- [FRAGMENT BY clause for indexes](#)
Use the FRAGMENT BY clause to redefine the storage distribution strategy of an index without redefining the index. The keywords FRAGMENT BY and PARTITION BY are synonyms in this context.

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3. If included, must be the last item in fragment list

Element	Description	Restrictions	Syntax
<i>column</i>	Column to which the strategy applies	Must exist in the table	Identifier
<i>dbspace</i>	Dbspace that contains the table fragment	Must specify at least 2 but no more than 2,048 dbspaces	Identifier
<i>expr</i>	Expression that defines a table fragment	Must evaluate to a Boolean value (t or f)	Expression
<i>part</i>	Name of a fragment	Required for any named fragment in the same dbspace as another named fragment of the same table. Name must be unique among fragments of the same table.	Identifier

This supports the same syntax as the FRAGMENT BY (or PARTITION BY) clause of the CREATE TABLE statement. For more information on the fragmentation strategies available for tables, see the [FRAGMENT BY clause](#) of the CREATE TABLE statement.

Examples of range interval fragmentation

These examples define statement define range interval fragmentation strategies for an existing table. The following ALTER FRAGMENT statement defines three fragments of a range interval fragmentation strategy that includes no NULL fragment, where numeric column **c1** is the fragmentation key:

```
ALTER FRAGMENT ON TABLE T1 INIT
  FRAGMENT BY RANGE (c1)
  INTERVAL (100+100) STORE IN (dbs3, dbs4, dbs5, dbs6, dbs7, dbs8)
  PARTITION part0 VALUES < 0 IN dbs0,
  PARTITION part1 VALUES < 1000 IN dbs1,
  PARTITION part2 VALUES < 2000 IN dbs2;
```

Here the interval value expression of (100+100 defines the interval fragment size as 200 within the range of column **c1**. No fragment is defined for fragmentation key values of 2000 or greater. If this were still the storage distribution when a row with **c1** equal to or greater than 2000 is inserted, the database server automatically creates a new fragment to store that row, which was outside the range of any existing fragment. Interval partitions are stored in the dbspaces **dbs2**, **dbs3**, **dbs4**, **dbs5**, **dbs6**, **dbs7**, and **dbs8** in round-robin fashion.

The following statement similarly defines three fragments of a range interval fragmentation strategy that includes no NULL fragment, and where the DATE or DATETIME column **c2** is the fragmentation key:

```
ALTER FRAGMENT ON TABLE T1 INIT
  FRAGMENT BY RANGE (c2)
  INTERVAL (NUMTOYMINTERVAL(1, 'MONTH'))
  PARTITION part0 VALUES < DATE('01/01/2009') IN dbs0,
  PARTITION part1 VALUES < DATE('07/01/2009') IN dbs1,
  PARTITION part2 VALUES < DATE('01/01/2010') IN dbs2;
```

Here the interval value expression of NUMTOYMINTERVAL(1, 'MONTH') defines the interval fragment size as a single month within the range of column **c2**. The PARTITION list defines three fragments: **part0** for December of 2008, **part1** for June of 2009, and **part2** for December of 2009. If rows are inserted whose **c2** value is not in one of these months, the database server will create new fragments for those rows. Because no STORE IN clause is specified, the database server will store these new range interval fragments in a round-robin fashion in the dbspaces **dbs0**, **dbs1**, and **dbs2** that this example lists after the IN keywords of the three PARTITION specifications.

- [Changing an Existing Fragmentation Strategy on a Table](#)
- [Defining a Fragmentation Strategy on a Nonfragmented Table](#)

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Changing an Existing Fragmentation Strategy on a Table

You can redefine a fragmentation strategy on a table if you decide that your initial strategy does not fulfill your needs. When you alter a fragmentation strategy, the database server discards the existing fragmentation strategy and moves records to fragments as defined in the new fragmentation strategy.

The following example shows the statement that originally defined the fragmentation strategy on the table **account** and then shows an ALTER FRAGMENT statement that redefines the fragmentation strategy:

```
CREATE TABLE account (col1 INT, col2 INT)
  FRAGMENT BY ROUND ROBIN IN dbbsp1, dbbsp2;
ALTER FRAGMENT ON TABLE account
  INIT FRAGMENT BY EXPRESSION
  col1 < 0 IN dbbsp1,
  col2 >= 0 IN dbbsp2;
```

If an existing dbspace is full when you redefine a fragmentation strategy, you must not use it in the new fragmentation strategy.

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Defining a Fragmentation Strategy on a Nonfragmented Table

The INIT clause can define a fragmentation strategy on a nonfragmented table, regardless of whether the table was created with a storage option.

```
CREATE TABLE balances (col1 INT, col2 INT) IN dbsp1;
ALTER FRAGMENT ON TABLE balances INIT
  FRAGMENT BY EXPRESSION col1 <= 500 IN dbsp1,
  col1 > 500 AND col1 <=1000 IN dbsp2, REMAINDER IN dbsp3;
```

When you use the INIT clause to fragment an existing nonfragmented table, all indexes on the table become fragmented in the same way as the table.

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FRAGMENT BY clause for indexes

Use the FRAGMENT BY clause to redefine the storage distribution strategy of an index without redefining the index. The keywords FRAGMENT BY and PARTITION BY are synonyms in this context.

FRAGMENT BY Clause for Indexes

```
|---+FRAGMENT -+----->
  '-PARTITION '

(1)
>---+BY RANGE--(--fragment_key--)--| Interval Fragment Clause |-----+
  |                                     |
  +-BY LIST--(--fragment_key--)--| List Fragment Clause |-----+
  '-BY EXPRESSION--| Expression Fragment Clause |-----+

Expression Fragment Clause

.-,-----.
 v                                     |
|-----+-----+--(--expr--)--IN--dbspace+----->
  '-PARTITION--part-'

>---+-----+-----+-----+-----+-----+-----+-----+-----+
  '-,---+-----+-----+-----+-----+-----+-----+-----+-----+
      '-PARTITION--part-'  '-(--expr--)-'
```

Notes:

1. See [Interval fragment clause](#)
2. See [List fragment clause](#)

Element	Description	Restrictions	Syntax
<i>dbspace</i>	Dbspace that contains the fragmented information	Must specify at least one (but no more than 2,048) dbspaces of the same page size	Identifier
<i>expr</i>	Expression defining an index fragment	Must be unique among fragmentation expressions for the same index, and must return a Boolean value	Condition ; Expression
<i>fragment_key</i>	Constant expression, based on a column value. The index is fragmented on this expression.	Any column must be in the current table.	Expression
<i>part</i>	Name that you declare here for the fragment. Default is the <i>dbspace</i> name.	Required for fragments in the same dbspace as another fragment of the same index. Must be unique among fragments of the same index.	Identifier

The INIT FRAGMENT BY clause for indexes of the ALTER FRAGMENT statement can accomplish any of the following operations on the storage distribution scheme of an existing index, without redefining the index:

- Change an existing fragmented index to a nonfragmented index.
- Change the distribution scheme of an existing fragmented index to another distribution scheme of the same expression, list, or range interval type, or to a different type of distribution scheme.
- Change the interval value or the interval fragment key (or both) of a range interval distribution scheme for an existing index.

To change the interval value expression or the fragment key expression for an existing index that is fragmented by a range interval strategy, you must use the INIT FRAGMENT BY RANGE option (rather than the MODIFY clause) of the ALTER FRAGMENT statement. When you change either or both of those expressions, the Interval Fragment clause in the ALTER FRAGMENT ON INDEX statement must also define at least one range fragment.

When you use the FRAGMENT BY or PARTITION BY clause to convert an existing storage fragmentation strategy to another fragmentation strategy, Informix® discards the existing fragmentation strategy and moves the data records to fragments that you define in the new fragmentation strategy. Data movement similarly occurs when you convert a nonfragmented index to a fragmented index, and when you convert a fragmented index to a nonfragmented index.

To convert an existing fragmented index to a nonfragmented index, you can use the INIT clause to specify IN *dbspace* (or else PARTITION *partition* IN *dbspace*) as the only storage specification for a previously fragmented index.

Just as for an expression-based index fragmentation scheme that the CREATE INDEX statement defines, restrictions apply to each expression (*expr*) that you specify in the ALTER FRAGMENT ON INDEX . . . INIT FRAGMENT BY EXPRESSION statement, including these:

- Any column that the expression references must be from the current table.

- The restrictions above also apply to fragment key expressions for list and for range interval index fragmentation schemes, including fragmentation strategies that are defined in the `FRAGMENT BY` clause of the `CREATE INDEX` statement.

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You can detach an index from a table-fragmentation strategy with the INIT clause of the ALTER FRAGMENT ON INDEX statement, so that an attached index becomes a detached index. This breaks any dependency of the index on the table fragmentation strategy. If the INIT clause specifies only IN *dbspace* or PARTITION *fragment* IN *dbspace* for a previously fragmented index, or if it specifies an index fragmentation strategy that differs from the storage option of the table, then the index becomes a detached index.

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You can fragment unique indexes on a table that uses a round-robin or expression-based distribution scheme, but any columns referenced in the fragment expression must be indexed columns. If your index fragmentation strategy violates this restriction, the ALTER FRAGMENT INIT statement fails, and work is rolled back.

You might have an attached unique index on a table fragmented by **Column A**. If you attempt to use ALTER FRAGMENT INIT to change the table fragmentation to **Column B**, the statement fails because the unique index is defined on **Column A**. To resolve this issue, use the INIT clause on the index to detach it from the table fragmentation strategy and fragment it separately.

System indexes (such as those used in referential constraints and unique constraints) use user-defined indexes if the indexes exist. If no user-defined indexes can be used, system indexes remain nonfragmented and are moved to the dbspace where the database was created. To fragment a system index, create the fragmented index on the constraint columns and then use the ALTER TABLE statement to add the constraint.

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Use the ADD clause to add another fragment to a list of fragments of an existing table or index.

ADD Clause

```

|--ADD----->
>+-----dbspace-----+
|'+-----REMAINDER IN-'+'-PARTITION-part-IN-'|
|'| (1) '|
|'-----PARTITION-part-'|
+-----| ADD Expression |--IN-dbspace-----+
|'-PARTITION-part-'| | (1) |
| | |'-----BEFORE--fragment-'|
| | |'AFTER--'|
| | |'.','-----.|
|(2)| |V|
|'-----INTERVAL--+---IN--((-new_dbspace+--)-)-----'|
|'STORE-'|

```

ADD Expression

```
(2)
|---+-----+VALUES < range_expr+-----+
|      |      |      |      |
|      |      |      |      |
|      |      |      |      |
+-expression-----+
|      |      |      |      |
|      |      |      |      |
(4)          v      .,-----.|
|      |      |      |      |
'-----VALUES +-const_expr+-----+'
|      |      |      |      |
|      |      |      |      |
|      |      |      |      |
```

Notes:

1. List or expression fragmentation only
2. Range interval fragmentation only
3. Use path no more than once
4. List fragmentation only

Element	Description	Restrictions	Syntax
<i>dbspace</i>	Name of a dbspace to store the new fragment	Must exist If the table is in a tenant database, the <i>dbspace</i> must be a dedicated dbspace in the tenant database properties list. If the table is not in a tenant database, the <i>dbspace</i> cannot be the name of a dbspace that is dedicated to a tenant database.	Identifier
<i>expression</i>	Expression that defines the new fragment that is to be added	Must return a Boolean value (t or f)	Condition ; Expression
<i>fragment</i>	Name of an existing fragment	Must exist	Identifier
<i>new_dspace</i>	Name of a dbspace being added to store new interval fragments	Must exist If the table is in a tenant database, the <i>new_dspace</i> must be a dedicated dbspace in the tenant database properties list. If the table is not in a tenant database, the <i>new_dspace</i> cannot be the name of a dbspace that is dedicated to a tenant database.	Identifier
<i>part</i>	Name that you declare here for the new fragment. The default is the name of the dbspace.	Required if another fragment in the fragment list is stored in the same dbspace. Must be unique among names of fragments of the index.	Identifier

The *expression* can contain *column* names only from the current table, and data values only from a single row. No subqueries or aggregates are allowed. In addition, the built-in **CURRENT**, **DATE**, **DBINFO**, **SYSDATE**, and **TODAY** expressions are not valid in this context.

- [Adding a New Dspace to a Round-Robin Distribution Scheme](#)
- [Adding a New Named Fragment to a Round-Robin Distribution Scheme](#)
- [Adding an expression-based fragment](#)
- [Using the BEFORE and AFTER Options](#)
- [Using the REMAINDER Option](#)

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Adding a New Dspace to a Round-Robin Distribution Scheme

You can add more dspace to a round-robin distribution scheme. The following example shows the original round-robin definition:

```
CREATE TABLE book (col1 INT, col2 INT)
  FRAGMENT BY ROUND ROBIN IN dbsp1, dbsp4;
```

To add another dbspace, use the ADD clause, as in this example:

```
ALTER FRAGMENT ON TABLE book ADD dbsp3;
```

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Adding a New Named Fragment to a Round-Robin Distribution Scheme

In Informix®, you can add a named fragment to an existing round-robin distribution scheme. The name must be unique within the distribution among fragments of the same dbspace. The following example specifies the same original round-robin fragmentation definition as in the previous section:

```
CREATE TABLE book (col1 INT, col2 INT)
  FRAGMENT BY ROUND ROBIN IN dbsp1, dbsp4;
```

To add a new named fragment, you can use the ADD clause, as in the following example:

```
ALTER FRAGMENT ON TABLE book
  ADD PARTITION chapter3 IN dbsp1;
```

The new distribution uses **dbsp1**, **dbsp4**, and **chapter3** as storage locations for a 3-part round-robin fragmentation scheme. The records in the fragment **chapter3** are stored separately in the dbspace **dbsp1** from the records in the first fragment, which is identified only by the dbspace name: **dbsp1**. The newly-added **chapter3**

fragment will be favored exclusively by inserts and loads until it no longer has the fewest rows among the table's fragments.

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Adding an expression-based fragment

Adding a fragment expression to the fragmentation list of an expression-based distribution scheme can relocate records from existing fragments into the new fragment. When you insert a new fragment into the fragmentation list, the database server reevaluates all the data in the existing fragments that follow the new fragment. (The **evalpos** column value for any fragment in the **sysfragments** system catalog table indicates the ordinal position of that fragment within the fragmentation list.)

The next statement fragment shows the original expression definition:

```
FRAGMENT BY EXPRESSION
  c1 < 100 IN dbsp1, c1 >= 100 AND c1 < 200 IN dbsp2,
  REMAINDER IN dbsp3
```

To add another named fragment in dbspace **dbbsp2** to hold rows for column **c1** values between 200 and 299, use the following ALTER FRAGMENT statement:

```
ALTER FRAGMENT ON TABLE news
  ADD PARTITION century3 (c1 >= 200 AND c1 < 300) IN dbsp2;
```

Any rows that were formerly in the remainder fragment but that fit the criteria (**c1** >= 200 AND **c1** < 300) move to the new **century3** fragment in dbspace **dbbsp2**.

If the ALTER FRAGMENT ADD operation results in the redistribution of data rows while the automatic mode for updating distribution statistics is enabled, the database server drops the distribution statistics of the affected fragments, but the table statistics are not dropped. The next query on the table will cause the database server to recalculate the statistics for the same fragments.

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Using the BEFORE and AFTER Options

The BEFORE and AFTER options can position the new fragment either before or after an existing fragment within the fragmentation list. The name of a fragment is the name of the dbspace or the name declared in the PARTITION clause. You cannot use the BEFORE and AFTER options if the distribution scheme is round-robin or range interval.

When you attach a new fragment without an explicit BEFORE or AFTER option, the database server places the added fragment at the end of the fragmentation list, unless a remainder fragment exists. If a remainder fragment exists, the new fragment is placed immediately before the remainder fragment. You cannot position a new fragment after the remainder fragment.

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Using the REMAINDER Option

You cannot add a remainder fragment if one already exists. If you add a new fragment when a remainder exists, the database server retrieves and reevaluates all records in the remainder fragment; some records might move to the new fragment. The remainder fragment is always the last item in the fragment list.

You cannot add a remainder fragment to the fragmentation list of a range interval fragmentation scheme.

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DROP Clause

Use the DROP clause to remove an existing fragment from the fragmentation list of a table or index that is fragmented by round-robin. For a table or index that is fragmented by range interval, you can use this clause to drop one or more dbspaces from the list of dbspaces that store system-generated interval fragments.

Use the DETACH clause, rather than the DROP clause, to remove an existing fragment from a table that uses range-interval fragmentation, such as a rolling window table.

DROP Clause

```
|--DROP--+-----+---fragment-----+-----+
| '-PARTITION-'                                     |
| (1)                                              V,----- |
| '-----INTERVAL-----+-----+---IN-- (----dbspace----)-'
|                                     '-STORE-'
```

Notes:

1. Range interval fragmentation only

Element	Description	Restrictions	Syntax
<i>dbspace</i>	Dbspace that stores system generated fragments	Must exist when you execute the statement.	Identifier
<i>fragment</i>	Name of the fragment	Must exist when you execute the statement. For list or range interval fragments, the PARTITION keyword must precede this name.	Identifier

If the table is fragmented by expression, you cannot drop a fragment containing data that cannot be moved to another fragment. If the distribution scheme has a REMAINDER option, or if the expressions overlap, you can drop a fragment that contains data. You cannot, however, drop a fragment if the table has only two fragments.

When you want to make a fragmented table nonfragmented, you can use either the INIT clause or the DETACH clause of the ALTER FRAGMENT statement, rather than the DROP clause.

If the *fragment* was not given a name by the user who created the table or index or added the fragment, then the name of the dbspace is also the name of the fragment. If the fragment is a system-generated range interval fragment of a table or of an index, its name is **sys_pevalpos**, where *evalpos* is the **sysfragments.evalpos** entry for the fragment in the system catalog. If a table and its index use the same range interval fragmentation strategy, each system-generated index fragment has the same identifier as a system-generated fragment of the table.

When you drop a fragment, the database server attempts to move all records in the dropped fragment to another fragment. In this case, the destination fragment might not have enough space for the additional records. If this happens, follow one of the procedures that [ALTER FRAGMENT and Transaction Logging](#) describes to increase your available space, and retry the ALTER FRAGMENT operation.

When the DROP clause specifies one or more dbspaces to remove from a range interval fragmentation strategy, those dbspaces are not affected, but the database server moves the data in any fragments of the table or index that are stored in those dbspaces to other available dbspaces. (The range interval fragmentation strategy is also affected, because it no longer includes the specified dbspaces among its storage locations for new system-generated fragments.)

You cannot use the DROP clause to drop a range interval fragment that contains data.

You can use this clause to drop a list fragment that contains data only if a remainder fragment exists to receive the data.

If the fragmented table has fragment level statistics, the ALTER FRAGMENT DROP operation also drops any fragment-level statistic distribution for the fragment been dropped. Table-level statistics, however, are not recalculated. The next explicit or automatic UPDATE STATISTICS operation on the table will rebuild stale fragment-level distributions and merge them to form table level distributions and store the results in the system catalog.

Examples of the DROP clause of the ALTER FRAGMENT statement

The following examples show how to drop a fragment from a round-robin fragmentation list. The first line shows how to drop an index fragment, and the second line shows how to drop a table fragment.

```
ALTER FRAGMENT ON INDEX cust_idx DROP dbsp2;
```

```
ALTER FRAGMENT ON TABLE customer DROP dbsp1;
```

The following examples each drop a fragment that was defined by list fragmentation strategies. The first line shows how to drop a table fragment, and the second line shows how to drop an index fragment.

```
ALTER FRAGMENT ON TABLE T2 DROP PARTITION part4;
```

```
ALTER FRAGMENT ON INDEX idx2 DROP PARTITION part4;
```

In both examples above, the PARTITION keyword is required, and the name of the dropped fragment is **part4**. If the index **idx2** is defined on table **T2** and thus the same storage distribution strategy as table **T2**, the second statement is not necessary, because the database server automatically modifies the fragmentation strategy of an attached index when the table fragmentation list is modified. If these fragments are not empty, the database server moves their data to the remainder fragments (or returns an error, if no remainder fragment exists).

The following examples each drop two dbspaces that store system-defined interval range fragments, as defined by range interval fragmentation strategies. The first statement drops dbspaces **db57** and **db58** from the storage spaces for table fragments, and the second statement drops the same storage spaces for index fragments:

```
ALTER FRAGMENT ON TABLE T1 DROP INTERVAL STORE IN (db57, db58);
```

```
ALTER FRAGMENT ON INDEX idx1 DROP INTERVAL STORE IN (db57, db58);
```

The PARTITION keyword is again required, and if **idx1** is an attached index on table **T1**, the second statement is not necessary: When the table fragmentation list is modified, the database server automatically modifies the fragmentation strategy of any attached index to match the modified strategy of its table. If these fragments are not empty, the database server moves any fragments from the specified **db57** and **db58** dbspaces to other available dbspaces.

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MODIFY Clause

Use the MODIFY clause to change the fragmentation list or the fragment key of a table or of an index that is fragmented by list or by expression, or to define, modify, or disable a range-interval or rolling window fragmentation scheme.

Use the MODIFY clause to change the existing fragmentation list of a table or of an index. You can use this clause to accomplish one or more of the following tasks:

- Move an existing fragment from one dbspace to a different dbspace
- Change the expression associated with an existing list-based or expression-based fragment
- Change the expression that defines the transition fragment in a range-interval fragmentation list
- Rename one or more existing fragments
- Enable or disable the automatic creation of interval fragments
- Replace the list of dbspaces or the function specifying where to store new interval fragments
- Change a rolling window table to a table fragmented by interval (with no purge policy)
- Change a table that is fragmented by range interval to a rolling window table
- Change the purge policy of a rolling window table by one or more of these actions:
 - Resetting the limit on the number of interval fragments,
 - Changing the allocated storage size limit for the table,
 - Replacing the ATTACH or DISCARD keyword option,
 - Replacing the ANY or INTERVAL FIRST or INTERVAL ONLY keyword option.

The MODIFY clause of the ALTER FRAGMENT statement has the following syntax:

MODIFY Clause

```

      .-,-----
      V
|--MODIFY--+-----+old--TO--PARTITION--new--+-----+-----+-----+-----+
|  '-PARTITION-'          | Fragment Expression |-'  '-IN--dbspace-'  |
|  (1)                    |                    |                    |
|  '-----INTERVAL-----+-----+-----+-----+-----+-----+
|                          | +-ENABLED--+  '-STORE-'  | '-dbspace_fun--( )-' |
|                          | '-DISABLED-' |                    |
|  +-ENABLED--+-----+-----+-----+-----+-----+
|  '-DISABLED-' |                    |
|  +-TRANSITION TO  const_expr-----+-----+
|                          |                    | (2)
|  '-| Rolling Window clause |-----+'

```

Fragment Expression

```

|--+expression-----+-----+
|  (1)
|  +-----+VALUES <  range_expr+-----+
|  |  (3)
|  |  '-----VALUES IS NULL-'
|  |  .-,-----
|  |  V
|  (4)
|  +-----VALUES +-----const_expr+-----+
|  |  (3)
|  |  '-----+-----NULL-'
|  |  '-IS-'
|  (3) (5)
|  '-----REMAINDER-----+'

```

Notes:

1. Range interval fragmentation only
2. See [Rolling Window clause](#)
3. Use this path no more than once
4. List fragmentation only
5. Not valid for range interval fragmentation

Element	Description	Restrictions	Syntax
<i>const_expr</i>	Constant expression that defines the list of values for a fragment to store, or a new upper limit for the range-interval transition fragment	Must be a quoted string or a literal value. For fragmentation by list, each value must be unique among the expression lists for fragments of the same object.	Constant Expressions
<i>dbspace</i>	Dbspace that stores the <i>new</i> fragment	Must exist at time of execution. All of the dbspaces must have the same page size. If the table is in a tenant database, the <i>dbspace</i> must be a dedicated dbspace in the tenant database properties list. If the table is not in a tenant database, the <i>dbspace</i> cannot be the name of a dbspace that is dedicated to a tenant database.	Identifier
<i>dbspace_fun</i>	Name of a UDF that returns the name of a dbspace	The user-defined function and the returned dbspace must exist when the database server calls the UDR to allocate storage for a new fragment.	CREATE FUNCTION statement
<i>expression</i>	Modified expression	Can specify columns in current table only and data from only a single row	Condition; Expression

Element	Description	Restrictions	Syntax
<i>new_dbspace</i>	Dbspace that stores system-generated range interval fragments	Must exist at time of execution. All of the dbspaces must have the same page size. If the table is in a tenant database, the <i>new_dbspace</i> must be a dedicated dbspace in the tenant database properties list. If the table is not in a tenant database, the <i>new_dbspace</i> cannot be the name of a dbspace that is dedicated to a tenant database.	Identifier
<i>new</i>	Name that you declare here for the modified fragment	Must be unique among fragment names in the fragmentation list. If a table and its index use the same range interval or list fragmentation strategy, each index fragment must have the same name as the corresponding table fragment.	Identifier
<i>old</i>	Name of an existing fragment	Must exist in the fragmentation list. For list or range interval fragments, the PARTITION keyword must precede this name.	Identifier
<i>range_expr</i>	Range expression. This constant expression defines the upper bound for fragment key values stored in the fragment	Must be a constant literal expression that evaluates to a numeric, DATETIME, or DATE data type compatible with the data type of the fragment key expression. See also Restrictions on the MODIFY clause for range interval fragments .	Constant Expressions

Usage

Here *dbspace* and *old* (or *old* and *new*) can be identical, if you are not changing the storage location. For tables or indexes that are fragmented by range interval, the specified list of dbspaces that follows the STORE IN keywords replaces the list of dbspaces that was in effect before you issued the ALTER FRAGMENT . . . MODIFY statement. Fragments in the former list of dbspaces are not relocated by this option.

Instead of a list of literal dbspace identifiers, the STORE IN clause can optionally specify a user-defined function that returns the name of an existing dbspace. The identifier that you declare for this UDF is arbitrary. For more information about this UDF and an example of how to create it, see the discussion of the STORE IN clause in the CREATE TABLE topic [Interval fragment clause](#).

To use the MODIFY clause both to change the *expression* and to move its corresponding fragment to a new storage location, you must change the *expression* and you must also specify the name of a different *dbspace* or partition.

You must declare a *new* fragment name if more than one fragment of the same table or index has the same identifier as the *dbspace*. The PARTITION keyword is required immediately before the *new* fragment name for range interval fragments and for list fragments, but it is optional for round-robin fragments and expression-based fragments.

The *expression* must evaluate to a Boolean value (true or false).

No subqueries or aggregates are allowed in the *expression*. In addition, the built-in **CURRENT**, **DATE**, **DBINFO**, **SYSDATE**, and **TODAY** expressions are not valid.

When you use the MODIFY clause to change an expression without changing the storage location for the expression, you must use the same name for the *old* and the *new* fragment. If the dbspace consists of only a single partition, however, you can specify the same name for *old* and for *dbspace*, as in the following example:

```
ALTER FRAGMENT ON TABLE cust_acct
MODIFY dbsp1 TO acct_num < 65 IN dbsp1;
```

For list fragmentation strategies, the ALTER FRAGMENT MODIFY statement fails with an error if a new list expression overlaps any existing list expressions for another fragment of the same table or index.

When you use the MODIFY clause to move a fragment from one dbspace to another, *old* is the name of the dbspace where the fragment was previously located, and *dbspace* is the new location for the fragment, as in the following example:

```
ALTER FRAGMENT ON TABLE cust_acct
MODIFY PARTITION part1 TO PARTITION part2 (acct_num < 35) IN dbsp2;
```

The ALTER FRAGMENT statement above modifies the distribution scheme for the **cust_acct** table, so that the rows with values in column **acct_num** that are less than 35 (and that had previously been assigned to fragment **part1** that was stored in the dbspace **dbsp1**) will now be assigned to the fragment **part2** that is stored in the dbspace **dbsp2**.

When you use the MODIFY clause, the underlying dbspaces are not affected. Only the data values within the fragments or dbspaces are affected.

Unless the fragmentation strategy is by range interval, if no remainder fragment already exists, you can redefine a nonremainder fragment as a remainder fragment for rows that do not match the fragment key values for any other fragment. You cannot change a REMAINDER fragment into a nonremainder fragment, however, if any rows already stored in the REMAINDER fragment do not satisfy the new *expression*.

An *attached* index has the same storage distribution as its table. If all the indexes on a table are attached indexes, and you use the MODIFY clause to modify the table fragments, the database server automatically modifies the storage distribution strategy for the index to match the new table fragmentation strategy.

The *old* specification cannot reference the transition fragment (the last range fragment) of any table that is fragmented by a range-interval storage distribution scheme. The only modification that is valid for that fragment is to use the TRANSITION TO *const_expr* clause to increase the transition value. For any other syntax that attempts to redefine the range expression of the transition fragment directly, the database server returns an error. For more information, see the topic [Using the MODIFY INTERVAL TRANSITION option](#).

- [Restrictions on the MODIFY clause for range interval fragments](#)

- [Rolling Window clause](#)
Use the Rolling Window clause of the ALTER FRAGMENT MODIFY INTERVAL statement to add a purge policy to a table that uses range-interval distributed storage, or to modify or drop the purge policy of a rolling window table.
- [Using the MODIFY INTERVAL TRANSITION option](#)
You can use this option to increase the transition value of the last range fragment of a table that has a range-interval fragmentation scheme. The transition value cannot be decreased by using this MODIFY INTERVAL TRANSITION option to the ALTER FRAGMENT statement.
- [Using the ONLINE keyword in MODIFY operations](#)
The ONLINE keyword instructs the database server to commit the ALTER FRAGMENT . . . MODIFY work internally, if there are no errors, and to apply an intent exclusive lock to the table, rather than an exclusive lock.
- [Examples of the MODIFY clause with interval fragments](#)
- [Examples of the MODIFY clause for list fragments](#)

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Restrictions on the MODIFY clause for range interval fragments

The MODIFY clause of the ALTER FRAGMENT statement cannot change the interval value, nor the fragment key. To change either of these elements of the range interval storage distribution scheme, you must use the INIT option of the ALTER FRAGMENT statement.

The MODIFY clause cannot change the value of the range expression of a fragment if any of the following are true:

- The fragment is the last fragment, and the new value is smaller than the current value.
- The new value overlaps the boundary of an existing fragment.
- The fragment is a system-generated interval fragment.

You can modify the value of a user-defined range fragment, but the new value cannot cross adjacent fragment boundaries, and the database server must be able to accomplish any data movement that the new range expression implies.

The MODIFY clause can change the list of storage spaces where an existing fragment is stored, and it can also change the list of storage spaces where new system-generated interval fragments will be stored, but the same MODIFY clause cannot accomplish both tasks. To change both lists, you must issue two separate ALTER FRAGMENT . . . MODIFY statements.

Similarly, a MODIFY clause that enables or disables the current range interval distribution scheme cannot also move an existing range interval fragment to a different dbspace, or create a new user-defined fragment. Separate ALTER FRAGMENT . . . MODIFY statements are required for each of these tasks.

For range fragments of tables and indexes fragmented by interval, you can modify the fragment expression for the first and for intermediate range fragments. Any overlaps are resolved by moving data, so that fragment key values of the rows stored in the redefined range fragments are non-overlapping. For the last range fragment, however, you can modify the transition value in its fragment expression only if the new range expression satisfies all of the following conditions:

- It does not partially or completely match any existing interval fragment expression.
- It will not partially match any future interval fragment expressions that the system can generate automatically.
- Any gap that the new transition value leaves between fragments must be an integer multiple of the *intvl_expr* interval value.

You cannot define a remainder fragment for a table that is fragmented by range interval.

If you use the MODIFY clause to rename an existing fragment, the new name cannot begin with the characters `sys_p`.

Range, interval, and transition fragments

For objects that use a range interval storage distribution strategy, it is useful to distinguish among three types of fragments:

- A *range* fragment is a fragment whose name, fragment-key expression, and storage location are defined explicitly in the Interval Fragment clause within the table or index definition. Range interval fragmentation requires that at least one range fragment be defined.
- An *interval* fragment is a fragment whose name, fragment-key expression, and storage location are defined automatically by the database server when an insert or load operation attempts to store a row whose fragment-key value is false for the fragment-key expression of every existing fragment.
- The range fragment whose upper limit in its VALUES clause is larger than for the fragment-key expression for any other range fragment is called the *transition* fragment. The upper limit specified in the VALUES clause of the transition fragment is called the *transition value* for the table. If no interval fragments have been created for the object, inserting a row whose fragment-key value exceeds that transition value requires the database server to create a new interval fragment.

Operations that the MODIFY clause of the ALTER FRAGMENT statement can perform on transition fragments are more restricted than MODIFY operations on other range and interval fragments.

The ALTER FRAGMENT MODIFY statement cannot change the range expression that defines a transition fragment unless you also include the MODIFY TRANSITION keywords.

The database server cannot create interval fragments unless the Interval Fragment clause within the table or index definition defined a range interval fragment key, and the fragmentation scheme is not currently disabled by the ALTER FRAGMENT . . . MODIFY INTERVAL DISABLE statement.

Restrictions on modifying rolling window tables

The Rolling Window clause of the ALTER FRAGMENT MODIFY INTERVAL statement cannot define a purging policy on a table that has any of the following attributes:

- The table has a ROWID shadow column.
- Another table has a foreign key constraint that references a PRIMARY KEY in the table.

Rolling Window clause

Use the Rolling Window clause of the ALTER FRAGMENT MODIFY INTERVAL statement to add a purge policy to a table that uses range-interval distributed storage, or to modify or drop the purge policy of a rolling window table.

For tables with range-interval distributed storage, the Rolling Window clause supports the following syntax to drop all purge policy limits on interval fragments, or to set new purge policy limits on interval fragments:

Rolling Window clause of ALTER FRAGMENT

```
>>--ALTER FRAGMENT FOR TABLE -table--MODIFY INTERVAL--| Rolling Window clause |--><
```

Case 1: Destroy all Purge Policies for a table

```
|--DROP ALL ROLLING-----|
```

Case 2: Limit the maximum allocated storage size

```
|--+-----+--LIMIT TO--size--units-->
  '-ROLLING--(--quantity--FRAGMENTS--)-'
                                .-INTERVAL FIRST----.
>----+--DETACH--+--+-----+-----|
      '-DISCARD-'    +-ANY-----+
                      '-INTERVAL ONLY-'
```

Case 3: Limit only the quantity of interval fragments

```
|--ROLLING--(--quantity--FRAGMENTS--)--+--DETACH--+-----|
                                           '-DISCARD-'
```

Element	Description	Restrictions	Syntax
<i>quantity</i>	Upper limit in purge policy on the number of interval fragments	Must be an integer greater than zero. User-defined range fragments are not included in this limit.	Literal integer
<i>size</i>	Upper limit on the total allocated storage for the table and its indexes	Must be greater than zero	Literal integer
<i>table</i>	Name of an existing table with range-interval fragmentation	Must not have a ROWID column or a primary-key constraint that a foreign-key constraint references. Any index must have the same storage distribution.	Identifier
<i>units</i>	Abbreviated unit of total mass storage for the table. Any trailing characters cause a syntax error.	Must be K, KB, KiB, M, MB, MiB, G, GB, GiB, T, TB, TiB (case insensitive).	Unquoted character string, beginning with the letter K, M, G, or T

Usage

The syntax of the Rolling Window clause in ALTER FRAGMENT MODIFY INTERVAL statement supports a superset of the syntax of the Rolling Window clause in CREATE TABLE FRAGMENT BY INTERVAL statements.

Modifying rolling window tables

The Rolling Window clause of the ALTER FRAGMENT MODIFY INTERVAL statement resembles in its syntax, but is not identical to, the Rolling Window clause of the CREATE TABLE statement. The Rolling Window clause of ALTER FRAGMENT supports the following functionality:

- You can define a purge policy for a table that uses range-interval fragmentation.
- You can modify an existing purge policy by any of the following changes:
 - Changing the ROLLING FRAGMENTS value for *quantity*
 - Changing the LIMIT TO value for *size*
 - Replacing the DETACH or DISCARD keyword with the DETACH or DISCARD keyword.
 - Replacing the ANY or INTERVAL FIRST or INTERVAL ONLY keyword specification without replacement, the default purge policy action is INTERVAL FIRST. (For more information about the effects of these keywords on which qualifying fragments will be purged, see the topic [Interval fragment clause](#).)

If you delete the ANY or INTERVAL FIRST or INTERVAL ONLY keyword specification without replacement, the default purge policy action is INTERVAL FIRST. (For more information about the effects of these keywords on which qualifying fragments will be purged, see the topic [Interval fragment clause](#).)

- You can specify the INTERVAL DISABLED keywords to disable interval fragmentation for a rolling window table, thereby suspending its purge policy.
- You can specify the INTERVAL ENABLED keywords to restore interval fragmentation (and re-enable the purge policy) for a table for which interval fragmentation and the creation and archiving or destruction of rolling fragments had been disabled.
- You can specify the DROP ALL ROLLING keywords to remove an existing purge policy. The effect is to change the rolling window table to a table fragmented by interval.

If you intend to suspend the current purge policy temporarily, and subsequently to restore the same purge policy, you should use the INTERVAL DISABLED keywords, rather than the DROP ALL ROLLING keywords.

Enforcing a purge policy

A rolling window table's purge policy is not immediately enforced when the total allocated storage size or the total number of interval fragments exceeds the limit that the Rolling Window clause specifies.

Purge policies are designed to be enforced daily as a Scheduler task at a time when the required DETACH and ATTACH operations on fragments of the rolling window table are unlikely to conflict with access attempts by concurrent users. By default, purge policies are enforced daily, at 00:45 local time. For more information, see the description of the built-in **purge_tables** task of the Scheduler in your *IBM® Informix® Administrator's Guide*.

Purge policies also can be manually enforced by running the **syspurge()** system function. After the DBA invokes the **syspurge()** function, the database server inspects the system catalog, and identifies any rolling window tables whose purging policy has been exceeded. The database server then either discards or detaches, as specified by the purge policy, qualifying rolling fragments until the purging policy is satisfied, or until no more rolling fragments can be removed. The **syspurge()** function requires no arguments, but accepts an optional argument that enables online log diagnostics.

Only users with DBA access privileges can call routines that implement the DETACH or DISCARD options for detached rolling fragments. Users with RESOURCE access privileges can execute the **syspurge()** function, but this can only enforce purging policies on tables that they own.

The database server silently ignores any invocation of the **syspurge()** function on secondary servers in High Availability Data Replication (HDR) cluster environments. Similarly, in grid environments, purge policies on replicated tables are not enforced. This is because grid environments and cluster environments do not replicate ALTER FRAGMENT changes that the DETACH and DISCARD options trigger, which are at the core of rolling window purge policies.

The Rolling Window clause provides two keyword options for processing detached rolling interval fragments:

- Use DETACH to attach the fragments into independent tables that the database server automatically creates, and whose table identifiers are of this form:

```
< original_table_name > < lower_value > < higher_value >
```

Here *lower_value* and *higher_value* are the minimum and maximum values of the interval range for that fragment, before it was detached.

If a table of that name already exists, a numeric counter is appended after the higher value, beginning with **_1** for the first additional table:

```
< original_table_name > < lower_value > < higher_value >_1
```

and so forth, with **_2** appended to the next table name (or a larger integer is appended, if appending **_2** does not produce a unique table name).

- Use DISCARD to destroy the detached fragments.
The DISCARD keyword specifies that successfully detached fragments be dropped, so that when the purge policy is enforced, unneeded data records are removed in a timely manner. In this way, the number of rolling fragments or the total amount of storage space for the rolling window table is constrained to the stipulated value

Examples of modifying an existing rolling window table

The examples of ALTER FRAGMENT ON TABLE . . . MODIFY INTERVAL statements that follow all change the current rolling-window options of a table called **window_orders** that the following CREATE TABLE statement defined:

```
CREATE TABLE window_orders
(
  order_id INT, cust_id INT,
  order_date DATE, order_desc CHAR (1024))
FRAGMENT BY RANGE (order_date)
INTERVAL (NUMTOYMINTERVAL (1, 'MONTH'))
ROLLING (4 FRAGMENTS) DETACH
STORE IN (dbs1, dbs2, dbs3)
PARTITION p0 VALUES < DATE ('01/01/2015') IN dbs1,
PARTITION p4 VALUES IS NULL in dbs3;
```

Here the **window_orders** table uses a range-interval distributed storage strategy

- a range fragment **p0** for fragment-key values earlier than the year 2015,
- and three rolling-window interval fragments,
- and fragment **p4** as a NULL fragment to store rows with no value in the **order_date** fragment-key column.

Because the interval within the range of this fragment key is defined as one month, and the interval transition value is the first day of the year 2015, the first interval fragment will be generated when a record is inserted with an **order_date** value in a year later than 2014. Successive interval fragments will be stored in the dbspaces **dbs1**, **dbs2**, and **dbs3** in round-robin fashion.

In the CREATE TABLE statement example above, the Rolling Window clause sets at 3 the maximum number of rolling interval fragments. If rows are added in each of the first three months of 2015, three rolling fragments will be generated by March of that year, because each new interval fragment stores data from only a single month. If a 5th interval fragment is created in May, this will exceed the purge policy limit on rolling fragments. Because no limit on storage size is specified, the default INTERVAL FIRST criterion will detach the interval fragment whose **evalpos** value is smallest among the four rolling fragments. That fragment will be attached to another table, rather than destroyed, because the purge policy specifies DETACH, rather than DISCARD.

ALTER FRAGMENT ON TABLE **window_orders** MODIFY INTERVAL statements that follow illustrate various changes to the original Rolling Window distribution scheme, as defined above for the **window_orders** table.

- Set a maximum size limit on the data stored in the table:

```
ALTER FRAGMENT ON TABLE window_orders MODIFY INTERVAL
LIMIT TO 30 MiB DETACH INTERVAL ONLY;
```

This sets a 30 megabyte limit on the total storage size of the **window_orders** table, and stipulates that range fragments like **p0** cannot be detached to reduce the current size below that limit. The maximum number of interval fragments (4) and the disposal mode of the purge policy (DETACH) are unchanged. Note that the actual storage size could exceed the new limit until the Scheduler enforces the purge policy. At that point, however, at least one interval fragment would be detached, in an effort to comply with the LIMIT TO setting.

The `ANY`, or `INTERVAL FIRST`, or `INTERVAL ONLY` option for the fragments to purge cannot be reset unless you also include a `LIMIT TO` specification in the Rolling Window clause of the `ALTER FRAGMENT MODIFY` statement.

- Changing the disposal option:

```
ALTER FRAGMENT ON TABLE window_orders MODIFY INTERVAL
ROLLING (4 FRAGMENTS) DISCARD;
```

This maintains the current number of interval fragments, but changes the disposal option to `DISCARD`, so that the detached will be dropped from the database, in accordance with this change to the original purge policy for the `window_orders` table.

- Changing the number of interval fragments:

```
ALTER FRAGMENT ON TABLE window_orders MODIFY INTERVAL
ROLLING (6 FRAGMENTS);
```

This increases the number of interval fragments to six, so that no new fragment is added (and no existing fragment is detached) until a new row is inserted whose fragment-key value is a `DATE` whose month is seven months later than the month values in the oldest fragment.

- Rolling back both previous changes to the quantity and disposal of interval fragments:

```
ALTER FRAGMENT ON TABLE window_orders MODIFY INTERVAL
ROLLING (4 FRAGMENTS) DETACH;
```

This restores the original `window_orders` storage options, and illustrates that a single `ALTER FRAGMENT ON TABLE . . . MODIFY INTERVAL` statement can change more than one option of a Rolling Window strategy.

- Drop the rolling-window distributed-storage behavior of the table:

```
ALTER FRAGMENT ON TABLE window_orders MODIFY INTERVAL
DROP ALL ROLLING;
```

This drops the automatic purge policy, changing `window_orders` from a rolling-window table to an ordinary range-interval table. If a `LIMIT TO` maximum size, or if `ANY` or other keyword option priorities for dropping fragments had been part of the purge policy, those would have also been dropped. No existing data is destroyed, but the future distributed-storage behavior of the `window_orders` table will match what the following `CREATE TABLE` statement (with no Rolling Window clause) implies:

```
CREATE TABLE window_orders
(
  order_id INT, cust_id INT,
  order_date DATE, order_desc CHAR (1024)
)
FRAGMENT BY RANGE (order_date)
INTERVAL (NUMTOYMINTERVAL (1, 'MONTH'))
STORE IN (dbs1, dbs2, dbs3)
PARTITION p0 VALUES < DATE ('01/01/2015') IN dbs1,
PARTITION p4 VALUES IS NULL IN dbs3;
```

Restrictions on rolling window tables

The `ALTER FRAGMENT MODIFY` statement cannot use the Rolling Window clause to change a table that has any of the following attributes into a rolling window table:

- a ROWID column
- a column or columns defined as the primary key of a referential constraint.
- a detached index (that is, an index whose storage distribution scheme is not identical to the fragmentation strategy of the table).

Similarly, the `ALTER TABLE` statement cannot add a ROWID column or a primary-key constraint to a rolling window table.

- The purging strategy that the Rolling Window clause defines for rolling fragments requires the database server to perform `ALTER FRAGMENT DETACH` operations on fragments that satisfy the `DETACH` or `DISCARD` criteria. The `ALTER FRAGMENT DETACH` statement is disallowed, however, on tables with primary keys that are referenced by an enabled foreign key constraint, or on tables with ROWIDs. For this reason, the `CREATE TABLE` and `ALTER FRAGMENT ON TABLE . . . MODIFY INTERVAL` statements cannot define or modify a purging policy on tables that have primary key constraints or ROWID shadow columns.
- Any index defined on a rolling window table must have the same range-interval storage distribution as the rolling window table.

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Using the MODIFY INTERVAL TRANSITION option

You can use this option to increase the transition value of the last range fragment of a table that has a range-interval fragmentation scheme. The transition value cannot be decreased by using this `MODIFY INTERVAL TRANSITION` option to the `ALTER FRAGMENT` statement.

You cannot use the `PARTITION partition VALUES` syntax of the `MODIFY` option to modify the range expression for the last range fragment (also called the *transition fragment*) of a table that uses a range-interval storage distribution scheme. The transition value, however, which is the upper limit in the range expression, can be increased by using the `MODIFY INTERVAL TRANSITION TO` keywords to specify the new upper limit. There is no data movement when the transition value is changed.

To decrease the transition value (by resetting the upper limit on the range of the transition fragment), you must perform an `ALTER FRAGMENT INIT` operation to redefine the range-interval distributed storage scheme for the table.

Automatic fragment renaming when the transition value increases

ALTER FRAGMENT statements that specify the MODIFY INTERVAL TRANSITION option can cause existing fragments to be renamed:

- If there are no interval fragments between the new and old transition values, but interval fragments already exist above the new transition value, the digit that terminates the system-generated interval fragment name is reduced by the number of interval fragment boundaries occupied by the difference between the new and old transition values.

For example, if the interval value expression defining an interval size evaluates to 20, and the difference between the old transition value and the new transition value is 60, then an interval fragment whose name is **sys_p7** is renamed to **sys_p4**, because the quotient is $(60/20) = 3$.

- If interval fragments exist between the new and old transition values, the characters **rg** are appended to their names to indicate that they have become range fragments, because the upper limit of their fragment expression is no longer greater than the transition value for the table.

For example, if the transition value of a table were increased to match the upper **VALUES** limit of its interval fragment **sys_p5**, that fragment would be changed to a range fragment, and renamed **sys_p5rg**. (It would also become the transition fragment.) If another interval fragment called **sys_p4** also had a smaller **VALUES** upper limit in its fragment expression, that fragment would also become a range fragment, and would be renamed **sys_p4rg**.

During a fragment renaming operation, an exclusive lock is placed on the fragment while the **sysfragments** system catalog table is being updated

- with new fragment-identifier values in the **partition** column,
- and with new integer values in the **evalpos** column for any interval fragments or rolling interval fragments whose ordinal positions in the fragment list changed during the current ALTER FRAGMENT MODIFY operation.

In the cases listed above, some fragments are renamed to ensure that every fragment name in the fragment list is unique, and to maintain the correlation between system-generated names for interval fragments and the corresponding **sysfragments.evalpos** value for those fragments in the system catalog. (See also the section [Automatic renaming of interval fragment identifiers](#).)

Several of the ALTER FRAGMENT examples that follow illustrate this fragment-renaming behavior.

Example of ALTER FRAGMENT MODIFY INTERVAL TRANSITION

The following statements define a fragmented **tabtrans** table that uses a range-interval storage distribution scheme, with the integer column **i** the fragment key, and an interval value of 100. The transition fragment **p2** has a transition value of 300, meaning that the database server will define a new interval fragment during any operation on the table to store a new row with a fragment key value of 300 or greater.

```
CREATE TABLE tabtrans (i INT, c CHAR(2))
  FRAGMENT BY RANGE (i)
  INTERVAL (100) STORE IN (dbs1, dbs2, dbs3)
  PARTITION p0 VALUES < 100 IN dbs0,
  PARTITION p1 VALUES < 200 IN dbs1,
  PARTITION p2 VALUES < 300 IN dbs0; -- last range fragment (also
                                     -- called transition fragment)
```

Examples that follow are based on this **tabtrans** table.

The following ALTER FRAGMENT statement attempts to increase the transition fragment value from 300 to 250:

```
ALTER FRAGMENT ON TABLE tabtrans
  MODIFY INTERVAL TRANSITION TO 250;
```

This statement fails, because it attempts to reduce the transition value. If the design goal is to keep the current interval value of 100, but for the new transition value to become 250, an ALTER FRAGMENT INIT operation is required to redefine the range fragments. To keep the range-fragment boundaries aligned, the new upper limit for the range fragment immediately preceding the transition fragment must be 150. In the new distributed storage scheme, if a row with a fragment-key value greater than 250 is inserted into the table, the database server generates a new interval fragment with a range of 100, and with an integer value of the form 50 (modulo 100) as the upper limit.

If there are no interval fragments between the new and old transition values, the database server updates the expression for the last range fragment to **VALUES < new**, where **new** is the new transition value:

```
INSERT INTO tabtrans VALUES (601, "BB"); -- creates interval fragment sys_p6
                                     -- with fragment expression >= 600 AND < 700
```

The fragment list and the fragment expressions for the **tabtrans** table become as follows

p0	VALUES < 100	- range fragment
p1	VALUES < 200	- range fragment
p2	VALUES < 300	- last range (or transition) fragment
sys_p6	VALUES >= 600 AND VALUES < 700	- interval fragment

Here the system-generated name of the new interval fragment is **sys_p6** because 6 is the **sysfragments.evalpos** value for the new fragment in the system catalog. The **evalpos** values 7 and 5 are reserved for (not yet created) interval fragments to store rows whose fragment key values match the fragment expressions **VALUES >= 300 AND VALUES < 400** and **VALUES >= 400 AND VALUES < 500**, based on the current transition value of the table and on the **INTERVAL (100)** specification in the **FRAGMENT BY** clause that defined the fragmentation scheme of the table.

During a change of transition value, the fragments are modified to not cause any data movement. The following statement successfully modifies the transition value to 500.

```
ALTER FRAGMENT ON TABLE tabtrans
  MODIFY INTERVAL TRANSITION TO 500;
```

The old transition value is 300 and the new transition value is 500, with no interval fragments in between. The first interval fragments starts at 600. This also means that there is no data between 300 and 500. So the expression of the last range fragment (the transition fragment) can be updated to **VALUES < 500** without data movement. Because there are interval fragments after the new transition value, the new transition value must align at an interval fragment boundary. In the above case, the new transition value 500 aligns at an interval fragment boundary (whether or not the fragment currently exists). As result of modification, the **evalpos** value in the system catalog for interval fragments changes, and the interval fragments are renamed to adhere to the **sys_pevalpos** naming format.

The resulting modified table has the following fragments:

```
p0    VALUES < 100 -- range fragment
p1    VALUES < 200 -- range fragment
p2    VALUES < 500 -- last range fragment (= transition fragment
-- with its expression modified)
sys_p4 VALUES >= 600 AND VALUES < 700 - interval fragment (renamed
-- to sys_p4 as evalpos changes from 6 to 4
-- after the transition fragment change)
```

The following modification fails with an error, because there are interval fragments beyond the new transition value, and the new transition value does not align at an interval fragment boundary:

```
ALTER FRAGMENT ON TABLE tab MODIFY INTERVAL TRANSITION TO 550;
```

The possible interval fragments are 300 to 400, 400 to 500, 500 to 600, 600 to 700 and so on. The new transition value of 550 is not at an interval fragment boundary, and therefore the error is issued.

If there are interval fragments between the new and old transition value, the new transition value must align to the boundary of an interval fragment (and the interval fragment need not exist), unless the new transition value is beyond the range of the last interval fragment. All interval fragments between the new and the old transition values are converted to range fragments, and their expressions are modified to match the expression format of range fragments. The expression for the last interval fragment that was converted to a range fragment is updated to `VALUES < new`, where *new* is the new transition value.

Here is another example of INSERT operations that result in new interval fragments:

```
CREATE TABLE tab (i INT, c CHAR(2))
  FRAGMENT BY RANGE (i)
  INTERVAL (100) STORE IN (dbs1, dbs2, dbs3)
  PARTITION p0 VALUES < 100 IN dbs0,
  PARTITION p1 VALUES < 200 IN dbs1,
  PARTITION p2 VALUES < 300 IN dbs0; -- last range fragment
-- or transition fragment

INSERT INTO tab
  VALUES (301, "AA"); -- creates interval fragment sys_p3 with
-- fragment expression >= 300 AND < 400

INSERT INTO tab
  VALUES (601, "BB"); -- creates interval fragment sys_p6
-- with fragment expression >= 600 AND < 700
```

The fragment list for the table now consists of these fragments:

```
p0    VALUES < 100 -- range fragment
p1    VALUES < 200 -- range fragment
p2    VALUES < 300 -- range fragment
sys_p3 VALUES >= 300 AND VALUES < 400 -- interval fragment
sys_p6 VALUES >= 600 AND VALUES < 700 -- interval fragment
```

The ALTER FRAGMENT examples that follow are based on the above statements.

The following statement increases the transition value from 300 to 500:

```
ALTER FRAGMENT ON TABLE tab MODIFY INTERVAL TRANSITION TO 500;
```

Because there is an interval fragment (**sys_p3**) between the old and new transition values, that fragment is converted to a range fragment (expression becomes `< 400`). Because there is also an interval fragment (**sys_p6**) beyond the new transition value, the new transition value must align at an interval fragment boundary, which as an integer multiple of the `INTERVAL (100)` specification, it does. Here the possible interval fragments are 300 to 400, 400 to 500, 500 to 600, 600 to 700 and so on. And the new transition value of 500 is at an interval fragment boundary (whose fragment need not exist). We also do not want to move data during the transition fragment modification or create any fragments. This can be accomplished by converting fragment **sys_p3** to the new transition fragment, updating its expression to `< 500` (because it is now a range fragment), and renaming it.

The resulting fragment list for the table consists of these fragments:

```
p0    VALUES < 100 -- range fragment
p1    VALUES < 200 -- range fragment
p2    VALUES < 300 -- range fragment (was the old transition fragment)
sys_p3rg VALUES < 500 -- range fragment (was previously interval
-- fragment sys_p3. Its expression was modified to a
-- range expression. Its name was changed to a
-- system-generated name in format sys_p<evalpos>rq )
-- becomes the new transition fragment
sys_p5    VALUES >= 600 AND VALUES < 700
-- interval fragment (renamed to sys_5 because the
-- evalpos value changes from 6 to 5 after the
-- transition fragment change.)
```

The following attempted modification of the transition value returns an error:

```
ALTER FRAGMENT ON TABLE tab
  MODIFY INTERVAL TRANSITION TO 550;
```

The statement above fails because there is an interval fragment **sys_p6** beyond the new transition value, and because the new transition value is not aligned at an interval fragment boundary.

The next example increases the transition value from 500 to 700:

```
ALTER FRAGMENT ON TABLE tab
  MODIFY INTERVAL TRANSITION TO 700;
```

The resulting fragment list for the table includes the following fragments:

```

p0      VALUES < 100 -- range fragment
p1      VALUES < 200 -- range fragment
p2      VALUES < 300 -- range fragment (was the old transition fragment)
sys_p3rg  VALUES < 400 -- range fragment (was previously interval fragment
                        -- sys_p3, and its expression changed to a range
                        -- expression.
                        -- The fragment has been renamed to system-generated name
                        -- in the format sys_p<evalpos>rg ).
sys_p6rg  VALUES < 700 -- range fragment (was previously the interval
                        -- fragment sys_p6. Its expression was modified to a
                        -- range expression and its name replaced by a system-
                        -- generated name in the format sys_p<evalpos>rg )
                        -- becomes the new transition fragment.

```

The following example increases the transition value from 700 to 750:

```
ALTER FRAGMENT ON TABLE tab MODIFY INTERVAL TRANSITION TO 750;
```

Because there are no interval fragments beyond the new transition value, it need not align to an interval fragment boundary.

The resulting table includes the following fragments:

```

p0      VALUES < 100 -- range fragment
p1      VALUES < 200 -- range fragment
p2      VALUES < 300 -- range fragment (was the old transition fragment)
sys_p3rg  VALUES < 400 -- range fragment (was previously interval
                        -- fragment sys_p3. expression modified to a
                        -- range expression. Fragment was renamed to a system
                        -- generated name in the format sys_p<evalpos>rg)
sys_p6rg  VALUES < 750 -- range fragment (was previously the interval
                        -- fragment sys_p6. Its expression was modified to a
                        -- range expression, and the fragment was renamed to a
                        -- system-generated name in format sys_p<evalpos>rg)
                        -- becomes the new transition fragment

```

If you wish to avoid having existing fragments automatically renamed during ALTER FRAGMENT MODIFY INTERVAL TRANSITION operations, you can first use the ALTER FRAGMENT MODIFY statement to rename with user-defined names the interval fragments whose system-generated names might otherwise be changed by the ALTER FRAGMENT MODIFY INTERVAL TRANSITION statement. The database server renames only system-generated interval fragment names (to avoid non-unique fragment names resulting when new interval fragments are created).

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Using the ONLINE keyword in MODIFY operations

The ONLINE keyword instructs the database server to commit the ALTER FRAGMENT ... MODIFY work internally, if there are no errors, and to apply an intent exclusive lock to the table, rather than an exclusive lock.

Requirements for ONLINE MODIFY operations

You can use the MODIFY option to the ALTER FRAGMENT ONLINE ON TABLE statement only for a table that is fragmented by a range interval fragmentation scheme.

Only the transition value (the starting value for interval fragments) can be modified ONLINE. All other restrictions that apply to the MODIFY option also apply to ONLINE MODIFY operations. For those restrictions, see [General Restrictions for the ATTACH Clause](#) and [Restrictions on the MODIFY clause for range interval fragments](#).

Example of ALTER FRAGMENT ONLINE ... MODIFY

The following SQL statements define a fragmented **employee** table that uses a range-interval storage distribution scheme, with a unique index **employee_id_idx** on the column **emp_id** (that is also the fragmentation key) and another index **employee_dept_idx** on the column **dept_id**.

```

CREATE TABLE employee
(emp_id INTEGER, name CHAR(32),
 dept_id CHAR(2), mgr_id INTEGER, ssn CHAR(12))
FRAGMENT BY RANGE (emp_id)
INTERVAL (100) STORE IN (dbs1, dbs2, dbs3, dbs4)
PARTITION p0 VALUES < 200 IN dbs1,
PARTITION p1 VALUES < 400 IN dbs2;
CREATE UNIQUE INDEX employee_id_idx ON employee(emp_id);
CREATE INDEX employee_dept_idx ON employee(dept_id);

INSERT INTO employee VALUES (401, "Susan", "DV", 101, "123-45-6789");
INSERT INTO employee VALUES (601, "David", "QA", 104, "987-65-4321");

```

The last two statements insert rows with fragment key values above the upper limit of the transition fragment, causing the database server to generate two new interval fragments, so that the fragment list consists of four fragments:

```

Fragments in surviving table before ALTER FRAGMENT ONLINE:
p0      VALUES < 200 -- range fragment
p1      VALUES < 400 -- range fragment (transition fragment)
sys_p2  VALUES >= 400 AND VALUES < 500 - interval fragment
sys_p4  VALUES >= 600 AND VALUES < 700 - interval fragment

```

The following statement returns an error because a transition value can only be increased. This is also a restriction for offline ALTER FRAGMENT . . . MODIFY operations.

```
ALTER FRAGMENT ONLINE ON TABLE employee
MODIFY INTERVAL TRANSITION TO 300;
```

The following statement runs successfully:

```
ALTER FRAGMENT ONLINE ON TABLE employee MODIFY INTERVAL TRANSITION TO 600;
```

```
Fragments in surviving table after ALTER FRAGMENT ONLINE:
p0      VALUES < 200                - range fragment
p1      VALUES < 400                - range fragment
sys_p2rg VALUES < 600              - range fragment (new transition fragment)
sys_p3  VALUES >= 600 AND VALUES < 700 - interval fragment
```

The following examples are also valid:

```
ALTER FRAGMENT ONLINE ON TABLE employee MODIFY INTERVAL TRANSITION TO 700;
ALTER FRAGMENT ONLINE ON TABLE employee MODIFY INTERVAL TRANSITION TO 900;
```

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Examples of the MODIFY clause with interval fragments

Sections that follow illustrate syntax features of the MODIFY clause of the ALTER FRAGMENT statement, and restrictions on what the MODIFY clause can change, for tables that use range and interval fragments as their distribution strategy.

For similar examples of using the MODIFY clause with tables that are fragmented by list, see [Examples of the MODIFY clause for list fragments](#).

Enabling or disabling range interval fragmentation

This statement disables range interval fragment creation:

```
ALTER FRAGMENT ON TABLE tab MODIFY INTERVAL DISABLED;
```

The following statement restores range interval fragment creation, undoing the effects of the previous example:

```
ALTER FRAGMENT ON TABLE tab MODIFY INTERVAL ENABLED;
```

The following statement disables range interval fragment creation, and also modifies the list of dbspaces in the STORE IN clause where new fragments will be stored (if a subsequent ALTER FRAGMENT MODIFY statement enables range interval fragment creation for table **tab**).

```
ALTER FRAGMENT ON TABLE tab MODIFY INTERVAL DISABLED
STORE IN (dbs4, dbs5);
```

Renaming fragments in range interval fragmentation

This statement renames two range interval fragments. No IN clause specifies new storage locations, so the new names replace the existing names for the two fragments:

```
ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p1 TO PARTITION newp1,
PARTITION sys_p6 TO PARTITION newsys_p6;
```

The PARTITION keywords are required for range interval fragments. If you use the MODIFY clause to rename an existing fragment, the new name that you declare in the MODIFY clause cannot begin with the character string **sys**, which is reserved for system-defined fragments, but the example above successfully renames the system-defined fragment **sys_p6**.

Relocating a range or interval fragment

Suppose that the following table was created with range interval fragmentation and received two rows from insert operations:

```
CREATE TABLE tab2 (i INT, c CHAR(2))
FRAGMENT BY RANGE (i)
INTERVAL (100) STORE IN (dbs1, dbs2, dbs3)
PARTITION p0 VALUES < 100 IN dbs0,
PARTITION p1 VALUES < 200 IN dbs1;

INSERT INTO tab2 VALUES (201, "AA");
-- creates a system-generated interval fragment sys_p2
-- with fragment expression >= 200 AND < 300
-- assume that this fragment is created in dbs1

INSERT INTO tab2 VALUES (601, "BB");
-- creates a system-generated interval fragment sys_p6
-- with fragment expression >= 600 AND < 700
---assume that this fragment is created in dbs2
```

The following statement instructs the database server to move range fragment **p1** from **dbs1** to **dbs2**:

```
ALTER FRAGMENT ON TABLE tab2 MODIFY
PARTITION p1 TO PARTITION p1 IN dbs2;
```

The next example moves range fragment **p1** from **dbs1** to **dbs2** and moves interval fragment **sys_p6** from **dbs2** to **dbs3**:

```
ALTER FRAGMENT ON TABLE tab2 MODIFY
PARTITION p1 TO PARTITION p1 IN dbs2,
PARTITION sys_p6 TO PARTITION sys_p6 IN dbs3;
```

Replacing the list of dbspaces that store new interval fragments

The following CREATE TABLE statement defines a range interval fragmentation strategy, in which

- column **i** is the fragmentation key,
- 100 is the range interval size,
- new fragments will be stored in dbspaces **dbs1**, **dbs2**, and **dbs3**,
- the initial fragments **p0** (in dbspace **dbs0**) and **p1** (in dbspace **dbs1**) have transition values of 100 and 200 respectively.

```
CREATE TABLE tab (i INT, c CHAR(2))
FRAGMENT BY RANGE (i)
INTERVAL (100) STORE IN (dbs1, dbs2, dbs3)
PARTITION p0 VALUES < 100 IN dbs0,
PARTITION p1 VALUES < 200 IN dbs1;
```

The following ALTER FRAGMENT statement replaces the STORE IN list (**dbs1**, **dbs2**, **dbs3**) with a new list (**dbs4**, **dbs5**).

```
ALTER FRAGMENT ON TABLE tab
MODIFY INTERVAL STORE IN (dbs4, dbs5);
```

In the example above, the MODIFY clause specifies that new fragments will be created alternately in **dbs4** and **dbs5**. Any system-defined fragments (and the fragment **p1**) that were created in dbspaces of the original STORE IN list (**dbs1**, **dbs2**, **dbs3**) remain in those dbspaces. Existing and subsequently inserted rows whose fragmentation-key values are within the range intervals of those fragments continue to be stored in those fragments, but new interval fragments will be created, alternating in round-robin fashion, in the **dbs4** and **dbs5** dbspaces.

Consider that the following fragmented table:

```
CREATE TABLE mytab (col1 int)
FRAGMENT BY RANGE (c1) INTERVAL (100)
STORE IN (dbs1, dbs2, dbs3, dbs4, dbs5)
PARTITION p1 VALUES < 300 in dbs0;
```

This ALTER FRAGMENT statement replaces the list of dbspaces where new interval fragments will be stored:

```
ALTER FRAGMENT ON TABLE mytab MODIFY
STORE IN (dbs1, dbs6, dbs3, dbs4, dbs8);
```

The new list replaces **dbs2** with **dbs6** and replaces **dbs5** with **dbs8**. If you want any of the dbspaces from the current STORE IN list to be available for new fragments, the MODIFY clause must also include them in the new list, which replaces the old list in the modified fragmentation scheme. In the example above, new range interval fragments will be created in the five dbspaces listed after the STORE IN keywords, but any existing fragments that were created in **dbs2** and **dbs5** continue to store rows whose data values match the fragmentation key ranges for those fragments.

You can modify the list of dbspaces in the STORE IN clause. The old list is replaced by the new list that you specify. Existing fragments in the old dbspace are not moved. Consider the following table:

You can move an existing fragment to another dbspace by changing the IN *dbspace* specification for the fragment:

```
CREATE TABLE tab (i INT, c CHAR(2))
FRAGMENT BY RANGE (i)
INTERVAL (100) STORE IN (dbs1, dbs2, dbs3)
PARTITION p0 VALUES < 100 IN dbs0,
PARTITION p1 VALUES < 200 IN dbs1;

INSERT INTO tab VALUES (201, "AA");
-- creates interval fragment sys_p2
-- with fragment expression >= 200 AND < 300
-- (assume that this fragment is created in dbs1)
INSERT INTO tab VALUES (601, "BB");
-- creates interval fragment sys_p6
-- with fragment expression >= 600 AND < 700
-- (assume that this fragment is created in dbs2)
```

The next statement instructs the database server to moves fragment **p1** from **dbs1** to **dbs2**:

```
ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p1 TO PARTITION p1 IN dbs2;
```

The next example moves range fragment **p1** from **dbs1** to **dbs2**, and moves interval fragment **sys_p6** from **dbs2** to **dbs3**:

```
ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p1 TO PARTITION p1 IN dbs2,
PARTITION sys_p6 TO PARTITION sys_p6 IN dbs3;
```

You cannot, however, modify an expression for an interval fragment after the system has generated the fragment. Consider this table:

```
CREATE TABLE tab (i INT, c CHAR(2))
FRAGMENT BY RANGE (i)
INTERVAL (100) STORE IN (dbs1, dbs2, dbs3)
PARTITION p0 VALUES < 100 IN dbs0,
PARTITION p1 VALUES < 200 IN dbs1;
```



```

INSERT INTO tab VALUES (201, "AA");
-- creates interval fragment sys_p2
-- with fragment expression >= 200 AND < 300
INSERT INTO tab VALUES (601, "BB");
-- creates interval fragment sys_p6
-- with fragment expression >= 600 AND < 700

```

Now you cannot modify the fragment expression for **sys_p2** or **sys_p6**. An error is returned if you try to do so.

```

ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION sys_p6 TO PARTITION sys_p6
VALUES < 900 IN dbs2;

```

The above statement fails with an error.

Modifying the expression that defines a range fragment

Under some circumstances, you can use the MODIFY clause to change the expression that defines a range fragment; examples that follow illustrate various restrictions on changes that you can make to the expressions that define to range fragments. You cannot, however, modify an expression for an interval fragment after the system has generated that fragment. Consider this table:

```

CREATE TABLE tab (i INT, c CHAR(2))
FRAGMENT BY RANGE (i)
INTERVAL (100) STORE IN (dbs1, dbs2, dbs3)
PARTITION p0 VALUES < 100 IN dbs0,
PARTITION p1 VALUES < 200 IN dbs1;

INSERT INTO tab VALUES (201, "AA");
-- creates interval fragment sys_p2
-- with fragment expression >= 200 AND < 300
INSERT INTO tab VALUES (601, "BB");
-- creates interval fragment sys_p6
-- with fragment expression >= 600 AND < 700

```

Now you cannot modify the expressions for interval fragments **sys_p2** or **sys_p6**. The database server returns an error if you try to do so.

```

ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION sys_p6 TO PARTITION sys_p6
VALUES < 900 IN dbs2;

```

The above statement fails with an error.

You can modify an expression for the first intermediate range fragment, but the replacement expression cannot cross adjacent fragment boundaries. This operation can result in data movement. Here is an example;

```

CREATE TABLE tab (i INT, c CHAR(2))
FRAGMENT BY RANGE (i)
INTERVAL (100) STORE IN (dbs1, dbs2, dbs3)
PARTITION p0 VALUES < 100 IN dbs0,
PARTITION p1 VALUES < 200 IN dbs1,
PARTITION p2 VALUES < 300 IN dbs0;

INSERT INTO tab VALUES (301, "AA");
-- creates interval fragment sys_p3
-- with fragment expression >= 300 AND < 400
INSERT INTO tab VALUES (601, "BB");
-- creates interval fragment sys_p6
-- with fragment expression >= 600 AND < 700

```

All of the ALTER examples below are based on fragments of the table defined in the CREATE statement above. The following ALTER FRAGMENT statement modifies the expression for range fragment **p0**

```

ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p0 TO PARTITION p0
VALUES < -50 IN dbs0;

```

The following modifies expression for fragment **p0** and also moves the fragment from **dbs0** to **dbs5**

```

ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p0 TO PARTITION p0
VALUES < -50 IN dbs5;

```

The following statement successfully makes three changes to fragment **p0**:

- modifies the fragment expression for **p0**,
- modifies the fragment name to **newp0**,
- and also moves the renamed fragment from **dbs0** to **dbs5**.

```

ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p0 TO PARTITION newp0
VALUES < -50 IN dbs5;

```

The next example fails with an error, however, because the new expression for fragment **p0** crosses the boundary of the range of the next adjacent fragment **p1**

```

ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p0 TO PARTITION p0
VALUES < 250 IN dbs0;

```

The following ALTER FRAGMENT example successfully modifies the expression for range fragment **p1**:


```
ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p1 TO PARTITION p1
VALUES < 150 IN dbs1;
```

The following modification fails with an error, because the new expression for fragment **p1** crosses the boundary of the previous adjacent fragment **p0**:

```
ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p0 TO PARTITION p0
VALUES < 50 IN dbs0;
```

If for any reason, as result of the ALTER FRAGMENT MODIFY operation, the rows cannot be moved to the new fragments, an error is returned. This is an example:

```
CREATE TABLE tab (i INT, c CHAR(2))
FRAGMENT BY RANGE (i)
INTERVAL (100) STORE IN (dbs1, dbs2, dbs3)
PARTITION p0 VALUES IS NULL IN dbs0,
PARTITION p1 VALUES < 200 IN dbs1,
PARTITION p2 VALUES < 300 IN dbs0;

ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p0 TO PARTITION p0
VALUES < 100 IN dbs0;
```

As a result of the modification, the resultant table will have the following fragments

```
PARTITION p0 VALUES < 100 IN dbs0,
PARTITION p1 VALUES < 200 IN dbs1,
PARTITION p2 VALUES < 300 IN dbs0
```

If the previous NULL fragment stored any rows (meaning rows in the table that have NULL value for column **i**), then those rows would not fit in any of the fragments in the new fragmentation scheme. The above ALTER FRAGMENT operation would therefore fail while moving rows.

Also note that the NULL fragment is always the first fragment in the table. Even if the user specifies the NULL fragment as the last fragment during CREATE TABLE or ALTER TABLE operations, it is rearranged as the first fragment in the table, with the smallest **evalpos** value in the fragment list. While modifying first and intermediate range fragments, the database server imposes the restriction that the new expression cannot cross adjacent fragment boundaries. So while modifying the NULL fragment, whatever new expression you specify cannot cross the boundary of the next range or interval fragment. Here is an example:

```
CREATE TABLE tab (i INT, c CHAR(2))
FRAGMENT BY RANGE (i)
INTERVAL (100) STORE IN (dbs1, dbs2, dbs3)
PARTITION p0 VALUES IS NULL IN dbs0,
PARTITION p1 VALUES < 200 IN dbs1,
PARTITION p2 VALUES < 300 IN dbs0;
```

Suppose that the table does not have any rows in fragment **p0**. In this case, **p0** can be modified to a non-NULL fragment.

```
ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p0 TO PARTITION p0
VALUES < 250 IN dbs0;
```

Because the new expression for **p0** (**VALUES < 250**) crosses the boundary for **p1** (**VALUES < 200**), however, the example above returns an error. The following ALTER FRAGMENT statement is possible:

```
ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p0 TO PARTITION p0 VALUES < 150 IN dbs0;
```

You can modify expression for last range fragment (transition fragment) but you can only increase the transition value. There is no data movement in this operation.

```
CREATE TABLE tab (i INT, c CHAR(2))
FRAGMENT BY RANGE (i)
INTERVAL (100) STORE IN (dbs1, dbs2, dbs3)
PARTITION p0 VALUES < 100 IN dbs0,
PARTITION p1 VALUES < 200 IN dbs1,
PARTITION p2 VALUES < 300 IN dbs0;
-- last range fragment or transition fragment
```

The following modification returns an error, because it attempts to decrease the transition value (from 300 to 250):

```
ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p2 TO PARTITION p2
VALUES < 250 IN dbs0;
```

The following statement modifies the fragment expression for **p2** (the transition fragment). Because there are not yet any system-generated interval fragments, the new transition value need not align at the interval fragment boundary.

```
ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p2 TO PARTITION p2
VALUES < 350 IN dbs0;
```

If there are no interval fragments between new and the old transition value, you can update the expression for the last range fragment to **VALUES < new transition value**. Here is an example:

```
CREATE TABLE tab (i INT, c CHAR(2))
FRAGMENT BY RANGE (i)
INTERVAL (100) STORE IN (dbs1, dbs2, dbs3)
PARTITION p0 VALUES < 100 IN dbs0,
PARTITION p1 VALUES < 200 IN dbs1,
PARTITION p2 VALUES < 300 IN dbs0;
-- last range fragment is the "transition fragment"

INSERT INTO tab VALUES (601, "BB");
```

```
-- creates interval fragment sys_p6
-- with fragment expression >= 600 AND < 700
-- (assume that this fragment is created in dbs3)
```

The modified table now has these fragments:

Fragment

Expression and Fragment Type

```
p0
VALUES < 100 - range fragment
p1
VALUES < 200 - range fragment
p2
VALUES < 300 - last range fragment (or transition fragment)
sys_p6
VALUES >= 600 AND VALUES < 700 - interval fragment
```

During the change of transition value, the fragments are modified in a manner that does not cause any data movement.

The following statement modifies the fragment expression for **p2**, the transition fragment (or last range fragment).

```
ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p2 TO PARTITION p2 VALUES < 500 IN dbs0;
```

The old transition value was 300 and the new transition value is 500. There are no system-generated interval fragments between these range fragments, and the first interval fragments starts at 600. This also means that there is no data rows between 300 and 500, so the expression of the transition fragment (the last range fragment) can be updated to `VALUES < 500` without data movement. Because there are now interval fragments after the new transition value, the new transition value must align at an interval fragment boundary. In this case, the new transition value of 500 aligns with an interval fragment boundary. (The interval fragment need not exist.)

As a result of this modification, the **evalpos** value for subsequent interval fragments changes, and interval fragments are renamed to adhere to the format for system-generated fragment names. After this `ALTER TABLE MODIFY` operation, the resulting table has these fragments:

Fragment

Expression and Fragment Type

```
p0
VALUES < 100 - range fragment
p1
VALUES < 200 - range fragment
p2
VALUES < 500 - modified expression for transition fragment
sys_p4
VALUES >= 600 AND VALUES < 700 - interval fragment
```

Here the modified expression is for fragment **p2**, which is the last range fragment. (This is also called the *transition fragment*, because any fragments to store larger values in the range of the fragment key will be system-generated interval fragments.) The system-generated interval fragment is renamed to **sys_p4** because the **evalpos** value changes from 6 to 4 after the expression for the transition fragment changed.

The following modification fails with an error because there are interval fragments beyond the new transition value, and the new transition value does not align at an interval fragment boundary:

```
ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p2 TO PARTITION p2 VALUES < 550 IN dbs0;
```

The ranges of the possible interval fragments are 300 to 400, 400 to 500, 500 to 600, 600 to 700, and so on, but the new transition value of 550 is not at an interval fragment boundary, and so the database server issues an error.

If there are interval fragments between the new and old transition value, then the new transition value must align to the boundary of an interval fragment (but that interval fragment need not exist), unless the new transition value is beyond the last interval fragment. All interval fragments between the new and old transition values are converted to range fragments, and their expressions are modified to match the range fragment expressions. The expression for the last interval fragment that was converted to a range fragment is updated to `VALUES < new transition value`.

This behavior is illustrated by the following example

```
CREATE TABLE tab (i INT, c CHAR(2))
FRAGMENT BY RANGE (i)
INTERVAL (100) STORE IN (dbs1, dbs2, dbs3)
PARTITION p0 VALUES < 100 IN dbs0,
PARTITION p1 VALUES < 200 IN dbs1,
PARTITION p2 VALUES < 300 IN dbs0;
-- last range fragment or transition fragment

INSERT INTO tab VALUES (301, "AA");
-- creates interval fragment sys_p3
-- with fragment expression >= 300 AND < 400
-- (assume this fragment is created in dbs1)
INSERT INTO tab VALUES (601, "BB");
-- creates interval fragment sys_p6
-- with fragment expression >= 600 AND < 700
-- (assume this fragment is created in dbs3)
```

After the two `INSERT` operations, the table would have these range and interval fragments:

Fragment

Expression and Fragment Type

```
p0
```

```

VALUES < 100 – range fragment
p1
VALUES < 200 – range fragment
p2
VALUES < 300 – range fragment
sys_p3
VALUES >= 300 AND VALUES <400 – interval fragment
sys_p4
VALUES >= 600 AND VALUES <700 – interval fragment

```

The ALTER FRAGMENT examples that follow are based on this table.

The following example modifies the expression for fragment **p2** (the transition fragment).

```

ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p2 TO PARTITION p2 VALUES < 500 IN dbs0;

```

Because there is an interval fragment (**sys_p3**) between the old and new transition value, that fragment is converted to range fragment (whose expression becomes `VALUES < 400`).

And because there are interval fragments beyond the new transition value (for fragment **sys_p6**), the new transition value must align at an interval fragment boundary, which it does. The possible interval fragments must be an integer multiple of the range interval size (including 400 to 500, 500 to 600, 700 to 800, and so on. The new transition value is 500, which is at an interval fragment boundary. It is also efficient to avoid move data during the transition fragment modification, and to avoid creating any fragments. This can be made possible by converting fragment **sys_p3** to the new transition fragment, updating its expression to `< 500`, and renaming it to the name of the old transition fragment.

The resulting table has the following fragments:

Fragment

Expression and Fragment Type

```

p0
VALUES < 100 – range fragment
p1
VALUES < 200 – range fragment
sys_p2rg
VALUES < 300 – range fragment (This was the old transition fragment, now renamed sys_p2rg in the system generated format sys_pevalposrg.)
p2
VALUES <500 - range fragment (This was previously interval fragment sys_p3. Its expression, modified to a range expression. now defines the new
transition fragment)
sys_p5
VALUES >= 600 AND VALUES <700 – interval fragment (renamed to sys_5 as its evalpos value changes from 6 to 5 after the transition fragment change)

```

The following modification of transition fragment **p2** returns an error:

```

ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p2 TO PARTITION p2 VALUES < 550 IN dbs0;

```

The error is issued because there is an interval fragment **sys_p6** beyond the new transition value, and the new transition value is not aligned at an interval fragment boundary.

The next example modifies the expression for fragment **p2**, which is a transition fragment:

```

ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p2 TO PARTITION p2 VALUES < 750 IN dbs0;

```

Because there are no interval fragments beyond the new transition value, it need not align to an interval fragment boundary.

The resulting table has the following fragments:

Fragment

Expression and Fragment Type

```

p0
VALUES < 100 – range fragment
p1
VALUES < 200 – range fragment
sys_p2rg
VALUES < 300 – range fragment (This was the old transition fragment, now renamed sys_p2rg in the system generated format sys_pevalposrg.)
sys_p3rg
< 400 – range fragment (This was previously interval fragment sys_p3 before its expression was modified to a range expression.)
p2
VALUES <750 - range fragment (Previously interval fragment sys_p6 before its expression was modified to a range expression. This becomes the new
transition fragment.)

```

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Examples of the MODIFY clause for list fragments

You can use the MODIFY clause to change fragments of a table or index that is fragmented by list, including these modifications:

- Change the names of existing list fragments
- Move the storage location of an existing list fragment to another dbspace
- Modify the expression list for one or more list fragments.

The following ALTER FRAGMENT ON TABLE statement modifies the name, the list of fragment expressions, and the storage location for a fragment of a table that is partitioned by list:

```
ALTER FRAGMENT ON TABLE T2 MODIFY
PARTITION part1 TO PARTITION part11
VALUES ('CA', 'OR', 'TX') IN dbs1;
```

This changes the partition name from **part1** to **part11**, adds the value 'TX' to the list of expressions for that fragment, and moves the renamed partition into the dbspace **dbs1**.

Examples that follow illustrate these and other uses of the MODIFY clause with list fragmentation schemes, and also illustrate MODIFY operations that fail because of logical restrictions on list fragmentation.

Suppose that this CREATE TABLE statement has defined table **myTable** with the following schema and with a list fragmentation strategy:

```
CREATE TABLE myTable (i int, c char(2))
FRAGMENT BY LIST (c)
PARTITION p1 VALUES ("AB", "CD") IN dbs1,
PARTITION p2 VALUES ("PQ", "RS") IN dbs2,
PARTITION p3 REMAINDER IN dbs3;
```

The next ALTER FRAGMENT statement modifies the storage distribution strategy for the **p2** fragment:

```
ALTER FRAGMENT ON TABLE myTable MODIFY
PARTITION p2 TO PARTITION newp2
VALUES (NULL) IN dbs5;
```

The statement above has these effects on the definition of the fragment and its storage distribution:

- redefines the fragment expression for fragment **p2** to make it a NULL fragment,
- changes the fragment name to **newp2**,
- moves the storage location of that fragment from **dbs2** to **dbs5**,
- and moves any existing data rows that had been stored in fragment **p2** to the remainder fragment **p3**, because the fragment key values ("PQ" and "RS") in column **c** of those rows do not match the new NULL expression.

If the automatic mode for updating distribution statistics is enabled, an ALTER FRAGMENT . . . MODIFY statement that results in data redistribution causes the fragment-level statistics for the affected fragments to be dropped. Table-level statistics, however, are not dropped. Because no fragment-level statistics exist for the affected fragments, the next explicit or automatic UPDATE STATISTICS operation on the table will rebuild the fragment-level distributions, and store the results in the system catalog.

The ALTER FRAGMENT examples that follow specify modifications to fragments of the **tab** table that this CREATE TABLE statement defines with a list fragmentation scheme:

```
CREATE TABLE tab (i int, c char(2))
FRAGMENT BY LIST (c)
PARTITION p1 VALUES ("AB", "CD") IN dbs1,
PARTITION p2 VALUES ("PQ", "RS") IN dbs2,
PARTITION p3 VALUES (NULL) IN dbs3,
PARTITION p4 REMAINDER IN dbs4;
```

The following modifies fragment expression for fragment **p1**

```
ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p1 TO PARTITION p1
VALUES ("AB", "CD", "EF") IN dbs1;
```

The following statement modifies the fragment expression for fragment **p3**:

```
ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p3 TO PARTITION p3
VALUES ("XX", "YY", "ZZ") IN dbs3;
```

If for any reason, as result of the ALTER FRAGMENT ON TABLE MODIFY operation, any rows cannot be moved to the new fragments, an error is returned, as in the following example:

```
ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p3 TO PARTITION p3
VALUES ("XX", "YY", "ZZ") IN dbs3;
```

As a result of the modification, the resulting storage distribution scheme for the **tab** table will have the following fragments:

```
PARTITION p1 VALUES ("AB", "CD") IN dbs1,
PARTITION p2 VALUES ("PQ", "RS") IN dbs2,
PARTITION p3 VALUES ("XX", "YY", "ZZ") IN dbs2
```

If the previous remainder fragment **p3** had a row with value "AA" in column **c**, then that row does not fit in any of the fragments in the new fragmentation scheme. The ALTER FRAGMENT statement above would therefore fail with an error while attempting to move rows from the remainder fragment.

The next three examples illustrate modifications to the same table fragmentation scheme that will fail because of overlaps.

```
ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p2 TO PARTITION p2 VALUES (NULL) IN dbs2;
```

Because the ALTER FRAGMENT statement above attempts to change fragment **p2** into a duplicate NULL fragment, the statement fails with an error, because the NULL fragment **p3** already exists.

The following modification of the same table attempts to modify fragment **p2** into a duplicate remainder fragment:

```
ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p2 TO PARTITION p2 REMAINDER IN dbs2;
```

The statement above fails with an error, because the existing fragment **p4** is already defined as a remainder fragment.

The following modification creates a duplicate expression-list value "RS" in two of the fragments:

```
ALTER FRAGMENT ON TABLE tab MODIFY
PARTITION p1 TO PARTITION p1
VALUES ("AB", "CD", "RS") IN dbs1;
```

Because list value "RS" is already defined in the expression list for fragment **p2**, the statement above fails with an error.

For an example of using the MODIFY option to the ALTER FRAGMENT ON INDEX statement, see [Examples of ALTER FRAGMENT ON INDEX statements](#).

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Examples of ALTER FRAGMENT ON INDEX statements

The following series of examples illustrate the use of ALTER FRAGMENT ON INDEX with the INIT, ADD, DROP, and MODIFY options.

This first example creates an index stored in **dbsp1**:

```
CREATE INDEX item_idx ON items (stock_num) IN dbsp1;
```

The following statement modifies the index to add fragmentation by expression. Values up to 50 are stored in **dbsp1**, values between 51 and 80 in **dbsp2**, and the remainder in **dbsp3**:

```
ALTER FRAGMENT ON INDEX item_idx INIT
FRAGMENT BY EXPRESSION
stock_num <= 50 IN dbsp1,
stock_num > 50 AND stock_num <= 80 IN dbsp2,
REMAINDER IN dbsp3;
```

The following statement adds a new fragment to the index:

```
ALTER FRAGMENT ON INDEX item_idx
ADD stock_num > 80 AND stock_num <= 120 IN dbsp4;
```

The following statement changes the first fragment of the index:

```
ALTER FRAGMENT ON INDEX item_idx
MODIFY dbsp1 TO stock_num <= 40 IN dbsp1;
```

The following statement drops the fragment in **dbsp4** from the index:

```
ALTER FRAGMENT ON INDEX item_idx
DROP dbsp4;
```

The following statement defines an index that is fragmented by expression, with the fragments stored in named partitions of the dbspaces **dbsp1** and **dbsp2**:

```
ALTER FRAGMENT ON INDEX item_idx INIT
PARTITION BY EXPRESSION
PARTITION part1 stock_num <= 10 IN dbsp1,
PARTITION part2 stock_num > 20 AND stock_num <= 30 IN dbsp1,
PARTITION part3 REMAINDER IN dbsp2;
```

The following statement adds a new named fragment:

```
ALTER FRAGMENT ON INDEX item_idx ADD
PARTITION part4 stock_num > 30 AND stock_num <= 40 IN dbsp2
BEFORE part3;
```

The following statement defines a range interval storage distribution scheme on the index **idx1**:

```
ALTER FRAGMENT ON INDEX idx2 INIT
FRAGMENT BY RANGE(c2)
INTERVAL (NUMTOYMINTERVAL(1, 'MONTH'))
PARTITION part0 VALUES < DATE('01/01/2007') IN dbs0,
PARTITION part1 VALUES < DATE('07/01/2007') IN dbs1,
PARTITION part2 VALUES < DATE('01/01/2008') IN dbs2
```

In the example above,

- the fragmentation key is the value of column **c2**,
- the interval value is one month,
- because no STORE IN clause is included, new system-generated interval partitions will be stored in **dbs0**, **dbs1**, and **dbs2** in round-robin fashion;
- the interval partition transition value is 01/01/2008. (This is the smallest value beyond the range of the last user-defined fragment.)

The following statement defines a list storage distribution scheme on the index **idx2**:

```
ALTER FRAGMENT ON INDEX idx2 INIT
FRAGMENT BY LIST(state)
PARTITION part0 VALUES ('KS', 'IL') IN dbs0,
```

In the list fragmentation example above,

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Use the ALTER FUNCTION statement to change the routine modifiers or pathname of a user-defined function. This statement is an extension to the ANSI/ISO standard for SQL.

```
>>-ALTER----->
      .-,-,------.
      V              |
>-+--FUNCTION--function--(---+--+---+--+)-+----->
    |                  |'-parameter_type-'|
    |                  |         (1)       |
    |'-SPECIFIC FUNCTION--| Specific Name |-----'
      .-,-,------.
      V              |
>-+--WITH(---+--+ADD-----+--| Routine Modifier |-----+--+)-><
    | +--MODIFY--+
    | '-DROP----'|
    |   (3)      |
    |'------MODIFY EXTERNAL NAME = -| Shared-Object Filename |(4)---'

```

Notes:

1. See [Specific Name](#)
2. See [Routine modifier](#)
3. External routines only
4. See [Shared-Object Filename](#)

Element	Description	Restrictions	Syntax
<i>function</i>	User-defined function to be modified	Must be registered in the database. If the name does not uniquely identify a function, you must enter one or more appropriate values for <i>parameter_type</i> .	Identifier
<i>parameter_type</i>	Data type of a parameter	Must be the same data types (and specified in the same order) as in the definition of <i>function</i> .	Data Type

The ALTER FUNCTION statement can modify a user-defined function to tune its performance by modifying characteristics that control how the function executes. You can also add or replace related user-defined routines (UDRs) that provide alternatives for the query optimizer, which can improve performance.

All modifications take effect on the next invocation of the function.

Only the UDR owner or the DBA can use the ALTER FUNCTION statement.

- Keywords That Introduce Modifications
Use the following keywords to introduce what you modify in the UDR.

Related concepts:

Overloading the Name of a Function

Related reference:

DROP FUNCTION statement

CREATE PROCEDURE statement

ALTER ROUTINE statement

Arguments

ALTER PROCEDURE statement

CREATE FUNCTION statement

Related information:

Create and use SPL routines

Create an external-language routine

Keywords That Introduce Modifications

Use the following keywords to introduce what you modify in the UDR.

Keyword	Effect on Specified Routine Modifier
ADD	Add a new routine modifier to the UDR
MODIFY	Change an attribute of the routine modifier
DROP	Delete the routine modifier from the UDR
MODIFY EXTERNAL NAME (for external functions only)	Replace the file specification of the executable file. When the IFX_EXTEND_ROLE configuration parameter = ON, this option is valid only for users to whom the DBSA has granted the EXTEND role. With IFX_EXTEND_ROLE = OFF (or not set), the UDR owner or the DBA can use this option.
WITH	Introduces all modifications

If the routine modifier is a BOOLEAN value, MODIFY sets the value to be `1` (equivalent of using the keyword ADD to add the routine modifier). For example, both of the following statements alter the **func1** function so that it can be executed in parallel in the context of a parallelizable data query:

```
ALTER FUNCTION func1 WITH (MODIFY PARALLELIZABLE);
ALTER FUNCTION func1 WITH (ADD PARALLELIZABLE);
```

See also [Example of Altering Routine Modifiers](#).

ALTER INDEX statement

Use the ALTER INDEX statement to change the clustering attribute of an existing index. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>--ALTER INDEX--index---TO--+-+-----+-+--CLUSTER-----><
      |           (1) |
      '-NOT-----'
```

Notes:

1. See [TO NOT CLUSTER Option](#)
2. See [TO CLUSTER Option](#)

Element	Description	Restrictions	Syntax
<i>index</i>	Name of the index to be altered	Must exist	Identifier

Usage

ALTER INDEX is valid only for indexes that the CREATE INDEX statement created explicitly. ALTER INDEX cannot modify an index on a temporary table, nor an index that the database server created implicitly to support a constraint.

You cannot change the collating order of an existing index. If you use ALTER INDEX to modify an index after the SET COLLATION statement of SQL has specified a non-default collating order, the SET COLLATION statement has no effect on the index.

The ALTER INDEX statement cannot reference a forest of trees index. For information on forest of trees indexes, see [HASH ON clause](#).

- [TO CLUSTER Option](#)
The TO CLUSTER option causes the database server to reorder the rows of the physical table according to the order of index-key values.
- [TO NOT CLUSTER Option](#)
The TO NOT CLUSTER option drops the cluster attribute on the specified index without affecting the physical order of rows in the table.

Related reference:

[RENAME INDEX statement](#)
[CREATE INDEX statement](#)


```

V
>--WITH(---+--ADD-----| Routine Modifier |-----+--)-><
| +-MODIFY-+
| '-DROP---'
| (3)
|-----MODIFY EXTERNAL NAME = -| Shared-Object Filename |-----'
(4)

```

Notes:

1. See [Specific Name](#)
2. See [Routine modifier](#)
3. External routines only
4. See [Shared-Object Filename](#)

Element	Description	Restrictions	Syntax
<i>procedure</i>	User-defined procedure to modify	Must be registered in the database. If the name does not uniquely identify a function, you must enter one or more appropriate values for <i>parameter_type</i> .	Identifier
<i>parameter_type</i>	Data type of a parameter	Must be the same data types (and specified in the same order) as in the definition of <i>procedure</i> .	Data Type

Usage

The ALTER PROCEDURE statement enables you to modify an external procedure to tune its performance by modifying characteristics that control how it executes. You can also add or replace related UDRs that provide alternatives for the optimizer, which can improve performance. All modifications take effect on the next invocation of the procedure.

Only the UDR owner or the DBA can use the ALTER PROCEDURE statement.

If the procedure name is not unique among routines registered in the database, you must enter one or more appropriate values for *parameter_type*.

The following keywords introduce what you want to modify in *procedure*.

Keyword	Effect
ADD	Add a new routine modifier to the UDR
MODIFY	Change an attribute of a routine modifier
DROP	Delete a routine modifier from the UDR
MODIFY EXTERNAL NAME (for external procedures only)	Replace the file specification of the executable file. When the IFX_EXTEND_ROLE configuration parameter = ON, this option is valid only for users to whom the DBSA has granted the EXTEND role. With IFX_EXTEND_ROLE = OFF (or not set), the UDR owner or the DBA can use this option.
MODIFY EXTERNAL NAME (for external procedures only)	Replace the file specification of the executable file. (Valid only for users who have the EXTEND role)
WITH	Introduces all modifications

If the routine modifier is a BOOLEAN value, MODIFY sets the value to be T (equivalent to using the keyword ADD to add the routine modifier). For example, both of the following statements alter the **proc1** procedure so that it can be executed in parallel in the context of a parallelizable data query:

```

ALTER PROCEDURE proc1 WITH (MODIFY PARALLELIZABLE);
ALTER PROCEDURE proc1 WITH (ADD PARALLELIZABLE);

```

See also [Example of Altering Routine Modifiers](#).

Related reference:

[CREATE PROCEDURE statement](#)
[ALTER ROUTINE statement](#)
[Arguments](#)
[ALTER FUNCTION statement](#)
[DROP PROCEDURE statement](#)
[DROP ROUTINE statement](#)

Related information:

[Create and use SPL routines](#)
[Create an external-language routine](#)
[Develop a user-defined routine](#)

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ALTER ROUTINE statement

Use the ALTER ROUTINE statement to change the routine modifiers or pathname of a previously defined user-defined routine (UDR). This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

Notes:

1. See [Specific Name](#)
2. See [Routine modifier](#)
3. External routines only
4. See [Shared-Object Filename](#)

Element	Description	Restrictions	Syntax
<i>routine</i>	User-defined routine to modify	Must be registered in the database. If the name does not uniquely identify a routine, you must enter one or more appropriate values for <i>parameter_type</i> .	Identifier
<i>parameter_type</i>	Data type of a parameter	Must be the same data types (and specified in the same order) as in the definition of <i>routine</i> .	Data Type

Usage

The ALTER ROUTINE statement allows you to modify a previously defined UDR to tune its performance by modifying characteristics that control how the UDR executes. You can also add or replace related UDRs that provide alternatives for the optimizer, which can improve performance.

This statement is useful when you do not know whether a UDR is a user-defined function or a user-defined procedure. When you use this statement, the database server alters the appropriate user-defined procedure or user-defined function.

All modifications take effect on the next invocation of the UDR.

Only the UDR owner or the DBA can use the ALTER ROUTINE statement.

- Restrictions
- Keywords That Introduce Modifications
- Example of Altering Routine Modifiers

Related concepts:

Overloading the Name of a Function

Related reference:

CREATE PROCEDURE statement

ALTER FUNCTION statement

ALTER PROCEDURE statement

CREATE FUNCTION statement

DROP FUNCTION statement

DROP PROCEDURE statement

DROP ROUTINE statement

Arguments

Related information:

Create and use SPL routines

Create an external-language routine

Creating UDR code

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Restrictions

If the name does not uniquely identify a UDR, you must enter one or more appropriate values for *parameter_type*.

When you use this statement, the type of UDR cannot be ambiguous. The UDR that you specify must refer to either a user-defined function or a user-defined procedure. If either of the following conditions exist, the database server returns an error:

- The name (and parameters) that you specify applies to both a user-defined procedure and a user-defined function.
- The specific name that you specify applies to both a user-defined function and a user-defined procedure.

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Keywords That Introduce Modifications

Use these keywords to introduce the items in the UDR that you want to modify:

Keyword	Effect
ADD	Add a routine modifier to the UDR
DROP	Delete a routine modifier from the UDR
MODIFY	Change an attribute of the routine modifier
MODIFY EXTERNAL NAME (for external routines only)	Replace the file specification of the executable file. When the IFX_EXTEND_ROLE configuration parameter = ON, this option is valid only for users to whom the DBSA has granted the EXTEND role. With IFX_EXTEND_ROLE = OFF (or not set), the UDR owner or the DBA can use this option.
WITH	Introduces all modifications

If the routine modifier is a BOOLEAN value, MODIFY sets the value to be **T** (equivalent to using the keyword ADD to add the routine modifier).

For example, both of the following statements alter the **func1** UDR so that it can be executed in parallel in the context of a parallelizable data query statement:

```
ALTER ROUTINE func1 WITH (MODIFY PARALLELIZABLE);
ALTER ROUTINE func1 WITH (ADD PARALLELIZABLE);
```

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Example of Altering Routine Modifiers

Suppose you have an external function **func1** that is set to handle NULL values and has a cost per invocation set to 40. The following ALTER ROUTINE statement adjusts the settings of the function by dropping the ability to handle NULL values, tunes the **func1** by changing the cost per invocation to 20, and indicates that the function can execute in parallel:

```
ALTER ROUTINE func1 (CHAR, INT, BOOLEAN)
  WITH (
    DROP HANDLESNULLS,
    MODIFY PERCALL_COST = 20,
    ADD PARALLELIZABLE
  );
```

Because the name **func1** is not unique to the database, the data type parameters are specified so that the routine signature is unique. If this function had a Specific Name, for example, **raise_sal**, specified when it was created, you could identify the function with the following first line:

```
ALTER SPECIFIC ROUTINE raise_sal;
```

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ALTER SECURITY LABEL COMPONENT statement

Use the **ALTER SECURITY LABEL COMPONENT** statement to add one or more new elements to an existing security label component in the current database. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```

>>-ALTER SECURITY LABEL COMPONENT-- component--ADD----->
      .-,-----.
      | .-,-----|
      | V V       |
>--+ARRAY--[------element+--+BEFORE+--+old_element+--+]-+-->
      |                                     |
      | .-,-----.                       |
      | V       |                         |
+--SET--{-{--element+--+}-----+-----+
      | .-,-----.                       |
      | V       |                         |
      |'-TREE--((-element--UNDER--old element+--+)-+-----|

```

Element	Description	Restrictions	Syntax
<i>component</i>	Component to which <i>element</i> is added	Must already exist in the database.	Identifier
<i>element</i>	New element of <i>component</i>	Must be unique among elements of this <i>component</i> , and no longer than 32 bytes. The left (<code>()</code>) and right (<code>()</code>) parentheses, comma (<code>,</code>), and colon (<code>:</code>) symbols are not valid characters.	Quoted String

Element	Description	Restrictions	Syntax
<i>old_element</i>	Existing element of <i>component</i>	Must be an element of <i>component</i> .	Quoted String

Usage

Only DBSECADM can issue the ALTER SECURITY LABEL COMPONENT statement, which defines new elements of an existing security label component. The new elements become part of any security policy defined in a CREATE SECURITY POLICY statement that references the specified component.

A security label component consists of a set of no more than 64 *elements* that the CREATE SECURITY LABEL COMPONENT statement defines as string constants. Each string constant can have no more than 32 bytes, and each must be unique among elements of this component. The declaration of each element, which is a valid value that the component can have, defines a category of data sensitivity. By adding new elements to an existing component, the ALTER SECURITY LABEL COMPONENT statement expands the set of values that a component can have within a security policy that includes the component, or within a security label that supports the security policy.

When the ALTER SECURITY LABEL COMPONENT statement executes successfully, Informix® updates the following tables of the system catalog of the current database:

- The **sysseclabelcomponentelements** table, to add new rows for each new elements of the component,
- The **sysseclabelcomponents** table, to show the new cardinality of the security elements that comprise the modified security component.

This statement can define new elements of a security label component, but it cannot modify or drop an existing element. If the security design changes so that different elements are required, DBSECADM can add the new elements, if the total number of elements remains within the size and cardinality limits, and not use any obsolete elements in defining labels that include the component.

Alternatively, DBSECADM can use the DROP SECURITY LABEL COMPONENT statement to drop the component, and then use the CREATE SECURITY LABEL COMPONENT statement to redefine a new component that has only the required elements. You cannot, however, drop a security component if it is part of an existing security policy. See [DROP SECURITY statement](#) for information about restrictions on dropping security label components and other security objects of Informix.

The security label component to which new elements are added must be one of three component types. The ARRAY, SET, or TREE keyword that immediately follows the *component* name must specify the same component type that the CREATE SECURITY LABEL COMPONENT statement specified when the component was originally defined. The syntax for specifying the new list of elements depends on whether the specified component is of type ARRAY, SET, or TREE, which are the three types of security component that Informix supports.

- [The ADD ARRAY Clause](#)
- [The ADD SET Clause](#)
- [The ADD TREE Clause](#)

A security label component of type TREE has the logical topology of a simple graph with no loops. Each TREE component has a single root node and no more than 63 additional nodes. Any new elements that the ALTER SECURITY LABEL COMPONENT statement adds to this hierarchy must be inserted below the root node. The string constant for each new node must be followed by the keyword UNDER and by the string constant for some previously declared node. The set of elements of the TREE component, including their UNDER keywords and comma separators, must be enclosed between a pair of parenthesis ((...)) symbols.

Related reference:

[RENAME SECURITY statement](#)
[DROP SECURITY statement](#)
[CREATE SECURITY LABEL statement](#)
[CREATE SECURITY LABEL COMPONENT statement](#)
[ALTER TABLE statement](#)
[CREATE SECURITY POLICY statement](#)
[CREATE TABLE statement](#)
[EXEMPTION Clause](#)
[SECURITY LABEL Clause](#)
[EXEMPTION Clause](#)
[SECURITY LABEL Clause](#)

Related information:

[Label-based access control](#)

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The ADD ARRAY Clause

A security label component of type ARRAY is an ordered set of no more than 64 elements. The order in which array elements are declared is significant, because it defines a descending order of data sensitivity, with each successive element ranking lower in data sensitivity than the preceding element. The set of label elements of the array and their comma (,) separators must be enclosed between a pair of bracket ([...]) symbols. The same new *element* cannot be declared more than once in the same ADD ARRAY clause.

In the ADD ARRAY clause, the BEFORE or AFTER keyword must follow the new element (or a comma-separated list of new elements) to specify the position of the new element within the descending order of data sensitivity. Within restrictions on the size and the number of elements, this syntax enables DBSECADM to insert a new element anywhere in the array, including the highest or the lowest position, or between consecutive existing elements. The ALTER SECURITY LABEL COMPONENT statement fails with an error, however, if the BEFORE or AFTER keyword of the ADD ARRAY clause specifies an array element that was not previously defined, either when the array component was created, or else in a previous ALTER SECURITY LABEL COMPONENT statement that modified the same array component.

If multiple ALTER SECURITY LABEL COMPONENT operations are performed to add elements to the same component of type ARRAY, DBSECADM might not be able to reach the maximum of 64 array elements because of how array elements are encoded. For information on how security elements are encoded, see the IBM® Informix® Security Guide.

The following example defines a security label component of type ARRAY called **aquilae** that is an ordered set of five elements, with **imperator** highest in data sensitivity and **asinus** lowest. The subsequent ALTER SECURITY LABEL COMPONENT statement adds two new elements:

- a new element called **legatus** that ranks between **imperator** and **tribunus**
- a new element called **cunctator** that ranks below **asinus** as the new low in data sensitivity.

```
CREATE SECURITY LABEL COMPONENT aquilae
  ARRAY [ "imperator", "tribunus", "centurio", "miles", "asinus" ];

ALTER SECURITY LABEL COMPONENT aquilae
  ADD ARRAY [ "legatus" BEFORE "tribunus", "cunctator" AFTER "asinus" ];
```

Successful execution of this ALTER SECURITY LABEL COMPONENT ... ADD ARRAY statement modifies the **aquilae** security label component array, so that the new descending order of component elements becomes this: **imperator, legatus, tribunus, centurio, miles, asinus, cunctator**.

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The ADD SET Clause

A security label component of type SET is an unordered set of no more than 64 elements. The order in which the elements of a SET component are declared is not significant. The set of elements of the array and their comma separators must be enclosed between a pair of braces ({ ... }) symbols. The same new *element* cannot be declared more than once in the same ADD SET clause.

The following example defines a type SET security label component called **departments** that is an unordered set of three elements, called **Marketing**, **HR**, and **Finance**, which the ALTER SECURITY LABEL COMPONENT statement modifies by adding three new elements called **Training**, **QA**, and **Security**:

```
CREATE SECURITY LABEL COMPONENT departments
  SET { 'Marketing', 'HR', 'Finance' };

ALTER SECURITY LABEL COMPONENT departments
  ADD SET { 'Training', 'QA', 'Security' };
```

Unlike ADD ARRAY or ADD TREE specifications, ADD SET operations of ALTER SECURITY LABEL COMPONENT do not create "greater than" or "less than" data-sensitivity relationships among the new and existing elements of the redefined component, because the elements of a type SET component have no implicit order of data sensitivity.

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The ADD TREE Clause

A security label component of type TREE has the logical topology of a simple graph with no loops. Each TREE component has a single root node and no more than 63 additional nodes. Any new elements that the ALTER SECURITY LABEL COMPONENT statement adds to this hierarchy must be inserted below the root node. The string constant for each new node must be followed by the keyword UNDER and by the string constant for some previously declared node. The set of elements of the TREE component, including their UNDER keywords and comma separators, must be enclosed between a pair of parenthesis ((...)) symbols.

The component element specified after the UNDER keyword is called the *parent* of the new element that precedes the same UNDER keyword. The new element is called the *child* of that parent element. The ALTER SECURITY LABEL COMPONENT statement fails with an error, however, if the ADD TREE clause specifies a parent element that is not already defined in the database for this component. The UNDER keyword cannot be followed by an element that is added to the component in the same ADD TREE clause.

The string constant that designates the root node of a TREE component has the highest data sensitivity of all the nodes within the TREE hierarchy. In any subset of successive parent nodes and child nodes in the tree, each non-root element has lower data sensitivity than its parent element or than any ancestor of its parent element, but has higher data sensitivity than any of its child elements or than the descendents of its child elements.

When a user who holds no exemptions attempts to access a data row that is protected by a label that includes a TREE component, a read operation fails if the security label of the user does not include an element that matches one of the TREE elements for the same component of the data row label, or that matches an ancestor of one of those elements. Unless the security policy of the label includes the OVERRIDE clause, a write operation also fails in the same circumstances. If the data row label has multiple TREE components, the user security label must include a matching (or an ancestral) element value for every TREE component of the data row security label.

In the following example, the ALTER SECURITY LABEL COMPONENT statement modifies a tree component called **Oakland** by adding two new nodes to its tree structure that was defined with six nodes by this CREATE SECURITY LABEL COMPONENT statement:

```
CREATE SECURITY LABEL COMPONENT Oakland
  TREE ( 'Port' ROOT,
    'Downtown' UNDER 'Port',
    'Airport' UNDER 'Port',
    'Estuary' UNDER 'Airport',
    'Avenues' UNDER 'Downtown',
    'Hills' UNDER 'Avenues');

ALTER SECURITY LABEL COMPONENT Oakland
  ADD TREE ( 'Uptown' UNDER 'Port',
    'Bay' UNDER 'Estuary');
```

Here new **Uptown** node is a child of **Port**, which has the highest data sensitivity because it is the root node. The new **Bay** node is the child of **Estuary**, which is the child of **Airport**, which is the child of **Port**, implying that **Bay** has a lower data sensitivity than these three nodes of the hierarchy. In practice, it is unlikely that any data would be labeled with **Port**, rather than classified at a lower level. The **Port** value might be used for a label granted to a user who is allowed to access all of the data about the **Port**.

If the ALTER SECURITY LABEL COMPONENT statement in this example succeeds, and a subsequently defined data row label specifies **Bay** as its value for the **Oakland** component, a user with no exemption for the security policy who attempts to read the protected row in a query would need either **Port**, **Airport**, **Estuary**, or **Bay** as a user label value to satisfy this component of the data row label. Values of **Uptown** or **Downtown** for this component in the user label are insufficient, because they do not match **Bay** and are not ancestors of **Bay**. For a query to read the protected row, the security label of the user must also include values that satisfy any other components of the row security label, and the user must also hold Select access privilege on the table and at least Connect access privilege on the database that contains the protected row.

The ADD TREE clause cannot interpose a new node between an existing child node and its parent.

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ALTER SEQUENCE statement

Use the ALTER SEQUENCE statement to modify the definition of a sequence object. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-ALTER SEQUENCE--+-sequence----->
      '-owner.-'

      .-----+
      V      |
>-----+-----><
      | (1)  .-NOCYCLE-.
      +-----+-----+
      | (1)  .-CYCLE-+-----+
      | +-----+-----+
      | | .-CACHE size+-----+
      | | .-NOCACHE---+-----+
      | | (1)  .-ORDER---+-----+
      | | .-NOORDER+-----+
      | | (1)  .-BY-.
      | +-----+-----+
      | .-INCREMENT+-----+step+
      | (1)  .-WITH-.
      | +-----+-----+restart+
      | (1)  .-NOMAXVALUE---+
      | +-----+-----+max+
      | | (1)  .-NOMINVALUE---+
      | +-----+-----+min+-----+
      | .-MINVALUE---min+-----+
      +-----+-----+
```

Notes:

1. Use path no more than once

Element	Description	Restrictions	Syntax
<i>max</i>	New upper limit on values	Must be integer > CURRVAL and <i>restart</i>	Literal Number
<i>min</i>	New lower limit on values	Must be integer < CURRVAL and <i>restart</i>	Literal Number
<i>owner</i>	Owner of <i>sequence</i>	Cannot be changed by this statement	Owner name
<i>restart</i>	New first value in sequence	Must be integer in the INT8 range	Literal Number
<i>sequence</i>	Name of existing sequence	Must exist. Cannot be a synonym.	Identifier
<i>size</i>	New number of values to preallocate in memory	Integer > 2 but < cardinality of values in one cycle (= $|(max - min)/step|$)	Literal Number
<i>step</i>	New interval between successive values	Must be a nonzero integer	Literal Number

Usage

The ALTER SEQUENCE statement can update the definition of a specified sequence object in the **syssequences** system catalog table.

ALTER SEQUENCE redefines an existing sequence object. It only affects subsequently generated values (and any unused values in the sequence cache). You cannot use the ALTER SEQUENCE statement to rename a sequence nor to change the owner of a sequence.

You must be the owner, or the DBA, or else have the Alter privilege on the sequence to modify its definition. Only elements of the sequence definition that you specify explicitly in the ALTER SEQUENCE statement are modified. An error occurs if you make contradictory changes, such as specifying both MAXVALUE and NOMAXVALUE, or both the CYCLE and NOCYCLE options.

Examples

The examples below are based on the following sequence object and table:

```

CREATE SEQUENCE seq_2
  INCREMENT BY 1 START WITH 1
  MAXVALUE 30 MINVALUE 0
  NOCYCLE CACHE 10 ORDER;

CREATE TABLE tab1 (col1 int, col2 int);
INSERT INTO tab1 VALUES (0, 0);

INSERT INTO tab1 (col1, col2) VALUES (seq_2.NEXTVAL, seq_2.NEXTVAL);

SELECT * FROM tab1;

ALTER SEQUENCE seq_2
  RESTART WITH 5
  INCREMENT by 2
  MAXVALUE 300;

INSERT INTO tab1 (col1, col2) VALUES (seq_2.NEXTVAL, seq_2.NEXTVAL);
INSERT INTO tab1 (col1, col2) VALUES (seq_2.NEXTVAL, seq_2.NEXTVAL);
SELECT * FROM tab1;

```

col1	col2
0	0
1	1

col1	col2
0	0
1	1
5	5
7	7

- [INCREMENT BY Option](#)
- [RESTART WITH Option](#)
- [MAXVALUE or NOMAXVALUE Option](#)
- [MINVALUE or NOMINVALUE Option](#)
- [CYCLE or NOCYCLE Option](#)
- [CACHE or NOCACHE Option](#)
- [ORDER or NOORDER Option](#)

Related reference:

[DROP SEQUENCE statement](#)
[CREATE SEQUENCE statement](#)
[RENAME SEQUENCE statement](#)
[CREATE SYNONYM statement](#)
[DROP SYNONYM statement](#)
[GRANT statement](#)
[REVOKE statement](#)
[INSERT statement](#)
[SELECT statement](#)
[UPDATE statement](#)
[NEXTVAL and CURRVAL Operators](#)

Related information:

[SYSSEQUENCES](#)

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INCREMENT BY Option

Use the INCREMENT BY option to specify a new interval between successive numbers in a sequence. The interval, or *step* value, can be a positive whole number (for ascending sequences) or a negative whole number (for descending sequences) in the INT8 range. The BY keyword is optional.

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RESTART WITH Option

Use the RESTART WITH option to specify a new first number of the sequence. The *restart* value must be an integer within the INT8 range that is greater than or equal to the *min* value (for an ascending sequence) or that is less than or equal to the *max* value (for a descending sequence), if *min* or *max* is specified in the ALTER SEQUENCE statement. The WITH keyword is optional.

When you modify a sequence using the RESTART option, the *restart* value is stored in the **syssequences** system catalog table only until the first use of the sequence object in a **NEXTVAL** expression. After that, the value is reset in the system catalog. Use of the **dbschema** utility can increment sequence objects in the database, creating gaps in the generated numbers that might not be expected in applications that require serialized integers.

MAXVALUE or NOMAXVALUE Option

Use the MAXVALUE option to specify a new upper limit of values in the sequence. The maximum value, or *max*, must be an integer in the INT8 range that is greater than *sequence.CURRVAL* and *restart* (or greater than the *origin* in the original CREATE SEQUENCE statement, if *restart* is not specified).

Use the NOMAXVALUE option to replace the current limit with a new default maximum of 2^{64} for ascending sequences or -1 for descending sequences.

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MINVALUE or NOMINVALUE Option

Use the MINVALUE option to specify a new lower limit of values in the sequence. The minimum value, or *min*, must be an integer the INT8 range that is less than *sequence.CURRVAL* and *restart* (or less than the *origin* in the original CREATE SEQUENCE statement, if *restart* is not specified).

Use the NOMINVALUE option to replace the current lower limit with a default of 1 for ascending sequences or $-(2^{64})$ for descending sequences.

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CYCLE or NOCYCLE Option

Use the CYCLE option to continue generating sequence values after the sequence reaches the maximum (ascending) or minimum (descending) limit, to replace the NOCYCLE attribute. After an ascending sequence reaches *max*, it generates the *min* value for the next value. After a descending sequence reaches *min*, it generates the *max* value for the next sequence value.

Use the NOCYCLE option to prevent the sequence from generating more values after reaching the declared limit. Once the sequence reaches the limit, the next reference to *sequence.NEXTVAL* returns an error message.

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CACHE or NOCACHE Option

Use the CACHE option to specify a new number of sequence values that are preallocated in memory for rapid access. The cache size must be a whole number in the INT range that is less than the number of values in a cycle (or less than $(\text{max} - \text{min})/\text{step}$). The minimum size is 2 preallocated values.

Use NOCACHE to have no values preallocated in memory. (See also the description of SEQ_CACHE_SIZE in [CREATE SEQUENCE statement](#).)

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ORDER or NOORDER Option

These keywords have no effect on the behavior of the sequence. The sequence always issues values to users in the order of their requests, as if the ORDER keyword were always specified. The ORDER and NOORDER keywords are accepted by the ALTER SEQUENCE statement, however, for compatibility with implementations of sequence objects in other dialects of SQL.

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ALTER TABLE statement

Use the ALTER TABLE statement to modify the schema of an existing table.

Syntax

```
>>-ALTER TABLE--++table-++-----| Basic Table Options |-----++<
      '-synonym-'      |          (1)          |
      +-| Logging TYPE Options |-----+
      |          (2)          |
      +-| ADD TYPE Clause |-----++
      |          (3)          |
```


The ALTER TABLE statement cannot add a fragmentation strategy to a nonfragmented table, nor modify the storage distribution strategy of a fragmented table. To modify the distributed storage strategy of a table, you must use the ALTER FRAGMENT statement, rather than the ALTER TABLE statement. For information on adding, modifying, or dropping the storage distribution strategy of a table, see the [ALTER FRAGMENT statement](#).

Altering a table on which a view depends might invalidate the view.

Warning: The clauses available with this statement have varying performance implications. Before you undertake alter operations, check information in the [Altering a table definition](#) section in your *IBM® Informix® Performance Guide* to review effects and strategies.

The table whose name or synonym follows the ALTER TABLE keywords must be a permanent table in the current database. It is subject to the following restrictions:

- It cannot be a temporary table.
- It cannot be a table in a database that is not the current database.
- It cannot be a table object that the CREATE EXTERNAL TABLE statement defined.
- It cannot be a violations table or a diagnostics table.
- If the USETABLENAME environment variable is set, you cannot specify a *synonym* for the table in the ALTER TABLE statement.

In addition, you cannot use the ALTER TABLE statement for the following operations:

- Add, drop, or modify a column in a table that has an associated violation table or diagnostics table.
- Define a referential constraint or a unique constraint on a RAW table.
- Define an index on a column or on a set of columns that would conflict with the [Restrictions on columns as index keys](#).
- [Add or drop specialized columns](#)
You can add or drop specialized columns when you alter a table. Most specialized columns are shadow columns that support Enterprise Replication or high availability.
- [ADD Column Clause](#)
Use the ADD Column clause to add a column to a table, and to define constraints on the new column. This clause can also associate a security policy with a table that has no security policy, or can specify a security label for the new column, if the table already has a security policy.
- [ADD AUDIT Clause](#)
Use the ADD AUDIT clause with the ALTER TABLE command to include a table in selective row-level auditing.
- [ADD CONSTRAINT Clause](#)
Use the ADD CONSTRAINT clause to specify a primary key, foreign key, referential, unique, or check constraint on a new or existing column or on a set of columns.
- [ADD TYPE Clause](#)
Use the ADD TYPE clause to convert a table that is not based on a named ROW data type into a typed table.
- [DROP AUDIT Clause](#)
Use the DROP AUDIT clause with the ALTER TABLE command to remove it from the set of tables that is audited when selective row-level auditing is enabled.
- [DROP CONSTRAINT Clause](#)
Use the DROP CONSTRAINT clause to destroy an existing constraint whose name you specify.
- [DROP Column Clause](#)
Use the DROP Column clause to remove one or more columns from the schema of a table.
- [LOCK MODE Clause](#)
Use the LOCK MODE keywords to change the locking granularity of an existing table.
- [Logging TYPE Options](#)
Use the Logging TYPE options to specify that the table has particular characteristics that can improve various bulk operations on it.
- [MODIFY Clause](#)
Use the MODIFY clause to change the data type, length, or default value of a column, to add or remove the security label of a column, to allow or disallow NULL values in a column, or to reset the serial counter of a SERIAL, SERIAL8, or BIGSERIAL column.
- [MODIFY EXTENT SIZE](#)
Use the MODIFY EXTENT SIZE clause with the ALTER TABLE statement to change the size of the first extent of a table in a dbspace.
- [MODIFY NEXT SIZE clause](#)
Use the MODIFY NEXT SIZE clause to change the size of the next extent.
- [PUT Clause](#)
Use the PUT clause of the ALTER TABLE statement to define sbospace storage for a column that contains smart large objects. This clause can define BLOB or CLOB storage attributes for a new column, or it can modify the current settings of those storage attributes for an existing column.
- [SECURITY POLICY Clause](#)
Use the Security Policy clause of the ALTER TABLE statement to drop the security policy that is currently associated with the table, or to associate a security policy with a table that has none.
- [Statistics options of the ALTER TABLE statement](#)
Use the Statistics Options clause of the ALTER TABLE statement to change values of the STATCHANGE property of a fragmented or nonfragmented table, and the STATLEVEL property of a fragmented table. These table properties control the threshold for recalculation in automatic mode, and the granularity of data distribution statistics.

Related reference:

[Modes for constraints and unique indexes](#)
[CREATE TABLE statement](#)
[CREATE TEMP TABLE statement](#)
[RENAME TABLE statement](#)
[ALTER FRAGMENT statement](#)
[DROP INDEX statement](#)
[RENAME SECURITY statement](#)
[RENAME COLUMN statement](#)
[SET Transaction Mode statement](#)
[CREATE SECURITY LABEL statement](#)
[CREATE SECURITY LABEL COMPONENT statement](#)
[ALTER SECURITY LABEL COMPONENT statement](#)
[CREATE SECURITY POLICY statement](#)

Related information:

[Table performance considerations](#)

Add or drop specialized columns

You can add or drop specialized columns when you alter a table. Most specialized columns are shadow columns that support Enterprise Replication or high availability.

This syntax fragment is part of the [ALTER TABLE statement](#).

Adding or dropping specialized columns

```
|---+ADD---+---+CRCOLS-----+-----|
  '-DROP-'   +-ERKEY-----+
              +-REPLCHECK---+
              +-ROWIDS-----+
              '-VERCOLS---'
```

Usage

The following keywords control one or more specialized columns.

CRCOLS

The ADD CRCOLS keywords create shadow columns, **cdrserver** and **cdrtime**, that Enterprise Replication uses for conflict resolution. If Enterprise Replication is active while you are altering the table with the ADD CRCOLS clause, you must first put the table in alter mode with the **cdr alter** command. Altering a table to add the CRCOLS shadow columns can be a slow alter operation, if any of the table columns have data types that require a slow alter. Slow alter operations require disk space at least twice the size of the original table plus log space. For information on the performance implications of ALTER TABLE statements, see [Altering a table definition](#).

Use the DROP CRCOLS keywords to drop the **cdrserver** and **cdrtime** shadow columns. You must stop replication before you drop the **cdrserver** and **cdrtime** shadow columns.

For more information, refer to [Using the WITH CRCOLS Option](#).

ERKEY

The ADD ERKEY keywords create shadow columns, **ifx_erkey_1**, **ifx_erkey_2**, and **ifx_erkey_3**, that Enterprise Replication uses in place of a primary key. If Enterprise Replication is active while you are altering the table with the ADD ERKEY clause, you must first put the table in alter mode with the **cdr alter** command. Altering a table to add the ERKEY shadow columns is a slow alter operation.

Use the DROP ERKEY keywords to drop the **ifx_erkey_1**, **ifx_erkey_2**, and **ifx_erkey_3** shadow columns.

For more information, see [Using the WITH ERKEY Keywords](#).

REPLCHECK

The ADD REPLCHECK keywords create the shadow column, **ifx_replcheck**, that you can create an index on, along with your primary key, to speed the processing of consistency checking with Enterprise Replication. If Enterprise Replication is active while you are altering the table with the ADD REPLCHECK clause, you must first put the table in alter mode with the **cdr alter** command. Altering a table to add the **ifx_replcheck** shadow column is a slow alter operation, which requires disk space at least twice the size of the original table plus log space.

Use the DROP REPLCHECK keywords to drop the **ifx_replcheck** shadow column.

For more information, see [Using the WITH REPLCHECK Keywords](#).

ROWIDS

Important: This is a deprecated feature. The query optimizer might not use an index scan when explicit **rowid** shadow columns are defined on fragmented tables. When you create new applications, use primary keys as a method of row identification instead of using **rowid** values.

Use the ADD ROWIDS keywords to add a column called **rowid** to a fragmented table. (Fragmented tables do not contain the hidden **rowid** column by default.) When you add a **rowid** column, the database server assigns a unique number to each row that remains stable for the life of the row. The database server creates an index that it uses to find the physical location of the row. After you add the **rowid** column, each row of the table contains an additional 4 bytes to store the **rowid** value. Use the ADD ROWIDS clause only on fragmented tables. In nonfragmented tables, the **rowid** column remains unchanged.

The DROP ROWIDS keywords can drop a **rowid** column that you added (with either the ALTER TABLE or ALTER FRAGMENT statement) to a fragmented table.

VERCOLS

The ADD VERCOLS keywords create shadow columns, **ifx_insert_checksum** and **ifx_row_version**, that are used to support secondary server updates.

Altering a table to add row versioning columns is a fast alter operation.

Use the DROP VERCOLS keywords to drop the **ifx_insert_checksum** and **ifx_row_version** shadow columns.

For more information, see [Using the WITH VERCOLS Option](#) and [Row versioning](#).

Example: ADD CRCOLS

In the following example, the **cdrserver** and **cdrtime** shadow columns are added to the **customer** table:

```
ALTER TABLE customer ADD CRCOLS;
```

Example: ADD ERKEY

The following example adds the **ifx_erkey_1**, **ifx_erkey_2**, and **ifx_erkey_3** columns to the **customer** table:

```
ALTER TABLE customer ADD ERKEY;
```

Example: ADD REPLCHECK and DROP REPLCHECK

In the following example, the **ifx_replcheck** shadow column is added to the **customer** table:

```
ALTER TABLE customer ADD REPLCHECK;
```

The following example drops the **ifx_replcheck** column from the **customer** table:

```
ALTER TABLE customer DROP REPLCHECK;
```

Example: DROP ROWIDS

The following example drops the **rowid** column from the **frag1** table:

```
ALTER TABLE frag1 DROP ROWIDS;
```

Example: ADD VERCOLS

In the following example, the **ifx_insert_checksum** and **ifx_row_version**, shadow columns are added to the **customer** table:

```
ALTER TABLE customer ADD VERCOLS;
```

Related information:

[Shadow columns](#)

[Row versioning](#)

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ADD Column Clause

Use the ADD Column clause to add a column to a table, and to define constraints on the new column. This clause can also associate a security policy with a table that has no security policy, or can specify a security label for the new column, if the table already has a security policy.

This syntax fragment is part of the [ALTER TABLE statement](#).

ADD Column Clause

```

      .-'.-----'.
      V          |
|--ADD--+-(----| New Column |---)-+-----|
      '-| New Column |-----'

New Column

      (1)
|--new_column--| Data Type |----->

      .-----'.
      V          |
>-----+-----+----->
      | (2)          (3)          |
+-----| DEFAULT Clause |-----+
      | (2)          (4)          |
+-----| Single-Column Constraint Format |-----'

>-----+-----+----->
      |          (5)          |
+-----| BEFORE--column-----'

>-----+-----+-----|
      |          (6)          |
+-----| Add Column SECURED WITH label clause |-----'

```

Notes:

1. See [Data Type](#)
2. Use this path no more than once
3. See [DEFAULT clause of ALTER TABLE](#)
4. See [Single-Column Constraint Format](#)
5. See [BEFORE Clause](#)
6. See [Add column SECURED WITH label clause](#)

Element	Description	Restrictions	Syntax
<i>column</i>	Name of column before which <i>new_column</i> is to be placed	Must already exist in the table	Identifier

Element	Description	Restrictions	Syntax
<i>new_column</i>	Name of column that you are adding	You cannot add a serial column if the table contains data	Identifier

The following restrictions apply to the ADD clause:

- You cannot add a serial column to a table that contains data.
- You cannot add columns beyond the maximum row size of 32,767 bytes.

Restrictions on adding columns of type IDSSecurityLabel

The following restrictions affect the use of the ADD Column clause to add a column of the IDSSecurityLabel data type to support a label-based access control (LBAC) security policy:

- If the table has no security policy, a user who holds the DBSECADM role must also include the `ADD SECURITY POLICY` keywords to specify an LBAC security policy, as in this example:

```
CREATE TABLE tA
  (Col_1 BIGINT
   Col_2 INTERVAL(YEAR TO MONTH);
   Col_3 VARCHAR (255));
.
.
.
ALTER TABLE tA
  ADD (Col_4 IDSSecurityLabel DEFAULT 'label4'), --to add this column
  ADD SECURITY POLICY Watchdog; --a security policy is also required
                                -- and 'label4' must be a Watchdog label
```

- Only a user who holds the DBSECADM role can add a column of type IDSSecurityLabel.
- A table can have at most one column of type IDSSecurityLabel.
- The IDSSecurityLabel column cannot have `SECURED WITH` column protection.
- The IDSSecurityLabel column has an implicit NOT NULL constraint by default. If no *label* name for the default security label is specified in the DEFAULT clause, the default value for this column is the security label for write access that is held by the current user.
- The IDSSecurityLabel column cannot have any explicit single-column constraints, and it cannot be part of multiple-column referential or check constraints.

For the ALTER TABLE syntax to add or drop row-level LBAC protection for the table, see [SECURITY POLICY Clause](#).

For the ALTER TABLE syntax to add column-level protection for a new column in a table already protected by an LBAC security policy, see [Add column SECURED WITH label clause](#).

For the ALTER TABLE syntax to add or drop column-level LBAC protection for an existing column, see [Modify Column Security clause](#).

- [Logical Character Support in Character Columns](#)
- [BEFORE Clause](#)
The optional BEFORE clause determines the ordinal positions of the new columns within the schema of the table by specifying the name of an existing column before which the ALTER TABLE ADD statement inserts the new columns.
- [DEFAULT clause of ALTER TABLE](#)
Use the DEFAULT clause of the ALTER TABLE statement to specify value that the database server should insert in a column in DML operations that specify no explicit value for the column.
- [Single-Column Constraint Format](#)
Use the Single-Column Constraint Format to associate one or more constraints with a single column when you alter a table.
- [Add column SECURED WITH label clause](#)
The SECURED WITH Label clause associates the new column that the ALTER TABLE ADD statement defines with a label-based access control (LBAC) security label. This clause is valid only for a table that is protected by an LBAC security policy, and for a security label of the same policy.

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Logical Character Support in Character Columns

For new columns that you declare as built-in character data types, explicit or default size specifications are interpreted in units of bytes, unless the `SQL_LOGICAL_CHAR` configuration parameter has enabled logical character semantics for the current database. This feature is designed to reduce the risk of truncating data strings in locales that support a multibyte code set, such as **UTF-8**. Enabling this feature causes the SQL parser to interpret the declared column size as units of logical characters, rather than as bytes, and multiplies the declared storage size allocated for the new character column by a positive integer value, based on the `SQL_LOGICAL_CHAR` setting.

- If the value of this setting is `OFF` or `1`, the `SQL_LOGICAL_CHAR` configuration parameter has no effect.
- If the value of this setting is `ON`, rather than a digit, the expansion factor is the number of bytes that are required to store the largest logical character in the code set of the database. (The `ON` setting is equivalent to `4`, which is the largest valid digit.)

The value of this expansion factor is an attribute of the database, and is based on the `SQL_LOGICAL_CHAR` setting when the database was created, rather than when the ALTER TABLE statement is issued, if the two settings are not identical.

For columns that you declare as VARCHAR or NCHAR data types when this feature is enabled, only the maximum size specification is expanded by this feature. The reserved size is the number of bytes specified by the explicit or default *reserved* value in the data type declaration, because the minimum size of a logical character is 1 byte.

Size specifications for character columns of user-defined types (UDTs) are always interpreted as bytes, and are not affected by this feature. Columns that store strings as large objects, such as CLOB and TEXT, are similarly unaffected.

For more information about the SQL_LOGICAL_CHAR configuration parameter, see your *IBM® Informix® Administrator's Reference*. For additional information about multibyte locales and logical characters, see the *IBM Informix GLS User's Guide*.

Related information:

[SQL_LOGICAL_CHAR configuration parameter](#)

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BEFORE Clause

The optional BEFORE clause determines the ordinal positions of the new columns within the schema of the table by specifying the name of an existing column before which the ALTER TABLE ADD statement inserts the new columns.

In the following example, the BEFORE option directs the database server to add the **item_weight** column before the **total_price** column:

```
ALTER TABLE items
  ADD (item_weight DECIMAL(6,2) NOT NULL BEFORE total_price);
```

By default, if you do not include the BEFORE clause, the database server appends the new columns after the last column in the current schema of the table, in their lexical order within the ADD clause.

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DEFAULT clause of ALTER TABLE

Use the DEFAULT clause of the ALTER TABLE statement to specify value that the database server should insert in a column in DML operations that specify no explicit value for the column.

This syntax fragment is part of the [ADD Column Clause](#) and the [MODIFY Clause](#).

```
DEFAULT Clause

|--DEFAULT----->

>--+label-----+--+
+-literal-----+
+-+NULL-----+
| '-+USER-----+'
|   '-CURRENT_USER-'
|   (1)
+-+-----+CURRENT--+--+
|   '-SYSDATE-'   |   (2) |
|   '-| DATETIME Field Qualifier |---'
+-+TODAY-----+
| '-+SITENAME-----+'
|   '-DBSERVERNAME-'
```

Notes:

1. Informix® extension
2. See [DATETIME Field Qualifier](#)

Element	Description	Restrictions	Syntax
<i>label</i>	Name of a security label	Must exist and must belong to the security policy that protects the table. The column must be of type IDSSECURITYLABEL.	Identifier
<i>literal</i>	Literal default value for the column	Must be appropriate for the data type of the column. See Using a Literal as a Default Value .	Expression

Usage

If the table that you are altering already has rows in it when you use the ALTER TABLE ADD statement to add a column that contains a default value, the default values are applied to all existing rows and rows inserted after the ALTER TABLE ADD statement that added the new column.

Similarly, when the ALTER TABLE MODIFY statement uses the DEFAULT clause to define a new default value for a column that had no default or that had a different default, the rows that existed before the column was modified are unchanged, unless you update those rows to insert some NULL or non-NULL value. New rows that you insert will have the default value that the DEFAULT clause of the ALTER TABLE MODIFY statement specified, unless you insert some other value into the new column.

You cannot specify a default value for columns of type SERIAL, SERIAL8, or BIGSERIAL. For information about using the ALTER TABLE MODIFY statement to set the next value of a serial column to an arbitrary value higher than the current maximum, see [Altering the Next Serial Value](#).

For columns of DISTINCT or OPAQUE data types, you cannot specify as the default value a constant expression (such as CURRENT, SYSDATE DBSERVERNAME, SITENAME, TODAY, USER, or CURRENT_USER) that behaves like a variant function.

The DEFAULT NULL keywords

If you use the ALTER TABLE ADD statement to add a new column with an explicit default value, or if you use the ALTER TABLE MODIFY statement to change the data type or the default value of an existing column, the following restrictions apply to NULL as a default value:

- For columns of large-object data types like BYTE, TEXT, BLOB, or CLOB, or for columns of key-value pair (KVP) data types like BSON or JSON, the only valid default value is NULL.
- If you specify NULL as the default value for a column, you cannot specify a NOT NULL constraint as part of the column definition. (For details of NOT NULL constraints, see [Using the NOT NULL Constraint](#).)
- NULL is not a valid default value for a column that is part of a primary key.
- Serial columns cannot have a default value, including DEFAULT NULL.
- If a column was created or altered with no DEFAULT clause, and with no implicit or explicit NOT NULL constraint, its implicit default value is NULL.

Examples of default column values

The following statement adds column **item_velocity** to the **items** table, with NULL as its implicit default value:

```
ALTER TABLE items
  ADD (item_velocity DECIMAL(6,3) BEFORE total_price);
```

The following statement modifies the default value of column **item_velocity** by replacing NULL with an explicit default value:

```
ALTER TABLE items
  MODIFY (item_velocity DECIMAL(6,3) DEFAULT 299792.458);
```

Each existing row in the **items** table has the default value of NULL for the **item_velocity** column. Any new rows have the default value of 299792.458.

The next example adds a new column of data type CHAR(12) to the **items** table, where the new **item_color** column has an explicit default value of **translucent**:

```
ALTER TABLE items
  ADD (item_color CHAR(12) DEFAULT "translucent"
  BEFORE item_velocity);
```

Suppose that table **tabB** has the following schema:

```
CREATE TABLE tabB
(
  id VARCHAR(128) NOT NULL,
  data DATE DEFAULT TODAY,
  modcount BIGINT,
  flags INTEGER DEFAULT 12,
);
```

The following statement modifies **tabB** by changing the data type and the default value of the **data** column from type DATE with a default of **TODAY** to a BSON type with a default of NULL:

```
ALTER TABLE tabB
  MODIFY ( data "informix".BSON DEFAULT NULL);
```

The original default value of **TODAY** for the **data** column is not valid for a key-value pair data type like BSON.

For more information about the options of the DEFAULT clause, refer to the [DEFAULT clause of CREATE TABLE](#) topic of the CREATE TABLE statement.

- [DEFAULT security labels](#)
When DBSECADM adds a IDSSECURITYLABEL column to a table that is protected by a security policy, the DEFAULT *label* specification is required unless the table is empty. If the table is not empty, the specified *label* is inserted into the existing rows of the table

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DEFAULT security labels

When DBSECADM adds a IDSSECURITYLABEL column to a table that is protected by a security policy, the DEFAULT *label* specification is required unless the table is empty. If the table is not empty, the specified *label* is inserted into the existing rows of the table

If the DEFAULT value is the name of a security label, an error is issued in the following cases:

- if the *label* is the default value for a column whose data type is not IDSSECURITYLABEL,
- or if the table has no security policy,
- or if the security policy of the *label* is not the security policy of the table.

The same ALTER TABLE statement that adds the IDSSECURITYLABEL column can add a security policy.

To define a specific *label* as the default value of an IDSSECURITYLABEL column, specify the *label* name without the *policy* qualifier, rather than as *policy.label*. The current security policy of the table is the only valid policy for any security label that protects data in the table.

Examples of security labels as default values

The ALTER TABLE statement in the following example adds security policy **MegaCorp** to table **T1** and specifies column-level protection for the table by declaring a new column **D** of type IDSSECURITYLABEL, whose default value is a security label called **mylabel**:

```
ALTER TABLE T1
  ADD (D IDSECURITYLABEL DEFAULT mylabel1)
  ADD SECURITY POLICY MegaCorp;
```

Because no BEFORE clause is included, column **D** is last among the columns in the schema of table **T1**. This statement fails if any of the database objects that it references (except new column **D**) does not already exist in the database, or if the table already has a different security policy.

To replace the security policy of a table, you must hold the DBSECADM role. You must first use the ALTER TABLE DROP SECURITY POLICY statement to drop the current security policy and any of its labels from the table. Then you must add the new security policy, and at least one of its labels, as in the following example:

```
ALTER TABLE T1
    DROP SECURITY POLICY MegaCorp;
ALTER TABLE T1
    ADD (D IDSECURITYLABEL DEFAULT myNewLabel1)
    ADD SECURITY POLICY Watchdog;
```

In these ALTER TABLE statements that reference table **T1**,

- The DROP SECURITY POLICY clause of the first statement removes table **T1** from the protection of the **MegaCorp** security policy,
- and automatically drops from the schema of table **T1** any IDSSecurityLabel column that stores a label of the **MegaCorp** security policy. This has no effect, however, on other tables in the database that are protected by the **MegaCorp** security policy.
- The ADD (D IDSSecurityLabel DEFAULT myNewLabel1) clause protects table **T1** with the **myNewLabel1** security label,
- and the ADD SECURITY POLICY Watchdog clause replaces **MegaCorp** with **Watchdog** as the new security policy of table **T1**.

The second ALTER TABLE example fails unless the **myNewLabel1** security label is a label of the **Watchdog** security policy.

For more information about using the ALTER TABLE statement to add, modify, or drop an association between a table and a label-based security policy, see [Modify Column Security clause](#) and [SECURITY POLICY Clause](#). See also the DDL statements for creating label-based security objects, including [CREATE SECURITY POLICY statement](#), [CREATE SECURITY LABEL statement](#), and [CREATE SECURITY LABEL COMPONENT statement](#).

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Single-Column Constraint Format

Use the Single-Column Constraint Format to associate one or more constraints with a single column when you alter a table.

This syntax fragment is part of the [ADD Column Clause](#) and the [MODIFY Clause](#).

Single-Column Constraint Format

```

V-----+-----|
|--++--NULL---+-+--+-----+--+-----+--+-----+
| | '-NOT NULL-' | | (1) | | Constraint Definition | (4) |
++UNIQUE-----+ | | -----| 
| | (1) | | 
| | '-----DISTINCT-' | | 
++PRIMARY KEY-----+ 
| | (2) | 
+-| REFERENCES Clause |--+ 
| | (3) | 
'-| CHECK Clause |-+-----'

```

Notes:

1. Informix® extension
2. See [REFERENCES Clause](#)
3. See [CHECK Clause](#)
4. See [Constraint Definition](#)

You cannot specify a primary-key or unique constraint on a new column if the table contains data. In the case of a unique constraint, however, the table can contain a *single* row of data. When you want to add a column with a primary-key constraint, the table must be empty when you issue the ALTER TABLE statement.

The following rules apply when you place primary-key or unique constraints on existing columns:

- When you place a primary-key or unique constraint on a column or on a set of columns, the database server creates an internal B-tree index on the constrained column or set of columns, and automatically calculates column statistics, equivalent to distributions created by the UPDATE STATISTICS statement in HIGH mode, unless a user-created index was already defined on the same column or set of columns.
- When you place a primary-key or unique constraint on a column or set of columns, and a unique index already exists on that column or set of columns, the constraint shares that index. If the existing index allows duplicates, however, the database server returns an error. You must then drop the existing index before you can add the constraint.
- When you place a primary-key constraint or a unique constraint on a column or on a set of columns on which a referential constraint already exists, the existing index that enforces the constraint is upgraded to UNIQUE (if possible), and the index is shared.

You cannot place a unique constraint on a BYTE or TEXT column, nor can you place referential constraints on columns of these data types. A check constraint on a BYTE or TEXT column can check only for IS NULL, IS NOT NULL, or LENGTH.

The statement fails with an error if you specify both a NOT NULL constraint and a NULL constraint on the same column. You cannot define a NULL constraint on a column whose data type is LIST, MULTISSET, SET, or IDSECURITYLABEL.

The IDSECURITYLABEL column has an implicit NOT NULL constraint, but it cannot have explicit single-column constraints nor be part of multiple-column referential constraints or check constraints. If the constraint is on a column that stores encrypted data, Informix cannot enforce the constraint.

Important:

You cannot use the Single-Column Constraint Format to add a new column with a foreign-key constraint in ENABLED NOVALIDATE or FILTERING WITH ERROR NOVALIDATE or FILTERING WITHOUT ERROR NOVALIDATE constraint mode. For the ALTER TABLE statement to create a new foreign-key constraint with the NOVALIDATE keyword bypassing violations-checking during the ALTER TABLE operation, you must use the ALTER TABLE ADD CONSTRAINT syntax with the Multiple-Column Constraint Format.

- [Using NOT NULL Constraints with ADD COLUMN](#)

If a table contains data, when you add a column with a NOT NULL constraint you must also include a DEFAULT clause.

- [Constraint Definition](#)

Use the Constraint Definition segment of the ALTER TABLE statement to declare the name of a constraint, and to set its mode to DISABLED or ENABLED, or for tables that have violations tables, two FILTERING modes.

- [REFERENCES Clause](#)

- [Restrictions on Referential Constraints](#)

- [Default Column for the References Clause](#)

- [Using the ON DELETE CASCADE Option](#)

Use the ON DELETE CASCADE option if you want rows deleted from the child table when the DELETE or MERGE statement removes corresponding rows from the parent table.

- [Locks Held During Creation of a Referential Constraint](#)

- [CHECK Clause](#)

A check constraint designates a condition that must be met before data can be inserted into a column.

Related reference:

[Choosing a Constraint-Mode Option](#)

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Using NOT NULL Constraints with ADD COLUMN

If a table contains data, when you add a column with a NOT NULL constraint you must also include a DEFAULT clause.

If the table is empty, however, you can add a column and apply only the NOT NULL constraint. The following statement is valid whether or not the table contains data:

ALTER TABLE items

```
ADD (item_weight DECIMAL(6,2)
     DEFAULT 2.0 NOT NULL
     BEFORE total_price);
```

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Constraint Definition

Use the Constraint Definition segment of the ALTER TABLE statement to declare the name of a constraint, and to set its mode to DISABLED or ENABLED, or for tables that have violations tables, two FILTERING modes.

For enabled or filtering foreign-key or check constraints that the ALTER TABLE ADD CONSTRAINT statements can create, the NOVALIDATE mode can prevent the database server from checking every row of the table for compliance with the enabled constraint while the ALTER TABLE statement is creating the constraint.

Both the [Single-Column Constraint Format](#) format and the [Multiple-Column Constraint Format](#) support the following syntax for defining constraints:

Constraint Definition

```
--CONSTRAINT--constraint--
| (1)
| '{KEEP|DROP} ANY REFERENCING FOREIGN KEY-----'
| (1)
| '{KEEP|DROP} ANY CHECK CONSTRAINT-----'
| (1)
| '{KEEP|DROP} ANY REFERENCING FOREIGN KEY OR CHECK CONSTRAINT--'
| (1)
| '{KEEP|DROP} ANY CHECK CONSTRAINT OR REFERENCING FOREIGN KEY--'
| (1)
| '-KEEP ANY REFERENCING FOREIGN KEY DROP ANY CHECK CONSTRAINT--'
| (1)
| '-DROP ANY REFERENCING FOREIGN KEY KEEP ANY CHECK CONSTRAINT--'
| (1)
| '-KEEP ANY CHECK CONSTRAINT DROP ANY REFERENCING FOREIGN KEY--'
| (1)
| '-DROP ANY CHECK CONSTRAINT KEEP ANY REFERENCING FOREIGN KEY--'

>--+-----+
| -+--DISABLED-----+
| | .-ENABLED-----+
| +-----+
| | (2) | (3) (4) |
| +-----+
| -FILTERING--+--WITHOUT ERROR+-----' | '-----NOVALIDATE--'
```

```
'-WITH ERROR----'
```

1. Valid for PRIMARY KEY constraints only
2. See [Filtering Modes](#)
3. Valid for FOREIGN KEY constraints only
4. Valid for CHECK constraints only

Element	Description	Restrictions	Syntax
<i>constraint</i>	Name declared here for the constraint	Must be unique among the names of indexes and constraints in database	Identifier

Usage

If the ALTER TABLE statement includes the Single-Column Constraint format or the Multiple-Column Constraint format, but the Constraint Definition is empty, the database server creates and enables whatever type of constraint the Single-Column Constraint or Multiple-Column Constraint format specified, assigns to the constraint a system-generated identifier and a default object state, and registers these attributes in the **sysconstraints** and **sysobjstate** system catalog tables.

If you specify no mode for the constraint, the constraint is enabled by default.

The optional `ON DELETE CASCADE` keywords can precede or follow the declaration of the constraint name. For referential constraints, the `ON DELETE CASCADE` keywords instructs the database server to delete foreign-key rows from the child tables when it deletes rows with the corresponding primary key from the parent table. For more information on the effects of these keywords on DELETE operations, see [Using the ON DELETE CASCADE Option](#).

While creating and enabling foreign-key or check constraints that the ALTER TABLE ADD CONSTRAINT statement defines, the NOVALIDATE keyword prevents the database server from checking every row of the table for compliance with the constraint while the ALTER TABLE statement is running. For more information on the restrictions and effects of this keyword for foreign-key constraints, see [Creating foreign-key constraints in NOVALIDATE modes](#).

Just as in the CREATE TABLE statement, you cannot define unique constraints, primary-key constraints, or referential constraints on a BYTE or TEXT column. In addition, the table cannot be a RAW table.

For more information about constraint-mode options, see [Choosing a Constraint-Mode Option](#).

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REFERENCES Clause

This syntax fragment is part of the [Single-Column Constraint Format](#).

REFERENCES Clause

```
--REFERENCES--table--+-----+>
|          |         .-.-.-.|
|          V      |
|'- (---column---)-'|
>+-----+|
| (1)   |
|'-----ON DELETE CASCADE-'
```

Notes:

- ## 1. Informix® extension

Element	Description	Restrictions	Syntax
<i>column</i>	Referenced column in the referenced table	See Restrictions on Referential Constraints .	Identifier
<i>table</i>	The referenced table	The referenced and the referencing tables must reside in the same database	Identifier

The REFERENCES clause allows you to place a foreign-key constraint on one or more columns. The referenced column can be in the same table as the referencing column, or in a different table in the same database.

For example, the following example declares a disabled foreign-key constraint called **detail_fork1** on the **detail** table.

```
CREATE TABLE master (col_one INT, col_two CHAR);
CREATE TABLE detail (col_one INT, col_twain CHAR);
. . .
ALTER TABLE detail ADD CONSTRAINT (FOREIGN KEY ( col_one )
REFERENCES master( col one ) CONSTRAINT detail fork1 DISABLED);
```

In DISABLED mode, **detail_fork1** has no effect, but if it were subsequently enabled, it would restrict INSERT and UPDATE operations on the **detail** table to rows whose column **col_one** values matched existing values in column **col_one** of the referenced **master** table. In the ALTER TABLE statement above, the parentheses (FOREIGN KEY . . . DISABLED) that delimit the new referential constraint definition are optional.

If the referenced table is different from the referencing table, the default *column* is the primary-key column. If the referenced table is the same as the referencing table, there is no default.

The optional ON DELETE CASCADE keywords can either be specified the last keywords in the REFERENCES clause, or they can follow the declaration of the constraint name in the Constraint definition.

For more information on the effects of these keywords in DELETE operations, see [Using the ON DELETE CASCADE Option](#).

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Restrictions on Referential Constraints

You must have the REFERENCES privilege to create a referential constraint.

The following restrictions apply to the *column* that is specified (the referenced column) in the REFERENCES clause:

- The referenced and referencing tables must be in the same database.
- The referenced column (or set of columns) must have a unique or primary-key constraint.
- The referencing and referenced columns must be the same data type.
The only exceptions are that a referencing column must be an integer data type if the referenced column is a serial data type:
 - For BIGSERIAL referenced columns, use BIGINT referencing columns.
 - For SERIAL referenced columns, use INT referencing columns.
 - For SERIAL8 referenced columns, use INT8 referencing columns.
- You cannot place a referential constraint on a BYTE or TEXT column.
- You cannot place a constraint on any column of a RAW table.
- Constraints uses the collation in effect at their time of creation.
- A column-level REFERENCES clause can include only a single column name.
- Maximum number of columns in a table-level REFERENCES clause is 16.
- The total length of the columns in a table-level REFERENCES clause cannot exceed 390 bytes.

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Default Column for the References Clause

If the referenced table is different from the referencing table, you do not need to specify the referenced column; the default column is the primary-key column (or columns) of the referenced table. If the referenced table is the same as the referencing table, you must specify the referenced column.

The following example creates a new column in the **cust_calls** table, **ref_order**. The **ref_order** column is a foreign key that references the **order_num** column in the **orders** table.

```
ALTER TABLE cust_calls
ADD ref_order INTEGER
REFERENCES orders (order_num)
BEFORE user_id;
```

When you place a referential constraint on a column or set of columns, and a duplicate or unique index already exists on that column or set of columns, the index is shared.

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Using the ON DELETE CASCADE Option

Use the ON DELETE CASCADE option if you want rows deleted from the child table when the DELETE or MERGE statement removes corresponding rows from the parent table.

Here the *parent table* is the table specified in the REFERENCING clause of the definition of an enabled foreign key constraint, and the *child table* is the table on which the enabled foreign key constraint is defined. If you do not specify cascading deletes, the default behavior of the database server prevents DELETE and MERGE statements from deleting data in a table that another tables references within a primary-key foreign-key relationship.

If you specify this option, when you delete a row in the parent table, the database server also deletes any rows associated with that row (foreign keys) in a child table. The advantage of the ON DELETE CASCADE option is that it allows you to reduce the quantity of SQL statements needed to perform delete actions.

For example, in the **stores_demo** database, the **stock** table contains the **stock_num** column as a primary key. The **catalog** table refers to the **stock_num** column as a foreign key. The following ALTER TABLE statements drop an existing foreign-key constraint (without cascading delete) and add a new constraint that specifies cascading deletes:

```
ALTER TABLE catalog DROP CONSTRAINT aa;

ALTER TABLE catalog ADD CONSTRAINT
(FOREIGN KEY (stock_num, manu_code) REFERENCES stock
ON DELETE CASCADE CONSTRAINT ab);
```

With cascading deletes specified on the child table, in addition to deleting a stock item from the **stock** table, the delete cascades to the catalog table that is associated with the **stock_num** foreign key. This cascading delete works only if the **stock_num** that you are deleting was not ordered; otherwise, the constraint from the **items** table would disallow the cascading delete. For more information, see [Restrictions on DELETE When Tables Have Cascading Deletes](#).

If a table has a trigger with a DELETE trigger event, you cannot define a cascading-delete referential constraint on that table. You receive an error when you attempt to add a referential constraint that specifies ON DELETE CASCADE to a table that has a delete trigger.

The TRUNCATE statement cannot result in cascading deletes from a child table. The target table of the TRUNCATE statement cannot be referenced in the definition of an enabled foreign-key constraint on another table (unless that child table has no rows).

For information about syntax restrictions and locking implications when you delete rows from tables that have cascading deletes, see [Considerations When Tables Have Cascading Deletes](#).

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Locks Held During Creation of a Referential Constraint

When you create a referential constraint, the database server places an exclusive lock on the referenced table. The lock is released after you finish with the ALTER TABLE statement or at the end of a transaction (if you are altering the table in a database that uses transaction logging).

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CHECK Clause

A check constraint designates a condition that must be met before data can be inserted into a column.

This syntax fragment is part of the [Single-Column Constraint Format](#).

```
CHECK Clause
(1)
|--CHECK--(--| Condition |-----)-----|
```

Notes:

1. See [Condition](#)

During an insert or update, if a row returns *false* for any check constraint defined on a table, the database server returns an error. No error is returned, however, if a row returns NULL for a check constraint. In some cases, you might want to use both a check constraint and a NOT NULL constraint.

Check constraints are defined using *search conditions*. The search condition cannot contain user-defined routines, subqueries, aggregates, host variables, or rowids. In addition, the condition cannot contain the variant built-in functions CURRENT, SYSDATE, USER, CURRENT_USER, SITENAME, DBSERVERNAME, or TODAY.

The check constraint cannot include columns in different tables. When you are using the ADD or MODIFY clause, the check constraint cannot depend upon values in other columns of the same table.

The next example adds a new **unit_price** column to the **items** table and includes a check constraint to ensure that the entered value is greater than 0:

```
ALTER TABLE items
  ADD (unit_price MONEY (6,2) CHECK (unit_price > 0));
```

To create a constraint that checks values in more than one column, use the ADD CONSTRAINT clause. The following example builds a constraint on the column that was added in the previous example. The check constraint now spans two columns in the table.

```
ALTER TABLE items ADD CONSTRAINT CHECK (unit_price < total_price);
```

When you create or enable a check constraint, you can speed up the statement by including the NOVALIDATE keyword to skip the checking of existing rows for violations. The check constraint is enabled when the statement completes.

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Add column SECURED WITH label clause

The SECURED WITH Label clause associates the new column that the ALTER TABLE ADD statement defines with a label-based access control (LBAC) security label. This clause is valid only for a table that is protected by an LBAC security policy, and for a security label of the same policy.

This syntax fragment is part of the [ADD Column Clause](#).

```
COLUMN SECURED WITH Label clause
|---+-----+---SECURED WITH--label-----|
|'-COLUMN-'|
```

Element	Description	Restrictions	Syntax
<i>label</i>	Name of an LBAC security label	Must exist and must belong to the same LBAC security policy that protects the table.	Identifier

Usage

In a database that supports label-based access control, only tables that have a column of type `IDSSECURITYLABEL` can be protected by an LBAC security policy. When the `ALTER TABLE ADD` statement adds a new column to a protected table, the `COLUMN SECURED WITH Label` clause can associate the column with a security label of the same security policy.

- In a protected table, any data in a column that the `SECURED WITH` label clause associates with an LBAC security label is protected with *column-level granularity* for those columns. Only users whose security credentials satisfy the label of the column can access data in the column.
- In the same table, the data in other columns not referenced by any `SECURED WITH` label clause are protected with *row-level granularity* by the LBAC label in the column of type `IDSSECURITYLABEL`. Only users whose security credentials satisfy that label can access data in any row.

Only users who hold the `DBSECADM` role can include this clause in the `ALTER TABLE` statement.

The `COLUMN SECURED WITH Label` clause is an extension to the ISO/ANSI standard for the SQL language.

The `COLUMN` keyword is optional, and has no effect on the result of the `ALTER TABLE SECURED WITH` operation, but it might make your code easier for human readers to understand.

The `ALTER TABLE` statement cannot add a security label to table objects in any of the following categories:

- virtual-table interface (VTI) tables or virtual-index interface (VII) tables
- user-defined or system-defined temporary (TEMP) tables
- tables of named or unnamed ROW types
- parent tables or child tables within a typed-table hierarchy
- a table with no label-based security policy.

You must specify the *label* name without the *policy* qualifier, rather than as *policy.label*, because the current security policy of the table is the only valid policy for any security label that protects data in the table.

The *column* cannot be of type `IDSSECURITYLABEL`.

When a user who holds appropriate label-based access privileges attempts to access a value in the protected column, the database server compares this label with the security credentials of the user, and allows or withholds access on the basis of this comparison.

You can use similar syntax in the `ALTER TABLE MODIFY` statement to associate an existing column of a protected table with an LBAC security label, or to drop the association between a protected column and its label. For more information, see [Modify Column Security clause](#).

For the `ALTER TABLE` syntax to add an LBAC security policy to protect a table that has no security policy, or to drop the association of the current security policy with the table, see [SECURITY POLICY Clause](#).

Example of adding a column protected by a security label

Suppose that protected table **SecuriTab** was created with the following schema:

```
CREATE TABLE SecuriTab
  (Col1 CHAR (18) ,
   Col2 INT,
   Col4 IDSSECURITYLABEL DEFAULT LabelRW)
SECURITY POLICY company;
```

The table **SecuriTab** is protected with row-level granularity by the LBAC security policy **company**, **Col4** of type `IDSSECURITYLABEL` stores security label **LabelRW**. The security label **LabelRW** in the `IDSSECURITYLABEL` column

In the following statement, a user who holds the `DBSECADM` role adds a new `CHAR(20)` column **Col3** and provides row-level protection for its data by protecting that column with security label **Label23**:

```
ALTER TABLE SecuriTab
  ADD (Col3 CHAR (20) BEFORE Col4 COLUMN SECURED WITH Label23);
```

Like the security label **Label23** in column **Col4**, the security label **Label23** must be a label of the current security policy, in this case the **company** policy.

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ADD AUDIT Clause

Use the `ADD AUDIT` clause with the `ALTER TABLE` command to include a table in selective row-level auditing.

This syntax fragment is part of the [ALTER TABLE statement](#).

```
-----+-----+>
|               |
|               |
+-- Add AUDIT --+
```

When you alter a table with the `ADD AUDIT` clause, row-level audit events in that table are recorded when selective row-level auditing is turned on. Applying the `ADD AUDIT` attribute to a table by itself does not enable selective row-level auditing. This type of auditing is enabled when the `ADTROWS` parameter of the `adtcfg`

file is set to 1 or 2 by using the **onaudit -R** command.

If selective row-level auditing is not enabled, the ADD AUDIT attribute on a table has no effect.

You must have RESOURCE or DBA privileges to run ALTER TABLE command with the ADD AUDIT clause.

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ADD CONSTRAINT Clause

Use the ADD CONSTRAINT clause to specify a primary key, foreign key, referential, unique, or check constraint on a new or existing column or on a set of columns.

This syntax fragment is part of the [ALTER TABLE statement](#).

```
ADD CONSTRAINT Clause
      (1)
|--ADD CONSTRAINT----->
      .-
      v
>--+-----| Multiple-Column Constraint Format |-----+-----|
      '-(-'                                     '-)-'
```

Notes:

1. For NULL and NOT NULL constraints, use instead the [MODIFY Clause](#)
2. See [Multiple-Column Constraint Format](#)

For example, to add a unique constraint to the **fname** and **lname** columns of the **customer** table, use the following statement:

```
ALTER TABLE customer ADD CONSTRAINT UNIQUE (lname, fname);
```

To declare a name for the constraint, change the preceding statement by adding the CONSTRAINT keyword and an identifier for the constraint:

```
ALTER TABLE customer
  ADD CONSTRAINT UNIQUE (lname, fname) CONSTRAINT u_cust;
```

The name must be unique among the identifiers of constraints that are defined on the same table. If you define no name for the constraint, the database server assigns to the constraint a system-defined identifier, and stores this in the **sysconstraints.constrid** column of the system catalog.

The new constraint is enabled by default. To add a constraint that is not enabled, you can include the DISABLED keyword after the name of the constraint:

```
ALTER TABLE customer
  ADD CONSTRAINT UNIQUE (lname, fname) CONSTRAINT u_cust DISABLED;
```

Before you perform subsequent DML operations in which you want the constraint to be enforced. You can use the SET Database Object Mode statement to enable the disabled constraint.

When you do not specify a name for a new constraint, the database server provides one. You can find the name of the constraint in the **sysconstraints** system catalog table. For more information about the **sysconstraints** system catalog table, see the *IBM® Informix® Guide to SQL: Reference*.

Restrictions on constraints defined by ALTER TABLE

The following restrictions on the ADD CONSTRAINT clause (and on the MODIFY clause) affect constraints that the ALTER TABLE statement defines:

- When you add a constraint, the collating order must be the same as when the table was created.
- The ADD CONSTRAINT clause cannot define NULL or a NOT NULL constraints on columns of any data type. Only the MODIFY clause can define a NULL or a NOT NULL constraint on columns in existing tables.
- You cannot define primary key constraints, foreign key constraints, or unique constraints on RAW tables. You can, however, use the MODIFY clause of the ALTER TABLE statement to define a NOT NULL constraint or a NULL constraint (but not both) on a column in a RAW table. For the syntax to add a NULL or NOT NULL constraint on a column in an existing table, see [MODIFY Clause](#).
- You cannot place a unique constraint nor referential constraints on a BYTE or TEXT column.
- A check constraint on a BYTE or TEXT column can check only for IS NULL, IS NOT NULL, or LENGTH.
- By default, every IDSECURITYLABEL column has an implicit NOT NULL constraint. You cannot, however, use the ADD CONSTRAINT clause to reference an IDSECURITYLABEL column in the definition of a single-column constraint, nor as part of a multiple-column referential constraint or check constraint.
- [Multiple-Column Constraint Format](#)
Use this option to assign one or more constraints to a column or to a set of columns in an existing table.

Related information:

[SYSCONSTRAINTS](#)

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Multiple-Column Constraint Format

This closely resembles the syntax of the Multiple Column Constraint Format of the CREATE TABLE statement, but the optional INDEX DISABLED keywords are not valid (and return an error) in foreign key constraints that the CREATE TABLE statement defines. This syntax fragment is part of the [ADD CONSTRAINT Clause](#).

```

      (1)                                     V (4)
|-----|
|--+--+--NOT NULL--+-----+--(-----column+--+-----|
| | | |'--NULL-----'| | | | | (2) | (6) |
| | | |'+--UNIQUE-----+--+| | | |'-----| Constraint |-----'|
| | | | | (2) | | | | |
| | | | +-----DISTINCT-----+ | | | |
| | | | +--PRIMARY KEY-----+ | | | |
| | | | | (3) | | | |
| | | | '-| REFERENCES Clause |-----'| | | |
| | | | | (5) | | | |
| | | | +--| CHECK Clause |-----+--+ | | |
| | | | '-| FOREIGN KEY Definition |-----+ | | |
| | | | | (2) | (7) |
| | | | '-| FOREIGN KEY Definition |--+-----+-----INDEX DISABLED-----'|
| | | | | '---CONSTRAINT---constraint-'

```

```

      .----- .
      V (4)   | (3)
|--FOREIGN KEY--(-----column+--)--| REFERENCES Clause |-----

```

1. Not valid in ALTER TABLE ADD CONSTRAINT statements. See [MODIFY Clause](#).
2. Informix® extension
3. See [REFERENCES Clause](#)
4. Use path no more than 16 times
5. See [CHECK Clause](#)
6. See [Constraint Definition](#)
7. See [Using the INDEX DISABLED keywords in a foreign key definition](#)

As in the CREATE TABLE statement, the Multiple-Column Constraint format for ALTER TABLE differs from the Single-Column Constraint format by requiring the FOREIGN KEY keywords before the REFERENCES clause when you specify a foreign key constraint. In addition, as its name implies, the Multiple-Column format can specify a list of columns as the scope of the new constraint, but this syntax is also valid with a single column.

A multiple-column constraint has these cardinality and size restrictions:

- It can specify no more than 16 column names.
- The maximum total length of the list of columns depends on the page size, according to this formula:

- For a page size of 2K, the total length cannot exceed 390 bytes.
- For a page size of 16K, the total length cannot exceed 3257 bytes.

The statement fails with an error if you specify both a NOT NULL constraint and a NULL constraint on the same column, or if you define a NOT NULL constraint on a column whose default value is NULL.

If the constraint is on a set of columns that includes a column that stores encrypted data, Informix cannot enforce the constraint. You can declare a name for the constraint and set its mode with [Constraint Definition](#).

If the database server implicitly creates an index on the same non-opaque column or set of columns as the referential constraint, distribution statistics are automatically calculated on the specified column, or on the lead column of a multiple-column constraint.

Example of adding a multiple-column referential constraint

In the **stores_demo** database, the **stock** table contains the **stock_num** column as its primary key. An enabled referential constraint **aa** on the **catalog** table has columns **catalog.stock_num** and **catalog.manu_code** as its multiple-column foreign-key, referencing the **stock** table. The following example drops that existing foreign-key constraint, and add a new constraint called **ai**, in DISABLED object mode, that disables the associated system-generated index on those columns:

```
ALTER TABLE catalog DROP CONSTRAINT aa;

ALTER TABLE catalog ADD CONSTRAINT
(FOREIGN KEY (stock_num, manu_code) REFERENCES stock
CONSTRAINT ai DISABLED INDEX DISABLED);
```

The parentheses that delimit the definition of the new constraint are optional, the following ALTER TABLE statement is equivalent:

```
ALTER TABLE catalog ADD CONSTRAINT
FOREIGN KEY (stock_num, manu_code) REFERENCES stock
CONSTRAINT ai DISABLED INDEX DISABLED;
```

The first DISABLED sets the object mode of the constraint. The last DISABLED sets the object mode of the index.

- [Creating foreign-key constraints when an index exists on the referenced table](#)
By default, the database server automatically validates enabled referential constraints when the ADD CONSTRAINT or MODIFY option to the ALTER TABLE statement includes the REFERENCES keyword to define a foreign-key constraint. You might be able to save time during validation of the new foreign-key constraint, if the referenced table already has a unique index or a primary-key constraint on the column (or on the set of columns) corresponding to the key of the referential constraint.
- [Using the INDEX DISABLED keywords in a foreign key definition](#)
By including the optional INDEX DISABLED keywords when you define a foreign key constraint, you prevent DML operations on the table from using the index that the database server associates with the foreign key. If you include the INDEX DISABLED keywords, they must be the last specification in the ALTER TABLE statement.
- [Creating foreign-key constraints in NOVALIDATE modes](#)
The ALTER TABLE ADD CONSTRAINT statement can create an enabled or filtering foreign-key constraint in a NOVALIDATE mode. The NOVALIDATE constraint modes prevent the database server from verifying that the foreign-key value in every row matches a primary-key value in the referenced table while the referential constraint is being created.
- [Adding a Primary-Key or Unique Constraint](#)
- [Recovery from Constraint Violations](#)

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Creating foreign-key constraints when an index exists on the referenced table

By default, the database server automatically validates enabled referential constraints when the ADD CONSTRAINT or MODIFY option to the ALTER TABLE statement includes the REFERENCES keyword to define a foreign-key constraint. You might be able to save time during validation of the new foreign-key constraint, if the referenced table already has a unique index or a primary-key constraint on the column (or on the set of columns) corresponding to the key of the referential constraint.

The database server makes a cost-based decision on how to validate the foreign-key constraint. The index-key algorithm might be faster in many contexts, because it validates the new constraint by scanning only the index values, rather than by scanning all the rows in the table.

The database server can consider using the index-key algorithm to validate the foreign-key constraint that it creates, but only if all of the following conditions are satisfied:

- The ALTER TABLE statement is creating only one foreign-key constraint.
If this is the case, the database server needs to check individual values for only the column on which the foreign-key constraint is being created. Validating two foreign-key constraints at the same time would require two indices to be used on the same scan, which is not supported.
- The statement is not also creating or enabling a CHECK constraint.
If the ALTER TABLE statement is creating more than one constraint, validating CHECK constraints requires that every row be checked, rather than individual values. In that case, the index-key algorithm cannot be used for validating the foreign-key constraint.
- The statement that creates the foreign-key constraint does not also change the data type of any existing column in the same table.
If the ALTER TABLE statement that creates the foreign-key constraint includes a MODIFY clause that changes the data type of any column, the database server does not consider an index-scan execution path for validating the constraint.
- The foreign-key columns do not include user-defined data types (UDTs) or built-in opaque data types.
To make the fast index-key algorithm as efficient as possible, it eliminates all the inefficiencies of executing routines associated with user-defined or opaque data types, such as the BOOLEAN and LVARCHAR built-in opaque types.
- The mode of the new foreign-key constraint is not DISABLED.
If it is disabled, then no constraint-checking algorithm is needed, because no checking for referential integrity violations occurs.
- The table is not associated with an active violation table.
Violations tables require that at the time of checking, every row that does not satisfy the new constraint must be inserted into the violation table. Scanning every row for violations prevents the database server from using the faster index-key algorithm that skips duplicate rows.

Except in the case of one or more violating rows, the ALTER TABLE ADD CONSTRAINT or ALTER TABLE MODIFY statement can create and validate a foreign-key constraint when some of these requirements are not satisfied, but the database server will not consider using the index-key algorithm to validate the foreign-key constraint. The additional validation costs for scanning the entire table are generally proportional to the size of the table. These costs can be substantial for very large tables.

When you create a self-referencing foreign-key constraint, whose REFERENCING clause specifies the same table on which the constraint is defined, the database server can consider an index-key algorithm for validating referential-integrity, if all of the conditions listed above are satisfied.

Related reference:

[Enabling foreign-key constraints when an index exists on the referenced table](#)

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Using the INDEX DISABLED keywords in a foreign key definition

By including the optional INDEX DISABLED keywords when you define a foreign key constraint, you prevent DML operations on the table from using the index that the database server associates with the foreign key. If you include the INDEX DISABLED keywords, they must be the last specification in the ALTER TABLE statement.

Defining foreign key constraints in the ALTER TABLE statement

To add a foreign key constraint, you must have the References privilege on either the referenced columns or the child table. If you own the parent table or have the Alter privilege on the parent table, you can create a foreign key constraint on that table and specify yourself as the owner of the constraint. When you hold the DBA privilege, you can create foreign key constraints for other users.

When the ALTER TABLE ADD CONSTRAINT statement places a foreign key constraint on a column or on a set of columns that reference a child table, and no referential constraint or user-defined index already exists on that column or on that set of columns, the database server creates an internal B-tree index on the specified column or set of columns. If a user-created index already exists on that column or set of columns, the constraint shares the existing index.

If the ALTER TABLE ADD CONSTRAINT statement defines more than one foreign key constraint on the same table, each constraint requires its own REFERENCES clause, and the INDEX DISABLED keywords can be specified (or omitted) for each constraint.

This INDEX DISABLED option is valid in ALTER TABLE ADD CONSTRAINT statements issued from updatable secondary servers in cluster environments.

Circumstances where a foreign key index can reduce performance

Although referential constraints protect data integrity, in some contexts the user-defined or system-generated B-tree index that the database server associates with a foreign key constraint can reduce the efficiency of data manipulation operations on tables that are very large. If there are no deletes from the parent table, the index is not used to look up rows in the child table for cascading deletes. If no queries use this index on the child table. In this scenario, the index is simply not needed, but it imposes unnecessary overhead in operations that update, delete, or insert rows into the child table. A data warehousing application on a child table with millions of rows could require fewer resources if the index that corresponds to the foreign key constraint were disabled.

In these cases, the INDEX DISABLED keyword option to the ALTER TABLE ADD CONSTRAINT statement offers a mechanism for defining a foreign key constraint but avoiding the overhead of the large associated b-tree index.

When you include the INDEX DISABLED keywords at the end of the constraint definition, the database server disables the system-generated index, if no appropriate user-defined index already exists. If a user-defined index on the foreign key column (or set of columns) of the child table already exists, the database server disables that index. Subsequent DML operations on the child table are accomplished without an index, and minimal system resources are needed for maintenance and storage of the disabled index.

Effects of the INDEX DISABLED keywords

When you include the INDEX DISABLED keywords at the end of the constraint definition, the database server disables the system-generated index, if no appropriate user-defined index already exists. If a user-defined index on the foreign key column (or set of columns) of the child table already exists, the database server disables that index. Subsequent foreign key enforcement during DML operations on the child or parent table are accomplished without this disabled index, and minimal system resources are needed for maintenance and storage of the disabled index.

These are the actions of the database server when you successfully add a foreign key constraint with the INDEX DISABLED option:

- The index associated with the foreign key constraint is identified.
- That index is disabled, and marked as disabled in the **sysobjstate** table of the system catalog.
- The physical index is dropped from the database.
- The **sysfragments** system catalog table is updated to show no storage allocation for that index.

The INDEX DISABLED keywords have no effect on foreign key constraint that you define. The database server enforces that constraint, and issues an error if any subsequent operation on the child table or on the parent table violates the specified foreign key constraint.

The following restrictions apply to the INDEX DISABLED keywords in constraint definitions:

- The INDEX DISABLED option is valid only in foreign key definitions.
- Only the ALTER TABLE ADD CONSTRAINT statement supports this syntax. The CREATE TABLE or ALTER TABLE MODIFY COLUMN statements return an exception if a foreign key constraint definition includes the INDEX DISABLED keywords.
- If the index used by the foreign key is in use by another constraint, the database server returns an error.
- If you include the DISABLED keyword in the constraint definition to disable the foreign key constraint, the database server returns an error if you also specify the INDEX DISABLED keywords, as in the following example.

```
ALTER TABLE child ADD
CONSTRAINT (FOREIGN KEY(x1) REFERENCES parent(c1)
CONSTRAINT cons_child_x1 DISABLED INDEX DISABLED);
```

To correct the error in ALTER TABLE ADD CONSTRAINT example above, you must either drop the first DISABLED keyword, or else drop the INDEX DISABLED keywords.

Example of creating a foreign key constraint with INDEX DISABLED

Suppose that the **parent** table and the **child** table in the following example have a primary key and foreign key dependency, and that the data stored in these tables satisfies the following conditions:

- The **parent** table has only a few rows.
- The **child** table has millions of rows.
- The foreign key columns in the **child** table have only few distinct possible values, based on the primary key of the **parent** table.

This example shows how to use the INDEX DISABLED keyword option of the ALTER TABLE ADD CONSTRAINT statement.

```
CREATE TABLE parent(c1 INT, c2 INT, c3 INT);
CREATE UNIQUE INDEX idx_parent_c1 ON parent(c1);
ALTER TABLE parent ADD
  CONSTRAINT PRIMARY KEY(c1)
  CONSTRAINT cons_parent_c1;
CREATE TABLE child(x1 INT, x2 INT, x3 VARCHAR(32));
CREATE INDEX idx_child_x1 ON child(x1);

ALTER TABLE child ADD
  CONSTRAINT(FOREIGN KEY(x1) REFERENCES parent(c1)
  CONSTRAINT cons_child_x1 INDEX DISABLED);
```

In the example above,

- **cons_parent_c1** is a primary key constraint on the **parent** table,
- **cons_child_x1** is a foreign key constraint on the **child** table,
- **idx_parent_c1** is a unique index shared by the **cons_parent_c1** constraint,
- and **idx_child_x1** is an index shared by the **cons_child_x1** constraint.

Data manipulation language operations like UPDATE, DELETE, INSERT, and MERGE on the child table cannot use the **idx_child_x1** index that is shared by with the foreign key constraint, because that index is now disabled.

For some tables that have a primary key and foreign key dependencies, however, the query optimizer might choose other indexes on the child table, based on WHERE clause predicates, in execution plans.

As indicated above, use of the INDEX DISABLED option in the foreign key definition can improve performance only when the child table is very large, typically in the context of data warehouse applications. This syntax option is not recommended for DML operations on small tables.

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Creating foreign-key constraints in NOVALIDATE modes

The ALTER TABLE ADD CONSTRAINT statement can create an enabled or filtering foreign-key constraint in a NOVALIDATE mode. The NOVALIDATE constraint modes prevent the database server from verifying that the foreign-key value in every row matches a primary-key value in the referenced table while the referential constraint is being created.

Use this syntax to create an enabled or filtering foreign-key constraint in NOVALIDATE mode:

```
ADD FOREIGN KEY CONSTRAINT in NOVALIDATE mode

>>-ALTER TABLE--+-table-----+--ADD CONSTRAINT----->
      '-synonym-'

>--+| Foreign key constraint in NOVALIDATE mode |-----+-----><
      '-(--| Foreign key constraint in NOVALIDATE mode |--)-'

Foreign key constraint in NOVALIDATE mode

      .-,-----.
      V          |
|--FOREIGN KEY--(----fk_col+--)--REFERENCES -pk_tab--+-----+----->
                                     |          .-,-----. |
                                     |          V          | |
                                     |          '-(----pk_col+--)-'

      .-----+-----+-----+-----+-----+-----+-----+-----+
      V          |
>-----+--CONSTRAINT--constraint--+-----+-----+-----+----->
      '-ON DELETE CASCADE-----'

      .-ENABLED-----+-----+-----+-----+-----+-----+-----+
>--+-----+-----+-----+-----+-----+-----+-----+-----+
      |          (1) |          (2) |          NOVALIDATE-----|
      |          '-FILTERING--+-WITHOUT ERROR--+-----+-----|
      |          '-WITH ERROR-----'
```

Notes:

1. See [Filtering Modes](#)
2. Valid for FOREIGN KEY constraints only

Element	Description	Restrictions	Syntax
<i>constraint</i>	Name declared here for the constraint	Must be unique among constraint and index names in the database	Identifier
<i>fk_col</i>	Foreign-key column for <i>constraint</i>	Must exist in the child table	Identifier
<i>pk_col</i>	Primary-key column in the referenced table	Must exist in the referenced table	Identifier
<i>pk_tab</i>	Name of the referenced table	Must exist in the current database	Identifier
<i>table, synonym</i>	Table on which <i>constraint</i> is placed	Must exist in the current database	Identifier

Usage

This diagram omits the `DISABLED` keyword. Because disabled constraints are not checked for violations, the `NOVALIDATE` keyword is unnecessary in that case.

If no column or list of columns immediately follows the `REFERENCES` keyword, the default column (or columns) is the primary key of the *pk_tab* table. If *pk_tab* and the *table* or *synonym* specify the same table, then the constraint is self-referencing, and there is no default primary-key column.

If you declare no constraint name, the database server generates an identifier for the new constraint that it registers in the `sysconstraints` and `sysobjstate` system catalog tables.

The `ALTER TABLE ADD CONSTRAINT` statement supports the `NOVALIDATE` mode for referential constraints as a mechanism for bypassing the data-integrity check when creating an enabled or filtering referential constraint.

Circumstances where NOVALIDATE modes can improve performance

Although referential constraints protect data integrity, in some contexts a database table that you are moving to a new database server instance is known to be free of referential integrity violations. For foreign-key constraints on large tables, the time required to validate the constraint can be substantial. If a table with a million rows is moving from an OLTP environment to a data warehousing environment, validating the foreign key in the target environment might increase the time required for migration by orders of magnitude.

For example, you can drop the foreign-key constraints on the large table, and then re-create those constraints in an `ENABLED NOVALIDATE` mode or in a `FILTERING NOVALIDATE` mode immediately before you migrate the large table to the target database environment. The cost of the `ALTER TABLE ADD CONSTRAINT` operation that re-creates the foreign-key constraint will be relatively small, because it bypasses validation of every row for each referential constraint. Because the `NOVALIDATE` mode does not persist beyond the `ALTER TABLE` operation that created the constraints, the table arrives in the warehousing environment with those constraints in an `ENABLED` or `FILTERING` mode, protecting the referential integrity of the data in subsequent DML operations.

Restrictions on using the NOVALIDATE keyword

The `ALTER TABLE ADD CONSTRAINT` statement is the only DDL context where the `NOVALIDATE` keyword is valid when a foreign-key constraint is being created. You cannot, for example, create a foreign-key constraint in a `NOVALIDATE` mode in any of the following SQL statements:

- `CREATE TABLE` statements
- `CREATE TEMP TABLE` statements
- `SELECT INTO TABLE` statements.

You can use the `ALTER TABLE ADD CONSTRAINT` statement to create an enabled constraint on an existing table in `NOVALIDATE` mode only if all of the following conditions are satisfied:

- The constraint that you are adding is a foreign-key constraint. If you create multiple constraints in an `ALTER TABLE` statement that includes the `NOVALIDATE` keyword, all must be foreign-key constraints.
- In `ALTER TABLE` statements, the `NOVALIDATE` keyword is valid only in the `ADD CONSTRAINT FOREIGN KEY` option.
- The `NOVALIDATE` keyword is not valid for constraints that `ALTER TABLE` creates in `DISABLED` mode.

The `ALTER TABLE` statement fails with an error if the constraint definition includes the `NOVALIDATE` keyword in any of the following syntax contexts:

- `ALTER TABLE ADD column` statements.
- `ALTER TABLE INIT` statements
- `ALTER TABLE MODIFY` statements.

The only other DDL statement where the `NOVALIDATE` keyword is valid is the `SET CONSTRAINTS` option to the `SET Database Object Mode` statement. While the `SET CONSTRAINTS` statement is running, it can change the mode of an existing foreign-key constraint to any of these `NOVALIDATE` constraint modes:

- `ENABLED NOVALIDATE` mode
- `FILTERING WITH ERROR NOVALIDATE` mode
- `FILTERING WITHOUT ERROR NOVALIDATE` mode.

For more information, see the [SET CONSTRAINTS statement](#).

Establishing NOVALIDATE modes as the default

Both the `SET ENVIRONMENT NOVALIDATE ON` statement of SQL and the `dbimport -nv` command for loading databases can override any foreign-key constraint mode (except `DISABLED`) that `ALTER TABLE ADD CONSTRAINT` or `SET CONSTRAINTS` statement specifies, if that constraint mode specification omits the `NOVALIDATE` keyword.

- The scope of the `SET ENVIRONMENT NOVALIDATE ON` statement is subsequent `ALTER TABLE ADD CONSTRAINT` and `SET CONSTRAINTS` statements in the same user session.

- The scope of the `dbimport -nv` command is the ALTER TABLE ADD CONSTRAINT and SET CONSTRAINTS statements in the `.sql` file of the exported database, whose path name is specified in the same `dbimport` command.

Just as when `NOVALIDATE` is specified explicitly in ALTER TABLE ADD CONSTRAINT and SET CONSTRAINTS statements, during the session that issued the SET ENVIRONMENT NOVALIDATE ON statement the default NOVALIDATE mode for foreign-key constraints persists

- only while the foreign-key constraint is being created,
- or only while an existing constraint is being reset to ENABLED or to FILTERING mode.

When the ADD CONSTRAINT or SET CONSTRAINTS statement completes execution without validating the foreign-key constraint, no record of the transient NOVALIDATE mode is created in the `sysobjstate` system catalog table. Instead, the database server registers the mode of the new or updated foreign-key constraint as ENABLED or as FILTERING in the `sysobjstate.state` column of its row in the system catalog.

Example of a constraint created in NOVALIDATE mode

The following DDL statements create a table called `parent` and define a unique index and a primary-key constraint on column `c1` of that table:

```
CREATE TABLE parent(c1 INT, c2 INT, c3 INT);
CREATE UNIQUE INDEX idx_parent_c1 ON parent(c1);
ALTER TABLE parent ADD CONSTRAINT
    PRIMARY KEY(c1) CONSTRAINT cons_parent_c1;
```

The next statements create another table, called `child`, whose first column is of the same data type as the primary-key column of the `parent` table, and define an enabled foreign-key constraint, called `cons_child_x1`, on the `child` table:

```
CREATE TABLE child(x1 INT, x2 INT, x3 VARCHAR(32));
ALTER TABLE child
    ADD CONSTRAINT (FOREIGN KEY(x1)
        REFERENCES parent(c1) CONSTRAINT cons_child_x1);
```

Suppose that subsequent DML operations (not shown) populate the `parent` table and the `child` table with rows of data. At some point, the workflow requires the data to be moved from its OLTP production environment to another database for processing by business-analytics applications.

If at this point the data set in the `child` table contains a large number of rows, a significant cost of importing the `child` table to its new database will be validating the `cons_child_x1` referential constraint. To avoid this cost, the following statement drops that constraint:

```
ALTER TABLE child DROP CONSTRAINT cons_child_x1;
```

After the `child` table has been exported to its new environment, the following statement can re-create a new constraint of the same name on the `child` table without checking every row for referential-integrity violations:

```
ALTER TABLE child
    ADD CONSTRAINT (FOREIGN KEY(x1)
        REFERENCES parent(c1)
        CONSTRAINT cons_child_x1 NOVALIDATE);
```

By default, the new `cons_child_x1` referential constraint is in ENABLED mode after the ALTER TABLE statement completes execution.

Like the optional parentheses that can enclose various ALTER TABLE ADD CONSTRAINT syntax options, the parentheses enclosing the "Foreign key constraint in NOVALIDATE mode" syntax segment are optional. The next statement has the same effect as the previous NOVALIDATE example:

```
ALTER TABLE child
    ADD CONSTRAINT FOREIGN KEY(x1)
        REFERENCES parent(c1)
        CONSTRAINT cons_child_x1 NOVALIDATE;
```

Including the parentheses might make the logical structure clearer to human readers, but those delimiters have no effect on how the database server processes this ALTER TABLE ADD CONSTRAINT NOVALIDATE statement without validating each record.

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Adding a Primary-Key or Unique Constraint

When you place a primary-key or unique constraint on a column or set of columns, those columns must contain unique values. The database server checks for existing constraints and indexes:

- If a user-created unique index already exists on that column or set of columns, the constraint shares the index.
- If a user-created index that allows duplicates already exists on that column or set of columns, the database server returns an error. In this case, you must drop the existing index before adding the primary-key or unique constraint.
- If a referential constraint already exists on that column or set of columns, the duplicate index is upgraded to unique (if possible) and the index is shared.
- If no referential constraint or user-created index exists on that column or set of columns, the database server creates an internal B-tree index on the specified columns.

When you place a referential constraint on a column or set of columns, and an index already exists on that column or set of columns, the index is shared.

If you own the table or have the Alter privilege on the table, you can create a check, primary-key, or unique constraint on the table and specify yourself as the owner of the constraint. To add a referential constraint, you must have the References privilege on either the referenced columns or the referenced table. When you have the DBA privilege, you can create constraints for other users.

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Recovery from Constraint Violations

If you use the ADD CONSTRAINT clause to add a constraint in the enabled mode, you receive an error message because existing rows would violate the constraint. For a procedure to add the constraint successfully, see [Adding a Constraint That Existing Rows Violate](#).

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ADD TYPE Clause

Use the ADD TYPE clause to convert a table that is not based on a named ROW data type into a typed table.

This clause is an extension to the ANSI/ISO standard for SQL.

```
>>-ALTER TABLE--++table---+--| ADD TYPE Clause |-----><
      '-synonym-'
ADD TYPE Clause
|--ADD TYPE -row_type-----|
```

Element	Description	Restrictions	Syntax
<i>row_type</i>	Identifier of an existing named ROW data type for this table	The <i>row_type</i> fields must exactly match the existing columns in their data types, order, and number	Identifier
<i>synonym</i>	Synonym for the table that becomes a typed table	Synonym and its table must exist, and USETABLENAME must not be set	Identifier
<i>table</i>	Identifier of the table that becomes a typed table	Must exist in the current database	Identifier

Usage

If the new ROW type is a subtype of an existing named ROW type, you must hold the UNDER privilege for that named ROW type.

When you use the ADD TYPE clause, you assign the specified named ROW data type to a table whose columns must exactly match the fields of that ROW data type

- in their names,
- in their individual data types,
- and in their order.

In addition to the requirements common to all ALTER TABLE operations (namely DBA privilege on the database, Alter privilege on the table, and ownership of the table), all of the following must be also true when you use the ADD TYPE clause to convert an untyped table to the specified named ROW data type:

- The named ROW data type is already registered in the database.
- You hold the Usage privilege on the named ROW data type.
- There must be a 1-to-1 correspondence between the ordered set of column data types of the untyped table and the ordered set of field data types of the named ROW data type.
- The table cannot be a fragmented table that has **rowid** values.

You cannot combine the ADD TYPE clause with any clause that changes the schema of the table. No other ADD, DROP, or MODIFY clause is valid in the same ALTER TABLE statement that has the ADD TYPE clause. The ADD TYPE clause does not allow you to change column data types. (To change the data type of a column, use the MODIFY clause in a separate ALTER TABLE statement from the ADD TYPE operation.)

ALTER TABLE operations on typed tables

Most options of the ALTER TABLE statement are restricted to untyped tables.

The database server supports only the following storage, locking, and constraint syntax options when *table_object* is the name or synonym of a typed table. As noted below, however, for some CONSTRAINT options in a typed-table inheritance hierarchy

- the scope of the operation includes all subtables of *table_object*,
- or the operation is not supported if *table_object* is a subtable.

```
ALTER TABLE options for typed tables

>>-ALTER TABLE--table_object--| Typed-table options |-----><

Typed-Table options

      .-,-----|
      v          (1) |
|-----| ADD CONSTRAINT Clause |-----|
      |          (2) |
```

```

+-| DROP CONSTRAINT Clause |-----+
| (3)                      (4) |
+-----| MODIFY NEXT SIZE Clause |-----+
| (3)                      (5) |
'-----| LOCK MODE Clause |-----'

```

Notes:

1. See [ADD CONSTRAINT Clause](#)
2. See [DROP CONSTRAINT Clause](#)
3. Use path no more than once
4. See [MODIFY NEXT SIZE clause](#)
5. See [LOCK MODE Clause](#)

Two additional considerations apply to typed tables of named ROW types that are part of inheritance hierarchies:

- For subtables, ADD CONSTRAINT and DROP CONSTRAINT are not valid on inherited constraints.
- For supertables, ADD CONSTRAINT and DROP CONSTRAINT propagate to all subtables.

Example of the ALTER TABLE . . . ADD TYPE statement

The following example changes an untyped table into a typed table by the following steps:

- Use the CREATE TABLE statement to create a table that will become the typed table.
- Use the CREATE ROW TYPE statement to create a named ROW type with fields exactly matching the untyped table schema.
- Use the ALTER TABLE . . . ADD TYPE statement to change the untyped table to a typed table.

```

CREATE TABLE postal (
  name    VARCHAR(30) ,
  address VARCHAR(20) ,
  city    VARCHAR(20) ,
  state   CHAR(2) ,
  zip     INTEGER,
);

```

. . .

```

CREATE ROW TYPE postal_t
(
  name    VARCHAR(30) ,
  address VARCHAR(20) ,
  city    VARCHAR(20) ,
  state   CHAR(2) ,
  zip     INTEGER,
);

```

. . .

```

ALTER TABLE postal ADD TYPE postal_t;

```

You could achieve the same result if the order of the first two DDL statements were reversed.

In that case, however, the ALTER TABLE statement could be avoided, if instead of defining columns individually, the CREATE TABLE instead included the OF TYPE clause to use the `postal_t` ROW type as a template for the six fields of a single named ROW type column:

```

CREATE TABLE postal OF TYPE postal_t;

```

By either path, table `postal` becomes a typed table of ROW type `postal_t`.

In the example above, as elsewhere in the documentation of typed tables, the database server does not require any similarity between the SQL identifier of the table and the SQL identifier of the ROW type. Table objects and named ROW data types have separate and uncorrelated name spaces, but mnemonic names can make SQL code examples easier for some human readers to understand.

Related reference:

[CREATE TABLE statement](#)
[DROP TABLE statement](#)
[LOCK TABLE statement](#)
[SET Database Object Mode statement](#)

Related information:

[Data integrity](#)
[The ON DELETE CASCADE option](#)
[Create the database](#)
[Table performance considerations](#)

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DROP AUDIT Clause

Use the DROP AUDIT clause with the ALTER TABLE command to remove it from the set of tables that is audited when selective row-level auditing is enabled.

This syntax fragment is part of the [ALTER TABLE statement](#).

```
-----+----->
|               |
+-- Drop AUDIT --+
```

The DROP AUDIT clause affects only tables that have been flagged for inclusion in selective row-level auditing. If you have not created or altered the table with the WITH AUDIT clause or ADD AUDIT clause, it is not necessary to use DROP AUDIT to exclude it from the set of tables that are audited at the row level.

Removing the AUDIT attribute from a table does not disable or change selective row-level auditing of other tables in the database.

You must be a DBSSO to run the ALTER TABLE command with the DROP AUDIT clause.

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DROP CONSTRAINT Clause

Use the DROP CONSTRAINT clause to destroy an existing constraint whose name you specify.

This syntax fragment is part of the [ALTER TABLE statement](#).

DROP CONSTRAINT Clause

```
          .-',-----'.
          V               |
|--DROP CONSTRAINT--+-+---constraint-+-+-----+-----|
          '- (-'          '-) -'
```

Element	Description	Restrictions	Syntax
<i>constraint</i>	Constraint to be dropped	Must exist in the database	Identifier

Usage

To drop an existing constraint, specify the `DROP CONSTRAINT` keywords and the identifier of the constraint. To drop multiple constraints on the same table, the constraint names must be in comma-separated list that is delimited by parentheses.

The constraint that you drop can have an ENABLED, DISABLED, or FILTERING mode.

Here is an example of dropping a constraint:

```
ALTER TABLE manufact DROP CONSTRAINT con_name;
```

The following example destroys both a referential constraint and a check constraint that had been defined on the **orders** table:

```
ALTER TABLE orders DROP CONSTRAINT (con_ref, con_check);
```

The Informix® implementation of SQL includes no DROP CONSTRAINT statement. This clause of the ALTER TABLE statement, however, provides functionality that one might expect of the DROP CONSTRAINT statement, if that statement existed.

The DROP TABLE statement implicitly drops all constraints on the specified table when it destroys that table.

Retrieving constraint names

The DROP CONSTRAINT clause requires the identifier of the constraint. If no name was declared when the constraint was created, the database server generated the identifier of the new constraint. You can query the **sysconstraints** system catalog table for the name and the owner of a constraint. For example, to find the name of the constraint placed on the **items** table, you can issue the following statement:

```
SELECT constrname FROM sysconstraints
WHERE tabid = (SELECT tabid FROM systables
WHERE tabname = 'items');
```

Dependencies between constraints

When you drop a primary-key constraint or a unique constraint that has a corresponding foreign key, any associated referential constraints are also dropped.

For example, in the **stores_demo** database, there is a primary-key constraint on the **order_num** column in the **orders** table. A corresponding foreign-key constraint is also defined on the **order_num** column in the **items** table. These constraints define a referential relationship between the **order_num** columns in both tables.

Suppose that you run the `ALTER TABLE orders DROP CONSTRAINT` statement to drop the primary-key constraint on the **order_num** column in the **orders** table. Because this referential-integrity relationship between the two tables can no longer be enforced without the primary-key constraint, the database server takes these actions if the ALTER TABLE statement in this example succeeds:

- It destroys the specified primary-key constraint on the **order_num** column in the **orders** table.
- It also destroys the corresponding referential constraint on the **order_num** column in the **items** table.
- It deletes from the system catalog all references to the primary key constraint on the **orders** table, or to the referential constraint on the **items** table.

System catalog effects of dropping constraints

The database maintains information about existing constraints in these system catalog tables:

- **sysconstraints** (all constraints)
- **sysobjstate** (all constraints)
- **syschecks** (check constraints)
- **syscoldepend** (check constraints and NOT NULL constraints)
- **syscheckudrdep** (check constraints that UDRs reference)
- **sysreferences** (referential constraints)
- **sysindices** (referential, primary-key, or unique constraints that have no corresponding Index entry in **sysindices**)

After the DROP CONSTRAINT clause successfully destroys a constraint, the database server deletes or updates at least one row in one or more of the above tables.

Data type considerations

By default, every IDSSecurityLabel column has an implicit NOT NULL constraint, but the DROP CONSTRAINT clause cannot reference columns of type IDSSecurityLabel.

You can include the DROP CONSTRAINT clause in ALTER TABLE operations on typed tables of ROW data types, but with these restrictions for table hierarchies.

- For a typed table with no supertable, DROP CONSTRAINT propagates to its child tables.
- For the child table of a supertable, DROP CONSTRAINT fails for inherited constraints.

For example, suppose ROW type **people_t** exists in the database. The following DDL statements respectively

- create a typed table called **MyPeople**,
- add a UNIQUE constraint on **MyPeople** called **very_unique** on all the fields of the ROW type column,
- and create a child table called **LittlePeople**:

```
CREATE TABLE IF NOT EXISTS MyPeople OF TYPE (people_t);
ALTER TABLE MyPeople ADD CONSTRAINT UNIQUE (people_t.*)
    CONSTRAINT very_unique;
CREATE TABLE IF NOT EXISTS LittlePeople OF TYPE (people_t)
    UNDER MyPeople;
```

Because **LittlePeople** inherited the **very_unique** constraint from its parent supertable **MyPeople**, the following ALTER TABLE DROP CONSTRAINT statement fails:

```
ALTER TABLE LittlePeople
    DROP CONSTRAINT very_unique; --cannot drop an inherited constraint
```

But because **MyPeople** is a typed table with no parent, the following statement destroys the **very_unique** constraint instances on both the **MyPeople** and the **LittlePeople** tables within their table hierarchy:

```
ALTER TABLE MyPeople DROP CONSTRAINT very_unique;
```

Restoring a referential constraint

For some operations, such as relocating a table to another database, you might require that a referential constraint temporarily have no effect on its table. After you complete that work without the constraint, however, the referential integrity of the database typically requires that the functionality of the constraint be restored. One possible option is this:

- Use the DROP CONSTRAINT clause to destroy the constraint.
- Complete the tasks that need to avoid the effects of the constraint.
- Use ALTER TABLE ADD CONSTRAINT to re-create the constraint.

For a very large table that already conforms to the dropped foreign-key or check constraint, using the NOVALIDATE option to the ALTER TABLE ADD CONSTRAINT statement can avoid the substantial cost of using a full-table scan to validate the constraint while it is being re-created. This NOVALIDATE option requires using the Multi-Column Constraint Format syntax to define the constraint.

Similarly, rather than destroying a referential constraint on a large table, you can temporarily disable it, and then complete tasks that require fewer resources with the constraint disabled. To resume enforcement of the constraint, you can use the SET CONSTRAINTS option of the SET Database Object Mode statement to reset the object mode to ENABLED NOVALIDATE, or to FILTERING WITH ERROR NOVALIDATE or to FILTERING WITHOUT ERROR NOVALIDATE. In each of these constraint modes, the NOVALIDATE keyword avoids the overhead of validating the constraint while its mode is being reset.

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DROP Column Clause

Use the DROP Column clause to remove one or more columns from the schema of a table.

This syntax fragment is part of the [ALTER TABLE statement](#).

DROP Column Clause

```
.,-----.
V         |
```



```
| --DROP--+ (---column---) +-----|
| '-column-----'
```

Element	Description	Restrictions	Syntax
<i>column</i>	Name of a column to be dropped	Must exist in the table. No fragment expression can reference the column, and it cannot be the last column in the table.	Identifier

You cannot issue an ALTER TABLE DROP statement that would drop every column from the table. At least one column must remain in the table.

You cannot drop a column that is part of the fragmentation key of a fragmentation strategy.

A column that is protected by a security label can be dropped by the ALTER TABLE DROP statement, but the user must be DBSECADM and must also hold the usual CONNECT, RESOURCE, and ALTER access privileges for modifying the schema of the table.

- [How Dropping a Column Affects Constraints](#)
When you drop a column, all constraints on that column are also dropped, unless the same ALTER TABLE statement also adds the same column in the same order within the table schema.
- [How Dropping a Column Affects Triggers](#)
- [How Dropping a Column Affects Views](#)

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How Dropping a Column Affects Constraints

When you drop a column, all constraints on that column are also dropped, unless the same ALTER TABLE statement also adds the same column in the same order within the table schema.

Dropping a column has these effects on its constraints:

- All single-column constraints are dropped.
- All referential constraints that reference the column are dropped.
- All check constraints that reference the column are dropped.
- If the column is part of a multiple-column primary-key or unique constraint, the constraints that are placed on the multiple columns are also dropped. This action, in turn, triggers the dropping of all referential constraints that reference the multiple columns.
- The **syscolumns** and **sysconstraints** system catalog tables are updated to remove all the rows corresponding to the dropped columns and the dropped constraints.

Because any constraints that are associated with a column are dropped when the column is dropped, the structure of other tables might also be altered when you use this clause. For example, if the dropped column is a unique or primary key that is referenced in other tables, those referential constraints also are dropped. Therefore, the structure of those other tables is also altered.

Dropping columns without changing the table schema

The same ALTER TABLE statement can include both a DROP Column clause that drops a column (or drops several columns), followed by an ADD Column clause that adds columns of the same name, data type, and ordinal position among the columns of the table. In this case, the database server takes no action to reorganize the schema of the table, or to drop constraints that are defined on the columns that were dropped and restored in the same ALTER TABLE statement. That is, nothing happens to the table or to its data.

For example, suppose that table **UnsTable** is created with five columns:

```
CREATE TABLE IF NOT EXISTS UnsTable (
  col1 CHAR(18),
  col2 INT NOT NULL,
  col3 CHAR(32) UNIQUE,
  col4 INT NOT NULL,
  col5 DATETIME YEAR TO MONTH);
```

The following ALTER TABLE statement instructs the database server to drop both INTEGER columns **col2** and **col4**, and also to add two columns with the same names and data type:

```
ALTER TABLE UnsTable (
  DROP (col2, col4)
  ADD (col2 INT NOT NULL BEFORE col3,
      col4 INT NOT NULL BEFORE col5);
```

This ALTER TABLE statement has no effect on the schema or the data in the **UnsTable** table, nor on any existing constraints that reference those columns, because the database server takes no action. Therefore, DDL statements that resemble the example that are generated by analytic tools do not affect the database server or the data.

When you need to reorganize a table and drop constraints by replacing one or more columns with new columns that have the same names, the same data types, and the same ordinal positions within the table schema, run two separate ALTER TABLE statements, as in the following example:

```
ALTER TABLE UnsTable (
  DROP (col2, col4);

ALTER TABLE UnsTable (
  ADD (col2 INT NOT NULL BEFORE col3,
      col4 INT NOT NULL BEFORE col5);
```

The ALTER TABLE DROP statement drops any existing constraints that reference columns **col2** or **col4** of the **UnsTable** table.

How Dropping a Column Affects Triggers

In general, when you drop a column from a table, the triggers based on that table remain unchanged. If the column that you drop appears in the action clause of a trigger, however, dropping the column can invalidate the trigger. The following statements illustrate the possible effects on triggers:

```
CREATE TABLE tab1 (i1 int, i2 int, i3 int);
CREATE TABLE tab2 (i4 int, i5 int);
CREATE TRIGGER coll1trig UPDATE OF i2 ON tab1
  BEFORE (INSERT INTO tab2 VALUES (1,1));
ALTER TABLE tab2 DROP i4;
```

After the ALTER TABLE statement, **tab2** has only one column. The **coll1trig** trigger is invalidated because the action clause as it is currently defined with values for two columns cannot occur.

If you drop a column that occurs in the triggering column list of an UPDATE trigger, the database server drops the column from the triggering column list. If the column is the only member of the triggering column list, the database server drops the trigger from the table. For more information on triggering columns in an UPDATE trigger, see [CREATE TRIGGER statement](#).

If a trigger is invalidated when you alter the underlying table, drop and then re-create the trigger.

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How Dropping a Column Affects Views

When you drop a column from a table, the views based on that table remain unchanged. That is, the database server does not automatically drop the corresponding columns from associated views.

The view is not automatically dropped because ALTER TABLE can change the order of columns in a table by dropping a column and then adding a new column with the same name. In this case, views based on the altered table continue to work, but retain their original sequence of columns.

If a view is invalidated when you alter the underlying table, you must rebuild the view by using the DROP VIEW and CREATE VIEW statements.

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LOCK MODE Clause

Use the LOCK MODE keywords to change the locking granularity of an existing table.

This syntax fragment is part of the [ALTER TABLE statement](#).

```
LOCK MODE Clause
|--LOCK MODE - (---PAGE---) -----
      '-ROW--'
```

The following table describes the locking-granularity options available.

Granularity	Effect
PAGE	Obtains and releases one lock on a whole page of rows If no system default locking granularity has been set by the IFX_DEF_TABLE_LOCKMODE environment variable or by the DEF_TABLE_LOCKMODE configuration parameter, this is the default. Page-level locking is especially useful when you know that the rows are grouped into pages in the same order that you are using to process all the rows. For example, if you are processing the contents of a table in the same order as its cluster index, PAGE is usually more appropriate setting than ROW .
ROW	Obtains and releases one lock per row Row-level locking supports the highest level of concurrency. Only tables with row-level locking support the LAST COMMITTED feature, which can improve performance in the Committed Read and Dirty Read isolation levels when another session holds an exclusive lock on a row that you attempt to read. If you are using many rows at one time, however, the lock-management overhead of row-level locking can become significant. You can also exceed the maximum number of locks available, depending on the configuration of your database server.

The following statement changes the lock mode for the **customer** table to page-level locking:

```
ALTER TABLE customer LOCK MODE (PAGE);
```

The next example changes the lock mode for the **customer** table to row-level locking:

```
ALTER TABLE customer LOCK MODE (ROW) ;
```

Important:

The SET LOCK MODE statement of SQL has no effect on the locking granularity of tables. You can use that statement, however, to define how the database server resolves locking conflicts when one process tries to access a row or a table that has been locked by a concurrent process. For the syntax and semantics, see [SET LOCK MODE statement](#).

The term *lock mode* also has a third meaning for smart large objects in JDBC contexts, when a row contains one or more smart large objects. Here the scope of a lock can be either only a subset the smart large object, or else it can lock the entire BLOB or CLOB.

- [Precedence and Default Behavior](#)

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Precedence and Default Behavior

The LOCK MODE setting in an ALTER TABLE statement takes precedence over the settings of the **IFX_DEF_TABLE_LOCKMODE** environment variable and the DEF_TABLE_LOCKMODE configuration parameter. For information about the **IFX_DEF_TABLE_LOCKMODE** environment variable, refer to the *IBM® Informix® Guide to SQL: Reference*. For information about the DEF_TABLE_LOCKMODE configuration parameter, refer to the *IBM Informix Administrator's Reference*.

Related information:

[IFX_DEF_TABLE_LOCKMODE environment variable](#)

[DEF_TABLE_LOCKMODE configuration parameter](#)

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Logging TYPE Options

Use the Logging TYPE options to specify that the table has particular characteristics that can improve various bulk operations on it.

This syntax fragment is part of the [ALTER TABLE statement](#).

Logging TYPE Options

```
|--TYPE-- (---STANDARD---) -----|
      '-RAW-----'
```

Here STANDARD, the default option of the CREATE TABLE statement, specifies a logged table, and RAW specifies an unlogged table.

A table can have any of the following logging characteristics.

Option

Effect

STANDARD

Logging table that allows rollback, recovery, and restoration from archives. This is the default. Use this type for recovery and constraints functionality on OLTP databases.

RAW

Nonlogging table that do not support primary key constraints, unique constraints, or referential constraints. RAW tables can have NOT NULL constraints and NULL constraints (but not on the same set of columns). They can be indexed and updated. Use this type for quickly loading data.

Warning: Use RAW tables for fast loading of data. It is recommended that you alter the logging type to STANDARD and perform a level-0 backup before you use the table in a transaction or modify the data within the table. If you must use a RAW table within a transaction, either set the isolation level to Repeatable Read or lock the table in exclusive mode to prevent concurrency problems.

The Logging TYPE option can convert a non-logging table, such as a RAW table, to a STANDARD table that supports transaction logging. If you use this feature, you should be aware that the database server does not check to see whether a level 0 archive has been performed on the table.

Operations on a RAW table are not logged and are not recoverable, so RAW tables are always at risk. When the database server converts a table that is not logged to a STANDARD table type, it is your responsibility to perform a level-0 backup before using the table in a transaction or modifying data in the table. Failure to do this might lead to recovery problems in the event of a server crash.

For more information on these logging types of tables, refer to your *IBM® Informix® Administrator's Guide*.

The Logging TYPE options have the following restrictions:

- You must perform a level-0 archive before the logging type of a table can be altered to STANDARD from any other logging type.
- The table cannot be a TEMP table, and you cannot change any of these types of tables to a TEMP table.

The following example changes a nonlogging table to a table that uses transaction logging:

```
ALTER TABLE tabnolog TYPE (STANDARD) ;
```

The following example changes a logging table to a nonlogging table.

```
ALTER TABLE tablog TYPE (RAW) ;
```

MODIFY Clause

Use the MODIFY clause to change the data type, length, or default value of a column, to add or remove the security label of a column, to allow or disallow NULL values in a column, or to reset the serial counter of a SERIAL, SERIAL8, or BIGSERIAL column.

This syntax fragment is part of the [ALTER TABLE statement](#).

MODIFY Clause

```

      .----- .
      V       |
|--MODIFY--(----| Modify Column Clause |---)-----|
Modify Column Clause
      (1)
|--column--| Data Type |----->
      .----- .
      V       |
>-----+-----+----->
      | (2)          (3)          |
+-----+ DEFAULT Clause |-----+
      | (2)          (4)          |
+-----+ Single-Column Constraint Format |-----+
>-----+-----+-----|
      |          (5)          |
+-----+ Modify Column Security |-----+

```

Notes:

1. See [Data Type](#)
2. Use this path no more than once
3. See [DEFAULT clause of ALTER TABLE](#)
4. See [Single-Column Constraint Format](#)
5. See [Modify Column Security clause](#)

Element	Description	Restrictions	Syntax
<i>column</i>	Column to modify	Must exist in table. Cannot be a collection or IDSECURITYLABEL data type.	Identifier

Usage

When you modify a column, all attributes previously associated with the column (that is, default value, single-column check constraint, or referential constraint) are dropped. When you want certain attributes of the column to persist, such as PRIMARY KEY, you must respecify those attributes in the same MODIFY clause.

For example, consider the **items** table in the **stores_demo** database, whose schema includes this original definition of the **quantity** column:

```

CREATE TABLE items (item_num INT . . . -- primary key of this table
                    order_num . . . -- foreign key to orders table
                    . . . -- two additional columns
                    quantity SMALLINT DEFAULT 1 NOT NULL,
                    total price MONEY(8) . . . );

```

If you are changing the data type of the existing **quantity** column to INT, but you want to keep the default value (in this case, 1) and the NOT NULL constraint, you can issue this statement:

```
ALTER TABLE items MODIFY (quantity INT DEFAULT 1 NOT NULL);
```

Note: Both the DEFAULT and NOT NULL attributes are specified again in the MODIFY clause. If you omit those keywords, both attributes are dropped from the modified column, and the modified table would accept NULL values in new or updated data rows in which the **quantity** value is missing.

When you specify a PRIMARY KEY constraint in the MODIFY clause, the database server also silently creates a NOT NULL constraint on the same column, or on the same set of columns that makes up the primary key

When you change the data type of a column, the database server does not perform the modification in place. The next example changes a VARCHAR(15) column to an LVARCHAR(3072) column:

```
ALTER TABLE stock MODIFY (description LVARCHAR(3072));
```

When you modify a column that has column constraints that are associated with it, the following constraints are dropped:

- All single-column constraints are dropped.
- All referential constraints that reference the column are dropped.
- If the modified column is part of a multiple-column primary-key or unique constraint, all referential constraints that reference the multiple columns also are dropped.

For example, if you modify a column that has a unique constraint, the unique constraint is dropped. If this column was referenced by columns in other tables, those referential constraints are also dropped. In addition, if the column is part of a multiple-column primary-key or unique constraint, the multiple-column constraints are not dropped, but any referential constraints that are placed on the column by other tables are dropped.

For another example, suppose that a column is part of a multiple-column primary-key constraint. This primary key is referenced by foreign keys in two other tables. When this column is modified, the multiple-column primary-key constraint is not dropped, but the referential constraints that are placed on it by the two other tables are dropped.

Consider the table that this statement defines:

```
CREATE TABLE tab1(c1 INT, c2 INT);
```

To add the NOT NULL constraint, an ALTER TABLE MODIFY statement is required:

```
ALTER TABLE tab1 MODIFY (c1 INT NOT NULL);
```

You cannot add a NULL or a NOT NULL constraint with the ADD CONSTRAINT clause.

Restrictions on changing column data types

You cannot use the ALTER TABLE MODIFY statement to change the data type of a column to a COLLECTION type or to a ROW type.

If the schema of a table exactly matches the order of data types in the fields of an existing named ROW type, however, you can use the ALTER TABLE ADD TYPE statement to change that table into a typed table, as the topic [ADD TYPE Clause](#) describes.

The IDSECURITYLABEL column of a protected table cannot be altered to a different data type, nor can an existing column be altered to be of type IDSECURITYLABEL.

In general, the database server does not validate the resulting column values when you change the data types of columns in tables that contain data. The database server does not validate the values when you convert a column from an INTEGER or SMALLINT data type to a SERIAL, SERIAL8, or BIGSERIAL column.

- [Altering BYTE and TEXT Column data types](#)
You can use the MODIFY clause to change a BYTE column to a TEXT column, and vice versa. You can also use the MODIFY clause to change a BYTE column to a BLOB column and a TEXT column to a CLOB column.
- [Altering the Next Serial Value](#)
- [Altering character columns](#)
- [Altering the Structure of Tables](#)
- [Modifying Tables for NULL Values](#)
- [Adding a Constraint on a Non-Opaque Column](#)
- [Modify Column Security clause](#)
The DBSECADM can use this clause of the ALTER TABLE statement to modify the column-level security of a column, either by associating the column with an LBAC security label, or by dropping an existing association between the column and a security label.
- [Adding a Constraint That Existing Rows Violate](#)
- [How Modifying a Column Affects Triggers](#)
- [How Modifying a Column Affects Views](#)

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Altering BYTE and TEXT Column data types

You can use the MODIFY clause to change a BYTE column to a TEXT column, and vice versa. You can also use the MODIFY clause to change a BYTE column to a BLOB column and a TEXT column to a CLOB column.

Except for these operations, however, you cannot use the MODIFY clause to change a BYTE or TEXT column to any other type of column, nor to change any other type of column to a BYTE or TEXT column.

When you use this clause to change a BYTE column to a BLOB column, or to change a TEXT column to a CLOB column, you can also use the [PUT Clause](#) of the ALTER TABLE statement to specify an sbspace and to define its characteristics for storing the BLOB or CLOB objects.

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Altering the Next Serial Value

You can use the MODIFY clause to reset the next value of a SERIAL, BIGSERIAL, or SERIAL8 column. You cannot set the next value below the current maximum value in the column because that action can cause the database server to generate duplicate numbers. You can set the next value, however, to any value higher than the current maximum, which creates a gap in the series of values.

If the new serial value that you specify is less than the current maximum value in the serial column, the maximum value is not altered. If the maximum value is less than what you specify, the next serial number will be what you specify. The next serial value is not equivalent to one greater than the maximum serial value in the column in two situations:

- There are no rows in the table, and an initial serial value was specified when the table was created (or by a previous ALTER TABLE statement).
- There are rows in the table, but the next serial value was modified by a previous ALTER TABLE statement.

The following example sets the next serial value to 1000:

```
ALTER TABLE my_table MODIFY (serial_num SERIAL (1000));
```

As an alternative, you can use the INSERT statement to create a gap in the series of serial values in the column. For more information, see [Inserting Values into Serial Columns](#).

- [Altering the Next Serial Value in a Typed Table](#)

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Altering the Next Serial Value in a Typed Table

You can set the initial serial number or modify the next serial number for a ROW-type field with the MODIFY clause of the ALTER TABLE statement. (You cannot set the initial number for a serial field when you create a ROW data type.)

Suppose you have ROW types **parent**, **child1**, **child2**, and **child3**.

```
CREATE ROW TYPE parent (a int);
CREATE ROW TYPE child1 (s serial) UNDER parent;
CREATE ROW TYPE child2 (b float, s8 serial8) UNDER child1;
CREATE ROW TYPE child3 (d int) UNDER child2;
```

You then create corresponding typed tables:

```
CREATE TABLE OF TYPE parent;
CREATE TABLE OF TYPE child1 UNDER parent;
CREATE TABLE OF TYPE child2 UNDER child1;
CREATE TABLE OF TYPE child3 UNDER child2;
```

To change the next SERIAL and SERIAL8 numbers to 75, you can issue the following statement:

```
ALTER TABLE child3 MODIFY (s serial(75), s8 serial8(75));
```

When the ALTER TABLE statement executes, the database server updates corresponding serial columns in the **child1**, **child2**, and **child3** tables.

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Altering character columns

You can use the MODIFY clause to change the declared length of an existing CHAR, LVARCHAR, NCHAR, NVARCHAR, or VARCHAR column.

Similarly, the MODIFY clause can change the data type of a character column to a non-character data type.

For modified columns that you declare as built-in character data types, explicit or default size specifications are interpreted in units of bytes, unless the database was created with the SQL_LOGICAL_CHAR configuration parameter set to enable logical character semantics in character type declarations. For more information about logical character semantics when the ALTER TABLE statement declares size specifications for character columns, see [Logical Character Support in Character Columns](#). For more information about the SQL_LOGICAL_CHAR configuration parameter, see your *IBM® Informix® Administrator's Reference*. For additional information about multibyte locales and logical characters, see the *IBM Informix GLS User's Guide*.

In a database that was created as NLSCASE INSENSITIVE, changing a character column of type NCHAR or NVARCHAR into type CHAR, LVARCHAR, or VARCHAR causes the database server to process values in the modified column as case-sensitive.

Conversely, in the same case-insensitive database, changing a character column of type CHAR, LVARCHAR, or VARCHAR into type NCHAR or NVARCHAR results in case-insensitive processing of values in the modified column. (The data values are not changed, but variations in letter case are ignored in comparison and collation operations on those values.)

Related information:

[SQL_LOGICAL_CHAR configuration parameter](#)

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Altering the Structure of Tables

When you use the MODIFY clause, you can also alter the structure of other tables. If the modified column is referenced by other tables, those referential constraints are dropped. You must add those constraints to the referencing tables again, using the ALTER TABLE statement.

When you change the data type of an existing column, all data is converted to the new data type, including numbers to characters and characters to numbers (if the characters represent numbers). The following statement changes the data type of the **quantity** column:

```
ALTER TABLE items MODIFY (quantity CHAR(6));
```

When a primary-key or unique constraint exists, however, conversion takes place only if it does not violate the constraint. If a data type conversion would result in duplicate values (by changing FLOAT to SMALLFLOAT, for example, or by truncating CHAR values), the ALTER TABLE statement fails.

Modifying Tables for NULL Values

You can modify an existing column that formerly permitted NULLs to disallow NULLs, provided that the column contains no NULL values. To do this, specify MODIFY with the same column name and data type and the NOT NULL keywords. Those keywords create a NOT NULL constraint on the column.

You can modify an existing column that did not permit NULLs to permit NULLs. To do this, specify MODIFY with the column name and the existing data type, and omit the NOT NULL keywords. The omission of the NOT NULL keywords drops the NOT NULL constraint on the column. If a unique index exists on the column, you can remove it using the DROP INDEX statement.

An alternative method of permitting NULL values in an existing column that did not permit NULL values is to use the DROP CONSTRAINT clause to drop the NOT NULL constraint on the column.

When you define a PRIMARY KEY constraint, the database server also silently creates a NOT NULL constraint on the same column, or on the same set of columns that make up the primary key.

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Adding a Constraint on a Non-Opaque Column

ALTER TABLE ... MODIFY operations that use the Single Column Constraint format to implicitly create an index on a non-opaque column also automatically calculate the distribution of the specified column. The distribution statistics are available to the query optimizer when it designs query plans for the table on which the constraint is defined:

- For columns on which the new constraint is implemented as a B-tree index, the recalculated column distribution statistics are equivalent to distributions created by the UPDATE STATISTICS statement in HIGH mode.
- If the new constraint is not implemented as a B-tree index, the automatically recalculated statistics correspond to distributions created by the UPDATE STATISTICS statement in LOW mode.

See also the section [Automatic Calculation of Distribution Statistics](#) in the description of the CREATE INDEX statement for additional information about statistical distributions that are produced automatically when an index or constraint is created on an existing table.

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Modify Column Security clause

The DBSECADM can use this clause of the ALTER TABLE statement to modify the column-level security of a column, either by associating the column with an LBAC security label, or by dropping an existing association between the column and a security label.

This clause is valid only for tables that are protected by an LBAC security policy. This syntax fragment is part of the [MODIFY Clause](#).

Modify Column Security Clause

```
|-----+-----SECURED WITH--label-----|
| '-COLUMN-' |
| '-DROP COLUMN SECURITY-----' |
```

Element	Description	Restrictions	Syntax
<i>label</i>	Name of an LBAC security label	Must exist and must belong to the same LBAC security policy that protects the table.	Identifier

Usage

The DBSECADM can use this clause to add or drop column-level protection for a table. This clause can add row-level protection by associating the column with an LBAC security label, or it can use the DROP COLUMN SECURITY keywords to drop existing column-level security protection that a label was currently providing for the column.

- To establish column-level protection to a column, specify SECURED WITH *label* (or equivalently, COLUMN SECURED WITH *label*) to associate a security label with the column.
- To drop the column-level protection that an existing label is providing for a column, specify the DROP COLUMN SECURITY keywords.

The security label can be the same label that protects other rows or columns of the table, or it can be a different label of the same security policy. The following restrictions apply to the SECURED WITH *label* option:

- The table must be protected by an LBAC security policy.
- The data type of the protected column cannot be IDSSecurityLabel.
- The *label* must be a label of the same security policy that secures the table.
- Any number of columns can be protected by a security label, but no more than one security label can protect a given column.

- No more than one column name can precede each `SECURED WITH` or `DROP COLUMN SECURITY` specification of the [MODIFY Clause](#).
- Specify the *label* without the policy qualifier, rather than as *policy.label*.

When the `ALTER TABLE MODIFY COLUMN SECURED WITH` statement or the `ALTER TABLE MODIFY DROP COLUMN SECURITY` statement run successfully, the database server registers the change in column security in the **syscolumns** system catalog table.

For example, if the table **Argoknot** is protected by a security policy called **Medea** that has a security label called **fleece**, the following `ALTER TABLE` statement defines column-level protection with the **Medea.fleece** label for the column **Argoknot.ColJ**:

```
ALTER TABLE Argoknot
  MODIFY (ColJ JSON SECURED WITH fleece);
```

When DBSECADM successfully runs this DDL statement, the new column-level security of column **Argoknot.ColJ** is registered in the **syscolumns** system catalog table. To do this, the database server takes this action:

- It updates the row in **syscolumns** that describes column **Argoknot.ColJ**
- by replacing the `NULL` value in column **syscolumns.seclabelid**
- with the numeric value in column **sysseclabels.seclabelid**
- for the row describing the **Medea.fleece** security label.

Similarly, DBSECADM can later detach the **Medea.fleece** security label from the **Argoknot.ColJ** column by running the following `ALTER TABLE` statement:

```
ALTER TABLE Argoknot
  MODIFY (ColJ JSON DROP COLUMN SECURITY);
```

After this DDL statement executes successfully, the database server registers the now unprotected status of column **ColJ** by updating column **seclabelid** to a `NULL` value in the row of the **syscolumns** system catalog table that describes column **Argoknot.ColJ**.

Example of enabling column-level security

Suppose that table **Alphanumeric** was created with the following columns but with no security policy:

```
CREATE TABLE Alphanumeric
  (ColB CHAR(18),
   Col2 INT,
   Col3 CHAR (20));
```

The following `ALTER TABLE` statement

- attaches the **watchdog** security policy to the **Alphanumeric** table,
- and changes the column-level security status of column **Col1** from *unprotected* to *protected*, by using the `SECURED WITH` keywords to associate that column with the LBAC **watchdog.Label23** security label:

```
ALTER TABLE Alphanumeric
  MODIFY (Col1 CHAR(18) SECURED WITH Label23)
  ADD SECURITY POLICY watchdog;
```

Because the **Alphanumeric** table was created with no security policy, the `ADD SECURITY POLICY` clause is required for the `Modify Column Security` clause to be valid in the example above.

The result of the `ALTER TABLE MODIFY` operation would be the same if the `COLUMN` keyword had preceded the `SECURED WITH` keywords:

```
ALTER TABLE Alphanumeric
  MODIFY (Col1 CHAR(18) COLUMN SECURED WITH Label23)
  ADD SECURITY POLICY watchdog;
```

In either case, the **Alphanumeric** table now has column-level protection for column **Col1**, which is secured by the **Label23** security label of the **watchdog** security policy.

If the data in other columns of the **Alphanumeric** table besides **Col1** have the same security requirements as **Col1**, the following statements secure the other columns with the same **Label23** security label:

```
ALTER TABLE Alphanumeric
  MODIFY (Col2 INT COLUMN SECURED WITH Label23);
```

```
ALTER TABLE Alphanumeric
  MODIFY (Col3 CHAR(20) COLUMN SECURED WITH Label23);
```

DBSECADM can also grant that security label to the specific users who require access to the data that **Label23** is designed to protect:

```
GRANT SECURITY LABEL watchdog.Label23
  TO sam FOR READ ACCESS;
```

```
GRANT SECURITY LABEL watchdog.Label23
  TO peter, elaine, olan FOR WRITE ACCESS;
```

```
GRANT SECURITY LABEL watchdog.Label23
  TO lynette FOR ALL ACCESS;
```

For detailed examples of creating LBAC security labels and granting them to users, see [Examples of Granting User Security Labels](#).

Dropping security-label protection from a column

Suppose table **Betanumeric** is a protected table that was created with **watchdog** as its security policy,

- with both column **Col1** and **Col3** secured by the column-level protection of label **labelK9**,
- and with column **Col4** providing row-level security for the table with a security label whose default value is **labelK2**;


```
CREATE TABLE Betanumeric
  (Col1 CHAR (18) SECURED WITH labelK9,
   Col2 INT,
   Col3 CHAR (20) SECURED WITH labelK9
   Col4 IDSECURITYLABEL DEFAULT 'labelK2')
SECURITY POLICY watchdog;
```

Here **labelK9** and **labelK2** must both be labels of the **watchdog** security policy.

Tip: For two or more columns of the same table to have column-level protection, it is not required that the same LBAC label secure all of those columns. If sensitive data in several columns logically require the same access restrictions, however, securing multiple columns with the same security label might be appropriate. Suppose that DBSECADAM subsequently determines that the sensitivity of the data stored in column **Col1** does not require the protection of **watchdog.labelK9**, but is sufficiently protected by the row-level protection of label **watchdog.labelK2**. In this case, DBSECADAM might issue the following ALTER TABLE MODIFY statement, thereby dropping the association between security label **watchdog.labelK9** and **Col1** of table **Betanumeric**:

```
ALTER TABLE Betanumeric
  MODIFY (Col1 CHAR (18) DROP COLUMN SECURITY);
```

This ALTER TABLE MODIFY statement drops the security restriction that users cannot access column **Col1** unless their LBAC credentials include all the components of label **watchdog.labelK9**, or unless they hold equivalent LBAC security exemptions. Detaching the specified column from the specified security label is the entire scope of the DROP COLUMN SECURITY option to the Modify Column Security clause.

That is, disabling column-level security of a single column has no effect on the column-level protection of any other columns of the same table that are secured by the same LBAC label, such as column **Betanumeric.Col3** in this example. This DROP COLUMN SECURITY example also has no effect on any the following:

- On the row-level protection of table **Betanumeric** by the **watchdog.labelK2** label.
- On any other tables protected by the **watchdog** security policy,
- On any other tables protected by the **labelK9** security label.

Thus, only the column-level protection of column **Betanumeric.Col1** was dropped by the preceding ALTER TABLE MODIFY statement. The **watchdog** security policy, through row-level protection by the **labelK2** security label in column **Col4**, and column-level protection with the **labelK9** security label for column **Col3**, continues to protect table **Betanumeric**.

Detaching a table from its security policy

The DROP SECURITY POLICY clause detaches only a single column from its security label. If you hold the DBSECADM role, it is important to avoid confusing the DROP COLUMN SECURITY clause with the DROP SECURITY POLICY clause.

The following example, based on the same **Betanumeric** table, illustrates the ALTER TABLE statement syntax to drop the association between a specific table and its LBAC security policy:

```
ALTER TABLE Betanumeric DROP SECURITY POLICY;
```

When this statement executes successfully, it removes all column-level and row-level protection from the table. The database server updates the system catalog to show these changes to database objects within the scope of this example:

- Table **Betanumeric** is no longer protected by any security policy. This change is registered in two columns of the row that describes **Betanumeric** in the **systables** system catalog table:
 - In column **secpolicyid**, a NULL value replaces the numeric value of the **watchdog** security policy ID.
 - In column **protgranularity** of the same row, a blank character (ASCII 32) to indicate no protection replaces the B that had encoded both row-level and column-level protection as the former LBAC granularity of the **Betanumeric** table.
- Columns **Betanumeric.Col1** and **Betanumeric.Col3** are no longer protected by LBAC label **watchdog.labelK9**. This change is registered in two rows that describe those columns in the **syscolumns** system catalog table:
 - In column **seclabelid** of the row describing the **Betanumeric.Col1** column, a NULL value replaces the numeric value of the **labelK9** security label ID.
 - In column **seclabelid** of the row describing the **Betanumeric.Col3** column, a NULL value replaces the numeric value of the **labelK9** security label ID.
- Column **Col4** is automatically dropped from the schema of table **Betanumeric**, because a table with no security policy cannot include a column of type IDSECURITYLABEL. This change is registered in the system catalog by dropping the row that had described the **Betanumeric.Col4** column from the **syscolumns** system catalog table.

Important: Except for the **Betanumeric** table and the data in its rows and columns, the ALTER TABLE DROP SECURITY POLICY statement in this example has no effect on any other database objects that the **watchdog** security policy or the **labelK2** or **labelK9** security labels protect. Only DROP SECURITY statements can destroy security objects. For more information about detaching a security policy from a table, see [SECURITY POLICY Clause](#).

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Adding a Constraint That Existing Rows Violate

If you use the MODIFY clause to add a constraint in the enabled mode and receive an error message because existing rows would violate the constraint, take the following steps to add the constraint successfully:

1. Add the constraint in the disabled mode.
Issue the ALTER TABLE statement again, but this time specify the DISABLED keyword in the MODIFY clause.
2. Start a violations and diagnostics table for the target table with the START VIOLATIONS TABLE statement.
3. Issue the SET CONSTRAINTS statement to switch the database object mode of the constraint to the enabled mode.
When you issue this statement, existing rows in the target table that violate the constraint are duplicated in the violations table; however, you receive an integrity-violation error message, and the constraint remains disabled.
4. Issue a SELECT statement on the violations table to retrieve the nonconforming rows that are duplicated from the target table.

You might need to join the violations and diagnostics tables to get all the necessary information.

5. Take corrective action on the rows in the target table that violate the constraint.
6. After you fix all the nonconforming rows in the target table, issue the SET statement again to enable the constraint that was disabled.
Now the constraint is enabled, and no integrity-violation error message is returned because all rows in the target table now satisfy the new constraint.

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How Modifying a Column Affects Triggers

If you modify a column that appears in the triggering column list of an UPDATE trigger, the trigger is unchanged.

When you modify a column in a table, the triggers based on that table remain unchanged, but the column modification might invalidate the trigger.

The following statements illustrate the possible effects on triggers:

```
CREATE TABLE tab1 (i1 INT, i2 INT, i3 INT);
CREATE TABLE tab2 (i4 INT, i5 INT);
CREATE TRIGGER colltrig UPDATE OF i2 ON tab1
  BEFORE (INSERT INTO tab2 VALUES (1,1));
ALTER TABLE tab2 MODIFY i4 CHAR;
```

After the ALTER TABLE statement, column **i4** accepts only character values. Because character columns accept only values enclosed in quotation marks, the action clause of the **colltrig** trigger is invalidated.

If a trigger is invalidated when you modify the underlying table, drop and then re-create the trigger.

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How Modifying a Column Affects Views

When you modify a column in a table, the views based on that table remain unchanged. If a view is invalidated when you alter the underlying table, you must rebuild the view.

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MODIFY EXTENT SIZE

Use the MODIFY EXTENT SIZE clause with the ALTER TABLE statement to change the size of the first extent of a table in a dbspace.

You cannot use the MODIFY EXTENT SIZE clause to change the size of the first extent:

- of a table in a blobspace
- of external tables, virtual tables, or system catalog tables
- in the tblspace **tblspace**

This syntax fragment is part of the [ALTER TABLE statement](#).

MODIFY EXTENT SIZE Clause

| --MODIFY EXTENT SIZE--kilobytes----- |

Element	Description	Restrictions	Syntax
<i>kilobytes</i>	Length (in kilobytes) assigned here to the first extent for this table	Specification cannot be a variable, and $(4(\text{page size})) \leq \text{kilobytes} \leq$ (chunk size)	Expression

The minimum extent size is 4 times the disk-page size. For example, on a system with 2-kilobyte pages, the minimum length is 8 kilobytes. The maximum length is the chunk size.

The following example specifies an extent size of 32 kilobytes:

```
ALTER TABLE customer MODIFY EXTENT SIZE 32;
```

When you change the size of the first extent, the database server records the change in the system catalog and on the partition page, but only makes the actual change when the table is rebuilt or a new partition or fragment is created.

For example, if a table has a first extent size of 8 kilobytes and you use the ALTER TABLE statement to change this to 16 kilobytes, the server does not drop the current first extent and recreate it with the new size. Instead, the new first extent size of 16 kilobytes takes effect only when the server rebuilds the table after actions such as creating a cluster index on the table or detaching a fragment from the table.

If a TRUNCATE TABLE statement without the REUSE option is executed before the ALTER TABLE statement with the MODIFY EXTENT SIZE clause, there is no change in the size of the current first extent.

If an existing table in a dbspace has data in it, the first and next extents are already allocated for the table and you will not be able to change the size of the first or next extent. If you want to change the size of existing extents, you must drop the table, recreate it with a storage clause indicating the desired size, and load the data again.

You can change the size of the first and next extent at the same time. The following example specifies changing the size of the first and next extent:

```
ALTER TABLE customer MODIFY EXTENT SIZE 32 NEXT SIZE 32
```

The first and next extent sizes are recorded in the PNSIZES logical log record.

Related reference:

[MODIFY NEXT SIZE clause](#)

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MODIFY NEXT SIZE clause

Use the MODIFY NEXT SIZE clause to change the size of the next extent.

This syntax fragment is part of the [ALTER TABLE statement](#).

MODIFY NEXT SIZE clause

```
|--MODIFY NEXT SIZE--kilobytes-----|
```

Element	Description	Restrictions	Syntax
<i>kilobytes</i>	Length (in kilobytes) assigned here to the next extent for this table	Specification cannot be a variable, and $(4(\text{page size})) \leq \text{kilobytes} \leq$ (chunk size)	Expression

The minimum extent size is 4 times the disk-page size. For example, on a system with 2-kilobyte pages, the minimum length is 8 kilobytes. The maximum length is the chunk size. The following example specifies an extent size of 32 kilobytes:

```
ALTER TABLE customer MODIFY NEXT SIZE 32;
```

This clause cannot change the size of existing extents. You cannot change the size of existing extents without unloading all of the data.

To change the size of existing extents, you must unload all the data, drop the table, modify the *first-extent* and *next-extent* sizes in the CREATE TABLE definition in the database schema, re-create the table, and reload the data. For information about how to optimize extent sizes, see your *IBM® Informix® Performance Guide*.

Related reference:

[EXTENT SIZE Options](#)

[MODIFY EXTENT SIZE](#)

Related information:

[Managing the size of first and next extents for the tblspace tblspace](#)

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PUT Clause

Use the PUT clause of the ALTER TABLE statement to define sbpace storage for a column that contains smart large objects. This clause can define BLOB or CLOB storage attributes for a new column, or it can modify the current settings of those storage attributes for an existing column.

This syntax fragment is part of the [ALTER TABLE statement](#).

PUT Clause

```

      .-,-,-----
      v          |
|--PUT--column--IN--(---sbpace---)----->

>+-----+-----+-----+-----+-----+
|      .-,-,-----,-----+-----+-----+
|      v          |
|'-(---+-----+-----+-----+-----+---)'
|      +-EXTENT SIZE--kilobytes--+
|      | .-NO LOG-.               |
|      +-----+-----+-----+
|      | '-LOG---'                 |
|      | .-HIGH INTEG-----      |
|      +-----+-----+-----+
|      | '-MODERATE INTEG-'        |
|      | .-NO KEEP ACCESS TIME-.   |
|      +-----+-----+-----+
|      | '-KEEP ACCESS TIME----'   |

```

Element	Description	Restrictions	Syntax
<i>column</i>	Column to store in the specified sbspace	Must be a UDT, or a complex, BLOB, or CLOB data type	Identifier
<i>kilobytes</i>	Number of kilobytes to allocate for the extent size	Must be an integer value	Literal Number
<i>sbspace</i>	Name of an area of storage for smart large objects	The sbspace must exist. See also Usage for <i>sbspace</i> restrictions on tables in tenant databases.	Identifier

Usage

The data type of the *column* can be BLOB or CLOB, or it can be a complex data type or a user-defined data type (UDT) that can store smart large objects.

The format *column.field* is not valid here. That is, the smart large object that you are storing cannot be one field of a ROW type.

If the table that the PUT clause of the ALTER TABLE statement is modifying is in a tenant database, the *sbspace* must be a dedicated sbspace in the tenant database properties list. If the table is not in a tenant database, the *sbspace* cannot be the name of an sbspace that is dedicated to a tenant database.

Specifying more than one *sbspace* distributes the storage of the BLOB or CLOB objects in a round-robin distribution scheme. When a new row is inserted, the database server favors the sbspace with the most available storage space.

When more than one *sbspace* name follows the **IN** keyword, parentheses must delimit the comma-separated list of sbspaces that store the BLOB or CLOB objects. Unless you accept default values for all of the storage options that can follow the *sbspace* list, delimiting parentheses must also enclose the list of storage options, as in the following example:

```
ALTER TABLE MyClobs ADD (c5 CLOB)
PUT c5 IN (sbs3,sbs4) (EXTENT SIZE 64, HIGH INTEG);
```

Here the ADD clause above appends a new column **c5** of type CLOB to table **MyClobs**. The PUT clause stores each CLOB object in sbspace **sbs3** or **sbs4**, in a round-robin distribution. The first extent size is 64 kilobytes, and the data pages will include page headers and page footers in **HIGH** data integrity mode. By default, the column is unlogged, and access times are not recorded.

When the PUT clause modifies a BLOB or CLOB column, the storage characteristics of smart large objects already stored in the column are unchanged. The new characteristics apply only to BLOB or CLOB objects in rows inserted into the table after the PUT clause takes effect.

This syntax resembles the PUT clause of the CREATE TABLE statement, but the PUT clause of ALTER TABLE can specify only a single column, rather than a list of columns. Changes made to storage attributes of BLOB or CLOB objects by the PUT clauses of the ALTER TABLE statement or the CREATE TABLE statement are registered in the **syscolattns** system catalog table.

Using the PUT clause with a new or modified column

When you use this clause to specify storage attributes for smart large objects in a new column that the ALTER TABLE statement is adding to the table schema, or for an existing column whose sbspace storage the ALTER TABLE statement is modifying, these keyword options of the PUT clause can define explicit or default characteristics for one or more existing sbspace:

IN (*sbspace_list*)

Here *sbspace_list* is a comma-separated list of one or more sbspace names. If you omit **IN sbspace_list** from the PUT clause, the SBSPACENAME configuration parameter specifies the system default sbspace in which smart large objects are stored. If the *sbspace_list* of the PUT clause specifies more than one sbspace, the smart blob objects are distributed round-robin among those sbspaces. Each smart large object is stored in a single sbspace.

EXTENT SIZE *integer*

This sets a lower limit on how many kilobytes can be stored in a smart-large-object extent. If you omit the **EXTENT SIZE** keywords, the database server calculates a default extent size.

NO LOG

This prevents the same logging procedure that is applied to other columns from being applied to the smart large objects. This default reduces log traffic, and reduces the risk of filling the logical log.

LOG

This alternative option to **NO LOG** applies the logging procedure used with the current database for smart large objects in the sbspaces that this PUT clause assigns.

HIGH INTEG

This high data-integrity option produces user-data pages that each contains a page header and a page trailer to detect incomplete writes and data corruption. This option is the default data-integrity behavior.

MODERATE INTEG

This alternative data-integrity option to **HIGH INTEG** produces user-data pages that each contains a page header but no page trailer. This option reduces operational costs, but cannot detect incomplete writes or data corruption by comparing the page header with a page trailer.

NO KEEP ACCESS TIME

This does not record the system time when the smart large object was last read or written. This option provides better performance than the **KEEP ACCESS TIME** option, and is the default tracking behavior.

KEEP ACCESS TIME

This alternative tracking option to **NO KEEP ACCESS TIME** maintains a record in the smart-large-object metadata of the system time when the smart large object was last read or written.

The PUT clause cannot specify a buffering mode or a locking granularity for the smart large object. The system default buffering mode is **OFF**, and the system default locking granularity is the entire smart large object. The **-Df** option of the **onspaces** utility can override these defaults for specific sbspaces that store BLOB or CLOB objects that require other settings.

When you modify the storage characteristics of an existing column, by default *all* attributes previously associated with the storage space for that column are dropped. If you want the same settings for certain attributes to persist, you must explicitly specify the settings for those attributes again. For example,

- to retain logging, you must specify the **LOG** keyword again. Otherwise, the default **NO LOG** option takes effect.

- to retain the less costly level of data-integrity, you must specify the `MODERATE INTEG` keywords again. Otherwise, the default `HIGH INTEG` option takes effect.
- to maintain a smart-large-object metadata record of when the smart large object was last read or written, you must specify `KEEP ACCESS TIME` keywords again. Otherwise, the default `NO KEEP ACCESS TIME` option takes effect.

Sections that follow illustrate `ALTER TABLE` operations that use these options of the `PUT` clause.

Suppose that permanent table **sbt** was created with the following schema:

```
CREATE TABLE sbtab (c2 INT);
```

Example 1: Adding a new BLOB column to a table

The following `ALTER TABLE` statement alters the schema of table **sbt** by adding BLOB column **c1** as the new first column, and stores its BLOB objects in existing subspace **sbs1**, for which the `PUT` clause defines additional attributes:

```
ALTER TABLE sbtab ADD (c1 BLOB BEFORE c2)
  PUT c1 IN (sbs1) (EXTENT SIZE 32,
                  NO LOG,
                  MODERATE INTEG,
                  KEEP ACCESS TIME);
```

The `PUT` clause specifies these storage attributes for new column **c1**:

- allocates 32 kilobytes for the first extent of each BLOB object,
- disables transaction logging for the new column in subspace **sbs1**,
- uses the data-integrity option of data page headers without footers,
- and maintains a record of when each BLOB object was last read or written.

Examples 2 and 3: Modifying subspace attributes

Suppose that the owner of table **sbt** subsequently decides to change the storage options for the BLOB objects in column **c1**. The following `ALTER TABLE` statement alters the storage attributes of BLOB column **c1** by changing the extent size in the subspace **sbs1** to 64 kilobytes, and turning on transaction logging:

```
ALTER TABLE sbtab PUT c1 IN (sbs1) (EXTENT SIZE 64, LOG);
```

Because this example does not repeat the nondefault settings for the data integrity and access time attributes that *Example 1* specified, the new `PUT` clause sets these storage options for new BLOB objects in column **c1**:

- continues to store new BLOB objects in subspace **sbs1**,
- increases to 64 kilobytes the first extent of each BLOB object,
- explicitly enables transaction logging for column **c1**,
- implicitly restores the default data-integrity option of data pages with headers and footers,
- and implicitly discontinues recording `ACCESS TIME` records.

But all of the storage attributes that the `ALTER TABLE sbtab ADD` statement set for subspace **sbs1** in *Example 1* persist in any rows that were added to the **sbt** table before *Example 2* reset those attributes.

The next example of the `PUT` clause modifies only one attribute of the same subspace **sbs1** to change its logging mode for BLOB column **c1** to `NO LOG`:

```
ALTER TABLE sbtab PUT c1 IN (sbs1) (EXTENT SIZE 64, NO LOG);
```

Because `NO LOG` is the default for smart large objects, this statement has the same effect if the `NO LOG` keywords are omitted, as in this equivalent example:

```
ALTER TABLE sbtab PUT c1 IN (sbs1) (EXTENT SIZE 64);
```

Example 4: Distributing storage across subspaces

This example alters the **sbt** table to distribute the storage of BLOB column **c1** in subspaces **sbs1** and **sbs2**.

```
ALTER TABLE sbtab PUT c1 IN (sbs1, sbs2)
  (EXTENT SIZE 100, LOG, KEEP ACCESS TIME);
```

The `PUT` clause also

- changes the extent size to 100 kilobytes,
- turns on transaction logging,
- and records the system times of the last read access and write access in the smart-large-object metadata.

For more information on the storage characteristics for smart large objects when database tables are created, refer to the counterpart of this topic in the [PUT Clause](#) of the `CREATE TABLE` statement. For a discussion of large-object characteristics, refer to [Large-Object Data Types](#).

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SECURITY POLICY Clause

Use the Security Policy clause of the `ALTER TABLE` statement to drop the security policy that is currently associated with the table, or to associate a security policy with a table that has none.

This syntax fragment is part of the [ALTER TABLE statement](#).

SECURITY POLICY Clause

```
|---+--ADD SECURITY POLICY--policy+-----|  
'-DROP SECURITY POLICY-----'
```

Element	Description	Restrictions	Syntax
<i>policy</i>	Name of a security policy	Must be an existing security policy	Identifier

Usage

Only DBSECADM can use this clause to add a security policy to an existing table, or to remove from the table the protection of the security policy that currently protects a table.

Restrictions on adding a security policy

The following guidelines apply to tables that can be protected by executing the ADD SECURITY POLICY clause of the ALTER TABLE statement:

- A table is not protected unless it has a security policy associated with it and has either rows secured, or has at least one column secured.
 - Having rows secured indicates that the table is a *protected table* with *row-level* granularity.
 - Having at least one column secured indicates that the table is a *protected table* with *column-level* granularity.
- Securing rows by using the ALTER TABLE ... ADD *column* statement to add an IDSSECURITYLABEL column to an existing table fails if the table does not have a security policy associated with it.
- Securing a column with the ALTER TABLE ... MODIFY *column* SECURED WITH *label* clause fails if the table does not have a security policy associated with it.
- A table can have at most one security policy. The ALTER TABLE ... ADD SECURITY POLICY statement fails if the table already has a security policy.
- A table can have any number of protected columns. Each protected column can have a different security label, or several protected columns can share the same security label, but all labels must have the same security policy.
- This clause cannot add a security policy to protect any of the following table objects
 - a temporary table,
 - a table outside the current database,
 - a typed table in a table hierarchy,
 - an object defined by the CREATE EXTERNAL TABLE statement.
- A table can have at most one column of type IDSSECURITYLABEL.
- The IDSSECURITYLABEL column cannot have column-level protection (that is, a security label).
- The IDSSECURITY LABEL column cannot have single column constraints.
- The IDSSECURITY LABEL column cannot be part of the multiple column key of a referential constraint or of a check constraint.
- The IDSSECURITYLABEL column cannot be encrypted.
- The IDSSECURITYLABEL column has an implicit DEFAULT NOT NULL constraint. The default column value is the value of the security label of the user for write access.
- The IDSSECURITYLABEL column cannot be modified by the ALTER TABLE MODIFY statement.

Security policies and tables with distributed storage

Detaching a fragment of a protected table creates a new table that is protected by the same security policy for the same row security label column, and the same set of protected columns.

Some restrictions apply to associating a fragmented table with a security policy. Attaching a fragment to a protected fragmented table fails if any of these conditions are true:

- if the source table and the target table are not protected using the same security policy;
- if the tables do not have the same protection granularity;
- if the tables do not have the same set of protected columns, each protected by the same security label.

For more information on using the ALTER FRAGMENT statement to attach fragments to protected tables, see [Additional Restrictions on the ATTACH Clause](#).

Associating a security policy with a table

In a database in which the LBAC security policy **Watchdog** is defined, consider an unprotected table with the following schema:

```
CREATE TABLE IF NOT EXISTS MyData  
(C1 CHAR (8) ,  
C2 INT,  
C3 CHAR (10));
```

The DBSECADM can change this to a table with row-level protection of the **Watchdog** security policy by issuing the following ALTER TABLE statement:

```
ALTER TABLE MyData  
ADD C4 IDSSECURITYLABEL,  
ADD SECURITY POLICY Watchdog;
```

Here no security label is specified, so the default security label for the rows of the **MyData** table is the label of the **Watchdog** security policy that the current user holds for write access. This example illustrates a requirement that if the table is protected by no security policy, both the ADD COLUMN IDSSECURITYLABEL clause and the ADD SECURITY POLICY clause must be included in the same ALTER TABLE statement.

An alternative to the syntax illustrated by the previous example is that the DBSECADM can instead change the **MyData** table to a table protected by a specific security label of the **Watchdog** security policy, rather than by a default security label, as in this ALTER TABLE statement:

```
ALTER TABLE MyData
  ADD C4 IDSSecurityLabel DEFAULT 'canine',
  ADD SECURITY POLICY Watchdog;
```

Here the security label **canine** must be part of the **Watchdog** security policy.

Dropping a security policy from a table

Conversely, in a database in which the LBAC security policy **Watchdog** is defined, consider a protected table called **MyOtherData** with the same schema that resulted after the ALTER TABLE statement in the previous example modified for the **MyData** table:

```
CREATE TABLE IF NOT EXISTS MyOtherData
  (C1 CHAR (8),
   C2 INT,
   C3 CHAR (10)
   C4 IDSSecurityLabel DEFAULT canine NOT NULL)
  SECURITY POLICY Watchdog;
```

The DBSECADM can change this **MyOtherData** table to an unprotected table with no security policy by issuing the following statement:

```
ALTER TABLE MyOtherData
  DROP SECURITY POLICY Watchdog;
```

When a security policy is dropped from a table by the ALTER TABLE DROP SECURITY POLICY statement, the IDSSecurityLabel column **C4** that provided row-level protection is automatically dropped. If labels table had protected any columns, those columns become unprotected when the security policy was dropped.

The DROP SECURITY POLICY option requires the Connect, Resource, and Alter discretionary access privileges for dropping columns, because this option drops the IDSSecurityLabel column that only tables associated with a security policy can include in their schema.

Replacing the security policy of an existing table

If the DROP SECURITY POLICY clause of the ALTER TABLE statement executes successfully, the table is no longer protected by any security policy. Other tables that are associated with the same security policy, however, are not affected by the alterations to this table. The IDSSecurityLabel column and any security label associated with the dropped security policy are no longer part of the table schema.

If no protection of a security policy is needed for the data in the table, no further action is needed.

If either row-level or column-level protection is needed for the table, however, a user who holds DBSECADM credentials should take steps to attach another security policy to the table :

- Replace the security policy that was dropped with another security policy, using the ADD SECURITY POLICY clause in an ALTER TABLE statement that also establishes row-level or column-level security. The following example establishes both row-level and column-level protection for the **MyOtherData** table, based on the **Robodog** security policy:

```
ALTER TABLE MyOtherData
  ADD (C4 IDSSecurityLabel DEFAULT),
  MODIFY (C2 INT COLUMN SECURED WITH label7),
  ADD SECURITY POLICY Robodog;
```

- If the new security design requires only row-level protection, then instead of the previous example, the **C2** column need not be associated with **label7**:

```
ALTER TABLE MyOtherData
  ADD (C4 IDSSecurityLabel DEFAULT),
  ADD SECURITY POLICY Robodog;
```

- If the new security design requires only column-level protection, use the MODIFY . . . COLUMN SECURED WITH clause to protect one of more columns with labels of the new security policy.

```
ALTER TABLE MyOtherData
  MODIFY (C1 CHAR (8) COLUMN SECURED WITH label9),
  ADD SECURITY POLICY Robodog;
```

Dropping a security policy from a table or from the database

Do not confuse this DROP SECURITY POLICY clause of the ALTER table statement with the DROP SECURITY POLICY statement of SQL.

- When the DROP SECURITY POLICY clause of the ALTER TABLE statement executes successfully, its immediate effects include these:
 - It terminates the association of that table with the security policy,
 - and it drops the IDSSecurityLabel column from that table,
 - and it removes LBAC protection from data that had been protected in that table.

It has no effect, however, on the security policy, nor on other tables protected by the policy.

- When the DROP SECURITY POLICY statement executes successfully, the scope of its effects depends on whether the policy is dropped in RESTRICT mode or in CASCADE mode, but in either mode, it destroys the specified policy.

See the description of [DROP SECURITY statement](#) for more information on the DROP SECURITY POLICY statement of SQL, and about restrictions on that statement.

Statistics options of the ALTER TABLE statement

Use the Statistics Options clause of the ALTER TABLE statement to change values of the STATCHANGE property of a fragmented or nonfragmented table, and the STATLEVEL property of a fragmented table. These table properties control the threshold for recalculation in automatic mode, and the granularity of data distribution statistics.

This clause supports the same syntax options as the Statistics Options clause of the CREATE TABLE statement. This syntax fragment is part of the [ALTER TABLE statement](#).

Statistics Options

```
|----->
|          .-AUTO----- . |
|  '-STATCHANGE---change_threshold---'
|
>-----|
|  '-STATLEVEL---FRAGMENT---'
|          +-TABLE-----+
|          '-AUTO-----'
|
```

Element	Description	Restrictions	Syntax
<i>change_threshold</i>	Percentage of changed data rows that defines stale distribution statistics	Must be an integer in the range 0 - 100	Literal Number

Usage

The Statistics Options clause of the ALTER TABLE statement can define or modify table statistics properties that can affect these operations while the automatic mode of UPDATE STATISTICS is enabled:

- UPDATE STATISTICS statements without the **FOR** keyword
- UPDATE STATISTICS FOR TABLE statements in **LOW**, **MEDIUM**, or **HIGH** mode.

The ALTER TABLE statement can modify the specified or default values of the STATCHANGE and STATLEVEL properties that were set when the table was created, or that were set by a previous ALTER TABLE statement.

The STATCHANGE property

The STATCHANGE table property specifies the minimum percentage of changes (from UPDATE, DELETE, LOAD, and INSERT operations) on the rows in the table or fragment since the previous calculation of distribution statistics) to consider the statistics stale. You can specify the percentage change as either an integer value in the range 0 - 100, or you can use the **AUTO** keyword to apply the current STATCHANGE configuration parameter setting in the ONCONFIG file, or the setting in the session environment, as the default change threshold value.

The **AUTO** keyword of the UPDATE STATISTICS statement also enables comparing the proportion of rows with changed values to the STATCHANGE setting to determine whether the statistics in the system catalog are stale. Including the **AUTO** keyword in the UPDATE STATISTICS statement enables checking for stale statistics (and selectively updating only the tables or fragments with stale or missing statistics) during the current UPDATE STATISTICS operation.

When the **AUTO_STAT_MODE** configuration parameter or the **AUTO_STAT_MODE** session environment variable enables the automatic mode, the UPDATE STATISTICS statement uses the explicit or default STATCHANGE value to identify table, index, or fragment distributions whose statistics are missing or stale, and updates only the missing or stale statistics. For more information about the automatic mode for UPDATE STATISTICS operations, see information about the **AUTO_STAT_MODE** configuration parameter in the *IBM® Informix® Administrator's Reference*.

The STATCHANGE property and the automatic mode of UPDATE STATISTICS do not directly affect the optimization of SPL execution plans, or UPDATE STATISTICS statements that include the **FORCE**, **FOR FUNCTION**, **FOR PROCEDURE**, **FOR ROUTINE**, or **FOR SPECIFIC** keywords.

The STATLEVEL property

The STATLEVEL property can determine the level of granularity of the data distributions and index statistics of fragmented tables. It can take one of the following three values, with **AUTO** being the default, if no value is specified at creation time:

- **TABLE** specifies that all distributions for the table be created at the table level.
- **FRAGMENT** specifies that distributions be created and maintained for each fragment.
- **AUTO** specifies that the database server apply criteria at run time to determine whether fragment-level distributions are necessary. These criteria require that the following conditions are true:
 - The **SYSSBSPACENAME** configuration parameter setting specifies an existing sbpace
 - The table is fragmented by an **EXPRESSION**, **INTERVAL**, **Rolling Window**, or **LIST** strategy
 - The table has more than a million rows.

If any of these criteria are not satisfied, the database server creates table-level distributions, rather than fragment-level.

These properties are always applied. If the STATLEVEL setting is **AUTO**, this setting overrides the default values.

Note: The **SYSSBSPACENAME** configuration parameter, which must be set when the database server instance is initialized, specifies the sbpace in which the database server stores fragment-level data distribution statistics. These are stored as BLOB objects in the **encdist** column of the **syfragsdist** system catalog table. For the database server to support fragment level statistics, the **SYSSBSPACENAME** configuration parameter setting must specify an existing sbpace.

If you use the Statistics Options clause to set the STATLEVEL property to **FRAGMENT**, the database server returns an error -9814 ("Invalid default sbpace name") if either of the following is true:

- The **SYSSBSPACENAME** configuration parameter is not set
- The sbpace that **SYSSBSPACENAME** specifies was not properly allocated by the **onspaces -c -S** command.

Example of changing the STATLEVEL

Suppose that table **tabFrag** uses a fragmented distribution strategy other than ROUND ROBIN, and includes a BLOB or CLOB column called **smartblob**. You decide to keep the storage distribution strategy, but to use TABLE, rather than FRAGMENT, as the STATLEVEL granularity.

The following SQL statements implement those changes:

```
ALTER TABLE tabFrag STATLEVEL TABLE;

UPDATE STATISTICS LOW
  FOR TABLE tabFrag (smartblob) DROP DISTRIBUTIONS;

UPDATE STATISTICS HIGH
  FOR TABLE tabFrag (smartblob);
```

The statements above have these respective effects:

- Change the STATLEVEL to TABLE, by using the Statistics Options clause of ALTER TABLE.
- Discard the current fragment-level distributions of **tabFrag.smartblob** in the **sysfragdist** system catalog table, by using UPDATE STATISTICS LOW.
- Create new table-level statistics for **tabFrag** in the **sysdistrib** system catalog table, by using UPDATE STATISTICS HIGH.

In the last statement above, the default HIGH resolution of 0.5 implies that the **tabFrag.smartblob** distribution statistics are based on approximately 200 bins.

Example of resetting the STATCHANGE value

For the same **tabFrag** table whose STATLEVEL property was changed from FRAGMENT to TABLE in the previous section, suppose that you also decide to change its STATCHANGE value to AUTO from whatever setting it currently has, and to replace the HIGH mode distribution statistics with a MEDIUM mode.

The following SQL statements implement those changes:

```
ALTER TABLE tabFrag STATCHANGE AUTO;

UPDATE STATISTICS LOW
  FOR TABLE tabFrag (smartblob) DROP DISTRIBUTIONS;

UPDATE STATISTICS MEDIUM
  FOR TABLE tabFrag (smartblob) AUTO;
```

In the last s

These are the respective effects on the **tabFrag** table of the statements above:

- The Statistics Options clause of ALTER TABLE changes the STATCHANGE setting to AUTO.
- The UPDATE STATISTICS LOW statement discards the current fragment-level distributions of **tabFrag.smartblob** from the **sysfragdist** system catalog table, but recalculates no table-level statistics. (Here the LOW keyword is required syntax to enable the DROP DISTRIBUTIONS operation.)
- The UPDATE STATISTICS MEDIUM statement refresh the table-level statistics for **tabFrag** in the **sysdistrib** system catalog table in automatic mode, by including the AUTO keyword.

tatement above, the default MEDIUM resolution of 2.5 implies that the **tabFrag.smartblob** distribution statistics are based on approximately 40 bins.

In this example, the AUTO setting for STATCHANGE in the ALTER TABLE statement and the AUTO keyword in the UPDATE STATISTICS MEDIUM apply automatic mode to the recalculation of **tabFrag.smartblob** statistics. Although no **tabFrag.smartblob** data values changed since the UPDATE STATISTICS HIGH operation in the STATLEVEL example, the preceding UPDATE STATISTICS LOW statement dropped the HIGH mode statistics, so the statistics for 100% of the rows became "missing" during the DROP DISTRIBUTIONS operation. In this case, no selective recalculation of **tabFrag.smartblob** statistics occurs, despite the automatic mode.

The examples above illustrate some effects of ALTER TABLE options for redefining the statistics properties of a table, and the effects of those modified properties on some UPDATE STATISTICS operations in automatic mode. They do not necessarily illustrate a recommended or efficient sequence of decisions for redefining the granularity or the resolution of column statistics for tables and for table fragments in the system catalog.

Related information:

[AUTO_STAT_MODE configuration parameter](#)

[STATCHANGE configuration parameter](#)

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ALTER TRUSTED CONTEXT statement

Use the ALTER TRUSTED CONTEXT statement to modify the current options and attributes (including the ENABLED or DISABLED mode) of a trusted-context object.

This statement is an extension to the ANSI/ISO standard for the SQL language.

Syntax

```
>>-ALTER TRUSTED CONTEXT--context----->

  |-----|
  | V      V (1) |
>---+--ALTER---+--SYSTEM AUTHID--user-----+---+>
  |          |          |-----|          |
```


database server interprets a subsequent incoming connection request as matching the ADDRESS attribute of a trusted-context object if the IP address from which the connection originates matches any of the IP addresses to which the domain name was converted.

The ALTER ATTRIBUTES clause replaces existing values for specified attributes with the new values. If an attribute is not currently part of the trusted-context object definition, an error is returned. Attributes that are not specified retain their previous values.

Specified ADDRESS values for the trusted-context object are removed by the ALTER ATTRIBUTES clause and by the DROP ATTRIBUTES clause. The ADDRESS attribute can be specified multiple times, but each *address* value must be unique for the set of attributes.

If a new *address* value is the name of a secure domain, that name is converted to an IP address by the domain-name server, where a resulting IPv4 or IPv6 address is determined. When a domain name is converted to an IP address, the result of this conversion might be a set of one or more IP addresses. In this case, the database server interprets a subsequent incoming connection request as matching the ADDRESS attribute of a trusted-context object if the IP address from which the connection originates matches any of the IP addresses to which the domain name was converted.

The ADD ATTRIBUTES clause specifies a list of one or more new trust attributes on which the trusted-context object is defined.

The DROP ATTRIBUTES clause specifies that one or more attributes are to be dropped from the definition of the trusted-context object. If the attribute is not currently part of the trusted-context object definition, an error is returned.

Attention:

If you have an existing application with an ALTER TRUSTED CONTEXT statement that includes the ENCRYPTION or WITH ENCRYPTION options in the ATTRIBUTES clause, the database server does not issue an SQL error. Except, however, for the WITH ENCRYPTION 'NONE' and the ENCRYPTION 'NONE' keyword options, the encryption options of the ALTER TRUSTED CONTEXT statement are not supported for Informix database servers.

DEFAULT ROLE attributes

The DEFAULT ROLE *role* option to the ALTER clause identifies a role that already exists on the current database server. This role can be used by a user who does not hold a user-specific role that was defined as part of the definition of the trusted-context object.

The NO DEFAULT ROLE keywords specify that the trusted-context object does not have a default role.

If a trusted connection for this trusted context is active, changes to the DEFAULT ROLE attribute take effect on the next new connection request, or on the next request to switch users.

ENABLE and DISABLE options of the ALTER clause

The ENABLE attribute specifies that the trusted-context object is enabled.

The DISABLE attribute specifies that the trusted-context object is in a disabled state, and is not enabled for any new trusted connections that are established.

You cannot use the SET Database Object Mode statement of SQL to change the ENABLE or DISABLE attributes of trusted contexts.

ADD USE FOR clause

The ADD USE FOR clause specifies additional users who can establish a trusted connection based on this trusted-context object. The PUBLIC attribute specifies that a trusted connection that is based on this trusted-context object can be used by any user.

The PUBLIC attribute must not already be specified for the trusted-context object, and PUBLIC must not be specified more than once in the ADD USE FOR clause. If the definition of a trusted-context object allows access by PUBLIC and also by one or more users, the user specifications override the PUBLIC specifications.

REPLACE USE FOR clause

The REPLACE USE FOR clause specifies that the way in which a specified user or the PUBLIC group uses the trusted-context object is to change. When you use the REPLACE USE FOR clause on PUBLIC, the trusted-context object must already be defined to allow use by PUBLIC, and PUBLIC must not be specified more than once in the REPLACE USE FOR clause.

The REPLACE USE FOR can specify a different role name, which must be a role that is defined on the database server. The role explicitly specified for the user overrides the default role, if a default role is currently associated with the trusted context.

The REPLACE USE FOR clause can also change the current authentication requirement for a user or for the PUBLIC group.

AUTHENTICATION attributes

The REPLACE USE FOR and ADD USE FOR clause can specify the authentication requirement for trusted connections based on this trusted-context object. The default is WITHOUT AUTHENTICATION.

The WITH AUTHENTICATION attribute specifies that switching the current user on a connection based on this trusted-context object to this user requires authentication.

The WITHOUT AUTHENTICATION attribute specifies that switching the current user does not require authentication.

DROP USE FOR clause

The DROP USE FOR clause specifies who can no longer use the trusted-context object. The users who are removed from the definition of the trusted-context object are those users who are currently allowed to use the trusted-context object. If one or more, but not all, users can be removed from the definition of the trusted-context object, the specified users are removed and a warning is returned. If none of the specified users can be removed from the definition of the trusted-context object, an error is returned.

If you use the DROP USE FOR clause on PUBLIC, it removes the ability of all users (except the SYSTEM AUTHID user ID, and any other individual users whose identifiers have been explicitly enabled) to use this trusted-context object.

Examples of modifying a trusted-context

For the following example, assume that trusted-context object `appserver` exists and that it is enabled. The following `ALTER TRUSTED CONTEXT` statement resets the object mode of the `appserver` trusted-context object to `DISABLE`. While in that mode, the `appserver` trusted context continues to exist, but it cannot be used to access the database server.

```
ALTER TRUSTED CONTEXT appserver
DISABLE;
```

For the following example, assume that trusted-context object `secure_role` exists. Issue an `ALTER TRUSTED CONTEXT` statement to modify the existing user `joe` to use the trusted-context object with authentication and to add everyone else to use the trusted-context object without authentication.

```
ALTER TRUSTED CONTEXT securerole
REPLACE USE FOR joe WITH AUTHENTICATION
ADD USE FOR PUBLIC WITHOUT AUTHENTICATION;
```

The following example modifies the trusted-context object `securerole` to use an IPv4 address that is different from what it was originally defined to use.

```
ALTER TRUSTED CONTEXT securerole
ALTER ATTRIBUTES (ADDRESS '9.12.155.200');
```

Related reference:

CREATE TRUSTED CONTEXT statement

DROP TRUSTED CONTEXT statement

RENAME TRUSTED CONTEXT statement

Related information:

Trusted-context objects and trusted connections

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ALTER USER statement (UNIX, Linux)

Use the ALTER USER statement to change one or more of the properties, including the password, user ID, surrogate group, administrative authorization, and home directory, and to enable or disable the account of an internally authenticated user, or of the default internally authenticated user.

This statement is an extension to the ANSI/ISO standard for the SQL language.

Syntax

```

>>-ALTER--++-DEFAULT USER-
      '-USER--user-
            +-ACCOUNT LOCK---+
            '-ACCOUNT UNLOCK-'

. -,-----
V                                     |
>-----++-ADD-----++-PASSWORD--password-----++-++>
      | '-MODIFY-'  +-UID--user_ID-----++
      |               . -,-----
      |               V (1) |
      | +-GROUP--((---++surrog_group_ID++---))++
      |               '-surrog_group-----'
      | +-USER--surrog_user-----++
      |               . -,-----
      |               V |
      | +-AUTHORIZATION--((---++DBSA-----++---))---+
      |               +-DBSSO-----+
      |               +-AAO-----+
      |               '-BARGROUP-'
      | '-HOME--"--directory--"-----'
      '-DROP--++-PASSWORD-----++
            +-UID-----++
            |               . -,-----
            |               V |
            | +-GROUP--((---++surrog_group_ID++---))---+
            |               '-surrog_group-----'
            | +-USER-----++
            |               . -,-----
            |               V |
            | +-AUTHORIZATION--((---++DBSA-----++---))---+
            |               +-DBSSO-----+
            |               +-AAO-----+
            |               '-BARGROUP-'
            | '-HOME-----'

```

Notes:

1. Use this path no more than 16 times

Element	Description	Restrictions	Syntax
<i>directory</i>	Path name of directory where user files are stored.	Must be 255 bytes or fewer, and must conform to the rules of your operating system. The <i>directory</i> must also: <ul style="list-style-type: none">• Belong to the mapped <i>user_ID</i> and <i>surrog_group_ID</i>.• Have read, write, and execute permissions for the owner.	Quoted String
<i>password</i>	Password for internal authentication of the user.	Must be between 6 and 32 bytes.	Quoted String
<i>surrog_group</i>	Name of an existing operating system group (surrogate group) that has the permissions to which you want to map <i>user</i> . The list of <i>surrog_group</i> values must be enclosed in parentheses.	Must be 32 bytes or fewer.	Owner name
<i>surrog_group_ID</i>	Group identifier number (surrogate group) to which you want to map the <i>user</i> . The list of <i>surrog_group_id</i> value or values that you specify must be enclosed in parentheses.	The <i>surrog_group_ID</i> cannot be: <ul style="list-style-type: none">• A group ID with server administrative privileges (DBSA, DBSSO, AAO, and BARGROUP)• Group 0 (root, sometimes referred to as wheel or system)• Group 80 on Mac OS X (admin)• A group ID associated with group bin or group sys	Literal Number
<i>surrog_user</i>	Name of an existing OS user account (surrogate user) on the host computer having the permissions to which you want to map <i>user</i> .	Must conform to the rules of your operating system	Owner name
<i>user</i>	Authorization identifier of the specific user that you are mapping to user properties.	Must be an authenticated authorization identifier	Owner name
<i>user_ID</i>	User identifier number to which you want to map <i>user</i> .	<i>user_ID</i> cannot be the one that belongs to user root or user informix .	Literal Number

Usage

Only a DBSA can run the ALTER USER statement. With a non-root installation, the user who installs the server is the equivalent of the DBSA, unless the user delegates DBSA privileges to a different user.

The USERMAPPING configuration parameter must be set to a value (ADMIN or BASIC) that enables support for mapped users before users created with the CREATE USER statement can connect to the database server.

The USERMAPPING configuration parameter must be set to ADMIN to enable the AUTHORIZATION clause. For more information about this deprecated syntax, see the [CREATE USER statement \(UNIX, Linux\)](#) description of the AUTHORIZATION clause.

You must also enter values in the SYSUSERMAP table of the **sysusers** database to map users with the appropriate user properties so that the mapped user statements of SQL to work correctly.

Mapped users can connect to with the surrogate user properties if they authenticate with pluggable authentication module (PAM) or single sign-on (SSO).

The best practice is to map *user* to a specific *surrog_user* that is reserved as a surrogate user identity only. You can add groups associated with the surrogate user identity with the GROUP keyword, and change the home directory with the HOME keyword.

The ALTER USER statement does not affect any active operations with the same surrogate user or user ID. Only subsequent operations that require authentication are affected.

An ALTER USER statement can add a password for a user with the ADD keyword only if that user does not have a password. To change an existing password, use the MODIFY option in the ALTER USER statement.

The total number of groups after the ALTER USER operation cannot exceed 16, which is the maximum number of allowed groups.

An ALTER USER statement can only add a home directory with the ADD keyword if no home directory exists. To modify an existing home directory, use the MODIFY keyword.

In a single ALTER USER statement, a specific property can only be specified once. For example, you cannot drop a GROUP property and add a GROUP property in the same statement.

After the ALTER USER statement, the user must have either one USER property or one UID property.

Execution of the ALTER USER statement can be audited with the ALUR audit code.

Related reference:

[COMMIT WORK statement](#)
[LOCK TABLE statement](#)
[ROLLBACK WORK statement](#)
[SAVEPOINT statement](#)
[WHENEVER statement](#)
[UNLOCK TABLE statement](#)

Related information:

[Specify transactions](#)
[How locks work](#)

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BEGIN WORK and ANSI-Compliant Databases

In an ANSI-compliant database, you do not need the BEGIN WORK statement because transactions are implicit; every SQL statement occurs within a transaction. The database server generates a warning when you use a BEGIN WORK statement immediately after any of the following statements:

- DATABASE
- COMMIT WORK
- CREATE DATABASE
- ROLLBACK WORK

The database server returns an error when you use a BEGIN WORK statement after any other statement in an ANSI-compliant database.

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BEGIN WORK WITHOUT REPLICATION (ESQL/C)

When you use Enterprise Replication for data replication, you can use the BEGIN WORK WITHOUT REPLICATION statement to start a transaction that does not replicate to other database servers.

You cannot execute BEGIN WORK WITHOUT REPLICATION as a stand-alone embedded statement in Informix® ESQL/C applications. Instead you must execute this statement indirectly. You can use either of the following methods:

- You can use a combination of the PREPARE and EXECUTE statements to prepare and execute the BEGIN WORK WITHOUT REPLICATION statement.
- You can use the EXECUTE IMMEDIATE statement to prepare and execute BEGIN WORK WITHOUT REPLICATION in a single step.

You cannot use the DECLARE *cursor* CURSOR WITH HOLD statement with the BEGIN WORK WITHOUT REPLICATION statement.

For more information about data replication, see the .

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Example of BEGIN WORK

When consecutive SQL statements perform what is logically a single unit of work, you can define a transaction by grouping them between the BEGIN WORK and COMMIT WORK statements. If the business requirements dictate that either all of the statements be performed successfully, or else that none of them be performed, you can enclose the statements of the transaction between BEGIN WORK to start a transaction and COMMIT WORK to complete the transaction successfully (or ROLLBACK WORK, to cancel the transaction, if the program detects an error).

In the following program fragment, the transaction locks the **stock** table (LOCK TABLE), updates rows in the **stock** table (UPDATE), deletes rows from the **stock** table (DELETE), and inserts a row into the **manufact** table (INSERT). In this example (with no error handling), the database server executes each of these SQL statements in sequence:

```
BEGIN WORK;  
  LOCK TABLE stock;  
  UPDATE stock SET unit_price = unit_price * 1.10  
    WHERE manu_code = 'KAR';  
  DELETE FROM stock WHERE description = 'baseball bat';  
  INSERT INTO manufact (manu_code, manu_name, lead_time)  
    VALUES ('LYM', 'LYMAN', 14);  
COMMIT WORK;
```

Each statement itself is atomic; it either completes successfully or else the database is unchanged afterwards. If any of these statements fail, the other statements will still be executed and the net result is as if the failed statement was never attempted. When the COMMIT WORK statement is executed, the successful changes are made permanent.

Typically, however, transactions are defined with error handling, so that the database server must perform a sequence of operations either completely or not at all. In this case, when you include all of the operations within a single transaction, the database server guarantees that all the statements are completely and perfectly committed to disk, or else the database can be restored to the same state that it was in before the transaction began.

By adding appropriate error handling (for example, by setting the **DBACCNOIGN** environment variable in DB-Access, or by adding EXEC SQL WHENEVER ERROR STOP in ESQL/C), the transaction can be implicitly rolled back because the program stops on an error without executing COMMIT WORK. More careful conditional coding in a programming language such as ESQL/C allows the programmer to explicitly roll back the transaction while continuing the larger program.

Error-handling and business logic in applications and UDRs can also delimit one or more portions of a transaction by including SAVEPOINT and ROLLBACK TO SAVEPOINT statements. If the ROLLBACK TO SAVEPOINT statement is issued after an error is encountered, or after the results of part of the transaction indicate a conflict with a business rule or with some other criterion, only the changes that were made to the database between the ROLLBACK statement and its specified or default savepoint are cancelled, rather than the entire transaction. The current transaction continues at the statement that follows the ROLLBACK statement, with any uncommitted changes to the data or to the schema of the database from operations that preceded the savepoint remain pending, until the entire transaction is either committed or rolled back. Any locks held by statements that were rolled back are retained until the complete transaction ends.

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CLOSE statement

Use the CLOSE statement when you no longer need to refer to the set of rows associated with a Select cursor or with a Function cursor. With ESQL/C, this statement can also flush and close an Insert cursor. Use this statement with Informix® ESQL/C or SPL.

Syntax

```
>>-CLOSE--+-cursor_id-----+-----><
          |  (1)   (2)
          |-----cursor_id_var-'
```

Notes:

1. Informix extension
2. ESQL/C only

Element	Description	Restrictions	Syntax
<i>cursor_id</i>	Name of cursor to be closed	Must have been declared	Identifier
<i>cursor_id_var</i>	Host variable that contains the value of <i>cursor_id</i>	Must be of a character data type	Must conform to language-specific rules for names.

Usage

Closing a cursor makes the cursor unusable in any statements except OPEN or FREE and releases resources that the database server had allocated to the cursor.

In a database that is not ANSI-compliant, you can close a cursor that has not been opened or that has already been closed. No action is taken in these cases.

In an ANSI-compliant database, the database server returns an error if you close a cursor that was not open.

Examples

The following statement closes the cursor, *democursor*.

```
EXEC SQL close democursor;
```

The following is ESQL/C Source code example from demo1.ec:

```
#include <stdio.h>

EXEC SQL define FNAME_LEN 15;
EXEC SQL define LNAME_LEN 15;

main()
{
EXEC SQL BEGIN DECLARE SECTION;
    char fname[ FNAME_LEN + 1 ];
    char lname[ LNAME_LEN + 1 ];
EXEC SQL END DECLARE SECTION;

    printf( "DEMO1 Sample ESQL Program running.\n\n");

    EXEC SQL WHENEVER ERROR STOP;

    EXEC SQL connect to 'stores7';

    EXEC SQL declare democursor cursor for
        select fname, lname
        into :fname, :lname
        from customer
        where lname < "C";

    EXEC SQL open democursor;
```



```

    for (;;)
    {
        EXEC SQL fetch democursor;
        if (strcmp(SQLSTATE, "00", 2) != 0)
            break;
        printf("%s %s\n", fname, lname);
    }
    if (strcmp(SQLSTATE, "02", 2) != 0)
        printf("SQLSTATE after fetch is %s\n", SQLSTATE);

    EXEC SQL close democursor;
    EXEC SQL free democursor;
    EXEC SQL create routine from 'del_ord.sql';
    EXEC SQL disconnect current;
    printf("\nDEMO1 Sample Program over.\n\n");
    exit(0);
}

```

- [Closing a Select or Function Cursor](#)
- [Closing an Insert Cursor](#)
- [Closing a Collection Cursor](#)
- [Using End of Transaction to Close a Cursor](#)

Related reference:

[FLUSH statement](#)
[DECLARE statement](#)
[FETCH statement](#)
[FREE statement](#)
[OPEN statement](#)
[PUT statement](#)
[SET AUTOFREE statement](#)
[INSERT statement](#)

Related information:

[Retrieve multiple rows](#)
[A database cursor](#)

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Closing a Select or Function Cursor

When a cursor is associated with a SELECT, EXECUTE FUNCTION, or EXECUTE PROCEDURE statement of SQL, closing the cursor terminates the associated SQL statement.

The database server releases all resources that it might have allocated to the active set of rows, for example, a temporary table that the cursor used to hold an ordered set. The database server also releases any locks that it might have held on rows that were selected through the cursor. If a transaction contains the CLOSE statement, however, the database server does not release the locks until you issue the COMMIT WORK or ROLLBACK WORK statement.

After you close a Select cursor or a Function cursor, the FETCH statement cannot reference that cursor until you reopen it.

In an SPL routine, the built-in **SQLCODE** function can indicate the result of the CLOSE statement for a Select cursor or a Function cursor. This function returns a value equivalent to the **SQLCODE** field of the **sqlca** structure. Informix® issues an error, however, if you invoke the built-in **SQLCODE** function outside the calling context of an SPL routine.

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Closing an Insert Cursor

Because Informix® does not support Insert cursors in SPL routines, the discussion of Insert cursors in this section applies only to Informix ESQL/C. In SPL routines, the CLOSE statement can reference only a Select cursor or a Function cursor that the DECLARE statement defined. (A FOREACH statement of SPL that has an INSERT statement in its statement block can declare a *direct cursor* that functionally resembles an Insert cursor, but the CLOSE statement cannot reference a direct cursor that FOREACH declared. Informix closes the direct cursor automatically at runtime when program control exits from the FOREACH loop where the direct cursor was defined.)

In Informix ESQL/C, the CLOSE statement treats a cursor that is associated with an INSERT statement differently from one that is associated with a SELECT, EXECUTE FUNCTION, or EXECUTE PROCEDURE statement. When a cursor identifier is associated with an INSERT statement, the CLOSE statement writes any remaining buffered rows into the database. The number of rows that were successfully inserted into the database is returned in the third element of the **sqlerrd** array, **sqlca.sqlerrd[2]**, in the **sqlca** structure. For information on how to use **SQLERRD** to count the total number of rows that were inserted, see [Error Checking](#).

The **SQLCODE** field of the **sqlca** structure indicates the result of the CLOSE statement for an Insert cursor. If all buffered rows are successfully inserted, **SQLCODE** is set to zero. If an error is encountered, the **SQLCODE** field is set to a negative error message number.

When **SQLCODE** is zero, the row buffer space is released, and the cursor is closed; that is, you cannot execute a PUT or FLUSH statement that names the cursor until you reopen it.

Tip: When you encounter an **sqlca.SQLCODE** error, a corresponding **SQLSTATE** error value also exists. For information about how to get the message text, check the GET DIAGNOSTICS statement.

If the insert is not successful, the number of successfully inserted rows is stored in **sqlerrd**. Any buffered rows that follow the last successfully inserted row are discarded. Because the insert fails, the CLOSE statement fails also, and the cursor is not closed. For example, a CLOSE statement can fail if insufficient disk space prevents some of the rows from being inserted. In this case, a second CLOSE statement can be successful because no buffered rows exist. An OPEN statement can also be successful because the OPEN statement performs an implicit close.

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Closing a Collection Cursor

You can declare both Select and Insert cursors on collection variables. Such cursors are called Collection cursors. Use the CLOSE statement to deallocate resources that have been allocated for the Collection cursor. Only ESQL/C routines can use CLOSE to reference Insert cursors on collection variables. The CLOSE statement in SPL routines cannot reference direct Collection cursors that the FOREACH statement of SPL can declare.

For more information on how to use a Collection cursor, see [Fetching from a Collection Cursor](#) and [Inserting into a Collection Cursor](#).

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Using End of Transaction to Close a Cursor

The COMMIT WORK and ROLLBACK WORK statements close all cursors except those that are declared with a hold. It is better to close all cursors explicitly, however. For Select or Function cursors, this action simply makes the intent of the program clear. It also helps to avoid a logic error if the WITH HOLD clause is later added to the declaration of a cursor.

For an Insert cursor in ESQL/C routines, it is important to use the CLOSE statement explicitly so that you can test the error code. Following the COMMIT WORK statement, **SQLCODE** reflects the result of the COMMIT statement, not the result of closing cursors. If you use a COMMIT WORK statement without first using a CLOSE statement, and if an error occurs while the last buffered rows are being written to the database, the transaction is still committed.

For how to use Insert cursors and the WITH HOLD clause, see [DECLARE statement](#).

In an ANSI-compliant database, a cursor cannot be closed implicitly. You must issue the CLOSE statement.

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CLOSE DATABASE statement

Use the CLOSE DATABASE statement to close the implicit connection to the current database. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-CLOSE DATABASE-----><
```

Usage

When you issue a CLOSE DATABASE statement, you can issue only the following SQL statements immediately after it:

- CONNECT
 - CREATE DATABASE
 - DATABASE
 - DROP DATABASE
 - DISCONNECT
- (The DISCONNECT statement is valid here only if an explicit connection existed before CLOSE DATABASE was executed.)

Issue the CLOSE DATABASE statement before you drop the current database.

If your current database supports transaction logging, and if you have started a transaction, you must issue a COMMIT WORK or ROLLBACK WORK statement before you can use the CLOSE DATABASE statement.

The following example shows how to use the CLOSE DATABASE statement before you drop the current database to which your session had established an implicit connection:

```
DATABASE stores_demo;  
.  
.  
CLOSE DATABASE;  
DROP DATABASE stores_demo;
```

In Informix® ESQL/C, the CLOSE DATABASE statement cannot appear in a multistatement PREPARE operation.

If a previous CONNECT statement has established an explicit connection to a database, and that connection is still your current connection, you cannot use the CLOSE DATABASE statement to close that explicit connection. (You can use the DISCONNECT statement to close the explicit connection.)

If you use the CLOSE DATABASE statement within a UDR called by a WHENEVER statement, specify WHENEVER SQLERROR CONTINUE and WHENEVER SQLWARNING CONTINUE before the ROLLBACK WORK statement. This action prevents the program from looping endlessly if the ROLLBACK WORK statement encounters an error or a warning.

When you issue the CLOSE DATABASE statement, any declared cursors are no longer valid. You must re-declare any cursors that you want to use.

In an ANSI-compliant database, if no error is encountered while you exit from DB-Access in non-interactive mode without issuing the CLOSE DATABASE, COMMIT WORK, or DISCONNECT statement, the database server automatically commits any open transaction.

Related reference:

[CREATE DATABASE statement](#)
[DROP DATABASE statement](#)
[DATABASE statement](#)
[CONNECT statement](#)
[DISCONNECT statement](#)

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COMMIT WORK statement

Use the COMMIT WORK statement to commit all modifications made to the database from the beginning of a transaction.

Syntax

```
>>-COMMIT--+-+-----+-----><
          '-WORK-'
```

Usage

The COMMIT WORK statement informs the database server that you reached the end of a series of statements that must succeed as a single unit. The database server takes the required steps to make sure that all modifications that the transaction makes are completed correctly and saved to disk.

Use COMMIT WORK only at the end of a multistatement operation in a database with transaction logging, when you are sure that you want to keep all changes made to the database from the beginning of a transaction.

The COMMIT WORK statement releases all row and table locks.

The WORK keyword is optional in a COMMIT WORK statement. The following two statements are equivalent:

```
COMMIT;
COMMIT WORK;
```

The following example shows a transaction bounded by BEGIN WORK and COMMIT WORK statements.

```
BEGIN WORK;
DELETE FROM call_type WHERE call_code = 'O';
INSERT INTO call_type VALUES ('S', 'order status');
COMMIT WORK;
```

In this example, the user first deletes the row from the **call_type** table where the value of the **call_code** column is O. The user then inserts a new row in the **call_type** table where the value of the **call_code** column is S. The database server guarantees that both operations succeed or else neither succeeds.

In Informix® ESQ/C, the COMMIT WORK statement closes all open cursors except those that were declared using the WITH HOLD option.

- [Issuing COMMIT WORK in a Database That Is Not ANSI Compliant](#)
- [Issuing COMMIT WORK in an ANSI-Compliant Database](#)

Related reference:

[BEGIN WORK statement](#)
[ROLLBACK WORK statement](#)
[DECLARE statement](#)
[LOCK TABLE statement](#)
[UNLOCK TABLE statement](#)

Related information:

[Interrupted modifications](#)

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Issuing COMMIT WORK in a Database That Is Not ANSI Compliant

In a database that is not ANSI compliant, but that supports transaction logging, if you initiate a transaction with a BEGIN WORK statement, you must issue a COMMIT WORK statement at the end of the transaction. If you fail to issue a COMMIT WORK statement in this case, the database server rolls back any modifications that the transaction made to the database.

If you do not issue a BEGIN WORK statement, however, each statement executes within its own transaction. These single-statement transactions do not require either a BEGIN WORK statement or a COMMIT WORK statement.

- [Explicit DB-Access Transactions](#)

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Explicit DB-Access Transactions

When you use DB-Access in interactive mode with a database that is not ANSI-compliant but that supports transaction logging, if you select the **Commit** menu but do not issue the COMMIT WORK statement after a transaction has been started by the BEGIN WORK statement, DB-Access automatically commits the data, but issues the following warning:

Warning: Data commit is a result of unhandled exception in TXN PROC/FUNC

The purpose of this warning is to remind you to issue COMMIT WORK explicitly to end a transaction that BEGIN WORK initiated.

In non-interactive mode, however, DB-Access rolls back the current transaction if you end a session without issuing the COMMIT WORK statement.

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Issuing COMMIT WORK in an ANSI-Compliant Database

In an ANSI-compliant database, you do not need BEGIN WORK to mark the beginning of a transaction. You only need to mark the end of each transaction, because a transaction is always in effect. A new transaction starts automatically after each COMMIT WORK or ROLLBACK WORK statement.

You must, however, issue an explicit COMMIT WORK statement to mark the end of each transaction. If you fail to do so, the database server rolls back any modifications that the transaction made to the database.

In an ANSI-compliant database, however, if no error is encountered while you exit from DB-Access in non-interactive mode without issuing the CLOSE DATABASE, COMMIT WORK, or DISCONNECT statement, the database server automatically commits any open transaction.

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CONNECT statement

Use the CONNECT statement to connect to a database environment. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-CONNECT TO----->

                                (1)
>--+| Database Environment |-----+--+>
|                                     | (2) | USER Clause |-----+--+>
|                                     |-----+-----+--+>
|                                     |'-TRUSTED-'|
|'-DEFAULT-----|

>--+-----+-----><
| (4) |-----+-----|
|-----WITH CONCURRENT TRANSACTION-----|
```

Notes:

1. See [Database Environment](#)
2. ESQL/C and DB-Access only
3. See [USER Authentication Clause](#)
4. ESQL/C only

Usage

The CONNECT statement connects an application to a *database environment*, which can be a database, a database server, or a database and a database server. If the application successfully connects to the specified database environment, the connection becomes the *current connection* for the application. The SQL

statements fail if the application has no current connection to a database server. If you specify a database name, the database server opens that database. You cannot include CONNECT within a PREPARE statement.

An application can connect to several database environments at the same time, and it can establish multiple connections to the same database environment, provided each connection has a unique connection name.

On UNIX, the only restriction on establishing multiple connections to the same database environment is that an application can establish only one connection to each local server that uses the shared-memory connection mechanism. To find out whether a local server uses the shared-memory connection mechanism or the local-loopback connection mechanism, examine the \$INFORMIXDIR/etc/sqlhosts file. For more information on the sqlhosts file, refer to your *IBM® Informix Administrator's Guide*.

On Windows, the local connection mechanism is named pipes. Multiple connections to the local server from one client can exist.

Only one connection is current at any time; other connections are dormant. The application cannot interact with a database through a dormant connection. When an application establishes a new connection, that connection becomes current, and the previous current connection becomes dormant. You can make a dormant connection current with the SET CONNECTION statement. See also [SET CONNECTION statement](#).

For connections between databases of different Informix instances, you cannot establish multiple active connections between the same two database servers using different server aliases. At any time, there can be only one active connection from the local server to a remote server. If you use CONNECT TO *dbserveralias* statements to specify different server aliases to connect to the same remote server, where the *dbserveralias* identifiers are declared in setting of the DBSERVERALIASES configuration parameter setting, no error message is issued, but the initial connection is reused.

- [Privileges for Executing the CONNECT Statement](#)
- [Connection Context](#)
- [Database Environment](#)
- [Declaring a Connection Name](#)
- [USER Authentication Clause](#)
- [The DEFAULT Connection Specification](#)
- [WITH CONCURRENT TRANSACTION Option](#)
- [TRUSTED clause](#)

Use the TRUSTED clause to specify that the application can connect to a database environment as a trusted connection.

Related reference:

[CREATE DATABASE statement](#)

[SET SESSION AUTHORIZATION statement](#)

[DROP DATABASE statement](#)

[DISCONNECT statement](#)

[SET CONNECTION statement](#)

[DATABASE statement](#)

[CLOSE DATABASE statement](#)

Related information:

[The sqlhosts file and the SQLHOSTS registry key](#)

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Privileges for Executing the CONNECT Statement

The current user, or PUBLIC, must hold the Connect privilege on the database that the CONNECT statement specifies. The user who executes the CONNECT statement cannot have the same authorization identifier as an existing role in that database.

For information on how to use the USER Authentication clause to specify an alternate user name when the CONNECT statement connects to a database server on a remote host, see [USER Authentication Clause](#).

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Connection Context

Each connection encompasses a set of information that is called the *connection context*. The connection context includes the name of the current user, the information that the database environment associates with this name, and information on the state of the connection (such as whether an active transaction is associated with the connection). The connection context is saved when an application becomes dormant, and this context is restored when the application becomes current again. (For more information, see [Making a dormant connection as the current connection](#).)

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Database Environment

The CONNECT statement, like the SET CONNECTION statement, can use the Database Environment syntax segment to specify the database or the database server to which the application is attempting to establish a connection. Unlike the SET CONNECTION statement, the CONNECT statement can also declare a name for this connection to the specified database environment.

```
|--+'dbname'-----+--+-----+--+|
|+ '@dbservername'-----+ | (1) |
|+ 'dbname@dbservername'+ | '-----AS--+-'connection'---+-'
| (1) | |
|-----db_var-----+ | '-----connection_var-----'
```

1. ESQL/C only

If the **DELIMIDENT** environment variable is set, any quotation (') marks in the database environment must be single. If **DELIMIDENT** is not set, then either single (') or double (") quotation marks are valid here.

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If you specify *dbservername*, it must satisfy the following restrictions.

- If the database server that you specify is not online, you receive an error.
- The database server that you specify in *dbservername* must match the name of a database server in the **sqlhosts** file.

Note: If the name of a database server is a delimited identifier, or if it includes uppercase letters, that database server cannot participate in cross-server distributed DML operations. (If the server name includes uppercase letters, it also cannot participate in cross-database distributed DML operations by SQL statements that specify the server name as a qualifier to a database name. These statements fail with error -908, because the SQL parser downshifts all uppercase letters in server names to lowercase characters.) To avoid this restriction, specify only undelimited names with no uppercase letters when you declare the name or the alias of a database server that will participate in distributed queries.

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You can specify a database server and a database, or a database server only, or a database only. How a database is located and opened depends on whether you specify a database server name in the database environment expression.

- Only Database Server Specified
- Database Server and Database Specified
- Only Database Specified

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The `@dbservername` option establishes a connection to the database server only; it does not open a database. When you use this option, you must subsequently use the `DATABASE` or `CREATE DATABASE` statement (or a `PREPARE` statement for one of these statements and an `EXECUTE` statement) to open a database.

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Database Server and Database Specified

If you specify both a database server and a database, your application connects to the database server, which locates and opens the database.

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Only Database Specified

The *dbname* option establishes a connection to the default database server or to another database server in the **DBPATH** environment variable. It also locates and opens the specified database. (The same is true of the *db_var* option if this specifies only a database name.)

If you specify only *dbname*, its database server is read from the **DBPATH** environment variable. The database server in the **INFORMIXSERVER** environment variable is always added before the **DBPATH** value.

On UNIX, set the **INFORMIXSERVER** and **DBPATH** environment variables as the following example (for the C shell) shows:

```
setenv INFORMIXSERVER srvA
setenv DBPATH //srvB://srvC
```

On Windows, choose **Start > Programs > Informix® > setnet32** from the Task Bar and set the **INFORMIXSERVER** and **DBPATH** environment variables:

```
set INFORMIXSERVER = srvA
set DBPATH = //srvA://srvB://srvC
```

The next example shows the resulting **DBPATH** that your application uses:

```
//srvA://srvB://srvC
```

The application first establishes a connection to the database server that **INFORMIXSERVER** specifies. The database server uses parameters in the configuration file to locate the database. If the database does not reside on the default database server, or if the default database server is not online, the application connects to the next database server in **DBPATH**. In the previous example, that database server would be **srvB**.

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Declaring a Connection Name

In ESQL/C applications, you can declare an identifier for the connection to the database environment by including the AS keyword, followed by a quoted string or by a host variable that stores the identifier. The host variable must be a fixed-length character data type.

- [Connection Identifiers](#)

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Connection Identifiers

The optional *connection* name is a unique identifier that an ESQL/C application can use to refer to a connection in subsequent SET CONNECTION and DISCONNECT statements. If the application does not provide a connection name (or a connection host variable), it can refer to the connection using the database environment. If the application makes more than one connection to the same database environment, however, each connection must have a unique name.

Only the CONNECT statement can use the AS keyword to declare a connection name. The CONNECT statement cannot, however, reference a previously declared connection name to specify a connection to a database environment.

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USER Authentication Clause

The USER Authentication clause specifies information that is used to determine whether the application can access the target computer on a remote host.

USER Authentication Clause

```
|--USER--+-'user_id'---+--USING--validation_var-----|
          '-user_id_var-'
```

Element	Description	Restrictions	Syntax
<i>user_id</i>	Valid login name	See Restrictions on the User Identifier Parameter .	Quoted String

Element	Description	Restrictions	Syntax
<i>user_id_var</i>	Host variable that contains <i>user_id</i>	Must be a fixed-length character data type; same restrictions as <i>user_id</i>	Language specific
<i>validation_var</i>	Host variable that contains a valid password for login name in <i>user_id</i> or <i>user_id_var</i>	Must be a fixed-length character type. See Restrictions on the Validation Variable Parameter .	Language specific

The USER Authentication clause is required when the CONNECT statement connects to the database server on a remote host. Subsequent to the CONNECT statement, all database operations on the remote host use the specified user name.

In DB-Access, the USING clause is valid within files executed from DB-Access. In interactive mode, DB-Access prompts you for a password, so the USING keyword and *validation_var* are not used.

- [Restrictions on the Validation Variable Parameter](#)
- [Restrictions on the User Identifier Parameter](#)
- [Use of the Default User ID](#)

If you do not supply the USER Authentication clause, the default user ID is used to attempt the connection.

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Restrictions on the Validation Variable Parameter

On UNIX, the password stored in *validation_var* must be a valid password and must exist in the */etc/passwd* file. If the application connects to a remote database server, the password must exist in this file on both the local and remote database servers.

On Windows, the password stored in *validation_var* must be valid and must be the password entered in **User Manager**. If the application connects to a remote database server, the password must exist in the domain of both the client and the server.

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Restrictions on the User Identifier Parameter

The connection is rejected if any of the following conditions occur:

- The specified user lacks the privileges to access the database specified in the database environment.
- The specified user lacks the permissions to connect to the remote host.
- You supply a USER Authentication clause but omit the USING *validation_var* specification.

In compliance with the X/Open standard for the CONNECT statement, the Informix® ESQL/C preprocessor supports a CONNECT statement that has a USER Authentication clause without the USING *validation_var* specification. If the *validation_var* is not present, however, the database server rejects the connection at runtime.

On UNIX, the *user_id* that you specify must be a valid login name and must exist in the */etc/passwd* file. If the application connects to a remote server, the login name must exist in this file on both the local and remote database servers.

On Windows, the *user_id* that you specify must be a valid login name and must exist in **User Manager**. If the application connects to a remote server, the login name must exist in the domain of both the client and the server.

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Use of the Default User ID

If you do not supply the USER Authentication clause, the default user ID is used to attempt the connection.

The default user ID is the login name of the user running the application. In this case, you obtain network permissions with the standard authorization procedures. For example, on UNIX, the default user ID must match a user ID in the trusted-host file (the */etc/hosts.equiv* file or the file specified by the REMOTE_SERVER_CFG configuration parameter). On Windows, you must be a member of the domain, or if the database server is installed locally, you must be a valid user on the computer where it is installed.

Related information:

[Trusted-host information](#)

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The DEFAULT Connection Specification

Instead of specifying an explicit database environment, you can use the DEFAULT keyword to request a *default connection* to a default database server. The default database server can be local or remote. To designate the default database server, set its name in the **INFORMIXSERVER** environment variable. This option of

CONNECT does not open a database.

If the CONNECT TO DEFAULT statement succeeds, you must use the DATABASE statement or the CREATE DATABASE statement to open or create a database in the default database environment.

- [The Implicit Connection with DATABASE Statements](#)

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The Implicit Connection with DATABASE Statements

If you do not execute a CONNECT statement in your application, the first SQL statement must be one of the following *database statements* (or a single statement PREPARE for one of the following statements):

- DATABASE
- CREATE DATABASE
- DROP DATABASE

If one of these database statements is the first SQL statement in an application, the statement establishes a connection to a database server, which is known as an *implicit* connection. If the database statement specifies only a database name, the database server name is obtained from the **DBPATH** environment variable. This situation is described in [Specifying the Database Environment](#).

An application that makes an implicit connection can establish other connections explicitly (using the CONNECT statement) but cannot establish another implicit connection unless the original implicit connection is closed. An application can terminate an implicit connection using the DISCONNECT statement. After you create an explicit connection, you cannot use any database statement to create implicit connections until after you close the explicit connection.

After *any* implicit connection is made, that connection is considered to be the default connection, regardless of whether the database server is the default that the **INFORMIXSERVER** environment variable specifies. This feature allows the application to refer to the implicit connection if additional explicit connections are made, because the implicit connection has no identifier.

For example, if you establish an implicit connection followed by an explicit connection, you can make the implicit connection current by issuing the SET CONNECTION DEFAULT statement. This means, however, that once you establish an implicit connection, you cannot use the CONNECT DEFAULT statement, because the implicit connection is now the default connection.

The database statements can always be used to open a database or create a new database on the current database server.

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WITH CONCURRENT TRANSACTION Option

The WITH CONCURRENT TRANSACTION clause enables you to switch to a different connection while a transaction is active in the current connection. If the current connection was *not* established using the WITH CONCURRENT TRANSACTION clause, you cannot switch to a different connection if a transaction is active; the CONNECT or SET CONNECTION statement fails, returning an error, and the transaction in the current connection continues to be active.

In this case, the application must commit or roll back the active transaction in the current connection before it switches to a different connection.

The WITH CONCURRENT TRANSACTION clause supports the concept of multiple concurrent transactions, where each connection can have its own transaction and the COMMIT WORK and ROLLBACK WORK statements affect only the current connection. The WITH CONCURRENT TRANSACTION clause does not support global transactions in which a single transaction spans databases over multiple connections. The COMMIT WORK and ROLLBACK WORK statements do not act on databases across multiple connections.

The following example illustrates how to use the WITH CONCURRENT TRANSACTION clause:

```
main()
{
EXEC SQL connect to 'a@srv1' as 'A';
EXEC SQL connect to 'b@srv2' as 'B' with concurrent transaction;
EXEC SQL connect to 'c@srv3' as 'C' with concurrent transaction;

/*
  Execute SQL statements in connection 'C' , starting a transaction
*/
EXEC SQL set connection 'B'; -- switch to connection 'B'

/*
  Execute SQL statements starting a transaction in 'B'.
  Now there are two active transactions, one each in 'B' and 'C'.
*/

EXEC SQL set connection 'A'; -- switch to connection 'A'

/*
  Execute SQL statements starting a transaction in 'A'.
  Now there are three active transactions, one each in 'A', 'B' and 'C'.
*/

EXEC SQL set connection 'C'; -- ERROR, transaction active in 'A'
```

```

/*
SET CONNECTION 'C' fails (current connection is still 'A')
The transaction in 'A' must be committed or rolled back because
connection 'A' was started without the CONCURRENT TRANSACTION
clause.
*/

EXEC SQL commit work;  -- commit tx in current connection ('A')

/*
Now, there are two active transactions, in 'B' and in 'C',
which must be committed or rolled back separately
*/

EXEC SQL set connection 'B'; -- switch to connection 'B'
EXEC SQL commit work;        -- commit tx in current connection ('B')

EXEC SQL set connection 'C'; -- go back to connection 'C'
EXEC SQL commit work;        -- commit tx in current connection ('C')

EXEC SQL disconnect all;
}

```

Warning: When an application uses the WITH CONCURRENT TRANSACTION clause to establish multiple connections to the same database environment, a deadlock condition can occur.

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TRUSTED clause

Use the TRUSTED clause to specify that the application can connect to a database environment as a trusted connection.

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CREATE ACCESS_METHOD statement

Use the CREATE ACCESS_METHOD statement to register a new primary or secondary access method in the **sysams** system catalog table.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```

>>-CREATE--+--SECONDARY--+----->
      '-PRIMARY---'

>--ACCESS_METHOD--+-----+--access_method----->
      '-IF NOT EXISTS-'

      .-+-----+
      V      (1) |
>--(----| Purpose Options |-----+--)><

```

Notes:

1. See [Purpose Options](#)

Element	Description	Restrictions	Syntax
<i>access method</i>	Name declared here for the new access method	Must be unique among access-method names in the sysams system catalog table	Identifier

Usage

The CREATE ACCESS_METHOD statement adds a user-defined access method to a database. To create an access method, you specify *purpose functions* (or *purpose methods*), *purpose flags*, or *purpose values* as attributes of the access method, and you associate keywords (based on column names in the **sysams** system catalog table) with UDRs. You must have the DBA or Resource privilege to create an access method.

For information on setting purpose options, including a list of all the purpose function keywords, refer to [Purpose Options](#).

The PRIMARY keyword specifies a user-defined primary-access method for a virtual table. The SECONDARY keyword specifies creating a user-defined secondary-access method for a virtual index. The SECONDARY keyword (and creating virtual indexes) is not supported in the Java™ Virtual-Table Interface.

The following statement creates a secondary-access method named **T_tree**:

```

CREATE SECONDARY ACCESS_METHOD T_tree
(

```

```

am_getnext = ttree_getnext,

. . .
am_unique,
am_cluster,
am_sptype = 'S'
);

```

In the preceding example, the **am_getnext** keyword in the Purpose Options list is associated with the **ttree_getnext()** UDR as the name of a method to scan for the next item that satisfies a query. This example indicates that the **T_tree** secondary access method supports unique keys and clustering, and resides in an sbspace.

Any UDR that the CREATE ACCESS_METHOD statement associates with the keyword for a purpose function task, such as the association of **ttree_getnext()** with **am_getnext** in the preceding example, must already have been registered in the database by the CREATE FUNCTION statement (or by a functionally equivalent statement, such as CREATE PROCEDURE FROM).

The following statement creates a primary-access method named **am_tabprops** that resides in an extspace.

```

CREATE PRIMARY ACCESS_METHOD am_tabprops
(
  am_open = FS_open,
  am_close = FS_close,
  am_beginscan = FS_beginScan,
  am_create = FS_create,
  am_scancost = FS_scanCost,
  am_endscan = FS_endScan,
  am_getnext = FS_getNext,
  am_getbyid = FS_getById,
  am_drop = FS_drop,
  am_truncate = FS_truncate,
  am_rowids,
  am_sptype = 'x'
);

```

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if an access method of the specified name is already registered in the current database.

Related reference:

[DROP ACCESS_METHOD statement](#)

[ALTER ACCESS_METHOD statement](#)

[Purpose Options](#)

[GRANT statement](#)

[REVOKE statement](#)

Related information:

[SYSAMS](#)

[Access methods](#)

[Access methods](#)

[Secondary-access methods](#)

[Grant and limit access to your database](#)

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CREATE AGGREGATE statement

Use the CREATE AGGREGATE statement to create a new aggregate function and register it in the **sysaggregates** system catalog table.

User-defined aggregates (UDA) extend the functionality of the database server by performing aggregate calculations that the user implements.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```

>>-CREATE AGGREGATE--+-+-----+--aggregate-->
                        '-IF NOT EXISTS-' | (1) |
                        '-| Owner Name |-----.-'

                        .-,-----
                        V |
>--WITH--(----| Modifiers |-+--)-><

Modifiers

|---INIT=init_func-----+-----|
+-ITER=iter_func-----+
+-COMBINE=comb_func----+
'---FINAL=final_func---+'
'-HANDLESNULLS-----'

```

Notes:

1. See [Owner name](#)

Element	Description	Restrictions	Syntax
<i>aggregate</i>	Name of the new aggregate	Must be unique among names of built-in aggregates and UDRs	Identifier
<i>comb_func</i>	Function that merges one partial result into the other and returns the updated partial result	Must specify the combined function both for parallel queries and for sequential queries	Identifier
<i>final_func</i>	Function that converts a partial result into the result type	If this is omitted, then the returned value is the final result of <i>iter_func</i>	Identifier
<i>init_func</i>	Function that initializes the data structures required for the aggregate computation	Must be able to handle NULL arguments	Identifier
<i>iter_func</i>	Function that merges a single value with a partial result and returns updated partial result	Must specify an iterator function. If <i>init_func</i> is omitted, <i>iter_func</i> must be able to handle NULL arguments	Identifier

Usage

You can specify the INIT, ITER, COMBINE, FINAL, and HANDLESNULLS modifiers in any order.

Important: You must specify the ITER and COMBINE modifiers in a CREATE AGGREGATE statement. You do not need to specify the INIT, FINAL, and HANDLESNULLS modifiers in a CREATE AGGREGATE statement.

The ITER, COMBINE, FINAL, and INIT modifiers specify the support functions for a user-defined aggregate. These support functions do not need to exist at the time when you create the user-defined aggregate.

If you omit the HANDLESNULLS modifier, rows with NULL aggregate argument values do not contribute to the aggregate computation. If you include the HANDLESNULLS modifier, you must define all the support functions to handle NULL values as well.

Important: A SELECT statement can include no more than one UDA expression whose first argument is the DISTINCT or UNIQUE keyword (rather than the ALL keyword, or no keyword). In a query that includes subqueries, however, you can specify either zero or one DISTINCT or UNIQUE user-defined aggregate expression at each level of the query. Built-in aggregates are not subject to this restriction.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if an aggregate of the specified name is already registered in the current database.

- [Extending the Functionality of Aggregates](#)
- [Parallel Execution](#)

The database server can break up an aggregate computation into several pieces and compute them in parallel.

Related concepts:

[User-Defined Aggregates](#)

Related reference:

[DROP AGGREGATE statement](#)

[CREATE FUNCTION statement](#)

Related information:

[SYSAGGREGATES](#)

[Create user-defined aggregates](#)

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Extending the Functionality of Aggregates

Informix® provides two ways to extend the functionality of aggregates. Use the CREATE AGGREGATE statement only for the second of the two cases.

- Extensions of built-in aggregates
A built-in aggregate is an aggregate that the database server provides, such as **COUNT**, **SUM**, or **AVG**. These only support built-in data types. To extend a built-in aggregate so that it supports a user-defined data type (UDT), you must create user-defined routines that overload the binary operators for that aggregate. For further information on extending built-in aggregates, see the *IBM® Informix User-Defined Routines and Data Types Developer's Guide*.
- Creation of user-defined aggregates
A user-defined aggregate is an aggregate that you define to perform an aggregate computation that the database server does not provide. You can use user-defined aggregates with built-in data types, extended data types, or both. To create a user-defined aggregate, use the CREATE AGGREGATE statement. In this statement, you name the new aggregate and specify the support functions that compute the aggregate result. These support functions perform initialization, sequential aggregation, combination of results, and type conversion.
- [Example of Creating a User-Defined Aggregate](#)

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Example of Creating a User-Defined Aggregate

The following example defines a user-defined aggregate named **average**:

```
CREATE AGGREGATE average
WITH (
    INIT = average_init,
```

```

ITER = average_iter,
COMBINE = average_combine,
FINAL = average_final
);

```

Before you use the **average** aggregate in a query, you must also use CREATE FUNCTION statements to create the support functions specified in the CREATE AGGREGATE statement.

The following table gives an example of the task that each support function might perform for **average**.

Keyword	Support Function	Effect
INIT	average_init	Allocates and initializes an extended data type storing the current sum and the current row count
ITER	average_iter	For each row, adds the value of the expression to the current sum and increments the current row count by one
COMBINE	average_combine	Adds the current sum and the current row count of one partial result to the other and returns the updated result
FINAL	average_final	Returns the ratio of the current sum to the current row count and converts this ratio to the result type

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Parallel Execution

The database server can break up an aggregate computation into several pieces and compute them in parallel.

The database server uses the INIT and ITER support functions to compute each piece sequentially. Then the database server uses the COMBINE function to combine the partial results from all the pieces into a single result value. Whether an aggregate is parallel is an optimization decision that is transparent to the user.

Related information:

[SYSAGGREGATES](#)

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CREATE CAST statement

Use the CREATE CAST statement to register a cast that converts data from one data type to another.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```

.-EXPLICIT-----
>>-CREATE--+-+-----+---CAST--+-+-----+----->
          '-IMPLICIT-'          '-IF NOT EXISTS-'

>--(--source_type--AS--target_type--+-+-----+-----><
                                '-WITH--function-'

```

Element	Description	Restrictions	Syntax
<i>function</i>	UDR that you register to implement the cast	See WITH Clause .	Identifier
<i>source_type</i>	Data type to be converted	Must exist in the database at the time the cast is registered. See also Source and Target Data Types .	Data Type
<i>target_type</i>	Data type that results from the conversion	The same restrictions that apply for the <i>source_type</i> (as listed above) also apply for the <i>target_type</i>	Data Type

Usage

A cast is a mechanism that the database server uses to convert one data type to another. The database server uses casts to perform the following tasks:

- To compare two values in the WHERE clause of a SELECT, UPDATE, or DELETE statement
- To pass values as arguments to user-defined routines
- To return values from user-defined routines

To create a cast, you must have the necessary privileges on both the *source* data type and the *target* data type. All users have access privileges to use the built-in data types. To create a cast to or from an OPAQUE, DISTINCT, or named ROW data type, however, requires the Usage privilege on that data type.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if a cast between the two specified data types is already registered in the current database.

The CREATE CAST statement registers a cast in the **syscasts** system catalog table. For more information on **syscasts**, see the chapter on system catalog tables in the *IBM® Informix Guide to SQL: Reference*.

- [Source and Target Data Types](#)
The CREATE CAST statement defines a cast that converts a *source* type to a *target* type. Both the *source* and *target* data types must exist in the database when you execute the CREATE CAST statement to register the cast.
- [Explicit and Implicit Casts](#)
Processing queries with multiple data types often requires casts that convert data from one data type to another.
- [WITH Clause](#)
The WITH clause of the CREATE CAST statement specifies the name of the user-defined function to invoke to perform the cast. This function is called the cast function.

Related concepts:

[Data types and expressions](#)

Related reference:

[CREATE FUNCTION statement](#)

[CREATE DISTINCT TYPE statement](#)

[CREATE OPAQUE TYPE statement](#)

[CREATE ROW TYPE statement](#)

[DROP CAST statement](#)

[CREATE SCHEMA statement](#)

Related information:

[SYSCASTS](#)

[Data types](#)

[Create and use user-defined casts](#)

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Source and Target Data Types

The CREATE CAST statement defines a cast that converts a *source* type to a *target* type. Both the *source* and *target* data types must exist in the database when you execute the CREATE CAST statement to register the cast.

The *source* and the *target* data types have the following restrictions:

- Either the *source* or the *target* type, but not both, can be a built-in data type.
- Neither the *source* nor the *target* type can be a DISTINCT type of the other.
- Neither the *source* nor the *target* types can be a COLLECTION data type.

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Explicit and Implicit Casts

Processing queries with multiple data types often requires casts that convert data from one data type to another.

You can use the CREATE CAST statement to create the following kinds of casts:

- Use the CREATE EXPLICIT CAST statement to define an *explicit* cast.
- Use the CREATE IMPLICIT CAST statement to define an *implicit* cast.

The database server invokes built-in casts to convert from one built-in data type to another built-in type that is not directly substitutable. For example, the database server performs conversion of a character type such as CHAR to a numeric type such as INTEGER through a built-in cast.

- [Explicit Casts](#)
An explicit cast is a cast that you must specifically invoke, with either the CAST AS keywords or with the cast operator (::). The database server does *not* automatically invoke an explicit cast to resolve data type conversions. The EXPLICIT keyword is optional; by default, the CREATE CAST statement creates an explicit cast.
- [Implicit Casts](#)
An implicit cast is a cast that the database server can invoke automatically when it encounters data types that cannot be compared with built-in casts. This type of cast enables the database server to automatically handle conversions between other data types.

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Explicit Casts

An explicit cast is a cast that you must specifically invoke, with either the CAST AS keywords or with the cast operator (::). The database server does *not* automatically invoke an explicit cast to resolve data type conversions. The EXPLICIT keyword is optional; by default, the CREATE CAST statement creates an

explicit cast.

The following CREATE CAST statement defines an explicit cast from the **rate_of_return** opaque data type to the **percent** distinct data type:

```
CREATE EXPLICIT CAST (rate_of_return AS percent
WITH rate_to_prct);
```

The following SELECT statement explicitly invokes this explicit cast in its WHERE clause to compare the **bond_rate** column (of type **rate_of_return**) to the **initial_APR** column (of type **percent**):

```
SELECT bond_rate FROM bond
WHERE bond_rate::percent > initial_APR;
```

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Implicit Casts

An implicit cast is a cast that the database server can invoke automatically when it encounters data types that cannot be compared with built-in casts. This type of cast enables the database server to automatically handle conversions between other data types.

To define an implicit cast, specify the IMPLICIT keyword in the CREATE CAST statement. For example, the following CREATE CAST statement specifies that the database server should automatically use the **prcnt_to_char()** function to convert from the CHAR data type to a distinct data type, **percent**:

```
CREATE IMPLICIT CAST (CHAR AS percent WITH char_to_prct);
```

This cast only supports automatic conversion *from* the CHAR data type *to* **percent**. For the database server to convert *from* **percent** *to* CHAR, you also need to define another implicit cast, as follows:

```
CREATE IMPLICIT CAST (percent AS CHAR WITH prcnt_to_char);
```

The database server automatically invokes the **char_to_prct()** function to evaluate the WHERE clause of the following SELECT statement:

```
SELECT commission FROM sales_rep WHERE commission > "25"
```

Users can also invoke implicit casts explicitly. For more information on how to explicitly invoke a cast function, see [Explicit Casts](#).

When a built-in cast does not exist for conversion between data types, you can create user-defined casts to make the necessary conversion.

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WITH Clause

The WITH clause of the CREATE CAST statement specifies the name of the user-defined function to invoke to perform the cast. This function is called the cast function.

You must specify a *function name* unless the *source data type* and the *target data type* have identical representations. Two data types have identical representations when the following conditions are met:

- Both data types have the same length and alignment.
- Both data types are passed by reference or both are passed by value.

The cast function must be registered in the same database as the cast at the time the cast is invoked, but need not exist when the cast is created. The CREATE CAST statement does not check privileges on the specified *function name*, or even verify that the cast function exists. Each time a user invokes the cast explicitly or implicitly, the database server verifies that the user has the Execute privilege on the cast function.

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CREATE DATABASE statement

Use the CREATE DATABASE statement to create a new database.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-CREATE DATABASE--+-+-----+---database--+-----+--->
                        '-IF NOT EXISTS-'          '-IN--dbspace-'

                        .-NLSCASE SENSITIVE-----
>-+-----+-----+-----+-----+-----+-----+-----+-----<
  '-WITH--+-+-----+---LOG+-'          '-NLSCASE INSENSITIVE-'
      | '-BUFFERED-'          |
```

'-LOG MODE ANSI-----'

Element	Description	Restrictions	Syntax
<i>database</i>	Name that you declare here for the new database that you are creating	Must be unique among names of databases of the database server	Database Name
<i>dbspace</i>	The dbspace to store the data for this database; default is the root dbspace	Must exist Cannot be the name of a dbspace that is dedicated to a tenant database.	Identifier

Usage

This statement is an extension to ANSI-standard syntax. (The ANSI/ISO standard for the SQL language does not specify any syntax for construction of a database, the process by which a database comes into existence and has its name declared.)

Important: If you plan to use UTF-8 character encoding, including the Chinese GB18030-2000 code set, you must set the GL_USEGLU environment variable before you create the database.

The *database* that CREATE DATABASE specifies becomes the current database.

You cannot create a tenant database with the CREATE DATABASE statement. To create a tenant database, run the **admin()** or **task()** SQL administration API command with the **tenant create** argument.

If the DBCREATE_PERMISSION configuration parameter is not set, any user can create a database. If the configuration file includes one or more DBCREATE_PERMISSION specifications, however, only the specified users can create databases. Whether DBCREATE_PERMISSION is set, user **informix** can use the CREATE DATABASE statement. For additional information about how to set the DBCREATE_PERMISSION parameter to control which users can create new databases.

The *database* name that you declare must be unique within the database server environment in which you are working. The database server creates the system catalog tables that describe the structure of the new database.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if a database of the specified name exists among the databases that are managed by the database server instance to which you are connected.

When you create a database, you alone can access it. It remains inaccessible to other users until you, as DBA, grant database privileges by running the GRANT statement.

If a previous CONNECT statement established an explicit connection to a database, and that connection is still your current connection, you cannot use the CREATE DATABASE statement (nor any SQL statement that creates an implicit connection) until after you use the DISCONNECT statement to close the explicit connection.

In Informix® ESQL/C, the CREATE DATABASE statement cannot appear in a multistatement PREPARE operation.

The SQL_LOGICAL_CHAR configuration parameter setting for the database server instance to which you are connected is recorded in the system catalog of the new database. The SQL_LOGICAL_CHAR configuration parameter controls the expansion of size specifications in declarations of built-in character data types. This setting cannot be changed, and persists until the database is dropped, even if the Informix instance that manages the database is stopped and restarted with a new SQL_LOGICAL_CHAR value. The **flags** column of the **systables** system catalog table encodes the SQL_LOGICAL_CHAR setting for the database.

If you do not specify a *dbspace*, the database server creates the system catalog tables in the **root** dbspace by default. However, if you enabled the automatic location of databases, databases are created by default in the dbspace that is chosen by the server. To enable the automatic location of databases, set the AUTOLOCATE configuration parameter or session environment variable to a positive integer.

The following statement creates the **vehicles** database in the **root** dbspace or in a dbspace that is chosen by the server, depending on whether automatic location is enabled:

```
CREATE DATABASE vehicles;
```

Because the example above includes no logging specification and no NLSCASE specification, then by default

- the **vehicles** database cannot support transaction logging,
- and if its locale uses a code set that distinguishes between uppercase and lowercase letters, the database is case-sensitive for all built-in character data types.

The following statement defines the **vehicles** database in the **research** dbspace:

```
CREATE DATABASE vehicles IN research;
```

But if no DROP DATABASE statement dropped existing the **vehicles** database that the first example created, the second example fails with an error, and no new database is created, because the identifier of the **vehicles** database is not unique for the database server instance.

- [Logging Options](#)
The logging options of the CREATE DATABASE statement determine the type of transaction logging for the database. In the event of a failure, the database server uses the log to re-create all committed transactions in your database, unless CREATE DATABASE statement does not include the WITH LOG keywords.
- [Specifying Buffered Logging](#)
- [ANSI-Compliant Databases](#)
When you use the LOG MODE ANSI option in the CREATE DATABASE statement, the database that you create is an ANSI-compliant database that conforms to the ANSI/ISO standard for the SQL language.
- [Specifying NLSCASE case sensitivity](#)
You can explicitly create a case-sensitive or case insensitive database.

Related reference:

[CLOSE DATABASE statement](#)

[CONNECT statement](#)
[DATABASE statement](#)
[DROP DATABASE statement](#)
[GRANT statement](#)
[CREATE TABLE statement](#)
[CREATE TEMP TABLE statement](#)
[RENAME DATABASE statement](#)
[SET TRANSACTION statement](#)
[SET ISOLATION statement](#)
[SET LOG statement](#)

Related information:

[DBC_CREATE_PERMISSION configuration parameter](#)
[SQL_LOGICAL_CHAR configuration parameter](#)
[AUTOLOCATE configuration parameter](#)
[GL_USEGLU environment variable](#)

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Logging Options

The logging options of the CREATE DATABASE statement determine the type of transaction logging for the database. In the event of a failure, the database server uses the log to re-create all committed transactions in your database, unless CREATE DATABASE statement does not include the WITH LOG keywords.

To create a database that supports transaction logging, the CREATE DATABASE statement provides three syntax options:

- **WITH BUFFERED LOG**

This option records transaction log information in a shared-memory buffer. This can allow the current transaction to complete sooner than in unbuffered logging mode, which requires that all the log information must be written to disk before the transaction can be completed. For a database using buffered logging, the database server does not write the contents of the logical-log buffer from shared memory to the logical log on disk until one of these events occurs:

- The buffer becomes full,
- or the connection is closed,
- or a checkpoint occurs,
- or a commit on a another database with unbuffered logging closes a distributed transaction, thereby flushing the buffer to disk.

The following example uses the WITH BUFFERED LOG option to create a database with buffered logging:

```
CREATE DATABASE bufDatabase WITH BUFFERED LOG;
```

- **WITH LOG**

This option writes the log information directly to permanent storage, to reduce the risk of losing data if the server crashes while data rows are being modified. The following statement uses the WITH LOG keywords to create a database with unbuffered logging:

```
CREATE DATABASE unbufDatabase WITH LOG;
```

- **WITH LOG MODE ANSI**

This option enables implicit transactions. This mode also imposes certain requirements of the ANSI/ISO standard for the SQL language that the database server does not enforce in unlogged databases, or in databases that use explicit transactions.

The following statement uses the WITH LOG MODE ANSI keywords to create an ANSI-compliant database with implicit transaction logging:

```
CREATE DATABASE ansiDatabase WITH LOG MODE ANSI;
```

Unlogged databases

If you do not specify the WITH LOG keywords Informix® creates an unlogged database that cannot use transactions, and cannot run these SQL statements that support transaction logging:

- BEGIN WORK
- COMMIT WORK
- ROLLBACK WORK
- RELEASE SAVEPOINT
- ROLLBACK TO SAVEPOINT
- SET IMPLICIT TRANSACTION
- SET LOG
- SET ISOLATION.

The following example creates an unlogged database:

```
CREATE DATABASE unlogDatabase;
```

An unlogged database can improve performance in contexts where the cost of lost data is small. Alternatively, to move existing rows outside a transaction, you can create a database that supports transaction logging, but use RAW tables or light appends for unlogged operations on data that can be recovered from backup sources, if for some reason your load or unload operation fails.

Restrictions on logging modes

Some distributed operations require participating databases to have the same logging mode as the database from which the operation is initiated.

You must use the `WITH LOG` option when you create a database on a secondary server in a high-availability cluster.

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Specifying Buffered Logging

The following example creates a database that uses a buffered log:

```
CREATE DATABASE vehicles WITH BUFFERED LOG;
```

If transactions are made against a database that uses buffered logging, the transaction log records are held in a logical-log memory buffer for as long as possible. They are not flushed from this logical-log buffer in shared memory to the logical log on disk until one of the following situations occurs:

- The buffer is full.
- A transaction is committed on the database with unbuffered logging.
- A checkpoint occurs.
- The connection is closed.

If you use a buffered log, you marginally enhance the performance of logging at the risk of not being able to re-create the last few transactions after an assertion failure.

ANSI/ISO-compliant databases cannot support buffered logging, but must be created with the `LOG MODE ANSI` keywords:

```
CREATE IF NOT EXISTS DATABASE nobuficles WITH LOG MODE ANSI;
```

See also the discussion of buffered logging in the *IBM® Informix® Database Design and Implementation Guide*.

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ANSI-Compliant Databases

When you use the `LOG MODE ANSI` option in the `CREATE DATABASE` statement, the database that you create is an ANSI-compliant database that conforms to the ANSI/ISO standard for the SQL language.

The following example creates an ANSI-compliant database:

```
CREATE DATABASE employees WITH LOG MODE ANSI;
```

ANSI-compliant databases are different from databases that are not ANSI compliant in several ways, including the following features:

- All SQL statements are automatically contained in transactions.
- All databases use unbuffered logging.
- Owner naming is enforced.

You must qualify with the owner name any table, view, synonym, index, or constraint that you do not own. Unless you enclose the owner name between quotation marks, alphabetic characters in owner names default to uppercase. (To prevent this upshifting of lowercase letters in undelimited owner names, you can set the **ANSIOWNER** environment variable to 1.)

In addition, the routine signature of a UDR includes the name of the owner; in databases that are not ANSI compliant, this is true only for the **sysdbopen()** and **sysdbclose()** procedures.

- For sessions, the default isolation level is **REPEATABLE READ**.
- Default privileges on objects differ from those in databases that are not ANSI compliant. When you create a table or a synonym, other users do not receive access privileges (as members of the **PUBLIC** group) on the object by default.
- All **DECIMAL** data types are fixed-point values. If you declare a column as **DECIMAL(p)**, the default scale is zero, meaning that only integer values can be stored. (In a database that is not ANSI compliant, **DECIMAL(p)** is a floating-point data type of a scale large enough to store the exponential notation for a value.)

Other slight differences exist between databases that are ANSI compliant and those that are not. These differences are noted with the related SQL statement in this document. For a detailed discussion of the differences between ANSI compliant databases and databases that are not ANSI-compliant, see the *IBM® Informix Database Design and Implementation Guide*.

Creating an ANSI-compliant database does not mean that you automatically receive warnings for Informix® extensions to the ANSI/ISO standard for SQL syntax when you run the database. You must also use the **-ansi** flag or the **DBANSIWARN** environment variable to receive such warnings.

For additional information about **-ansi** and **DBANSIWARN**, see the *IBM Informix Guide to SQL: Reference*.

Related information:

[DBANSIWARN environment variable](#)

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Specifying NLSCASE case sensitivity

You can explicitly create a case-sensitive or case insensitive database.

By default, in databases where the locale classifies disjunct subsets of the code set as *uppercase letters* and as *lowercase letters*, Informix® databases are created as case-sensitive. The database locale is defined by setting the **DB_LOCALE** environment variable. An example of a locale whose code set recognizes letter case is the default US English locale, where lowercase letters precede uppercase letters in the ascending order of collation. In the default locale, the following statement creates a case-sensitive database:

```
CREATE DATABASE employees IN dbspaceYee WITH BUFFERED LOG;
```

To explicitly create a case-sensitive database, include the **NLSCASE SENSITIVE** keywords as the last specification of the **CREATE DATABASE** statement, as in the following example:

```
CREATE DATABASE stores IN dbbsp1 WITH LOG NLSCASE SENSITIVE;
```

Because case sensitivity is enabled by default, the following statement has the same effect:

```
CREATE DATABASE stores IN dbbsp1 WITH LOG;
```

In a database that is case sensitive, for a table in which column **col3** is of type **NCHAR** or **NVARCHAR**, for example, the Boolean condition **col3 MATCHES 'SAM'** evaluates as false for rows where 'Sam' is the value in **col3**. In contrast, in a different database created with the **NLSCASE INSENSITIVE** keyword option, the same Boolean condition **col3 MATCHES 'SAM'** evaluates as true for the same rows of the same table. As this example implies, for tables that include **NCHAR** or **NVARCHAR** columns in which some row values differ only in letter case, query results depend on the **NLSCASE** setting of the database.

All Informix databases are case sensitive for operations on character strings of the built-in **CHAR**, **LVARCHAR**, and **VARCHAR** data types. If you create a case-sensitive database, whether by default, or explicitly with the **NLSCASE SENSITIVE** keywords, that database also treats strings of the National Language Support data types **NCHAR** and **NVARCHAR** as case-sensitive, if the database locale supports letter case.

Creating a database that is not case sensitive

In some applications, the letter case of character strings can be disregarded. Data entry procedures, for example, might accept the strings 'M' and 'm' as logically equivalent within a record. For large data sets, applying conditional logic to convert both case variants to a single value can result in slower performance than storing the records in an **NCHAR** or **NVARCHAR** column of a case-insensitive database, in which the strings 'M' and 'm' encode the same case-insensitive value. Here the condition **'M' MATCHES 'm'** evaluates as true for **NCHAR** or **NVARCHAR** columns.

Every database created with the **NLSCASE INSENSITIVE** property stores uppercase and lowercase **NCHAR** and **NVARCHAR** letters exactly as they are loaded into their tables; any unmodified record that a query returns has its original lettercase. In all operations on **NCHAR** and **NVARCHAR** values, however, such as sorting, grouping, or identifying duplicate rows, the database server ignores any letter case variants, and treats, for example, the strings 'Mi' and 'mI' as the same value. Information about the case of letters not discarded, but it is also not used when the database server processes NLS data types.

When you include the **NLSCASE INSENSITIVE** keywords as the last specification of the **CREATE DATABASE** statement, the database server creates a database that always processes the following types of character strings without regard to letter case:

- Strings stored in columns of the NLS data types **NCHAR** and **NVARCHAR**
- Strings stored as a **DISTINCT** data type whose base type is **NCHAR** or **NVARCHAR**
- Strings stored as elements of these data types within a collection data type
- Strings stored in fields of the above data types in a named or unnamed **ROW** data type
- Strings stored as **SPL** variables of these data types
- Strings implicitly or explicitly cast to these data types
- Strings returned by functions as output parameters of these data types.

Here "these data types" refers to the character data types that are identified in the same list.

The following statement creates a database with the **NLSCASE** property set to **INSENSITIVE**:

```
CREATE DATABASE stores IN dbbsp2 WITH BUFFERED LOG NLSCASE INSENSITIVE;
```

Important: A database created as **NLSCASE INSENSITIVE** treats all other built-in character data types (**CHAR**, **LVARCHAR**, and **VARCHAR**) as case sensitive. That is, a case-insensitive database can also perform case-sensitive processing of string values, if their data types are not among the NLS character data types in the list above.

To perform case-sensitive operations on a string of the **NCHAR** or **NVARCHAR** data type in a case-insensitive database, you must first explicitly cast the string to a **CHAR**, **LVARCHAR**, or **VARCHAR** data type, and then perform the case-sensitive operation. (See, however, the topic [Return Types from CONCAT and String Functions](#), which identifies contexts in which the database server automatically casts the result of built-in string-manipulation functions and string operators to **NCHAR** or **NVARCHAR** data types.)

Examples of NLSCASE INSENSITIVE queries

In a case-insensitive database, when a query calls an aggregate function or includes the **GROUP BY** clause for an **NCHAR** or **NVARCHAR** column, the database server treats letter-case variants in the data as duplicate column values, as in the following program fragment.

```
CREATE DATABASE casedb WITH LOG NLSCASE INSENSITIVE;
CREATE TABLE foo (cc CHAR(5), nc NCHAR(5));
INSERT INTO foo VALUES ('IBM', 'ibm');
INSERT INTO foo VALUES ('ibm', 'ibM');
INSERT INTO foo VALUES ('ibm', 'ibM');
INSERT INTO foo VALUES ('Ibm', 'Ibm');

SELECT COUNT(nc) FROM foo
GROUP BY nc;
SELECT COUNT(nc) FROM foo
WHERE nc = 'ibm' GROUP BY nc;
```

In both of the queries above, the **COUNT** aggregate function returns 4, the total number of rows that the **INSERT** statements loaded into **foo**. Because column **nc** is an NLS data type, all of the rows satisfy the **nc = 'ibm'** condition in the **WHERE** clause, despite variations in letter case among the **nc** values.

For the following query on the same tables,

```
SELECT nc FROM foo GROUP BY nc;
```

the output can be any of the string values from the INSERT statements (namely 'IBM', 'iBM', 'ibm', 'iBm', or 'Ibm'), depending on the order in which the server processes or scans the rows.

The next query on the same table excludes duplicate rows from the result set by including the DISTINCT keyword in the projection clause:

```
SELECT DISTINCT nc FROM foo;
```

This returns a single row, because from the **NLSCASE INSENSITIVE** perspective, all of the rows have the same value, despite the variations in letter case. As in the previous example, the first row retrieved from among the inserted rows will be returned by the query.

The next example includes the DISTINCT keyword as one of the arguments to the **COUNT** aggregate function:

```
SELECT COUNT(DISTINCT nc) FROM foo;
```

This returns a count of 1, again because in this case-insensitive database, all of the rows in table **foo** evaluate as duplicates.

Restrictions on NLSCASE INSENSITIVE databases

The following restrictions apply to databases that are created with the NLSCASE INSENSITIVE property:

- They support distributed cross-database and cross-server queries only with databases that also have the NLSCASE INSENSITIVE property.
- Case-sensitive databases cannot connect to NLSCASE INSENSITIVE databases. Attempts to do so fail with this error:

```
-26801 Cannot reference an external database that is not case sensitive.
```

- NLSCASE INSENSITIVE databases cannot connect to case-sensitive databases. Attempts to do so fail with this error:

```
-26802 Cannot reference an external database that is case sensitive.
```

The only exception is that the NLSCASE setting does not prevent connections to the case-sensitive system databases, such as **sysmaster**, **sysadmin**, **sysutils**, **sysusers**, and **syscdr**, of the same Informix database server instance. The results of operations that access a system database depends on the NLSCASE setting of the other database.

- The **onload** and **onunload** utilities do not support databases that have the NLSCASE INSENSITIVE property.
- In an Enterprise Replication cluster, no error or warning is issued if you specify a replication pair in whose databases differ in their NLSCASE property. To reduce the risk of data inconsistencies, replicate case-sensitive databases only with case-sensitive databases. and replicate NLSCASE INSENSITIVE databases only with NLSCASE INSENSITIVE databases.

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CREATE DEFAULT USER statement (UNIX, Linux)

Use the CREATE DEFAULT USER statement to define the properties set of the default internally authenticated user. This statement is an extension to the ANSI/ISO standard for the SQL language.

Syntax

```
>>-CREATE DEFAULT USER WITH -| Properties |-----><
                                     (1)
```

Notes:

1. See the Properties clause in the [CREATE USER statement \(UNIX, Linux\)](#).

Usage

CREATE DEFAULT USER is a special case of the CREATE USER statement. After you use the CREATE DEFAULT USER statement to define default user properties, you can use the CREATE USER statement (but omitting the PROPERTIES clause) to create new users who have default user properties.

Only a DBSA can issue the CREATE DEFAULT USER statement. With a non-root installation, the user who installs the server is the equivalent of the DBSA, unless the user delegates DBSA privileges to a different user.

The USERMAPPING configuration parameter must be set to a value (ADMIN or BASIC) that enables support for mapped users before default users who were created with the CREATE DEFAULT USER statement can connect to the database server. A DBSA can issue the CREATE DEFAULT USER statement to map default users to properties that correspond to the appropriate level of authorization. The USERMAPPING configuration parameter must be set to ADMIN to enable a default user to have a server administrative privilege with the AUTHORIZATION keyword, where **AAO**, **BARGROUP**, **DBSA**, and **DBSSO** are the keyword options for specific administrative privileges.

You must also enter values in the SYSUSERMAP table of the **sysusers** database to map users with the appropriate user properties, so that the mapped user statements of SQL can work correctly.

You cannot specify a password, or account lock, or account unlock information in the CREATE DEFAULT USER statement. This statement is equivalent to the GRANT ACCESS TO PUBLIC PROPERTIES statement. The equivalent syntax to

```
REVOKE ACCESS TO PUBLIC;
```

is this:

```
DROP DEFAULT USER;
```

To alter the properties of the default internally authenticated user, you can issue the `ALTER DEFAULT USER WITH PROPERTIES` statement. Execution of the `CREATE DEFAULT USER` statement can be audited with the CRUR audit code, which is the same mnemonic as for the `CREATE USER` statement.

For more information about the `PROPERTIES` options to the `CREATE DEFAULT USER` statement, see the [CREATE USER statement \(UNIX, Linux\)](#).

Related reference:

[CREATE USER statement \(UNIX, Linux\)](#)

[ALTER USER statement \(UNIX, Linux\)](#)

Related information:

[USERMAPPING configuration parameter \(UNIX, Linux\)](#)

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CREATE DISTINCT TYPE statement

Use the `CREATE DISTINCT TYPE` statement to create a new distinct data type.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-CREATE DISTINCT TYPE--+-+-----+--distinct_type----->
                               '-IF NOT EXISTS-'
>-AS--source_type-----><
```

Element	Description	Restrictions	Syntax
<i>distinct_type</i>	Name that you declare here for the new distinct data type	In an ANSI-compliant database, the combination of the owner and data type must be unique within the database. In a database that is not ANSI compliant, the name must be unique among names of data types in the database.	Data Type
<i>source_type</i>	Name of existing type on which the new type is based	Must be either a built-in data type or one created with the <code>CREATE DISTINCT TYPE</code> , <code>CREATE OPAQUE TYPE</code> , or <code>CREATE ROW TYPE</code> statement	Data Type

Usage

A *distinct type* is a data type based on a built-in data type or on an existing opaque data type, a named ROW data type, or another distinct data type. Distinct data types are strongly typed. Although the distinct type has the same physical representation of data as its source type, values of the two types cannot be compared without an explicit cast from one type to the other.

To create a distinct data type, you must have the Resource privilege on the database. Any user with the Resource privilege can create a distinct type from one of the built-in data types, which user **informix** owns.

Important: You cannot create a distinct type on the `SERIAL`, `BIGSERIAL`, or `SERIAL8` data types.

To create a distinct type from an opaque type, from a named ROW type, or from another distinct type, you must be the owner of the data type or have the Usage privilege on the data type.

By default, after a distinct type is defined, only the owner of the distinct type and the DBA can use it. The owner of the distinct type, however, can grant to other users the Usage privilege on the distinct type.

A distinct type has the same storage structure as its source type. The following statement creates the distinct type **birthday**, based on the built-in `DATE` data type:

```
CREATE DISTINCT TYPE birthday AS DATE;
```

Although Informix® uses the same storage format for the distinct type as it does for its source type, a distinct type and its source type cannot be compared in an operation unless one type is cast explicitly to the other type.

If you include the optional `IF NOT EXISTS` keywords, the database server takes no action (rather than sending an exception to the application) if a `DISTINCT` data type of the specified name is already registered in the current database.

- [Privileges on Distinct Types](#)
- [Support Functions and Casts](#)
- [Manipulating Distinct Types](#)

Related reference:

[CREATE CAST statement](#)

[CREATE OPAQUE TYPE statement](#)

[CREATE SCHEMA statement](#)

[CREATE FUNCTION statement](#)

[CREATE ROW TYPE statement](#)

[DROP TYPE statement](#)

[DROP ROW TYPE statement](#)

Related information:

[DISTINCT data types](#)
[Distinct data type](#)

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Privileges on Distinct Types

To create a distinct type, you must have the Resource privilege on the database. When you create the distinct type, only you, the owner, have Usage privilege on this type. Use the GRANT or REVOKE statements to grant or revoke Usage privilege to other database users.

To find out what privileges exist on a particular type, check the **sysxdtypes** system catalog table for the owner name and the **sysxdtypeauth** system catalog table for additional data type privileges that might have been granted. For more information on system catalog tables, see the *IBM® Informix® Guide to SQL: Reference*.

The DB-Access utility can also display privileges on distinct types.

Related information:

[System catalog tables](#)

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Support Functions and Casts

When you create a distinct type, Informix® automatically defines two explicit casts:

- A cast from the distinct type to its source type
- A cast from the source type to the distinct type

Because the two data types have the same representation (the same length and alignment), no support functions are required to implement the casts.

You can create an implicit cast between a distinct type and its source type. To create an implicit cast, use the Table Options clause to specify the format of the external data. You must first drop the default explicit cast, however, between the distinct type and its source type.

All support functions and casts that are defined on the source type can be used on the distinct type. Casts and support functions that are defined on the distinct type, however, are not available to the source type. Use the Table Options clause to specify the format of the external data.

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Manipulating Distinct Types

When you compare or manipulate data of a distinct type and its source type, you must explicitly cast one type to the other in the following situations:

- To insert or update a column of one type with values of the other type
- To use a relational operator to add, subtract, multiply, divide, compare, or otherwise manipulate two values, one of the source type and one of the distinct type

For example, suppose you create a distinct type, **dist_type**, that is based on the NUMERIC data type. You then create a table with two columns, one of type **dist_type** and one of type NUMERIC.

```
CREATE DISTINCT TYPE dist_type AS NUMERIC;  
CREATE TABLE t(col1 dist_type, col2 NUMERIC);
```

To directly compare the distinct type and its source type or assign a value of the source type to a column of the distinct type, you must cast one type to the other, as the following examples show:

```
INSERT INTO tab (col1) VALUES (3.5::dist_type);
```

```
SELECT col1, col2  
FROM t WHERE (col1::NUMERIC) > col2;
```

```
SELECT col1, col2, (col1 + col2::dist_type) sum_col  
FROM tab;
```

For information about queries and other distributed DML operations that access DISTINCT data types in tables outside the local database, see the topic [DISTINCT Types in Distributed Operations](#).

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CREATE EXTERNAL TABLE Statement

Use the CREATE EXTERNAL TABLE statement to define an external source that is not part of your database to load and unload data for your database.

The implementation of the CREATE EXTERNAL TABLE statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-CREATE EXTERNAL TABLE--+-+-----+---table----->
                        '-IF NOT EXISTS-'

                        (1)
>--| Column Definition |----->

                        (3)
>--USING(-+-----+---| DATAFILES Clause |-----+---)-><
          |           (2) |           |           (2) |
          '-| Table Options |-----'           '-| Table Options |-----'
```

Notes:

1. See [Column Definition](#)
2. See [Table options](#)
3. See [DATAFILES Clause](#)

Element	Description	Restrictions	Syntax
table	The name of the table to store external data	Must be unique among names of tables, views, and synonyms in the current database	Identifier

Usage

You use external tables to load and unload data to or from your database. You can also use external tables to query data in text files that are not in Informix® databases.

The first portion of the syntax diagram declares the name of the table and defines its columns.

The portion that follows the USING keyword identifies external files that the database server opens when you use the external table, and specifies additional options for characteristics of the external table.

After executing the CREATE EXTERNAL TABLE statement, you can move data to and from the external source with an INSERT INTO ... SELECT statement. See the section [INTO EXTERNAL clause](#) for more information about loading the results of a query into an external table.

The CREATE EXTERNAL TABLE statement is not supported on secondary servers within a high-availability cluster.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if an external table of the specified name is already registered in the **systables** system catalog table of the current database, or if the specified name is the identifier of a database table, view, sequence object, or synonym in the current database.

- [Column Definition](#)
Use the column definition segment of the CREATE EXTERNAL TABLE statement to declare the name and data type of a single column of the new external table.
- [DATAFILES Clause](#)
The DATAFILES clause specifies the operating system file or pipe that is opened when you use an external table.
- [Table options](#)
These options specify additional characteristics that define the external table, and that define attributes of load or unload operations on that table.
- [Reject Files](#)
Rows that have conversion errors during a load or rows that violate check constraints on the external table are written to a reject file. The REJECTFILE clause declares the path and file name of the reject file.
- [External Table Examples](#)
The examples in this section illustrate different ways to load and unload data using external tables.
- [Restrictions on External Tables](#)
Certain operations on external tables are not supported or have limited scope.

Related reference:

[CREATE TABLE statement](#)

Related information:

[External tables](#)

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Column Definition

Use the column definition segment of the CREATE EXTERNAL TABLE statement to declare the name and data type of a single column of the new external table.

Column Definition

```

|---+--SAMEAS--template-----+-----|
| .,-----|
| V |
|---column--data_type--| Other Optional Clauses |---+
Other Optional Clauses

|---+-----+-----|
| -EXTERNAL--CHAR--(--size--)---+
| +--NULL--'--null_string--'+
| -NOT NULL-----|

```

Element	Description	Restrictions	Syntax
<i>column</i>	One column name for each column of the external table	For each column, you must specify a built-in data type	Identifier
<i>data_type</i>	Data type of the column	The <i>data_type</i> can be any data type supported by Informix®.	Data Type
<i>template</i>	Existing table with the same schema as the external table	Cannot be a subset of columns nor differ in any column data type	Database Object Name
<i>size</i>	Column size in bytes. Default is 1.	Integer; $1 \leq size \leq 32,767$	Literal Number
<i>null_string</i>	Value to represent NULL	See Defining NULL Values .	Quoted String

- [Using the SAMEAS Clause](#)
The SAMEAS *template* clause uses all the column names and data types from the *template* table in the definition of the new table.
- [Using the EXTERNAL Keyword](#)
Use the EXTERNAL keyword to specify a CHAR data type for each column of your external table that has a data type different from the internal table.
- [Manipulating Data in Fixed Format Files](#)
A fixed format file is one in which all rows have the same length.

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Using the SAMEAS Clause

The SAMEAS *template* clause uses all the column names and data types from the *template* table in the definition of the new table.

You cannot use the SAMEAS clause for FIXED-format files.

Example

Consider loading a delimited ASCII text file into a table with the following schema:

```

TABLE employee (
  name CHAR(18) NOT NULL,
  hiredate DATE DEFAULT TODAY,
  address VARCHAR(40),
  empno INTEGER);

```

The SQL statements used to load data into the employee table would be as follows:

```

CREATE EXTERNAL TABLE emp_ext
SAMEAS employee
USING (
  DATAFILES ("DISK:/work2/mydir/emp.dat"),
  REJECTFILE "/work2/mydir/emp.rej"
);
INSERT INTO employee SELECT * FROM emp_ext;

```

The external table has the same name, type, and default for each column because the CREATE statement includes the SAMEAS keyword. The default format is delimited, so no format keyword is required.

Check constraints defined on columns in database tables are not inherited by the external table. However, NOT NULL constraints are inherited by the external table.

Delimited files are ASCII by default. The default row delimiter is an end-of-line character unless you use the RECORDEND keyword to specify a different delimiter when you created the external table. (The RECORDEND keyword works for delimited format only.)

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Using the EXTERNAL Keyword

Use the EXTERNAL keyword to specify a CHAR data type for each column of your external table that has a data type different from the internal table.

For example, you might have a VARCHAR column in the internal table that you want to map to a CHAR column in the external table.

You must specify an external type for every column that is in fixed format. You cannot specify an external type for delimited format columns except for BYTE and TEXT columns where your specification is optional.

- [Defining NULL Values](#)
You can define a value to be interpreted as a NULL when loading or unloading data from an external source.

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Defining NULL Values

You can define a value to be interpreted as a NULL when loading or unloading data from an external source.

The database server uses the NULL representation for a FIXED-format external table to both interpret values as the data is loaded into the database and to format NULL values into the appropriate data type when data is unloaded to an external table.

The NULL representation must fit into the length of the external field.

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Manipulating Data in Fixed Format Files

A fixed format file is one in which all rows have the same length.

For files in FIXED format, you must declare the column name and the EXTERNAL item for each column to set the name and number of characters. For FIXED-format files, the only data type allowed is CHAR. You can use the keyword NULL to specify what string to interpret as a NULL value.

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DATAFILES Clause

The DATAFILES clause specifies the operating system file or pipe that is opened when you use an external table.

DATAFILES Clause

```
|--DATAFILES----->
      .-
      V
>--(-----'---+-DISK+---:---+fixed_path-----+---+-----'---+---)---|
      '-PIPE-'      '-formatted_path-' |      .-;-----+-----'---+---|
                                   V |
                                   '-;-----+BLOBDIR+---:---+fixed_path+---'
                                   '-CLOBDIR-'
```

Element	Description	Restrictions	Syntax
<i>fixed_path</i>	Path name for input or output files in the definition of the external table	See the notes that follow this table	Must conform to operating-system rules
<i>formatted_path</i>	Formatted path name that uses pattern-matching characters	See the notes that follow this table	Must conform to operating-system rules

The database server does not verify that any file or pipe exists at the specified *fixed_path* or *formatted_path*, that the specified pipe is open, nor that the user has permission to access that file system. Subsequent operations on the external table will fail, however, unless the path is valid and, if a named pipe is being used, that it is open, when the database server attempts to read or write to the external table.

For examples of the DATAFILES clause, see [External Table Examples](#).

Keyword

Description

CLOBDIR

Specifies the server directory in which the CLOB file is stored.

BLOBDIR

Specifies the server directory in which the BLOB file is stored. When creating queries, specify DISK followed by BLOBDIR followed by CLOBDIR. If BLOBDIR is omitted, BLOB files are stored the same directory as specified by the DISK clause. If both BLOBDIR and CLOBDIR are omitted, a new file is created for each BLOB or CLOB column and stored in the directory in which the DISK clause is specified.

In the following example, rows stored in `/work1/exttab1.dat` have their BLOBs located in `/work1/blobdir1` and CLOBs in the `/work1/clobdir1` directory.

Rows stored in `/work1/exttab2.dat` have their BLOBs located in the `/work1` directory and CLOBs in the `/work1/clobdir2` directory. Because the BLOBDIR clause is omitted, the BLOBs are stored in the directory where `exttab2.dat` is stored.

Rows stored in the /work1/exttab3.dat have their BLOBs and CLOBs located in the /work1 directory because both BLOBDIR and CLOBDIR are omitted.

```
CREATE EXTERNAL TABLE exttab (
    id SERIAL,
    lobc CLOB,
    lobb BLOB)
USING (DATAFILES(
    "DISK:/work1/exttab1.dat;BLOBDIR:/work1/blobdir1;CLOBDIR:/work1/clobdir1",
    "DISK:/work1/exttab2.dat;CLOBDIR:/work1/clobdir2",
    "DISK:/work1/exttab3.dat"),
    DELIMITER '|');
```

- [Using Formatting Characters with External Tables](#)
You can use a formatted path name to designate a file name by using the substitution character %r (first ..last).

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Using Formatting Characters with External Tables

You can use a formatted path name to designate a file name by using the substitution character %r (first ..last).

Formatting String

Effect

%r(first ..last)

Specifies multiple files on the Informix® server for the external table.

The first and last arguments represent a range of values that are substituted in the expression when the statement is run. For example, specifying my_file.%r(1..3) expands to:

my_file.1

my_file.2

my_file.3

The only supported formatting character supported by Informix is %r.

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Table options

These options specify additional characteristics that define the external table, and that define attributes of load or unload operations on that table.

Table Options

```
.-+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
V      (1)  .-DELIMITED-.      |
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|      'FIXED-----'      |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|      (1) (2)      |
+-+ Loading mode options |-----+
'--+DBDATE--'date_format'-----+
+--DBMONEY--'currency'-----+
+--DELIMITER--'field_delimiter'--+
+--RECORDEND--'record_delimiter'--+
+--MAXERRORS--num_errors-----+
+--REJECTFILE--'filename'-----+
|      (1)      .-ON-----+
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|      'OFF-'      |
'--+--NUMROWS+--+num_rows-----+
'--SIZE-----'
```

Loading mode options

```
(2)
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|      'DELUXE--'      |
```

Notes:

1. Use this path no more than once
2. The default loading mode depends on the table and database logging characteristics. See the keyword descriptions in the usage section for details.

Element	Description	Restrictions	Syntax
field_delimiter	Character that separates fields. Default is pipe (|)	For nonprinting characters, use octal notation.	Quoted String

Element	Description	Restrictions	Syntax
<i>filename</i>	Full path name for conversion error messages	See Reject Files .	Must conform to operating-system rules.
<i>num_errors</i>	Number of errors before load operations are terminated	Value is ignored unless the REJECTFILE value is set. This specification is ignored during unload tasks.	Literal Number
<i>num_rows</i>	Approximate number of rows contained in the external table	Must be a positive number.	Literal Number
<i>record_delimiter</i>	Character to separate records. Default is Newline (\n)	For nonprinting characters, use octal.	Quoted String

Usage

If no RECORDEND value is specified, *record_delimiter* defaults to the Newline character (\n). To specify a nonprinting character as the record delimiter or field delimiter, you must encode it as the octal representation of the ASCII character. For example, \006 can represent CTRL-F.

On Windows systems, if you use the **DB-Access** utility or the **dbexport** utility to unload a database table into a file and then plan to use the file as an external table datafile, you should define RECORDEND as '\012' in the CREATE EXTERNAL TABLE statement.

Use the table options keywords as the following table describes. You can use each keyword whenever you plan to either load or unload data except where noted.

Keyword

Description

DBDATE

Specifies the date format when reading or writing an external table. You use the DBDATE clause to convert data during load and unload operations from external tables. In the following example, DBDATE is set to DMY2-. If the date value in the database table was stored as 06/24/2009, the value written to the external table is 24-06-09.

```
CREATE EXTERNAL TABLE ext_date (dob date)
USING ( DATAFILES ("DISK:/tmp/datedisk"),
        REJECTFILE "/tmp/datereject",
        DBDATE "DMY2-",
        FORMAT "delimited");
```

```
INSERT INTO ext_date SELECT * FROM basetab;
```

The DBDATE clause is also used when inserting date values from external tables into database tables. In the following example, data in the external table is converted to internal binary format based on the DBDATE value set by the CREATE EXTERNAL TABLE statement.

```
INSERT INTO basetab SELECT * FROM ext_date;
```

If the DBDATE keyword is not specified in the USING clause of the CREATE EXTERNAL TABLE statement, the date format is determined by the setting of the DBDATE environment variable. If the DBDATE environment variable is not specified, the date format is determined by the setting of the GL_DATE environment variable. The value specified by the DBDATE clause takes precedence over the value specified by the DBDATE environment variable. The setting of the DBDATE variable takes precedence over that of the GL_DATE environment variable. See the *IBM® Informix Guide to SQL: Reference* for information about DBDATE and GL_DATE values.

DBMONEY

Specifies the currency format when reading or writing an external table. You use the DBMONEY clause to convert data during load and unload operations from external tables. In the following example, DBMONEY is set to DM, . Currency is formatted as DM (deutsche mark) units, using the currency symbol DM and comma (,). If the currency value in the database table is stored as 100.50, the value written to the external table is 100,50.

```
CREATE EXTERNAL TABLE ext_money (sales money)
USING ( DATAFILES ( "DISK:/tmp/moneydisk" ),
        REJECTFILE "/tmp/moneyreject",
        DBMONEY "DM,",
        FORMAT "delimited");
```

```
INSERT INTO ext_money SELECT * FROM basetab;
```

When reading data from an external table into a database table, the currency symbol is not required in the external table. For example, if the external table contained the value 1000,78 and DBMONEY was set to DM, then the data is not rejected and the row is stored correctly.

If the decimal separator in the external table and the value set for DBMONEY do not match, then the row is rejected. For example, if the external table contained the value 1000,78 (with a comma instead of a decimal point) and the DBMONEY clause is set to DM, then the row is rejected. If the data file contains a currency symbol and the currency symbol does not match the DBMONEY currency symbol, the row is rejected.

When writing data from a database table into an external table, the currency symbol is not written to the external table.

If the DBMONEY clause is not specified, the data format is determined by the setting of the DBMONEY environment variable. The value specified by the DBMONEY clause takes precedence over the value specified by the DBMONEY environment variable. If the DBMONEY clause is not specified and the DBMONEY environment variable is not set, the decimal separator specified by the database locale is used. See the *IBM Informix Guide to SQL: Reference* for information about DBMONEY values.

DEFAULT (load only)

Specifies replacing missing values in delimited input files with column defaults (if they are defined) instead of NULLs, so input files can be sparsely populated. Files do not need an entry for every column in the file where a default is the value to be loaded.

DELIMITED

Specifies that the data file is a delimited text file. A delimiter character can be specified using the optional DELIMITER table option.

DELIMITER

Specifies the character that separates fields in a delimited text file. If the table options include no DELIMITER specification, the pipe (|) character is the default field separator.

DELUXE (load only)

The database server always uses DELUXE mode for STANDARD tables if the database uses transaction logging, and on any table on which an index is defined.

You can specify DELUXE mode to override the default EXPRESS load mode for RAW target tables without indexes if the database is logged.

The DELUXE mode updates indexes, performs constraint checking, and evaluates triggers as data is inserted into the table. DELUXE mode loads are not as fast as EXPRESS mode loads, but are more flexible. In DELUXE mode, you can access and update the table that is being loaded.

ESCAPE

Inserts the default escape character immediately before any instances of the *field_delimiter* separator that DELIMITER specifies, where that character is a literal value in the data, rather than a separator. Whether you include or omit the ESCAPE keyword, this functionality is enabled by default, or you can specify the `ESCAPE ON` keywords to make it clearer to human readers of your SQL code that this feature is enabled. To prevent literal *field_delimiter* separator characters in the data from being escaped, you must specify the `ESCAPE OFF` keywords.

By default, the escape character that the ESCAPE keyword inserts before literal *field_delimiter* characters is the backslash (\) character. But if the DEFAULTESCCHAR configuration parameter is set to a single-character value, that character replaces backslash (\) for delimiter characters used as literals when `ESCAPE` or `ESCAPE ON` is specified.

Note:

The default setting for ESCAPE is OFF in Informix® releases earlier than version 12.10.

EXPRESS (load only)

EXPRESS mode is always used if the database is not logged and the target table (of any table type) has no indexes.

EXPRESS is the default if the database is logged for RAW target tables without indexes; however, you can override that default by specifying the DELUXE keyword.

EXPRESS mode loads use light appends and are significantly faster than DELUXE mode loads, but less flexible. In EXPRESS mode you cannot update the table or read the new data entries until the load is complete.

An error message is generated and the load is stopped if EXPRESS mode is specified and the table contains objects of type BLOB, BYTE, CLOB, or TEXT.

When data is loaded using EXPRESS mode, the target table cannot be located within an Enterprise Replication (ER) replicate. In addition, the target database server must not have high-availability data replication (HDR) enabled.

FIXED

Specifies that the data file is fixed width. When using EXTERNAL data types in the external table, the FIXED format must be used.

FORMAT

Specifies the format of the data in the data files.

INFORMIX

Specifies that the format of the data file is internal Informix format. Loading data from an external table saved in Informix format is faster than loading data from a fixed or delimited external file. Use Informix format when moving data from one Informix database to another.

MAXERRORS

Sets the number of errors that are allowed before the database server stops loading data.

The minimum value for MAXERRORS is 1. Setting MAXERRORS to a value less than 1 produces an error. The maximum value for MAXERRORS is 2,147,483,647.

RECORDEND

Specifies the character that separates records in a delimited text file.

REJECTFILE

Sets the full path name where the database server writes data-conversion errors. If not specified or if files cannot be opened, any error ends the loading of data abnormally. See also [Reject Files](#).

NUMROWS or SIZE

The approximate number of rows in the external table.

Specifying NUMROWS (or its synonym, SIZE) can improve performance when an external table is used in a join query. This value cannot be NULL.

Related information:

[DBMONEY environment variable](#)

[DBDATE environment variable](#)

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Reject Files

Rows that have conversion errors during a load or rows that violate check constraints on the external table are written to a reject file. The REJECTFILE clause declares the path and file name of the reject file.

If you perform another load to the same table during the same session, any earlier reject file of the same name is overwritten.

Reject file entries have the following format:

```
filename, record, reason-code,  
field-name: bad-line
```

The following table describes these elements of the reject file:

Element	Description
filename	Name of the input file.

record

Record number in the input file where the error was detected.

reason-code

Description of the error.

field-name

External field name where the first error in the line occurred, or `<none>` if the rejection is not specific to a particular column.

bad-line

Line that caused the error (delimited or fixed-position character files only).

The reject file writes the *filename*, *record*, *field-name*, and *reason-code* in ASCII. The *bad-line* information varies with the type of input file.

- For delimited files or fixed-position character files, up to 80 characters of the bad line are copied directly into the reject file.
- For Informix® internal data files, the bad line information is not placed in the reject file because you cannot edit the binary representation in a file; but the *filename*, *record*, *reason-code*, and *field-name* are still reported in the reject file so you can isolate the problem. Use the Table Options clause to specify the format of the external data.

The following errors can cause a row to be rejected.

Error Text

Explanation

CONSTRAINT *constraint name*

This constraint was violated.

CONVERT_ERR

Any field encounters a conversion error.

MISSING_DELIMITER

No delimiter was found.

MISSING_RECORDEND

No end of record was found.

NOT NULL

A NULL was found in *field-name*.

ROW_TOO_LONG

The input record is longer than 32 kilobytes.

Virtual Processors

A FIFO virtual processor is used by external tables in Informix. One FIFO virtual processor is created when the server is initialized. Additional FIFO virtual processors can be added using the **onmode -p** command. For example, use the following command to add three FIFO virtual processors:

```
onmode -p +3 fifo
```

FIFO virtual processors cannot be deleted.

The FIFO virtual processors are used to process I/O related to the pipes that are defined with the PIPE clause.

See the *IBM® Informix Administrator's Guide* for more information about using FIFO virtual processors.

Related information:

[FIFO virtual processors](#)

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External Table Examples

The examples in this section illustrate different ways to load and unload data using external tables.

The following is an example of the CREATE EXTERNAL TABLE syntax. In the example, an external table named empdata is created with two columns. The DATAFILES clause indicates the location of the data file, specifies that the file is delimited, indicates the location of the reject file, and indicates that the reject file can contain no more than 100 errors.

```
CREATE EXTERNAL TABLE empdata
(
  empname      char(40) ,
  empdoj       date
)
USING
(DATAFILES
(
  "DISK:/work/empdata.unl"
),
FORMAT "DELIMITED",
REJECTFILE "/work/errlog/empdata.rej",
MAXERRORS 100);
```

Creating an external table using the SAMEAS clause

The SAMEAS *template* clause uses all the column names and data types from the *template* table in the definition of the new table. The following example uses the column names and data types of the empdata table and uses them for the external table.

```
CREATE EXTERNAL TABLE emp_ext SAMEAS empdata
USING
(DATAFILES
(
"DISK:/work/empdata2.unl"
),
REJECTFILE "/work/errlog/empdata2.rej",
DELUXE
);
```

Unloading data into an external table

The following example shows statements used to load data from a database table into an external table.

```
CREATE EXTERNAL TABLE ext1( coll int )
USING
(DATAFILES
(
"DISK:/tmp/ext1.unl"
)
);
```

```
CREATE TABLE base (coll int);
INSERT INTO ext1 SELECT * FROM base;
```

You can also use the SELECT...INTO EXTERNAL syntax to unload data as in the following example.

```
SELECT * FROM base
INTO EXTERNAL emp_target
USING
(DATAFILES
(
"DISK:/tmp/ext1.unl"
)
);
```

Selecting from an external table and loading into a database table

The following example selects from an external and shows various ways to load external data into a database table.

```
CREATE EXTERNAL TABLE ext1( coll int )
USING
(DATAFILES
(
"DISK:/tmp/ext1.unl"
)
);

CREATE TABLE target1 (coll int);
CREATE TABLE target2 (coll serial8, col2 int);

SELECT * FROM ext1;
SELECT coll,COUNT(*) FROM ext1 GROUP BY 1;
SELECT MAX(coll) FROM ext1;
SELECT coll FROM ext1 a, systables b WHERE a.coll=b.tabid;

INSERT INTO target1 SELECT * FROM ext1;
INSERT INTO target2 SELECT 0,* FROM ext1;
```

Unloading from a database table to a text file using FIXED format

The next example creates an external table named emp_ext, defines the column names and data types, and unloads the data from the database using fixed format.

```
CREATE EXTERNAL TABLE emp_ext
( name CHAR(18) EXTERNAL CHAR(20),
address VARCHAR(40) EXTERNAL CHAR(40),
empno INTEGER EXTERNAL CHAR(6)
)
USING (
FORMAT 'FIXED',
DATAFILES
(
"DISK:/work2/mydir/emp.fix"
)
);

INSERT INTO emp_ext SELECT * FROM employee;
```

Loading data from a data file into a database table using FIXED format

The next example creates an external table named emp_ext and loads data into the database from a fixed format file.

```
CREATE EXTERNAL TABLE emp_ext
( name CHAR(18) EXTERNAL CHAR(18),
address VARCHAR(40) EXTERNAL CHAR(40),
empno INTEGER EXTERNAL CHAR(6)
```

```

)
USING (
  FORMAT 'FIXED',
  DATAFILES
  (
    "DISK:/work2/mydir/emp.fix"
  )
);

INSERT INTO employee SELECT * FROM emp_ext;

```

Using formatting characters in the DATAFILES clause

To process three files, create the DATAFILES clause as in the following example.

```

DATAFILES
(
  "DISK:/work2/extern.dir/mytbl.%r(1..3) "
)

```

The following shows how the list is expanded when the statement is run:

```

DATAFILES
(
  "DISK:/work2/extern.dir/mytbl.1",
  "DISK:/work2/extern.dir/mytbl.2",
  "DISK:/work2/extern.dir/mytbl.3"
)

```

- [Loading Data from External Tables into Informix](#)
To load data, you define the external data as an external table and then insert the data into the database.
- [Unloading Data to External Tables from Informix](#)
You unload data by creating an external table and inserting the data into it, or by selecting data from an internal table into an external file.

Related information:

[External tables](#)

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Loading Data from External Tables into Informix®

To load data, you define the external data as an external table and then insert the data into the database.

The database server performs express-mode loads and deluxe-mode loads. You can perform express-mode loads only when the table is type RAW and does not have any active indexes. The database server allows constraint checking for both load modes.

Express mode provides the highest performance during a load.

Deluxe mode combines fast parallel loading with evaluation of indexes and unique constraints, and is more efficient in the following situations:

- The cost of rebuilding an index is too high for the amount of data that you are loading.
- You want to use the empty space from deleted rows in the table that you are loading. database

If the table receiving the rows from the external table is a STANDARD table (that is, a database table that was not created by the CREATE TEMP TABLE or CREATE RAW TABLE statement), the EXPRESS keyword has no effect, and the table is loaded in DELUXE mode. The database server does not issue an exception when it ignores the EXPRESS keyword in load operations where the receiving table is not a RAW table.

- [Loading Data in Express Mode](#)
Express® mode supports rapid loading of data into tables that have no indexes. In logged databases, only RAW tables can use this mode.
- [Loading data in DELUXE mode](#)
DELUXE mode combines fast parallel loading with evaluation of indexes and unique constraints. The database server chooses this mode for indexed target tables in all databases, and for STANDARD target tables in logged databases.
- [Loading from a Delimited File to a Database Table with the Same Schema](#)
You can avoid defining the schema of an external table if it has the same schema as the database table.
- [Loading from a Fixed Text File](#)
A fixed text file is one in which data resides in fixed positions within the file.
- [Loading Between Tables That Have the Same Schema](#)
You can easily move data from an external table to a database table if the tables have the same schema.
- [Loading Values into Serial Columns](#)
You can insert successive numbers or explicit values in a serial column.
- [Loading Data Warehousing Tables](#)
You can use external tables to load very large tables for data warehousing applications.

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Loading Data in Express Mode

Express® mode supports rapid loading of data into tables that have no indexes. In logged databases, only RAW tables can use this mode.

Warning: Express-mode loads are not allowed for STANDARD tables in databases that support transaction logging.

Express-mode loads use light appends, which bypass the buffer pool. Light appends eliminate the overhead associated with buffer management but do not log the data. In express mode, the database server automatically locks the table exclusively. No other users can access the table.

You can use express mode for any newly created table with no data if you define the table as type RAW and do not define any indexes until after you load the data. Choose RAW tables if you do not want to use logging in a database that supports transaction logging.

To prepare an existing table for express-mode load, drop all indexes, and make sure the table type is RAW.

Data loaded from an external table into a raw table is not logged; therefore, you must perform a level-0 backup before the database can be dropped. If you try to drop the database before you perform a level-0 backup, the database server issues ISAM error -197, as follows:

Partition recently appended to; can't open for write or logging

Consider a table with the following schema:

```
TABLE employee (  
  name CHAR(18),  
  hiredate DATE,  
  address CHAR(40),  
  empno INTEGER);
```

To use express-mode load on an existing table

1. Alter the table type to allow fast loading.

```
ALTER TABLE employee TYPE (RAW);
```

2. Create the external table description.

```
CREATE EXTERNAL TABLE emp_ext  
SAMEAS employee  
USING (  
  FORMAT 'DELIMITED',  
  DATAFILES  
    ("DISK:/work2/mydir/emp.dat"),  
  REJECTFILE "/work2/mydir/emp.rej",  
  EXPRESS  
);
```

3. Load the table.

```
INSERT INTO employee SELECT * FROM emp_ext;
```

If the database server chooses express mode, the load stops with an error message if the destination table contains indexes, constraints, or any other problem conditions.

4. Create a level-0 backup.

Because the data is not logged, you must perform a level-0 backup to allow data recovery. If a disk fails, you cannot recover the data automatically. You need to use the most recent level-0 backup files. ,

If the table type is RAW (nonlogging), omit the statements BEGIN WORK and COMMIT WORK.

Note: If you delete many rows from a table and then load many new rows into the table in EXPRESS mode, the table grows in size because light appends insert rows at the end of the table, and do not reuse the empty space inside the table. (Whether or not you specify EXPRESS mode, the loader might choose DELUXE mode to fill in the space if a table has many deleted rows.)

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Loading data in DELUXE mode

DELUXE mode combines fast parallel loading with evaluation of indexes and unique constraints. The database server chooses this mode for indexed target tables in all databases, and for STANDARD target tables in logged databases.

DELUXE mode loads use regular single-row inserts, which add rows to a table that can contain indexes. The insert modifies each index for each row during the load. The insert also checks all constraints for each row. A DELUXE mode load allows you to keep the table unlocked during the load so other users can continue to use it.

You also can use DELUXE mode on tables that do not contain indexes; for instance, if you want to have complete recoverability or maintain access to tables during a load.

You can specify DELUXE mode to override the default EXPRESS load mode for RAW target tables without indexes if the database is logged.

The following steps show you how to prepare a table for DELUXE mode load, create the internal table as type STANDARD, and create the external table.

Tip: The database server will automatically use DELUXE mode to load this type of table. You do not need to specify the DELUXE keyword when you define the external table. If you specify the EXPRESS keyword in the table definition, the database server will use DELUXE mode anyway and issue an informational message. To use DELUXE-mode load on a table:

1. If you want row locking, specify row locking in the CREATE TABLE statement. (Page locking is the default.) If you want other users to be able to read the table during the load, set the lock mode to `share`. Otherwise, set it to `exclusive`.


```
BEGIN WORK;
LOCK TABLE employee IN SHARE MODE;
```

2. Define the external table.

```
CREATE EXTERNAL TABLE emp_ext
SAMEAS employee
USING (
  DATAFILES ("DISK:/work2/mydir/emp.dat"),
  REJECTFILE "/work2/mydir/emp.rej",
);
```

3. Load the table.

```
INSERT INTO employee SELECT * FROM emp_ext;
```

4. Commit the load, releasing row or page locks.

```
COMMIT WORK;
```

Important: Configure logical logs to allow maximum concurrent DELUXE load transactions to complete.

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Loading from a Delimited File to a Database Table with the Same Schema

You can avoid defining the schema of an external table if it has the same schema as the database table.

Consider loading a delimited ASCII text file into a table with the following schema:

```
TABLE employee (
  name CHAR(18) NOT NULL,
  hiredate DATE DEFAULT TODAY,
  address VARCHAR(40),
  empno INTEGER);
```

The SQL statements used to load data into the employee table would be as follows:

```
CREATE EXTERNAL TABLE emp_ext
SAMEAS employee
USING (
  DATAFILES ("DISK:/work2/mydir/emp.dat"),
  REJECTFILE "/work2/mydir/emp.rej"
);
INSERT INTO employee SELECT * FROM emp_ext;
```

The external table has the same name, type, and default for each column because the CREATE statement includes the SAMEAS keyword. The default format is delimited, so no format keyword is required.

Delimited files are ASCII by default. The default row delimiter is an end-of-line character unless you use the RECORDEND keyword to specify a different delimiter when you created the external table. (The RECORDEND keyword works for delimited format only.)

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Loading from a Fixed Text File

A fixed text file is one in which data resides in fixed positions within the file.

The following SQL statements load data from the **emp_ext** external table to a fixed-position table (**employee**):

```
CREATE EXTERNAL TABLE emp_ext
( name CHAR(18) EXTERNAL CHAR(18),
  hiredate DATE EXTERNAL CHAR(10),
  address VARCHAR(40) EXTERNAL CHAR(40),
  empno INTEGER EXTERNAL CHAR(6) )
USING (
  FORMAT 'FIXED',
  DATAFILES ("DISK:/work2/mydir/emp.fix")
);
INSERT INTO employee SELECT * FROM emp_ext;
```

The enumerated columns use the keyword EXTERNAL to describe the format in which to store the data in the external file.

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Loading Between Tables That Have the Same Schema

You can easily move data from an external table to a database table if the tables have the same schema.

You can load data from one table to another table that has the same schema (for example, **worldemp**) with a simple INSERT statement.

```
INSERT INTO worldemp SELECT * FROM emp_ext;
```

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Loading Values into Serial Columns

You can insert successive numbers or explicit values in a serial column.

The database server loads serial columns with either the values from the original data file or values that the database server automatically generates.

If you want the serial column values to be the values from the data file, the INSERT statement does not require special handling. If you want the database server to generate the value automatically, omit the serial column from the INSERT statement. For example, if the first column in the table (**col1**) is the serial column and you use the following statement, the default mechanism provides the serial value:

```
INSERT INTO mytable (col12, ...) SELECT ...
```

If the table is being loaded into multiple partitions, the serial values are incremented in the same sequence as the table fragments.

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Loading Data Warehousing Tables

You can use external tables to load very large tables for data warehousing applications.

This section discusses various scenarios to load very large tables:

- Loading initially
- Refreshing periodically
- Loading of OLTP data from database servers other than Informix®.
- [Loading Initially](#)
- [Refreshing Periodically](#)
This scenario loads new data in a data warehouse table periodically from some other source.
- [Initial Loading of OLTP Data from Other Database Servers](#)
This scenario loads data into Informix for the first time, as you might do when you migrate from a different database server.

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Loading Initially

The following scenario creates and loads a data warehouse table with external data.

To load a table initially

1. Create the table as type RAW to take advantage of light appends and to avoid the overhead of logging during the load.

```
CREATE RAW TABLE tab1 ...
```

2. Describe the external data file to the database server with the CREATE EXTERNAL TABLE statement, specifying the EXPRESS statement in the USING clause.
3. Load the table.

```
INSERT INTO tab1 SELECT * FROM ext_tab
```

The table loads quickly, and the operation uses very little log space.

4. Verify the integrity of the data.
5. Create indexes on the table so that queries run more quickly.
6. Perform a level-0 backup so that you can restore the table later, if necessary. You do not need to perform this level-0 backup if it would be just as easy to reload the table from the original source in the case of a problem.

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Refreshing Periodically

This scenario loads new data in a data warehouse table periodically from some other source.

The scenario assumes that the table is type STANDARD during normal operation and that the CREATE EXTERNAL TABLE statement has been previously executed and the EXPRESS keyword was specified in the USING clause.

To refresh a table periodically

1. Drop all indexes on the table.
2. Alter the table to type RAW.

```
ALTER TABLE tab1 TYPE(RAW) ;
```

3. Load the new data in the table.

```
INSERT INTO tab1 SELECT * FROM ext_tab
```

This insert statement quickly appends new data to the end of the table, and the operation uses very little log space.

4. Verify the integrity of the data.
5. Change the table to type STANDARD.

```
ALTER TABLE tab1 TYPE(STANDARD) ;
```

6. Re-create indexes on the table so that queries run more quickly.
7. Perform a level-0 backup to enable you to restore the table later, if necessary. You do not need to perform this level-0 backup if it would be just as easy to reload the table from the original source in the case of a problem.

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Initial Loading of OLTP Data from Other Database Servers

This scenario loads data into Informix® for the first time, as you might do when you migrate from a different database server.

In this scenario, the table to load will be used for OLTP, so you need logged transactions, rollback, and recoverability.

To load OLTP data initially from a different database server using the CREATE EXTERNAL TABLE statement:

1. Create the table as type RAW to take advantage of light appends and to avoid the overhead of logging during the load.

```
CREATE RAW TABLE tab1 ...
```

2. Describe the external data file to the database server with the CREATE EXTERNAL TABLE statement.
3. Load the table.

```
INSERT INTO tab1 SELECT * FROM ext_tab
```

The table loads quickly, and the operation uses very little log space.

4. Verify the integrity of the data.
5. Perform a level-0 backup to provide a point from which to recover.
6. Change the table to type STANDARD.

```
ALTER TABLE tab1 TYPE(STANDARD) ;
```

7. Create indexes on the table so that queries run more quickly.
8. Enable constraints on the table to preserve the integrity of the data.

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Unloading Data to External Tables from Informix®

You unload data by creating an external table and inserting the data into it, or by selecting data from an internal table into an external file.

To unload data in parallel, initiate a query that runs in parallel and writes its output to multiple files. The unload job uses a round-robin technique to equalize the number of rows in the output files.

- [Unloading to a Delimited File](#)
- [Unloading to Informix Data Files](#)
- [Unloading to a Fixed-Text File](#)

You can unload data from the database into fixed format files.

- [Adding an End-of-Line Character to a Fixed Text File](#)

You can add an end-of-line character to each line of a fixed-text file to use the file for other applications.

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Unloading to a Delimited File

You can unload data to a delimited-ASCII text file from a table, as the following example shows:

```
CREATE EXTERNAL TABLE emp_ext
  SAMEAS employee
  USING (
    DATAFILES ("DISK:/work2/mydir/emp.dat")
  );
INSERT INTO emp_ext SELECT * FROM employee;
```

Delimited files are ASCII by default.

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Unloading to Informix Data Files

To unload from the **employee** table to a table in Informix® internal format, use statements similar to the following ones:

```
SELECT * FROM employee
WHERE hiredate > "1/1/1996"
INTO EXTERNAL emp_ext
USING (
  FORMAT 'INFORMIX',
  DATAFILES ("DISK:/work2/mydir/emp.dat")
);
```

Because the output files use Informix internal representation, you need to specify the FORMAT 'INFORMIX' option in the USING clause. (The default is delimited-ASCII format.)

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Unloading to a Fixed-Text File

You can unload data from the database into fixed format files.

The following SQL statements unload the **employee** table in fixed text format into the **emp_ext** external table:

```
CREATE EXTERNAL TABLE emp_ext
( name CHAR(18) EXTERNAL CHAR(20),
  hiredate DATE EXTERNAL CHAR(10),
  address VARCHAR(40) EXTERNAL CHAR(40),
  empno INTEGER EXTERNAL CHAR(6) )
USING (
  FORMAT 'FIXED',
  DATAFILES ("DISK:/work2/mydir/emp.fix")
);
INSERT INTO emp_ext SELECT * FROM employee;
```

These statements create a fixed-text file with 20 character positions in the first field, the next 10 character positions in the second field, and so on. Because you are choosing the rows with a SELECT statement, you can format the SELECT list in any way that you want.

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Adding an End-of-Line Character to a Fixed Text File

You can add an end-of-line character to each line of a fixed-text file to use the file for other applications.

If you are writing text in a fixed-text format, separate lines for each record are helpful. An end-of-line character makes the data more legible and clear. If you use delimited format defaults, an end-of-line character is automatic. However, for fixed-format unloads, you need to add an end-of-line character to your records. For example, consider a table with the following schema:

```
TABLE sample (
  lastname CHAR(10),
  firstname CHAR(10),
  dateofbirth DATE);
```

This table contains the following values:

Adams	Sam	10-02-1957
Smith	John	01-01-1920

Next, consider an external table with the following schema:

```
CREATE EXTERNAL TABLE sample_ext (
  lastname CHAR(10) EXTERNAL CHAR(10),
  firstname CHAR(10) EXTERNAL CHAR(10),
  dateofbirth DATE EXTERNAL CHAR(12));
```

Unloading **sample_ext** without an end-of-line character produces the following output:

Adams Sam 10-02-1957 Smith John 01-01-1920

You can add end-of-line characters by using a program or script, or by adding a newline field in a SELECT statement.

- [Using a Program or Script](#)
To add an end-of-line character, you can write the fixed-length records to a data file and then modify the data file with a program or script.
- [Adding a Newline Field in a SELECT Statement](#)
You can use an external table to load the newline character in your internal table.

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Using a Program or Script

To add an end-of-line character, you can write the fixed-length records to a data file and then modify the data file with a program or script.

For example, you could use a C program to find the length of each record, locate the end of a line, and then add an end-of-line character.

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Adding a Newline Field in a SELECT Statement

You can use an external table to load the newline character in your internal table.

To add an end-of-line character, select a final value from a table that contains a newline character, as in the following example:

1. Create a file that contains only a newline character.

```
echo "" > /tmp/cr.fixed
```
2. Create an internal table to store this newline value to use when you unload the data.

```
CREATE TABLE dummyCr (cr CHAR(1));
```

3. Create the external table to load the newline value.

```
CREATE EXTERNAL TABLE x_cr (cr CHAR(1) EXTERNAL CHAR(1))  
USING (DATAFILES ('DISK:/tmp/cr.fixed'), FORMAT 'FIXED');
```

4. Load the external table in the internal **dummyCr** table.

```
INSERT INTO dummyCr SELECT * FROM x_cr;
```

The internal table, **dummyCr**, now contains an end-of-line character that you can use to unload in a SELECT statement:

1. To unload data from your internal table to an external table, create the external table with the end-of-line character as an EXTERNAL CHAR.

```
CREATE EXTERNAL TABLE sample_ext  
(  
  lastname CHAR(10) EXTERNAL CHAR(10),  
  firstname CHAR(10) EXTERNAL CHAR(10),  
  dateofbirth DATE EXTERNAL CHAR(12),  
  eol CHAR(1) EXTERNAL CHAR(1))  
USING (DATAFILES ...), FORMAT 'FIXED');
```

2. Select from the internal table and the **dummyCr** table to create an output file that has rows separated by end-of-line characters.

```
INSERT INTO sample_ext(lastname, firstname, dateofbirth, eol)  
SELECT a.lastname, a.firstname, a.dateofbirth, b.cr  
FROM mytable a, dummyCr b;
```

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Restrictions on External Tables

Certain operations on external tables are not supported or have limited scope.

[Table 1](#) compares table operations that are supported for database tables and external tables.

Table 1. Database Tables and External Tables

Table Operation	Database Table	External Table
-----------------	----------------	----------------

Table Operation	Database Table	External Table
Support for indexes and: <ul style="list-style-type: none"> Primary keys Foreign keys Unique and non-unique indexes Index scans Automatic index (autoindex) during query execution Index join 	Yes	No, sequential scans are used.
Triggers are supported	Yes	No
Table can be a target in a MERGE statement	Yes	No. Not allowed as target but allowed as source. See MERGE Example
Table fragmentation is supported	Yes	No
Multiple database tables are allowed in the FROM clause	Yes	No. See Query Example
DB-Access LOAD FROM ... INSERT INTO statement is supported	Yes	No
The TRUNCATE TABLE statement truncates a table	Yes	No. Data in external tables is not truncated using the TRUNCATE statement. Unloading data from a database table to an external table automatically truncates the external table.
Table data is replicated	Yes	No
The UPDATE STATISTICS statement is supported	Yes	No
UPDATE and DELETE statements are supported	Yes	No
The ALTER TABLE statement is supported	Yes	No
LBAC is supported	Yes	No
Compression is supported	Yes	No
START and STOP VIOLATIONS statements supported	Yes	No
TEMP tables are supported	Yes	No
The EXTERNAL data type is supported for table columns	No	Yes
DEFAULT clause is supported	Yes	No
PUT clause is supported for BLOB and CLOB types	Yes	No. BLOBDIR and CLOBDIR can be specified using the DATAFILES clause.
SERIAL, SERIAL8, and BIGSERIAL data types generate serial numbers	Yes	No. These data types are converted to equivalent integer types and no serial value is generated.
Table can be replicated using Enterprise replication (ER)	Yes	No
Changes to tables are logged and can be replicated	Yes	No. External tables are not logged and cannot be replicated; however system catalogs are replicated.
ACID (atomicity, consistency, isolation, durability) properties are supported	Yes	No
ETL (extract, transform, load) is supported	SQL interface for ETL operations is not supported; however, utilities such as HPL, dbload, onload, onunload and LOAD, UNLOAD statements are supported.	Supported using a simple SQL interface using the INSERT ... SELECT statement for high performance loading and unloading of data.

Certain high-availability cluster operations are not supported (see *External Tables in High-Availability Cluster Environments* in the *IBM® Informix® Administrator's Guide*).

To load BLOB or CLOB objects from an external table, you must create a temporary sbspace and create temporary smart large objects in that space to store the BLOB or CLOB data from the external table. Loading BLOB or CLOB data from a read-only secondary server is not supported, because you cannot create a

temporary smart large object on a read-only secondary server.

MERGE Example

An external table cannot be the target of the MERGE statement. For example, if **ext** is an external table, the following MERGE statement is valid with **ext** as the source table:

```
MERGE INTO t1
  USING ext ON t1.c1 = ext.c1
  WHEN MATCHED THEN UPDATE
  SET t1.c2 = ext.c2
  WHEN NOT MATCHED THEN INSERT VALUES (99, '999');
```

The following statement, however, fails with **ext** as the target table:

```
MERGE INTO ext
  USING t1 ON ext.c1 = t1.c1
  WHEN MATCHED THEN UPDATE
  SET ext.c2 = t1.c2
  WHEN NOT MATCHED THEN INSERT VALUES (99, '999');
```

Query Example

Only the outermost query can have an external table reference. Only one external table can be specified in any query. For example, the following statement is allowed:

```
SELECT * FROM ext, t2 WHERE ext.c1 = t2.c1;
```

However, the following statements are not allowed:

- Multiple external tables cannot be specified within a query:

```
SELECT * FROM ext, ext3 WHERE ext.c1 = ext3.c1;
```

- An external table cannot be used in a subquery:

```
SELECT * FROM t1 WHERE t1.c1 IN (SELECT c1 FROM ext);
```

Related information:

[External tables in high-availability cluster environments](#)

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CREATE FUNCTION statement

Use the CREATE FUNCTION statement to create a user-defined function, to register an external function, or to write and register an SPL function.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-CREATE----->
| (1) | | (2) |
|'-OR REPLACE---' |'-DBA-----'
|
>--FUNCTION-----function(-----+----->
|'-IF NOT EXISTS-' | (3) |
|'-| Routine Parameter List |-----'

>--FUNCTION-----function(-----+----->
|'-IF NOT EXISTS-' | (3) |
|'-| Routine Parameter List |-----'

>-----+----->
| (4) |
|'-| REFERENCING Clause |-----FOR +-----+-----table_object-'
|'-|-----owner--'-'-'

(5)
>--| Return Clause |-----+----->
| (6) |
|'-SPECIFIC--| Specific Name |-----'

>-----+----->
| .,-----, | '-;--'
| V (7) |
|'-WITH(---| Routine Modifier |-----+-----'

(8) (9)
>-----+-----END FUNCTION-->
| (10) (11) |
```

```
'-----| External Routine Reference |-----'
>+-----+
|          v          (12) |
'-DOCUMENT---| Quoted String |-----+'
>+-----+
'-WITH LISTING IN 'pathname'-'
```

Note:

1. See [OR REPLACE Clause](#)
2. See [DBA Keyword and Privileges on the Procedure](#)
3. Stored Procedure Language only
4. See [Routine Parameter List](#)
5. See [The REFERENCING and FOR Clauses](#)
6. See [Return Clause](#)
7. See [Specific Name](#)
8. See [Routine modifier](#)
9. See [Statement Block](#)
10. External routines only
11. See [External Routine Reference](#)
12. See [Quoted String](#)

Element	Description	Restrictions	Syntax
<i>function</i>	Name of new function that is defined here	You must have the appropriate language privileges. See GRANT statement and Overloading the Name of a Function .	Identifier
<i>owner</i>	Owner of <i>table_object</i>	Must own <i>table_object</i>	Owner name
<i>pathname</i>	Pathname to a file in which compile-time warnings are stored	The specified pathname must exist on the computer where the database resides	The path and filename must conform to your operating-system rules.
<i>table_object</i>	Name or synonym of the table or view whose triggers can call <i>function</i>	Must exist in the local database	Identifier

Tip: If you are trying to create a function from text of source code that is in a separate file, use the CREATE FUNCTION FROM statement.

Usage

IBM® Informix® supports user-defined functions written in these languages:

- The IBM Informix stored procedure language (SPL).
- One of the external languages (C or Java™) that supports (*external functions*).

When the IFX_EXTEND_ROLE configuration parameter is set to ON, only users to whom the DBSA grants the built-in EXTEND role can create external functions. Additional requirements for using the CREATE FUNCTION statement are identified in the topic [Privileges necessary for using CREATE FUNCTION](#).

How many values a function can return is language-dependent. Functions written in SPL can return one or more values. External functions written in the C or Java languages must return exactly one value. But a C function can return a collection type, and external functions in queries can return additional values indirectly from OUT parameters (and for the SPL and Java languages, from INOUT parameters) that can process as statement-local variables (SLVs).

Return values from OUT and INOUT parameters of an SPL function can be processed as SLVs. You can also use local variables or parameters of an SPL routine to retrieve values from SPL or C routines that have OUT or INOUT parameters.

For information about how this document uses the terms UDR, function, and procedure, as well as recommended usage, see [Relationship Between Routines, Functions, and Procedures](#) and [Using CREATE PROCEDURE Versus CREATE FUNCTION](#).

In ESQ/C, you can use a CREATE FUNCTION statement only within a PREPARE statement. If you want to create a user-defined function for which the text is known at compile time, you must put the text in a file and specify this file with the CREATE FUNCTION FROM statement.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if a function of the specified name is already registered in the current database. (Because the identifier of a function can be overloaded, it might be unnecessary to include these keywords, if the database server can resolve the argument list of the new function as different from that of any other function of the same name in the current database.)

Functions use the collating order that was in effect when they were created. See [SET COLLATION statement](#) for information about using non default collation.

- [Privileges necessary for using CREATE FUNCTION](#)
You must hold the Resource privilege or the DBA privilege on a database to create a function within that database.
- [DBA keyword and Execute privilege on the created function](#)
If you create a UDR with the DBA keyword, it is known as a DBA-privileged UDR. You need the DBA privilege to create a DBA-privileged UDR. If you omit the DBA keyword, the UDR is known as an owner-privileged UDR. Other users who have Execute privilege on the UDR run the UDR with the privileges of the user who created the UDR.
- [OR REPLACE Clause](#)
The OR REPLACE clause is used to update an existing function without changing any object privileges granted on it.
- [The REFERENCING and FOR Clauses](#)
The REFERENCING clause can declare correlation names for the original value and for the updated value in columns of the *table_object* that the FOR clause specifies.

- [Overloading the Name of a Function](#)
- [DOCUMENT Clause](#)
- [WITH LISTING IN Clause](#)
- [SPL Functions](#)
- [External Functions](#)

Related concepts:

[INSTEAD OF Triggers on Views](#)

Related reference:

[CREATE CAST statement](#)

[CREATE ROUTINE FROM statement](#)

[CREATE OPAQUE TYPE statement](#)

[DROP FUNCTION statement](#)

[CREATE PROCEDURE statement](#)

[EXECUTE FUNCTION statement](#)

[CREATE AGGREGATE statement](#)

[EXECUTE PROCEDURE statement](#)

[DROP ROUTINE statement](#)

[ALTER ROUTINE statement](#)

[Arguments](#)

[CREATE OPCLASS statement](#)

[ALTER FUNCTION statement](#)

[CREATE DISTINCT TYPE statement](#)

[CREATE FUNCTION FROM statement](#)

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Privileges necessary for using CREATE FUNCTION

You must hold the Resource privilege or the DBA privilege on a database to create a function within that database.

Before you can create a function, you must also hold the Usage privilege on the programming language in which the function is written. The GRANT USAGE ON LANGUAGE statement can specify the SPL, C, or Java™ language when it grants a language-level privilege to a user or to a role. For more information, see [Language-Level Privileges](#).

By default, Usage privilege on SPL is granted to PUBLIC.

To register functions in the C or Java external programming languages, you must also hold the built-in EXTEND role, unless the IFX_EXTEND_ROLE configuration parameter is set to 0 or to OFF.

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DBA keyword and Execute privilege on the created function

If you create a UDR with the DBA keyword, it is known as a DBA-privileged UDR. You need the DBA privilege to create a DBA-privileged UDR. If you omit the DBA keyword, the UDR is known as an owner-privileged UDR. Other users who have Execute privilege on the UDR run the UDR with the privileges of the user who created the UDR.

DBA-privileged UDRs

For a DBA-privileged UDR, users who do not hold the DBA privilege can run the routine under the following conditions:

- The DBA grants the user Execute privilege on the UDR.
- The DBA grants the Execute privilege to PUBLIC so that all users can run the UDR.

When you have Execute privilege on a DBA-privileged UDR, you run the UDR with DBA privileges.

For additional information about DBA-privileged UDRs, see [Ownership of Created Database Objects](#).

Owner-privileged UDRs

In an ANSI-compliant database, before other users can execute an owner-privileged UDR, the owner must grant the Execute privilege, either to individual users, or to roles, or to PUBLIC.

In a database that is not ANSI compliant, any user can run the UDR because PUBLIC is granted the Execute privilege by default. To restrict access to an owner-privileged UDR to specific users, the owner must revoke the Execute privilege on the UDR from PUBLIC, and then grant it to specified users or roles. However, you can prevent privileges on UDRs from being granted to PUBLIC by default, by setting the NODEFDAC environment variable to yes. Then the owner must grant the Execute privilege for the UDR to other users.

For an owner-privileged UDR, all non-qualified database objects that the UDR references are implicitly qualified by the name of the UDR owner. To allow other users to run the UDR, the owner of the UDR must be granted the necessary privileges on any underlying database objects with the WITH GRANT OPTION keyword in the GRANT statement.

The privileges of the owner determine who can run an owner-privileged UDR:

- If the owner does not have privileges on all of the objects that are referenced by the UDR, then the UDR fails regardless of whether the owner or another user runs it.
- If the owner has privileges on all referenced objects, but does not have the GRANT option, then only the owner can run the UDR. Other users cannot run the UDR, even if they have Execute privilege on the UDR.
- If the owner has privileges with the GRANT option on all referenced objects, then the owner and other users who have the Execute privilege can run the UDR. Other users who have Execute privilege run the UDR with the owner's privileges.

If an external C or Java™ language function has a negator function, you must grant the Execute privilege on both the external function and on its negator function before users can execute the external function.

Related reference:

[WITH GRANT OPTION keywords](#)

Related information:

[NODEFDAC environment variable](#)

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OR REPLACE Clause

The OR REPLACE clause is used to update an existing function without changing any object privileges granted on it.

Example

```
create function testfunc() returning char(50);
  return "this is the original function";
end function;
Routine created.

execute function testfunc();

(expression)

this is the original function

1 row(s) retrieved.

create function testfunc() returning char(50);
  return "this is the replaced function";
end function;

673: Another routine (testfunc) with same signature already exists in database

create or replace function testfunc() returning char(50);
  return "this is the replaced function";
end function;
Routine created.

execute function testfunc();

(expression)

this is the replaced function

1 row(s) retrieved.
```

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The REFERENCING and FOR Clauses

The REFERENCING clause can declare correlation names for the original value and for the updated value in columns of the *table_object* that the FOR clause specifies.

REFERENCING and FOR Clauses

```

      .-----
      V      (1)      |
|--REFERENCING-----+-----OLD-----+-----+correlation+----->
      |      (1)      |      '-AS-'
      '-----NEW-'

>--FOR +-----+-----table_object-----+-----+
      '-owner--'-'
```

Notes:

1. Use path no more than once

Element	Description	Restrictions	Syntax
<i>correlation</i>	Name that you declare here to qualify an old or new column value (as <i>correlation.column</i>) in a trigger routine	Must not be <i>table_object</i>	Identifier
<i>owner</i>	Owner of <i>table_object</i>	Must own <i>table_object</i>	Owner name
<i>table_object</i>	Name or synonym of a table or view whose triggers can call <i>function</i>	Must exist in the local database	Identifier

If you include the REFERENCING and FOR *table_object* clauses immediately after the parameter list of the CREATE FUNCTION statement, the function that you create is known as a *trigger function* (or *trigger UDR* or *trigger routine*). The FOR clause specifies the table or view whose triggers can invoke the function from the FOR EACH ROW section of their Triggered Action list.

In the REFERENCING clause, the OLD *correlation* specifies a prefix by which the trigger routine can reference the value that a column of *table_object* had before the trigger routine modifies that column value. The NEW *correlation* specifies a prefix for referencing the new value that the trigger routine assigns to the column. Whether the trigger routine can use correlation names to reference the OLD column value, the NEW column value, or both values depends on the type of triggering event:

- A trigger routine invoked by an Insert trigger can reference only the NEW correlation name.
- A trigger routine invoked by a Delete trigger or by a Select trigger can reference only the OLD correlation name.
- A trigger routine invoked by an Update trigger can reference both the OLD and the NEW correlation names.

For information about how to use the *correlation.column* notation in triggered actions, see [REFERENCING Clauses](#).

Besides the general requirements for any Informix® UDR that is written in the SPL language, trigger routines can support certain additional syntax features, and are subject to certain restrictions, that are not features (or that are not restrictions) for ordinary UDRs that are not trigger routines:

- A trigger routine must include the FOR *table_object* clause that specifies the name of the table or view in the local database whose triggers can invoke this routine.
- A trigger routine can also include the REFERENCING clause to declare correlation names for OLD and NEW values that SPL statements in the UDR can reference.
- Trigger routines can be invoked only in the FOR EACH ROW section of the Triggered Action list in the trigger definition.
- Correlated variables for OLD or NEW values can appear in the IF statement of SPL and in CASE expressions.
- Correlated variables for OLD values cannot be on the left-hand side of a LET expression.
- Correlated variables for NEW values cannot be on the left-hand side of a LET expression if the FOR clause specifies a view whose INSTEAD OF trigger action list invokes the trigger routine.
- Only correlated variables for NEW values can be on the left-hand side of a LET expression that references correlated variables. In this case, however, the FOR clause must specify a table, rather than a view.
- Both OLD and NEW values can be on the right-hand side of a LET expression.
- The Boolean operators SELECTING, INSERTING, DELETING, and UPDATING are valid in trigger routines (and only in trigger routines and in other UDRs that are invoked in triggered action statements) in contexts where Boolean expressions are valid. These operators return TRUE ('t') if the triggering event matches the DML operation referenced by the name of the operator, and they return FALSE ('f') otherwise.
- If a single triggering event activates multiple triggers on the same table or view, then all of the BEFORE actions take place before any of the FOR EACH ROW actions, and all of the AFTER actions follow the FOR EACH ROW actions. The order of execution of different triggers on the same event is not guaranteed.
- Trigger routines must be written in the SPL language. They cannot be written in an external language, like the C or Java™ language, but they can include calls to external language routines, such as the **mi_trigger** application programming interface for trigger introspection.
- Trigger functions cannot reference savepoints. Any changes to the data values or to the schema of the database by a triggered action must be committed or rolled back in their entirety. Informix does not support the partial rollback of triggered actions.

For more information about the **mi_trigger** API, refer to the *IBM® Informix DataBlade API Programmer's Guide* and to the *IBM Informix DataBlade API Function Reference*.

If you include the REFERENCING clause but omit the FOR clause, or if you include the FOR clause but omit the REFERENCING clause, the CREATE FUNCTION statement fails with an error.

If you omit the REFERENCING and FOR clauses, the UDR cannot use the SELECTING, INSERTING, DELETING, and UPDATING operators, and cannot declare variables that can represent and manipulate column values in triggered actions on the table or view that the trigger definition specifies.

See the [REFERENCING Clauses](#) section in the CREATE TRIGGER statement description for the syntax of the REFERENCING clause for Delete, Insert, Select, and Update triggers.

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Overloading the Name of a Function

Because Informix® supports *routine overloading*, you can define more than one function with the same name, but different parameter lists. You might want to overload functions in the following situations:

- You create a user-defined function with the same name as a built-in function (such as **equal()**) to process a new user-defined data type.
- You create *type hierarchies*, in which subtypes inherit data representation and functions from supertypes.
- You create *distinct types*, which are data types that have the same internal storage representation as an existing data type, but have different names and cannot be compared to the source type without casting. Distinct types inherit support functions from their source types.

For a brief description of the routine signature that uniquely identifies each user-defined function, see [Routine Overloading and Routine Signatures](#).

Examples

Overloaded functions are uniquely identified by the name and the input parameter list. Instead of providing a long unique identifier, it is possible to provide specific name and use it later. The following example illustrates an overloaded function, whose identifier is **getArea**, that has the specific names **getSquareArea** and **getRectangleArea**:

```
CREATE FUNCTION getArea
(i INT DEFAULT 0)
RETURNING INT SPECIFIC getSquareArea;
DEFINE j INT;
LET j = i * i;
RETURN j;
END FUNCTION;

CREATE FUNCTION getArea
(i INT DEFAULT 0, j INT DEFAULT 0)
RETURNING INT SPECIFIC getRectangleArea;
DEFINE k INT;
LET k = i * j;
RETURN k;
END FUNCTION;
```

Now you can use the specific name, as in the following example:

```
GRANT EXECUTE ON SPECIFIC FUNCTION getSquareArea TO informix;
GRANT EXECUTE ON SPECIFIC FUNCTION getRectangleArea TO informix;
```

Without the specific name, you would need to issue the following:

```
GRANT EXECUTE ON FUNCTION getArea (INTEGER) TO informix;
GRANT EXECUTE ON FUNCTION getArea (INTEGER,INTEGER) TO informix;
```

- [Using the SPECIFIC Clause to Specify a Specific Name](#)

Related concepts:

[SPL statements](#)

Related reference:

[ALTER FUNCTION statement](#)

[ALTER ROUTINE statement](#)

[CREATE PROCEDURE statement](#)

[CREATE FUNCTION FROM statement](#)

[DROP FUNCTION statement](#)

[DROP ROUTINE statement](#)

[GRANT statement](#)

[EXECUTE FUNCTION statement](#)

[PREPARE statement](#)

[REVOKE statement](#)

[UPDATE STATISTICS statement](#)

Related information:

[Create and use SPL routines](#)

[Create an external-language routine](#)

[Develop a user-defined routine](#)

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Using the SPECIFIC Clause to Specify a Specific Name

You can declare a specific name, unique to the database, for a user-defined function. A specific name is useful when you are overloading a function.

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DOCUMENT Clause

The quoted string in the DOCUMENT clause provides a synopsis and description of the UDR. The string is stored in the **sysprocbody** system catalog table and is intended for the user of the UDR. Anyone with access to the database can query the **sysprocbody** system catalog table to obtain a description of one or all of the UDRs stored in the database.

For example, the following query obtains a description of the SPL function **update_by_pct**, that [SPL Functions](#) shows:

```
SELECT data FROM sysprocbody b, sysprocedures p
WHERE b.procid = p.procid
--join between the two catalog tables
AND p.procname = 'update_by_pct'
-- look for procedure named update_by_pct
AND b.datakey = 'D'-- want user document;
```

The preceding query returns the following text:

```
USAGE: Update a price by a percentage
Enter an integer percentage from 1 - 100
```

and a part id number

A UDR or application program can query the system catalog tables to fetch the DOCUMENT clause and display it for a user.

For C and Java™ language functions, you can include a DOCUMENT clause at the end of the CREATE FUNCTION statement, whether or not you use the END FUNCTION keywords.

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WITH LISTING IN Clause

The WITH LISTING IN clause specifies a filename where compile time warnings are sent. After you compile a UDR, this file holds one or more warning messages.

If you do not use the WITH LISTING IN clause, the compiler does not generate a list of warnings.

On UNIX platforms, if you specify a filename but not a directory, this listing file is created in your home directory on the computer where the database resides. If you do not have a home directory on this computer, the file is created in the root directory (the directory named “/”).

On Windows systems, if you specify a filename but not a directory, this listing file is created in your current working directory if the database is on the local computer. Otherwise, the default directory is %INFORMIXDIR%\bin.

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SPL Functions

SPL functions are UDRs written in SPL that return one or more values. To write and register an SPL function, use a CREATE FUNCTION statement. Embed appropriate SQL and SPL statements between the CREATE FUNCTION and END FUNCTION keywords. You can also follow the function with the DOCUMENT and WITH FILE IN options.

SPL functions are parsed, optimized (as far as possible), and stored in the system catalog tables in executable format. The body of an SPL function is stored in the **sysprocbody** system catalog table. Other information about the function is stored in other system catalog tables, including **sysprocedures**, **sysprocplan**, and **sysprocauth**. For more information about these system catalog tables, see the *IBM® Informix® Guide to SQL: Reference*.

The END FUNCTION keywords are required in every SPL function, and a semicolon (;) must follow the clause that immediately precedes the statement block. The following code example creates an SPL function:

```
CREATE FUNCTION update_by_pct ( pct INT, pid CHAR(10))
RETURNING INT;
UPDATE inventory SET price = price + price * (pct/100)
WHERE part_id = pid;
return (select price from inventory where part_id = pid);
END FUNCTION
DOCUMENT "USAGE: Update a price by a percentage",
"Enter an integer percentage from 1 - 100",
"and a part id number"
WITH LISTING IN '/tmp/warn_file';
```

For more information on how to write SPL functions, see the chapter about SPL routines in *IBM Informix Guide to SQL: Tutorial*.

See also the section [Transactions in SPL Routines](#).

You can include valid SQL or SPL language statements in SPL functions. See, however, the following sections in [Other syntax segments](#) that describe restrictions on SQL and SPL statements within SPL routines: [Subset of SPL Statements Valid in the Statement Block](#); [SQL Statements Valid in SPL Statement Blocks](#); and [Restrictions on SPL Routines in Data-Manipulation Statements](#).

Related information:

[System catalog tables](#)

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External Functions

External functions are functions you write in an external language (that is, a programming language other than SPL) that Informix® supports.

To create a C user-defined function

1. Write the C function.
2. Compile the function and store the compiled code in a shared library (the shared-object file for C).
3. Register the function in the database server with the CREATE FUNCTION statement.

To create a user-defined function written in the Java™ language

1. Write a Java static method, which can use the JDBC functions to interact with the database server.
2. Compile the Java source file and create a .jar file (the shared-object file for Java).

3. Execute the **install_jar()** procedure with the EXECUTE PROCEDURE statement to install the JAR file in the current database.
4. If the UDR uses user-defined data types, create a map between SQL data types and Java classes. Use the **setUDTextName()** procedure that is explained in [EXECUTE PROCEDURE statement](#).
5. Register the UDR with the CREATE FUNCTION statement.

Rather than storing the body of an external routine directly in the database, the database server stores only the pathname of the shared-object file that contains the compiled version of the routine. When it executes the external routine, the database server invokes the external object code.

The database server stores information about an external function in system catalog tables, including **sysprocbody** and **sysprocauth**. For more information on the system catalog, see the *IBM® Informix Guide to SQL: Reference*.

- [Example of Registering a C User-Defined Function](#)
- [Example of Registering a UDR Written in the Java Language](#)
- [Ownership of Created Database Objects](#)

Related information:

[System catalog tables](#)

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Example of Registering a C User-Defined Function

The following example registers an external C user-defined function named **equal()** in the database. This function takes two arguments of the type **basetype1** and returns a single Boolean value. The external routine reference name specifies the path to the C shared library where the function object code is actually stored. This library contains a C function **basetype1_equal()**, which is invoked during execution of the **equal()** function.

```
CREATE FUNCTION equal ( arg1 basetype1, arg2 basetype1)
  RETURNING BOOLEAN;
  EXTERNAL NAME
    "/usr/lib/basetype1/lib/libbtype1.so(basetype1_equal)"
  LANGUAGE C
END FUNCTION;
```

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Example of Registering a UDR Written in the Java Language

The following CREATE FUNCTION statement registers the user-defined function, **sql_explosive_reaction()**. This function is discussed in [sqlj.install_jar](#).

```
CREATE FUNCTION sql_explosive_reaction(INT) RETURNS INT WITH (class="jvp")
  EXTERNAL NAME "course_jar:Chemistry.explosiveReaction" LANGUAGE JAVA;
```

This function returns a single INTEGER value. The EXTERNAL NAME clause specifies that the Java™ implementation of the **sql_explosive_reaction()** function is a method called **explosiveReaction()**, which resides in the **Chemistry** Java class that resides in the **course_jar** JAR file.

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Ownership of Created Database Objects

The user who creates an owner-privileged UDR, rather than the user who executes the UDR, owns any database objects that are created by the UDR when the UDR is executed, unless another owner is specified for the created object.

For example, assume that user **mike** creates this user-defined function:

```
CREATE FUNCTION func1 () RETURNING INT;
  CREATE TABLE tab1 (colx INT);
  RETURN 1;
END FUNCTION;
```

If user **joan** now executes function **func1**, user **mike**, not user **joan**, is the owner of the newly created table **tab1**.

In the case of a DBA-privileged UDR, however, the user who executes a UDR (rather than the UDR owner) owns any database objects created by the UDR, unless another owner is specified for the database object within the UDR.

For example, assume that user **mike** creates this user-defined function:

```
CREATE DBA FUNCTION func2 () RETURNING INT;
  CREATE TABLE tab2 (coly INT);
  RETURN 1;
END FUNCTION;
```

If user **joan** now executes function **func2**, user **joan**, not user **mike**, is the owner of the newly created table **tab2**.

See also the section [Support for roles and user identity](#).

CREATE FUNCTION FROM statement

Use the CREATE FUNCTION FROM statement to access a user-defined function whose CREATE FUNCTION statement resides in a separate file.

This statement is an extension to the ANSI/ISO standard for SQL. Use this statement with ESQL/C.

Syntax

```
>>-CREATE FUNCTION FROM--+-+-----+---+-'file'-----+-----><
      '-IF NOT EXISTS-'  '-file_var-'
```

Element	Description	Restrictions	Syntax
<i>file</i>	Path and filename of a file that contains the full CREATE FUNCTION statement text. Default pathname is current directory.	Must exist and contain exactly one CREATE FUNCTION statement	Must conform to operating-system rules.
<i>file_var</i>	Variable storing value of <i>file</i>	Same as for <i>file</i>	Language specific

Usage

Functions written in the C or Java™ language are called *external* functions. When the IFX_EXTEND_ROLE configuration parameter is set to ON, only users who have been granted the built-in EXTEND role can create external functions.

Informix® ESQL/C programs cannot directly create user-defined functions. That is, they cannot contain the CREATE FUNCTION statement.

To create these functions within Informix ESQL/C programs:

1. Create a source file with the CREATE FUNCTION statement.
2. Use the CREATE FUNCTION FROM statement to send the contents of this source file to the database server for execution.
The file that you specify in the *file* parameter can contain only one CREATE FUNCTION statement.

For example, suppose that the following CREATE FUNCTION statement is in a separate file, called **del_ord.sql**:

```
CREATE FUNCTION delete_order( p_order_num INT) RETURNING INT, INT;
  DEFINE item_count INT;
  SELECT count(*) INTO item_count FROM items
    WHERE order_num = p_order_num;
  DELETE FROM orders WHERE order_num = p_order_num;
  RETURN p_order_num, item_count;
END FUNCTION;
```

In the Informix ESQL/C program, you can access the **delete_order()** SPL function with the following CREATE FUNCTION FROM statement:

```
EXEC SQL create function from 'del_ord.sql';
```

If you are not sure whether the UDR in the file is a user-defined function or a user-defined procedure, use the CREATE ROUTINE FROM statement.

The filename that you provide is relative. If you provide a simple filename with no pathname (as in the preceding example), the client application looks for the file in the current directory.

Important: The Informix ESQL/C preprocessor does not process the contents of the file that you specify. It only sends the contents to the database server for execution. Therefore, there is no syntactic check that the file that you specify in CREATE FUNCTION FROM actually contains a CREATE FUNCTION statement. To improve readability of the code, however, it is recommended that you match these two statements.

Related concepts:

[Overloading the Name of a Function](#)

Related reference:

[CREATE ROUTINE FROM statement](#)

[DROP FUNCTION statement](#)

[CREATE PROCEDURE statement](#)

[EXECUTE FUNCTION statement](#)

[CREATE PROCEDURE FROM statement](#)

[Arguments](#)

[CREATE FUNCTION statement](#)

CREATE INDEX statement

Use the CREATE INDEX statement to create an index for one or more columns in a table, or on values returned by a UDR that uses column values as arguments.

This statement is an extension to the ANSI/ISO standard for SQL.

```

(1)
>>-CREATE--| Index-Type Options |----->
>--INDEX--|-----|index--ON--|table--|----->
        '-IF NOT EXISTS-'          '-synonym-'

(2)
>--| Index-Key Specs |-----| Index Options |-----><
Index Options

|-----|
|         (3) |
| -| USING Access-Method Clause |-----'

>--|-----|
|         (4) | |         (5) |
| -| FILLFACTOR Option |-----' -| Storage Options |-----'

>--|-----|
|         (6) | |         (7) |
| -| Index Modes |-----' -| HASH ON Clause-----'

>--|-----|
|         (8) | |         (9) |
| -| ONLINE-----' -| COMPRESSED-----'

>--|-----|
|         (10) |
| -| Extent Size Options |-----'

```

Notes:

1. See [Index-type options](#)
2. See [Index-key specification](#)
3. See [USING access-method clause](#)
4. See [FILLFACTOR Option](#)
5. See [Storage options](#)
6. See [Index modes](#)
7. See [HASH ON clause](#)
8. See [The ONLINE keyword of CREATE INDEX](#)
9. See [COMPRESSED option for indexes](#)
10. See [Extent Size Options](#)

Element	Description	Restrictions	Syntax
<i>index</i>	The name declared here for a new index.	The name must be unique among names of indexes in the database.	Identifier
<i>synonym, table</i>	The name or synonym of a standard or temporary <i>table</i> to be indexed	The synonym and its table must exist in the current database. Note: BTS index on temp table is not supported.	Identifier

Usage

When you issue the CREATE INDEX statement, the table is locked in exclusive mode. If another process is using the table, CREATE INDEX returns an error. (For an exception, however, see [The ONLINE keyword of CREATE INDEX](#).)

If the index is on a column that stores encrypted data, the database server cannot use the index.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if an index of the specified name is already defined on the specified table in the current database.

Indexes use the collation that was in effect when CREATE INDEX executed.

A *secondary-access method* (sometimes referred to as an *index-access method*) is a set of database server functions that build, access, and manipulate an index structure such as a B-tree, R-tree, or an index structure that a DataBlade module provides, in order to speed up the retrieval of data.

Neither *synonym* nor *table* can refer to a virtual table or to a table object that the CREATE EXTERNAL TABLE statement defined.

You cannot directly base a functional index on a built-in function, but you can create an SPL wrapper that calls and returns a value from a built-in function. The arguments to a user-defined function that defines a functional index cannot be the values from a column of a collection data type.

The following statistics are generated automatically by the CREATE INDEX statement, with or without the ONLINE keyword:

- Index-level statistics, equivalent to the statistics gathered in the UPDATE STATISTICS operation in LOW mode for B-tree indexes.
- Column-distribution statistics, equivalent to the distribution generated in the UPDATE STATISTICS operation in HIGH mode, for a non-opaque leading indexed column of an ordinary B-tree index.

- [Index-type options](#)
Use the DISTINCT or UNIQUE and CLUSTER options of the CREATE INDEX statement to specify the characteristics of the index.
- [Index-key specification](#)
Use the Index-key specification of the CREATE INDEX statement to define the key value for the index. This can also specify the ascending or descending sort order, and the operator class.
- [Creating Composite Indexes](#)
- [Using the ASC and DESC Sort-Order Options](#)
- [USING access-method clause](#)
The USING clause specifies the secondary-access method for the new index.
- [HASH ON clause](#)
Use the HASH ON clause of the CREATE INDEX statement to specify the columns and number of subtrees (buckets) for a forest of trees index.
- [FILLFACTOR Option](#)
Use the FILLFACTOR option to specify the degree of index-page fullness when you want to create compacted indexes or provide information for the expansion of an index at a later date.
- [Storage options](#)
The storage options specify the distribution scheme of an index. You can use the IN clause to specify a storage space for the entire index, or you can use the FRAGMENT BY clause to fragment the index across multiple storage spaces.
- [COMPRESSED option for indexes](#)
Use the COMPRESSED keyword of the CREATE INDEX statement to compress the B-tree index if the index has 2000 or more keys.
- [Extent Size Options](#)
- [IN Clause](#)
- [FRAGMENT BY Clause for Indexes](#)
Use the FRAGMENT BY clause to create a detached index and to define its fragmentation strategy across dbspaces or partitions.
- [Index modes](#)
Use the index mode options of the CREATE INDEX statement to specify the behavior of the index during INSERT, DELETE, MERGE, and UPDATE operations.
- [How the Database Server Treats Disabled Indexes](#)
- [The ONLINE keyword of CREATE INDEX](#)
The DBA can reduce the risk of nonexclusive access errors, and can increase the availability of the indexed table, by including the ONLINE keyword as the last specification of the CREATE INDEX statement. The ONLINE keyword instructs the database server to create the index while minimizing the duration of an exclusive lock, so that the index can be created while concurrent users are accessing the table.
- [Automatic Calculation of Distribution Statistics](#)

Related reference:

[Modes for constraints and unique indexes](#)

[CREATE TABLE statement](#)

[RENAME INDEX statement](#)

[ALTER FRAGMENT statement](#)

[ALTER INDEX statement](#)

[CREATE OPCLASS statement](#)

[DROP INDEX statement](#)

[SET Database Object Mode statement](#)

[CREATE SCHEMA statement](#)

[START VIOLATIONS TABLE statement](#)

Related information:

[Structure of B-Tree Index Pages](#)

[Structure of R-Tree Index Pages](#)

[Indexes and index performance considerations](#)

[SQL features](#)

[Operator classes](#)

[Collation order in CREATE INDEX](#)

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Index-type options

Use the DISTINCT or UNIQUE and CLUSTER options of the CREATE INDEX statement to specify the characteristics of the index.

Index-Type Options

```
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|
+-DISTINCT-+   '-CLUSTER-'
'-UNIQUE---'
```

DISTINCT

Specifies that the columns on which the index is based accept only unique data.

UNIQUE

Specifies that the columns on which the index is based accept only unique data.

CLUSTER

Reorders the rows of the table in the order that the index designates.

UNIQUE or DISTINCT option usage

If you do not specify the UNIQUE or DISTINCT keyword, the index allows duplicate values in the indexed column or in the set of indexed columns.

A column with a unique index can have, at most, one NULL value.

You cannot specify an R-tree secondary-access method for a UNIQUE index key.

The following example creates a unique index that prevents duplicate values in the **customer_num** column:

```
CREATE UNIQUE INDEX c_num_ix ON customer (customer_num);
```

The DISTINCT and UNIQUE keywords are synonyms, so the following statement has the same effect as the previous example:

```
CREATE DISTINCT INDEX c_num_ix ON customer (customer_num);
```

The index in both examples is maintained in ascending order, which is the default order. The next example defines a unique descending index called **c_num_desc_ix** on the same column:

```
CREATE UNIQUE INDEX c_num_desc_ix ON customer (customer_num DESC);
```

You can also prevent duplicate values in a column or in a set of columns by creating a unique constraint with the CREATE TABLE or ALTER TABLE statement and the ADD CONSTRAINT clause.

In an NLSCASE INSENSITIVE database, indexes on columns of the NCHAR and NVARCHAR data types disregard lettercase differences, so that the database server treats case variants among strings composed of the same sequence of letters as duplicate values. You cannot insert or update a row of table with an NCHAR or NVARCHAR column on which a unique index or a unique constraint is defined, if that column value in the new row differs only by letter case from the value in the same column of any existing row of the same table. For more information about databases with the NLSCASE INSENSITIVE property, see [Duplicate rows in NLSCASE INSENSITIVE databases](#) and [NCHAR and NVARCHAR expressions in case-insensitive databases](#).

CLUSTER option usage

You cannot specify the CLUSTER option and the ONLINE keyword in the same statement. In addition, some secondary-access methods (such as R-tree) do not support clustering. Before you specify CLUSTER for your index, be sure that the index uses an access method that supports clustering.

The CREATE CLUSTER INDEX statement fails if a CLUSTER index already exists on the same table.

```
CREATE CLUSTER INDEX c_clust_ix ON customer (zipcode);
```

This statement creates an index on the **customer** table and physically orders the rows according to their postal code values, in (by default) ascending order.

If the CLUSTER option is specified and fragments exist on the data, values are clustered only within each fragment, and not globally across the entire table.

If the CREATE CLUSTER INDEX statement also includes the COMPRESSED keyword as a storage option, the database server issues error -26950. To create a cluster index that supports compression requires two steps:

- Use the CREATE CLUSTER INDEX statement to define a cluster index with no index compression.
- Call the SQL administration API **task()** or **admin()** function with the 'index compress' argument to compress the existing cluster index.

You cannot use the CLUSTER option on a forest of trees index.

- [How indexes affect primary-key, unique, and referential constraints](#)

The database server creates internal B-tree indexes for primary-key, unique, and referential constraints. If a primary-key, unique, or referential constraint is added after the table is created, any user-created indexes on the constrained columns are used, if appropriate.

Related concepts:

[Differences Between a Unique Constraint and a Unique Index](#)

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How indexes affect primary-key, unique, and referential constraints

The database server creates internal B-tree indexes for primary-key, unique, and referential constraints. If a primary-key, unique, or referential constraint is added after the table is created, any user-created indexes on the constrained columns are used, if appropriate.

An appropriate index is one that indexes the same columns that are used in the primary-key, referential, or unique constraint.

If an appropriate user-created index is not available, the database server creates a nonfragmented internal index on the constrained column or columns.

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Index-key specification

Use the Index-key specification of the CREATE INDEX statement to define the key value for the index. This can also specify the ascending or descending sort order, and the operator class.

This is the syntax of the Index-Key Specification:

Index-Key Specification

Notes:

1. See [Indexing a BSON field](#).

The index-key value can be one or more columns of built-in data types. If you specify multiple columns, the concatenation of values from the set of columns is treated as a single composite column for indexing.

The index-key value also can be one of the following:

- A column of type `LVARCHAR(size)`, if `size` is smaller than 387 bytes
- One or more columns of user-defined data types
- One or more values that a user-defined function returns (referred to as a *functional index*), where the argument list of the UDF is one or more column values in the same row
- A combination of one or more column values and the return value from one or more user-defined functions.

The 387-byte VARCHAR size limit is for dbspaces of the default (2 kilobyte) page size, but dbspaces of larger page sizes can support larger index key sizes, as listed in the following table.

Table 1. Maximum Index Key Size for Selected Page Sizes

Page Size	Maximum Index Key Size
2 kilobytes	387 bytes
4 kilobytes	796 bytes
8 kilobytes	1,615 bytes
12 kilobytes	2,435 bytes
16 kilobytes	3,245 bytes

Specifying the sort order

By default, the index is sorted in ascending order, from the lowest value to the highest, according to the collation order for the locale, or else to the collation order that was in effect when the index was created, if the SET COLLATION statement has specified a nondefault collation. You can use the DESC keyword to reverse the sort order, so that the index is sorted from the highest value to the lowest.

If you explicitly specify the ASC keyword in the Index-Key Specification, the index is sorted in ascending order.

Specifying an operator class

If the secondary access method in the USING clause has no default operator class, the Index-Key Specification can specify an operator class for the index key.

If the secondary access method in the USING clause has a default operator class, the Index-Key Specification can specify an operator class to override the default operator class for the index.

- [Indexing a BSON field](#)
You can create an index on a field within a BSON column.
- [Restrictions on columns as index keys](#)
Whether the database server accepts the Index Key specification as valid can depend on various factors, including attributes of the table, and the data types, the storage size, and the total number of index-key columns, as well as dependencies between index-key columns and constraints on the same table.
- [Using the return value of a function as an index key](#)
A functional index is indexed on the value that a specified function returns from a column-value argument, rather than on the value of a column.

Related concepts:

BSON and JSON built-in opaque data types

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Indexing a BSON field

You can create an index on a field within a BSON column.

Syntax

Use the following syntax in the index-key specification. See [Index-key specification](#).

BSON field specification

```

      .-----|
      v       |
|---+BSON_GET-----+---+--BSON_column_name-----+BSON_field_name-----+---+-->
      '-BSON_value_function-'              '-BSON_array_position-'

>--USING BSON-----|
```

Element	Description	Restrictions	Syntax
<i>BSON_array_position</i>	A positive integer that represents the position of a value in an array, starting with 0 for the first value.	Must be preceded by all ancestor field names.	
<i>BSON_column_name</i>	A BSON column name	Must be of type BSON.	Expression
<i>BSON_field_name</i>	BSON field name	Must be a literal BSON field name. Can be a multilevel field identifier, up to 32 levels. All ancestor field names must be included.	Column Expressions
<i>BSON_value_function</i>	A BSON value function for a specific data type, except the BSON_VALUE_OBJECTID function	You cannot use the BSON_VALUE_OBJECTID function to create an index	BSON processing functions

You cannot create an index on a BSON column. You must create the index on a field within the BSON column.

The BSON_GET or BSON value function specifies which field to index. The USING BSON keywords are necessary to specify that the index is created on a BSON column.

Example: Create an index on a BSON field

The following statements create and populate a table that has a BSON column:

```
CREATE DATABASE testdb WITH LOG;
CREATE TABLE IF NOT EXISTS bson_table(bson_col BSON);

INSERT INTO bson_table VALUES (
  '{person:{givenname:"Jim",surname:"Flynn",age:29,cars:["dodge","olds"]}}'
  ::JSON::BSON);
```

The following statement creates an index on the **surname** field in the BSON column:

```
CREATE INDEX idx2 ON bson_table(
  BSON_GET(bson_col, "person.surname")) USING BSON;
```

Related concepts:

[BSON and JSON built-in opaque data types](#)

Related reference:

[BSON_GET function](#)

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Restrictions on columns as index keys

Whether the database server accepts the Index Key specification as valid can depend on various factors, including attributes of the table, and the data types, the storage size, and the total number of index-key columns, as well as dependencies between index-key columns and constraints on the same table.

The following restrictions apply to any column or column list that the Index Key Specification of the CREATE INDEX statement references:

- All the columns must exist in the table on which the index is defined.
- The table must exist in the current database, and cannot be an object that the CREATE EXTERNAL TABLE statement defined.
- A column defined as an index key cannot be a complex data type (LIST, MULTISSET, SET, a generic COLLECTION type, or a ROW type) or a JSON or BSON data type, with the following exceptions:
 - You can create a *functional index* on a column of a named ROW type.
 - You can create an index on a specific field of a BSON column, or create multiple indexes, each on a different field of the same BSON column. You cannot create an index on an entire BSON column.

- The maximum number of columns and the total width of all column index keys are dependent on the page size of the database server. See [Creating Composite Indexes](#).
- You cannot add an ascending index to a column list on which a unique constraint is defined. See [Using the ASC and DESC Sort-Order Options](#).
- You cannot add a unique index to a column list that has a primary-key constraint. The reason is that defining the column or column list as the primary key causes the database server to implement the constraint by creating a unique internal index on the column or column list. The CREATE INDEX statement cannot define another unique index whose key is the same column or column list.
- The number of indexes that you can define on the same list of columns is restricted. See [Restrictions on the Number of Indexes on a Set of Columns](#).

For additional index-key restrictions that apply to columns that are specified as arguments to functional indexes, see [Using the return value of a function as an index key](#).

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Using the return value of a function as an index key

A *functional index* is indexed on the value that a specified function returns from a column-value argument, rather than on the value of a column.

For example, the following statement creates a functional index on table **zones** using the value that the user-defined function **Area()** returns as the key:

```
CREATE INDEX zone_func_ind ON zones (Area(length,width));
```

You can create the function on which to define a functional index within an SPL routine. You can also create an index on a nonvariant user-defined function that does not return a large object.

The functional index can be a B-tree index, an R-tree index, or a user-defined secondary-access method.

The value returned by the function can be the index key, as in the example above, or it can be part of a composite index whose other key parts are the values of columns, the values of partial columns, or the return values of other functional indexes. (For more information, see the topic [Creating Composite Indexes](#)).

Important: The database server imposes the following restrictions on the user-defined routines (UDRs) on which a functional index is defined:

- The arguments cannot be the names of column of a collection data type (LIST, MULTISET, or SET).
- The function cannot return a large object of the data types BLOB, BYTE, CLOB, and TEXT.
- The function cannot be a VARIANT function.
- The function cannot include any DML statement of SQL.
- The ONLINE keyword is not valid when you create a functional index; see [The ONLINE keyword of CREATE INDEX](#).
- The function must be a user-defined function, or, to create an index on a field in a BSON column, the BSON_GET function or a BSON value function. You cannot create a functional index on any other built-in function of SQL.

Despite the last restriction above, however, you can create a functional index on a user-defined function that calls a non-variant built-in SQL function, so that the value returned by the built-in function is the index key of a functional index. (That is, create an SPL wrapper that calls and returns the value from a built-in function of SQL, and then define a functional index on this user-defined SPL function.)

Related concepts:

[BSON processing functions](#)

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Creating Composite Indexes

A *simple* index lists only one *column* (or only one *function*, whose argument list must be a list of one or more columns) in its Index Key Specification. Any other index is a *composite* index. You should list the columns in a composite index in the order from most frequently used to least frequently used.

If you use SET COLLATION to specify the collating order of a nondefault locale, you can create multiple indexes on the same set of columns, using different collations. (Such indexes are useful only on NCHAR or NVARCHAR columns.)

The following example creates a composite index using the **stock_num** and **manu_code** columns of the **stock** table:

```
CREATE UNIQUE INDEX st_man_ix ON stock (stock_num, manu_code);
```

The UNIQUE keyword prevents any duplicates of a given combination of **stock_num** and **manu_code**. The index is in ascending order by default.

You can include up to 16 columns in a composite index. The total width of all indexed columns in a single composite index cannot exceed 380 bytes.

An *index key part* is either a column in a table, or the result of a user-defined function on one or more columns. A composite index can have up to 16 key parts that are columns, or up to 341 key parts that are values returned by a UDR. This limit is language-dependent and applies to UDRs written in SPL or Java™. Functional indexes based on C language UDRs can have up to 102 key parts. A composite index can include any of the following index key parts in its index key:

- One or more columns
- One or more values that a user-defined function returns (referred to as a *functional index*).

The index key parts of a composite index can be a combination of columns and user-defined functions.

For dbspaces of the default page size of 2 kilobytes, the total width of all indexed columns in a single CREATE INDEX statement cannot exceed 387 bytes, except for functional indexes of Informix®, whose language-dependent limits are described earlier in this section. For the maximum sizes in dbspaces larger than 2 kilobytes, see [Index-key specification](#).

Whether the index is based directly on column values in the table, or on functions that take column values as arguments, the maximum size of the index key depends only on page size. The maximum index key size for functional indexes in dbspaces larger than 2 kilobytes are the same as for column indexes. The only difference between limits on column indexes and functional indexes is the number of key parts. An index based on columns can have no more than 16 key parts, but a functional index has different language-dependent limits on key parts. For a given page size, the maximum index key size is the same for both column-based and functional indexes.

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Using the ASC and DESC Sort-Order Options

The ASC option specifies an index maintained in ascending order; this is the default order. The DESC option can specify an index that is maintained in descending order. These ASC and DESC options are valid with B-trees only.

- [Effects of Unique Constraints on Sort Order Options](#)
- [Bidirectional Traversal of Indexes](#)
- [Restrictions on the Number of Indexes on a Set of Columns](#)
- [Using an Operator Class](#)

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Effects of Unique Constraints on Sort Order Options

When a column or list of columns is defined as unique in a CREATE TABLE or ALTER TABLE statement, the database server implements that UNIQUE CONSTRAINT by creating a unique ascending index. Thus, you cannot use the CREATE INDEX statement to add an ascending index to a column or column list that is already defined as unique.

However, you can create a descending index on such columns, and you can include such columns in composite ascending indexes in different combinations. For example, the following sequence of statements is valid:

```
CREATE TABLE customer (
  customer_num SERIAL(101) UNIQUE,
  fname        CHAR(15),
  lname        CHAR(15),
  company       CHAR(20),
  address1      CHAR(20),
  address2      CHAR(20),
  city          CHAR(15),
  state         CHAR(2),
  zipcode       CHAR(5),
  phone         CHAR(18)
);

CREATE INDEX c_temp1 ON customer (customer_num DESC);
CREATE INDEX c_temp2 ON customer (customer_num, zipcode);
```

In this example, the **customer_num** column has a unique constraint placed on it. The first CREATE INDEX statement places an index sorted in descending order on the **customer_num** column. The second CREATE INDEX includes the **customer_num** column as part of a composite index. For more information on composite indexes, see [Creating Composite Indexes](#).

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Bidirectional Traversal of Indexes

If you do not specify the ASC or DESC keywords when you create an index on a single column, key values are stored in ascending order by default; but the bidirectional-traversal capability of the database server lets you create just one index on a column and use that index for queries that specify sorting of results in either ascending or descending order of the sort column.

Because of this capability, it does not matter whether you create a single-column index as an ascending or descending index. Whichever storage order you choose for an index, the database server can traverse that index in ascending or descending order when it processes queries.

If you create a composite index on a table, however, the ASC and DESC keywords might be required. For example, if you want to enter a SELECT statement whose ORDER BY clause sorts on multiple columns and sorts each column in a different order, and you want to use an index for this query, you need to create a composite index that corresponds to the ORDER BY columns. For example, suppose that you want to enter the following query:

```
SELECT stock_num, manu_code, description, unit_price
FROM stock ORDER BY manu_code ASC, unit_price DESC;
```

This query sorts first in ascending order by the value of the **manu_code** column and then in descending order by the value of the **unit_price** column. To use an index for this query, you need to issue a CREATE INDEX statement that corresponds to the requirements of the ORDER BY clause. For example, you can enter either of the following statements to create the index:

```
CREATE INDEX stock_idx1 ON stock
(manu_code ASC, unit_price DESC);
```

```
CREATE INDEX stock_idx2 ON stock
(manu_code DESC, unit_price ASC);
```

The composite index that was used for this query (**stock_idx1** or **stock_idx2**) cannot be used for queries in which you specify the same sort direction for the two columns in the ORDER BY clause. For example, suppose that you want to enter the following queries:

```
SELECT stock_num, manu_code, description, unit_price
FROM stock ORDER BY manu_code ASC, unit_price ASC;
SELECT stock_num, manu_code, description, unit_price
FROM stock ORDER BY manu_code DESC, unit_price DESC;
```

If you want to use a composite index to improve the performance of these queries, you need to enter one of the following CREATE INDEX statements. You can use either one of the created indexes (**stock_idx3** or **stock_idx4**) to improve the performance of the preceding queries.

```
CREATE INDEX stock_idx3 ON stock
(manu_code ASC, unit_price ASC);
CREATE INDEX stock_idx4 ON stock
(manu_code DESC, unit_price DESC);
```

You can create no more than one ascending index and one descending index on a column. Because of the bidirectional-traversal capability of the database server, you only need to create one of the indexes. Creating both would achieve exactly the same results for an ascending or descending sort on the **stock_num** column.

After INSERT or DELETE operations are performed on an indexed table, the number of index entries can vary within a page, and the number of index pages that a table requires can depend on whether the index specifies ascending or descending order. For some load and DML operations, a descending single-column or multi-column index might cause the database server to allocate more index pages than an ascending index requires.

Related information:

[Page Types Within an Index Extent](#)

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Restrictions on the Number of Indexes on a Set of Columns

You can create multiple indexes on a set of columns, provided that each index has a unique combination of ascending and descending columns. For example, to create all possible indexes on the **stock_num** and **manu_code** columns of the **stock** table, you could create four indexes:

- The **ix1** index on both columns in ascending order
- The **ix2** index on both columns in descending order
- The **ix3** index on **stock_num** in ascending order and on **manu_code** in descending order
- The **ix4** index on **stock_num** in descending order and on **manu_code** in ascending order

Because of the bidirectional-traversal capability of the database server, you do not need to create these four indexes. You only need to create two indexes:

- The **ix1** and **ix2** indexes achieve the same results for sorts in which the user specifies the same sort direction (ascending or descending) for both columns, so you only need one index of this pair.
- The **ix3** and **ix4** indexes achieve the same results for sorts in which the user specifies different sort directions for the two columns (ascending on the first column and descending on the second column or vice versa). Thus, you only need to create one index of this pair. (See also [Bidirectional Traversal of Indexes](#).)

Informix® can also support multiple indexes on the same combination of ascending and descending columns, if each index has a different collating order; see [SET COLLATION statement](#).

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Using an Operator Class

An *operator class* is the set of operators associated with a secondary-access method for query optimization and building the index. You must specify an operator class when you create an index if either one of the following is true:

- No default operator class for the secondary-access method exists. (A user-defined access method can provide no default operator class.)
- You want to use an operator class that is different from the default operator class that the secondary-access method provides.

If you use an alternative access method, and if the access method has a default operator class, you can omit the operator class here; but if you do not specify an operator class and the secondary-access method does not have a default operator class, the database server returns an error. For more information, see [Default Operator Classes](#). The following CREATE INDEX statement creates a B-tree index on the **cust_tab** table that uses the **abs_btree_ops** operator class for the **cust_num** key:

```
CREATE INDEX c_num1_ix ON cust_tab (cust_num abs_btree_ops);
```

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USING access-method clause

The USING clause specifies the secondary-access method for the new index.

USING Access-Method Clause

```

      .-,-,-----
      v      |
|--USING--sec_acc_method--(----parameter = value+--)------|

```

Element	Description	Restrictions	Syntax
<i>parameter</i>	Secondary-access-method parameter for this index	See the user documentation for your user-defined access method	Quoted String
<i>sec_acc_method</i>	Secondary-access method for this index	Method can be a B-tree, R-tree, BTS, or user-defined access method, such as one that a DataBlade module defines	Identifier
<i>value</i>	Value of the specified <i>parameter</i>	Must be a valid literal value for <i>parameter</i> in this secondary-access method	Quoted String or Literal Number

A *secondary-access method* is a set of routines that perform all of the operations that are needed for an index, such as create, drop, insert, delete, update, and scan.

The database server provides the following secondary-access methods:

- The generic B-tree index is the built-in secondary-access method.
A B-tree index is good for a query that retrieves a range of data values. The database server implements this secondary-access method and registers it as **btree** in the system catalog tables.
- The R-tree method is a registered secondary-access method.
An R-tree index is good for searches on multidimensional data. The database server registers this secondary-access method as **rtree** in the system catalog tables of a database. An R-tree secondary-access method is not valid for a UNIQUE index key. An R-tree index cannot be clustered. An R-tree index can be stored in a dbspace with a non-default page size. For more information about R-tree indexes, see the *IBM® Informix® R-Tree Index User's Guide*.
- The **bts** method is a registered secondary-access method.
Use the **bts** access method to perform basic text searching for words and phrases in a document repository that is stored in a column of a table. To perform basic text searches, you create an index using the **bts** access method on a text column and then use the **bts_contains()** search predicate function and other management functions. For more information about the **bts** access method, see [bts access method syntax](#).

The access method that you specify must be registered in the **sysams** system catalog table. The default secondary-access method is B-tree.

If the access method is B-tree, you can create only one index for each unique combination of ascending and descending columnar or functional keys with operator classes. (This restriction does not apply to other secondary-access methods.) By default, CREATE INDEX creates a generic B-tree index. If you want to create an index with a secondary-access method other than B-tree, you must specify the name of the secondary-access method in the USING clause.

Some user-defined access methods are packaged as DataBlade modules. Some DataBlade modules provide indexes that require specific parameters when you create them. For more information about user-defined access methods, refer to the documentation of your secondary access-method or DataBlade module.

The following example (for a database that implements R-tree indexes) creates an R-tree index on the **location** column that contains an opaque data type, **point**, and performs a query with a filter on the **location** column.

```

CREATE INDEX loc_ix ON TABLE emp (location) USING rtree;
SELECT name FROM emp WHERE location N_equator_equals point('500, 0');

```

The following CREATE INDEX statement creates an index that uses the **fulltext** secondary-access method, which takes two parameters: WORD_SUPPORT and PHRASE_SUPPORT. It indexes a table **t**, which has two columns: **i**, an integer column, and **data**, a TEXT column.

```

CREATE INDEX tx ON t(data)
  USING fulltext (WORD_SUPPORT='PATTERN',
  PHRASE_SUPPORT='MAXIMUM');

```

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HASH ON clause

Use the HASH ON clause of the CREATE INDEX statement to specify the columns and number of subtrees (buckets) for a forest of trees index.

HASH ON clause

```

      .-,-,-----
      v      |
|--HASH ON--(----column+--)-WITH--number--BUCKETS-----|

```

Element	Description	Restrictions	Syntax
<i>column</i>	The name of the column or columns on which you use the HASH ON clause to create a forest of trees index	The list must be a prefix list of the index columns used in the CREATE INDEX statement	Identifier
<i>number</i>	The number of subtrees (buckets) to create for a forest of trees index	The number of buckets for a forest of trees index must range from 2 to the number of available index pages per dbspace	Integer Literals

Usage

Forest of trees indexes are detached indexes. They cannot be attached indexes.

You can create forest of trees indexes on columns with base data types.

You cannot:

- Create forest of trees indexes on columns with complex data types, UDTs, or functional columns.
- Use the `FILLFACTOR` option of the `CREATE INDEX` statement when you create forest of trees indexes, because the indexes are built from top to bottom.
- Create clustered forest of trees indexes.
- Run the `ALTER INDEX` statement on forest of trees indexes.
- Use forest of trees indexes in queries that use aggregates, including minimum and maximum range values
- Perform range scans directly on the `HASH ON` columns of a forest of trees index.
However, you can perform range scans on columns that are not listed in the `HASH ON` column list. For range scans on columns listed in `HASH ON` column list, you must create an additional B-tree index that contains the appropriate column list for the range scan. This additional B-tree index might have the same column list as the forest of trees index, plus or minus a column.
- Use a forest of trees index for an `OR` index path. The database server does not use forest of trees indexes for queries that have an `OR` predicate on the indexed columns.

When you create a forest of trees index, choose enough columns to create unique values.

Tip: Generally, the columns to choose depend on the number of duplicates for each column. For example, if the first column contains a small number of duplicates, the first two columns are sufficient for hashing if they do not contain a large number of duplicates. If the first two columns contain a majority of duplicates, then you need to also choose a third column.

The number of subtrees depends on your goal for the index. If your goal is:

- To reduce contention, initially create a forest of trees index with 2 subtrees per CPU VP. You might need more subtrees, depending on the number of rows in the table and how many duplicates exist.
- To reduce the number of levels in the B-tree:
 1. Run the **oncheck -pT** command.
 2. In the output, find the number of nodes at each level.
 3. Determine how many subtrees are required to achieve the desired depth for each tree in the index.

For example, suppose an index averages 100 keys per page, the index has 1M keys, and the tree looks like this:

- Level 1 (root) 100 keys
- Level 2 10K keys
- Level 3 1M keys

To reduce the 3-level tree to 100 2-level trees, the index needs roughly 100 subtrees. To reduce the 3-level tree to 10K 1-level trees, the index needs roughly 10K subtrees.

Forest of tree pages can be sparser than traditional B-tree pages if too many or too few subtrees are used. When the pages are sparser, more pages occupy the buffer pool, and therefore, cause other tables to become less cached.

Examples

The following command creates a forest of trees index named `idx1` with 100 subtrees on column `c1`:

```
CREATE INDEX idx1 ON tab1(c1) HASH ON (c1) with 100 buckets;
```

The following command creates a forest of trees index named `idx2`. In the command, the prefix list for the `HASH ON` portion of the statement is `c1` and `c2`, which is a prefix list of the `c1`, `c2`, and `c3` columns used in the `CREATE INDEX` portion of the statement.

```
CREATE INDEX idx2 on tab2(c1, c2, c3) HASH ON (c1, c2) with 10 buckets;
```

The following command creates a forest of trees index for equality lookups on columns `c1` and `c2`:

```
CREATE INDEX idx3 on tab3(c1, c2) HASH ON (c1, c2) with 100 buckets;
```

The following command creates a B-tree index that is similar to the previous forest of trees index. This index is for range scans on columns `c1` and `c2`:

```
CREATE INDEX idx4 on tab4(c1, c2, c3);
```

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FILLFACTOR Option

Use the `FILLFACTOR` option to specify the degree of index-page fullness when you want to create compacted indexes or provide information for the expansion of an index at a later date.

The `FILLFACTOR` option takes effect only in the following cases:

- when you build an index on a table that contains more than 5,000 rows and that uses more than 100 table pages
- when you create an index on a fragmented table

- when you create a fragmented index on a nonfragmented table.

You cannot use the FILLFACTOR option on a forest of trees index.

FILLFACTOR Option

```
|--FILLFACTOR--percent-----|
```

Element	Description	Restrictions	Syntax
<i>percent</i>	Percentage of each index page that is filled by index data when the index is created. The default is 90.	$1 \leq \text{percent} \leq 100$	Literal Number

When the index is created, the database server initially fills only that percentage of the nodes specified with the FILLFACTOR value.

The FILLFACTOR can also be set as a parameter in the ONCONFIG file. The FILLFACTOR clause on the CREATE INDEX statement overrides the setting in the ONCONFIG file. For more information about the ONCONFIG file and the parameters you can use, see your *IBM® Informix® Administrator's Guide*.

- [Providing a Low Percentage Value](#)
- [Providing a High Percentage Value](#)

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Providing a Low Percentage Value

If you provide a low percentage value, such as 50, you allow room for growth in your index. The nodes of the index initially fill to a certain percentage and contain space for inserts. The amount of available space depends on the number of keys in each page as well as the percentage value.

For example, with a 50-percent FILLFACTOR value, the page would be half full and could accommodate doubling in size. A low percentage value can result in faster inserts and can be used for indexes that you expect to grow.

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Providing a High Percentage Value

If you provide a high percentage value, such as 99, indexes are compacted, and any new index inserts result in splitting nodes. The maximum density is 100 percent. With a 100-percent FILLFACTOR value, the index has no room available for growth; any addition to the index results in splitting the nodes.

A 99-percent FILLFACTOR value allows room for at least one insertion per node. A high percentage value can result in faster queries and is appropriate for indexes that you do not expect to grow, or for mostly read-only indexes.

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Storage options

The storage options specify the distribution scheme of an index. You can use the IN clause to specify a storage space for the entire index, or you can use the FRAGMENT BY clause to fragment the index across multiple storage spaces.

Storage Options

```

(1)
|--+--IN--+--dbspace-----+-----+-----+-----+-----+-----+-----+
|      | |      (2) | |      |      |      |      |      |      |      |
|      | '-extspace-----' |      |      |      |      |      |      |
|      | (3)      (4) |      |      |      |      |      |      |
|      | '-----TABLE-----' |      |      |      |      |      |      |
|      |      (5) |      |      |      |      |      |      |
|      | '-| FRAGMENT BY Clause for Indexes |-----' |

```

Notes:

1. See [Storing an Index in a dbspace](#)
2. See [Storing Data in an extspace](#)
3. B-tree indexes on nonfragmented tables only
4. See [Creating an Index with the IN TABLE Keywords](#)
5. See [FRAGMENT BY Clause for Indexes](#)

Element	Description	Restrictions	Syntax
<i>dbspace</i>	The dbspace in which to store the index	Must exist	Identifier

Element	Description	Restrictions	Syntax
<i>extspace</i>	Name assigned by the onspaces command to a storage area outside the database server	Must exist	See the documentation for your access method.

If you specify any storage option (except IN TABLE), you create a *detached index*. Detached indexes are indexes that are created with a specified distribution scheme. Even if the distribution scheme specified for the index is identical to that specified for the table, the index is still considered to be detached. If the distribution scheme of a table changes, all detached indexes continue to use the distribution scheme that the Storage Option clause specified.

If you do not include the Storage Option clause, by default an attached index is created in the same dbspaces as the corresponding table fragments. However, if automatic location is enabled, an index created on a round-robin table is detached by default in a single fragment, located in a dbspace chosen by the server. You enable automatic location by setting the AUTOLOCATE configuration parameter or session environment option to a positive integer.

Important:

When you are defining an index on a table that was created with AUTOLOCATE enabled, if a round-robin storage distribution scheme was automatically defined for the table, you cannot use the IN TABLE keywords to specify nonfragmented storage for the index. That storage option is valid only for B-tree indexes on nonfragmented tables.

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COMPRESSED option for indexes

Use the COMPRESSED keyword of the CREATE INDEX statement to compress the B-tree index if the index has 2000 or more keys.

You can create a compressed index on a fragmented or non-fragmented table.

You cannot create a compressed index that is also a cluster index. However, you can compress an existing cluster index by running an SQL administration API **task()** or **admin()** function with the index compress argument.

To be compressed, the index or fragment within the index must have at least 2000 keys. If you use the COMPRESSED option when you create an index that does not have enough keys, the database server does not compress the index or fragment when it creates the index. The index remains uncompressed even if new keys are added to it. If you want to compress the index, run an SQL administration API **task()** or **admin()** function with the index compress argument.

If a table does not have enough data to provide a large enough sample of index keys, the database server does not compress the index or fragment. Even the minimum required number of new keys are added to an existing index that is not compressed, the database server does not compress the index.

However, after an index is compressed, the database server compresses and inserts any new key added to the index.

The following example creates a compressed index named **cust3_ix** on the address column of the customer table.

```
CREATE INDEX cust3_ix ON customer (address) COMPRESSED
EXTENT SIZE 32 NEXT SIZE 32;
```

The following example creates a unique, compressed index:

```
CREATE UNIQUE INDEX cust3_ix ON customer (address) COMPRESSED ;
```

Related information:

[B-tree index compression](#)

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Extent Size Options

The Extent Size options can define the size of storage extents allocated to the index.

Extent Size Options

```
|---+-----+----->
  '-EXTENT SIZE--first_kilobytes-'
>---+-----+-----|
  '-NEXT SIZE--next_kilobytes-'
```

Element	Description	Restrictions	Syntax
<i>first_kilobytes</i>	Length in kilobytes of the first extent for the index	Must return a positive number; maximum is the chunk size, in kilobytes	Expression
<i>next_kilobytes</i>	Length in kilobytes of each subsequent extent	Same as for <i>first_kilobytes</i>	Expression

The minimum length of *first_kilobytes* (and of *next_kilobytes*) is four times the disk-page size on your system. For example, if you have a 2-kilobyte page system, the minimum length is 8 kilobytes.

If you need to revise the extent sizes of an index, you can modify the extent and next-extent sizes in the generated schema files of an unloaded table. For example, to make a database more efficient, you might drop an index, modify the extent sizes in the schema files, and then create a new index. For information about how to optimize extents, see your *IBM® Informix® Administrator's Guide*.

Only extent size values that you explicitly assign as extent sizes for the new index are stored in the system catalog. The value that you specify in the EXTENT SIZE option to the CREATE INDEX statement is stored in the **textsize** column of the **sysindices** system catalog table, and the value that you specify in the NEXT SIZE option is stored in the **nextsize** column of the same table. If you omit these options, however, the database server stores a value of zero (0) in those system catalog columns, rather than the default value that it calculates and allocates for the first extent or the next extent of the index.

Example of an index defined with explicit extent sizes

The following program fragment creates a new table and defines two nonfragmented indexes on the table.

```
CREATE TABLE IF NOT EXISTS t (a INT, b INT);
CREATE INDEX IF NOT EXISTS idx1 ON t(a) EXTENT SIZE 32 NEXT SIZE 32;
CREATE INDEX IF NOT EXISTS idx2 ON t(b);
```

Here the definition of **idx1** specifies 32 kilobytes as explicit extent sizes. The second index, **idx2**, has default extent sizes that the system calculates. The two CREATE INDEX statements produce system catalog descriptions of these indexes that include these extent size entries:

- The **sysindices.textent** and **sysindices.nextent** column values are each 32 for **idx1**.
- The **sysindices.textent** and **sysindices.nextent** column values are each 0 for **idx2**.

Here the 0 values for **idx2** indicate that no explicit extent sizes were specified (rather than indicating that no storage space was allocated).

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IN Clause

Use the IN clause to specify a storage space to hold the entire index. The storage space that you specify must already exist.

- [Storing an Index in a dbspace](#)
- [Storing an Index Fragment in a Named Partition](#)
- [Storing Data in an extspace](#)
- [Creating an Index with the IN TABLE Keywords](#)

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Storing an Index in a dbspace

Use the IN *dbspace* clause to specify the dbspace where you want your index to reside. When you use this clause with any option except the TABLE keyword, you create a detached index.

The IN *dbspace* clause allows you to isolate an index. For example, if the **customer** table is created in the **custdata** dbspace, but you want to create an index in a separate dbspace called **custind**, use the following statements:

```
CREATE TABLE customer
...
IN custdata EXTENT SIZE 16;

CREATE INDEX idx_cust ON customer (customer_num) IN custind;
```

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Storing an Index Fragment in a Named Partition

Besides the option of storing a fragment of the index in a dbspace, Informix® supports storing named fragments of the index in one or more dbspaces. Unless you explicitly declare names for the fragments in the PARTITION BY or FRAGMENT BY clause, each fragment, by default, has the same name as the dbspace where it resides. This includes all fragmented tables and indexes migrated from earlier releases of Informix.

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Storing Data in an extspace

In general, use the *extspace* storage option in conjunction with the [USING access-method clause](#). For more information, refer to the user documentation for your custom-access method.

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Creating an Index with the IN TABLE Keywords

Specifying IN TABLE as the storage option creates an index where both the index and the data pages for its table are stored together in the same extents, and the dbspace distribution scheme for the index is the same as that of the table on which it was built.

Using IN TABLE as the storage option specifies the same storage design for non-fragmented B-tree indexes as enabling the **DEFAULT_ATTACH** environment variable, but both **DEFAULT_ATTACH** and the IN TABLE keywords are deprecated features.

The name of the **DEFAULT_ATTACH** environment variable preserves an obsolete definition of the term *attached index*. In current Informix® nomenclature, this term now designates an index whose data pages are stored in separate tablespaces and separate extents from the data pages of the table, but the index and its table share the same dbspace distribution scheme. For more information, see the description of **DEFAULT_ATTACH** in the *IBM® Informix Guide to SQL: Reference*.

The following restrictions apply to the IN TABLE keywords as an index storage option:

- If the table on which you define the index is a fragmented table, Informix issues errors -212 and -130 if you specify the IN TABLE option.
- You cannot apply the IN TABLE storage option to forest of trees indexes.
- This option does not support extensibility-related indexes, such as R-tree indexes, functional indexes, or indexes that DataBlade modules provide.
- You cannot specify this storage option for any index that uses a collating order different from that of its table, nor different from what the **DB_LOCALE** setting specifies. For more information about the **DB_LOCALE** environment variable, see the *IBM Informix Guide to SQL: Reference*.
- You cannot apply the IN TABLE storage option to indexes on tables implicitly fragmented by the AUTOLOCATE configuration parameter or by the SET ENVIRONMENT AUTOLOCATE session environment option.

For example, suppose that automatic location is enabled for the current session when the following DDL statements are issued:

```
CREATE TABLE tab_autoloc (col1 INT);
CREATE INDEX ind_intab ON tab_autoloc (col1) IN TABLE;
```

Although no explicit storage option is specified for the **tab_autoloc** table, it has an implicit round-robin storage distribution, based on the AUTOLOCATE setting. Consequently, the CREATE INDEX statement fails, and no **ind_intab** index is registered in the system catalog, because in-table indexes cannot be created on fragmented tables.

Restriction: When you are defining an index on a table that was created with AUTOLOCATE enabled, if a round-robin storage distribution scheme was automatically defined for the table, you cannot use the IN TABLE keywords to specify nonfragmented storage for the index. That storage option is valid only for B-tree indexes on nonfragmented tables.

Informix does not recommend use in new applications of the IN TABLE storage option, nor of the **DEFAULT_ATTACH** environment variable. Such indexes are a deprecated feature that might not be supported in some future release of Informix.

Related information:

[DEFAULT_ATTACH environment variable](#)

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FRAGMENT BY Clause for Indexes

Use the FRAGMENT BY clause to create a detached index and to define its fragmentation strategy across dbspaces or partitions.

This closely resembles the syntax of the FRAGMENT BY clause for tables, but the ROUND ROBIN keywords are not supported for index fragmentation. The PARTITION BY keywords are a synonym for the FRAGMENT BY keywords in this context.

FRAGMENT BY Clause for Indexes

```
|---+FRAGMENT +---BY----->
|'-PARTITION '|

(1)
>---+EXPRESSION--| Expression Fragment Clause |-----+--|
|                                     (2) |
|+-RANGE--(fragment_key)--| Interval Fragment Clause |-----+
|                                     (3) |
|'-LIST--(fragment_key)--| List Fragment Clause |-----'
```

Notes:

1. See [Expression Fragment Clause](#)
2. See [Interval fragment clause](#)
3. See [List fragment clause](#)

Element	Description	Restrictions	Syntax
<i>dbspace</i>	The <i>dbspace</i> to store the index fragment	You can specify no more than 2,048 <i>dbspaces</i> . All <i>dbspaces</i> that store the fragments must have the same page size.	Identifier
<i>fragment_key</i>	Cast, column, or function expressions on an index column. Index is fragmented on the value of this expression.	Columns must be from the current table only.	Expression

Here the IN keyword introduces the name of a storage space where an index fragment is to be stored. If you list multiple *dbspace* names after the IN keyword, use parentheses to delimit the *dbspace* list. All *dbspaces* that store the fragments must have the same page size. The parentheses around the list of fragment definitions that follow the EXPRESSION keyword are optional.

For indexes that use the same RANGE interval or LIST fragmentation strategy as their table, each fragment name that you declare after the PARTITION keyword must be the same as the identifier of the corresponding table fragment.

For attached indexes that are fragmented by a RANGE interval fragmentation strategy, if no existing table fragment is in the range of a new inserted row, the database server creates a new table fragment to store the new row, and declares a system-generated name for the new table fragment. If the table is indexed, and the index is fragmented by the same RANGE interval strategy as its table, the database server also creates a new index fragment. In this case, the index fragment has the same system-generated identifier as the corresponding table fragment. For more information about system-generated RANGE interval fragments, see [Interval fragment clause](#).

- [Storing an Index Fragment in a Named Partition](#)
- [Restrictions on fragmentation expressions](#)
- [Fragmentation of System Indexes](#)
- [Fragmentation of Unique Indexes](#)
- [Fragmentation of Indexes on Temporary Tables](#)

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Storing an Index Fragment in a Named Partition

Besides the option of storing a fragment of the index in a dbspace, Informix® supports storing named fragments of the index in one or more dbspaces. Unless you explicitly declare names for the fragments in the PARTITION BY or FRAGMENT BY clause, each fragment, by default, has the same name as the dbspace where it resides. This includes all fragmented tables and indexes migrated from earlier releases of Informix.

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Restrictions on fragmentation expressions

The following restrictions apply to the expression:

- Each fragment expression can contain columns only from the current table, with data values only from a single row.
- The expression must return a BOOLEAN (true or false) value.
- No subqueries, aggregates, user-defined routines, nor references to fields of a ROW type column or sequence objects are valid.
- The built-in CURRENT, SYSDATE, TODAY, SITENAME, DBSERVERNAME, CURRENT_USER, or USER functions are not valid.
- The DEFAULT_ROLE and CURRENT_ROLE operators are not valid.

The restrictions listed above also apply to indexes that use a LIST fragmentation strategy.

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Fragmentation of System Indexes

System indexes (such as those that implement referential constraints and unique constraints) utilize user-defined indexes if they exist. If no user-defined indexes can be utilized, system indexes remain nonfragmented, and are moved to the dbspace where the database was created.

To fragment a system index, create the fragmented index on the constraint columns, and then add the constraint using the ALTER TABLE statement.

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Fragmentation of Unique Indexes

You can fragment unique indexes on a table that uses a round-robin or an expression-based distribution scheme, but any columns referenced in the fragment expression must be indexed columns. If your index fragmentation strategy violates this restriction, the CREATE INDEX statement fails, and work is rolled back.

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Fragmentation of Indexes on Temporary Tables

You can fragment a unique index on a temporary table only if the underlying table uses an expression-based distribution scheme. That is, the CREATE TEMP TABLE statement that defines the temporary table must specify an explicit expression-based distribution scheme. (Fragmentation of the index by ROUND ROBIN is not supported, and fragmentation by LIST or by INTERVAL is automatic, for a unique index on a table that uses a list or interval storage partitioning strategy.)

If you try to create a fragmented, unique index on a temporary table for which you did not specify a fragmentation strategy when you created the table, the database server creates the index in the first dbspace that the **DBSPACETEMP** environment variable specifies. For more information on the **DBSPACETEMP**

environment variable, see the *IBM® Informix® Guide to SQL: Reference*.

For more information on the default storage characteristics of temporary tables, see [Where temporary tables are stored](#).

Related information:

[DBSPACETEMP environment variable](#)

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Index modes

Use the index mode options of the CREATE INDEX statement to specify the behavior of the index during INSERT, DELETE, MERGE, and UPDATE operations.

Index Modes

```
.-ENABLED-----
|+-----+-----+
| |'-DISABLED-'|
| | |'-WITHOUT ERROR--'|
| |'-FILTERING--'+-----+
| | |'-WITH ERROR-'|
```

DISABLED

The database server does not update the index after insert, delete, and update operations that modify the base table. The optimizer does not use the index during the execution of queries.

ENABLED

The database server updates the index after insert, delete, and update operations that modify the base table. The optimizer uses the index during query execution. If an insert or update operation causes a duplicate key value to be added to a unique index, the statement fails.

FILTERING

The database server updates a unique index after insert, delete, and update operations that modify the base table. (This option is not available with duplicate indexes.)

The optimizer uses the index during query execution. If an insert or update operation causes a duplicate key value to be added to a unique index in filtering mode, the statement continues processing, but the bad row is written to the violations table associated with the base table. Diagnostic information about the unique-index violation is written to the diagnostics table associated with the base table.

If you specify filtering for a unique index, you can also specify one of the following error options.

WITHOUT ERROR

A unique-index violation during an insert or update operation returns no integrity-violation error to the user.

WITH ERROR

Any unique-index violation during an insert or update operation returns an integrity-violation error to the user.

For information on changing the database object mode of a unique index, see [Modes for constraints and unique indexes](#).

- [Specifying Modes for Unique Indexes](#)
- [Specifying Modes for Duplicate Indexes](#)

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Specifying Modes for Unique Indexes

You must observe the following guidelines when you specify modes for unique indexes in CREATE INDEX statements:

- You can set the mode of a unique index to enabled, disabled, or filtering.
- If you do not specify a mode, then by default the index is enabled.
- For an index set to filtering mode, if you do not specify an error option, the default is WITHOUT ERROR.
- When you add a new unique index to an existing base table and specify the disabled mode for the index, your CREATE INDEX statement succeeds even if duplicate values in the indexed column would cause a unique-index violation.
- When you add a new unique index to an existing base table and specify the enabled or filtering mode for the index, your CREATE INDEX statement succeeds provided that no duplicate values exist in the indexed column that would cause a unique-index violation. However, if any duplicate values exist in the indexed column, your CREATE INDEX statement fails and returns an error.
- When you add a new unique index to an existing base table in the enabled or filtering mode, and duplicate values exist in the indexed column, erroneous rows in the base table are not filtered to the violations table. Thus, you cannot use a violations table to detect the erroneous rows in the base table.
- [Adding a Unique Index When Duplicate Values Exist in the Column](#)

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Adding a Unique Index When Duplicate Values Exist in the Column

If you attempt to add a unique index in the enabled mode but receive an error message because duplicate values are in the indexed column, take the following steps to add the index successfully:

1. Add the index in the disabled mode. Issue the CREATE INDEX statement again, but this time specify the DISABLED keyword.
2. Start a violations and diagnostics table for the target table with the START VIOLATIONS TABLE statement.
3. Issue a SET Database Object Mode statement to change the mode of the index to enabled. When you issue this statement, existing rows in the target table that violate the unique-index requirement are duplicated in the violations table. You receive an integrity-violation error message, however, and the index remains disabled.
4. Issue a SELECT statement on the violations table to retrieve the nonconforming rows that are duplicated from the target table. You might need to join the violations and diagnostics tables to get all the necessary information.
5. Take corrective action on the rows in the target table that violate the unique-index requirement.
6. After you fix all the nonconforming rows in the target table, issue the SET Database Object Mode statement again to switch the disabled index to the enabled mode. This time the index is enabled, and no integrity violation error message is returned because all rows in the target table now satisfy the new unique-index requirement.

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Specifying Modes for Duplicate Indexes

You must observe the following guidelines when you specify modes for duplicate indexes in CREATE INDEX statements:

- You can set a duplicate index to enabled or disabled mode. Filtering mode is available only for unique indexes.
- If you do not specify the mode of a duplicate index, by default the index is enabled.

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How the Database Server Treats Disabled Indexes

Whether a disabled index is a unique or duplicate index, the database server effectively ignores the index during data-manipulation (DML) operations.

When an index is disabled, the database server stops updating it and stops using it during queries, but the catalog information about the disabled index is retained. You cannot create a new index on a column or set of columns if a disabled index on that column or set of columns already exists. Similarly, you cannot create an active (enabled) unique, foreign-key, or primary-key constraint on a column or on a set of columns if the indexes on which the active constraint depends are disabled.

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The ONLINE keyword of CREATE INDEX

The DBA can reduce the risk of nonexclusive access errors, and can increase the availability of the indexed table, by including the ONLINE keyword as the last specification of the CREATE INDEX statement. The ONLINE keyword instructs the database server to create the index while minimizing the duration of an exclusive lock, so that the index can be created while concurrent users are accessing the table.

By default, CREATE INDEX attempts to place an exclusive lock on the indexed table to prevent all other users from accessing the table while the index is being created. The CREATE INDEX statement fails if another user already has a lock on the table, or is currently accessing the table at the Dirty Read isolation level.

The database server builds the index, even if other users are performing Dirty Read and DML operations on the indexed table. Immediately after you issue the CREATE INDEX ONLINE statement, the new index is not yet visible to the query optimizer for use in query plans or cost estimates, and the database server does not support any other DDL operations on the indexed table, until after the specified index has been built without errors. At this time, the database server briefly locks the table while updating the system catalog with information about the new index.

The indexed table in a CREATE INDEX ONLINE statement can be permanent or temporary, logged or unlogged, and fragmented or non-fragmented. You cannot specify the ONLINE keyword, however, when you are creating an index that has any of the following attributes:

- a functional index
- a clustered index
- a virtual index
- an R-tree index
- an index that is partitioned by an interval fragmentation strategy
- an index on a table that is partitioned by an interval fragmentation strategy.

In addition, if a primary key constraint is defined on the table, a CREATE INDEX ONLINE operation can generate error -710 if one or more concurrent sessions are performing DML operations on a child table that has a foreign key constraint referencing that primary key. Before the index can be created ONLINE, you must wait until all the user sessions with those child tables have completed.

The following statement instructs the database server to create a unique online index called **idx_1** on the **lname** column of the **customer** table:

```
CREATE UNIQUE INDEX IF NOT EXISTS idx_1 ON customer(lname) ONLINE;
```

If, while this index is being constructed, other users insert into the **customer** table new rows in which **lname** is not unique, the database server issues an error after it has created the new **idx_1** index and registered it in the system catalog.

The term *online index* refers to the locking strategy that the database follows in creating or dropping an index with the ONLINE keyword, rather than to properties of the index that persist after its creation (or its destruction) has completed. This term appears in some error messages, however, and in recovery or restore operations, the database server re-creates as an online index any index that you created as an online index.

No more than one CREATE INDEX ONLINE or DROP INDEX ONLINE statement can concurrently reference online indexes on the same table, or online indexes that have the same identifier.

For indexes defined with the IN TABLE keyword option, however, the indexed table remains locked for the duration of the CREATE INDEX ONLINE operation. While the in-table index is being created, attempted access by other sessions to the locked table would fail with these errors:

```
107: ISAM error: record is locked.
211: Cannot read system catalog (systables).
710: Table (table.tix) has been dropped, altered or renamed.
```

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Automatic Calculation of Distribution Statistics

When the CREATE INDEX statement runs successfully, with or without the ONLINE keyword, Informix® automatically gathers statistics for the newly created index, and updates the **systdistrib** system catalog table with values that are equivalent to an UPDATE STATISTICS operation in a mode that depends on the type of index:

- Index level statistics, equivalent to the statistics gathered by UPDATE STATISTICS in the LOW mode, are calculated for most types of indexes, including B-tree, Virtual Index Interface, and functional indexes.
- Column distribution statistics, equivalent to the distribution generated in the HIGH mode, for a non-opaque leading indexed column of an ordinary B-tree index. The resolution percentage is 1.0 if the table has fewer than a million rows, and 0.5 for larger table sizes.

These distribution statistics are available to the query optimizer when it designs query plans for the table on which the new index was created.

For composite key indexes, only distributions of the leading column are created implicitly by the CREATE INDEX statement.

The implicit creation of distribution statistics is not supported for the following types of indexes:

- Indexes on columns of user-defined data types
- Indexes on columns of the built-in opaque data types (including BOOLEAN and LVARCHAR)
- R-tree indexes
- Attached indexes.

If the calculation of distribution statistics fails during the CREATE INDEX operation, the database server reports that failure in the error log, but continues to create the index.

When distributions are successfully created by an explicit or implicit CREATE INDEX operation, explain information (similar to one generated by UPDATE STATISTICS) such as following is generated if the SET EXPLAIN facility is set to ON.

```
Index:          idx_01 on nita.foo
STATISTICS CREATED AUTOMATICALLY:
Column Distribution for:          nita.foo.a
Mode:          MEDIUM
Number of Bins:      101 Bin size:  100.0
Sort data:          0.3 MB
Completed building distribution in:  0 minutes 33 seconds
```

See the description of the [UPDATE STATISTICS statement](#) for information about distribution statistics and about the difference between LOW mode and MEDIUM mode distributions.

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CREATE OPAQUE TYPE statement

Use the CREATE OPAQUE TYPE statement to create an opaque data type.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-CREATE OPAQUE TYPE--+-+-----+--type----->
                        '-IF NOT EXISTS-'

>--(--INTERNALLENGTH-- = -+length--+-----+-->
                        '-VARIABLE-' | .,-----+-->
                        | v | (1) | |
                        '-,---| Opaque-Type Modifier |-----+--'
```

Notes:

1. See [Opaque-Type Modifier](#)

Element	Description	Restrictions	Syntax
<i>length</i>	Number of bytes needed to store a value of this data type	Positive integer returned when sizeof() directive is applied to the type structure	Literal Number
<i>type</i>	Name that you declare here for the new opaque data type	Must be unique among data type names in the database	Identifier

Usage

The CREATE OPAQUE TYPE statement registers a new opaque data type in the **sysxdtypes** system catalog table.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if an OPAQUE data type of the specified name is already registered in the current database.

To create an opaque type, you must have the Resource privilege on the database. When you create the opaque type, only you, the owner, have the Usage privilege on the new opaque data type. You can use the GRANT or REVOKE statements to grant or revoke the Usage privilege of other users of the database.

To view the privileges on a data type, check the **sysxdtypes** system catalog table for the owner name, and check the **sysxdttypeauth** system catalog table for additional type privileges that might have been granted.

For details of system catalog tables, see the *IBM® Informix® Guide to SQL: Reference*.

The DB-Access utility can also display privileges on opaque data types.

- [Declaring a Name for an Opaque Type](#)
- [INTERNALLENGTH Modifier](#)
- [Opaque-Type Modifier](#)
- [Defining an Opaque Type](#)

To define a new opaque data type to the database server, you must provide the following information in the C or Java™ language.

Related reference:

[CREATE CAST statement](#)
[CREATE DISTINCT TYPE statement](#)
[CREATE FUNCTION statement](#)
[CREATE ROW TYPE statement](#)
[CREATE TABLE statement](#)
[DROP TYPE statement](#)
[CREATE SCHEMA statement](#)

Related information:

[System catalog tables](#)
[OPAQUE data types](#)
[Opaque data type](#)
[Opaque user-defined data types](#)
[Opaque data types](#)

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Declaring a Name for an Opaque Type

The name that you declare for an opaque data type is an SQL identifier. When you create an opaque type in a database that is not ANSI-compliant, the name must be unique among the names of data types within the database.

When you create an opaque type in an ANSI-compliant database, *owner.type* combination must be unique within the database. The owner name is case sensitive. If you do not put quotation marks around the owner name, the name of the opaque-type *owner* is stored in uppercase letters.

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INTERNALLENGTH Modifier

The INTERNALLENGTH modifier specifies the storage size that is required for the opaque data type as fixed length or varying length.

- [Fixed-Length Opaque Types](#)
- [Varying-Length Opaque Types](#)

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Fixed-Length Opaque Types

A fixed-length opaque type has an internal structure of fixed size. To create a fixed-length opaque type, specify the size of the internal structure, in bytes, for the `INTERNALLENGTH` modifier. The next example creates a fixed-length opaque type called **fixlen_typ** and allocates 8 bytes for storing this data type.

```
CREATE OPAQUE TYPE fixlen_typ(INTERNALLENGTH=8, CANNOTHASH)
```

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Varying-Length Opaque Types

A varying-length opaque type has an internal structure whose size might vary from one value to another. For example, the internal structure of an opaque data type might hold the actual value of a string up to a certain size, but beyond this size it might use an LO-pointer to a CLOB to hold the value.

To create a varying-length opaque data type, use the `VARIABLE` keyword with the `INTERNALLENGTH` modifier. The following statement creates a variable-length opaque data type called **varlen_typ**:

```
CREATE OPAQUE TYPE varlen_typ
(INTERNALLENGTH=VARIABLE, MAXLEN=1024)
```

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Opaque-Type Modifier

Opaque-Type Modifier

```
|-----+-----|
+-MAXLEN=length-----+
+-CANNOTHASH-----+
+-PASSEDBYVALUE-----+
'-ALIGNMENT=align_value-'
```

Element	Description	Restrictions	Syntax
<i>align_value</i>	Byte boundary on which to align an opaque type that is passed to a user-defined routine. Default is 4 bytes.	Must be 1, 2, 4, or 8, depending on the C definition of the opaque data type and hardware and compiler used to build the object file for the data type	Literal Number
<i>length</i>	Maximum length to allocate for instances of varying-length opaque types. Default is 2 kilobytes.	Must be a positive integer ≤ 32 kilobytes. Do not specify for fixed-length data types. Values that exceed this length return errors.	Literal Number

Modifiers can specify the following optional information for opaque types:

- `MAXLEN` specifies the maximum length for varying-length types.
- `CANNOTHASH` specifies that the database server cannot use the built-in hash function on the opaque type.
- `ALIGNMENT` specifies the byte boundary on which the database server aligns the opaque type.
- `PASSEDBYVALUE` specifies that an opaque type that requires 4 bytes or fewer of storage is passed by value.

By default, opaque types are passed to user-defined routines by reference.

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Defining an Opaque Type

To define a new opaque data type to the database server, you must provide the following information in the C or Java™ language.

- A data structure that serves as the internal storage of the opaque data type
The internal storage details of the type are hidden, or opaque. Once you define a new opaque data type, the database server can manipulate it without knowledge of the C or Java structure in which it is stored.
- Support functions that allow the database server to interact with this internal structure.
The support functions tell the database server how to interact with the internal structure of the data type. These support functions must be written in the C or Java programming language.
- Additional user-defined functions that other support functions or end users can invoke to operate on the opaque type (optional)
Possible support functions include operator functions and cast functions. Before you can use these functions in SQL statements, they must be registered with the appropriate `CREATE CAST`, `CREATE PROCEDURE`, or `CREATE FUNCTION` statement.

The following table summarizes the support functions for an opaque data type.

Function	Description	Invoked
----------	-------------	---------

Function	Description	Invoked
input()	Converts the opaque type from its external LVARCHAR representation to its internal representation	When a client application sends a character representation of the opaque type in an INSERT, UPDATE, or LOAD statement
output()	Converts the opaque type from its internal representation to its external LVARCHAR representation	When the database server sends a character representation of the opaque type as a result of a SELECT or FETCH statement
receive()	Converts the opaque type from its internal representation on the client computer to its internal representation on the server computer Provides platform-independent results regardless of differences between client and server computer types	When a client application sends an internal representation of the opaque type in an INSERT, UPDATE, or LOAD statement
send()	Converts the opaque type from its internal representation on the server computer to its internal representation on the client computer Provides platform-independent results regardless of differences between client and database server computer types	When the database server sends an internal representation of the opaque type as a result of a SELECT or FETCH statement
db_receive()	Converts the opaque type from its internal representation on the local database to the dbsendrecv type for transfer to an external database on the local server	When a local database receives a dbsendrecv type from an external database on the local database server
db_send()	Converts the opaque type from its internal representation on the local database to the dbsendrecv type for transfer to an external database on the local server	When a local database sends a dbsendrecv type to an external database on the local database server
server_receive()	Converts the opaque type from its internal representation on the local server computer to the srvsendrecv type for transfer to a remote database server Use any name for this function.	When the local database server receives a srvsendrecv type from a remote database server
server_send()	Converts the opaque type from its internal representation on the local server computer to the srvsendrecv type for transfer to a remote database server Use any name for this function.	When the local database server sends a srvsendrecv type to a remote database server
import()	Performs any tasks needed to convert from the external (character) representation of an opaque type to the internal format for a bulk copy	When DB-Access (LOAD) or the High Performance Loader (HPL) initiates a bulk copy from a text file to a database
export()	Performs any tasks needed to convert from the internal representation of an opaque type to the external (character) format for a bulk copy	When DB-Access (UNLOAD) or the High Performance Loader initiates a bulk copy from a database to a text file
importbinary()	Performs any tasks needed to convert from the internal representation of an opaque type on the client computer to the internal representation on the server computer for a bulk copy	When DB-Access (LOAD) or the High Performance Loader initiates a bulk copy from a binary file to a database
exportbinary()	Performs any tasks needed to convert from the internal representation of an opaque type on the server computer to the internal representation on the client computer for a bulk copy	When DB-Access (UNLOAD) or the High Performance Loader initiates a bulk copy from a database to a binary file
assign()	Performs any processing required before storing the opaque type to disk This support function must be named assign() .	When the database server executes INSERT, UPDATE, or LOAD, before it stores the opaque type to disk
destroy()	Performs any processing necessary before removing a row that contains the opaque type This support function must be named destroy() .	When the database server executes the DELETE or DROP TABLE, before it removes the opaque type from disk
lohandles()	Returns a list of the LO-pointer structures (pointers to smart large objects) in an opaque type	When the database server must search opaque types for references to smart large objects; when oncheck runs, or an archive is performed
compare()	Compares two values of the opaque type and returns an integer value to indicate whether the first value is less than, equal to, or greater than the second value	When the database server encounters an ORDER BY, UNIQUE, DISTINCT, or UNION clause in a SELECT statement, or when CREATE INDEX creates a B-tree index

After you write the necessary support functions for the opaque type, use the CREATE FUNCTION statement to register these support functions in the same database as the opaque type. Certain support functions convert other data types to or from the new opaque type. After you create and register these support functions, use the CREATE CAST statement to associate each function with a particular cast. The cast must be registered in the same database as the support function.

After you have written the necessary C language or Java language source code to define an opaque data type, you then use the CREATE OPAQUE TYPE statement to register the opaque data type in the database.

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CREATE OPCLASS statement

Use the CREATE OPCLASS statement to create an *operator class* for a *secondary-access method*.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-CREATE OPCLASS--+-+-----+--opclass----->
      '-IF NOT EXISTS-'

>>-FOR--sec_acc_method----->
      .-+-----+
      v      (1) |
>>-STRATEGIES--(----| Strategy Specification |----->
      .-+-----+
      v      |
>>-SUPPORT--(----support_function+--)><
```

Notes:

1. See [CREATE OPCLASS statement](#)

Element	Description	Restrictions	Syntax
<i>opclass</i>	Name that you declare here for a new operator class	Must be unique among operator classes within the database	Identifier
<i>sec_acc_method</i>	Secondary-access method with which the new operator class is associated	Must already exist and must be registered in the sysams table	Identifier
<i>support_function</i>	Support function that the secondary-access method requires	Must be listed in the order expected by the access method	Identifier

Usage

An *operator class* is the set of operators that support a secondary-access method for query optimization and building the index. A *secondary-access method* (sometimes referred to as an *index access method*) is a set of database server functions that build, access, and manipulate an index structure such as a B-tree, R-tree, or an index structure that a DataBlade module provides.

The database server provides the B-tree and R-tree secondary-access methods. For more information on the **btree** secondary-access method, see [Default Operator Classes](#).

Define a new operator class when you want one of the following:

- An index to use a different order for the data than the sequence that the default operator class provides
- A set of operators that is different from any existing operator classes that are associated with a particular secondary-access method

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if an operator class of the specified name is already registered in the current database.

You must have the Resource privilege or be the DBA to create an operator class. The actual name of an operator class is an SQL identifier. When you create an operator class, the *opclass* name must be unique within the database.

When you create an operator class in an ANSI-compliant database, the *owner.opclass* combination must be unique within the database. The owner name is case sensitive. If you do not put quotation marks around the *owner* name (or else set the **ANSIOWNER** environment variable), the name of the operator-class owner is stored in uppercase letters.

The following CREATE OPCLASS statement creates a new operator class called **abs_btree_ops** for the **btree** secondary-access method:

```
CREATE OPCLASS abs_btree_ops FOR btree
STRATEGIES (abs_lt, abs_lte, abs_eq, abs_gte, abs_gt)
SUPPORT (abs_cmp);
```

An operator class has two kinds of operator-class functions:

- Strategy functions
Specify strategy functions of an operator class in the STRATEGY clause of the CREATE OPCLASS statement. In the preceding CREATE OPCLASS code example, the **abs_btree_ops** operator class has five strategy functions.
- Support functions
Specify support functions of an operator class in the SUPPORT clause. In the preceding CREATE OPCLASS code example, the **abs_btree_ops** operator class has one support function.
- [STRATEGIES Clause](#)
- [Strategy Specification](#)
- [Indexes on Side-Effect Data](#)
- [SUPPORT Clause](#)
- [Default Operator Classes](#)
Each secondary-access method has a default operator class that is associated with it. By default, the CREATE INDEX statement associates the default operator class with an index.

Related reference:

[CREATE INDEX statement](#)
[CREATE SCHEMA statement](#)
[CREATE FUNCTION statement](#)
[DROP OPCLASS statement](#)
[Purpose Options](#)

Related information:

[Support functions](#)
[Extend an operator class](#)
[About operator classes](#)
[Name database objects](#)

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STRATEGIES Clause

Strategy functions are functions that users can invoke within a DML statement to operate on a specific data type. The query optimizer uses the strategy functions to determine whether a given index can be used to process a query.

If a query includes a UDF or a column on which an index exists, and if the qualifying operator in the query matches any function in the STRATEGIES clause, then the query optimizer considers using the index for the query. For more information on query plans, see your *IBM® Informix® Performance Guide*.

When you create a new operator class, the STRATEGIES clause identifies the strategy functions for the secondary-access method. Each strategy specification lists the name of a strategy function (and optionally, the data types of its parameters). You must list these functions in the order that the secondary-access method expects. For the specific order of strategy operators for the default operator classes for a B-tree index and for an R-tree index, see *IBM Informix User-Defined Routines and Data Types Developer's Guide*.

Related information:

[The query plan](#)

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Strategy Specification

The STRATEGIES keyword introduces a comma-separated list of function names or function signatures for the new operator class. Each element of this list is called a *strategy specification* and has the following syntax:

Strategy Specification

```
|--strategy_function----->
>--+-----+-----|
'--input_type--,--input_type--+-----+--)'
                                     '-,--output_type-'
```

Element	Description	Restrictions	Syntax
<i>input_type</i>	Data type of an input parameter to the strategy function for which you intend to use a specific secondary-access method	A <i>strategy function</i> accepts two input parameters and can have one optional output parameter	Data Type
<i>output_type</i>	Data type of the optional output parameter of the strategy function	Optional output parameter for side-effect indexes	Data Type
<i>strategy_function</i>	Strategy function to associate with the specified operator class	Must be listed in the order that the specified secondary-access method expects	Identifier

Each *strategy_function* is an external function. The CREATE OPCLASS statement does not verify that a user-defined function of the name you specify exists. However, for the secondary-access method to use the strategy function, the external function must be:

- Compiled in a shared library
- Registered in the database with the CREATE FUNCTION statement

Optionally, you can specify the signature of a strategy function in addition to its name. A strategy function requires two input parameters and an optional output parameter. To specify the function signature, specify:

- An *input data type* for each of the two input parameters of the strategy function, in the order that the strategy function uses them
- Optionally, one *output data type* for an output parameter of the strategy function

You can specify UDTs as well as built-in data types. If you do not specify the function signature, the database server assumes that each strategy function takes two arguments of the same data type and returns a BOOLEAN value.

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Indexes on Side-Effect Data

Side-effect data are additional values that a strategy function returns after a query that contains the strategy function. For example, an image DataBlade module might use a *fuzzy* index to search image data. The index ranks the images according to how closely they match the search criteria. The database server returns the rank values as side-effect data with the qualifying images.

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SUPPORT Clause

Support functions are functions that the secondary-access method uses internally to build and search the index. Specify these functions for the secondary-access method in the SUPPORT clause of the CREATE OPCLASS statement.

You must list the names of the support functions in the order that the secondary-access method expects. For the specific order of support operators for the default operator classes for a B-tree index and an R-tree index, refer to [Default Operator Classes](#).

The support function is an external function. CREATE OPCLASS does not verify that a specified support function exists. For the secondary-access method to use a support function, however, the support function must meet these criteria:

- Be compiled in a shared library
- Be registered in the database with the CREATE FUNCTION statement

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Default Operator Classes

Each secondary-access method has a default operator class that is associated with it. By default, the CREATE INDEX statement associates the default operator class with an index.

For example, the following CREATE INDEX statement creates a B-tree index on the **zipcode** column and automatically associates the default B-tree operator class with this column:

```
CREATE INDEX zip ix ON customer(zipcode)
```

For each of the secondary-access methods that Informix® provides, it provides a default operator class, as follows:

- The default B-tree operator class is a built-in operator class.
The database server implements the operator-class functions for this operator class and registers it as **bttree_ops** in the system catalog tables of a database.
- The default R-tree operator class is a registered operator class.
The database server registers this operator class as **rtree_ops** in the system catalog tables. The database server does *not* implement the operator-class functions for the default R-tree operator class.

Important: To use an R-tree index, you must install a spatial DataBlade module, such as a third-party DataBlade module that implements the R-tree index. These implement the R-tree operator-class functions.

DataBlade modules can provide other types of secondary-access methods. If a DataBlade module provides a secondary-access method, it might also provide a default operator class. For more information, refer to your DataBlade module user's guide.

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CREATE PROCEDURE statement

Use the CREATE PROCEDURE statement to create a user-defined procedure. (To create a procedure from text of source code that is in a separate file, use the CREATE PROCEDURE FROM statement.)

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>--CREATE-----+-----+-----+-----PROCEDURE-----+-----+----->
      |   (1)       |   |   (2)   |                                     '-IF NOT EXISTS-'
      +-----+-----+-----+-----+-----+-----+
      |'-OR REPLACE---'|-DBA-----|
      +-----+-----+-----+-----+-----+-----+
      |
      +-----+-----+-----+-----+-----+-----+
      |
      +-----+-----+-----+-----+-----+-----+
>-+--procedure-----+-----+-----+----->
    |   (3)       |
    +-----+-----+-----+-----+-----+-----+
    |-----function-'
```

```

>--(-----+-----)----->
|          (4) |
|'-| Routine Parameter List |-----'

>+-----+-----+----->
|          (5) |
|'-| REFERENCING Clause |-----FOR +-----+-----table_object-|
|          |'---owner--'-.-'

>+-----+----->
| (2)          (6) |
|-----| Return Clause |-----'

>+-----+----->
|          (7) |
|'-SPECIFIC--| Specific Name |-----'

>+-----+-----+----->
|          |'-;-'
| (3)          V          (8) | |
|-----WITH--(----| Routine Modifier |-----+--)-'

(3)          (9)
>+-----+-----+----->
| (10)          | Statement Block |-----+----->
|-----| External Routine Reference |-----' (11) |

>--END PROCEDURE-->
|          |'-;-'
|          V          (12) | |
|'-DOCUMENT---| Quoted String |-----+--'

>+-----+-----><
|'-WITH LISTING IN--'pathname'-'

```

Note:

1. See [OR REPLACE Clause](#)
2. See [DBA Keyword and Privileges on the Procedure](#)
3. Stored Procedure Language only
4. See [Routine Parameter List](#)
5. See [The REFERENCING and FOR Clauses](#)
6. See [Return Clause](#)
7. See [Specific Name](#)
8. See [Routine modifier](#)
9. See [Statement Block](#)
10. External routines only
11. See [External Routine Reference](#)
12. See [Quoted String](#)

Element	Description	Restrictions	Syntax
<i>function</i> , <i>procedure</i>	Name declared here for a new SPL routine	See Procedure names in Informix .	Identifier
<i>owner</i>	Owner of <i>table_object</i>	Must own <i>table_object</i>	Owner name
<i>pathname</i>	File to store compile-time warnings	Must exist on the computer where the database resides	Operating system specific
<i>table_object</i>	Name or synonym of a table or view whose triggers can call this UDR	Must exist in the local database	Identifier

Usage

In IBM® Informix® ESQL/C, you can use CREATE PROCEDURE only as text within a PREPARE statement. If you want to create a procedure for which the text is known at compile time, you must use a CREATE PROCEDURE FROM statement.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if a procedure of the specified name is already registered in the current database. (Because the identifier of a procedure can be overloaded, it might be unnecessary to include these keywords, if the database server can resolve the argument list of the new procedure as different from that of any other procedure of the same name in the current database.)

Routines use the collating order that was in effect when they were created. See [SET COLLATION statement](#) of Informix for information about using non-default collation.

Example

For this example, assume that you have two overloaded procedures that are defined as follows:

```

CREATE PROCEDURE raise_prices ( per_cent INT)
    UPDATE stock SET unit_price = unit_price + (unit_price * (per_cent/100) );
END PROCEDURE

CREATE PROCEDURE raise_prices ( per_cent INT, selected_unit CHAR )
    UPDATE stock SET unit_price = unit_price + (unit_price * (per_cent/100) )

```



```

        where unit=selected_unit;
END PROCEDURE

```

In order to refer to the above procedures, you would need to provide the procedure name followed by the parameter list, as in the following examples:

```

DROP PROCEDURE raise_prices(INT);
DROP PROCEDURE raise_prices(INT, CHAR);

```

A more convenient way is to use the specific name to identify each of them. The following example will create the procedure using the specific name:

```

CREATE PROCEDURE raise_prices ( per_cent INT ) SPECIFIC
    raise_prices_all
    UPDATE stock SET unit_price = unit_price + (unit_price * (per_cent/100) );
END PROCEDURE

DROP SPECIFIC PROCEDURE raise_prices_all;

CREATE PROCEDURE raise_prices ( per_cent INT, selected_unit CHAR )
    SPECIFIC raise_prices_by_unit
    UPDATE stock SET unit_price = unit_price + (unit_price * (per_cent/100) )
    where unit=selected_unit;
END PROCEDURE

```

We can simply drop them using their specific names:

```

DROP SPECIFIC PROCEDURE raise_prices_by_all;
DROP SPECIFIC PROCEDURE raise_prices_by_unit;

```

- [Using CREATE PROCEDURE Versus CREATE FUNCTION](#)
- [Relationship Between Routines, Functions, and Procedures](#)
- [Privileges Necessary for Using CREATE PROCEDURE](#)
- [OR REPLACE Clause](#)

The OR REPLACE clause is used to update an existing procedure without changing any object privileges granted on it.

- [DBA Keyword and Privileges on the Procedure](#)

If you create a UDR with the DBA keyword, it is known as a DBA-privileged UDR. You need the DBA privilege to create a DBA-privileged UDR. If you omit the DBA keyword, the UDR is known as an owner-privileged UDR. Other users who have Execute privilege on the UDR run the UDR with the privileges of the user who created the UDR.

- [The REFERENCING and FOR Clauses](#)

The REFERENCING clause can declare correlation names for the original value and for the updated value in columns of the *table_object* that the FOR clause specifies

- [Procedure names in Informix](#)
- [DOCUMENT Clause](#)
- [Using the WITH LISTING IN Option](#)
- [SPL Procedures](#)
- [External Procedures](#)

Related concepts:

[Overloading the Name of a Function](#)

[INSTEAD OF Triggers on Views](#)

Related reference:

[CREATE ROUTINE FROM statement](#)

[ALTER FUNCTION statement](#)

[ALTER PROCEDURE statement](#)

[ALTER ROUTINE statement](#)

[CREATE FUNCTION statement](#)

[CREATE FUNCTION FROM statement](#)

[CREATE PROCEDURE FROM statement](#)

[DROP FUNCTION statement](#)

[DROP PROCEDURE statement](#)

[DROP ROUTINE statement](#)

[EXECUTE FUNCTION statement](#)

[EXECUTE PROCEDURE statement](#)

[GRANT statement](#)

[PREPARE statement](#)

[REVOKE statement](#)

Related information:

[Create and use SPL routines](#)

[Create an external-language routine](#)

[Develop a user-defined routine](#)

[System catalog tables](#)

[NODEFDAC environment variable](#)

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Using CREATE PROCEDURE Versus CREATE FUNCTION

Although you can use CREATE PROCEDURE to write and register an SPL routine that returns one or more values (that is, an SPL function) In Informix®, it is recommended that you use CREATE FUNCTION instead. To register an external function, you must use CREATE FUNCTION.

Use the CREATE PROCEDURE statement to write and register an SPL procedure or to register an external procedure.

For information on how terms such as user-defined procedures and user-defined functions are used in this document, see [Relationship Between Routines, Functions, and Procedures](#).

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Relationship Between Routines, Functions, and Procedures

A *procedure* is a routine that can accept arguments but does not return any values. A *function* is a routine that can accept arguments and returns one or more values. *User-defined routine* (UDR) is a generic term that includes both user-defined procedures and user-defined functions. For information about named and unnamed returned values, see [Return Clause](#).

You can write a UDR in SPL (a SPL *routine*) or in an external language (an *external routine*) that the database server supports. Where the term UDR appears in this document, it can refer to both SPL routines and external routines.

The term *user-defined procedure* refers to SPL procedures and external procedures. *User-defined function* refers to SPL functions and external functions.

In the documentation of earlier releases, the term *stored procedure* was used for both SPL procedures and SPL functions. In this document, the term *SPL routine* replaces the term stored procedure. When it is necessary to distinguish between an SPL function and an SPL procedure, this document does so.

The term *external routine* applies to an external procedure or an external function, both constructs designating UDRs that are written in a programming language other than SPL. When it is necessary to distinguish between an external function and an external procedure, this document does so.

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Privileges Necessary for Using CREATE PROCEDURE

You must have the Resource privilege on a database to create a user-defined procedure within that database.

Before you can create an SPL procedure, you must also have the Usage privilege on the SPL, C, or Java™ language in which the procedure is written. For more information, see [Language-Level Privileges](#).

By default, the Usage privilege on SPL is granted to PUBLIC. You must also have at least the Resource privilege on a database to create an SPL procedure within that database.

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OR REPLACE Clause

The OR REPLACE clause is used to update an existing procedure without changing any object privileges granted on it.

Example

```
create procedure testproc() returning char(50);
  return "this is the original procedure";
end procedure;
Routine created.

call testproc();

(expression)
this is the original procedure
1 row(s) retrieved.

create procedure testproc() returning char(50);
  return "this is the replaced procedure";
end procedure;
673: Another routine (testproc) with same signature already exists in database

create or replace procedure testproc() returning char(50);
  return "this is the replaced procedure";
end procedure;
Routine created.

call testproc();

(expression)
this is the replaced procedure
```

1 row(s) retrieved.

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DBA Keyword and Privileges on the Procedure

If you create a UDR with the DBA keyword, it is known as a DBA-privileged UDR. You need the DBA privilege to create a DBA-privileged UDR. If you omit the DBA keyword, the UDR is known as an owner-privileged UDR. Other users who have Execute privilege on the UDR run the UDR with the privileges of the user who created the UDR.

DBA-privileged UDRs

For a DBA-privileged UDR, users who do not hold the DBA privilege can run the routine under the following conditions:

- The DBA grants the user Execute privilege on the UDR.
- The DBA grants the Execute privilege to PUBLIC so that all users can run the UDR.

When you have Execute privilege on a DBA-privileged UDR, you run the UDR with DBA privileges.

For additional information about DBA-privileged UDRs, see [Ownership of Created Database Objects](#).

Owner-privileged UDRs

In an ANSI-compliant database, before other users can execute an owner-privileged UDR, the owner must grant the Execute privilege, either to individual users, or to roles, or to PUBLIC.

In a database that is not ANSI compliant, any user can run the UDR because PUBLIC is granted the Execute privilege by default. To restrict access to an owner-privileged UDR to specific users, the owner must revoke the Execute privilege on the UDR from PUBLIC, and then grant it to specified users or roles. However, you can prevent privileges on UDRs from being granted to PUBLIC by default. by setting the NODEFDAC environment variable to yes. Then the owner must grant the Execute privilege for the UDR to other users.

For an owner-privileged UDR, all non-qualified database objects that the UDR references are implicitly qualified by the name of the UDR owner. To allow other users to run the UDR, the owner of the UDR must be granted the necessary privileges on any underlying database objects with the WITH GRANT OPTION keyword in the GRANT statement.

The privileges of the owner determine who can run an owner-privileged UDR:

- If the owner does not have privileges on all of the objects that are referenced by the UDR, then the UDR fails regardless of whether the owner or another user runs it.
- If the owner has privileges on all referenced objects, but does not have the GRANT option, then only the owner can run the UDR. Other users cannot run the UDR, even if they have Execute privilege on the UDR.
- If the owner has privileges with the GRANT option on all referenced objects, then the owner and other users who have the Execute privilege can run the UDR. Other users who have Execute privilege run the UDR with the owner's privileges.

Related reference:

[WITH GRANT OPTION keywords](#)

Related information:

[NODEFDAC environment variable](#)

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The REFERENCING and FOR Clauses

The REFERENCING clause can declare correlation names for the original value and for the updated value in columns of the *table_object* that the FOR clause specifies

REFERENCING and FOR Clauses

```
.-----  
V      (1)      |  
|--REFERENCING---+-----OLD---+-----+correlation+----->  
                  | (1)      | '-AS-'  
                  '-----NEW-'  
  
>--FOR +-----+table_object-----|  
        '-owner-' '-'
```

Notes:

1. Use path no more than once

Element	Description	Restrictions	Syntax
---------	-------------	--------------	--------

Element	Description	Restrictions	Syntax
<i>correlation</i>	Name that you declare here to qualify an old or new column value (as <i>correlation.column</i>) in a trigger routine	Must not be <i>table_object</i>	Identifier
<i>owner</i>	Owner of <i>table_object</i>	Must own <i>table_object</i>	Owner name
<i>table_object</i>	Name or synonym for the table or view whose triggers can call this procedure	Must exist in the local database	Identifier

If you include the REFERENCING and FOR *table_object* clauses immediately after the parameter list of the CREATE PROCEDURE statement, the routine that you create is known as a *trigger procedure* (or *trigger UDR* or *trigger routine*). The FOR clause specifies the table or view whose triggers can invoke the routine from the FOR EACH ROW section of their Triggered Action list.

In the REFERENCING clause, the OLD *correlation* specifies a prefix by which the trigger routine can reference the value that a column of *table_object* had before the trigger routine modifies that column value. The NEW *correlation* specifies a prefix for referencing the new value that the trigger routine assigns to the column. Whether the trigger routine can use correlation names to reference the OLD column value, the NEW column value, or both values depends on the type of triggering event:

- A trigger routine invoked by an Insert trigger can reference only the NEW correlation name.
- A trigger routine invoked by a Delete trigger or by a Select trigger can reference only the OLD correlation name.
- A trigger routine invoked by an Update trigger can reference both the OLD and the NEW correlation names.

For information about how to use the *correlation.column* notation in triggered actions, see [REFERENCING Clauses](#).

Besides the general requirements for any Informix® UDR that is written in the SPL language, trigger routines can support certain additional syntax features, and are subject to certain restrictions, that are not features (or that are not restrictions) for ordinary UDRs that are not trigger routines:

- A trigger routine must include the FOR *table_object* clause that specifies the name of the table or view in the local database whose triggers can invoke this routine.
- A trigger routine can also include the REFERENCING clause to declare correlation names for OLD and NEW values that SPL statements in the UDR can reference.
- Trigger routines can be invoked only in the FOR EACH ROW section of the Triggered Action list in the trigger definition.
- Correlated variables for OLD or NEW values can appear in the IF statement of SPL and in CASE expressions.
- Correlated variables for OLD values cannot be on the left-hand side of a LET expression
- Correlated variables for NEW values cannot be on the left-hand side of a LET expression if the FOR clause specifies a view whose INSTEAD OF trigger action list invokes the trigger routine.
- Only correlated variables for NEW values can be on the left-hand side of a LET expression that references correlated variables. In this case, the FOR clause must specify a table, rather than a view, and the trigger whose action invokes the SPL routine cannot be an INSTEAD OF trigger.
- Both OLD and NEW values can be on the right-hand side of a LET expression.
- The Boolean operators SELECTING, INSERTING, DELETING, and UPDATING are valid in trigger routines (and only in trigger routines and in other UDRs that are invoked in triggered action statements) in contexts where Boolean expressions are valid. These operators return TRUE ('t') if the triggering event matches the DML operation referenced by the name of the operator, and they return FALSE ('f') otherwise.
- If a single triggering event activates multiple triggers on the same table or view, then all of the BEFORE actions take place before any of the FOR EACH ROW actions, and all of the AFTER actions follow the FOR EACH ROW actions. The order of execution of different triggers on the same event is not guaranteed.
- Trigger routines must be written in the SPL language. They cannot be written in an external language, like the C or Java™ language, but they can include calls to external language routines, such as the **mi_trigger** application programming interface for trigger introspection.
- Trigger routines cannot reference savepoints. Any changes to the data values or to the schema of the database by a triggered action must be committed or rolled back in their entirety. Partial rollback of a triggered action is not supported.

For more information about the **mi_trigger** API, refer to the *IBM® Informix DataBlade API Programmer's Guide* and to the *IBM Informix DataBlade API Function Reference*.

If you include the REFERENCING clause but omit the FOR clause, or if you include the FOR clause but omit the REFERENCING clause, the CREATE PROCEDURE statement fails with an error.

If you omit the REFERENCING and FOR clauses, the UDR cannot use the SELECTING, INSERTING, DELETING, and UPDATING operators, and cannot declare variables that can represent and manipulate column values in triggered actions on the table or view that the trigger definition specifies.

See the [REFERENCING Clauses](#) section in the CREATE TRIGGER statement description for the syntax of the REFERENCING clause for Delete, Insert, Select, and Update triggers on tables, and for Delete, Insert, and Update INSTEAD OF triggers on views.

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Procedure names in Informix

Because IBM® Informix® offers *routine overloading*, you can define more than one user-defined routine (UDR) with the same name, but different parameter lists. You might want to overload UDRs in the following situations:

- You create a UDR with the same name as a built-in routine (such as **equal()**) to process a new user-defined data type.
- You create *type hierarchies* in which subtypes inherit data representation and UDRs from supertypes.
- You create *distinct types*, which are data types that have the same internal storage representation as an existing data type, but have different names and cannot be compared to the source type without casting. Distinct types inherit UDRs from their source types.

For a brief description of the routine signature that uniquely identifies each UDR, see [Routine Overloading and Routine Signatures](#).

- [Using the SPECIFIC Clause to Specify a Specific Name](#)

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Using the SPECIFIC Clause to Specify a Specific Name

You can declare a *specific name* that is unique in the database for a user-defined procedure. A specific name is useful when you are overloading a procedure.

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DOCUMENT Clause

The quoted string in the DOCUMENT clause provides a synopsis and description of a UDR. The string is stored in the **sysprocbody** system catalog table and is intended for the user of the UDR.

Anyone with access to the database can query the **sysprocbody** system catalog table to obtain a description of one or all the UDRs stored in the database. A UDR or application program can query the system catalog tables to fetch the DOCUMENT clause and display it for a user.

For example, to find the description of the SPL procedure **raise_prices**, shown in [SPL Procedures](#), enter a query such as this example:

```
SELECT data FROM sysprocbody b, sysprocedures p
WHERE b.procid = p.procid
      --join between the two catalog tables
      AND p.procname = 'raise_prices'
      -- look for procedure named raise_prices
      AND b.datakey = 'D';-- want user document
```

The preceding query returns the following text:

```
USAGE: EXECUTE PROCEDURE raise_prices( xxx )
xxx = percentage from 1 - 100
```

For external procedures, you can use a DOCUMENT clause at the end of the CREATE PROCEDURE statement, whether or not you use the END PROCEDURE keywords.

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Using the WITH LISTING IN Option

The WITH LISTING IN clause specifies a filename where compile time warnings are sent. After you compile a UDR, this file holds one or more warning messages. This listing file is created on the computer where the database resides.

If you do not use the WITH LISTING IN clause, the compiler does not generate a list of warnings.

On UNIX, if you specify a filename but not a directory, this listing file is created in your home directory on the computer where the database resides. If you do not have a home directory on this computer, the file is created in the root directory (the directory named "/").

On Windows, if you specify a filename but not a directory, this listing file is created in your current working directory if the database is on the local computer. Otherwise, the default directory is **%INFORMIXDIR%\bin**.

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SPL Procedures

SPL procedures are UDRs written in Stored Procedure Language (SPL) that do not return a value. To write and register an SPL routine, use the CREATE PROCEDURE statement. Embed appropriate SQL and SPL statements between the CREATE PROCEDURE and END PROCEDURE keywords. You can also follow the UDR definition with the DOCUMENT and WITH FILE IN options.

SPL routines are parsed, optimized (as far as possible), and stored in the system catalog tables in executable format. The body of an SPL routine is stored in the **sysprocbody** system catalog table. Other information about the routine is stored in other system catalog tables, including **sysprocedures**, **sysprocplan**, and **sysprocauth**.

If the Statement Block portion of the CREATE PROCEDURE statement is empty, no operation takes place when you call the procedure. You might use such a "dummy" procedure in the development stage when you intend to establish the existence of a procedure but have not yet coded it.

If you specify an optional clause after the parameter list, you must place a semicolon after the clause that immediately precedes the Statement Block.

The following example creates an SPL procedure:

```
CREATE PROCEDURE raise_prices ( per_cent INT )
  UPDATE stock SET unit_price =
    unit_price + (unit_price * (per_cent/100));
END PROCEDURE
DOCUMENT "USAGE: EXECUTE PROCEDURE raise_prices( xxx )",
"xxx = percentage from 1 - 100 "
WITH LISTING IN '/tmp/warn_file';
```

External Procedures

External procedures are procedures you write in an external programming language that the database server supports. (Procedures written in the SPL language are not external procedures.)

To create a C user-defined procedure

1. Write a C function that does not return a value.
2. Compile the C function and store the compiled code in a shared library (the shared-object file for C).
3. Register the C function in the database server with the CREATE PROCEDURE statement.

To create a user-defined procedure written in the Java™ language:

1. Write a Java static method, which can use the JDBC functions to interact with the database server.
2. Compile the Java source and create a JAR file (the shared-object file).
3. Execute the **install_jar()** procedure with the EXECUTE PROCEDURE statement to install the JAR file in the current database.
4. If the UDR uses user-defined types, create a mapping between SQL data types and Java classes, using the **setUDTextName()** procedure that is explained in [EXECUTE PROCEDURE statement](#).
5. Register the UDR with the CREATE PROCEDURE statement. (If an external routine returns a value, you must register it with the CREATE FUNCTION statement, rather than with CREATE PROCEDURE.)

Rather than storing the body of an external routine directly in the database, the database server stores only the pathname of the shared-object file that contains the compiled version of the routine. The database server executes an external routine by invoking the external object code.

You must also hold either the Resource privilege or the DBA privilege on the database in which the external procedure will be registered, as well as the Usage privilege on the programming language in which the routine is written. (For the syntax of granting Usage privileges on the C language or on the Java language to a user, or to a role, or to the PUBLIC group, see [Language-Level Privileges](#).)

When the IFX_EXTEND_ROLE configuration parameter is set to 1 or to ON, only users who have the built-in EXTEND role can create external procedures.

- [Registering a User-Defined Procedure](#)
- [Ownership of Created Database Objects](#)

Registering a User-Defined Procedure

This example registers a C user-defined procedure named **check_owner()** that takes one argument of the type LVARCHAR. The external routine reference specifies the path to the C shared library where the procedure object code is stored. This library contains a C function **unix_owner()**, which is invoked during execution of the **check_owner()** procedure.

```
CREATE PROCEDURE check_owner ( owner lvvarchar )
  EXTERNAL NAME "/usr/lib/ext_lib/genlib.so(unix_owner)"
  LANGUAGE C
END PROCEDURE;
```

This example registers a user-defined procedure named **showusers()** that is written in the Java™ language:

```
CREATE PROCEDURE showusers()
  WITH (CLASS = "jvp") EXTERNAL NAME 'admin_jar:admin.showusers'
  LANGUAGE JAVA;
```

The EXTERNAL NAME clause specifies that the Java implementation of the **showusers()** procedure is a method called **showusers()**, which resides in the **admin** Java class that resides in the **admin_jar** JAR file.

Ownership of Created Database Objects

The user who creates an owner-privileged UDR owns any database objects that the UDR creates when it executes, unless some other *owner* is specified for the object. In other words, the UDR owner, not the user who executes the owner-privileged UDR, is the owner of any database objects created by the UDR unless another owner is specified in the DDL statement that creates the database object.

In the case of a DBA-privileged UDR, however, the user who executes the UDR, not the UDR owner, owns any database objects that the UDR creates, unless some other owner is specified for the database object within the UDR.

For examples, see [Ownership of Created Database Objects](#) in the description of the CREATE FUNCTION statement.

CREATE PROCEDURE FROM statement

Use the CREATE PROCEDURE FROM statement to access a user-defined procedure. The actual text of the CREATE PROCEDURE statement resides in a separate file.

This statement is an extension to the ANSI/ISO standard for SQL. You can use this statement with Informix® ESQL/C.

Syntax

```
>>-CREATE PROCEDURE FROM--+-+-----+---+-'file'-----><
      '-IF NOT EXISTS-'  '-file_var-'
```

Element	Description	Restrictions	Syntax
<i>file</i>	Pathname and filename of file that contains full text of a CREATE PROCEDURE statement. Default pathname is the current directory.	Must exist, and can contain only one CREATE PROCEDURE statement. See also Default Directory That Holds the File .	Operating-system specific
<i>file_var</i>	Name of a program variable that contains <i>file</i> specification	Must be of a character data type; its contents have same restrictions as <i>file</i>	Language specific

Usage

You cannot create a user-defined procedure directly in Informix ESQL/C programs. That is, the program cannot contain the CREATE PROCEDURE statement.

To use a user-defined procedure in an ESQL/C program:

1. Create a source file with the CREATE PROCEDURE statement.
2. Use the CREATE PROCEDURE FROM statement to send the contents of this source file to the database server for execution. The file can contain only one CREATE PROCEDURE statement.

For example, suppose that the following CREATE PROCEDURE statement is in a separate file, called **raise_pr.sql**:

```
CREATE PROCEDURE raise_prices( per_cent INT )
  UPDATE stock -- increase by percentage;
  SET unit_price = unit_price +
    ( unit_price * (per_cent / 100) );
END PROCEDURE;
```

In the Informix ESQL/C program, you can access the **raise_prices()** SPL procedure with the following CREATE PROCEDURE FROM statement:

```
EXEC SQL create procedure from 'raise_pr.sql';
```

If you are not sure whether the UDR in the file returns a value, use the CREATE ROUTINE FROM statement.

When the IFX_EXTEND_ROLE configuration parameter is set to ON, only users who have the built-in EXTEND role can create external routines.

When the IFX_EXTEND_ROLE configuration parameter is set to 1 or to ON, only users to whom the Database Server Administrator (DBSA) has granted the built-in EXTEND role can create external routines. In addition, you must hold at least the Resource access privilege on the database in which the routine will be registered. You must also hold the Usage privilege on the programming language in which the routine is written. (For the syntax of granting Usage privileges on the C language to a user or to a role, see [Language-Level Privileges](#).)

User-defined procedures, like user-defined functions, use the collating order that was in effect when they were created. See [SET COLLATION statement](#) for information about using non-default collation.

- [Default Directory That Holds the File](#)

Related reference:

[CREATE ROUTINE FROM statement](#)
[DROP PROCEDURE statement](#)
[CREATE PROCEDURE statement](#)
[CREATE FUNCTION FROM statement](#)
[Arguments](#)

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Default Directory That Holds the File

The database server treats the specified filename (and any pathname) as relative.

On UNIX, if you specify a simple filename instead of a full pathname as the *file* parameter, the client application looks for the file in your home directory on the computer where the database resides. If you do not have a home directory on this computer, the default directory is the root directory.

On Windows, if you specify a filename but no directory as the *file* parameter, the client application looks for the file in your current working directory if the database is on the local computer. Otherwise, the default directory is **%INFORMIXDIR%\bin**.

Important: The Informix® ESQL/C preprocessor does not process the contents of the file that you specify. It only sends the contents to the database server for execution. Therefore, there is no syntactic check that the file that you specify in CREATE PROCEDURE FROM actually contains a CREATE PROCEDURE statement. To improve readability of the code, however, it is recommended that you match these two statements.

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CREATE ROLE statement

Use the CREATE ROLE statement to declare and register a new role.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-CREATE ROLE-----+--+role-----><
      '-IF NOT EXISTS-'  '- 'role'-'
```

Element	Description	Restrictions	Syntax
<i>role</i>	Name declared here for a role that the DBA creates	Must be unique among <i>role</i> and user names in the database. Maximum number of bytes is 32.	Owner name

Usage

CREATE ROLE declares a new role and registers it in the system catalog. A role can associate a set of authorization identifiers with a set of access privileges on database objects. The system catalog maintains information about the roles (and their corresponding privileges) that are granted to users or to other roles.

Only the database administrator (DBA) can use CREATE ROLE to create a new role. The DBA can assign the privileges required for some work task to a role, such as **engineer**, and then use the GRANT statement to assign that role to specific users, instead of granting that set of privileges to each user individually.

The *role* name is an *authorization identifier*. It cannot be a user name that is known to the database server or to the operating system of the database server. The *role* name cannot already be listed in the **username** column of the **sysusers** system catalog table, nor in the **grantor** or **grantee** columns of the **sysabauth**, **syscolauth**, **sysfragauth**, **sysprocauth**, or **sysroleauth** system catalog tables.

The *role* name also cannot match the name of any user or role that is already listed in the **grantor** or **grantee** columns of the **sysxtdtypeauth** system catalog table, nor any built-in role, such as EXTEND or DBSECADM.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if a role of the specified name is already registered in the current database.

After a role is created, the DBA can use the GRANT statement to assign the role to PUBLIC, to users, or to other roles, and to grant specific privileges to the role. (A role cannot, however, hold database-level privileges.) After a role is granted successfully to a user or to PUBLIC, the user must use the SET ROLE statement to enable the role. Only then can the user exercise the privileges of the role.

To create the role **engineer**, for example, enter the following statement:

```
CREATE ROLE engineer;
```

To grant access privileges to the role **engineer**, the DBA can issue GRANT statements that include **engineer** in the list of grantees:

```
GRANT USAGE ON LANGUAGE SPL TO engineer;
```

To assign the role **engineer** to user **kaycee**, the DBA could issue this statement:

```
GRANT engineer TO kaycee;
```

To activate the role **engineer**, user **kaycee** must issue the following statement:

```
SET ROLE engineer;
```

If this SET ROLE statement is successful, user **kaycee** acquires whatever privileges have been granted to the role **engineer**, in addition to any other privileges that **kaycee** already holds as an individual or as PUBLIC.

A user can be granted several roles, but no more than one non-default role, as specified by SET ROLE, can be enabled for any user at a given time.

An exception to requiring SET ROLE to explicitly enable a role is any default role that the DBA specifies in the GRANT DEFAULT ROLE *role* TO *user* statement. If that statement succeeds, the default *role* is automatically enabled when *user* connects to the database. Any role can be a default role. (Similarly, users to whom the Informix® DBSA grants the EXTEND role need not execute SET ROLE before they can create and drop external routines and shared libraries.)

CREATE ROLE, when used with the GRANT and SET ROLE statements, enables a DBA to create one set of privileges for a role and then grant the role to many users, instead of granting the same set of privileges individually to many users.

With the GRANT DEFAULT ROLE and SET ROLE DEFAULT statements, *default roles* enable a DBA to assign privileges to a role that is activated automatically when any user who holds that default role connects to the database. This feature is useful when an application performs operations that require specific access privileges, but the application does not include SET ROLE statements.

The REVOKE statement can cancel access privileges of a role, remove users from a role, or cancel the default status of a role for one or more users. A role exists until either the DBA or a user to whom the role was granted with the WITH GRANT OPTION keywords uses the DROP ROLE statement to drop the role.

Important: The scope of a user-defined role (and of discretionary access privileges that the GRANT statement assigns to the role) is the current database. When the GRANT DEFAULT ROLE or SET ROLE statement activates a role, the role and its privileges take effect in the current database only. As a security precaution, discretionary access privileges that a user receives only from a role cannot provide access to tables outside the current database through a view or through a trigger action.

Related reference:

[SET ROLE statement](#)

[DROP ROLE statement](#)

[GRANT statement](#)

[REVOKE statement](#)

Related information:

[Roles](#)

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CREATE ROUTINE FROM statement

Use the CREATE ROUTINE FROM statement to register a UDR by referencing the text of a CREATE FUNCTION statement or CREATE PROCEDURE statement that resides in a separate file.

This statement is an extension to the ANSI/ISO standard for SQL.

You can use this statement with ESQL/C.

Syntax

```
>>-CREATE ROUTINE FROM---+-----+---+-'file'---+-----><
                        '-IF NOT EXISTS-'  '-file_var-'
```

Element	Description	Restrictions	Syntax
<i>file</i>	Pathname and filename for the text of a CREATE PROCEDURE or CREATE FUNCTION statement. Default path is the current directory.	Must exist and can contain only one CREATE FUNCTION or CREATE PROCEDURE statement.	Operating-system dependent
<i>file_var</i>	Name of a program variable that contains <i>file</i> specification	Must be a character data type; contents must satisfy <i>file</i> restrictions	Language specific

Usage

ESQL/C programs cannot use the CREATE FUNCTION or CREATE PROCEDURE statement directly to define a UDR. You must instead do this:

1. Create a source file with the CREATE FUNCTION or CREATE PROCEDURE statement.
2. Execute the CREATE ROUTINE FROM statement from an ESQL/C program to send the contents of this source file to the database server for execution. The file that you specify can contain only one CREATE FUNCTION or CREATE PROCEDURE statement.

The file specification that you provide is relative. If you include no pathname, the client application looks for the file in the current directory.

If you do not know at compile time whether the UDR in the file is a function or a procedure, use the CREATE ROUTINE FROM statement in the Informix® ESQL/C program. If you know whether the UDR is a function or a procedure, you can improve the readability of your code by using the matching SQL statement to access the source file:

- To access user-defined functions, use CREATE FUNCTION FROM.
- To access user-defined procedures, use CREATE PROCEDURE FROM.

When the IFX_EXTEND_ROLE configuration parameter is set to 1 or to ON, only users to whom the Database Server Administrator (DBSA) has granted the built-in EXTEND role can create external routines. In addition, you must hold at least the Resource access privilege on the database in which the routine will be registered. You must also hold the Usage privilege on the programming language in which the routine is written. (For the syntax of granting Usage privileges on the C language to a user or to a role, see [Language-Level Privileges](#).)

Routines use the collating order that was in effect when they were created. See [SET COLLATION statement](#) for information about using non-default collation.

Examples

The following statement registers at UDR by referencing the text in the del_ord.sql file.

```
EXEC SQL CREATE ROUTINE FROM 'del_ord.sql';
```

ESQL/C source code example:

```
#include <stdio.h>

main ()
```

```
{
    printf( "CREATE ROUTINE FROM ESQL Program running.\n\n");
    EXEC SQL WHENEVER ERROR STOP;
    EXEC SQL connect to 'stores_demo';

    EXEC SQL CREATE ROUTINE FROM 'del_ord.sql';

    EXEC SQL disconnect current;
    printf("\nCREATE ROUTINE Sample Program over.\n\n");

    exit(0);
}

del_ord.sql

CREATE FUNCTION delete_order( p_order_num int) RETURNING int, int;
    DEFINE item_count int;
    SELECT count(*) INTO item_count FROM items
        WHERE order_num = p_order_num;
    DELETE FROM orders WHERE order_num = p_order_num;
    RETURN p_order_num, item_count;
END FUNCTION;
```

Use the CREATE ROW TYPE statement to create a named ROW type.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

Element	Description	Restrictions	Syntax
<i>data_type</i>	Data type of the <i>field</i>	See Restrictions on Serial and Simple-Large-Object Data Types .	Identifier
<i>field</i>	Name of a field in <i>row_type</i>	Must be unique among field names of this ROW type and of its supertype	Identifier
<i>owner</i>	Authorization identifier of the owner of this ROW type	In an ANSI-compliant database, the combination <i>owner,row_type</i> must be unique among data-type objects	Owner name
<i>row_type</i>	Name declared here for a new named ROW data type	See Procedure for Creating a Subtype . Must be unique among data type names in the database.	Identifier
<i>supertype</i>	Name of the supertype of <i>row_type</i> within a data-type inheritance hierarchy	To create a child ROW type, this must exist in the database as a named ROW type, all of whose fields this <i>row_type</i> inherits	Data Type

Usage

You must hold the Resource privilege to use this statement. If the UNDER clause declares the new ROW type as a subtype of an existing named ROW type, you must also hold the UNDER privilege for that named ROW type. You are, by default, the owner of the named ROW types that you create, but a DBA who issues the CREATE ROW TYPE statement can designate another user as *owner*.

The CREATE ROW TYPE statement declares a named ROW data type and registers it in the **sysxdtypes** system catalog table. You can assign a named ROW data type to a table or view to create a *typed table* or *typed view*. You can also define a column as a named ROW type.

The following example creates a named ROW type called **people_t** with four fields:

```
CREATE ROW TYPE people_t
(
  name    VARCHAR(40) NOT NULL,
  address VARCHAR(35) ,
  city    VARCHAR(25) ,
  bdate   DATE
);
```

In some SQL code examples in this document, the SQL identifiers of named ROW types have `_t` as the last two characters. This suffix is only a documentation convention, and not a requirement of the database server.

Although you can assign a ROW type to a table to define the schema of the table, ROW data types are not the same as table rows. Table rows consist of one or more *columns*; ROW data types consist of one or more *fields*, defined using the Field Definition syntax.

A named ROW data type is valid in most contexts where you can specify a data type.

The following CREATE TABLE statement defines a typed table whose only column is of the **people_t** ROW type:

```
CREATE TABLE birthdays OF TYPE people_t
  LOCK MODE ROW;
```

Named ROW types are said to be *strongly typed*. No two named ROW types are equivalent, even if they are structurally equivalent. To compare values of a named ROW type with values of another named ROW type, or with values of an unnamed ROW type, you must use an explicit cast, so that both rows are of the same data type.

ROW types without identifiers are called *unnamed ROW types*. Any two unnamed ROW types are considered equivalent if they are structurally equivalent. For more information, see [ROW Data Types](#).

Discretionary access privileges on the fields of named ROW types are the same as privileges on columns. For more information, see [Table-Level Privileges](#). (To see what privileges you have on a column, check the **syscolauth** system catalog table, which is described in the *IBM® Informix Guide to SQL: Reference*.)

If you include the optional `IF NOT EXISTS` keywords, the database server takes no action, rather than sending an exception to the application, if a named ROW of the specified name is already registered in the current database. In this case, the CREATE ROW TYPE statement has no effect, and does not register a new named ROW type in the **sysxdtypes** system catalog table.

If no field is of the SERIAL, BIGSERIAL, or SERIAL8 data type, named ROW data types that the CREATE ROW TYPE statement defines can be the source type for DISTINCT ROW data types that the CREATE DISTINCT TYPE statement can define.

Important:

You cannot use the CREATE ROW TYPE statement to create an unnamed ROW type. Unnamed ROW types are created in the CREATE TABLE statement or in the ALTER TABLE statement by including the ROW constructor syntax segment in the definition of a column. This can be an unnamed ROW type column that you declare in the CREATE TABLE statement, or an unnamed ROW type that you add to the schema of an existing table by using the ALTER TABLE statement.

Field definition

When you define a new named ROW type with no UNDER clause, the Field Definition clause defines an ordered list of the data types and NOT NULL constraints of one or more fields in the new named ROW type.

If the UNDER clause identifies a *supertype*, however, the Field Definition clause can append one or more fields to the ordered list of fields that the new child ROW type inherits from its parent supertype within a named ROW type hierarchy.

If you omit the Field definition, the new subtype has only the fields that it inherits from the parent supertype that the UNDER clause specifies.

The NOT NULL constraint on the named ROW type field applies to the corresponding columns when a typed table of the named ROW type is created. If you omit the NOT NULL keywords, then by default, the field accepts NULL values.

The NOT NULL constraint is the only constraint that the CREATE ROW TYPE statement can define for a field of a named ROW type. To define any other constraints on the fields of a column of a named ROW type, you must use the CREATE TABLE statement, or in the ALTER TABLE statement.

The Informix® implementation of the SQL language supports no ALTER ROW TYPE statement for changing the definition of an existing named ROW type. For named ROW types that are not currently instantiated by any existing table, column, view, or named ROW type hierarchy in the database, you can use the DROP ROW TYPE statement to remove an existing named ROW type from the system catalog. You can then use the CREATE ROW TYPE statement to define a replacement named ROW type.

See, however, the [DROP ROW TYPE statement](#) for restrictions on dropping an existing named ROW type.

- [Privileges on named ROW data types](#)
- [Inheritance and Named ROW Types](#)
- [Creating a Subtype](#)
- [Type Hierarchies](#)
- [Procedure for Creating a Subtype](#)
- [Restrictions on Serial and Simple-Large-Object Data Types](#)

Related reference:

[CREATE CAST statement](#)
[CREATE OPAQUE TYPE statement](#)
[DROP ROW TYPE statement](#)
[CREATE TABLE statement](#)
[GRANT statement](#)
[REVOKE statement](#)
[Literal Row](#)
[CREATE SCHEMA statement](#)
[CREATE DISTINCT TYPE statement](#)
[DROP TYPE statement](#)
Related information:
[Cast individual fields of a row type](#)
[ROW data type, Named](#)
[SYSCOLAUTH](#)

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Privileges on named ROW data types

The discretionary access privileges required for operations on a typed table (a table that is assigned a named ROW data type) are the same as privileges on any table. For more information, see [Table-Level Privileges](#). The following table shows which access privileges you need to create a named ROW type.

Task	Privileges Required
Create a named ROW type	Resource privilege on the database
Create a named ROW type as a subtype under a supertype	Under privilege on the supertype, as well as the Resource privilege

For information about Resource and Under privileges and the ALL keyword in the context of privileges, see the [GRANT statement](#).

o find out what privileges exist on a ROW type, check the **sysxdtypes** system catalog table for the *owner* name and the **sysxdttypeauth** system catalog table for privileges on the ROW type that might have been granted to users or to roles.

To find out what privileges you have on a given table, check the **sysstabauth** system catalog table. For more information on system catalog tables, see the *IBM® Informix® Guide to SQL: Reference*.

Related information:
[SYSTABAUTH](#)

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Inheritance and Named ROW Types

A named ROW type can belong to an inheritance hierarchy, as either a subtype or a supertype. Use the UNDER clause in the CREATE ROW TYPE statement to create a named ROW data type as a subtype of an existing ROW data type.

The supertype must also be a named ROW data type. If you create a named ROW data type under an existing supertype, then the new type name *row_type* becomes the name of the subtype.

When you create a named ROW type as a subtype, the subtype inherits all fields of the supertype. In addition, you can add new fields to the subtype when you create it. The new fields are specific to the subtype alone.

You cannot substitute a ROW type in an inheritance hierarchy for its supertype or for its subtype. For example, consider a type hierarchy in which **person_t** is the supertype and **employee_t** is the subtype. If a column is of type **person_t**, the column can only contain **person_t** data. It cannot contain **employee_t** data. Likewise, if a column is of type **employee_t**, the column can only contain **employee_t** data. It cannot contain **person_t** data.

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Creating a Subtype

In most cases, you add new fields when you create a named ROW type as a subtype of another named ROW type (its supertype). To create the fields of a named ROW type, use the field definition clause, as described in [CREATE ROW TYPE statement](#). When you create a subtype, you must use the UNDER keyword to associate the supertype with the named ROW type that you want to create. The next example creates the **employee_t** type under the **person_t** type:

```
CREATE ROW TYPE employee_t (salary NUMERIC(10,2),  
    bonus NUMERIC(10,2)) UNDER person_t;
```

The **employee_t** type inherits all the fields of **person_t** and has two additional fields: **salary** and **bonus**; but the **person_t** type is not altered.

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Type Hierarchies

When you create a subtype, you create a *type hierarchy*. In a type hierarchy, each subtype that you create inherits its properties from a single supertype. If you create a named ROW type **customer_t** under **person_t**, **customer_t** inherits all the fields of **person_t**. If you create another named ROW type, **salesrep_t** under **customer_t**, **salesrep_t** inherits all the fields of **customer_t**.

Thus, **salesrep_t** inherits all the fields that **customer_t** inherited from **person_t** as well as all the fields defined specifically for **customer_t**. For a discussion of type inheritance, refer to the *IBM® Informix® Guide to SQL: Tutorial*.

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Procedure for Creating a Subtype

Before you create a named ROW type as a subtype in an inheritance hierarchy, check the following information:

- Verify that you are authorized to create new data types. You must have the Resource privilege on the database. You can find this information in the **sysusers** system catalog table.
- Verify that the supertype exists. You can find this information in the **sysxdtypes** system catalog table.
- Verify that you are authorized to create subtypes to that supertype. You must have the Under privilege on the supertype. You can find this information in the **sysusers** system catalog table.
- Verify that the name that you declare for the named ROW type is unique. In an ANSI-compliant database, the *owner.type* combination must be unique within the database. In a database that is not ANSI-compliant, the name must be unique among data type names in the database. To verify whether the name for a new data type is unique, check the **sysxdtypes** system catalog table. The name must not be the name of an existing data type.
- If you are defining fields for the ROW type, check that no duplicate field names exist in both new and inherited fields.

Important: When you create a subtype, you cannot redefine fields that it inherited for its supertype. If you attempt to redefine these fields, the database server returns an error.

You cannot apply constraints to named ROW data types, but you can specify constraints when you create or alter a table that uses the named ROW types. You can also specify NOT NULL constraints on individual fields of a ROW type.

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Restrictions on Serial and Simple-Large-Object Data Types

Serial and simple-large-object data types cannot be nested within a table. Therefore, if a ROW type contains a BYTE, TEXT, SERIAL, BIGSERIAL, or SERIAL8 field, you cannot use the ROW type to define a column in a table that is not based on a ROW type. For example, the following code example produces an error:

```
CREATE ROW TYPE serialtype (s serial, s8 serial8);
CREATE TABLE tab1 (col1 serialtype); --INVALID CODE
```

You cannot create a ROW type that has a BYTE or TEXT value that is stored in a separate storage space. That is, you cannot use the IN clause to specify the storage location. For example, the following example produces an error:

```
CREATE ROW TYPE row1 (field1 byte IN blobspacel); --INVALID CODE
```

A table hierarchy can include no more than one SERIAL, BIGSERIAL, or SERIAL8 column. If a supertable has a SERIAL column, none of its subtables can contain a SERIAL column (but a subtable can have a BIGSERIAL or SERIAL8 column if no other subtable contains a BIGSERIAL or SERIAL8 column, respectively). Consequently, when you create the named ROW types on which the table hierarchy is to be based, they can contain at most one SERIAL and one BIGSERIAL or SERIAL8 field among them.

You cannot set the starting SERIAL, BIGSERIAL, or SERIAL8 value in the CREATE ROW TYPE statement. To modify the value for a serial field, you must use either the MODIFY clause of the ALTER TABLE statement, or else use the INSERT statement to insert a value that is larger than the current maximum (or default) serial value.

Serial fields in ROW types have performance implications across a table hierarchy. To insert data into a subtable whose supertable (or its supertable) contains the serial counter, the database server must also open the supertable, update the serial value, and close the supertable, thus adding extra overhead.

In contexts where these restrictions or performance issues for SERIAL, BIGSERIAL, or SERIAL8 data types conflict with your design goals, you might consider using sequence objects to emulate the functionality of serial fields or serial columns.

Related information:

[ROW Data Types](#)

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CREATE SCHEMA statement

Use the CREATE SCHEMA statement to issue a block of data definition language (DDL) and GRANT statements as a unit.

Use this statement with DB-Access.

Syntax

```
>>-CREATE SCHEMA AUTHORIZATION--user----->

.-----
V              (1)
>-----+--| CREATE TABLE Statement |-----+-->
|              (2)
+-| CREATE VIEW Statement |-----+
|              (3)
+-| GRANT Statement |-----+
|              (4)
+-| CREATE INDEX Statement |-----+
|              (5)
+-| CREATE SYNONYM Statement |-----+
|              (6)
+-| CREATE TRIGGER Statement |-----+
|              (7)
+-| CREATE SEQUENCE Statement |-----+
|              (8)
+-| CREATE ROW TYPE Statement |-----+
|              (9)
+-| CREATE OPAQUE TYPE Statement |-----+
|              (10)
+-| CREATE DISTINCT TYPE Statement |-----+
|              (11)
+-| CREATE CAST Statement |-----+
|              (12)
+-|
>-----+--|
|;-|
><
```

Notes:

1. See [CREATE TABLE statement](#)
2. See [CREATE VIEW statement](#)
3. See [GRANT statement](#)
4. Informix® extension
5. See [CREATE INDEX statement](#)
6. See [CREATE SYNONYM statement](#)
7. See [CREATE TRIGGER statement](#)
8. See [CREATE SEQUENCE statement](#)
9. See [CREATE ROW TYPE statement](#)
10. See [CREATE OPAQUE TYPE statement](#)
11. See [CREATE DISTINCT TYPE statement](#)
12. See [CREATE CAST statement](#)

Element	Description	Restrictions	Syntax
<i>user</i>	User who owns the database objects that this statement creates	If you have DBA privileges, you can specify the name of any user. Otherwise, you must have the Resource privilege, and you must specify your own user name.	Owner name

Usage

The CREATE SCHEMA statement allows the DBA to specify an owner for all database objects that the CREATE SCHEMA statement creates. You cannot issue CREATE SCHEMA until you have created the database that stores the objects.

Users with the Resource privilege can create a schema for themselves. In this case, *user* must be the name of the person with the Resource privilege who is running the CREATE SCHEMA statement. Anyone with the DBA privilege can also create a schema for someone else. In this case, *user* can specify a user other than the person who is running the CREATE SCHEMA statement.

You can put CREATE and GRANT statements in any logical order, as the following example shows. Statements are considered part of the CREATE SCHEMA statement until a semicolon (;) or an end-of-file symbol is reached.

```
CREATE SCHEMA AUTHORIZATION sarah
CREATE TABLE mytable (mytime DATE, mytext TEXT)
GRANT SELECT, UPDATE, DELETE ON mytable TO rick
CREATE VIEW myview AS
  SELECT * FROM mytable WHERE mytime > '12/31/2004'
CREATE INDEX idxtime ON mytable (mytime);
```

- [Creating Database Objects Within CREATE SCHEMA](#)

All database objects that a CREATE SCHEMA statement creates are owned by *user*, even if you do not explicitly name each database object. If you are the DBA, you can create database objects for another user. If you are not the DBA, specifying an owner other than yourself results in an error message.

Related reference:

[CREATE CAST statement](#)
[CREATE DISTINCT TYPE statement](#)
[CREATE INDEX statement](#)

[CREATE OPAQUE TYPE statement](#)
[CREATE OPCLASS statement](#)
[CREATE ROW TYPE statement](#)
[CREATE SEQUENCE statement](#)
[CREATE SYNONYM statement](#)
[CREATE TABLE statement](#)
[CREATE VIEW statement](#)
[GRANT statement](#)

Related information:
[Create the database](#)

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Creating Database Objects Within CREATE SCHEMA

All database objects that a CREATE SCHEMA statement creates are owned by *user*, even if you do not explicitly name each database object. If you are the DBA, you can create database objects for another user. If you are not the DBA, specifying an owner other than yourself results in an error message.

Suppose that user **oswald** holds the DBA access privilege and issues the following CREATE SCHEMA statement:

```
CREATE SCHEMA AUTHORIZATION hilda
CREATE ROW TYPE IF NOT EXISTS
  hildago (field1 INT,
          field2 CHAR(18) NOT NULL,
          field3 DATE);
```

The owner of this named ROW type is the user whose authorization identifier is **hilda**, rather than user **oswald** who issued the CREATE ROW TYPE statement. This example would fail if user **oswald** does not hold the DBA privilege.

You can only grant access privileges with the CREATE SCHEMA statement; you cannot use CREATE SCHEMA to revoke or to drop access privileges.

If you create a database object or use the GRANT statement outside a CREATE SCHEMA statement, you receive warnings if you use the **-ansi** flag or set **DBANSIWARN**.

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CREATE SECURITY LABEL statement

Use the CREATE SECURITY LABEL statement to define a new security label for a specified security policy in the current database and to identify its components and the elements of its components.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>CREATE SECURITY LABEL--+-+-----+---policy--.--label--->
                        '-IF NOT EXISTS-'
      .-+-----+-----+-----+-----+-----+-----+
      | | | | | | | | | | | | | | | | | | | | | | | | | | |
      v               v               | |
>---COMPONENT--component---element-+-+-----+-----><
```

Element	Description	Restrictions	Syntax
<i>component</i>	A security label component	Must already exist in the database as a component of the specified <i>policy</i> , and be unique among names of components of this <i>label</i> .	Identifier
<i>label</i>	Name you declare here for this label	Must be unique among security label names for this security <i>policy</i>	Identifier
<i>element</i>	An element of the specified <i>component</i>	Must have been defined when its <i>component</i> was defined or was last altered. If <i>component</i> is an array, only a single <i>element</i> can be specified.	Quoted String
<i>policy</i>	The security policy of this <i>label</i>	Must already exist in the database	Identifier

Usage

A *security label* is a named database object that supports a specified security policy. A security label can be applied to a user, or to a row or to a column (or to both a row and a column) of a table in the database. When a user who holds a security label attempts to access data that has a security label, the database server takes into account the security label of the column or row and the security label of the user in determining whether to allow the user to access the data.

Every security label stores the following categories of information:

- It identifies an existing security policy that the label supports.
- It identifies at least one, but no more than 16 existing components of the security policy that the label supports.
- It identifies one or more existing elements of each component of the security label. (Only security label components of type SET or TREE can include more than one element in the same security label.)

Only DBSECADM can issue this statement. When the CREATE SECURITY LABEL statement executes successfully, it registers the specified *label* name, the numeric identifier of the associated security *policy*, and the cardinality of its security label *components* in the **sysseclabels** system catalog table.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if a security label of the specified name is already registered in the current database.

- [Components and Elements of a Security Label](#)

Like a security policy, a security label must have at least one component, but no more than 16. The CREATE SECURITY LABEL statement cannot list security label components that are not components of the specified security policy. The same *component* name cannot be specified more than once in the same CREATE SECURITY LABEL statement. These components must already exist in the database, where DBSECADM can register them with the CREATE SECURITY LABEL COMPONENT statement.

Related reference:

[RENAME SECURITY statement](#)

[DROP SECURITY statement](#)

[ALTER SECURITY LABEL COMPONENT statement](#)

[ALTER TABLE statement](#)

[CREATE SECURITY LABEL COMPONENT statement](#)

[CREATE SECURITY POLICY statement](#)

[CREATE TABLE statement](#)

[EXEMPTION Clause](#)

[SECURITY LABEL Clause](#)

[EXEMPTION Clause](#)

[SECURITY LABEL Clause](#)

Related information:

[Label-based access control](#)

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Components and Elements of a Security Label

Like a security policy, a security label must have at least one component, but no more than 16. The CREATE SECURITY LABEL statement cannot list security label components that are not components of the specified security policy. The same *component* name cannot be specified more than once in the same CREATE SECURITY LABEL statement. These components must already exist in the database, where DBSECADM can register them with the CREATE SECURITY LABEL COMPONENT statement.

Security label components can be of type ARRAY, SET, or TREE, as described in CREATE SECURITY LABEL COMPONENT. For a *component* of type ARRAY, the *element* list can identify only a single element. For components of type SET or TREE, the *element* list can identify multiple component elements that were defined when the component was created (or when it was last altered). See the CREATE SECURITY LABEL COMPONENT statement for more information about the structure and semantics of security label components.

The following example creates a security label called **label1** for a security policy called **MegaCorp**. The label uses two security label components, called **levels** and **compartments**, each with one element, called **VP** and **Marketing** respectively:

```
CREATE SECURITY LABEL MegaCorp.label1
  COMPONENT levels 'VP',
  COMPONENT compartments 'Marketing';
```

For this example to be valid, the **levels** and **compartments** components, and their security label components, **VP** and **Marketing** elements, must have been defined in previously executed CREATE SECURITY LABEL COMPONENT statements.

In the next example, DBSECADM creates a security label called **label2** for the same **MegaCorp** security policy. This label uses three security label components, called **levels**, **compartments**, and **groups**, where two of these components have one element, and another has two:

```
CREATE SECURITY LABEL MegaCorp.label2
  COMPONENT level 'Director',
  COMPONENT compartments 'HR', 'Finance',
  COMPONENT groups 'EntireRegion';
```

These examples illustrate that the components of a security label can be a subset of the components of the security policy that the label supports, and that more than one security label can support the same security policy.

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CREATE SECURITY LABEL COMPONENT statement

Use the CREATE SECURITY LABEL COMPONENT statement to define a new security label component in the current database and to define the elements the component.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-CREATE SECURITY LABEL COMPONENT--+-+-----+-- component-->
                                     '-IF NOT EXISTS-'

                                     .-,-----
                                     V      |
>--+--ARRAY--[---element+---]-----+--><
|      |      |      |      |
|      .-,-----
|      V      |
|+--SET--{---element+---}-----+
|      |      |      |      |
|      .-,-----
|      V      |
|+--TREE--(--element--ROOT---,--element--UNDER--element+---)-'
```

Element	Description	Restrictions	Syntax
<i>component</i>	Name declared here for this component	Must be unique among the names of security label components in the database.	Identifier
<i>element</i>	Component element that is defined here	Must be unique among elements of this <i>component</i> , and no longer than 32 bytes. The left () and right () parentheses, comma (,), and colon (:) symbols are not valid characters.	Quoted String

Usage

Only the DBSECADM can issue the CREATE SECURITY LABEL COMPONENT statement, which defines a *security label component*. This is a database object that defines one or more logical categories whose values can be used in a security policy to determine whether a user's request to read or write data is accepted or rejected. The set of all the valid individual values that the security component can have is defined by the set of *security label elements* that this statement specifies for the component.

The logical categories that security label components implement are identified by DBSECADM in the process of designing a *security policy*, which is the core construct of label-based access control (LBAC). To implement this security feature in the database, however, DBSECADM must create security objects in the following sequence:

1. A set of one or more *security components*, each of which can be defined by the CREATE SECURITY LABEL COMPONENT statement. This statement specifies the name of a security component, the structure of its range of values, and the possible values for this component that can be assigned to a security label that applies a security policy to data or to a user.
2. One or more *security policies*, each of which can be defined by the CREATE SECURITY POLICY statement, which specifies a list of one or more components and a set of rules that the security policy applies to data and to users who attempt read or write operations on data that the security policy protects in the database. A security policy always includes all the elements of a component that CREATE SECURITY POLICY specifies.
3. A *security label* can be defined by the CREATE SECURITY LABEL statement, which specifies one or more values for each of one or more components of the security policy that the label supports. The security label can be applied to data and to users. All the components of a security label must be components of the same security policy, but multiple security policies and multiple security labels can share the same component. A security label typically includes only a subset of the elements of a security component that CREATE SECURITY LABEL COMPONENT defines.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if a security label component of the specified name is already registered in the current database.

See the GRANT Security and REVOKE Security statements for information on how security labels and exemptions from the rules of a security policy define the LBAC credentials of a user or of a role.

See the CREATE TABLE and ALTER TABLE statements for information on how security labels can be associated with a database table or with an individual data row in a table.

- [Types and Elements of Security Label Components](#)
- [ARRAY Components](#)
- [SET Components](#)
- [TREE Components](#)

Related reference:

[RENAME SECURITY statement](#)
[DROP SECURITY statement](#)
[CREATE SECURITY LABEL statement](#)
[ALTER SECURITY LABEL COMPONENT statement](#)
[ALTER TABLE statement](#)
[CREATE SECURITY POLICY statement](#)
[CREATE TABLE statement](#)
[EXEMPTION Clause](#)
[SECURITY LABEL Clause](#)
[EXEMPTION Clause](#)
[SECURITY LABEL Clause](#)

Related information:

[Label-based access control](#)

Types and Elements of Security Label Components

A security label component itself consists of one or more *elements* that the CREATE SECURITY LABEL COMPONENT statement declares as string constants. These elements define the set of values that are valid for the component,

When the CREATE SECURITY LABEL statement executes successfully, Informix® updates the system catalog of the database with the following new entries:

- It creates a new row in the **sysseclabelcomponents** table to register the new component.
- For each *element* of the new component, it creates a new row in the **sysseclabelcomponentelements** table.

The security label component must be defined as one of the three component types. The ARRAY, SET, or TREE keyword that immediately follows the declaration of the *component* name specifies the component type, which must be followed by a list of the *elements* of the security component. These elements define the set of values that the component can have within a security policy. For all three types of security label components, the set of elements is under the following restrictions:

- The security component can have no more than 64 elements.
- Each element of a security component is a quoted string constant of no more than 32 bytes.
- Characters in the quoted string constant cannot include the left (() or right ()) parentheses, comma (,), or colon (:) symbols, but other symbols that the **DB_LOCALE** setting supports are valid, including the blank space (ASCII 32) character.
- Each element must be unique among elements of the same security label component, but the same quoted string constant value can also be an element of other security label components.

The definition of each element within the component implies a level of data sensitivity that a security label associates with a database table or with an individual data row, and also affects the security credentials of users who hold a security label to read or write data that is protected by the same label or by a different label that specifies one or more elements of the component.

Like other database Data Definition Language statements of SQL that can define database objects, CREATE SECURITY LABEL COMPONENT must specify a literal value for each component element, rather than a placeholder. To change the definition of an existing security label component, DBSECADM can use the ALTER SECURITY LABEL COMPONENT to insert a new element into an ARRAY, SET, or TREE component. To drop or rename one or more individual elements of a component, however, DBSECADM must use the DROP SECURITY LABEL COMPONENT statement to destroy the existing component, and then reissue the CREATE SECURITY LABEL COMPONENT statement to create a new component that defines the required set of element values within an ARRAY, SET, or TREE component structure.

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ARRAY Components

A security label component of type ARRAY is an ordered set of no more than 64 elements. Each element defines a value that is valid for that component within a security policy. The order in which elements are declared is significant, because it defines a descending order of data sensitivity, with each successive element ranking lower in data sensitivity than the preceding element. The set of label elements of the array and their comma separators must be enclosed between a pair of bracket ([...]) symbols.

When an ARRAY component is specified in the definition of a security label, the label can specify no more than one element of that component as the value of the component.

The following example defines a security label component of type ARRAY called **aquilae** that is an ordered set of five elements called **imperator**, **tribunus**, **centurio**, **miles**, and **asinus**:

```
CREATE SECURITY LABEL COMPONENT aquilae
  ARRAY [ "imperator", "tribunus", "centurio", "miles", "asinus" ];
```

Here the component element with the highest data sensitivity is **imperator** and **asinus** has the lowest data sensitivity, with the data sensitivity of **tribunus** ranking above that of **centurio** but below that of **imperator**.

A component of type ARRAY can be appropriate in contexts where some dimension of a multidimensional security policy can be mapped onto a single scale that is monotonically descending.

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SET Components

A security label component of type SET is an unordered set of no more than 64 elements. Each element of the SET is a string constant of no more than 32 bytes, and must be unique within the component, but the same value can be used in other components. The order in which the elements of a SET component are declared is not significant in regard to the data sensitivity of the categories that these elements identify. The elements and their comma separators must be enclosed between a pair of braces ({ ... }) symbols.

When a SET component is specified in the definition of a security label, the label can specify one or multiple elements of that component as valid values for the component.

In the following example, DBSECADM defines a security label component called **departments** that is an unordered set of three elements, called **Marketing**, **HR**, and **finance**:

```
CREATE SECURITY LABEL COMPONENT departments
  SET { 'Marketing', 'HR', 'Finance' };
```

Like all components of type SET, the order in which these elements are declared implies no relative rank in data sensitivity. A component of type SET can be appropriate in contexts where some dimension of a multidimensional security policy can be represented as nominal categories, without any logical basis for ordering them on a monotonic scale, nor for arranging them in a hierarchy.

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TREE Components

A security label component of type TREE has the logical topology of a hierarchy (that is, a simple graph with no loops) that has a single root node and no more than 63 additional nodes. The string constant for the root node must be listed first and must be followed by the ROOT keyword. The string constant for each subsequently declared node must be followed by the keyword UNDER and by the string constant for some previously declared node. The set of elements of the TREE component, including their ROOT and UNDER keywords and comma separators, must be enclosed between a pair of parenthesis ((. . .)) symbols.

The label element specified after the UNDER keyword is called the *parent* of the label element that precedes the same UNDER keyword (which is called the *child* of that parent element). The CREATE SECURITY LABEL COMPONENT statement fails with an error if a node name that follows the UNDER keyword has not already been declared in the same statement.

The string constant that designates the root node of a tree component has the highest data sensitivity. For a user to read or write protected data, each tree component of the user security label must include at least one of the elements in the tree component of the data row security label, or the ancestor of one such element. For example, if "Beta" is declared UNDER "Alpha" and "Gamma" is declared UNDER "Beta" then "Gamma" also ranks below "Alpha" in data sensitivity. Only elements that are in the same chain of parent-child relationships can be compared in their data sensitivity.

The next example defines a security label component called **Oakland** as a tree structure with six nodes:

```
CREATE SECURITY LABEL COMPONENT Oakland
TREE ( 'Port' ROOT,
      'Downtown' UNDER 'Port',
      'Airport' UNDER 'Port',
      'Estuary' UNDER 'Airport',
      'Avenues' UNDER 'Downtown',
      'Hills' UNDER 'Avenues');
```

Here the root node is **Port**, which has the highest data sensitivity. Within this hierarchy, the **Downtown**, **Avenues**, and **Hills** elements represent descending levels of data sensitivity, and the **Airport** element has a higher data sensitivity than the **Estuary** element. In this example, the four component elements that the UNDER keyword designates as parent nodes are each declared before being included in UNDER specifications. A modified version of this example would also be valid if the **Avenues** node declaration preceded the **Airport** node declaration, but an error would result if the **Hills** node declaration had preceded the **Avenues** node declaration.

A component of type TREE can be appropriate in contexts where some dimension of a multidimensional security policy can be mapped to a single logical hierarchy, or to a group of hierarchies that share a common root.

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CREATE SECURITY POLICY statement

Use the CREATE SECURITY POLICY statement to define a new security policy in the current database and to identify its security label components and access rules.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-CREATE SECURITY POLICY--+-----+--policy--COMPONENTS-->
      '-IF NOT EXISTS-'

      .- ,------.
      v          (1) |
>---component-----+----->

      .-WITH IDSLBACRULES-. .-RESTRICT NOT AUTHORIZED WRITE SECURITY LABEL-----
>--+-----+-----+-----+-----+-----+-----+-----+-----+-----<
      '-OVERRIDE NOT AUTHORIZED WRITE SECURITY LABEL-'
```

Notes:

1. You can specify no more than 16 components.

Element	Description	Restrictions	Syntax
<i>component</i>	A security label component	Must already exist in the database, and be unique among the names of components for this <i>policy</i>	Identifier
<i>policy</i>	Name declared here for a security policy	Must be unique among the names of security policies in the database	Identifier

A *security policy* is a named database object that stores the following information:

- It defines a set of security label components that comprise a security label.
- It associates that security label with a set of access rules.

For tables that are protected by a security policy, the access rules enable Informix® to compare the security credentials of a user with the security label of a row or column. The security policy is applied to determine whether a user who holds a given security label can read or write data in a row or column that is labeled with a security label. A security policy has no effect on data that has no security label.

No more than one security policy can be attached to a table at any point in time, and a security policy can include no more than 16 security label components.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if a security policy of the specified name is already registered in the current database. In this case, no new security policy is created, and the CREATE SECURITY POLICY statement has no effect on the existing security policy that it referenced.

Only DBSECADM can issue this statement. When the CREATE SECURITY POLICY statement executes successfully, Informix makes the following updates to the system catalog of the current database:

- Registers the specified *policy* name and the cardinality of its security label components in the **syssecpolicies** table
- Creates for each *component* a new row in the **syssecpolicycomponentrules** table.

Example of creating a new security policy

This is the sequence in which LBAC security objects associated with a specific security label must be created:

- Security label components
- Security policy
- Security label

For example, the following CREATE SECURITY LABEL COMPONENT statement registers a security label component named **Departments** of type SET in the **sysseclabelcomponents** system catalog table of the database:

```
CREATE SECURITY LABEL COMPONENT departments
SET { 'Sales', 'Legal', 'IT', 'CanineResources' };
```

The same statement also registers the four elements of the **departments** component, namely **'Sales'**, **'Legal'**, **'IT'**, and **'CanineResources'** in the **sysseclabelcomponentelements** system catalog table.

Note that this example of a security label component definition specifies no security policy, because only the CREATE SECURITY POLICY statement can associate a component with a security policy.

For more information about security label components, see [Types and Elements of Security Label Components](#) and [CREATE SECURITY LABEL COMPONENT statement](#).

The following SQL statement registers a new security policy called **WatchDog** in the current database:

```
CREATE SECURITY POLICY WatchDog
COMPONENTS departments
WITH IDSLBACRULES;
```

Here the security label component **departments** must already exist in the database, and the name **WatchDog** must be unique among the identifiers of existing security policies in the database. For an explanation of the WITH IDSLBACRULES keywords, see [Rules Associated with a Security Policy](#), which also provides a more general example of defining a security policy with multiple components.

Note that the definition of the **WatchDog** security policy includes no explicit references to security labels. Any security labels that the CREATE SECURITY LABEL statement associates with the **WatchDog** security policy must reference **departments** as their *component*, because this security policy has no other component. The following example illustrates this requirement for **WatchDog** labels:

```
CREATE SECURITY LABEL WatchDog.label9
COMPONENT departments 'Sales', 'CanineResources';
```

This statement declares **label9** as the name of a new label of the **WatchDog** security policy. It also registers the following information in the **sysseclabels** system catalog table:

- this label name,
- and the numeric identifier of the associated **WatchDog** security policy,
- and the cardinality of its two (2) security label components.

The COMPONENT clause in the same example specifies that the **label9** label is valid for both the **'Sales'** and for the **'CanineResources'** elements of the **departments** component of the **WatchDog** security policy.

For more information about security labels, see [Components and Elements of a Security Label](#) and [CREATE SECURITY LABEL statement](#).

For information on protecting a new table by attaching a security policy when the table is being created, see the [SECURITY POLICY Clause](#) of the CREATE TABLE statement.

For the syntax to attach or to drop a security policy for an existing table, see [SECURITY POLICY Clause](#) of the ALTER TABLE statement.

- [Security Label Components of a Security Policy](#)
- [Rules Associated with a Security Policy](#)

The WITH IDSLBACRULES keywords specify the read access rules and write access rules that the new security policy enforces. If you do not specify them, these keywords are in effect by default, because the **IDSLBACRULES** access rules are the only access rules that the a security policy can support.

Related reference:

[RENAME SECURITY statement](#)
[DROP SECURITY statement](#)
[CREATE SECURITY LABEL statement](#)
[CREATE SECURITY LABEL COMPONENT statement](#)
[ALTER SECURITY LABEL COMPONENT statement](#)
[ALTER TABLE statement](#)
[CREATE TABLE statement](#)
[EXEMPTION Clause](#)
[SECURITY LABEL Clause](#)
[EXEMPTION Clause](#)
[SECURITY LABEL Clause](#)

Related information:
[Label-based access control](#)

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Security Label Components of a Security Policy

The CREATE SECURITY POLICY statement must specify at least one (but no more than 16) security label components. These components must already exist in the database, where DBSECADM can register them with the CREATE SECURITY LABEL COMPONENT statement. The same *component* name cannot be specified more than once in the same CREATE SECURITY POLICY statement.

See the section CREATE SECURITY LABEL COMPONENT for more information about the structure and semantics of security label components.

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Rules Associated with a Security Policy

The WITH IDSLBACRULES keywords specify the read access rules and write access rules that the new security policy enforces. If you do not specify them, these keywords are in effect by default, because the **IDSLBACRULES** access rules are the only access rules that a security policy can support.

The following **IDSLBACRULES** access rules for read access, called **IDSLBACREAD**, apply when data values are read from labeled rows or columns in SELECT, UPDATE, or DELETE operations:

- **IDSLBACREADARRAY**: Each array component of the user security label must be greater than or equal to the array component of the data row security label. That is, only data at or below the level of the user can be read.
- **IDSLBACREADTREE**: Each tree component of the user security label must include at least one of the elements in the tree component of the data row security label (or the ancestor of one such element).
- **IDSLBACREADSET**: Each set component of the user security label must include the set component of the data row security label.

The following **IDSLBACRULES** access rules for write access, called **IDSLBACWRITE**, apply when data values are written to labeled rows or columns in INSERT, UPDATE, or DELETE operations:

- **IDSLBACWRITEARRAY**: Each array component of the user security label must be equal to the array component of the data row security label. That is, only data at the same level as the user can be written.
- **IDSLBACWRITETREE**: Each tree component of the user security label must include at least one of the elements in the tree component of the data row security label (or the ancestor of one such element).
- **IDSLBACWRITESET**: Each set component of the user security label must include the set component of the data row security label.

If DBSECADM omits the WITH IDSLBACRULES keywords, then those rules are in effect by default. If any specification except IDSLBACRULES follows the WITH keyword, however, the CREATE SECURITY POLICY statement fails with an error, and no security policy is created.

Besides the explicit or default WITH IDSLBACRULES keywords, the CREATE SECURITY POLICY statement must also specify the write access rule to enforce when a user is not authorized to write the explicitly specified security label provided in the DELETE, INSERT, or UPDATE statement for a table protected with this security policy. The security label of the user and the exemption credentials that the user holds determine whether the user has write access to an explicitly provided security label.

- If the CREATE SECURITY POLICY statement specifies **OVERWRITE NOT AUTHORIZED WRITE SECURITY LABEL**, then Informix® uses the value of the user security label, rather than the security label that is explicitly specified in the DELETE, INSERT, or UPDATE statement, to determine whether the user has write-access to data values that are protected by a security label in the DELETE, INSERT, or UPDATE operation.
- The default is **RESTRICT NOT AUTHORIZED WRITE SECURITY LABEL**. If you specify these keywords explicitly, or if they are in effect by default, then DELETE, INSERT, or UPDATE statements fail with an error if the user is not authorized to write data in a row or column that has the explicitly specified security label.

The following example creates a security policy called **MegaCorp** that uses three security label components, with no **OVERWRITE** provision for the user security label to provide write access in DELETE, INSERT, or UPDATE operations on data whose explicitly specified security label does not authorize write access for that user:

```
CREATE SECURITY POLICY MegaCorp
COMPONENTS levels, compartments, groups
WITH IDSLBACRULES;
```

For this example to be valid, the **levels**, **compartments**, and **groups** security label components (or components that have been renamed to these identifiers) must have been previously defined by the CREATE SECURITY LABEL COMPONENT statement.

CREATE SEQUENCE statement

Use the CREATE SEQUENCE statement to create a sequence database object from which multiple users can generate unique integers.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-CREATE SEQUENCE--+-----+--+-----+--sequence--->
                        '-IF NOT EXISTS-' '-owner--,-'

>--+-----+-----+-----+-----><
| .-----+-----+-----+-----+
| V          .-BY-.          | (1) |
|-----+-----+-----+-----+
| -+-INCREMENT--+-----+step--+-----+
|          .-WITH-.          |
| +--START--+-----+origin--+
| | .-NOMAXVALUE-----+
| +--+MAXVALUE--max--+-----+
| | .-NOMINVALUE-----+
| +--+MINVALUE--min--+-----+
| | .-NOCYCLE-.          |
| +--+CYCLE-----+
| +--+CACHE--size--+-----+
| | '-NOCACHE-----'
| | .-ORDER---+
| +--+NOORDER--+-----+'
```

Notes:

1. Each keyword option can appear no more than once.

Element	Description	Restrictions	Syntax
<i>max</i>	Upper limit of values	Must be an integer > <i>origin</i>	Literal Number
<i>min</i>	Lower limit of values	Must be an integer less than <i>origin</i>	Literal Number
<i>origin</i>	First number in the sequence	Must be an integer in INT8 or BIGINT range	Literal Number
<i>owner</i>	Owner of <i>sequence</i>	Must be an authorization identifier	Owner name
<i>sequence</i>	Name that you declare here for the new sequence	Must be unique among sequence, table, view, and synonym names	Identifier
<i>size</i>	Number of values that are preallocated in memory	Integer > 1, but < cardinality of a cycle ($= |(max - min)/step|$)	Literal Number
<i>step</i>	Interval between successive values	Nonzero integer in INT range	Literal Number

Usage

A sequence (sometimes called a *sequence generator* or *sequence object*) returns a monotonically ascending or descending series of unique integers, one at a time. The CREATE SEQUENCE statement defines a new sequence object, declares its identifier, and registers it in the **syssequences** system catalog table.

Authorized users of a sequence can request a new value by including the *sequence.NEXTVAL* expression in DML statements. The *sequence.CURRVAL* expression returns the current value of the specified *sequence*. **NEXTVAL** and **CURRVAL** expressions are valid only within SELECT, DELETE, INSERT, and UPDATE statements; Informix® returns an error if you attempt to invoke the built-in **NEXTVAL** or **CURRVAL** functions in any other context.

Generated values logically resemble the BIGSERIAL or SERIAL8 data type, but can be negative, and are unique within the sequence. Because the database server generates the values, sequences support a much higher level of concurrency than a serial column can. The values are independent of transactions; a generated value cannot be rolled back, even if the transaction in which it was generated fails.

You can use a sequence to generate primary key values automatically, using one sequence for many tables, or each table can have its own sequence.

CREATE SEQUENCE can specify the following characteristics of a sequence:

- Initial value
- Size and sign of the increment between values
- Maximum and minimum values
- Whether the sequence recycles values after reaching its limit
- How many values are preallocated in memory for rapid access.

A database can support multiple sequences concurrently, but the name of a sequence (or in an ANSI-compliant database, the *owner.sequence* combination) must be unique within the current database among the names of tables, temporary tables, views, synonyms, and sequences.

An error occurs if you include contradictory options, such as specifying both the MINVALUE and NOMINVALUE options, or both CACHE and NOCACHE.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if a sequence object of the specified name is already registered in the current database, or if the specified name is the identifier of a table, view, or synonym in the current database.

Example

The following example creates a sequence, inserts values from the sequence into the table, and selects all rows and columns from the table.

```
CREATE SEQUENCE seq_2
  INCREMENT BY 1 START WITH 1
  MAXVALUE 30 MINVALUE 0
  NOCYCLE CACHE 10 ORDER;

CREATE TABLE tab1 (col1 int, col2 int);
INSERT INTO tab1 VALUES (0, 0);

INSERT INTO tab1 (col1, col2) VALUES (seq_2.NEXTVAL, seq_2.NEXTVAL)

SELECT * FROM tab1;
```

col1	col2
0	0
1	1

- [INCREMENT BY Option](#)
- [START WITH Option](#)
- [MAXVALUE or NOMAXVALUE Option](#)
- [MINVALUE or NOMINVALUE Option](#)
- [CYCLE or NOCYCLE Option](#)
- [CACHE or NOCACHE Option](#)

Use the CACHE option to specify the number of new sequence values that are preallocated in memory for rapid access. This option can enhance the performance of a sequence that grows quickly.

- [ORDER or NOORDER Option](#)

Related reference:

[DROP SEQUENCE statement](#)
[ALTER SEQUENCE statement](#)
[RENAME SEQUENCE statement](#)
[CREATE SYNONYM statement](#)
[DROP SYNONYM statement](#)
[GRANT statement](#)
[REVOKE statement](#)
[NEXTVAL and CURRVAL Operators](#)
[CREATE SCHEMA statement](#)

Related information:

[SYSSEQUENCES](#)

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INCREMENT BY Option

Use the INCREMENT BY option to specify the interval between successive numbers in the sequence. The BY keyword is optional. The interval, or *step* value, can be a positive whole number (for an *ascending* sequence) or a negative whole number (for a *descending* sequence) in the INT8 range. If you do not specify any *step* value, the default interval between successive generated values is 1, and the sequence is an ascending sequence.

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START WITH Option

Use the START WITH option to specify the first number of the sequence. This *origin* value must be an integer within the INT8 range that is greater than or equal to the *min* value (for an ascending sequence) or that is less than or equal to the *max* value (for a descending sequence), if *min* or *max* is specified in the CREATE SEQUENCE statement. The WITH keyword is optional.

If you do not specify an *origin* value, the default initial value is *min* for an ascending sequence or *max* for a descending sequence. (The [MAXVALUE or NOMAXVALUE Option](#) and [MINVALUE or NOMINVALUE Option](#) sections that follow describe the *max* and *min* specifications respectively.)

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MAXVALUE or NOMAXVALUE Option

Use the MAXVALUE option to specify the upper limit of values in a sequence. The maximum value, or *max*, must be an integer in the INT8 range that is greater than the value of the *origin*.

If you do not specify a *max* value, the default is NOMAXVALUE. This default setting supports values that are less than or equal to 2^{64} for ascending sequences, or less than or equal to -1 for descending sequences.

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MINVALUE or NOMINVALUE Option

Use the MINVALUE option to specify the lower limit of values, or *min*. This integer must be in the INT8 range and be less than the value of *origin*.

If you do not specify a *min* value, the default is NOMINVALUE. This default setting supports values that are greater than or equal to 1 for ascending sequences, or greater than or equal to $-(2^{64})$ for descending sequences.

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CYCLE or NOCYCLE Option

Use the CYCLE option to continue generating sequence values after the sequence reaches the maximum (ascending) or minimum (descending) limit. After an ascending sequence reaches the *max* value, it generates the *min* value for the next sequence value. After a descending sequence reaches the *min* value, it generates the *max* value for the next sequence value.

The default is NOCYCLE. At this default setting, the sequence cannot generate more values after reaching the declared limit. Once the sequence reaches the limit, the next reference to *sequence*.NEXTVAL returns an error.

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CACHE or NOCACHE Option

Use the CACHE option to specify the number of new sequence values that are preallocated in memory for rapid access. This option can enhance the performance of a sequence that grows quickly.

The cache size must be a positive whole number in the INT range. If you specify the CYCLE option, then size must be less than the number of values in a cycle (or less than $|(max - min)/step|$). The minimum is 2 preallocated values. The default is 20 preallocated values.

The NOCACHE keyword specifies that no generated values (that is, zero) are preallocated in memory for this sequence object.

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ORDER or NOORDER Option

These keywords have no effect on the behavior of the sequence. The sequence always issues values to users in the order of their requests, as if the ORDER keyword were always specified. The ORDER and NOORDER keywords are accepted by the CREATE SEQUENCE statement for compatibility with implementations of sequence objects in other dialects of SQL.

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CREATE SYNONYM statement

Use the CREATE SYNONYM statement to declare and register an alternative name for an existing table, view, or sequence object.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-CREATE--(1) .-PUBLIC-.SYNONYM-----synonym--FOR--+-table-----><
| (1) | '-IF NOT EXISTS-' +-view-----
|-----PRIVATE-----' -sequence-
```

Notes:

1. This keyword is valid only in databases that are not ANSI/ISO-compliant.

Element	Description	Restrictions	Syntax
<i>sequence</i>	Name of a local sequence	Must exist in the current database	Identifier
<i>table, view</i>	Name of database table, external table, or view for which <i>synonym</i> is being created	Must be registered in the current database, or in a database specified in a qualifier	Database Object Name
<i>synonym</i>	Synonym declared here for the name of <i>table, view, or sequence</i>	Must be unique among table object names in the database; see also Usage notes.	Database Object Name

Usage

Users have the same privileges for a synonym that they have for the database object that the synonym references. The **sysstable** and **sysstable** system catalog tables maintain information about synonyms.

You cannot create a synonym for a synonym in the same database.

The identifier of the synonym must be unique among the names of tables, temporary tables, external tables, views, and sequence objects in the same database. (See, however, the section [Synonyms with the Same Name](#).)

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if a synonym of the specified name is already registered in the current database, or if the specified name is the identifier of a table, view, or sequence object in the current database.

Once a synonym is created, it persists until the owner executes the DROP SYNONYM statement. (This persistence distinguishes a synonym from an alias that you can declare in the FROM clause of a SELECT statement. The alias is in scope only while that SELECT statement is executing.)

If a synonym refers to a table, view, or sequence in the same database, however, the synonym is automatically dropped if the referenced table, view, or sequence object is dropped. For additional information, see the section [Synonyms for objects outside the current database](#).

- [Synonyms for objects outside the current database](#)
A synonym can be created for any table or view in any database of the database server to which your session is currently connected.
- [PUBLIC and PRIVATE Synonyms](#)
If you use the **PRIVATE** keyword to declare a synonym in a database that is not ANSI-compliant, the unqualified synonym can be used by its owner. Other users must qualify the synonym with the name of the owner.
- [Synonyms with the Same Name](#)
- [Chaining Synonyms](#)

Related reference:

[ALTER SEQUENCE statement](#)
[CREATE SEQUENCE statement](#)
[CREATE SCHEMA statement](#)
[DROP SYNONYM statement](#)
[RENAME SEQUENCE statement](#)

Related information:

[Use synonyms for table names](#)
[Use synonym chains](#)

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Synonyms for objects outside the current database

A synonym can be created for any table or view in any database of the database server to which your session is currently connected.

This example declares a synonym for a table outside your current database, in the **payables** database of your current database server.

```
CREATE SYNONYM mysum FOR payables:jean.summary;
```

You can also create a synonym for an external table that the CREATE EXTERNAL TABLE statement registered in the current database. (The external table is registered in the system catalog of the database where it was created, but it is not stored in any database.)

You can also create a synonym for a table or view that exists in a database of a database server that is not your current database server. Both database servers must be online when you create the synonym. In a network, the remote database server verifies that the table or view referenced by the synonym exists when you create the synonym. The next example creates a synonym for a table in a database of a remote database server:

```
CREATE SYNONYM mysum FOR payables@phoenix:jean.summary;
```

The identifier **mysum** now refers to the table **jean.summary**, which is in the **payables** database on the **phoenix** database server. If the **summary** table is dropped from the **payables** database, the **mysum** synonym is left intact. Subsequent attempts to use **mysum** return the error: Table not found.

Informix®, however, does not support synonyms for these table objects :

- Typed tables (including any table that is part of a table hierarchy)
- Tables or views with columns of any extended data types
- Sequence objects outside the local database

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PUBLIC and PRIVATE Synonyms

If you use the `PRIVATE` keyword to declare a synonym in a database that is not ANSI-compliant, the unqualified synonym can be used by its owner. Other users must qualify the synonym with the name of the owner.

If you use the `PUBLIC` keyword (or no keyword at all), anyone who has access to the database can use your synonym. If the database is not ANSI-compliant, a user does not need to know the name of the owner of a public synonym.

In an ANSI-compliant database, all synonyms are private. If you use the `PUBLIC` or `PRIVATE` keywords, the database server issues a syntax error.

Examples of PRIVATE and PUBLIC synonyms

Suppose that in a database that is not ANSI-compliant, user **primus** issues the following SQL statements:

```
CREATE SEQUENCE IF NOT EXISTS MySequence
  INCREMENT BY 1 START WITH 1
  MAXVALUE 8000 MINVALUE 0
  NOCYCLE CACHE 20 ORDER;
```

```
CREATE PRIVATE SYNONYM IF NOT EXISTS anaphora FOR MySequence;
```

Now user **primus** is the owner of two new objects in the current database:

- a sequence object called **MySequence**,
- and a private synonym called **anaphora** for the **MySequence** sequence.

Suppose that in the same database, user **primus** also issues the following SQL statements

- to create a permanent table called **twoSmall**,
- and to declare **litotes** as a private synonym for the **twoSmall** table:

```
CREATE TABLE IF NOT EXISTS twoSmall (c1 SMALLINT, c2 SMALLINT);
INSERT INTO twoSmall VALUES (0, 0);
```

```
CREATE PRIVATE SYNONYM litotes FOR twoSmall;
```

In the same database that is not ANSI-compliant, another user could reference both the **litotes** and **anaphora** synonyms in the following INSERT statement, where **twoSmall** is the target table:

```
INSERT INTO primus.litotes (col1, col2)
  VALUES (primus.anaphora.NEXTVAL, primus.anaphora.NEXTVAL);
```

Although both synonyms in the INSERT statement were created as `PRIVATE`, the user can access the objects that those synonyms reference by qualifying the synonym names with the authorization identifier of **primus**, who is the owner of those synonyms.

If instead of creating the private synonyms in the previous examples, user **primus** had implicitly or explicitly created both **anaphora** and **litotes** as `PUBLIC` synonyms, any other user who held sufficient access privileges could omit the authorization identifier of **primus** in the previous INSERT statement:

```
INSERT INTO litotes (col1, col2)
  VALUES (anaphora.NEXTVAL, anaphora.NEXTVAL);
```

In a database that was not created as `MODE ANSI`, the following example shows the syntax for user **primus** to create **synecdoche** as a `PUBLIC` synonym for the **MySequence** object:

```
CREATE SYNONYM IF NOT EXISTS synecdoche FOR MySequence;
```

In the example above, **synecdoche** is a public synonym by default, because neither the `PUBLIC` nor `PRIVATE` keyword was specified.

In the same database, the next statement creates **zeugma** as an explicit `PUBLIC` synonym:

```
CREATE PUBLIC SYNONYM IF NOT EXISTS zeugma FOR MySequence;
```

In the same database, the next statement creates **pleonasm** as a `PRIVATE` synonym for the same sequence object:

```
CREATE PRIVATE SYNONYM IF NOT EXISTS pleonasm FOR MySequence;
```

In a database created as `MODE ANSI`, the next statement creates **asyndeton** as a `PRIVATE` synonym, because ANSI-compliant databases do not support `PUBLIC` synonyms:

```
CREATE SYNONYM asyndeton FOR MySequence;
```

In a database created as `MODE ANSI`, the next statement fails with a syntax error, because the `CREATE SYNONYM` statement does not support the `PRIVATE` or `PUBLIC` keywords in ANSI-compliant databases:

```
CREATE PRIVATE SYNONYM litotes FOR MySequence;
```

For information about the scope of reference of the identifiers of public and private synonyms in databases that are not ANSI-compliant, see the topic [Synonyms with the Same Name](#).

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Synonyms with the Same Name

In an ANSI-compliant database, the *owner.synonym* combination must be unique among all synonyms, tables, views, and sequences. You must specify *owner* when you refer to a synonym that you do not own, as in this example:

```
CREATE SYNONYM emp FOR acting.employee
```

In a database that is not ANSI-compliant, no two public synonyms can have the same identifier, and the identifier of a synonym must also be unique among the names of tables, views, and sequences in the same database.

The *owner.synonym* combination of a private synonym must be unique among all the synonyms in the database. That is, more than one private synonym with the same name can exist in the same database, but a different user must own each of these synonyms. The same user cannot create both a private and a public synonym that have the same name. For example, the following code generates an error:

```
CREATE SYNONYM our_custs FOR customer;  
CREATE PRIVATE SYNONYM our_custs FOR cust_calls;-- ERROR!!!
```

A private synonym can be declared with the same name as a public synonym only if the two synonyms have different owners. If you own a private synonym, and a public synonym exists with the same name, the database server resolves the unqualified name as the private synonym. (In this case, you must specify *owner.synonym* to reference the public synonym.) If you use DROP SYNONYM with the unqualified synonym identifier when your private synonym and the public synonym of another user both have the same identifier, only your private synonym is dropped. If you repeat the same DROP SYNONYM statement, the database server drops the public synonym.

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Chaining Synonyms

If you create a synonym for a table or view that is not in the current database, and this table or view is dropped, the synonym remains registered in the system catalog. You can create a new synonym whose identifier is the name of the dropped table or view, but that points to a table or view in the current database (or in another database).

In this way, after you rename a table, or after you move a table or view to another database location, you can chain synonyms together so that the original synonym remains valid in existing applications. You can chain up to 16 synonyms in this manner.

Chaining synonyms to reference a relocated table object is possible for tables or views, but this is not valid for synonyms that point to a sequence object, because CREATE SYNONYM can define synonyms only for sequences that are registered in the current database.

The following steps chain two synonyms together for the **customer** table, which will ultimately reside on the **zoo** database server. Here ellipses (. . .) mark CREATE TABLE statements that are not complete:

1. In the **stores_demo** database on the database server that is called **training**, issue the following statement:

```
CREATE TABLE customer (lname CHAR(15) . . . );
```

2. On the database server called **acctng**, issue the following statement:

```
CREATE SYNONYM cust FOR stores_demo@training:customer;
```

3. On the database server called **zoo**, issue the following statement:

```
CREATE TABLE customer (lname CHAR(15) . . . );
```

4. On the database server called **training**, issue the following statement:

```
DROP TABLE customer;  
CREATE SYNONYM customer FOR stores_demo@zoo:customer;
```

The synonym **cust** on the **acctng** database server now points to the **customer** table on the **zoo** database server.

The following steps show an example of chaining two synonyms together and changing the table to which a synonym points:

1. On the database server called **training**, issue the following statement:

```
CREATE TABLE customer (lname CHAR(15) . . . );
```

2. On the database server called **acctng**, issue the following statement:

```
CREATE SYNONYM cust FOR stores_demo@training:customer;
```

3. On the database server called **training**, issue the following statement:

```
DROP TABLE customer;  
CREATE TABLE customer (lastname CHAR(20) . . . );
```

The synonym **cust** on the **acctng** database server now points to a new version of the **customer** table on the **training** database server.

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CREATE TABLE statement

Use the CREATE TABLE statement to create a new permanent table in the current database.

Syntax

Notes:

- | Element | Description | Restrictions | Syntax |
|--------------|--|--|----------------------------|
| <i>table</i> | Name that you declare here for the new table | Must be unique among the names of tables, synonyms, views, and sequences in the database | Identifier |

Usage

The following keywords and clauses define column attributes of a new table:

Table 1. Defining the name, data-type, default value, and security label for a column

Specification	Topic	What the keyword or clause defines
Column Definition	Column definition	Column name and attributes, including data type, constraints, default value
DEFAULT	DEFAULT clause of CREATE TABLE	Default value for a column
COLUMN SECURED WITH	Column SECURED WITH label clause	An LBAC label for a protected column

The following keywords and clauses define constraints on the new table:

Table 2. Defining constraints on one or more columns of the table

Specification	Topic	What the keyword or clause defines
Single-Column Constraint	Single-Column Constraint Format	Data-integrity, referential, or other constraints on an individual column
Constraint Definition	Constraint Definition	Name, attributes, and enabled or disables status of constraints on the table
NULL	Using the NULL Constraint	Column allows NULL values
NOT NULL	Using the NOT NULL Constraint	Column does not allow NULL values
UNIQUE or DISTINCT	Using UNIQUE or DISTINCT Constraints	Column does not allow duplicate values
CHECK	CHECK Clause	Check constraints with other columns
PRIMARY KEY	Using the PRIMARY KEY Constraint	Contains a non-NULL unique value for each row in a table
FOREIGN KEY	Using the FOREIGN KEY Constraint	Establishes dependencies between tables
REFERENCES	REFERENCES Clause	Referential-integrity constraints with other columns
Multiple-Column Constraint	Multiple-Column Constraint Format	Data-integrity constraints on a set of columns

The following keywords and clauses define shadow columns and row-level audit support for the table:

Table 3. Defining shadow columns and row-level audit support

Specification	Topic	What the keyword or clause defines
WITH <i>keyword</i>	Specialized columns	Keyword options for shadow columns or for row-level audit support
WITH AUDIT	Using the WITH AUDIT Clause	Row-level audit support
WITH CRCOLS	Using the WITH CRCOLS Option	Keyword option for shadow columns or for row-level audit support
WITH ERKEY	Using the WITH ERKEY Keywords	3 shadow columns on which Enterprise Replication defines a primary key
WITH REPLCHECK	Using the WITH REPLCHECK Keywords	Shadow column that Enterprise Replication uses in consistency checking
WITH ROWIDS	Using the WITH ROWIDS Option	Hidden column in a fragmented table (deprecated)
WITH VERCOLS	Using the WITH VERCOLS Option	2 shadow columns for UPDATE operations on secondary servers

The following keywords and clauses define storage options for a new table:

Table 4. Defining storage for the table or for its smart-large-object columns

Specification	Topic	What the keyword or clause defines
Storage Options	Storage options	Where the table is physically stored and other information about how the table is stored
IN dbspace, sbspace, blobspace, or extspace	Using the IN Clause	Storage object to hold the new table (or part of it, or a large object)
FRAGMENT BY or PARTITION BY	FRAGMENT BY clause	Storage distribution scheme of a fragmented table
BY ROUND ROBIN	Fragmenting by ROUND ROBIN	A list of dbspaces for storing table fragments
BY EXPRESSION	Expression Fragment Clause	Expression-based fragment distribution
BY LIST	List fragment clause	List-based fragment distribution
BY RANGE . . . INTERVAL	Interval fragment clause	RANGE INTERVAL-based fragment distribution
PUT Clause	PUT Clause	Storage location, extent size, and other sbspace attributes for a BLOB or CLOB column
EXTENT SIZE	EXTENT SIZE Options	Sizes of the first and subsequent storage extents of the table
COMPRESSED	COMPRESSED option for tables	Whether automatic compression of large amounts of row data is enabled

The following keywords and clauses define the logging mode and additional table attributes, or insert into the new table the qualifying rows that a specified query returns.

Table 5. Logging options, locking granularity, access methods, typed table attributes, data distribution statistics options, data insertion from query results, or an LBAC security policy for the table.

Specification	Topic	What the keyword or clause defines
Logging Options (STANDARD or RAW)	Logging Options	Logging characteristics of the new table
LOCK MODE (PAGE or ROW)	LOCK MODE Options	Locking granularity of the new table
USING Access-Method	USING Access-Method Clause	How to access the new table

Specification	Topic	What the keyword or clause defines
OF TYPE	OF TYPE Clause	Named ROW type of a typed table in an object-relational database
UNDER	Using the UNDER Clause	Supertable of a new subtable within a typed table hierarchy
SECURITY POLICY	SECURITY POLICY Clause	Label-based access control (LBAC) policy for the table
STATCHANGE, STATLEVEL	Statistics options of the CREATE TABLE statement	Change threshold and granularity of data distribution statistics
AS SELECT	AS SELECT clause	Creates and populates a query result table

Uniqueness rules for table names and column names

When you create a new table, every column must have a data type associated with it. The names of columns must be unique among the column in the same table. (The OF TYPE option specifies an existing named ROW type, whose fields provide column names and column data types for the typed table that you are creating.)

If the database was not created as MODE ANSI, the *table* name must be unique among all the identifiers of tables, views, sequence objects, and synonyms within the same database.

In an ANSI-compliant database, the combination *owner.table* must be unique among all the tables, synonyms, views, and sequence objects in the same database. Table objects qualified with different *owner* names can have the same identifier.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if a table of the specified name is already registered in the current database.

Additional syntax notes for CREATE TABLE

For the restricted syntax options of CREATE TABLE statements that store the result set of a query in a new permanent table, see the [AS SELECT clause](#).

In DB-Access, using CREATE TABLE outside the CREATE SCHEMA statement generates warnings if you use the **-ansi** flag or if the **DBANSIWARN** environment variable is set.

The order of table options

The syntax diagram shows the order of table options in CREATE TABLE statements that include more than one of the following options:

- WITH options for specialized columns
- SECURITY POLICY options
- Storage options
- LOCK MODE options
- USING Access-Method clause
- Statistics options

For example, the following two CREATE TABLE statements are equivalent:

```
CREATE STANDARD TABLE IF NOT EXISTS myShadowy_tab(colA INT, colB CHAR)
WITH ERRKEY, WITH CRCOLS, WITH AUDIT LOCK MODE ROW;
```

```
CREATE STANDARD TABLE IF NOT EXISTS myShadowy_tab(colA INT, colB CHAR)
WITH AUDIT, WITH ERRKEY, WITH CRCOLS LOCK MODE ROW;
```

If you issue both statements consecutively in the same database, the second statement fails, because the table called **myShadowy_tab** that the first statement created already exists in the database. Because of the IF NOT EXISTS keywords, the redundant second statement returns no error, but it creates no new table. The following example fails with an error, because no other Options clause can precede a WITH clause:

```
CREATE TABLE shadow_columns (colA INT, colB CHAR)
LOCK MODE ROW WITH AUDIT, WITH ERRKEY, WITH CRCOLS; --incorrect options order
```

The next CREATE TABLE example also fails, because the Statistics option cannot precede the LOCK MODE option within the same Options clause:

```
CREATE TABLE shadow_columns (colA INT, colB CHAR)
STATCHANGE 25 STATLEVEL TABLE LOCK MODE PAGE; --bad options order
```

- [AS SELECT clause](#)
Use the AS SELECT clause of the CREATE TABLE statement to create a new table and to insert into it the data rows that are the result set of a specified query.
- [Logging Options](#)
Use the Logging Type options to specify logging characteristics that can improve performance in various bulk operations on the table.
- [Column definition](#)
Use the column definition segment of the CREATE TABLE statement to declare the name and data type (and optionally the default value and the constraints or the security label) of a single column of the new table.
- [Multiple-Column Constraint Format](#)
Use the multiple-column constraint format to associate one or more columns with a constraint. This alternative to the single-column constraint format allows you to associate multiple columns with a constraint.
- [OF TYPE Clause](#)
Use the OF TYPE clause to create a *typed table* for an object-relational database. A typed table is a table in which every row is an object of the named ROW data type that you specify in this clause.

- [Specialized columns](#)
You can create specialized columns to support Enterprise Replication, high availability, or row-level auditing.
- [SECURITY POLICY Clause](#)
The optional Security Policy clause can use the following syntax to specify the name of an existing security policy that is thereby associated with the table.
- [Storage options](#)
Use the FRAGMENT BY clause, PUT clause, EXTENT size options, and COMPRESSED option of the CREATE TABLE statement to specify the storage location, the distribution scheme, the extent size for the table, and whether the table is enabled for the automatic compression of large amounts of new row data.
- [LOCK MODE Options](#)
Use the LOCK MODE options to specify the locking granularity of the new table.
- [USING Access-Method Clause](#)
The USING Access Method clause can specify an access method.
- [Statistics options of the CREATE TABLE statement](#)
Use the Statistics Options clause of the CREATE TABLE statement to set the values of the STATCHANGE property of a fragmented or nonfragmented table, and the STATLEVEL property of a fragmented table.

Related reference:

[Modes for constraints and unique indexes](#)
[CREATE OPAQUE TYPE statement](#)
[CREATE ROW TYPE statement](#)
[ALTER TABLE statement](#)
[CREATE INDEX statement](#)
[CREATE DATABASE statement](#)
[CREATE EXTERNAL TABLE Statement](#)
[CREATE TEMP TABLE statement](#)
[DROP TABLE statement](#)
[SET Database Object Mode statement](#)
[SET Transaction Mode statement](#)
[RENAME TABLE statement](#)
[ALTER FRAGMENT statement](#)
[CREATE VIEW statement](#)
[DROP INDEX statement](#)
[RENAME SECURITY statement](#)
[RENAME COLUMN statement](#)
[ADD TYPE Clause](#)
[DROP SECURITY statement](#)
[CREATE SCHEMA statement](#)
[CREATE SECURITY LABEL statement](#)
[DROP TYPE statement](#)
[CREATE SECURITY LABEL COMPONENT statement](#)
[START VIOLATIONS TABLE statement](#)
[ALTER SECURITY LABEL COMPONENT statement](#)
[CREATE SECURITY POLICY statement](#)

Related information:

[Implement a relational data model](#)
[DBANSIWARN environment variable](#)

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AS SELECT clause

Use the AS SELECT clause of the CREATE TABLE statement to create a new table and to insert into it the data rows that are the result set of a specified query.

This syntax closely resembles in its functionality the [INTO STANDARD and INTO RAW Clauses](#) of the SELECT statement.

Only the following subset of the CREATE TABLE statement syntax is valid when you include the AS SELECT clause to create a new query result table, and to populate that table with the qualifying rows that the specified query returns:

```

      .-STANDARD-.
>>-CREATE----->
      '-RAW-'

>--TABLE----->
      '-IF NOT EXISTS-' '-owner--,-'

>----->
      | .-STANDARD-. |
      | V |
      |-----|
      |-(---+column-----+---)-|
      |   +column_alias-----+
      |   '-column--:--target_data_type-'

>----->
      | (1) | (2) | | (3) |
      |-----| Storage Options |-----| '-| LOCK MODE |-----|

      (1) (3)
>-----AS--| SELECT clause |-----><

```

Notes:

1. Informix® extension
2. See [Storage options](#)
3. See [LOCK MODE Options](#)
4. See [SELECT statement](#)

Element	Description	Restrictions	Syntax
<i>column</i>	Column in a table in the FROM clause of the query. This will be a column name in the result table.	Must exist in the query result set	Identifier
<i>column_alias</i>	Alias or display label for a column. This declares a column name in the result table.	Any nontrivial expression in the Projection clause of the query requires an alias or display label for its column name in the result table.	Identifier
<i>owner</i>	Authorization identifier of the owner of the result table	Without this, the user issuing CREATE TABLE is <i>owner</i> by default	Owner name
<i>table</i>	Name that you declare here for the result table	Must be unique among the names of tables, synonyms, views, and sequences in the database	Identifier
<i>target_data_type</i>	Data type that is returned by an explicit cast. This will be the data type of a column in the result table.	See Rules for the Target Data Type	Data Type

Usage

When using the CREATE TABLE . . . AS SELECT statement to create a new permanent table to store the result of a query, you can specify the logging mode of the table as STANDARD or RAW. If you omit both of these keywords, the default is STANDARD.

You can also optionally specify the following attributes for the query result table:

- A single storage location, or a distributed storage scheme
- The storage sizes of its first extent and next extent
- Its PAGE or ROW locking granularity

If you omit a storage or locking specification, the database server uses the default value.

If an error occurs while the database server is populating the new table with qualifying rows from the query in the AS SELECT clause, the operation is rolled back, and no new table is created or populated.

The columns that appear in the Projection list of the AS SELECT clause can be from any local table, or view, or from a remote database (which must be referenced in the qualified table name), but the new table must be created in the local database.

In a grid environment, if the tables in the FROM clause of the AS SELECT clause have the same schema in all the participating database servers of the specified grid or region, you can include the AS SELECT clause to create a result table from a grid query.

Supported data types

The CREATE TABLE . . . AS SELECT statement supports user-defined data types and all the built-in Informix data types.

No more than one serial column, however, is allowed in the new result table. After the first column of type SERIAL, SERIAL8, or BIGSERIAL is included, any subsequent SERIAL, SERIAL8, or BIGSERIAL column is created as an INTEGER, INTEGER8, or BIGINTEGER column.

Column names in the result table

By default, the column names in the new permanent table are the names that are specified in the SELECT list of the Projection clause. If an asterisk (*) is the SELECT list of the Projection clause, the asterisk is expanded to all the column names in the corresponding tables or views in the FROM clause of the SELECT statement. Any explicit or implicit shadow columns in table objects specified by the FROM clause are not expanded by the asterisk specification.

On systems that implement Enterprise Replication, you can use the ADD CRCOLS, ADD REPLCHECK, and ADD ERKEY options to the ALTER TABLE statement to add the corresponding shadow columns to a result table that the AS SELECT clause creates.

All expressions in the SELECT list of the Projection clause, other than simple column expressions, must have a display label (also called a *column alias*). This is used as the identifier of the corresponding column in the new query result table. If a column expression has no display label, the result table uses the column name from the source table in the FROM clause of the query.

In the CREATE TABLE . . . AS SELECT statement, a column alias can be specified in either of two ways:

- As a comma-separated list of aliases, immediately following the TABLE keyword, similar to the syntax of the INSERT INTO . . . SELECT FROM statement
- As a part of the SELECT list in the Projection clause, just as in result tables that the SELECT . . . INTO STANDARD or SELECT . . . INTO RAW statements can create.

If both the SELECT list of the Projection clause and the comma-separated list of aliases that follows the TABLE keyword are present in the CREATE TABLE . . . AS SELECT statement, the comma-separated list of column aliases takes precedence. In this case, any column alias that you declare in the AS SELECT clause is ignored.

The CREATE TABLE . . . AS SELECT statement fails with an error in the following cases:

- If no display label or column alias is declared for a nontrivial column expression.
- If a display label or column alias has the same name as another column in the new result table.
- Except for storage options and LOCK MODE properties, the CREATE TABLE . . . AS SELECT statement cannot define constraints or any other special properties for columns of the new table.
- If a comma-separated list of aliases follows the TABLE keyword, but that list has fewer aliases than the number of expressions in the SELECT list of the Projection clause.

But if the column alias list that follows the TABLE keyword has more items than the SELECT list of the Projection clause, in this case the database server ignores the excess column aliases, and no exception occurs.

The AS SELECT clause can include a column in its ORDER BY clause that is not in the SELECT list of its Projection clause.

Restrictions on result tables

Besides restrictions that the section above identifies for display labels or column aliases and for unsupported column properties in result tables, the SELECT INTO . . . TABLE syntax of the SELECT statement is not valid as a part of a subquery.

As with most DDL statements, attempts to create the new result table in another database using the fully qualified table name fail with a syntax error. It is similarly an error to create a result table with the same name as an existing table, unless the AS SELECT clause includes the IF NOT EXISTS keywords, as described below.

IF NOT EXISTS keywords

If the name that you declare for the query result table in the AS SELECT clause is unique among the names of permanent tables, synonyms, views, and sequences in the database, the database server creates a query result table and populates it with all the qualifying rows that the query returns, whether or not the AS SELECT clause includes the IF NOT EXISTS keywords. (If the query returns no rows, the result table is empty, but its schema is registered in the system catalog of the database as a new permanent table.)

If the AS SELECT clause includes the IF NOT EXISTS keywords, and the name that you declare for the query result table is not unique among the names of permanent table objects in the database, the query that the AS SELECT clause defines is not executed, no result table is created, and the database server returns the message

```
0 row(s) retrieved into table.
```

If the AS SELECT clause omits the IF NOT EXISTS keywords, and the name that you declare for the query result table is not unique among the names of permanent table objects in the database, no result table is created, and the database server returns an error.

Examples of creating and populating result tables

The following example creates a new raw table called **rtable** to store the results of a join query:

```
CREATE RAW TABLE IF NOT EXISTS rtable
AS
SELECT t1col1, t1col2, t2col1
FROM tab1, tab2
WHERE t1col1 < 100 and t2col1 > 5;
```

In the example above, the new query result table **rtable** would contain the columns **t1col1**, **t1col2** and **t2col1**.

The next example fails with error -249, because it declares no display label for the `col1+5` column expression:

```
CREATE TABLE IF NOT EXISTS qtable
AS
SELECT col1+5, col2
FROM tab1;
```

By declaring the column alias **qcol1** for the column expression in the Projection clause that includes the **+** operator, the following revised query avoids the -249 error that the previous example returns:

```
CREATE TABLE IF NOT EXISTS qtable (qcol1, col2)
AS
SELECT col1+5, col2
FROM tab1;
```

The corrected example above creates the standard **qtable** table to store the AS SELECT clause query results.

The next example uses different but equivalent aliasing syntax to declare the same **qcol1** alias in the AS SELECT clause, rather than in the list of column aliases:

```
CREATE TABLE IF NOT EXISTS qtable
AS
SELECT col1+5 qcol1, col2
FROM tab1;
```

The CREATE TABLE statement above similarly avoids the -249 error, and creates a result table that is identical in schema and in data content to the **qtable** table in the previous example. In both of these examples, the result table has two columns, **qcol1** and **col2**. If **col1** is of type INTEGER, then **qcol1** would be type DECIMAL, the return data type from the expression `col1+5`.

As the syntax diagram indicates, the Storage and Lock Mode options to the CREATE TABLE statement are valid with the AS SELECT clause. The following example uses the FRAGMENT BY EXPRESSION keywords to define distributed storage for the query result table, where the **fcol1** column alias is the fragment key, and ROW is the locking granularity:

```
CREATE TABLE IF NOT EXISTS permtab (fcol1, col2)
FRAGMENT BY EXPRESSION
fcol1 < 300 IN dbs1,
fcol1 >=300 IN dbs2
```

Any rows with **fc01** values below 300 are inserted into dbspace **db1**. Rows with larger **fc01** values are stored in the **db2** dbspace.

Logging Options

A permanent table can have either of the following logging characteristics.

For more information on these logging types of tables, refer to your *IBM® Informix® Administrator's Guide*.

Column definition

This syntax fragment is part of the [CREATE TABLE statement](#).

Notes:

- | Element | Description | Restrictions | Syntax |
|---------------|--|------------------------------|----------------------------|
| <i>column</i> | Name that you declare here for a column in the table | Must be unique in this table | Identifier |

Usage

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columns is an approximate lower limit that applies to platforms with a 2 KB base page size. For platforms with a base page size of 4 KB, such as Windows and AIX® systems, the upper limit is approximately 450 columns of these data types.)

The upper limit on the number of columns of these data types also depends on other data that describes the table that the database server stores in the same partition. For some tables, the maximum number of columns might be lower, if the aggregate length of all the SQL identifiers (including the database name, table names, and index names) that are compressed and stored on the disk reduces the free space that is available for the columns.

Character column size semantics

Any explicit or default storage size specifications for columns of built-in character types, such as CHAR, LVARCHAR, NCHAR, NVARCHAR, or VARCHAR, are interpreted in units of bytes, unless the SQL_LOGICAL_CHAR configuration parameter is set to enable logical character semantics in data type declarations.

Interpreting size declarations as logical character semantics reduces the risk of insufficient storage for column values in INSERT and UPDATE operations. When the data length exceeds the maximum size of the column, then the result depends on the ANSI-compliance status of the database:

- If the database is not ANSI-compliant, IBM® Informix® truncates the value. No warning is generated when this truncation occurs.
- If the database is ANSI-compliant, then the INSERT or UPDATE operation fails and this error is returned:

```
-1279: Value exceeds string column length.
```

See the *IBM Informix Administrator's Reference* description of the SQL_LOGICAL_CHAR configuration parameter for more information about the effect of its setting in locales that support a multibyte code set, such as **UTF-8**, where a single logical character can require more than one byte of storage.

Restrictions on IDSSECURITYLABEL columns

The following restrictions affect the use of the Column Definition clause to specify a column of the IDSSECURITYLABEL data type to support label-based access control (LBAC):

- If the table has no security policy, a user who holds the DBSECADM role must also include the SECURITY POLICY clause to specify a security policy.
- Only a user who holds the DBSECADM role can specify a column of type IDSSECURITYLABEL.
- A table can have at most one column of type IDSSECURITYLABEL.
- The IDSSECURITYLABEL column cannot have column protection.
- The IDSSECURITYLABEL column has an implicit NOT NULL constraint by default. If no *label* name for the default security label is specified in the DEFAULT clause, the default value for this column is the security label for write access that is held by the user.
- The IDSSECURITY LABEL column cannot have any explicit single-column constraints, and it cannot be part of multiple-column referential or check constraints.
- The IDSSECURITYLABEL column cannot be encrypted.
- If the table is secured with both row-level and column-level protection, the default or explicit security label of the IDSSECURITYLABEL column must have the same security policy as any labels that the Column SECURED WITH clause references.

As with any SQL identifier, syntactic ambiguities (and sometimes error messages or unexpected behavior) can occur if the *column* name is a keyword, or if it is the same as the *table* name, or the name of another table that you later join with the *table*. For information about the keywords of Informix, see [Keywords of SQL for IBM Informix](#).

If you define a column of a table as a named ROW type, the table does not adopt any constraints of the named ROW.

- [Column SECURED WITH label clause](#)
Use the Column SECURED WITH label clause to provide label-based column-level security protection for a table by attaching a security label to the column. The label must be part of a security policy that the SECURITY POLICY clause attaches to the table.
- [DEFAULT clause of CREATE TABLE](#)
Use the DEFAULT clause in the CREATE TABLE statement to specify the default value for the database server to insert into a column when no explicit value for the column is specified.
- [Single-Column Constraint Format](#)
Use the Single-Column Constraint format to define and declare the name of at least one constraint on a single column, and to specify the mode of each constraint.

Related information:

[SQL_LOGICAL_CHAR configuration parameter](#)

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Column SECURED WITH label clause

Use the Column SECURED WITH label clause to provide label-based column-level security protection for a table by attaching a security label to the column. The label must be part of a security policy that the SECURITY POLICY clause attaches to the table.

This syntax fragment is part of the [Column definition](#).

Column SECURED WITH label clause

```
|-----+---SECURED WITH--label-----|  
'-COLUMN-'
```

Element	Description	Restrictions	Syntax
---------	-------------	--------------	--------


```

| '-SYSDATE-' | | (2) | |
| | | '-| DATETIME Field Qualifier |-----' |
+-----+
+-TODAY-----+
+-SITENAME-----+
+-DBSERVERNAME-----+

```

Notes:

1. Informix® extension
2. See [DATETIME Field Qualifier](#)

Element	Description	Restrictions	Syntax
<i>label</i>	Name of a security label	Must exist and must belong to the security policy that protects the table. The column must be of type IDSSECURITYLABEL.	Identifier
<i>literal</i>	String of alphabetic or numeric characters	Must be an appropriate data type for the column. See Using a Literal as a Default Value .	Expression

You cannot specify default values for SERIAL, BIGSERIAL, or SERIAL8 columns.

Using NULL as a default value

If you specify no default value for a column, the default is `NULL` unless you place a NOT NULL constraint on the column. In this case, no default value exists.

If you specify `NULL` as the default value for a column, you cannot specify a NOT NULL constraint as part of the column definition. (For details of NOT NULL constraints, see [Using the NOT NULL Constraint](#).)

`NULL` is not a valid default value for a column that is part of a primary key.

For columns of large-object data types like `BYTE`, `TEXT`, `BLOB`, or `CLOB`, or of field-value pair data types like `BSON` or `JSON`, the only valid default value is `NULL`.

Example of setting the default value of a BSON column

The following CREATE TABLE statement fails with an exception, because the `BSON` data type of the `data` column requires `NULL` as its default, rather than the specified field-value pair:

```

CREATE TABLE tabl
(
  id VARCHAR(128) NOT NULL,
  data "informix".BSON DEFAULT '{"id:1"}::JSON',
  modcount BIGINT,
  flags INTEGER DEFAULT 12,
  PRIMARY KEY (data)
);

(U0001) - bson_to_char: unhandled storage type '98'
Error in line 8

```

The following successful statement replaces the non-`NULL` default value for `data` with the only valid default for `BSON` columns, and drops the PRIMARY KEY constraint on the `data` column.

```

CREATE TABLE tabl
(
  id VARCHAR(128) NOT NULL,
  data "informix".BSON DEFAULT NULL,
  modcount BIGINT,
  flags INTEGER DEFAULT 12
);

```

If this successful revision of the first example had defined a the PRIMARY KEY constraint on the `data` column, however, as in the first example, the CREATE TABLE statement would have failed with a different error, because for any data type, a column that has `NULL` as its default value cannot be part of a primary key.

Using a Literal as a Default Value

You can designate a literal value as a default value. A literal value is a string of alphabetic or numeric characters. To use a literal value as a default value, you must adhere to the syntax restrictions in the following table.

For Columns of Data Type	Format of Default Value
BOOLEAN	Use <code>'t'</code> or <code>'f'</code> (respectively for <i>true</i> or <i>false</i>) as a Quoted String .
CHAR, CHARACTER VARYING, DATE, VARCHAR, NCHAR, NVARCHAR, LVARCHAR	Quoted String . DATE literals must be of the format that the DBDATE (or else GL_DATE) environment variable specifies. In the default locale, if neither DBDATE nor GL_DATE is set, date literals must be of the <i>mm/dd/yyyy</i> format.
DATETIME	Literal DATETIME
BIGINT, DECIMAL, FLOAT, INT8, INTEGER, MONEY, SMALLFLOAT, SMALLINT	Literal Number
INTERVAL	Literal INTERVAL
Opaque data types	Quoted String in format of Single-Column Constraint Format

For example, the following statement includes a column definition with a literal DATETIME:

```
CREATE TABLE tab1
(
  id VARCHAR(128) NOT NULL,
  date DATETIME YEAR TO FRACTION(3) DEFAULT DATETIME(1971-01-01 00:00:00.000)
    YEAR TO FRACTION(3),
  modcount BIGINT,
  flags INTEGER DEFAULT 12
);
```

Using a Constant Expression as a Default Value

You can specify a constant expression as the default column value.

The following table lists constant expressions that you can specify, the data type requirements, and the recommended size (in bytes) for their corresponding columns.

Table 1. Constant expressions as default values

Constant Expression	Data Type Requirement	Recommended Size
CURRENT, SYSDATE	DATETIME column with matching qualifier	Enough bytes to store the longest DATETIME value for the locale
DBSERVERNAME, SITENAME	CHAR, VARCHAR, NCHAR, NVARCHAR, or CHARACTER VARYING column	128 bytes
TODAY	DATE column	Enough bytes to store the longest DATE value for the locale
USER, CURRENT_USER	CHAR, VARCHAR, NCHAR, NVARCHAR, or CHARACTER VARYING column	32 bytes

These column sizes are recommended because, if the column length is too small to store the default value during INSERT or ALTER TABLE operations, the database server returns an error.

You cannot designate a constant expression that behaves like a variant function (that is, CURRENT, SYSDATE, USER, TODAY, SITENAME, or DBSERVERNAME) as the default value for a column that holds an OPAQUE or DISTINCT data type. In addition, larger column sizes are required if the data values are encrypted, or if they are encoded in the Unicode character set of the **UTF-8** locale. (See the description of the SET ENCRYPTION statement later in this chapter for more information about storage size requirements for encrypted data.)

For descriptions of these functions, see [Constant Expressions](#).

The following example creates a table with columns that have literal default values. The **acc_id** column value defaults to the authorization identifier of the current user.

```
CREATE TABLE accounts (
  acc_num INTEGER DEFAULT 1,
  acc_type CHAR(1) DEFAULT 'A',
  acc_descr CHAR(20) DEFAULT 'New Account',
  acc_date DATETIME YEAR TO DAY DEFAULT SYSDATE DATETIME YEAR TO DAY,
  acc_id CHAR(32) DEFAULT CURRENT_USER);
```

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Single-Column Constraint Format

Use the Single-Column Constraint format to define and declare the name of at least one constraint on a single column, and to specify the mode of each constraint.

The Single-Column Constraint format can associate one or more constraints with a column, in order to perform any of the following tasks:

- Create one or more data-integrity constraints for a column.
- Specify a meaningful name for a constraint.
- Specify the constraint-mode that controls the behavior of a constraint during insert, delete, and update operations.

This syntax fragment is part of the [Column definition](#).

Single-Column Constraint Format

```

.-+--+NULL-----+-----+-----+-----+-----+-----+-----+
| | '-NOT NULL-' | | (1) | | (4) | |
| | (1) | | '-----| Constraint Definition |-----' |
| +-----DISTINCT-----+-----+-----+-----+-----+-----+
| | +-UNIQUE-----+ | | |
| | '-PRIMARY KEY-----' | |
| | (2) | |
| | '++| REFERENCES Clause |-----+ |
.-| | (3) | |
V | '-| CHECK Clause |-----' |
|-----+-----+-----+-----+-----+-----+-----+-----+

```

Notes:

1. Informix® extension

2. See [REFERENCES Clause](#)
3. See [CHECK Clause](#)
4. See [Constraint Definition](#)

The NULL constraint specifies that the column can store NULL values. It is not valid for columns of serial or complex data types. The CREATE TABLE statement fails with an error if you specify both NOT NULL and NULL constraints on the same column.

The following example creates a standard table with two constraints: **num**, a primary-key constraint on the **acc_num** column; and **code**, a unique constraint on the **acc_code** column:

```
CREATE TABLE accounts (
  acc_num   INTEGER PRIMARY KEY CONSTRAINT num,
  acc_code  INTEGER UNIQUE CONSTRAINT code,
  acc_descr CHAR(30) );
```

The types of constraints used in this example are defined in sections that follow.

- [Restrictions on Using the Single-Column Constraint Format](#)
- [Using the NOT NULL Constraint](#)
- [Using the NULL Constraint](#)
- [Using UNIQUE or DISTINCT Constraints](#)
- [Differences Between a Unique Constraint and a Unique Index](#)
- [Using the PRIMARY KEY Constraint](#)
- [REFERENCES Clause](#)
- [CHECK Clause](#)
- [Constraint Definition](#)

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Restrictions on Using the Single-Column Constraint Format

The single-column constraint format cannot specify a constraint that involves more than one column. Thus, you cannot use the single-column constraint format to define a composite key. For information on multiple-column constraints, see [Multiple-Column Constraint Format](#).

You cannot define a referential constraint or a unique constraint on any column of a RAW table. Only NOT NULL or NULL constraints are supported on RAW tables.

You cannot place unique, primary-key, or referential constraints on BLOB, BYTE, CLOB, or TEXT columns. You can, however, check for NULL or non-NULL values on BYTE or TEXT columns with a check constraint.

If the constraint is on a column that stores encrypted data, Informix® cannot enforce the constraint.

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Using the NOT NULL Constraint

Use the NOT NULL keywords to require that a column receive a value during insert or update operations. If you place a NOT NULL constraint on a column (and no default value is specified), you *must* enter a value into this column when you insert a row or update that column in a row. If you do not enter a value, the database server returns an error, because no default value exists.

The following example creates the **newitems** table. In **newitems**, the column **manucode** does not have a default value nor does it allow NULL values.

```
CREATE TABLE newitems (
  newitem_num INTEGER,
  manucode CHAR(3) NOT NULL,
  promotype INTEGER,
  descrip CHAR(20) );
```

When you define a PRIMARY KEY constraint, the database server also silently creates a NOT NULL constraint on the same column, or on the same set of columns that make up the primary key.

You cannot specify NULL as the explicit default value for a column if you also specify the NOT NULL constraint.

The CREATE TABLE statement fails with an error if you specify both a NOT NULL constraint and a NULL constraint on the same column.

The NOT NULL constraint is required for columns of the collection data types LIST, MULTISET, and SET. No other column constraints are allowed on a collection data type.

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Using the NULL Constraint

Use the NULL keyword to specify that a column can store the NULL value for its data type. This implies that the column need not receive any value during insert or update operations. The NULL constraint is logically equivalent to omitting the NOT NULL constraint from the column definition.

The following example creates the **newitems** table. In **newitems**, the column **descrip** does not have a default value, but it allows NULL values.

```
CREATE TABLE newitems (
  newitem_num INTEGER,
  manucode CHAR(3) NOT NULL,
  promotype INTEGER,
  descrip CHAR(20) NULL);
```

In the example above, the columns **newitem_num** and **promotype** also allow NULL values implicitly, because no NOT NULL constraint is defined on them.

The CREATE TABLE statement fails with an error if you specify both a NOT NULL constraint and a NULL constraint on the same column.

You cannot specify both a NULL constraint and a PRIMARY KEY constraint on the same column, because when the CREATE TABLE statement defines a PRIMARY KEY constraint, the database server also silently creates a NOT NULL constraint on the same column, or on the same set of columns that make up the primary key.

The NULL constraint is not valid for columns of the collection data types LIST, MULTISSET, and SET, nor for IDSECURITYLABEL columns.

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Using UNIQUE or DISTINCT Constraints

Use the UNIQUE or DISTINCT keyword to require that a column or set of columns accepts only unique data values. You cannot insert values that duplicate the values of some other row into a column that has a unique constraint. When you create a UNIQUE or DISTINCT constraint, the database server automatically creates an internal index on the constrained column or columns. (In this context, the keyword DISTINCT is a synonym for UNIQUE.)

You cannot place a unique constraint on a column that already has a primary-key constraint. You cannot place a unique constraint on a BYTE or TEXT column.

As previously noted, you cannot place a unique or primary-key constraint on a BLOB or CLOB column of Informix®.

Opaque data types support a unique constraint only where a secondary-access method supports uniqueness for that type. The default secondary-access method is a generic B-tree, which supports the **equal()** operator function. Therefore, if the definition of the opaque type includes the **equal()** function, a column of that opaque type can have a unique constraint.

The following example creates a simple table that has a unique constraint on one of its columns:

```
CREATE TABLE accounts
(acc_name CHAR(12),
 acc_num SERIAL UNIQUE CONSTRAINT acc_num);
```

For an explanation of the constraint name, refer to [Declaring a Constraint Name](#).

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Differences Between a Unique Constraint and a Unique Index

Although a unique index and a unique constraint are functionally similar, besides various differences in the syntax by which you declare, alter, or destroy them, there are additional differences between these two types of database objects:

- In DDL statements, they are registered or dropped in different tables of the system catalog
- In DML statements, enabled unique constraints on a logged table are checked at the end of a statement, but unique indexes are checked on a row-by-row basis, thereby preventing any insert or update of a row that might potentially violate the uniqueness of the specified column (or for a multiple-column column constraint or index, the column list).

For example, if you stored the values 1, 2, and 3 in rows of a logged table that has an INT column, an UPDATE operation on that table that specifies **SET c = c + 1** would fail with an error if there were a unique index on the column **c**, but the statement would succeed if the column had a unique constraint.

Related reference:

[Index-type options](#)

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Using the PRIMARY KEY Constraint

A *primary key* is a column (or a set of columns, if you use the multiple-column constraint format) that contains a non-NULL, unique value for each row in a table. When you define a PRIMARY KEY constraint, the database server automatically creates an internal index on the column or columns that make up the primary key, and silently creates a NOT NULL constraint on the same column or columns.

You can designate only one primary key for a table. If you define a single column as the primary key, then it is unique by definition. You cannot explicitly give the same column a unique constraint.

You cannot place a unique or primary-key constraint on a BLOB or CLOB column.

Opaque types of Informix® support a primary key constraint only where a secondary-access method supports the uniqueness for that type. The default secondary-access method is a generic B-tree, which supports the **equal()** function. Therefore, if the definition of the opaque type includes the **equal()** function, a column of that opaque type can have a primary-key constraint.

- When you use the multiple-column constraint format, the maximum number of columns in the REFERENCES clause is 16, and the total length of the columns cannot exceed 390 bytes if the page size is 2 kilobytes. (The maximum length increases with the page size.)

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Default Values for the Referenced Column

If the referenced table is different from the referencing table, you do not need to specify the referenced column; the default column is the primary-key column (or columns) of the referenced table. If the referenced table is the same as the referencing table, you must specify the referenced column.

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Referential Relationships Within a Table

You can establish a referential relationship between two columns of the same table. In the following example, the **emp_num** column in the **employee** table uniquely identifies every employee through an employee number. The **mgr_num** column in that table contains the employee number of the manager who manages that employee. In this case, **mgr_num** references **emp_num**. Duplicate values appear in the **mgr_num** column because managers manage more than one employee.

```
CREATE TABLE employee
(
  emp_num INTEGER PRIMARY KEY,
  mgr_num INTEGER REFERENCES employee (emp_num)
);
```

A table in which referential relationships exist among its rows can have a PRIMARY KEY constraint with no explicit foreign key. For the syntax to recursively query a table in which multiple levels of a logical hierarchy exist among the rows, see [Hierarchical Clause](#).

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Locking Implications of Creating a Referential Constraint

When you create a referential constraint, an exclusive lock is placed on the referenced table. The lock is released when the CREATE TABLE statement is finished. If you are creating a table in a database that supports transaction logging, and you are using transactions, the lock is released at the end of the transaction.

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Examples of the Single-Column Constraint format

These examples illustrate single-column constraint format options to define a foreign-key constraint that is enabled by default, and to declare the name of a disabled referential constraint.

A referential constraint enabled by default

The following example uses the single-column constraint format to define a referential relationship between the **sub_accounts** and **accounts** tables. (The terms *foreign-key constraint* and *referential constraint* are synonyms.) The **ref_num** column (the foreign key) in the **sub_accounts** table references the **acc_num** column (the primary key) in the **accounts** table.

```
CREATE TABLE accounts (
  acc_num INTEGER PRIMARY KEY,
  acc_type INTEGER,
  acc_descr CHAR(20));
CREATE TABLE sub_accounts (
  sub_acc INTEGER PRIMARY KEY,
  ref_num INTEGER REFERENCES accounts (acc_num),
  sub_descr CHAR(20));
```

The single-column constraint format syntax of the CREATE TABLE statement above that defines the **sub_accounts** table does not explicitly specify that the **ref_num** column is a foreign key, but the REFERENCES keyword specifies that **ref_num** must have the same value as the **acc_num** column in some row of the **accounts** table. This implies that the **ref_num** column is the foreign key in a referential relationship in which **sub_accounts** is the referencing table, and **accounts** is the referenced table.

In single-column constraint format, you do not explicitly specify that the **ref_num** column is a foreign key. To include the FOREIGN KEY keywords when you place a referential constraint on a single column (or on a list of columns that reference the same primary key) of the referencing table, you must instead use the multiple-column constraint format syntax to define the referential constraint.

By default, this constraint on the **sub_accounts** table is enabled without filtering, because no explicit constraint mode is specified. You can use the neither the DISABLED or FILTERING keyword is specified in the example. The SET CONSTRAINTS option to the SET Database Object Mode statement can reset the object

mode of existing constraints.

Because the **sub_accounts** example above declares no name for the referential constraint, the database server generates an implicit identifier when it registers this constraint in the **sysconstraints** system catalog table, and registers its mode (**E**) in the **sysobjstate** system catalog table.

A disabled referential constraint

The next CREATE TABLE statement creates a **xeno_counts** table, and defines a referential constraint between its **xeno_num** column and the **acc_num** column in the **accounts** table from the first example. This single-column constraint format syntax also includes a constraint definition, specifying **DISABLED** as its constraint mode, and declaring **xeno_constr** as the name of this foreign-key constraint. Here **xeno_accounts** is the referencing table, and **accounts** is the referenced table.

```
CREATE TABLE xeno_counts (
  xeno_acc INTEGER PRIMARY KEY,
  xeno_num INTEGER REFERENCES accounts (acc_num)
    CONSTRAINT xeno_constr DISABLED,
  xeno_descr CHAR(20));
```

In **DISABLED** mode, the **xeno_constr** constraint is not enforced when DML operations produce violating rows in the **xeno_counts** table. To enforce referential integrity, however, you can use the SET CONSTRAINTS option to the SET Database Object Mode statement to change the constraint mode to **ENABLED**. Alternatively, SET CONSTRAINTS can reset the **xeno_constr** constraint to a **FILTERING** mode, after the START VIOLATIONS statement associates a violations table with the **xeno_counts** table.

Related reference:

[SET CONSTRAINTS statement](#)

[Choosing a Constraint-Mode Option](#)

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Using the ON DELETE CASCADE Option

Use the ON DELETE CASCADE option to specify whether you want rows deleted in a child table when corresponding rows are deleted in the parent table. If you do not specify cascading deletes, the default behavior of the database server prevents you from deleting data in a table if other tables reference it.

If you specify this option, later when you delete a row in the parent table, the database server also deletes any rows associated with that row (foreign keys) in a child table. The principal advantage to the cascading-deletes feature is that it allows you to reduce the quantity of SQL statements you need to perform delete actions.

For example, the **all_candy** table contains the **candy_num** column as a primary key. The **hard_candy** table refers to the **candy_num** column as a foreign key. The following CREATE TABLE statement creates the **hard_candy** table with the cascading-delete option on the foreign key:

```
CREATE TABLE all_candy
(candy_num SERIAL PRIMARY KEY,
 candy_maker CHAR(25));

CREATE TABLE hard_candy
(candy_num INT,
 candy_flavor CHAR(20),
 FOREIGN KEY (candy_num) REFERENCES all_candy
 ON DELETE CASCADE);
```

Because ON DELETE CASCADE is specified for the dependent table, when a row of the **all_candy** table is deleted, the corresponding rows of the **hard_candy** table are also deleted. For information about syntax restrictions and locking implications when you delete rows from tables that have cascading deletes, see [Considerations When Tables Have Cascading Deletes](#).

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CHECK Clause

Use the CHECK clause to designate conditions that must be met *before* data can be assigned to a column during an INSERT or UPDATE statement.

This syntax fragment is part of the [Single-Column Constraint Format](#) and the [Multiple-Column Constraint Format](#).

CHECK Clause

```

(1)
|--CHECK--(--| Condition |-----)-----|
```

Notes:

1. See [Condition](#)

The *condition* cannot include a user-defined routine.

During an insert or update, if the check constraint of a row evaluates to *false*, the database server returns an error. The database server does not return an error if a row evaluates to NULL for a check constraint. In some cases, you might want to use both a check constraint and a NOT NULL constraint.

- [Using a Search Condition](#)
- [Restrictions When Using the Single-Column Constraint Format](#)

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Using a Search Condition

The *search condition* that defines a check constraint cannot contain the following elements: user-defined routines, subqueries, aggregates, host variables, or rowids. In addition, the search condition cannot contain the following built-in variant functions: CURRENT, SYSDATE, USER, CURRENT_USER, SITENAME, DBSERVERNAME, or TODAY.

When you specify a date value in a search condition, make sure you specify four digits for the year, so that the **DBCENTURY** environment variable has no effect on the condition. When you specify a two-digit year, the **DBCENTURY** environment variable can produce unpredictable results if the condition depends on an abbreviated year value. For more information about **DBCENTURY**, see the *IBM® Informix® Guide to SQL: Reference*.

More generally, the database server saves the settings of environment variables from the time of creation of check constraints. If any of these settings are subsequently changed in a way that can affect the evaluation of a condition in a check constraint, the new settings are disregarded, and the original environment variable settings are used when the condition is evaluated.

With a BYTE or TEXT column, you can check for NULL or not-NULL values. This constraint is the only constraint allowed on a BYTE or TEXT column.

Related information:

[DBCENTURY environment variable](#)

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Restrictions When Using the Single-Column Constraint Format

When you use the single-column constraint format to define a check constraint, the check constraint cannot depend on values in other columns of the table. The following example creates the **my_accounts** table that has two columns with check constraints, each in the single-column constraint format:

```
CREATE TABLE my_accounts (
  chk_id SERIAL PRIMARY KEY,
  acct1 MONEY CHECK (acct1 BETWEEN 0 AND 99999),
  acct2 MONEY CHECK (acct2 BETWEEN 0 AND 99999));
```

Both **acct1** and **acct2** are columns of MONEY data type whose values must be between 0 and 99999. If, however, you want to test that **acct1** has a larger balance than **acct2**, you cannot use the single-column constraint format. To create a constraint that checks values in more than one column, you must use the [Multiple-Column Constraint Format](#).

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Constraint Definition

Use the constraint definition portion of CREATE TABLE for these purposes:

- To declare a name for the constraint
- To set a constraint to disabled, enabled, or filtering mode.

This syntax fragment is part of the [Single-Column Constraint Format](#) and the [Multiple-Column Constraint Format](#).

Constraint Definition

```
|----->
|'-CONSTRAINT--constraint-'
|
|-----|
| |.-ENABLED-----|
| |'-+-----+'
| |+-DISABLED-----+
| | |.-WITHOUT ERROR-. |
| |'-FILTERING---+WITH ERROR---+'
|
```

Element	Description	Restrictions	Syntax
<i>constraint</i>	Name of constraint	Must be unique for the table among index and constraint names	Identifier

- [Declaring a Constraint Name](#)
- [Choosing a Constraint-Mode Option](#)

Use the constraint-mode options (ENABLED, DISABLED, and FILTERING) to control the behavior of constraints in INSERT, DELETE, MERGE, and UPDATE operations.

Declaring a Constraint Name

The database server implements the constraint as an index. Whenever you use the single- or multiple-column constraint format to place a data restriction on a column, but without declaring a *constraint* name, the database server creates a constraint and adds a row for that constraint in the **sysconstraints** system catalog table.

The database server also generates an identifier and adds a row to the **sysindices** system catalog table for each new primary-key, unique, or referential constraint that does not share an index with an existing constraint. Even if you declare a name for a constraint, the database server generates the name that appears in the **sysindices** table. (The system catalog also includes a view on the **sysindices** table, called **sysindexes**, which also lists each component of a composite index.)

If you want, you can specify a meaningful name for the constraint. The name must be unique among the names of constraints and indexes in the database.

Constraint names appear in error messages having to do with constraint violations. You can use this name when you use the DROP CONSTRAINT clause of the ALTER TABLE statement.

You also specify a constraint name when you change the mode of constraint with the SET Database Object Mode statement or the SET Transaction Mode statement, and in the DROP INDEX statement for constraints that are implemented as indexes with user-defined names.

In an ANSI-compliant database, when you declare the name of a constraint of any type, the combination of the *owner* name and *constraint* name must be unique within the database.

- [Constraint Names That the Database Server Generates](#)

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Constraint Names That the Database Server Generates

If you do not specify a constraint name, the database server generates a constraint name using the following template:

`constraint_type tabid constraintid`

In this template, *constraint_type* is the letter **u** for unique or primary-key constraints, **r** for referential constraints, **c** for check constraints, and **n** for NOT NULL constraints. In the template, *tabid* and *constraintid* are values from the **tabid** and **constrid** columns of the **systables** and **sysconstraints** system catalog tables, respectively. For example, the constraint name for a unique constraint might look like "**u111_14**" (with a leading blank space).

If the generated name conflicts with an existing identifier, the database server returns an error, and you must then supply an explicit constraint name.

The generated index name in **sysindexes** (or **sysindices**) has this format:

`[blankspace] tabid constraintid`

For example, the index name might be something like "**111_14**" (quotation marks used here to show the blank space).

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Choosing a Constraint-Mode Option

Use the constraint-mode options (ENABLED, DISABLED, and FILTERING) to control the behavior of constraints in INSERT, DELETE, MERGE, and UPDATE operations.

For constraints that the CREATE TABLE statement defines, these are the options.

DISABLED

Does not enforce the constraint during INSERT, DELETE, and UPDATE operations

ENABLED

Enforces the constraint during INSERT, DELETE, and UPDATE operations If a target row causes a violation of the constraint, the statement fails. This mode is the default.

FILTERING

Enforces the constraint during INSERT, DELETE, and UPDATE operations, if the START VIOLATIONS statement has created a violations table and a diagnostics table. If a target row causes a violation of the constraint, the statement continues processing. The database server writes the row in question to the violations table associated with the target table, and writes diagnostic information to the associated diagnostics table.

If you choose filtering mode, you can specify the WITHOUT ERROR or WITH ERROR options. The following list explains these ERROR options.

WITH ERROR

Returns an integrity-violation error when a filtering-mode constraint is violated during an INSERT, DELETE, or UPDATE operation.

WITHOUT ERROR

Does not return an integrity-violation error when a filtering-mode constraint is violated during an INSERT, DELETE, or UPDATE operation. This is the default ERROR option.

For the **FILTERING WITHOUT ERROR** mode to have these effects, you must also use the **START VIOLATIONS TABLE** statement to start the violations and diagnostics tables for the target table on which the constraints are defined. You can issue that statement

- Constraint modes are registered in the **sysobjstate** system catalog table.

The modes listed above are only a subset of the constraint modes that the SET CONSTRAINTS option to the SET Database Object Mode statement can specify while it is resetting the mode of an existing foreign-key or check constraint. They are also a subset of the constraint modes that the ALTER TABLE ADD CONSTRAINT statement can specify while creating a new foreign-key or check constraint on an existing table.

Because most tables are empty when they are created, referential-integrity checking of existing rows typically does not occur during table creation, and the CREATE TABLE statement does not support NOVALIDATE constraint modes. Those modes can be efficient, however, in contexts where non-empty tables with foreign-key or check constraints need to be moved to another database or to a data warehouse.

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This syntax fragment is part of the [CREATE TABLE statement](#) and the [OF TYPE Clause](#).

```

      .,-----.
      V         |
|--+--NOT NULL--+--UNIQUE-----+--(---column---+-->
|   '-NULL-----' | (1) |
|                   +-----DISTINCT-----+
|                   +-PRIMARY KEY-----+
|                   (2) |
|   '-| REFERENCES Clause |-----'
|   .,-----.
|   V         | (2)
+-FOREIGN KEY--(---column---+--| REFERENCES Clause |-----+
|                   (3) |
|   '-| CHECK Clause |-----'
|
(1) (4)
>-----| Constraint Definition |-----|

```

1. Informix® extension
2. See [REFERENCES Clause](#)
3. See [CHECK Clause](#)
4. See [Constraint Definition](#)

A multiple-column constraint has these cardinality and size restrictions:

- For a page size of 2K, the total length cannot exceed 390 bytes.
- For a page size of 16K, the total length cannot exceed 3257 bytes.

Here the slash (/) symbol represents integer division.

When you define a unique constraint (by using the UNIQUE or DISTINCT keyword), a column cannot appear in the constraint list more than once.

Using the multiple-column constraint format, you can perform these tasks:

- Create data-integrity constraints for a set of one or more columns
- Declare a mnemonic name for a constraint
- Specify the constraint-mode option that controls the behavior of a constraint during insert, delete, and update operations.

When you use this format, you can create composite primary and foreign keys, or define check constraints that compare data in different columns.

See also the section [Differences Between a Unique Constraint and a Unique Index](#).

- [Restrictions with the Multiple-Column Constraint Format](#)

When you use the multiple-column constraint format, you cannot define any default values for columns. In addition, you cannot establish a referential relationship between two columns of the same table.

- [Using the FOREIGN KEY Constraint](#)
- [Examples of the Multiple-Column Constraint Format](#)
- [Default Index Creation Strategy for Constraints](#)

When you create a table with unique or primary-key constraints, the database server creates a system-generated, internal index that is unique and ascending for each constraint.

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Restrictions with the Multiple-Column Constraint Format

When you use the multiple-column constraint format, you cannot define any default values for columns. In addition, you cannot establish a referential relationship between two columns of the same table.

To define a default value for a column, or to establish a referential relationship between two columns of the same table, refer to [Single-Column Constraint Format](#) or to [Referential Relationships Within a Table](#) respectively.

- [Using Large-Object Types in Constraints](#)

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Using Large-Object Types in Constraints

You cannot place unique, primary-key, or referential (FOREIGN KEY) constraints on BYTE or TEXT columns. You can, however, check for NULL or non-NULL values with a check constraint.

You cannot place unique or primary-key constraints on BLOB or CLOB columns. If the constraint is on a set of columns that includes a column that stores encrypted data, Informix® cannot enforce the constraint.

You can find detailed discussions of specific constraints in the following sections:

Constraint	For more information, see	For an example, see
CHECK	CHECK Clause	Defining Check Constraints Across Columns
DISTINCT	Using UNIQUE or DISTINCT Constraints	Examples of the Multiple-Column Constraint Format
FOREIGN KEY	Using the FOREIGN KEY Constraint	Defining Composite Primary and Foreign Keys
PRIMARY KEY	Using the PRIMARY KEY Constraint	Defining Composite Primary and Foreign Keys
UNIQUE	Using UNIQUE or DISTINCT Constraints	Examples of the Multiple-Column Constraint Format

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Using the FOREIGN KEY Constraint

A foreign key *joins* and establishes dependencies between tables. That is, it creates a referential constraint. (For more information on referential constraints, see the [REFERENCES Clause](#).)

A foreign key references a unique or primary key in a table. For every entry in the foreign-key columns, a matching entry must exist in the unique or primary-key columns if all foreign-key columns contain non-NULL values.

You cannot specify BYTE or TEXT columns as foreign keys.

You cannot specify BLOB or CLOB columns as foreign keys.

Examples of the Multiple-Column Constraint Format

The following example creates a standard table, called **order_items**, with a unique constraint, called **items_constr**, using the multiple-column constraint format:

```
CREATE TABLE order_items
(
  order_id SERIAL,
  line_item_id INT not null,
  unit_price DECIMAL(6,2),
  quantity INT,
  UNIQUE (order_id,line_item_id) CONSTRAINT items_constr
);
```

For constraint names, see [Declaring a Constraint Name](#).

- [Defining Check Constraints Across Columns](#)
- [Defining Composite Primary and Foreign Keys](#)

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Defining Check Constraints Across Columns

When you use the multiple-column constraint format to define check constraints, a check constraint can apply to more than one column in the same table. (You cannot, however, create a check constraint whose *condition* uses a value from a column in another table.)

This example compares two columns, **acct1** and **acct2**, in the new table:

```
CREATE TABLE my_accounts
(
  chk_id SERIAL PRIMARY KEY,
  acct1 MONEY,
  acct2 MONEY,
  CHECK (0 < acct1 AND acct1 < 99999),
  CHECK (0 < acct2 AND acct2 < 99999),
  CHECK (acct1 > acct2)
);
```

In this example, the **acct1** column must be greater than the **acct2** column, or the insert or update fails.

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Defining Composite Primary and Foreign Keys

When you use the multiple-column constraint format, you can create a composite key. A *composite key* specifies multiple columns for a primary-key or foreign-key constraint.

The next example creates two tables. The first table has a composite key that acts as a primary key, and the second table has a composite key that acts as a foreign key.

```
CREATE TABLE accounts (
  acc_num INTEGER,
  acc_type INTEGER,
  acc_descr CHAR(20),
  PRIMARY KEY (acc_num, acc_type));

CREATE TABLE sub_accounts (
  sub_acc INTEGER PRIMARY KEY,
  ref_num INTEGER NOT NULL,
  ref_type INTEGER NOT NULL,
  sub_descr CHAR(20),
  FOREIGN KEY (ref_num, ref_type) REFERENCES accounts
    (acc_num, acc_type));
```

In this example, the foreign key of the **sub_accounts** table, **ref_num** and **ref_type**, references the composite key, **acc_num** and **acc_type**, in the **accounts** table. If, during an insert or update, you tried to insert a row into the **sub_accounts** table whose value for **ref_num** and **ref_type** did not exactly correspond to the values for **acc_num** and **acc_type** in an existing row in the **accounts** table, the database server would return an error.

A referential constraint must have a one-to-one relationship between referencing and referenced columns. In other words, if the primary key is a set of columns (a composite key), then the foreign key also must be a set of columns that corresponds to the composite key.

Because of the default behavior of the database server, when you create the foreign-key reference, you do not need to reference the composite-key columns (**acc_num** and **acc_type**) explicitly. You can rewrite the references section of the previous example as follows:

```
FOREIGN KEY (ref_num, ref_type) REFERENCES accounts
```


Default Index Creation Strategy for Constraints

When you create a table with unique or primary-key constraints, the database server creates a system-generated, internal index that is unique and ascending for each constraint.

When you drop a primary-key or foreign-key constraint, the corresponding system-generated index is also dropped. However, you can preserve the index by renaming it with the RENAME INDEX statement.

When you create a table with a referential constraint, the database server creates an internal index that is ascending and that allows duplicate values for each column that you specify in the referential constraint.

An internal index occupies the same storage location as its table. For fragmented tables, the fragments of an internal index occupy the same dbspace partitions that you specify for the table fragments (or in some cases, the database dbspace).

If you require an index fragmentation strategy that is independent of the underlying table fragmentation, do not define the constraint when you create the table. Instead, use the CREATE INDEX statement to create a unique index with the desired fragmentation strategy. Then use the ALTER TABLE statement to add the constraint. The new constraint uses the previously defined index.

Important: In a database without logging, *detached checking* is the only kind of constraint checking available. Detached checking means that constraint checking is performed on a row-by-row basis.

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OF TYPE Clause

Use the OF TYPE clause to create a *typed table* for an object-relational database. A typed table is a table in which every row is an object of the named ROW data type that you specify in this clause.

This syntax fragment is part of the [CREATE TABLE statement](#).

```
OF TYPE Clause
|--OF TYPE--row_type----->
>+-----+
|      .,-----+-----+      |
|      V              (1) |      |
|'-----| Multiple-Column Constraint Format |-----'
>+-----+
|'-----UNDER--supertable--'
```

Notes:

1. See [Multiple-Column Constraint Format](#)

Element	Description	Restrictions	Syntax
<i>row_type</i>	Name of the ROW type on which this table is based	Must be a named ROW data type registered in the local database	Identifier
<i>supertable</i>	Name of the table from which this table inherits its properties	Must already exist as a typed table	Identifier

If you use the UNDER clause, the *row_type* must be derived from the ROW type of the *supertable*. A type hierarchy must already exist in which the named ROW type of the new table is a subtype of the named ROW type of the *supertable*.

Jagged rows are any set rows from a table hierarchy in which the number of columns is not fixed among the typed tables within the hierarchy. Some APIs, such as Informix® ESQL/C and Informix JDBC Driver, do not support queries that return jagged rows.

When you create a typed table, CREATE TABLE cannot specify names for its columns, because the column names were declared when you created the ROW type. Columns of a typed table correspond to the fields of the named ROW type. The ALTER TABLE statement cannot add additional columns to a typed table.

For example, suppose you create a named ROW type, **student_t**, as follows:

```
CREATE ROW TYPE student_t
(name          VARCHAR(30),
average       REAL,
birthdate     DATETIME YEAR TO DAY);
```

If a table is assigned the type **student_t** in the OF TYPE clause, the table is a typed table whose columns are of the same name and data type, and in the same order, as the fields of the named ROW type **student_t**. For example, the following CREATE TABLE statement creates a typed table named **students** whose type is **student_t**:

```
CREATE TABLE students OF TYPE student_t;
```

The **students** table has the following columns:

```
name      VARCHAR (30)
average   REAL
birthdate DATETIME YEAR TO DAY
```

For more information about named ROW types, refer to the [CREATE ROW TYPE statement](#).

- [Using Large-Object Data in Typed Tables](#)
 - [Using the UNDER Clause](#)
 - [Access Privileges on Tables](#)
- The discretionary access privileges on a table describe both who can access the information in the table and who can create new tables.
- [System Catalog Information](#)

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Using Large-Object Data in Typed Tables

Use the BLOB or CLOB instead of BYTE or TEXT data types when you create a typed table that contains columns for large objects. For backward compatibility, you can create a named-ROW type that contains BYTE or TEXT fields and use that ROW type to re-create an existing (untyped) table as a typed table. Although you can use a ROW type that contains BYTE or TEXT fields to create a typed table, such a ROW type is not valid as a column. You can, however, use a ROW type that contains BLOB or CLOB fields both in typed tables and in columns.

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Using the UNDER Clause

Use the UNDER clause to specify inheritance (that is, define the new table as a subtable). The subtable inherits properties from the specified supertable. In addition, you can define new properties specific to the subtable.

Continuing the example shown in [OF TYPE Clause](#), the following statements create a typed table, **grad_students**, that inherits all of the columns of the **students** table but also has columns for **adviser** and **field_of_study** that correspond to fields in the **grad_student_t** ROW type:

```
CREATE ROW TYPE grad_student_t
(adviser      CHAR(25),
 field_of_study CHAR(40)) UNDER student_t;

CREATE TABLE grad_students OF TYPE grad_student_t UNDER students;
```

When you use the UNDER clause, the subtable inherits these properties:

- All columns in the supertable
 - All constraints defined on the supertable
 - All indexes defined on the supertable
 - All triggers defined on the supertable.
 - All referential integrity constraints
 - The access method
 - The storage option specification (including fragmentation strategy)
- If a subtable defines no fragments, but if its supertable has fragments defined, then the subtable inherits the fragments of the supertable.

Tip: Any heritable attributes that are added to a supertable after subtables have been created are automatically inherited by existing subtables. You do not need to add all heritable attributes to a supertable before you create its subtables.

- [Restrictions on Table Hierarchies](#)

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Restrictions on Table Hierarchies

Inheritance occurs in one direction only, namely from supertable to subtable. Properties of subtables are *not* inherited by supertables. The section [System Catalog Information](#) lists the inherited database objects for which the system catalog maintains no information regarding subtables.

No two tables in a table hierarchy can have the same data type. For example, the final line of the next code example is invalid, because the tables **tab2** and **tab3** cannot have the same row type (**rowtype2**):

```
create row type rowtype1 (...);
create row type rowtype2 (...) under rowtype1;
create table tab1 of type rowtype1;
create table tab2 of type rowtype2 under tab1;
create table tab3 of type rowtype2 under tab1; -- This is not valid.
```

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Access Privileges on Tables

The discretionary access privileges on a table describe both who can access the information in the table and who can create new tables.

For more information about discretionary access privileges, see the description of the [GRANT statement](#) statement.

In an ANSI-compliant database, no default table-level privileges exist. You must grant these privileges explicitly.

Setting the environment variable **NODEFDAC** to **yes** prevents default privileges from being granted to PUBLIC on new tables in a database that is not ANSI compliant, as described in the *IBM® Informix® Guide to SQL: Reference*.

Important: Enabling **NODEFDAC** withholds default table access or routine access privileges from PUBLIC when the object is registered in the system catalog, but the **NODEFDAC** setting cannot prevent the PUBLIC group from being granted the same privileges by a user who holds the necessary access privileges on the new table or on the new UDR.

For more information about discretionary access privileges, see the *IBM Informix Guide to SQL: Tutorial*.

Related information:

[NODEFDAC environment variable](#)

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System Catalog Information

When you create a table, the database server adds information about the table to the **systables** system catalog table, and column information to **syscolumns** system catalog table. The **sysfragments** system catalog table contains information about fragmentation strategies and the storage location of fragments. The **sysblobs** system catalog table contains information about the location of dbspaces and of simple large objects. (The **syschunks** table in the **sysmaster** database contains information about the location of smart large objects.)

The **systabauth**, **syscolauth**, **sysfragauth**, **sysprocauth**, **sysusers**, and **sysxtdtypeauth** tables contain information about the discretionary access privileges that various CREATE TABLE options require.

The **sysextcols**, **sysextdfiles**, and **sysexternal** tables contain additional information about objects that the CREATE EXTERNAL TABLE statement registers in the database.

The **systables**, **sysxtdtypes**, and **sysinherits** system catalog tables provide information about typed tables. For typed-table hierarchies, constraints, indexes, and triggers are recorded in the system catalog for the supertable, but not for subtables that inherit them. Fragmentation information, however, is recorded for both supertables and subtables. For more information about inheritance, refer to the *IBM® Informix® Guide to SQL: Tutorial*.

Related information:

[System catalog tables](#)

[syschunks](#)

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Specialized columns

You can create specialized columns to support Enterprise Replication, high availability, or row-level auditing.

Specialized columns

```
.WITH--+--AUDIT-----+-----><
      '-CRCOLS-----'
      '-ERKEY-----'
      '-REPLCHECK--'
      '-VERCOLS----
```

There is no required order among multiple WITH options in the same CREATE TABLE statement.

- [Using the WITH AUDIT Clause](#)
Use the WITH AUDIT keywords to create a table that will be included in the set of tables that are audited at the row level if selective row-level is enabled.
- [Using the WITH CRCOLS Option](#)
- [Using the WITH ERKEY Keywords](#)
Use the WITH ERKEY keywords to create the ERKEY shadow columns that Enterprise Replication uses for a replication key.
- [Using the WITH REPLCHECK Keywords](#)
Use the WITH REPLCHECK keywords to create the **ifx_replcheck** shadow column that Enterprise Replication uses for consistency checking.
- [Using the WITH VERCOLS Option](#)
Use the WITH VERCOLS keywords to create two shadow columns that Informix® uses to support update operations on secondary servers.

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Using the WITH AUDIT Clause

Use the WITH AUDIT keywords to create a table that will be included in the set of tables that are audited at the row level if selective row-level is enabled.

When you create a table with the WITH AUDIT clause, row-level audit events in that table are recorded when selective row-level auditing is turned on. Applying the WITH AUDIT attribute to a table by itself does not enable selective row-level auditing. This type of auditing is enabled when the ADTROWS parameter of the adtcfg file is set to 1 or 2 by using the **onaudit -R** command.

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Using the WITH CRCOLS Option

Use the WITH CRCOLS keywords to create two shadow columns that Enterprise Replication uses for conflict resolution. The first column, **cdrserver**, contains the identity of the database server where the last modification occurred. The second column, **cdrtime**, contains the time stamp of the last modification. You must add these columns before you can use time stamps for UDR conflict resolution. These two columns are hidden shadow columns, because they cannot be indexed and cannot be viewed in system catalog tables.

For most database operations, the **cdrserver** and **cdrtime** columns are hidden. For example, if you include the WITH CRCOLS keywords when you create a table, the **cdrserver** and **cdrtime** columns have the following behavior:

- They are not returned by queries that specify an asterisk (*****) as the projection list, as in the statement:

```
SELECT * FROM tablename;
```

- They do not appear in DB-Access when you ask for information about the columns of the table.
- They are not included in the number of columns (**ncols**) in the **systables** system catalog table entry for *tablename*.

To view the contents of **cdrserver** and **cdrtime**, you must explicitly specify the columns in the projection list of a SELECT statement, as the following example shows:

```
SELECT cdrserver, cdrtime FROM tablename;
```

For more information about how to use this option, refer to the .

Related information:

[Preparing Tables for a Consistency Check Index](#)

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Using the WITH ERKEY Keywords

Use the WITH ERKEY keywords to create the ERKEY shadow columns that Enterprise Replication uses for a replication key.

The ERKEY shadow columns (**ifx_erkey_1**, **ifx_erkey_2**, and **ifx_erkey_3**) are visible shadow columns because they are indexed and can be viewed in system catalog tables. After you create the ERKEY shadow columns, a new unique index and a unique constraint are created on the table using these columns. Enterprise Replication uses that index as the replication key.

For most database operations, the ERKEY columns are hidden. For example, if you include the WITH ERKEY keywords when you create a table, the ERKEY columns have the following behavior:

- They are not returned by queries that specify an asterisk (*****) as the projection list, as in the statement:

```
SELECT * FROM tablename;
```

- They do appear in DB-Access when you ask for information about the columns of the table.
- They are included in the number of columns (**ncols**) in the **systables** system catalog table entry for *tablename*.

To view the contents of the ERKEY columns, you must explicitly specify the columns in the projection list of a SELECT statement, as the following example shows:

```
SELECT ifx_erkey_1, ifx_erkey_2, ifx_erkey_3 FROM customer;
```

Example

In the following example, the ERKEY shadow columns are added to the **customer** table:

```
CREATE TABLE customer (id INT) WITH ERKEY;
```

Related information:

[Preparing tables without primary keys](#)

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Using the WITH REPLCHECK Keywords

Use the WITH REPLCHECK keywords to create the **ifx_replcheck** shadow column that Enterprise Replication uses for consistency checking.

The **ifx_replcheck** column is a visible shadow column because it can be indexed and can be viewed in system catalog tables. After you create the **ifx_replcheck** shadow column, you must create a new unique index on the primary key and the **ifx_replcheck** column. The **ifx_replcheck** shadow column must be the last column in the index. Enterprise Replication uses that index to speed consistency checking.

For most database operations, the **ifx_replcheck** column is hidden. For example, if you include the WITH REPLCHECK keywords when you create a table, the **ifx_replcheck** column has the following behavior:

- It is not returned by queries that specify an asterisk (*****) as the projection list, as in the statement:

```
SELECT * FROM tablename;
```
- It does appear in DB-Access when you ask for information about the columns of the table.
- It is included in the number of columns (**ncols**) in the **systables** system catalog table entry for *tablename*.

To view the contents of the **ifx_replcheck** column, you must explicitly specify the columns in the projection list of a SELECT statement, as the following example shows:

```
SELECT ifx_replcheck FROM customer;
```

Example

In the following example, the **ifx_replcheck** shadow column is added to the **customer** table:

```
CREATE TABLE customer (id int) WITH REPLCHECK;
```

Related information:

[Shadow columns](#)

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Using the WITH VERCOLS Option

Use the WITH VERCOLS keywords to create two shadow columns that Informix® uses to support update operations on secondary servers.

The first column, **ifx_insert_checksum**, contains a checksum of the row when it was first created. The second column, **ifx_row_version**, contains a version number of the row. When a row is first inserted, **ifx_insert_checksum** is generated, and **ifx_row_version** will be set to one. Each time the row is updated, **ifx_row_version** is incremented by one, but **ifx_insert_checksum** does not change. These two columns are visible shadow columns because they can be indexed and can be viewed in system catalog tables.

For most database operations, the **ifx_insert_checksum** and **ifx_row_version** columns are hidden. For example, if you include the WITH VERCOLS keywords when you create a table, the **ifx_insert_checksum** and **ifx_row_version** columns have the following behavior:

- They are not returned by queries that specify an asterisk (*****) as the projection list, as in the statement:

```
SELECT * FROM tablename;
```
- They appear in DB-Access when you ask for information about the columns of the table.
- They are included in the number of columns (**ncols**) in the **systables** system catalog table entry for *tablename*.

To view the contents of **ifx_insert_checksum** and **ifx_row_version**, you must explicitly specify the column names in the projection list of a SELECT statement, as the following example shows:

```
SELECT ifx_insert_checksum, ifx_row_version FROM tablename;
```

When row versioning is enabled, **ifx_row_version** is incremented by one each time the row is updated; however, row updates made by Enterprise Replication do not increment the row version. To update the row version on a server using Enterprise Replication, you must include the **ifx_row_version** column in the replicate participant definition.

For more information about how to use this option, refer to the *IBM® Informix Administrator's Guide*.

Related information:

[Row versioning](#)

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SECURITY POLICY Clause

The optional Security Policy clause can use the following syntax to specify the name of an existing security policy that is thereby associated with the table.

This syntax fragment is part of the [CREATE TABLE statement](#).

```
SECURITY POLICY Clause
```

```
|--SECURITY POLICY--policy-----|
```


If you specify no IN clause nor fragmentation scheme, the new table is stored in the same dbspace where the current database is stored. However, if you enabled automatic location and fragmentation, tables are created and fragmented in dbspaces that are chosen by the server. To enable the automatic location and fragmentation of tables, set the AUTOLOCATE configuration parameter or session environment variable to a positive integer. The value of the integer represents the number of fragments to initially allocate to the table. Additional fragments are added as the table grows.

Sbspaces for smart large objects

You can use the PUT clause to specify sbspace storage locations and storage characteristics for smart large objects, such as BLOB or CLOB column values. Note: If your table contains simple large objects (TEXT or BYTE), you can specify a separate blobspace for each object.

Dbspaces in tenant databases

If the table is in a tenant database, the *dbspace* must be a dedicated dbspace in the tenant database properties list. If the table is not in a tenant database, the *dbspace* cannot be the name of a dbspace that is dedicated to a tenant database.

- [Using the IN Clause](#)
Use the IN clause of the CREATE TABLE statement to specify a storage space for the table. The storage space that you specify must already exist.
- [PUT Clause](#)
Use the PUT clause to specify the storage spaces and their characteristics for each column that will contain smart large objects.
- [FRAGMENT BY clause](#)
Use the FRAGMENT BY clause to create a fragmented table and to specify its storage distribution scheme. The keywords PARTITION BY are a synonym for FRAGMENT BY.
- [EXTENT SIZE Options](#)
The EXTENT SIZE options can define the size of storage extents allocated to the table.
- [COMPRESSED option for tables](#)
Use the COMPRESSED option of the CREATE TABLE statement to enable the automatic compression of large amounts of row data when the data is loaded into the table or table fragment.

Related reference:

[Large-Object Data Types](#)

[USING Access-Method Clause](#)

Related information:

[AUTOLOCATE configuration parameter](#)

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Using the IN Clause

Use the IN clause of the CREATE TABLE statement to specify a storage space for the table. The storage space that you specify must already exist.

You can use the IN clause to isolate a table. For example, if the **history** database is in the **dbs1** dbspace, but you want the **family** data placed in a separate dbspace called **famdata**, use the following statements:

```
CREATE DATABASE history IN dbs1;

CREATE TABLE family
(
  id_num      SERIAL(101) UNIQUE,
  name        CHAR(40) ,
  nickname    CHAR(20) ,
  mother      CHAR(40) ,
  father      CHAR(40)
)
IN famdata;
```

For more information about how to store and manage your tables in separate dbspaces, see your *IBM® Informix® Administrator's Guide*.

In general, use the *extspace* storage option in conjunction with the [USING Access-Method Clause](#). For more information, refer to the documentation of your access method.

If IN *dbspace* is the only storage specification for the new table, then by default 16 kilobytes of storage (or enough storage for four pages, if 4 pages require more than 16 kilobytes) are allocated for the first extent size at the time of table creation.

No storage is allocated for the first extent, however, if the CREATE TABLE statement includes none of the following storage specifications:

- EXTENT SIZE
- NEXT SIZE
- IN *dbspace*.

In this case, storage allocation for the first extent is deferred until the first row is stored in the table.

The same storage allocation deferral applies to tables defined by the CREATE TEMP TABLE statement that do not include any of the storage specifications listed above.

When rows are first inserted into a table for which extent allocation has been deferred, the default size for the first extent is 16 kilobytes. If 16 kilobytes are insufficient for 4 pages, the first extent size will be 4 pages.

When reverting a Version 11.70 or later database server to an earlier release that does not support deferred extent allocation for empty tables, you must either drop or else insert a row into any empty database table that you wish to revert. Empty external tables that do not support INSERT operations must be dropped.

This syntax fragment is part of the [Storage options](#).

```

      .-,-----'
      |               V,-'------|
      |               v             |
--PUT---+column-IN-(-sbspace+-)+-----+-----+
      |               v             |
      |-'(-'+-----+-----)'
      |               +EXTENT SIZE--kilobytes--+
      |       |.-NO LOG-.|
      |+-----+-----+
      | '-LOG----'|
      |.-HIGH INTEG----.|
      |+-----+-----+
      | '-MODERATE INTEG-'|
      |.-NO KEEP ACCESS TIME-.|
      |+-----+-----+
      | '-KEEP ACCESS TIME----'|

```

The specified column cannot be in the form *column.field*. That is, the smart large object that you are storing cannot be one field of a ROW type.

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image05 are stored in sbspace **sbspace03**:

```
CREATE TABLE tabw2sblobs
(
  image04 BLOB,
  commentary05 CLOB
) PUT image04 IN (sbspace01,sbspace02),
  commentary05 IN (sbspace03);
```

If an INSERT or MERGE operation adds six new rows to the table in this example,

- three of the **image04** BLOB objects will be stored in **sbspace01**,
- the other three **image04** BLOB objects will be stored in **sbspace02**,
- and all six **commentary05** CLOB objects will be stored in **sbspace03**.

When you distribute smart large objects across different sbspaces, you can work with smaller sbspaces. If you limit the size of an sbspace, backup and archive operations can perform more quickly.

Specifying sbspace characteristics

The following storage options are available to store BLOB and CLOB data:

Option

Effect

EXTENT SIZE

Specifies a lower limit on how many kilobytes can be stored in a smart-large-object extent. The database server might round the specified *kilobytes* value up, so that the extent size is an integer multiple of the sbspace page size.

HIGH INTEG

This high data-integrity option produces user-data pages that contain a page header and a page trailer to detect incomplete writes and data corruption. This option is the default data-integrity behavior.

MODERATE INTEG

This data-integrity option produces user-data pages that contain a page header but no page trailer. This option cannot compare the page header with the page trailer to detect incomplete writes and data corruption.

KEEP ACCESS TIME

This maintains a record in the smart-large-object metadata of the system time when the smart large object was last read or written.

NO KEEP ACCESS TIME

Does not record the system time when the smart large object was last read or written. This provides better performance than the KEEP ACCESS TIME option, and is the default tracking behavior.

LOG

Follows the logging procedure used with the current database log for the corresponding smart large object. This option can generate large amounts of log traffic and increase the risk of filling the logical log.

NO LOG

Turns off logging. This option is the default behavior.

The comma-separated list of keyword options that define sbspace characteristics must be enclosed in parentheses, and immediately follows the sbspace (or the list of sbspaces) that stores the BLOB or CLOB column. In the following example, the PUT clause specifies that the unlogged **sbspace01** and **sbspace02** sbspaces that store the BLOB objects of column **image04** have characteristics different from **sbspace03**, a logged sbspace that stores CLOB objects of column **commentary05**:

```
CREATE TABLE tabw2sblobs
(
  image04 BLOB,
  commentary05 CLOB
) PUT image04 IN (sbspace01,sbspace02) (KEEP ACCESS TIME, MODERATE INTEG),
  commentary05 IN (sbspace03) (EXTENT SIZE 30, LOG);
```

When you turn logging on for a smart large object, you must immediately perform a level-0 backup to be able to recover and restore the smart large object.

The **syscolattns** system catalog table contains one row for each *sbspace* and *column* combination in the PUT clause:

- The **syscolattns.extentsize** column stores the extent size, based on the *kilobytes* value.
- The **syscolattns.flags** column stores a bitmap corresponding to the logging and access time status, and data integrity setting.

If a user-defined or complex data type contains more than one large object, the specified large-object storage options apply to all large objects in the type, unless the storage options are overridden when the large object is created.

Important: The PUT clause does not affect the storage of simple-large-object data types (BYTE and TEXT). For information on how to store BYTE and TEXT data, see [Large-Object Data Types](#).

Alternative to full logging

Instead of full logging, you can turn off logging when you load the smart large object initially and then turn logging back on once the object is loaded.

Use the NO LOG option to turn off logging. If you use NO LOG, you can restore the smart-large-object metadata later to a state in which no structural inconsistencies exist. In most cases, no transaction inconsistencies will exist either, but that result is not guaranteed.

The following statement creates the **greek** table. Data values for the table are fragmented into the **dbs1** and **dbs2** dbspaces. The PUT clause assigns the smart-large-object data in the **gamma** and **delta** columns to the **sb1** and **sb2** sbspaces, respectively. The TEXT data values in the **eps** column are assigned to the **blb1** blob space.

```
CREATE TABLE greek
(alpha INTEGER,
```

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Use the **FRAGMENT BY** clause to create a fragmented table and to specify its storage distribution scheme. The keywords **PARTITION BY** are a synonym for **FRAGMENT BY**.

FRAGMENT BY clause for tables

Notes:

1. See [Expression Fragment Clause](#)
2. See [Interval fragment clause](#)
3. See [List fragment clause](#)

Element	Description	Restrictions	Syntax
<i>column</i>	Column to which to apply the fragmentation strategy	Must be a column within the table	Identifier
<i>dbspace</i>	Dbspace to store the table fragment	You can specify no more than 2,048 <i>dbspaces</i> . All <i>dbspaces</i> that store the fragments must have the same page size.	Identifier
<i>fragment_key</i>	Cast, column, or function expression on a table column. This is the expression on which the table is fragmented.	Columns must be from the current table only	Expression
<i>partition</i>	Name declared here for a fragment	Must be unique among the names of fragments of the table	Identifier

When you fragment a table, the IN keyword is followed by the name of the storage space where a table fragment is to be stored.

- Using the WITH ROWIDS Option
- Fragmenting by ROUND ROBIN
- Expression Fragment Clause

In an *expression-based* distribution scheme, each fragment expression in a rule specifies a storage space. Each fragment expression in the rule isolates data and aids the database server in searching for rows.

- List fragment clause

Use the List Fragment clause to specify a list of fragment key values to store in the same fragment. The rows assigned to each fragment must match the fragment key value (or one of a comma-separated list of fragment key values) that defines the fragment.

- Interval fragment clause

Use the Interval Fragment clause to store rows in fragments defined by one or more range expressions that evaluate to a numeric or INTERVAL data type. After you specify at least one non-NULL range for a fragment, the database server can create new interval fragments automatically during DML operations that insert new rows whose fragment key values are outside the range of any existing fragment. The interval fragmentation strategy is useful when all possible fragment-key values in a growing table are not known, and you do not want to preallocate fragments for data that is not yet there.

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Nonfragmented tables contain a hidden column called **rowid**, but by default, fragmented tables have no **rowid** column. You can use the WITH ROWIDS keywords to add the **rowid** column to a fragmented table. Each row is automatically assigned a unique **rowid** value that remains stable for the life of the row and that the

- Range rule
A range rule specifies fragment expressions that use a range to specify which rows are placed in a fragment, as the next example shows:

```
FRAGMENT BY EXPRESSION c1 < 100 IN dbsp1,  
c1 >= 100 AND c1 < 200 IN dbsp2, c1 >= 200 IN dbsp3;
```

- Arbitrary rule
An arbitrary rule specifies fragment expressions based on a predefined SQL expression that typically uses OR clauses to group data, as the following example shows:

```
FRAGMENT BY EXPRESSION  
zip_num = 95228 OR zip_num = 95443 IN dbsp2,  
zip_num = 91120 OR zip_num = 92310 IN dbsp4,  
REMAINDER IN dbsp5;
```

Warning: See the note about the **DBCENTURY** environment variable and date values in fragment expressions in the section [Logging Options](#).

REMAINDER keyword

Use the REMAINDER keyword to specify the storage space in which to store valid values that fall outside the specified expression or expressions. If you do not specify a remainder, and a row is inserted or updated with values that do not correspond to any fragment definition, the database server returns an error.

The following example uses an arbitrary rule to define five fragments for specific values of the **c1** column, and a sixth fragment for all other values:

```
CREATE TABLE T1 (c1 INT) FRAGMENT BY EXPRESSION  
PARTITION PART_1 (c1 = 10) IN dbsp1,  
PARTITION PART_2 (c1 = 20) IN dbsp1,  
PARTITION PART_3 (c1 = 30) IN dbsp1,  
PARTITION PART_4 (c1 = 40) IN dbsp2,  
PARTITION PART_5 (c1 = 50) IN dbsp2,  
PARTITION PART_6 REMAINDER IN dbsp2;
```

Here the first three fragments are stored in partitions of the **dbsp1** dbspace, and the other fragments, including the remainder, are stored in named fragments of the **dbsp2** dbspace. Explicit fragment names are required in this example, because each dbspace has multiple partitions.

Fragmentation in NLSCASE INSENSITIVE databases

In databases with the NLSCASE INSENSITIVE property, operations on NCHAR and NVARCHAR data ignore lettercase, so that the database server treats case variants among strings composed of same sequence letters as duplicates. If the fragment keys for a table that is fragmented by expression are NCHAR or NVARCHAR columns, then each fragment defined by a character expression stores all lettercase variants that match the expression that defines the fragment. For example, for the expression `lname = 'Garcia'` where **lname** is a column of type NCHAR or NVARCHAR, rows with the following values in that column would all be stored in the same fragment, because the case-insensitive expression evaluates to TRUE for these (and similar) string values:

```
'Garcia' 'garcia' 'GARCIA' 'GarCia' 'gARCia'
```

For more information about NLSCASE INSENSITIVE databases, see [CREATE DATABASE statement](#), [Duplicate rows in NLSCASE INSENSITIVE databases](#), and [NCHAR and NVARCHAR expressions in case-insensitive databases](#).

- [User-Defined Functions in Fragment Expressions](#)
- [Partial Index in Fragment Expressions](#)

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User-Defined Functions in Fragment Expressions

For rows that include user-defined data types, you can use comparison conditions or user-defined functions to define the range rules. In the following example, comparison conditions define the range rules for the **long1** column, which contains an opaque data type:

```
FRAGMENT BY EXPRESSION  
long1 < '3001' IN dbsp1,  
long1 BETWEEN '3001' AND '6000' IN dbsp2,  
long1 > '6000' IN dbsp3;
```

An implicit, user-defined cast converts 3001 and 6000 to the opaque type.

Alternatively, you can use user-defined functions to define the range rules for the opaque data type of the **long1** column:

```
FRAGMENT BY EXPRESSION  
(lessthan(long1, '3001')) IN dbsp1,  
(greaterthanorequal(long1, '3001') AND  
lessthanorequal(long1, '6000')) IN dbsp2,  
(greaterthan(long1, '6000')) IN dbsp3;
```

Explicit user-defined functions require parentheses around the entire fragment expression before the IN clause, as the previous example shows.

User-defined functions in a fragment expression can be written in SPL or in the C or Java™ language. These functions must satisfy four requirements:

- They must evaluate to a Boolean value.
- They must be nonvariant.
- They must reside within the same database as the table.
- They must not generate OUT nor INOUT parameters.

Partial Index in Fragment Expressions

Starting 14.10xC2 onwards, Informix supports FRAGMENT BY EXPRESSION partial index.

A *partial index* is an index built over a subset of a table. The subset is defined by a conditional expression (called the *predicate* of the partial index). The index contains entries for only those table rows that satisfy the predicate.

Partial indexes avoid indexing common values. As the query searching for a common value will not use the index, there is no point in keeping those rows in the index. This reduces the size of the index, which will speed up queries that do use the index. It will also speed up many table update operations because the index does not need to be updated in all cases.

Example 1: Setting up a Partial Index to Exclude Common Values

```
create table tab1 (n int, n2 int, n4 int, cc char(16));
-- insert 10,000 rows
with cte(n) as (
    select 1 as n
    union all
    select n+1 from cte where n < 10000
)
insert into tab1
select n,
       case when mod(n,10) == 0 then n else null end,
       mod(n,4),
       n from cte;
```

To create a partial index that suits the above example for non-null values, create index as:

```
create index idx1 on tab1(n) fragment by expression
(n2 is null) in dbs1 INDEX OFF,
remainder in dbs2;
```

```
"oncheck -pk | grep '^Key' | wc -l" shows only 1000 rows are indexed.
```

The query that can use this index would be:

```
select count(*) from tab1 where n < 1000 and n2 is not null;
```

The query that cannot use this index would be:

```
select count(*) from tab1 where n < 1000;
```

Example 2: Setting up a Partial Index to Exclude Un-wanted Values

If you have a table that contains customers from different states, where one specific state records take up a small fraction of the total table and yet those are the most-accessed rows, you can improve performance by creating an index on just that specific state rows. The command to create the index:

```
create index zip_ix on customer(zipcode)
fragment by expression
(state = 'CA') in dbs1,
remainder in INDEX OFF;
```

The query that can use this index would be:

```
select fname, lname from customer
where zipcode >= '94117'
and state='CA';
```

Note: A partial index can be used in a query only if the system can recognize that the WHERE condition of the query mathematically implies the predicate of the index..

List fragment clause

Use the List Fragment clause to specify a list of fragment key values to store in the same fragment. The rows assigned to each fragment must match the fragment key value (or one of a comma-separated list of fragment key values) that defines the fragment.

This syntax fragment is part of the [FRAGMENT BY clause](#).

List Fragment Clause

.,-----.

List Expression Clause

1. Use this path no more than once

Fragmenting by list defines fragments that are each based upon a list of discrete values of the fragment key.

Fragmenting by list also helps to logically segregate data.

- Both a table and its indexes can be fragmented by list.
- The fragment key can be a column expression based on a single column or on multiple columns.
- The list can optionally include a remainder fragment.
- The list can optionally include a NULL fragment that stores only NULL values.

- The list that includes NULL (or IS NULL) cannot include any other value.
- The fragment key must be based on a single row.
- The fragment key must be a column expression. This *constant expression* can be based on a single column or on multiple columns.
- Lists cannot include duplicate *constant expression* values. Each value must be unique within the FRAGMENT BY LIST clause.

- The fragment key for a row evaluates to NULL, but the FRAGMENT BY LIST clause defined no NULL fragment.
- The fragment key for a row matches no *constant expression* value for any fragment, but no remainder fragment is defined.

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Use the Interval Fragment clause to store rows in fragments defined by one or more range expressions that evaluate to a numeric or INTERVAL data type. After you specify at least one non-NULL range for a fragment, the database server can create new interval fragments automatically during DML operations that insert new rows whose fragment key values are outside the range of any existing fragment. The interval fragmentation strategy is useful when all possible fragment-key values in a growing table are not known, and you do not want to preallocate fragments for data that is not yet there.

Interval Fragment clause

Notes:

- | Element | Description | Restrictions | Syntax |
|----------------------|---|--|---|
| <i>dbspace</i> | Name of a dbspace to store a fragment | You can specify no more than 2,048 <i>dbspaces</i> . All <i>dbspaces</i> that store the fragments must have the same page size. | Identifier |
| <i>dbspace_fun</i> | Name of a UDF that returns the name of a dbspace | The user-defined function and the returned dbspace must exist when the database server calls the UDR to allocate storage for a new fragment. | CREATE FUNCTION statement |
| <i>intvl_valexpr</i> | Interval value expression that defines an interval size in the fragment key range | Must be a constant literal expression that evaluates to a numeric or INTERVAL value compatible with the data type of the fragment key expression | Identifier |
| <i>partition</i> | Name that you declare here for a range fragment | Must be unique among fragment names of the same table. If a table and its index use the same range interval fragmentation strategy, each index fragment must have the same name as the corresponding table fragment. | Identifier |
| <i>range_expr</i> | Constant expression that defines the upper bound for fragment key values stored in the fragment | Must be a constant literal expression that evaluates to a numeric, DATETIME, or DATE data type compatible with the data type of the fragment key expression | Constant Expressions |

The Interval Fragment clause defines one or more non-overlapping intervals in the range of the fragment key expression that you specify (within parentheses) immediately after the **FRAGMENT BY RANGE** keywords of the **FRAGMENT BY** clause. The **PARTITION BY RANGE** keywords are a synonym for the **FRAGMENT BY RANGE** keywords. When a DML operation updates or inserts into the table a row that matches a range that you defined for a fragment, the database server store the new or updated row in that fragment.

The Interval Fragment clause does not support a REMAINDER fragment, because the database server automatically creates new interval fragments to store inserted rows that have fragment-key values outside the range of any existing fragment.

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- on the current number of system-generated interval fragments,
- or on the total size of storage space allocated for the table and its indexes.

For information on the syntax and behavior of Rolling Window tables, see the link in the syntax diagram above.

The fragment key for range interval fragmentation can reference only a single column. For example, the following specification is not valid:

```
FRAGMENT BY RANGE (basepay + varpay)
```

The fragment key can be a column expression, as in the following specification:

```
FRAGMENT BY RANGE ( (ROUND (basepay) ) )
```

The INTERVAL size specification

The *intvl_valexp* expression that follows (within parentheses) the INTERVAL keyword defines the size of an interval within the range of fragment key values.

The data type of the *intvl_valexp* expression depends on the data type of the fragment key column that followed the RANGE keyword:

- If the fragment key is a numeric data type, the *intvl_valexp* expression must evaluate to a numeric value. A numeric *intvl_valexp* expression must be a constant expression greater than zero, with no fractional part.
- If the fragment key is a DATE or DATETIME data type, the *intvl_valexp* expression must evaluate to an INTERVAL value. An INTERVAL *intvl_valexp* expression must be a constant expression greater than zero.

The minimum value of the *intvl_valexp* expression depends on the data type of the fragment key expression.

- The minimum is a second if the fragment key is a DATETIME column
- The minimum is a day if the fragment key is DATE column
- The minimum is 1 if the fragment key is a numeric column.

You can use a literal number or a literal INTERVAL value as the *intvl_valexp* expression. You can also use the built-in **NUMTODSINTERVAL**, **NUMTOYMINTERVAL**, **TO_DSINTERVAL**, or **TO_YMINTERVAL** functions to specify the *intvl_valexp* expression. For the syntax of these functions, and examples of their use in the Interval Fragment clause, see [TO_YMINTERVAL function](#) and [TO_DSINTERVAL function](#).

If you specify no *intvl_valexp* expression, the automatic creation of interval fragments is disabled, but empty parentheses are still required after the INTERVAL keyword to avoid a syntax error.

The STORE IN specification

The dbspace (or the comma-separated list of dbspace names) that follows the STORE IN keywords identifies storage spaces for new interval fragments that the server automatically creates when DML operations store rows whose fragment key values are outside the range of existing fragments. If you specify multiple dbspaces, the database server creates interval fragment in a round-robin fashion in the dbspaces specified in the STORE IN clause, and declares system-generated names for the new fragments.

The dbspaces in the STORE IN clause need not be present when the table or index is created. You can add the dbspaces to the system after creating the table or index. All of the dbspaces referenced in the Interval Fragment clause must have the same page size.

If you omit the STORE IN clause, and the table needs to store rows outside the existing interval and range fragments, the database server automatically creates new interval fragments in a round-robin fashion in the dbspaces that the PARTITION specifications list for the range expression fragments.

Instead of a list of literal dbspace identifiers, the STORE IN clause can optionally specify a user-defined function that returns the name of an existing dbspace. The identifier that you declare for this UDF is arbitrary.

The function accepts four parameters:

- a table owner, of a CHAR(32) data type
- a table name, of a CHAR(255) data type
- a fragmentation value of the same data type as the fragment key, or a compatible type that can be implicitly cast to that data type
- and a retry flag, of an INT data type.

Important: When you reference an arbitrary UDR in the STORE IN clause, however, do not specify any parameters to the UDF. All that is required is the UDF name, followed by an empty pair of parentheses, as indicated in the syntax diagram above. The database server automatically supplies a parameter list at invocation time.

User-defined range fragments

You must define at least one range fragment in the Interval Fragment clause. Each fragment declaration requires these elements:

- The PARTITION keyword, followed by a name that you declare for the fragment. No other fragment of the table can have the same name.
- The VALUES keyword, followed by a Boolean expression with one of the following formats:
 - the less than (<) relational operator and a range expression defining the upper bound for fragment key values that can be stored in the fragment
 - the IS NULL operator. If the fragment key can take a NULL value, you can use this to define the NULL fragment that stores only the rows with NULL as their fragment key value.

No more than one fragment can be defined by the IS NULL operator. The NULL fragment is not required, but if the NULL fragment does not exist, the database server returns an error if a user attempts to insert a row in which the fragment key column is NULL.
- The IN keyword, followed by the name of the dbspace that stores the fragment. This can be a dbspace that the STORE IN specification also references, or a dbspace that is not included in the STORE IN list.

If the range fragments are not defined in ascending order, the database server sorts them in ascending order, so that the fragment in the first ordinal position has the smallest upper bound.

Two fragments in the same Interval Fragment clause cannot have the same upper bound. None of the range fragments defined in the PARTITION specifications can overlap. If an (*intvl_valexp*) size specification follows the INTERVAL keyword, the database server issues an error if the difference between the range expressions that define consecutive range fragments is not the same value as the INTERVAL size specification.

The NULL fragment is not required, but the database server returns an error if a user attempts to insert a row in which the fragment key value is NULL, but no NULL fragment exists.

Important:

Output from the **dbschema -ss** command to display the schema of a table fragmented by a range-interval distribution scheme returns only the range fragments that the user defined in the CREATE TABLE or ALTER FRAGMENT statement.

The same is true for output from the **dbexport -ss** command.

System-generated interval fragments

When you use the Interval Fragment clause to define range interval fragmentation for a table or index, it is not necessary to know what the full range of fragment key values will be. When a row is inserted that does not fit in any range fragment or interval fragment, the database server automatically creates a new interval fragment to store the row, based on the interval *intvl_valexp* value, without DBA intervention.

The interval fragments are created in round-robin fashion in the dbspaces specified in the STORE IN clause. If this clause had been omitted, interval fragments would be created in the dbspaces that store the range fragments. If a dbspace specified for the interval fragment is full or down, the database server skips that dbspace and selects the next one in the list.

The system-generated name for interval partitions of a table or of an index is **sys_evalpos**, where *evalpos* is the **sysfragments.evalpos** entry for the fragment in the system catalog. If a table and its index use the same range interval fragmentation strategy, each system-generated index fragment will have the same identifier as a system-generated fragment of the table.

These automatically generated fragments correspond to parts of the fragment key range that include the new data values. Gaps can separate automatically generated interval fragments, if between two successive fragments a portion of the range that is larger than *intvl_valexp* includes no rows. Gaps are not allowed, however, between the fragments that you explicitly define in the Interval Fragment clause.

If you specify no *intvl_valexp* expression, the range fragments that you explicitly define in the Interval Fragment clause are available to store rows that have corresponding fragment key values within their range intervals, as are any existing interval fragments that were generated before the ALTER FRAGMENT statement disabled the automatic creation of interval fragments. In both cases, however, the automatic creation of new interval fragments is disabled. If a user attempts to insert a row whose fragment key value does not fall in the range of any existing fragment, the database server issues error -772, and the insertion fails.

As noted above, output from the **dbschema -ss** and **dbexport -ss** commands to display the schema of a table fragmented by range interval includes only the user-defined range fragments. No system-generated interval fragments are visible in the output display.

When data records are loaded from the **dbexport** data file, however, the database server can create additional interval fragments automatically,

- based on the range fragments and the interval-transition fragment,
- and on the fragment-key values in the inserted rows,
- and on other storage specifications of the Interval Fragment clause, as registered in the system catalog.

Example: Fragment by integer values

The following is an example of a table fragmented by range interval, using an integer column as the partitioning key:

```
CREATE TABLE employee (id INTEGER, name CHAR(32), basepay DECIMAL (10,2),
                        varpay DECIMAL (10,2), dept CHAR(2), hiredate DATE)
    FRAGMENT BY RANGE (id)
    INTERVAL (100) STORE IN (dbs1, dbs2, dbs3, dbs4)
    PARTITION p0 VALUES IS NULL IN dbs0,
    PARTITION p1 VALUES < 200 IN dbs1,
    PARTITION p2 VALUES < 400 IN dbs2;
```

In this table

- the value of the interval size is 100,
- the fragment key is the value of the **employee.id** column,
- and the VALUES IS NULL keywords define p0 as the table fragment to store rows that have no **id** column value.

When employee ID exceeds 199, fragments are created automatically in intervals of 100, the specified interval size.

If a row is inserted with an employee ID of 405, a new interval fragment is created to accommodate the row. The new fragment holds rows with **id** column values in the range **>= 400 AND < 500**.

If a row is updated and the employee ID is modified to 821, the database server creates a new fragment to accommodate the new row. The fragment holds rows with **id** column values in the range **>= 800 AND < 900**.

Example: Fragment by integer values

The following example uses the value of the INT column **cust_id** as the numeric fragment key, and defines four range fragments. Interval fragments whose interval size is 1000000 will be created by the database server for inserted rows with **cust_id** values that exceed 7999999:

```
CREATE TABLE customer (cust_id INT, name CHAR (128), street CHAR (1024),
                        state CHAR (2), zipcode CHAR (5), phone CHAR (12))
    FRAGMENT BY RANGE (cust_id)
    INTERVAL (1000000) STORE IN (dbs2, dbs1)
    PARTITION p0 VALUES < 2000000 IN dbs1,
```

```
PARTITION p1 VALUES < 4000000 IN dbs1,
PARTITION p2 VALUES < 6000000 IN dbs2,
PARTITION p3 VALUES < 8000000 IN dbs3;
```

Example: Fragment by 25-year intervals

In the following example of a DATETIME fragment key, if values of the **dt1** column exceed the limit of the range fragment that the VALUES clause specifies, interval fragments will be created in the **dbs1** dbspace for rows with year values after 2005 in 25-year intervals:

```
CREATE TABLE t1 (c1 int, d1 date, dt1 DATETIME YEAR TO FRACTION)
  FRAGMENT BY RANGE (dt1) INTERVAL (INTERVAL(25) YEAR(2) TO YEAR)
  PARTITION p1 VALUES <
    DATETIME(2006-01-01 00:00:00.00000) YEAR TO FRACTION(5) IN dbs1;
```

Example: Fragment by year

In this example, the value of the DATE column **order_date** is the fragment key, and four range fragments are defined, including **p4** for rows that have NULL values for **order_date**. For an inserted row where the year value in **order_date** is later than 2007, interval fragments will be created automatically in intervals of 1 month after 01/01/2008, with successive fragments created in the **dbs1**, **dbs2**, and **dbs3** dbspaces:

```
CREATE TABLE orders (order_id INT, cust_id INT,
  order_date DATE, order_desc CHAR (1024))
  FRAGMENT BY RANGE (order_date)
  INTERVAL (NUMTOYMINTERVAL (1,'MONTH')) STORE IN (dbs1, dbs2, dbs3)
  PARTITION p0 VALUES < DATE ('01/01/2005') IN dbs1,
  PARTITION p1 VALUES < DATE ('01/01/2006') IN dbs1,
  PARTITION p2 VALUES < DATE ('01/01/2007') IN dbs2,
  PARTITION p3 VALUES < DATE ('01/01/2008') IN dbs3,
  PARTITION p4 VALUES IS NULL in dbs3;
```

Example: Fragment by 1.5 years

In this example, the DATE fragment key is similar to the previous example, but here the interval size is specified as 1.5 years. Interval fragments will be created in intervals of 18 months (1.5 years) for **order_date** values after 12/31/2009:

```
CREATE TABLE orders1 (order_id INT, cust_id INT, order_date DATE,
  order_desc CHAR (1024))
  FRAGMENT BY RANGE (order_date)
  INTERVAL (NUMTOYMINTERVAL (1.5,'YEAR')) STORE IN (dbs1, dbs2, dbs3)
  PARTITION p0 VALUES < DATE ('01/01/2004') IN dbs1,
  PARTITION p1 VALUES < DATE ('01/01/2006') IN dbs1,
  PARTITION p2 VALUES < DATE ('01/01/2008') IN dbs2,
  PARTITION p3 VALUES < DATE ('01/01/2010') IN dbs3;
```

You cannot insert rows into the **orders1** table if the **order_date** value is missing, because no NULL fragment is defined. For the syntax to add a NULL fragment to an existing table that uses range interval fragmentation, see the [ADD Clause](#) topic of the ALTER FRAGMENT statement.

Example: Create a UDF to assign dbspaces

Here is an example of a UDF that can return a dbspace name, and a CREATE TABLE statement that defines a table fragmented by range interval, and calls that function in the STORE IN clause:

```
CREATE FUNCTION mydbname
(
  owner CHAR(255),
  table CHAR(255),
  value DATE,
  retry INTEGER
)
RETURNING CHAR(255)
IF (retry > 0)
THEN
  RETURN NULL;
END IF;
IF (MONTH(value) < 7)
THEN
  RETURN "dbs1";
ELSE
  RETURN "dbs2";
END IF;
END FUNCTION;

CREATE TABLE orders
(
  order_num          SERIAL(1001),
  order_date         DATE,
  customer_num       INTEGER NOT NULL,
  ship_instruct      CHAR(40),
  backlog            CHAR(1),
  po_num             CHAR(10),
  ship_date          DATE,
  ship_weight        DECIMAL(8,2),
```

```

    ship_charge      MONEY (6) ,
    paid_date        DATE
)
PARTITION BY RANGE (order_date) INTERVAL (1 UNITS MONTH)
STORE IN (mydbname())
PARTITION prv_partition VALUES < DATE ("01/01/2010") IN mydbs;

```

The database server calls the specified function when a new interval fragment needs to be created for the table. If the attempted fragment creation in the returned dbspace fails, the same function is called a second time with the **retry** flag set, so that a different existing dbspace name can be returned. Upon a second failure, the DML statement that is being executed return an error. (The UDF in the example above does not handle retries, but returns **NULL**, an invalid dbspace name, if the first attempt fails.)

- [Rolling Window clause](#)
Use the Rolling Window clause to define a range-interval distributed storage strategy for a table and for its indexes, and to define a *purge policy* for detaching excess fragments. Like other tables with range-interval fragmentation, new interval fragments of each *rolling window table* are created automatically by the database server to store new rows with fragment-key values outside the range of any current fragment.

Related reference:

[TO_DSINTERVAL function](#)

[TO_YMINTERVAL function](#)

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Rolling Window clause

Use the Rolling Window clause to define a range-interval distributed storage strategy for a table and for its indexes, and to define a *purge policy* for detaching excess fragments. Like other tables with range-interval fragmentation, new interval fragments of each *rolling window table* are created automatically by the database server to store new rows with fragment-key values outside the range of any current fragment.

After the set of rolling fragments exceeds a user-defined "window" that the purge policy defines for the quantity of the fragments, or for the allocated storage size, the database server identifies and detaches the excess fragments from all the rolling window tables in its databases. By default, their purge policies are enforced as a daily task of the Scheduler.

This syntax fragment is part of the [Interval fragment clause](#).

Rolling Window clause

```

|---+| Rolling Window (no size limit) |---+-----|
  '-| Rolling Window (with size limit) |-'

```

Rolling Window (no size limit)

```

|--ROLLING-- (--quantity--FRAGMENTS--) --+--DETACH-- +-----|
                                   '-DISCARD-'

```

Rolling Window (with size limit)

```

|---+-----+-----+--LIMIT TO--size--units-->
  '-ROLLING-- (--quantity--FRAGMENTS--) -'

      .-INTERVAL FIRST----.
>-----+--DETACH-- +-----+-----+-----|
      '-DISCARD-'    +-ANY-----+
                      '-INTERVAL ONLY-'

```

Element	Description	Restrictions	Syntax
<i>quantity</i>	Maximum number of rolling interval fragments	Must be an integer greater than zero. User-defined range fragments are not included in this limit.	Literal integer
<i>size</i>	Upper limit on total storage size of the table	Must be greater than zero	Literal integer
<i>units</i>	Abbreviated unit of total mass storage for the table	Must be K, KB, KiB, M, MB, MiB, G, GB, GiB, T, TB, TiB (or lowercase forms of these letters). Any trailing characters cause a syntax error.	Unquoted character string

Usage

The **ROLLING FRAGMENTS** and **LIMIT TO** keyword options of the **INTERVAL** fragment clause, which define a Rolling Window distributed storage strategy, can enable the automatic creation of new fragments, based on an interval value expression. This Rolling Window clause of the **CREATE TABLE** statement resembles in its syntax, but is not identical to, the Rolling Window clause of the **ALTER FRAGMENT MODIFY INTERVAL** statement.

Unlike ordinary range-interval distributed storage, which creates new fragments, but makes no provision for managing the growth over time in table size, the Rolling Window option defines an upper limit on the current number of interval fragments, or on the total size of storage allocated for the table and its indexes, or both limits. After either limit is exceeded, the database server automatically archives or destroys what the Rolling Window clause identifies as excess fragments, and replaces those with new interval fragments, based on a *purge policy* that the Rolling Window clause defines.

Tables whose range-interval distributed-storage strategy includes the Rolling Window clause are called *rolling window tables*. Interval fragments that the database server creates for Rolling Window tables are called *rolling fragments*.

Unlike the round-robin fragments of tables that enabled AUTOLOCATE configuration or session environment settings create, the dynamic "window" of rolling fragments that this clause defines can support fragment elimination in queries in which fragment-key values in numeric, DATE, and DATETIME expressions are correlated with query predicates. Another efficiency of rolling window tables is the automated archiving or destruction of excess fragments when the Scheduler enforces the purge policy by running the **purge_tables** task.

The Rolling Window clause defines either or both of the following criteria for automatically removing an existing fragment from the table:

- The ROLLING FRAGMENTS keywords specify a limit on how many interval fragments of the table can exist concurrently.
- The LIMIT TO keywords specify a limit on the total storage space allocated for the table and for its indexes.

When either of these limits is exceeded, the excess interval fragments are automatically destroyed or detached by the database server, as specified by the DISCARD or DETACH keywords respectively. These specifications define a *purging policy* for the table. This policy limits how much data the table can store by defining criteria for automatically removing an existing fragment, and for automatically replacing those fragments with new empty fragments in which to insert new data records.

Purge policies for rolling window tables

The Rolling Window clause defines a purge policy for the table. This purge policy limits how much data the table can store by defining criteria for automatically detaching table fragments, after the table reach a user-specified limit on the *quantity* of rolling fragments, or on the total *size* of allocated storage. When the purge policy is enforced, the database server automatically replaces detached fragments with new empty fragments in which to insert new data records.

After the purge policy limit is reached, which fragments qualify to be detached is determined by the keywords that define the limit, and by the keywords that define the actions of the purge policy:

- For a number-of-fragments limit specified with the ROLLING INTERVALS keywords, only interval fragments are considered. These are detached in order of lowest fragment-key value, as indicated by the **sysfragments.evalpos** value for the fragment in the system catalog. This behavior for selecting the interval fragments to detach is equivalent to what the INTERVAL FIRST keywords specify with the LIMIT TO option. The ROLLING INTERVALS option, however, does not support the explicit INTERVAL FIRST keywords, nor any subsequent LIMIT TO option keywords after the DETACH or DISCARD purging specification.

The ROLLING INTERVALS option also makes no provision for detaching range fragments, because range fragments are preserved empty after DETACH or DISCARD purging. For this reason, including range fragments as ROLLING INTERVALS options, which the Rolling Window clause syntax does not support, would achieve no reduction in the number of fragments remaining in a table.

- For an allocated storage-size limit specified with the LIMIT TO keywords, three keyword options can indicate which fragment to detach:
 - If the ANY keyword immediately follows the DETACH or the DISCARD keyword, a range or interval fragment will be detached, starting with the fragment having the lowest **sysfragments.evalpos** value. Purge policies specifying ANY for what fragments can be detached can reduce the current size of allocated storage, but as indicated above, detaching range fragments cannot reduce the total number of fragments.
 - If the INTERVAL ONLY keywords are specified, only interval fragments are detached, again starting with the fragment having the lowest **sysfragments.evalpos** value, a value correlated with the age of the rows in the fragment. If no interval fragment exists, then the database server will not be able to satisfy the LIMIT clause restriction. If this occurs for an existing rolling window table, you might consider using the ALTER FRAGMENT MODIFY INTERVAL statement to change the purge policy, so that range fragments can be detached. This can be done by replacing the INTERVAL ONLY keywords with the ANY or INTERVAL FIRST keywords. Alternatively, you might use ALTER FRAGMENT to increase the LIMIT TO size value, if your storage resources can support a larger size limit.
 - If the INTERVAL FIRST keywords immediately follow the DETACH or DISCARD keyword, the database server detaches interval fragments first, starting with the lowest **sysfragments.evalpos** value, until the allocated storage size requirement has been met.

If the Rolling Window clause includes the LIMIT TO keywords, but none of the above options for which fragment to detach, then by default the INTERVAL FIRST policy determines which fragments to detach.

If after having detached all interval fragments, the storage size limit has not been met, the database server, as a safety measure, detaches range fragments, starting with the lowest. In any case, when range fragments are being detached or discarded, they are replaced with new empty fragments for storing the same ranges of values, so that the schema of the table is preserved.

Disposition of the data in purged fragments

The Rolling Window clause provides two keyword options, DETACH and DISCARD, for automated processing of the detached fragments of rolling window tables. There is no default value for this choice of keywords. The database server returns an error if the Rolling Window clause includes neither the DETACH nor the DISCARD keyword.

- Use DETACH to attach the fragments into independent tables that the database server automatically creates, and whose table identifiers are of this form:

```
< original_table_name >_< lower value >_< higher value >
```

Here *lower_value* and *higher_value* are the minimum and maximum values of the interval range for that fragment, before it was detached.

If a table of that name already exists, a numeric counter is appended after the higher value, beginning with **_1** for the first additional table:

```
< original_table_name >_< lower value >_< higher value >_1
```

and so forth, with **_2** appended to the next table name (or a larger integer is appended, if appending **_2** does not produce a unique table name).

- Use DISCARD to destroy the detached fragments. The DISCARD keyword specifies that successfully detached fragments be dropped, so that when the purge policy is enforced, unneeded data records are removed in a timely manner. In this way, the number of rolling fragments or the total amount of storage space for the rolling window table is constrained to the stipulated value.

These disposition options are designed to automate space management for tables fragmented by range interval, so that unneeded data is removed in a timely manner, and storage space is contained to the stipulated amount. The alternative to discarding data is to detach fragments. This provides an opportunity to recover from incorrectly specified purge policies, and allows purged fragments to be attached (or their data otherwise moved) to archival tables.

Enforcing a purge policy

In a database with finite storage, DML or load operations that insert new rows, including rows outside the range of existing fragments, can result in an allocated storage size or a quantity of interval fragments that exceeds a limit (or both limits) that the Rolling Window clause specified for a rolling window table, or for multiple rolling window tables.

A rolling window table's purge policy not immediately enforced, however, at the moment when its limit is exceeded

Purge policies are designed to be enforced daily as a Scheduler task at a time when the required ALTER FRAGMENT DETACH and ALTER FRAGMENT ATTACH operations that remove and process fragments of the rolling window table are unlikely to conflict with access attempts by concurrent users. By default, purge policies are enforced daily, at 00:45 local time. For more information, see the description of the built-in **purge_tables** task of the **Scheduler** in your *IBM® Informix® Administrator's Guide*.

Purge policies also can be manually enforced by running the **syspurge()** system function. After the DBA invokes this function, the database server inspects the system catalog, and identifies any rolling window tables whose purging policy has been exceeded. The database server then either discards or detaches, as specified by the purge policy, qualifying rolling fragments until the purging policy is satisfied, or until no more rolling fragments can be removed. The **syspurge()** function requires no arguments, but accepts an optional argument that enables online log diagnostics.

Modifying, dropping, or adding a purge policy

You can use the ALTER FRAGMENT statement to change or drop the purge policy of a rolling window table, or to change a table that was created with some other storage option into a rolling window table. Simply by adding a purge policy, for example, the Rolling Window clause of the ALTER FRAGMENT statement can change a table that uses simple range-interval fragmentation into a rolling window table.

The Rolling Window clause of the CREATE TABLE statement supports a subset of the syntax of the Rolling Window clause in ALTER FRAGMENT ON TABLE . . . MODIFY INTERVAL statements.

If you are dissatisfied with the purge policy of an existing rolling window table, the ALTER FRAGMENT statement can modify it in several ways, including these:

- Change the ROLLING FRAGMENTS or LIMIT TO specifications,
- Replace the DETACH or the DISCARD keyword of a purge policy
- Suspend a purge policy with the DISABLE keyword option
- Resume a suspended purging policy while the ENABLE keyword
- Remove the purge policy and the rolling fragments of a rolling window table

To change a rolling window distributed storage strategy into a simple range-interval fragmentation strategy, you can run the ALTER FRAGMENT MODIFY INTERVAL DROP ALL ROLLING statement for the table. You should first archive the rows in any non-empty rolling interval fragments of the table before you do this, if you need to preserve the data.

Restrictions on rolling window tables

Tables that use the ROLLING INTERVALS or LIMIT TO keywords to define a rolling window fragmentation strategy and its purge policy have the following restrictions:

- The purging strategy that the Rolling Window clause defines for rolling fragments requires the database server to perform ALTER FRAGMENT DETACH operations on fragments that satisfy the DETACH or DISCARD criteria. The ALTER FRAGMENT DETACH statement is disallowed on tables with columns are primary keys that are referenced by an enabled foreign-key constraint, or on tables created with ROWIDs. For this reason, the CREATE TABLE and ALTER FRAGMENT MODIFY INTERVAL statements cannot define a fragment purging policy on tables that have primary-key constraints or ROWID shadow columns.
- Any index that is defined on a rolling window table must have the same storage distribution as the rolling window table.
- Only users with DBA access privileges can call routines that implement the DETACH or DISCARD options for detached rolling fragments. Users with RESOURCE access privileges can execute the **syspurge()** function, but this can enforce purging policies only on tables that they own.
- The database server silently ignores any invocation of the **syspurge()** function on secondary servers in High Availability Data Replication (HDR) cluster environments. This is because cluster environments do not replicate ALTER FRAGMENT changes that the DETACH and DISCARD options trigger, which are at the core of rolling window purge policies.
- Similarly, in a grid environment, purge policies on replicated tables are not enforced.

A rolling window with no storage size limit

The following example of a CREATE TABLE statement defines a range-interval distributed storage strategy, including **p4** as a NULL fragment to store rows with no value in the **order_date** fragment-key column. Because the interval within the range of this fragment key is defined as one month, and the interval transition value is the first day of 2014, the first interval fragment will be generated when a record is inserted with an **order_date** value in a year later than 2013. Successive interval fragments will be stored in the dbspaces **db1**, **db2**, and **db3** in round-robin fashion:

```
CREATE TABLE orders
  (order_id INT, cust_id INT,
   order_date DATE, order_desc CHAR (1024))
  FRAGMENT BY RANGE (order_date)
  INTERVAL (NUMTOYMINTERVAL (1,'MONTH'))
  ROLLING (3 FRAGMENTS) DETACH
  STORE IN (db1, db2, db3)
  PARTITION p0 VALUES < DATE ('01/01/2014') IN db1,
  PARTITION p4 VALUES IS NULL IN db3;
```

In the example above, the Rolling Window clause sets at 3 the maximum number of rolling interval fragments. If rows will be added in each of the first three months of 2014, three rolling fragments will be generated by March of that year, because each new interval fragment stores data from only a single month. If a 4th interval fragment is created in April, this will exceed the purge policy limit on rolling fragments. Because no limit on storage size is specified, the default INTERVAL FIRST criterion will detach the interval fragment whose **evalpos** value is smallest among the four rolling fragments. That fragment will be attached to another table, rather than destroyed, because the purge policy specifies DETACH, rather than DISCARD.

A rolling window with a storage size limit

The following range-interval distributed storage strategy for the **employee** table uses the value in INTEGER column **emp_id** as the fragment-key column, and 1000 is the interval within the range of this fragment key for rolling interval fragments. Among the three range fragments, the last has an interval transition value of 20000, implying that the first rolling interval fragment will be generated when a record is inserted with an **emp_id** value of 20002 or larger. Rolling interval fragments will again be stored in the dbspaces **db1**, **db2**, and **db3** in round-robin fashion:

```
CREATE TABLE employee
(
  emp_id INTEGER, emp_name CHAR(64),
  ssn CHAR(12), basepay FLOAT, varpay FLOAT,
  dept_id SMALLINT, hire_date DATE)
  FRAGMENT BY RANGE(emp_id)
  INTERVAL(1000)
  ROLLING ( 10 FRAGMENTS )
  LIMIT TO 100000MiB DETACH ANY
  STORE IN (db1, db2, db3)
  PARTITION p1 VALUES < 5000 IN db0,
  PARTITION p2 VALUES < 10000 IN db0,
  PARTITION p3 VALUES < 20000 IN db4;
```

Here the Rolling Window clause sets at 10 the maximum number of rolling interval fragments. The purge policy will not be enforced until either of the following events occur:

- The database server creates an eleventh rolling fragment, after a record is inserted outside the ranges of any of the three 3 fragments or, by the time an 11th interval fragment is needed, the 10 rolling interval fragments.
- The total storage space that the database server has allocated for the **employee** table and its indexes exceeds 100000 megabytes.

If the limit of the 10 rolling intervals is exceeded before the storage size limit, the database server will detach the interval fragment with the smallest **evalpos** value among the 11 rolling fragments.

If the limit of 100000 megabytes is exceeded before the limit on the number of interval fragments, the **DETACH ANY** option allows the database server to select any range fragment or interval fragment to detach.

In either case, that fragment will be attached to another table, rather than destroyed, because the purge policy specifies **DETACH**, rather than **DISCARD**.

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EXTENT SIZE Options

The **EXTENT SIZE** options can define the size of storage extents allocated to the table.

This syntax fragment is part of the [Storage options](#).

EXTENT SIZE Options

```
|-----+----->
'-EXTENT SIZE--first_kilobytes-'

>-----+-----|
'-NEXT SIZE--next_kilobytes-'
```

Element	Description	Restrictions	Syntax
<i>first_kilobytes</i>	Length in kilobytes of the first extent for the table; default is 16 kilobytes.	Must return a positive number; maximum is the chunk size	Expression
<i>next_kilobytes</i>	Length in kilobytes of each subsequent extent; default is 16 kilobytes.	Must return a positive number; maximum is the chunk size	Expression

Usage

The minimum length of *first_kilobytes* (and of *next_kilobytes*) is four times the disk-page size on your system. For example, if you have a 2-kilobyte page system, the minimum length is 8 kilobytes.

If the **CREATE TABLE** (or the **CREATE TEMP TABLE**) statement includes no **IN** dspace clause, no **EXTENT SIZE** specification, and no **NEXT SIZE** specification, no storage is allocated for the table until at least one data row is inserted into it. The default size of the first extent is either 16 kilobytes or 4 pages.

The next example specifies a first extent of 20 kilobytes and allows the rest of the extents to use the default size:

```
CREATE TABLE emp_info
(
  f_name CHAR(20),
  l_name CHAR(20),
  position CHAR(20),
  start_date DATETIME YEAR TO DAY,
  comments VARCHAR(255)
)
EXTENT SIZE 20;
```

If a table contains no data, you can use the ALTER TABLE MODIFY EXTENT SIZE or ALTER TABLE MODIFY NEXT SIZE statements of SQL to change the size of the first extent and of the next extent of the empty table. These operations are not supported, however, for tables that contain one or more rows. For more information about these options to the ALTER TABLE statement, see [MODIFY EXTENT SIZE](#) and [MODIFY NEXT SIZE clause](#).

If you need to revise the extent sizes of a table, you can modify the first extent and next-extent sizes in the generated schema files of an unloaded table. For example, to make a database more efficient, you might unload a table, modify the extent sizes in the schema files, and then create and load a new table. For information about how to optimize extents, see your *IBM® Informix® Administrator's Guide*.

Related reference:
[MODIFY NEXT SIZE clause](#)

Related information:
[Extents](#)

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COMPRESSED option for tables

Use the COMPRESSED option of the CREATE TABLE statement to enable the automatic compression of large amounts of row data when the data is loaded into the table or table fragment.

After you create a table with the COMPRESSED option, the database server automatically creates a compression dictionary and compresses the in-row data after 2000 or more rows of data are loaded into a table or fragment. If the data is loaded by a light append, the first 2000 rows and all subsequent rows are compressed. If the data is loaded by another method, all subsequent rows after the first 2000 rows are compressed. To compress the original 2000 rows, run the SQL administration API **task()** or **admin()** function with the **table compress** or **fragment compress** argument.

The COMPRESSED option enables only the compression of in-row data. The COMPRESSED option does not enable the automatic compression of simple large objects in dbspaces or indexes. (You can use the COMPRESSED keyword of the CREATE INDEX statement to create a compressed B-tree index.)

The following example creates a table that is set up for the automatic compression:

```
CREATE TABLE cust5 ( ... ) COMPRESSED;
```

The following example also creates a table named **t**, which defines first and next extent sizes and is set up for the automatic compression:

```
CREATE TABLE t(c int, d int) EXTENT SIZE 32 NEXT SIZE 32 COMPRESSED;
```

To disable the automatic compression of data in new rows, run an SQL administration API **task()** or **admin()** function with the **table uncompress** argument. To re-enable automatic compression, run the SQL administration API **task()** or **admin()** function with the **table compress** argument on the table. You can control compression for a table fragment with the **fragment uncompress** and **fragment compress** arguments.

Related information:
[table or fragment arguments: Compress data and optimize storage \(SQL administration API\)](#)
[Compression](#)

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LOCK MODE Options

Use the LOCK MODE options to specify the locking granularity of the new table.

The following table describes the locking-granularity options.

Granularity	Effect
PAGE	Obtains and releases one lock on a whole page of rows If neither the IFX_DEF_TABLE_LOCKMODE environment variable nor the DEF_TABLE_LOCKMODE configuration parameter has set a default locking granularity, this is the system default. Page-level locking is especially useful when you know that the rows are grouped into pages in the same order that you are using to process all the rows. For example, if you are processing the contents of a table in the same order as its cluster index, page locking is appropriate.
ROW	Obtains and releases one lock per row Row-level locking provides the highest level of concurrency. If you are using many rows at one time, however, the lock-management overhead can become significant. You might also exceed the maximum number of locks available, depending on the configuration of your database server, but Informix® can support up to 18 million locks on 32-bit platforms, or 600 million locks on 64-bit platforms. Only tables with row-level locking can support the LAST COMMITTED isolation level feature.

Examples of setting the locking granularity

The following CREATE TABLE statement defines a new table **tsTab_j** with column **id** of type INT and column **ts** of the **TIMESERIES(ts_data_j)** extended data type, with ROW as the locking granularity:

```
CREATE TABLE IF NOT EXISTS tsTab_j(  
  id INT NOT NULL PRIMARY KEY,  
  ts TIMESERIES(ts_data_j)  
) LOCK MODE ROW;
```



```
CREATE TABLE Tab5 (C1 IDSSECURITYLABEL,  
C2 int,  
C3 char (10) COLUMN SECURED WITH label6)  
SECURITY POLICY company  
LOCK MODE(PAGE);
```

This ALTER TABLE ... LOCK MODE statement can change the locking granularity, as in this example for the **Tab5** table:

```
ALTER TABLE Tab5 LOCK MODE (ROW) ;
```

Important:

The SET LOCK MODE statement of SQL has no effect on the locking granularity of tables. For the syntax and semantics, see [SET LOCK MODE statement](#).

- Precedence and Default Behavior

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Precedence and Default Behavior

In Informix®, you do not need to specify the lock mode each time you create a new table. You can globally set the locking granularity of all new tables in the following environments:

- Database session of an individual user
You can set the **IFX_DEF_TABLE_LOCKMODE** environment variable to specify the lock mode of new tables during your current session.
- Database server (all sessions on the database server)
If you are a DBA, you can set the DEF_TABLE_LOCKMODE configuration parameter in the ONCONFIG file to determine the lock mode of all new tables in the database server.

If you are not a DBA, you can set the **IFX_DEF_TABLE_LOCKMODE** environment variable for the database server, before you run **oninit**, to specify the lock mode of all new tables of the database server.

The LOCK MODE setting in a CREATE TABLE statement takes precedence over the settings of the **IFX_DEF_TABLE_LOCKMODE** environment variable and the DEF_TABLE_LOCKMODE configuration parameter.

If CREATE TABLE specifies no lock mode setting, the default mode depends on the setting of the **IFX_DEF_TABLE_LOCKMODE** environment variable or the DEF_TABLE_LOCKMODE configuration parameter. For information about **IFX_DEF_TABLE_LOCKMODE**, refer to the *IBM® Informix Guide to SQL: Reference*. For information about the DEF_TABLE_LOCKMODE configuration parameter, refer to the *IBM Informix Administrator's Reference*.

Related information:

IFX_DEF_TABLE_LOCKMODE environment variable

DEF TABLE LOCKMODE configuration parameter

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USING Access-Method Clause

The USING Access Method clause can specify an access method.

This syntax fragment is part of the [CREATE TABLE statement](#).

USING Access-Method Clause

[illegible]

Notes:

1. See [Specific Name](#)

Element	Description	Restrictions	Syntax
<i>config_keyword</i>	Configuration keyword associated with the specified access method	No more than 18 bytes. The access method must exist.	Literal keyword

Element	Description	Restrictions	Syntax
<i>config_value</i>	Value of the specified configuration keyword	No more than 236 bytes. Must be defined by the access method.	Quoted String

A *primary-access method* is a set of routines to perform DDL and DML operations, such as create, drop, insert, delete, update, and scan, to make a table available to the database server. Informix® provides a built-in primary-access method.

You store and manage a virtual table either outside of the database server in an extspace or inside the database server in an sbspace. (See [Storage options](#).) You can access a virtual table with SQL statements. Access to a virtual table requires a user-defined primary-access method.

DataBlade modules can provide other primary-access methods to access virtual tables. When you access a virtual table, the database server calls the routines associated with that access method rather than the built-in table routines. For more information on these other primary-access methods, refer to your access-method documentation.

You can retrieve a list of configuration values for an access method from a table descriptor (**mi_am_table_desc**) using the MI_TAB_AMPARAM macro. Not all keywords require configuration values.

The access method must already exist. For example, if an access method called **textfile** exists, you can specify it with the following syntax:

```
CREATE TABLE mybook
( ... )
IN myextspace
USING textfile (DELIMITER=' ');
```

Related reference:

[Storage options](#)

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Statistics options of the CREATE TABLE statement

Use the Statistics Options clause of the CREATE TABLE statement to set the values of the STATCHANGE property of a fragmented or nonfragmented table, and the STATLEVEL property of a fragmented table.

This syntax fragment is part of the [CREATE TABLE statement](#).

Statistics Options

```
.-STATCHANGE AUTO-----
|-----+----->
|          .-AUTO-----|
|'-STATCHANGE---+change_threshold---'

.-STATLEVEL AUTO-----
>-----+-----|
|'-STATLEVEL---+FRAGMENT---'
|          +-TABLE-----+
|          '-AUTO-----'
```

Element	Description	Restrictions	Syntax
<i>change_threshold</i>	Percentage of changed data rows that defines stale distribution statistics	Must be an integer in the range 0 - 100	Literal Number

Usage

These table attributes control the threshold for automatic recalculation (STATCHANGE) and the granularity (STATLEVEL) of data distribution statistics.

The Statistics Options clause of the CREATE TABLE statement can define table statistics properties that allow the user to control the actions of

- UPDATE STATISTICS, when that SQL statement is run without the FOR keyword,
- and of UPDATE STATISTICS FOR TABLE, when that statement runs in LOW, MEDIUM, or HIGH mode.

The two table properties that the Statistics Options clause can set are STATCHANGE and STATLEVEL.

The STATCHANGE property

The STATCHANGE table attribute specifies the minimum percentage of changes (from UPDATE, DELETE, MERGE, and INSERT operations on the rows in the table or fragment since the previous calculation of distribution statistics) to consider the statistics stale. You can specify an integer value in the range 0 - 100, or you can use the AUTO keyword to apply the current STATCHANGE configuration parameter setting in the ONCONFIG file or in the session environment variable as the default change threshold value.

The automatic mode for selectively updating table and fragment statistics can be enabled in any of the following ways:

- The AUTO_STAT_MODE configuration parameter is set to 1 (or is not set). Enables automatic mode as the system default.
- The AUTO_STAT_MODE session environment variable is set to ON. Enables automatic mode during the current session.
- The UPDATE STATISTICS statement includes the AUTO keyword. Enables automatic mode while that UPDATE STATISTICS statement is running.

Enabling automatic mode has no effect, however, on any of these UPDATE STATISTICS statements:

- While automatic mode is enabled, UPDATE STATISTICS statements use the explicit or default STATCHANGE value to identify table, index, or fragment distributions statistics in the system catalog that are missing or stale, and selectively updates only the missing or stale statistics. For more information about the automatic mode for UPDATE STATISTICS operations, see the description of the AUTO_STAT_MODE configuration parameter in the *IBM® Informix® Administrator's Reference*. See also [AUTO_STAT_MODE session environment option](#) and [Using the FORCE and AUTO keywords](#).

The `STATLEVEL` property of a fragmented table can determine the level of granularity of its data distributions and index statistics. It can take one of the following three values, with `AUTO` being the default, if no value is specified at creation time:

- If any of these criteria are not satisfied, the database server creates table-level distributions, rather than fragment-level.

Note: The SYSSBSPACENAME configuration parameter, which must be set when the database server instance is initialized, specifies the sbspace in which the database server stores fragment-level data distribution statistics. These statistics are stored as BLOB objects in the **endcst** column of the **syfragsdist** system catalog table. For the database server to support fragment level statistics, the SYSSBSPACENAME configuration parameter setting specifies an existing sbspace. If you use the Statistics Options clause to set the STATLEVEL property to FRAGMENT, the database server returns an error if either of the following is true:

- [STATCHANGE configuration parameter](#)

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Use the CREATE TEMP TABLE statement to create a temporary table in the current database.

[illegible]

1. See [Column definition](#)
2. See [Multiple-Column Constraint Format](#)
3. Informix® extension
4. See [Storage options for temporary tables](#)
5. See [LOCK MODE Options](#)
6. See [USING Access-Method Clause](#)

Element	Description	Restrictions	Syntax
<i>table</i>	Name declared here for a table	Must be unique in session. See Declaring a name for a temporary table	Identifier

Usage

You must have the Connect privilege on the database to create a temporary table. The temporary table is visible only to the user who created it.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if a temporary table of the specified name already exists in the current session.

You can also define indexes and constraints on temporary tables that you define with the CREATE TEMP TABLE statement.

In DB-Access, using the CREATE TEMP TABLE statement outside the CREATE SCHEMA statement generates warnings if you set **DBANSIWARN**.

In ESQ/C, the CREATE TEMP TABLE statement generates warnings if you use the **-ansi** flag or set the **DBANSIWARN** environment variable.

- [Declaring a name for a temporary table](#)
A temporary table is associated with a session, not with a database. When you create a temporary table, you cannot create another temporary table with the same name (even for another database) until you drop the first temporary table or end the session.
- [Column definition](#)
Use the Column Definition segment of the CREATE TEMP TABLE statement to declare the name and the data type (and optionally a default value and constraints) of a single column of the temporary table.
- [Single-Column Constraint Format](#)
- [Multiple-Column Constraint Format](#)
- [Using the WITH NO LOG option](#)
Use the WITH NO LOG option to reduce the overhead of transaction logging for the temporary table. If you specify WITH NO LOG, data manipulation language (DML) operations on the temporary table are not included in the transaction log records.
- [Storage options for temporary tables](#)
Use the Storage Options segment of the CREATE TEMP TABLE statement to specify the storage location and distribution scheme for the table. This is an extension to the ANSI/ISO standard for SQL syntax.
- [Differences between temporary and permanent tables](#)
- [Duration of temporary tables](#)
The duration of a temporary table depends on whether or not it is logged.

Related reference:

[CREATE TABLE statement](#)
[ALTER TABLE statement](#)
[CREATE DATABASE statement](#)
[DROP TABLE statement](#)
[SELECT statement](#)
[DROP INDEX statement](#)

Related information:

[Environment variables in Informix products](#)
[DBSPACETEMP configuration parameter](#)

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Declaring a name for a temporary table

A temporary table is associated with a session, not with a database. When you create a temporary table, you cannot create another temporary table with the same name (even for another database) until you drop the first temporary table or end the session.

The name of a temporary table must follow the naming requirements for SQL identifiers, but it cannot be a component of a qualified database-object name. When you create a temporary table with the CREATE TEMP TABLE statement, you cannot specify any authorization identifier as its *owner*. Unlike a permanent table, a temporary table cannot be referenced in an SQL statement by qualifying its identifier with an *owner* name, or a *database* name, or a *database server* name.

The name of a temporary table must be different from the name of any other table, view, sequence object, or synonym in the current database server. Otherwise, the temporary table takes precedence in your session over any permanent table of the same name. The name that you declare for the temporary table, however, need not be different from the temporary table names that are declared in other sessions of the same database server.

If you issue a cross-database DML statement that references a remote permanent table while your local database contains a temporary table with the same name, the DML statement accesses that local temporary table, rather than the remote permanent table.

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Column definition

Use the Column Definition segment of the CREATE TEMP TABLE statement to declare the name and the data type (and optionally a default value and constraints) of a single column of the temporary table.

```

(1)
|--column--| Data Type |----->
.-----|
V-----|
>-----|
| (2) | (3) |
+-----+
| (2) | (4) |
'-----' Single-Column Constraint Format |-----'

```

1. See [Data Type](#)
2. Use this path no more than once
3. See [DEFAULT clause of CREATE TABLE](#)
4. See [Single-Column Constraint Format](#)

Element	Description	Restrictions	Syntax
<i>column</i>	Name declared here for a column in the table	Must be unique in its table	<u>Identifier</u>

- You cannot define a referential constraint on the column.
- The data type cannot be `IDSSECURITYLABEL`.
- The `SECURED WITH label` option is not supported for temporary tables.

Related information:
[SQL_LOGICAL_CHAR configuration parameter](#)

Single-Column Constraint Format

```
.------.  
|v                                             |  
|--++--+-NULL-++--+--+--+--+--+--+--+--+--+--+  
|   |   | '-NOT NULL-'   |   |   |   |   |   | |
|   |   | +-UNIQUE-----+   |   |   |   |   |  
|   |   | (1)              |   |   |   |   |  
|   |   | +-----DISTINCT+   |   |   |   |   |  
|   |   | '-PRIMARY KEY----'   |   |   |   |   |  
|   |   | (2)                  |   |   |   |   |  
|   |   | '-| CHECK Clause |-----'   |   |   |   |   |
```

1. Informix® extension
2. See [CHECK Clause](#)

You can find detailed discussions of specific constraints in these sections.

UNIQUE

Constraints that you define on temporary tables are always enabled.

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Multiple-Column Constraint Format

Use the multiple-column constraint format to associate one or more columns with a constraint. This alternative to the single-column constraint format allows you to associate multiple columns with a constraint.

Multiple-Column Constraint Format

```

      .-.-.-.-.
      V
|---+---+NOT NULL+---+ (---column+---) +---+-----|
| | '-NULL-----' | | |
| +-+UNIQUE-----+ | | |
| | (1) | | |
| | '-----DISTINCT-' | | |
| | '-PRIMARY KEY-----' | | |
| | (2) | | |
| '-| CHECK Clause |-----' | |

```

Notes:

1. Informix® extension
2. See [CHECK Clause](#)

Element	Description	Restrictions	Syntax
<i>column</i>	Name of column or columns on which the constraint is placed	Must be unique in a table, but the same name can be in different tables of the same database	Identifier

This is a subset of the syntax of [Multiple-Column Constraint Format](#) that the CREATE TABLE statement supports.

This alternative to the single-column constraint segment of CREATE TEMP TABLE can associate multiple columns with a constraint. Constraints that you define on temporary tables are always enabled.

The following table indicates where you can find detailed discussions of specific constraints.

Constraint	For more information, see	For an example, see
CHECK	CHECK Clause	Defining Check Constraints Across Columns
DISTINCT	Using UNIQUE or DISTINCT Constraints	Examples of the Multiple-Column Constraint Format
PRIMARY KEY	Using the PRIMARY KEY Constraint	Defining Composite Primary and Foreign Keys
UNIQUE	Using UNIQUE or DISTINCT Constraints	Examples of the Multiple-Column Constraint Format

See also the section [Differences Between a Unique Constraint and a Unique Index](#).

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Using the WITH NO LOG option

Use the WITH NO LOG option to reduce the overhead of transaction logging for the temporary table. If you specify WITH NO LOG, data manipulation language (DML) operations on the temporary table are not included in the transaction log records.

The WITH NO LOG keywords are required on all temporary tables that you create in temporary dbspaces. Within a cluster environment, the WITH NO LOG keywords are required when you create a temporary table on a secondary server.

If the ONCONFIG parameter TEMPTAB_NOLOG is set to 1, logging of temporary tables is disabled and all temporary tables are non-logging by default. This setting can improve the performance of operations that use temporary tables, such as HDR operations. The WITH NO LOG option is not needed when the TEMPTAB_NOLOG setting has disabled logging of temporary tables. For information about how to set the TEMPTAB_NOLOG parameter, see your *IBM® Informix® Administrator's Reference*.

If you use the WITH NO LOG option in a database that does not use logging, the WITH NO LOG keywords of the CREATE TEMP TABLE statement have no effect. If your database does not support transaction logging, every table behaves as if the WITH NO LOG option were specified.

The ALTER TABLE statement cannot change the logging status of a temporary table. Once you turn off logging on a temporary table, you cannot turn it back on; a temporary table, therefore, is either always logged or else never logged.

The following temporary table is not logged in a database that uses transaction logging:

```
CREATE TEMP TABLE tab2 (fname CHAR(15), lname CHAR(15))
WITH NO LOG;
```

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Temporary tables created with `SELECT INTO TEMP` and `WITH NO LOG` are spread across the dbspaces listed in the `DBSPACETEMP` configuration parameter or **DBSPACETEMP** environment variable. Thus, the **DBSPACETEMP** (or `DBSPACETEMP`) settings that specify multiple dbspaces can result in round-robin fragmentation across all dbspaces in the temporary dbspace.

If you create a temporary table and specify `WITH NO LOG`, operations on the temporary table are not included in the transaction log records. If there is a logged space in the `DBSPACETEMP` list, the temporary table created with the `SELECT .. INTO TEMP WITH NO LOG` option is fragmented by a round-robin distribution scheme in the non-logged temporary dbspaces. For example, if from a list of 10 dbspaces, only one dbspace is logged, the table is fragmented by a round-robin distribution scheme in the 9 non-logged temporary dbspaces.

The following example shows how to insert data into a temporary table called **result_tmp** to output to a file the results of a user-defined function (**f_one**) that returns multiple rows:

```
CREATE TEMP TABLE result_tmp( ... );
INSERT INTO result_tmp EXECUTE FUNCTION f_one();
UNLOAD TO 'file' SELECT * FROM result_tmp;
```

Related information:

[DBSPACETEMP environment variable](#)

[DBSPACETEMP configuration parameter](#)

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Differences between temporary and permanent tables

Compared to permanent tables, temporary tables differ in these ways:

- They have fewer types of constraints available.
- They have fewer options that you can specify.
- They are not visible to other users or sessions.
- They do not appear in the system catalog tables.
- They are not preserved, as described in the section [Duration of temporary tables](#).

The `INFO` statement and the **Info Menu** option of DB-Access cannot reference temporary tables.

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Duration of temporary tables

The duration of a temporary table depends on whether or not it is logged.

A logged temporary table exists until one of the following events occurs:

- The application disconnects.
- The `DROP TABLE` statement is issued on the temporary table.
- The database is closed.

When any of these events occurs, the temporary table is deleted.

Nonlogging temporary tables include tables that were created using the `WITH NO LOG` option of `CREATE TEMP TABLE`.

A nonlogging temporary table exists until one of the following situations occurs:

- The application disconnects.
- The `DROP TABLE` statement is issued on the temporary table.
- The database is closed, and the nonlogging temporary table includes at least one column of a user-defined type, or of a built-in opaque data type. (The Informix® built-in opaque data types include `BLOB`, `BOOLEAN`, `BSON`, `CLOB`, `JSON`, `LVARCHAR`, and `IDSSECURITYLABEL`.)

If the nonlogging temporary table does not include any columns of UDTs or of built-in opaque data types, you can use that table to transfer data from one database to another while the application remains connected, because the table is not destroyed when the database is closed. You must use a permanent table (or some other strategy) if the data to be transferred includes UDTs or built-in opaque data types.

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CREATE TRIGGER statement

Use the `CREATE TRIGGER` statement to define a trigger on a table. You can also use `CREATE TRIGGER` to define an `INSTEAD OF` trigger on a view.

This is an extension to the ANSI/ISO standard for SQL.

Syntax

```

>>-CREATE TRIGGER--|-----+-----+-----+----->
      '-IF NOT EXISTS-' | (1) |
                        '-| Owner Name |-----'

(2) .-ENABLED-----.
>--trigger--| Trigger on a Table |-----+-----+-----+----->
      | (3) |
      '-INSTEAD OF--| Trigger on a View |-----'

```

Notes:

1. See [Owner name](#)
2. See [Defining a Trigger Event and Action](#)
3. See [INSTEAD OF Triggers on Views](#)

Element	Description	Restrictions	Syntax
<i>trigger</i>	Name that you declare here for a new trigger	Must be unique among the names of triggers in the current database	Identifier

Usage

A *trigger* is a database object that, unless disabled, automatically executes a specified set of SQL statements, called the *trigger action*, when a specified *trigger event* occurs.

The trigger event that initiates the trigger action can be an INSERT, DELETE, UPDATE, or a SELECT statement. The MERGE statement can also be the triggering event for an UPDATE, DELETE, or INSERT trigger. The event definition must specify the table or view on which the trigger is defined. (SELECT or UPDATE events for triggers on tables can also specify one or more columns.)

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if a trigger of the specified name is already defined on a table or view in the current database.

You can use the CREATE TRIGGER statement in two distinct ways:

- You can define a trigger on a table in the current database.
- You can also define an INSTEAD OF trigger on a view in the current database.

Any SQL statement that is an instance of the trigger event is called a *triggering statement*. When the event occurs, triggers defined on tables and triggers defined on views differ in whether the triggering statement is executed:

- For tables, the trigger event and the trigger action both execute.
- For views, only the trigger action executes, instead of the event.

That is, if you define an INSTEAD OF trigger on an updatable view, the database server does not perform the DML operation that corresponds to the *trigger event*, but instead performs the specified *trigger action* on the view or on its base table.

Important: In some cases, however, after the CREATE TRIGGER statement defines queries on a table or on a column as triggering events for enabled Select triggers, the database server does not execute the trigger action when the query executes. For a list of contexts where this is the expected behavior, see [Circumstances When a Select Trigger Is Not Activated](#). For a similar list of contexts where the trigger actions of enabled Insert, Delete, or Update triggers on views are not executed, see [Restrictions on INSTEAD OF Triggers on Views](#).

The CREATE TRIGGER statement can support the integrity of data in the database by defining rules by which specified DML operations (the triggering events) cause the database server to take specified actions. The following sections describe the syntax elements.

Clause	Page	Effect
Defining a Trigger Event and Actions	Defining a Trigger Event and Action	Associates triggered actions with an event
Trigger Modes	Trigger Modes	Enables or disables the trigger
Insert Events and Delete Events	INSERT Events and DELETE Events	Defines Insert events and Delete events
Update Events	UPDATE Event	Defines Update events
Select Events	SELECT Event	Defines Select events
Action Clause	Action Clause	Defines triggered actions
REFERENCING Clause for Delete	REFERENCING Clause for Delete	Declares qualifier for deleted values
REFERENCING Clause for Insert	REFERENCING Clause for Insert triggers	Declares qualifier for inserted values
REFERENCING Clause for Update	REFERENCING Clause for Update	Declares qualifiers for old and new values
REFERENCING Clause for Select	REFERENCING Clause for Select	Declares qualifier for result set values
Correlated Table Action	Correlated Table Action	Defines triggered actions
Triggered Action	Triggered Action on a Table	Defines triggered actions
INSTEAD OF Trigger on Views	INSTEAD OF Triggers on Views	Defines a trigger on views
Action Clause of INSTEAD OF Triggers	The Action Clause of INSTEAD OF Triggers	Triggered actions on views

- [Defining a Trigger Event and Action](#)

- [Restrictions on Triggers](#)
- [Trigger Modes](#)
- [Trigger Inheritance in a Table Hierarchy](#)
- [Triggers and SPL Routines](#)
- [Trigger Events](#)
- [INSERT Events and DELETE Events](#)
- [UPDATE Event](#)
- [Defining Multiple Update Triggers](#)
- [SELECT Event](#)
- [Circumstances When a Select Trigger Is Activated](#)
- [Stand-alone SELECT Statements](#)
- [SELECT Statements Within UDRs in the Select List](#)

A Select trigger is activated by a UDR if the UDR contains a SELECT statement within its statement block, and the UDR also appears in the Projection clause of a SELECT statement.

- [UDRs that EXECUTE PROCEDURE or EXECUTE FUNCTION call](#)

A Select trigger is activated by a UDR if the UDR contains a SELECT statement within its statement block that queries the table, and the UDR is called by an EXECUTE PROCEDURE or the EXECUTE FUNCTION statement.

- [Subqueries in the Select List](#)

A Select trigger can be activated by a subquery that appears in the select list of the Projection clause of a SELECT statement.

- [Subqueries in the FROM Clause of SELECT](#)

- [Subqueries in the WHERE Clause of DELETE or UPDATE](#)

Subqueries that are specified using the Condition with Subquery syntax in the WHERE clause of the DELETE statement or the UPDATE statement cannot be the triggering event for a Select trigger.

- [Select Triggers in Table Hierarchies](#)

- [Circumstances When a Select Trigger Is Not Activated](#)

- [Action Clause](#)

- [Guaranteeing Row-Order Independence](#)

- [REFERENCING Clauses](#)

- [Correlated Table Action](#)

- [Triggered Action on a Table](#)

- [Using Correlation Names in Triggered Actions](#)

- [Re-Entrancy of Triggers](#)

- [Rules for SPL Routines](#)

- [Privileges to Execute Trigger Actions](#)

- [Cascading Triggers](#)

- [Tables in Remote Databases](#)

- [Logging and Recovery](#)

- [INSTEAD OF Triggers on Views](#)

Related reference:

[Modes for constraints and unique indexes](#)

[CREATE VIEW statement](#)

[RENAME COLUMN statement](#)

[EXECUTE PROCEDURE statement](#)

[DROP TRIGGER statement](#)

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Defining a Trigger Event and Action

This syntax defines the event and action of a trigger on a table or on a view.

Trigger on a Table

```
|---+-DELETE-----+---ON--table--| DELETE and SELECT Clauses |---+-|
| | '-SELECT-----+---+ |
| | | .-,-----+---+ |
| | | V |
| | | '-OF---column--+---+ |
|---UPDATE-----+---ON--table--| UPDATE Clause |-----+---+
| | | .-,-----+---+ | |
| | | V |
| | | '-OF---column--+---+ |
| | | (1) | (2) |
| | '-INSERT--ON--table---+---| NEW Declaration |-----| Correlated Action |-----+---+
| | | (3) |
| | | '-| Action Clause |-----+---+
| | |
```

DELETE and SELECT Clauses

```
(3)
|---+-| Action Clause |-----+-----+
| | (4) | (2) |
| | '-| OLD Declaration |-----| Correlated Action |-----+
| |
```

UPDATE Clause

(3)

Trigger on a View

Notes:

1. See [REFERENCING Clause for Insert triggers](#)
2. See [Correlated Table Action](#)
3. See [Action Clause](#)
4. See [REFERENCING Clause for Update](#)
5. See [INSTEAD OF Triggers on Views](#)

Element	Description	Restrictions	Syntax
column	The name of a column in the triggering <i>table</i>	Must exist	Identifier
correlation	Name that you declare here to qualify an old or new column value (as <i>correlation.column</i>) in a triggered action	Must be unique in this trigger	Identifier
<i>table, view</i>	Name or synonym of the triggering table or view. The <i>table</i> or <i>view</i> can include an <i>owner.</i> qualifier.	Must exist in the current database	Identifier

For the syntax to specify the triggered action of triggers on tables, see [Action Clause](#) and [Correlated Table Action](#).

For the syntax to specify the triggered action of INSTEAD OF triggers on views, see [The Action Clause of INSTEAD OF Triggers](#).

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Restrictions on Triggers

The table on which you create a trigger must exist in the current database. You cannot create a trigger on any of the following types of tables:

- A diagnostics table, a violations table, or a table in another database
- A temporary table or a system catalog table
- A table object that the CREATE EXTERNAL TABLE or CREATE SEQUENCE statement created.

In DB-Access, if you want to define a trigger as part of a schema, place the CREATE TRIGGER statement inside a CREATE SCHEMA statement.

If you are embedding the CREATE TRIGGER statement in Informix® ESQL/C programs, you cannot use a host variable in the trigger definition.

You can use the DROP TRIGGER statement to remove an existing trigger. If you use the DROP TABLE or DROP VIEW statement to remove triggering tables or views from the database, all triggers on those tables or views are also dropped.

The ON EXCEPTION statement of SPL has no effect when it is issued from a trigger routine, nor from the Action clause or the Correlated Action clause of a trigger.

The triggered action of an Insert trigger that increments a BIGSERIAL, SERIAL, or SERIAL8 column does not update the **sqlca.sqlerrd[1]** field of the SQL Communication Area structure. The triggered INSERT operation can successfully increment the serial counter for the column, but the value of the **sqlca.sqlerrd[1]** field remains zero, rather than being reset to the new serial value.

You cannot define a DELETE trigger on a table that has a referential constraint that specifies ON DELETE CASCADE.

UNION subqueries cannot be triggering events. If a valid UNION subquery specifies a column on which a Select trigger has been defined, the query succeeds, but the trigger (or the INSTEAD OF trigger on a view) is ignored.

The database server cannot use parallel processing for some triggered actions. PDQ is automatically disabled in the FOR EACH ROW section for any DML statement that corresponds to the type of triggering event:

- SELECT statements in the Action clause of a Select trigger
- DELETE or MERGE statements in the Action clause of a Delete trigger
- INSERT or MERGE statements in the Action clause of an Insert trigger
- UPDATE or MERGE statements in the Action clause of an Update trigger.

The scope of this restriction on PDQ is the FOR EACH ROW section. It has no effect on DML statements in the BEFORE or AFTER sections of the Action clause. For additional restrictions on INSTEAD OF triggers on views, see [Restrictions on INSTEAD OF Triggers on Views](#).

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Trigger Modes

You can set a trigger mode to enable or disable a trigger when you create it.

```
Trigger Modes
.-ENABLED--.
>>--+DISABLED--+-----><
```

You can create triggers on tables or on views in ENABLED or DISABLED mode.

- When a trigger is created in ENABLED mode, the database server executes the trigger action when the trigger event is encountered. (If you specify no mode when you create a trigger, ENABLED is the default mode.)
- When a trigger is created in DISABLED mode, the trigger event does not cause execution of the trigger action. In effect, the database server ignores the trigger and its action, even though the **systriggers** system catalog table maintains information about the disabled trigger.

You can also use the SET TRIGGERS option of the Database Object Mode statement to set an existing trigger to the ENABLED or DISABLED mode.

After a DISABLED trigger is enabled by the SET TRIGGERS statement, the database server can execute the trigger action when the trigger event is encountered, but the trigger does not perform retroactively. The database server does not attempt to execute the trigger for rows that were selected, inserted, deleted, or updated while the trigger was disabled and before it was enabled.

Warning: Because the behavior of a trigger varies according to its ENABLED or DISABLED mode, be cautious about disabling a trigger. If disabling a trigger will eventually destroy the semantic integrity of the database, do not disable the trigger.

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Trigger Inheritance in a Table Hierarchy

By default, any trigger that you define on a typed table of Informix® is inherited by all its subtables.

In versions of Informix earlier than version 11.10, however, if you define a trigger on a subtable of a typed table, that trigger overrides any trigger for the same type of triggering event (Select, Delete, Insert, or Update) that the subtable inherits from its supertable. In this version of Informix, however, a table can inherit more than one trigger that the same triggering event activates, so both triggers are defined for the same type of event on the subtable.

In all versions of Informix, a trigger that you set on a subtable is inherited by all its dependent tables, but has no effect on its supertable.

This behavior is important when you require a trigger to be enabled in a supertable, but to be disabled in its subtable. In Informix 10.00 and in earlier versions, you cannot use the SET TRIGGERS option of the SET Database Object Mode statement to disable an inherited trigger selectively within a hierarchy. In this release, however, disabling a trigger on a table within a table hierarchy has no effect on inherited triggers. For example, the following statement has no effect on triggers on table objects that are above or below *subtable* within a table hierarchy:

```
SET TRIGGERS FOR subtable DISABLED
```

Similarly, the DROP TRIGGER statement cannot destroy an inherited trigger without also destroying the trigger on the supertable. In this situation, you must instead define a trigger with no Action clause on the subtable. Because triggers are not additive, this empty trigger overrides the inherited trigger and executes for the subtable and for any subtables under the subtable, which are not subject to further overrides.

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Triggers and SPL Routines

You cannot define a trigger in an SPL routine that is called inside a DML (data manipulation language) statement, as listed in [Data Manipulation Language Statements](#). Thus, the following statement returns an error if the **sp_items** procedure includes the CREATE TRIGGER statement:

```
INSERT INTO items EXECUTE PROCEDURE sp_items;
```

You can use the CREATE FUNCTION or CREATE PROCEDURE statement of SQL with the REFERENCING clause to define *trigger routines* that include the FOR *table* or FOR *view* specification. These UDRs must include the REFERENCING clause that declares *correlation* names for OLD or NEW column values in the specified *table*

or *view*. Triggers on the *table* or *view* can invoke the trigger routine from the FOR EACH ROW section of the Triggered Action list. Triggers can also invoke non-trigger routines from the BEFORE and AFTER sections of the Triggered Action list, but these UDRs cannot use *correlation* names to reference the NEW or OLD column values. The REFERENCING clause in a trigger routine supports the same syntax as in the CREATE TRIGGER statement, as described in the section [REFERENCING Clauses](#).

Multiple triggers that the same triggering event executes can invoke more than one trigger routine, and these trigger routines can access the same NEW or OLD column values by using SPL variables that have the same names or different names. When a single triggering event executes multiple triggers, the order of execution is not guaranteed, but all of the BEFORE triggered actions execute before any of the FOR EACH ROW triggered actions, and all of the AFTER triggered actions execute after all of the FOR EACH ROW triggered actions.

For UDRs that are not trigger routines, SPL variables are not valid in CREATE TRIGGER statements. An SPL routine cannot perform INSERT, DELETE, or UPDATE operations on any table or view that is not local to the current database. See also [Rules for SPL Routines](#) for additional restrictions on SPL routines that are invoked in triggered actions.

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Trigger Events

The *trigger event* specifies what DML statements can initiate the trigger. The event can be an INSERT, DELETE, or UPDATE operation on the *table* or *view*, or a SELECT operation that queries the *table*. Each CREATE TRIGGER statement must specify exactly one trigger event. Any SQL statement that is an instance of the trigger event is called a *triggering statement*.

For each *table*, you can define triggers that are activated by INSERT, DELETE, UPDATE, or SELECT statements. For each *view*, you can define INSTEAD OF triggers that are activated by INSERT, DELETE, or UPDATE statements. Multiple triggers on the same table or view can be activated by different types of trigger events or by the same type of trigger event.

You cannot specify a DELETE event if the triggering table has a referential constraint that specifies ON DELETE CASCADE.

You are responsible for guaranteeing that the triggering statement returns the same result with and without the trigger action on a table. See also the sections [Action Clause](#) and [Triggered Action on a Table](#).

A triggering statement from an external database server can activate the trigger.

As the following example shows, an Insert trigger on **newtab**, managed by **dbserver1**, is activated by an INSERT statement from **dbserver2**. The trigger executes as if the INSERT originated on **dbserver1**.

```
-- Trigger on stores_demo@dbserver1:newtab
CREATE TRIGGER ins_tr INSERT ON newtab
REFERENCING new AS post_ins
FOR EACH ROW(EXECUTE PROCEDURE nt_pct (post_ins.mc));
-- Triggering statement from dbserver2
INSERT INTO stores_demo@dbserver1:newtab
SELECT item_num, order_num, quantity, stock_num, manu_code,
total_price FROM items;
```

Informix® also supports INSTEAD OF triggers on views, which are initiated when a triggering DML operation references the specified view. The INSTEAD OF trigger replaces the trigger event with the specified trigger action on a view, rather than execute the triggering INSERT, DELETE, or UPDATE operation. A *view* can have any number of INSTEAD OF trigger defined for each type of INSERT, DELETE, or UPDATE triggering event.

- [Trigger Events with Cursors](#)
- [Privileges on the Trigger Event](#)
- [Performance Impact of Triggers](#)

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Trigger Events with Cursors

For triggers on tables, if the triggering statement uses a cursor, each part of the trigger action (including BEFORE, FOR EACH ROW, and AFTER, if these are specified for the trigger) is activated for each row that the cursor processes.

This behavior differs from what occurs when a triggering statement does not use a cursor and updates multiple rows. In this case, any BEFORE and AFTER triggered actions execute only once, but the FOR EACH ROW action list is executed for each row processed by the triggering statement. For additional information about trigger actions, see [Action Clause](#)

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Privileges on the Trigger Event

You must have appropriate Insert, Delete, Update, or Select privilege on the triggering table or view to execute a triggering INSERT, DELETE, UPDATE, or SELECT statement as the trigger event. The triggering statement might still fail, however, if you do not also have the privileges necessary to execute one of the SQL statements in the trigger action. When the trigger actions are executed, the database server checks your privileges for each SQL statement in the trigger definition,

as if the statement were being executed independently of the trigger. For information on the privileges needed to execute the trigger actions, see [Privileges to Execute Trigger Actions](#).

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Performance Impact of Triggers

The INSERT, DELETE, UPDATE, and SELECT statements that initiate triggers might appear to execute slowly because they execute additional SQL statements, and the user might not know that other actions are occurring.

The execution time for a trigger event depends on the complexity of the trigger action and whether it initiates other triggers. The time increases as the number of cascading triggers increases. For more information on triggers that initiate other triggers, see [Cascading Triggers](#).

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INSERT Events and DELETE Events

INSERT and DELETE events on tables are defined by those keywords and by the ON *table* clause, using the following syntax.

INSERT or DELETE Event on a Table

```
|--+-INSERT+--+ON--+table-----|
      '-DELETE-'
```

Element	Description	Restrictions	Syntax
<i>table</i>	Name of the triggering table	Must exist in the database	Identifier

An Insert trigger is activated when an INSERT statement includes the specified *table* (or a synonym for *table*) in its INTO clause. Similarly, a Delete trigger is activated when a DELETE statement includes the specified *table* (or a synonym for *table*) in its FROM clause.

The MERGE statement can also activate an Insert trigger, if the specified *table* of the Insert trigger is the target table of a MERGE statement that includes the Insert clause. Similarly, the MERGE statement can also activate a Delete trigger, if the specified *table* of the Delete trigger is the target table of a MERGE statement that includes the Delete clause.

The TRUNCATE TABLE statement does not activate Delete triggers when it removes all the rows from a table. If an enabled Delete trigger is defined for a table on which you do not hold the Alter privilege, the database server returns an error if you attempt to truncate that table, even though the TRUNCATE statement cannot be the triggering event for a Delete trigger. (For more information about the discretionary access privileges that truncate operations require, see the [TRUNCATE statement](#).)

For triggers on views, the INSTEAD OF keywords must immediately precede the INSERT, DELETE, or UPDATE keyword that specifies the type of trigger event, and the name or synonym of a *view* (rather than of a table) must follow the ON keyword. The section [INSTEAD OF Triggers on Views](#) describes the syntax for defining INSTEAD OF trigger events.

Any number of Insert triggers, and any number of Delete triggers, can be defined on the same table.

If you define a trigger on a subtable within a table hierarchy, and the subtable supports cascading deletes, then a DELETE operation on the supertable activates the Delete triggers on the subtable.

See also the section [Re-Entrancy of Triggers](#) for information about dependencies and restrictions on the actions of Insert triggers and Delete triggers.

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UPDATE Event

UPDATE events (and SELECT events) can include an optional *column* list.

UPDATE Event

```
|--UPDATE+-----+ON--+table-----|
      | .,----- |
      | V         |
      '-OF---column+--'
```

Element	Description	Restrictions	Syntax
<i>column</i>	Column that activates the trigger	Must exist in the triggering table	Identifier
<i>table</i>	Name of the triggering table	Must exist in the database	Identifier

The *column* list is optional. If you omit the OF *column* list, updating any column of *table* activates the trigger.

The *OF column* clause is not valid for an *INSTEAD OF* trigger on a view.

An *UPDATE* on the triggering table can activate the trigger in two cases:

- The *UPDATE* statement references any column in the *column* list.
- The *UPDATE* event definition has no *OF column* list specification.

Whether it updates one column or more than one column from the *column* list, a triggering *UPDATE* statement activates each Update trigger only once.

The *MERGE* statement can also activate an Update trigger, if the specified *table* of a trigger with no *columns* list is the target table of the *MERGE* statement, or if the Update clause of the *MERGE* statement references a column in the *column* list of the Update trigger.

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Defining Multiple Update Triggers

Multiple Update triggers on a table can include the same or different columns. In the following example, **trig3** on the **items** table includes in its column list **stock_num**, which is a triggering column in **trig1**.

```
CREATE TRIGGER trig1 UPDATE OF item_num, stock_num ON items
REFERENCING OLD AS pre NEW AS post
FOR EACH ROW(EXECUTE PROCEDURE proc1());
CREATE TRIGGER trig2 UPDATE OF manu_code ON items
BEFORE(EXECUTE PROCEDURE proc2());
CREATE TRIGGER trig3 UPDATE OF order_num, stock_num ON items
BEFORE(EXECUTE PROCEDURE proc3());
```

When an *UPDATE* statement updates multiple columns that have different triggers, the firing order is based on the lowest-numbered column that is defined in the triggers that actually fired, regardless of whether that lowest-numbered column was actually the triggering column when the trigger fired. If several Update triggers are set on the same column or on the same set of columns, however, the order of trigger execution is not guaranteed.

The following example shows that table **taba** has four columns (**a**, **b**, **c**, **d**):

```
CREATE TABLE taba (a int, b int, c int, d int);
```

Define **trig1** as an update on columns **a** and **c**, and define **trig2** as an update on columns **b** and **d**, as the following example shows:

```
CREATE TRIGGER trig1 UPDATE OF a, c ON taba
AFTER (UPDATE taba SET y = y + 1);

CREATE TRIGGER trig2 UPDATE OF b, d ON taba
AFTER (UPDATE taba SET z = z + 1);
```

The following example shows a triggering statement for the Update trigger:

```
UPDATE taba SET (b, c) = (b + 1, c + 1);
```

Then **trig1** for columns **a** and **c** executes first, and **trig2** for columns **b** and **d** executes next. In this case, the smallest column number in the two triggers is column 1 (**a**), and the next is column 2 (**b**).

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SELECT Event

DELETE and *INSERT* events are defined by those keywords (and the *ON table* clause), but *SELECT* and *UPDATE* events also support an optional *column* list.

SELECT Event

```
|--SELECT--+-+-----+--ON--+-+-----+--table-----|
|          |,-----|   '---owner--'-'
|          | V      |
|          |'-OF---column--+'
```

Element	Description	Restrictions	Syntax
<i>column</i>	Column that activates the trigger	Must exist in the triggering <i>table</i>	Identifier
<i>owner</i>	Owner of <i>table</i>	Must own <i>table</i>	Owner name
<i>table</i>	Name of the triggering table	Must exist in the database	Identifier

If you define more than one Select trigger on the same table, the *column* list is optional, and the *column* lists for each trigger can be unique or can duplicate that of another Select trigger.

A *SELECT* on the triggering table can activate the trigger in two cases:

- The *SELECT* statement references any column in the *column* list.
- The *SELECT* event definition has no *OF column* list specification.

(Sections that follow, however, describe additional circumstances that can affect whether or not a SELECT statement activates a Select trigger.)

Whether it specifies one column or more than one column from the *column* list, a triggering SELECT statement activates the Select trigger only once.

The action of a Select trigger cannot include an UPDATE, INSERT, or DELETE on the triggering table. The action of a Select trigger can include UPDATE, INSERT, and DELETE actions on tables other than the triggering table. The following example defines a Select trigger on one column of a table:

```
CREATE TRIGGER mytrig
  SELECT OF cola ON mytab REFERENCING OLD AS pre
  FOR EACH ROW (INSERT INTO newtab VALUES('for each action'));
```

You cannot specify a SELECT event for an INSTEAD OF trigger on a view.

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Circumstances When a Select Trigger Is Activated

A query on the triggering table activates a Select trigger in these cases:

- The SELECT statement is a stand-alone SELECT statement.
- The SELECT statement occurs within a UDR called in a select list.
- The SELECT statement is a subquery in the Projection list.
- The SELECT statement is a subquery in the FROM clause.
- The SELECT statement occurs within a UDR called by EXECUTE PROCEDURE or EXECUTE FUNCTION.
- The SELECT statement selects data from a supertable in a table hierarchy. In this case the SELECT statement activates Select triggers for the supertable and all the subtables in the hierarchy.

For information on SELECT statements that do not activate a Select trigger, see [Circumstances When a Select Trigger Is Not Activated](#).

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Stand-alone SELECT Statements

A Select trigger is activated if the triggering column appears in the select list of the Projection clause of a stand-alone SELECT statement.

For example, if a Select trigger is defined to execute whenever column **col1** of table **tab1** is selected, then both of the following stand-alone SELECT statements activate the Select trigger:

```
SELECT * FROM tab1;
SELECT col1 FROM tab1;
```

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SELECT Statements Within UDRs in the Select List

A Select trigger is activated by a UDR if the UDR contains a SELECT statement within its statement block, and the UDR also appears in the Projection clause of a SELECT statement.

For example, assume that an enabled Select trigger is defined on the table **tab1**, and that a UDR named **my_rtn** contains this SELECT statement in its statement block:

```
SELECT col1 FROM tab1;
```

Now suppose that the following SELECT statement invokes the **my_rtn** UDR in its projection list:

```
SELECT my_rtn() FROM tab2;
```

This SELECT statement activates the Select trigger defined on column **col1** of table **tab1** when the **my_rtn** UDR is executed.

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UDRs that EXECUTE PROCEDURE or EXECUTE FUNCTION call

A Select trigger is activated by a UDR if the UDR contains a SELECT statement within its statement block that queries the table, and the UDR is called by an EXECUTE PROCEDURE or the EXECUTE FUNCTION statement.

For example, assume that an enabled Select trigger is defined on the table **tab1**, and that the user-defined routine named **my_rtn** contains the following SELECT statement in its statement block:

```
SELECT col1 FROM tab1;
```

Now suppose that the following statement invokes the **my_rtn** routine:

```
EXECUTE PROCEDURE my_rtn();
```

This statement activates the Select trigger defined on column **col1** of table **tab1** when the SELECT statement within the statement block is executed.

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Subqueries in the Select List

A Select trigger can be activated by a subquery that appears in the select list of the Projection clause of a SELECT statement.

For example, if an enabled Select trigger is defined on **col1** of **tab1**, the subquery in the following SELECT statement activates that trigger:

```
SELECT (SELECT col1 FROM tab1 WHERE col1=1), colx, coly FROM tabz;
```

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Subqueries in the FROM Clause of SELECT

Table expressions in the FROM clause of a SELECT statement can be the triggering event on a table that is referenced by an uncorrelated subquery. In the following example, the subquery that specifies a table expression is the triggering event for any enabled Select triggers that are defined on **col1** of **tab1**:

```
SELECT vcol FROM (SELECT FIRST 5 col1 FROM tab1 ORDER BY col1 ) vtab(vcol);
```

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Subqueries in the WHERE Clause of DELETE or UPDATE

Subqueries that are specified using the Condition with Subquery syntax in the WHERE clause of the DELETE statement or the UPDATE statement cannot be the triggering event for a Select trigger.

In the following example, the subquery is not the triggering event for any enabled Select triggers that are defined on **col2** of **tab1**:

```
DELETE tab1 WHERE EXISTS  
(SELECT col2 FROM tab1 WHERE col2 > 1024);
```

The DELETE operation in same example, however, activates any enabled Delete triggers that are defined on **tab1**. No enabled Select trigger on **tab1** can be activated by a subquery within a DELETE statement that modifies a table referenced in the FROM clause of the subquery.

Similarly, the subquery in the WHERE clause of the following UPDATE statement is not the triggering event for any enabled Select triggers that are defined on **col3** of **tab1**:

```
UPDATE tab1 SET col3 = col3 + 10  
WHERE col3 > ANY  
(SELECT col3 from tab1 WHERE col3 > 1);
```

The same example activates any enabled Update trigger that is defined on **col3** of **tab1**, but no Select trigger can be updated by the subquery. For additional restrictions on Select triggers, see [Circumstances When a Select Trigger Is Not Activated](#).

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Select Triggers in Table Hierarchies

A subtable in the Informix® database inherits the Select triggers that are defined on its supertable. When you select from a supertable, the SELECT statement activates the Select triggers on the supertable and the inherited Select triggers on the subtables in the table hierarchy.

For example, assume that table **tab1** is the supertable and table **tab2** is the subtable in a table hierarchy. If the Select trigger **trig1** is defined on table **tab1**, a SELECT statement on table **tab1** activates the Select trigger **trig1** for the rows in table **tab1** and the inherited Select trigger **trig1** for the rows in table **tab2**.

If you add a Select trigger to a subtable, this Select trigger does not override the Select trigger that the subtable inherits from its supertable, but increases the number of Select triggers on the subtable. For example, if the Select trigger **trig1** is defined on column **col1** in supertable **tab1**, the subtable **tab2** inherits this trigger. If you define a Select trigger named **trig2** on column **col1** in subtable **tab2**, and a SELECT statement selects from **col1** in supertable **tab1**, this SELECT statement activates trigger **trig1** for the rows in table **tab1** and both triggers **trig1** and **trig2** for the rows in table **tab2**.

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Circumstances When a Select Trigger Is Not Activated

A SELECT statement on the triggering table does not activate a Select trigger in certain circumstances:

- If a subquery or UDR that contains the triggering SELECT statement appears in any clause of a SELECT statement other than the Projection clause or the FROM clause, the Select trigger is not activated.
For example, if the subquery or UDR appears in the WHERE clause or HAVING clause of a SELECT statement, the SELECT statement within the subquery or UDR does not activate the Select trigger.
- If the trigger action of a Select trigger calls a UDR that includes a triggering SELECT statement, the Select trigger on the SELECT in the UDR is not activated. Cascading Select triggers are not supported.
- If a SELECT statement contains a built-in aggregate or user-defined aggregate in its Projection clause, the Select trigger is not activated. For example, the following SELECT statement does not activate a Select trigger defined on **col1** of **tab1**:

```
SELECT MIN(col1) FROM tab1;
```

- A SELECT statement that includes a set operator (including INTERSECT, MINUS, EXCEPT, UNION, or UNION ALL) does not activate a Select trigger.
- The SELECT clause of INSERT does not activate a Select trigger.
- A subquery in the WHERE clause of the DELETE or UPDATE statement cannot activate a Select trigger on the same table that the DELETE or UPDATE statement is modifying.
- If the Projection clause of a SELECT includes the DISTINCT or UNIQUE keywords, the SELECT statement does not activate a Select trigger.
- Select triggers are not supported on scroll cursors.
- If a SELECT statement refers to a remote triggering table, the Select trigger is not activated on the remote database server.
- Columns in the ORDER BY list of a query activate no Select triggers (nor any other triggers) unless they are also listed in the Projection clause.

An exception to the last restriction is that a Select trigger can be activated by a column in the ORDER BY list of a subquery in the FROM clause, whether or not the same column also appears in the Projection clause. In the following example, a table expression that includes **col1** in the ORDER BY clause (but not in the select list of the Projection clause) is the triggering event for any enabled Select triggers that are defined on **col1** of **tab1**:

```
SELECT vcol FROM (SELECT col2 FROM tab1 ORDER BY col1 ) vtab(vcol);
```

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Action Clause

The Action clause defines the SQL statements that are executed when the trigger is activated. For a trigger on a table, there can be up to three sections in the Action clause: BEFORE, AFTER and FOR EACH ROW.

- The BEFORE actions are executed once for each triggering event, before the database server performs the triggering DML operation.
- The AFTER actions are also executed once for each triggering DML event, after the operation on the table is complete, in the context of the triggering statement.
- The FOR EACH ROW actions are executed for each row that is inserted, updated, deleted or selected in the DML operation, after the DML operation is executed on each row, but before the database server writes the values into the log and into the table.

If the same table has multiple triggers that are activated by the same triggering event, the order of trigger execution is not guaranteed, but all of the BEFORE triggered actions execute before any of the FOR EACH ROW triggered actions, and all of the AFTER triggered actions execute after all of the FOR EACH ROW triggered actions.

When you define an INSTEAD OF trigger on a view, the BEFORE and AFTER keywords are not supported, but the FOR EACH ROW section of the Action clause is valid. See the section [INSTEAD OF Triggers on Views](#) for the syntax of specifying triggered actions on a view.

The Action clause has the following syntax.

Action Clause

```
|----->
|                                     (1) |
| '-BEFORE--| Triggered Action |-----'
>----->
|                                     (1) |
| '-FOR EACH ROW--| Triggered Action |-----'
>-----|
|                                     (1) |
| '-AFTER--| Triggered Action |-----'
```

Notes:

1. See [Triggered Action on a Table](#)

For the trigger to have any effect on the table, you must define at least one triggered action, using the keywords BEFORE, FOR EACH ROW, or AFTER to indicate when the action occurs relative to execution of the triggering event.

You can specify actions for any or all of these three options on a single trigger, but any BEFORE action list must be specified first, and any AFTER action list must be specified last. For more information on the Action clause when a REFERENCING clause is also specified, see [Correlated Table Action](#).

- [BEFORE Actions](#)
- [FOR EACH ROW Actions](#)
- [AFTER Actions](#)
- [Actions of Multiple Triggers](#)

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BEFORE Actions

The list of BEFORE trigger actions execute once before the triggering statement executes. Even if the triggering statement does not process any rows, the database server executes the BEFORE trigger actions.

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FOR EACH ROW Actions

After a row of the triggering table is processed, the database server executes all of the statements of the FOR EACH ROW trigger action list; this cycle is repeated for every row that the triggering statement processes. (But if the triggering statement does not insert, delete, update, or select any rows, the database server does not execute the FOR EACH ROW trigger actions.)

The FOR EACH ROW action list of a Select trigger is executed once for each instance of a row. For example, the same row can appear more than once in the result of a query joining two tables. For more information on FOR EACH ROW actions that reference specific values in rows that the triggering statement processes, see [REFERENCING Clauses](#).

As noted in the section [Restrictions on Triggers](#), parallel data processing is disabled in FOR EACH ROW trigger actions for DML statements that correspond to the type of trigger event. For example, the database server does not apply PDQ to UPDATE statements in the FOR EACH ROW section of the Action clause of an Update trigger, nor to DELETE statements in the FOR EACH ROW section of the Action clause of a Delete trigger. This restriction on PDQ processing does not apply to DML statements in the BEFORE or AFTER sections of the Action clause.

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AFTER Actions

The specified set of AFTER trigger actions executes once after the action of the triggering statement is complete. If the triggering statement does not process any rows, the AFTER trigger actions still execute.

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Actions of Multiple Triggers

When an UPDATE or MERGE statement activates multiple triggers, the trigger actions merge. Assume that **taba** has columns **a**, **b**, **c**, and **d**, as this example shows:

```
CREATE TABLE taba (a INT, b INT, c INT, d INT);
```

Next, assume that you define **trig1** on columns **a** and **c**, and **trig2** on columns **b** and **d**. If both triggers specify BEFORE, FOR EACH ROW, and AFTER actions, then the trigger actions are executed in the following order:

1. BEFORE action list for trigger (**a**, **c**)
2. BEFORE action list for trigger (**b**, **d**)
3. FOR EACH ROW action list for trigger (**a**, **c**)
4. FOR EACH ROW action list for trigger (**b**, **d**)
5. AFTER action list for trigger (**a**, **c**)
6. AFTER action list for trigger (**b**, **d**)

The database server treats all the triggers that are activated by the same triggering statement as a single trigger, and the trigger action is the merged-action list. All the rules that govern a trigger action apply to the merged list as one list, and no distinction is made between the two original triggers.

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Guaranteeing Row-Order Independence

In a FOR EACH ROW triggered-action list, the result might depend on the order of the rows being processed. You can ensure that the result is independent of row order by following these suggestions:

- Avoid selecting the triggering table in the FOR EACH ROW section.
If the triggering statement affects multiple rows in the triggering table, the result of the SELECT statement in the FOR EACH ROW section varies as each row is processed. This condition also applies to any cascading triggers. See [Cascading Triggers](#).
- In the FOR EACH ROW section, avoid updating a table with values derived from the current row of the triggering table.
If the trigger actions modify any row in the table more than once, the final result for that row depends on the order in which rows from the triggering table are processed.
- Avoid modifying a table in the FOR EACH ROW section that is selected by another statement in the same FOR EACH ROW trigger action, including any cascading trigger actions.

If FOR EACH ROW actions modify a table, the changes might not be complete when a subsequent action of the trigger refers to the table. In this case, the result might differ, depending on the order in which rows are processed.

The database server does not enforce rules to prevent these situations because doing so would restrict the set of tables from which a trigger action can select. Furthermore, the result of most trigger actions is independent of row order. Consequently, you are responsible for ensuring that the results of the trigger actions are independent of row order.

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REFERENCING Clauses

The REFERENCING clause for any event declares a *correlation* name (or for Update triggers, two *correlation* names) that can be used to qualify column values in the triggering table. These names enable FOR EACH ROW actions to reference new or old column values in the result of trigger events.

They also enable FOR EACH ROW actions to reference old column values that existed in the triggering table prior to modification by trigger events.

Correlation names are not valid if the triggered action includes both the INSERT statement and the BEFORE WHEN or AFTER WHEN keywords. This restriction does not affect triggered actions that specify the FOR EACH ROW keywords without the BEFORE or AFTER keywords, or that include no INSERT statement.

The REFERENCING clause syntax that is described here for the CREATE TRIGGER statement is also valid in CREATE FUNCTION and CREATE PROCEDURE statements that define a trigger routine, provided that the CREATE FUNCTION or CREATE PROCEDURE statement also includes the FOR *table_object* clause to specify the table or view whose FOR EACH ROW actions can invoke the trigger routine.

- [REFERENCING Clause for Delete](#)
- [REFERENCING Clause for Insert triggers](#)
- [REFERENCING Clause for Update](#)
- [REFERENCING Clause for Select](#)

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REFERENCING Clause for Delete

The REFERENCING clause for a Delete trigger can declare a correlation name for the deleted value in a column.

REFERENCING Clause for Delete

```
|--REFERENCING--OLD--++-----+--correlation-----|
      '-AS-'
```

Element	Description	Restrictions	Syntax
<i>correlation</i>	Name that you declare here to qualify an old column value (as <i>correlation.column</i>) in a triggered action	Must be unique within this CREATE TRIGGER statement	Identifier

The *correlation* is a qualifier for the column value in the triggering table before the triggering statement executed. The *correlation* is in scope in the FOR EACH ROW trigger action list. See [Correlated Table Action](#).

To use a correlation name in a trigger action to refer to an old column value, prefix the column name with the correlation name and a period (.) symbol. For example, if the NEW *correlation* name is **post**, refer to the new value for the column **fname** as **post.fname**.

If the trigger event is a DELETE statement, using the new correlation name as a qualifier causes an error, because the column has no value after the row is deleted. For the rules that govern the use of correlation names, see [Using Correlation Names in Triggered Actions](#).

You can use the REFERENCING clause for Delete only if you define a FOR EACH ROW trigger action.

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REFERENCING Clause for Insert triggers

The REFERENCING clause for an Insert trigger can declare a correlation name for the inserted value in a column.

```
|--REFERENCING--NEW--+---+--correlation-----|
                        '-AS-'
```

Element	Description	Restrictions	Syntax
<i>correlation</i>	Name that you declare here to qualify a new column value (as <i>correlation.column</i>) in a triggered action	Must be unique within this CREATE TRIGGER statement	Identifier

The *correlation* is a name for the new column value after the triggering statement has executed. Its scope of reference is only the FOR EACH ROW trigger action list; see [Correlated Table Action](#). To use the correlation name, precede the column name with the *correlation* name, followed by a period (.) symbol. Thus, if the NEW *correlation* name is **post**, refer to the new value for the column **fname** as **post.fname**.

If the trigger event is an INSERT statement, using the old *correlation* name as a qualifier causes an error, because no value exists before the row is inserted. For the rules that govern how to use correlation names, see [Using Correlation Names in Triggered Actions](#). You can use the INSERT REFERENCING clause only if you define a FOR EACH ROW trigger action.

The following example illustrates use of the INSERT REFERENCING clause. This example inserts a row into **backup_table1** for every row that is inserted into **table1**. The values that are inserted into **col1** and **col2** of **backup_table1** are an exact copy of the values that were just inserted into **table1**.

```
CREATE TABLE table1 (col1 INT, col2 INT);
CREATE TABLE backup_table1 (col1 INT, col2 INT);
CREATE TRIGGER before_trig
  INSERT ON table1 REFERENCING NEW AS new
  FOR EACH ROW
  (
    INSERT INTO backup_table1 (col1, col2)
    VALUES (new.col1, new.col2)
  );
```

As the preceding example shows, the REFERENCING clause for INSERT triggers allows you to refer to data values produced by the trigger action.

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REFERENCING Clause for Update

The REFERENCING clause for an Update trigger can declare correlation names for the original value and for the updated value in a column.

REFERENCING Clause for Update

```

      .------.
      V      (1) |
|--REFERENCING--+--OLD--+-----+correlation+-----+
      |      (1) | '-AS-'
      |-----NEW-'

```

Notes:

1. Use path no more than once

Element	Description	Restrictions	Syntax
<i>correlation</i>	Name that you declare here to qualify an old or new column value (as <i>correlation.column</i>) in a triggered action	Must be unique within this CREATE TRIGGER statement	Identifier

The OLD *correlation* is the name of the value of the column in the triggering table before execution of the triggering statement; the NEW *correlation* identifies the corresponding value after the triggering statement executes.

The scope of reference of the *correlation* names that you declare here is only within the FOR EACH ROW trigger action list. See [Correlated Table Action](#).

To refer to an old or new column value, prefix the column name with the *correlation* name and a period (.) symbol. For example, if the new *correlation* name is **post**, you can refer to the new value in column **fname** as **post.fname**.

If the trigger event is an UPDATE statement, you can define both old and new *correlation* names to refer to column values before and after the triggering UPDATE statement. For rules that govern the use of *correlation* names, see [Using Correlation Names in Triggered Actions](#).

You can use the UPDATE REFERENCING clause only if you define a FOR EACH ROW trigger action.

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REFERENCING Clause for Select

The REFERENCING clause for a Select trigger can declare a correlation name for the value in a column.

```
|--REFERENCING--OLD--+---+--correlation-----|
                        '-AS-'
```

This has the same syntax as the [REFERENCING Clause for Delete](#). The scope of reference of the *correlation* name that you declare here is only within the FOR EACH ROW trigger action list. See [Correlated Table Action](#).

If the trigger event is a SELECT statement, using the new *correlation* name as a qualifier causes an error because the column does not have a new value after the column is selected. For the rules that govern the use of correlation names, see [Using Correlation Names in Triggered Actions](#).

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Use the Correlated Trigger Action clause to define the SQL statements that are executed as the trigger action when a triggering event activates a trigger on a table.

[illegible]

1. See [Triggered Action on a Table](#)

For information on the BEFORE, FOR EACH ROW, and AFTER triggered-action lists, see [Action Clause](#)

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The Triggered Action specifies a list of SQL statements to execute when a trigger is activated. The BEFORE, FOR EACH ROW, and AFTER sections of the Action Clause can each specify different list of triggered actions for the same trigger.

V	V	(2)
(1)	INSERT Statement	(3)
'-WHEN--(--| Condition |-----)-'	DELETE Statement	(4)
	UPDATE Statement	(5)
	EXECUTE PROCEDURE Statement	(6)
	EXECUTE FUNCTION Statement	

1. See [Condition](#)

2. See [INSERT statement](#)
3. See [DELETE statement](#)
4. See [UPDATE statement](#)
5. See [EXECUTE PROCEDURE statement](#)
6. See [EXECUTE FUNCTION statement](#)

For a trigger on a table, the trigger action consists of an optional WHEN condition and the action statements. You can specify a triggered-action list for each WHEN clause, or you can specify a single list (of one or more trigger actions) if you include no WHEN clause.

Database objects that are referenced explicitly in the trigger action or in the definition of the trigger event, such as tables, columns, and UDRs, must exist when the CREATE TRIGGER statement defines the new trigger.

The following Update trigger includes no WHEN clause, but invokes the SPL routine `upd_items_p1()` as its triggered action whenever the **quantity** column of the **items** table is updated:

```
CREATE TRIGGER up_itemqty
  UPDATE OF quantity ON items
  BEFORE (EXECUTE PROCEDURE upd_items_p1);
```

If no `upd_items_p1()` routine is registered in the database when this CREATE TRIGGER statement is issued, the database server issues an error, and no **up_itemqty** trigger is created.

Attention: When you specify a date expression in the WHEN condition or in an action statement, make sure to specify four digits instead of two digits for the year. For more about abbreviated years, see the description of **DBCENTURY** in the *IBM® Informix Guide to SQL: Reference*, which also describes how the behavior of some database objects can be affected by environment variable settings. Like fragmentation expressions, check constraints, and UDRs, triggers are stored in the system catalog with the creation-time settings of environment variables that can affect the evaluation of expressions like the WHEN condition. The database server ignores any subsequent changes to those settings when evaluating expressions in those database objects.

- [WHEN Condition](#)
- [Action Statements](#)

Related information:

[DBCENTURY environment variable](#)

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WHEN Condition

The WHEN condition makes the triggered action dependent on the outcome of a test. When you include a WHEN condition in a triggered action, the statements in the triggered action list execute only if the condition evaluates to `true`. If the WHEN condition evaluates to `false` or `unknown`, then the statements in the triggered action list are not executed.

If the triggered action is in a FOR EACH ROW section, its condition is evaluated for each row. For example, the triggered action in the following trigger executes only if the condition in the WHEN clause is true:

```
CREATE TRIGGER up_price
  UPDATE OF unit_price ON stock
  REFERENCING OLD AS pre NEW AS post
  FOR EACH ROW WHEN (post.unit_price > pre.unit_price * 2)
  (INSERT INTO warn_tab VALUES (pre.stock_num, pre.order_num,
    pre.unit_price, post.unit_price, CURRENT));
```

An SPL routine that executes inside the WHEN condition carries the same restrictions as a UDR that is called in a data manipulation statement. That is, the SPL routine cannot contain certain SQL statements. For information on which statements are restricted, see [Restrictions on SPL Routines in Data-Manipulation Statements](#).

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Action Statements

The triggered-action statements can be INSERT, DELETE, UPDATE, EXECUTE FUNCTION, or EXECUTE PROCEDURE statements. If the action list contains multiple statements, and the WHEN condition is satisfied (or is absent), then these statements execute in the order in which they appear in the list.

- [UDRs as Triggered Actions](#)
- [Achieving a Consistent Result](#)
- [Declaring keywords of SQL as correlation names](#)

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UDRs as Triggered Actions

Calls to user-defined functions and procedures, including trigger routines, can be triggered actions. The triggered action list of the FOR EACH ROW clause can include calls to UDRs that call `mi_trigger*()` functions. Triggered actions are the only context in which a trigger routine of Informix® can be invoked. For restrictions

on the calling context and the syntax of trigger routines, see [The REFERENCING and FOR Clauses](#).

You can use the EXECUTE FUNCTION statement to call any user-defined function or trigger function. Use the EXECUTE PROCEDURE statement to call any user-defined procedure or trigger procedure.

In contexts where Boolean expressions are valid, the Boolean operators SELECTING, INSERTING, DELETING, and UPDATING are valid in trigger routines and in other UDRs that are invoked in triggered action statements. These operators return TRUE ('t') if the triggering event matches the DML operation that matches the name of the operator; otherwise they return FALSE ('f'). A single trigger routine can be designed to perform different triggered actions for different types of triggering events, using these Boolean operators to execute program blocks that are appropriate to the type of trigger.

For restrictions on using SPL routines as triggered actions, see [Rules for SPL Routines](#) and [Triggers and SPL Routines](#).

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Achieving a Consistent Result

To guarantee that the triggering statement returns the same result with and without the triggered actions, make sure that the triggered actions in the BEFORE and FOR EACH ROW sections do not modify any table referenced in the following clauses:

- WHERE clause
- SET clause in the UPDATE statement
- SELECT clause
- EXECUTE PROCEDURE clause or EXECUTE FUNCTION clause in a multiple-row INSERT statement.

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Declaring keywords of SQL as correlation names

If you use the INSERT, DELETE, UPDATE, or EXECUTE keywords as a *correlation* identifier in any of the following clauses inside a triggered action list, you must qualify them by the *owner* name, the *table* name, or both:

- FROM clause of a SELECT statement
- INTO clause of the EXECUTE PROCEDURE or EXECUTE FUNCTION statement
- GROUP BY clause
- SET clause of the UPDATE statement.

The database server issues a syntax error if these keywords are *not* qualified when you include these clauses inside a triggered action.

If you use the keyword as a column name, it must be qualified by the table name; for example, **table.update**. If both the table name and the column name are keywords, they must be qualified by the owner name (for example, **owner.insert.update**). If the owner name, table name, and column name are all keywords, the owner name must be in quotation marks; for example, **'delete'.insert.update**. (These are general rules regarding reserved words as identifiers, rather than special cases for triggers. Your code will be easier to read and to maintain if you avoid using the keywords of SQL as identifiers.)

The only exception is when these keywords are the first table or column name in the list, and you do not need to qualify them. For example, **delete** in the following statement does not need to be qualified because it is the first column listed in the INTO clause:

```
CREATE TRIGGER t1 UPDATE OF b ON tab1
FOR EACH ROW (EXECUTE PROCEDURE p2() INTO delete, d);
```

The following statements show examples in which you must qualify the column name or the table name:

- FROM clause of a SELECT statement

```
CREATE TRIGGER t1 INSERT ON tab1
BEFORE (INSERT INTO tab2 SELECT * FROM tab3, 'owner1'.update);
```

- INTO clause of an EXECUTE PROCEDURE statement

```
CREATE TRIGGER t3 UPDATE OF b ON tab1
FOR EACH ROW (EXECUTE PROCEDURE p2() INTO
d, tab1.delete);
```

An INSTEAD OF trigger on a view cannot include the EXECUTE PROCEDURE INTO statement among its triggered actions.

- GROUP BY clause of a SELECT statement

```
CREATE TRIGGER t4 DELETE ON tab1
BEFORE (INSERT INTO tab3 SELECT deptno, SUM(exp)
FROM budget GROUP BY deptno, budget.update);
```

- SET clause of an UPDATE statement

```
CREATE TRIGGER t2 UPDATE OF a ON tab1
BEFORE (UPDATE tab2 SET a = 10, tab2.insert = 5);
```

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Using Correlation Names in Triggered Actions

These rules apply when you use correlation names in triggered actions:

- You can use the correlation names as qualifiers for the old and new column values in SQL statements of the FOR EACH ROW triggered-action list and in the WHEN condition.
- The WHEN conditions and FOR EACH ROW clauses of multiple triggers on the same table can use different correlated variables in the REFERENCING clauses of triggers and of trigger routines to reference values in the same column.
- The old and new correlation names refer to all rows affected by the triggering statement.
- You cannot use the correlation name to qualify a column name in the GROUP BY, the SET, or the COUNT DISTINCT clause.
- The scope of reference of the correlation names is the entire trigger definition. This scope is statically determined, meaning that it is limited to the trigger definition; it does not encompass cascading triggers or columns that are qualified by a table name in a UDR that is a triggered action, except for trigger routines that are invoked in the FOR EACH ROW clause.

For additional information on using correlation names in trigger routines, see [Rules for SPL Routines](#).

- [When to Use Correlation Names](#)
- [Qualified Versus Unqualified Value](#)

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When to Use Correlation Names

In SQL statements of the FOR EACH ROW list, you must qualify all references to columns in the triggering table with either the old or new correlation name, unless the statement is valid independent of the triggered action.

In other words, if a column name inside a FOR EACH ROW triggered action list is not qualified by a correlation name, even if it is qualified by the triggering table name, it is interpreted as if the statement were independent of the triggered action. No special effort is made to search the definition of the triggering table for the non-qualified column name.

For example, assume that the following DELETE statement is a triggered action inside the FOR EACH ROW section of a trigger:

```
DELETE FROM tab1 WHERE col_c = col_c2;
```

For the statement to be valid, both **col_c** and **col_c2** must be columns from **tab1**. If **col_c2** is intended to be a correlation reference to a column in the triggering table, it must be qualified by either the old or the new correlation name. If **col_c2** is not a column in **tab1** and is not qualified by either the old or new correlation name, you get an error.

In a statement that is valid independent of the triggered action, a column name with no *correlation* qualifier refers to the current value in the database.

In the triggered action for trigger **t1** in the next example, **mgr** in the WHERE clause of the correlated subquery is an unqualified column in the triggering table. In this case, **mgr** refers to the current column value in **empsal** because the INSERT statement is valid independent of the triggered action.

```
CREATE DATABASE db1;
CREATE TABLE empsal (empno INT, salary INT, mgr INT);
CREATE TABLE mgr (eno INT, bonus INT);
CREATE TABLE biggap (empno INT, salary INT, mgr INT);

CREATE TRIGGER t1 UPDATE OF salary ON empsal
AFTER (INSERT INTO biggap SELECT * FROM empsal WHERE salary <
(SELECT bonus FROM mgr WHERE eno = mgr));
```

In a triggered action, an unqualified column name from the triggering table refers to the current column value, but only when the triggered statement is valid independent of the triggered action.

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Qualified Versus Unqualified Value

The following table summarizes what value is retrieved when the **column** name is qualified by the *old* or by the *new* correlation name after various trigger events.

Trigger Event	old.column	new.column
INSERT	No value (error)	Inserted value
UPDATE (column updated)	Original value	Current value (U)
UPDATE (column not updated)	Original value	Original value (N)
DELETE	Original value	No value (error)
SELECT	Original value	No value (error)

When a correlation name has no value, an error is issued only when an SQL or SPL statement referencing the undefined correlation is executed, rather than when the correlation name is declared. Refer to the following key when you read the previous table.

Term

Meaning

Original value

Value before the triggering event

Current value

Value after the triggering event

(N)

Cannot be changed by triggered action

(U)

Can be updated by triggered actions; updated value might be different from the original value because of preceding triggered actions.

Outside a FOR EACH ROW triggered-action list, you cannot qualify a column from the triggering table with either the old correlation name or the new correlation name; it always refers to the current value in the database.

Statements in the trigger action list use whatever collating order was in effect when the trigger was created, even if a different collation is in effect when the trigger action is executed. See [SET COLLATION statement](#) for details of how to specify a collating order different from what **DB_LOCALE** specifies.

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Re-Entrancy of Triggers

In some cases a trigger can be re-entrant. In these cases the triggered action can reference the triggering table. In other words, both the trigger event and the triggered action can operate on the same table. The following list summarizes the situations in which triggers can be re-entrant and the situations in which triggers cannot be re-entrant:

- The trigger action of an Update trigger cannot be an INSERT or DELETE of the table that the trigger event updated.
- Similarly, the trigger action of an Update trigger cannot be an UPDATE of a column that the trigger event updated. (But the trigger action of an Update trigger can update a column that was not updated by the trigger event.)

For example, assume that the following UPDATE statement, which updates columns **a** and **b** of **tab1**, is the triggering statement:

```
UPDATE tab1 SET (a, b) = (a + 1, b + 1);
```

Now consider the trigger actions in the following example. The first UPDATE statement is a valid trigger action, but the second one is not, because it updates column **b** again.

```
UPDATE tab1 SET c = c + 1;    -- OK
UPDATE tab1 SET b = b + 1;    -- INVALID
```

- If the trigger has an UPDATE event, the trigger action can be an EXECUTE PROCEDURE or EXECUTE FUNCTION statement with an INTO clause that references a column that was updated by the trigger event or any other column in the triggering table. When an EXECUTE PROCEDURE or EXECUTE FUNCTION statement is the trigger action, the INTO clause for an UPDATE trigger is valid only in FOR EACH ROW trigger actions, and column names that appear in the INTO clause must be from the triggering table.

The following statement illustrates the appropriate use of the INTO clause:

```
CREATE TRIGGER upd_totpr UPDATE OF quantity ON items
REFERENCING OLD AS pre_upd NEW AS post_upd
FOR EACH ROW (EXECUTE PROCEDURE
  calc_totpr(pre_upd.quantity, post_upd.quantity,
    pre_upd.total_price) INTO total_price);
```

The column that follows the INTO keyword must be in the triggering table, but need not have been updated by the trigger event.

When the INTO clause appears in the EXECUTE PROCEDURE or EXECUTE FUNCTION statement, the database server updates the specified columns with values returned from the UDR, immediately upon returning from the UDR.

- If the trigger has an INSERT event, the trigger action cannot be an INSERT or DELETE statement that references the triggering table.
- If the trigger has an INSERT event, the trigger action can be an UPDATE statement that references a column in the triggering table, but this column cannot be a column for which a value was supplied by the trigger event.

If the trigger has an INSERT event, and the trigger action updates the triggering table, the columns in both statements must be mutually exclusive. For example, assume that the triggering statement inserts values for columns **cola** and **colb** of table **tab1**:

```
INSERT INTO tab1 (cola, colb) VALUES (1,10);
```

Now consider the following trigger actions. The first UPDATE is valid, but the second one is not, because it updates column **colb** even though the trigger event already supplied a value for column **colb**:

```
UPDATE tab1 SET colc=100; --OK
UPDATE tab1 SET colb=100; --INVALID
```

- If the trigger has an INSERT event, the trigger action can be an EXECUTE PROCEDURE or EXECUTE FUNCTION statement with an INTO clause that references a column that was supplied by the trigger event or a column that was not supplied by the trigger event. When an EXECUTE PROCEDURE or EXECUTE FUNCTION statement is the trigger action, you can specify the INTO clause for an INSERT trigger only when the trigger action occurs in the FOR EACH ROW list. In this case, the INTO clause can contain only column names from the triggering table.

The following statement illustrates the valid use of the INTO clause:

```
CREATE TRIGGER ins_totpr INSERT ON items
REFERENCING NEW AS new_ins
FOR EACH ROW (EXECUTE PROCEDURE calc_totpr
  (0, new_ins.quantity, 0) INTO total_price);
```

The column that follows the INTO keyword can be a column in the triggering table that was supplied by the trigger event, or a column in the triggering table that was not supplied by the trigger event.

When the INTO clause appears in the EXECUTE PROCEDURE or the EXECUTE FUNCTION statement, the database server immediately updates the specified columns with values returned from the UDR.

- If the trigger action is a SELECT statement, the SELECT statement can reference the triggering table. The SELECT statement can be a trigger action in the following instances:
 - The SELECT statement appears in a subquery in the WHEN clause or in a trigger-action statement.
 - The trigger action is a UDR, and the SELECT statement appears inside the UDR.
- [Re-Entrancy and Cascading Triggers](#)

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Re-Entrancy and Cascading Triggers

The cases when a trigger cannot be re-entrant apply recursively to all cascading triggers, which are considered part of the initial trigger. In particular, this rule means that a cascading trigger cannot update any columns in the triggering table that were updated by the original triggering statement, including any nontriggering columns affected by that statement. For example, assume this UPDATE statement is the triggering statement:

```
UPDATE tab1 SET (a, b) = (a + 1, b + 1);
```

In the cascading triggers of the next example, **trig2** fails at runtime because it references column **b**, which the triggering UPDATE statement updates:

```
CREATE TRIGGER trig1 UPDATE OF a ON tab1-- Valid
AFTER (UPDATE tab2 SET e = e + 1);

CREATE TRIGGER trig2 UPDATE OF e ON tab2-- Invalid
AFTER (UPDATE tab1 SET b = b + 1);
```

Now consider the following SQL statements. When the final UPDATE statement is executed, column **a** is updated and the trigger **trig1** is activated.

The trigger action again updates column **a** with an EXECUTE PROCEDURE INTO statement.

```
CREATE TABLE temp1 (a INT, b INT, e INT);
INSERT INTO temp1 VALUES (10, 20, 30);

CREATE PROCEDURE proc(val iINT) RETURNING INT,INT;
RETURN val+10, val+20;
END PROCEDURE;

CREATE TRIGGER trig1 UPDATE OF a ON temp1
FOR EACH ROW (EXECUTE PROCEDURE proc(50) INTO a, e);

CREATE TRIGGER trig2 UPDATE OF e ON temp1
FOR EACH ROW (EXECUTE PROCEDURE proc(100) INTO a, e);

UPDATE temp1 SET (a,b) = (40,50);
```

Several questions arise from this example of cascading triggers. First, should the update of column **a** activate trigger **trig1** again? The answer is no. Because the trigger was activated, it is not activated a second time. If the trigger action is an EXECUTE PROCEDURE INTO or EXECUTE FUNCTION INTO statement, the only triggers that are activated are those that are defined on columns that are mutually exclusive from the columns updated until then (in the cascade of triggers) in that table. Other triggers are ignored.

Another question that arises from the example is whether trigger **trig2** should be activated. The answer is yes. The trigger **trig2** is defined on column **e**. Until now, column **e** in table **temp1** has not been modified. Trigger **trig2** is activated.

A final question that arises from the example is whether triggers **trig1** and **trig2** should be activated after the trigger action in **trig2** is performed. The answer is no. Neither trigger is activated. By this time columns **a** and **e** have been updated once, and triggers **trig1** and **trig2** have been executed once. The database server ignores and does not activate these triggers. For more about cascading triggers, see [Cascading Triggers](#).

As noted earlier, an INSTEAD OF trigger on a view cannot include the EXECUTE PROCEDURE INTO statement among its trigger actions. In addition, an error results if two views each have INSERT INSTEAD OF triggers with actions defined to perform INSERT operations on the other view.

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Rules for SPL Routines

In addition to the rules listed in [Re-Entrancy of Triggers](#), the following guidelines apply to an SPL routine that is specified as a trigger action:

- The SPL routine cannot be a cursor function (one that returns more than one row) in a context where only one row is expected.
- You cannot use the old or new correlation name inside the SPL routine unless the CREATE FUNCTION or CREATE PROCEDURE statement includes the REFERENCING clause that defines the UDR as a trigger routine. If you need to use the corresponding values in a routine that is not a trigger routine, you must pass them as parameters. In this case, the routine should be independent of triggers, and the old or new correlation name does not have any meaning outside the trigger.
- A trigger routine must include the REFERENCING clause that can declare a correlation name for OLD or NEW column values that SPL statements in the trigger routine can reference.

- A trigger routine must include the `FOR table_object` clause that specifies the name of the table or view in the local database whose triggers can invoke this routine. The triggered action cannot call a trigger routine that does not specify the triggering table or view.
- Only trigger routines invoked in the `FOR EACH ROW` section of the Triggered Action list can operate directly on old or new correlation names that are defined in the `REFERENCING` clause of the trigger or of the trigger routine.
- Trigger routines can be invoked only in the `FOR EACH ROW` section of the Triggered Action list in the trigger definition.
- Correlated variables for OLD or NEW values can appear in the `IF` statement of SPL and in `CASE` expressions.
- Only correlated variables for NEW values can be on the left-hand side of a `LET` expression that references correlated variables. In this case, the `FOR` clause of the SPL routine must specify a table, rather than a view, and the trigger whose action invokes the SPL routine cannot be an `INSTEAD OF` trigger.
- Both OLD and NEW values can be on the right-hand side of a `LET` expression.
- Only trigger routines that are invoked in the `FOR EACH ROW` clause can use the Boolean operators `SELECTING`, `INSERTING`, `DELETING`, and `UPDATING`. These operators return `TRUE` ('t') if the triggering event matches the DML operation referenced by the name of the operator, and they return `FALSE` ('f') otherwise.
- The `IF` statement of SPL and `CASE` expressions of SQL can specify these operators as the condition in a trigger routine.
- Trigger routines must be written in the SPL language. They cannot be written in an external language, such as the C or Java™ language, but the trigger routine can include calls to external language routines, such as the `mi_trigger` application programming interface for trigger introspection.
- Trigger routines cannot reference savepoints. Any changes to the data values or to the schema of the database by a triggered action must be committed or rolled back in their entirety. Informix® does not support the `ROLLBACK TO SAVEPOINT` statement in a trigger routine for the partial rollback of a triggered action.

For more information about the `mi_trigger` API, refer to the *IBM® Informix DataBlade API Programmer's Guide* and to the *IBM Informix DataBlade API Function Reference*.

When you use an SPL routine as a trigger action, the database objects that the routine references are not checked until the routine is executed.

See also the SPL restrictions in [Triggers and SPL Routines](#).

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Privileges to Execute Trigger Actions

If you do not own the trigger, but the access privileges held by the trigger owner include `WITH GRANT OPTION`, then for each triggered SQL statement you inherit the privileges of the trigger owner (with grant option), in addition to any privileges that have been granted to you individually, or through an active or default role that you hold, or that you hold as a member of the `PUBLIC` group. If the triggered action calls a UDR, you need `Execute` privilege on the UDR, or the trigger owner must have `Execute` privilege with grant option.

Important: As a security precaution, discretionary access privileges that the user holds only from a role (but that were not granted to the user individually or as member of the `PUBLIC` group) cannot provide access to tables outside the current database through a triggered action or through a trigger routine.

As a security precaution, however, discretionary access privileges that the user holds only from a role (but that were not granted to the user individually or as member of the `PUBLIC` group) cannot provide access to tables outside the current database through a triggered action or through a trigger routine.

While executing the UDR, however, you do not inherit the privileges of the trigger owner; instead, you receive the privileges granted with the UDR, depending on whether the routine is a `DBA`-privileged or an `owner`-privileged UDR:

1. Privileges for a `DBA`-privileged UDR

When a UDR is registered with the `DBA` keyword, and you are granted the `Execute` privilege on the UDR, the database server automatically grants you temporary `DBA` privileges that are available only when you are executing the UDR.

2. Privileges for an `owner`-privileged UDR

If the UDR was created without the `DBA` keyword, but the owner of the UDR was granted the necessary privileges on the underlying database objects with the `WITH GRANT OPTION` keywords, then you inherit these privileges when you are granted the `Execute` privilege on the UDR.

For a UDR that is not `DBA` privileged, all non-qualified database objects that the UDR references are implicitly qualified by the name of the UDR owner.

If the UDR owner has no `WITH GRANT OPTION` privilege, you have your original privileges on the underlying database objects when the UDR executes. For more information on privileges on SPL routines, refer to the *IBM® Informix® Guide to SQL: Tutorial*.

A view that has no `INSTEAD OF` trigger has only `Select` (with grant option) privilege. If an `INSTEAD OF` trigger is created on it, however, then the view has `Insert` (with grant option) privilege during creation of the trigger. The view owner can now grant only `Select` and `Insert` privileges to others. This is independent of the trigger action. It is not necessary to obtain `Execute` (with grant option) privilege on the procedure or function. By default, `Execute` privilege (without grant option) is granted on each UDR in the action list.

You can use roles with triggers. Role-related statements (`CREATE ROLE`, `DROP ROLE`, `GRANT`, `REVOKE`, and `SET ROLE`) and `SET SESSION AUTHORIZATION` statements are valid in a UDR that the triggered action invokes. Privileges that a user acquired by enabling a role or by a `SET SESSION AUTHORIZATION` statement are not relinquished when a trigger is executed.

On a complex view (one with columns from more than one table), only the owner or `DBA` can create an `INSTEAD OF` trigger. The owner receives `Select` privileges when the trigger is created. Only after obtaining the required `Execute` privileges can the owner of the view grant privileges to other users. When the trigger on the complex view is dropped, all of these privileges are revoked.

- [Creating a Trigger Action That Anyone Can Use](#)

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Creating a Trigger Action That Anyone Can Use

For a trigger to be executable by anyone who has the privileges to execute the triggering statement, you can ask the DBA to create a DBA-privileged UDR and grant you the Execute privilege with the WITH GRANT OPTION right.

You then use the DBA-privileged UDR as the trigger action. Anyone can execute the trigger action because the DBA-privileged UDR carries the WITH GRANT OPTION right. When you activate the UDR, the database server applies privilege-checking rules for a DBA.

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Cascading Triggers

The database server allows triggers other than Select triggers to cascade, meaning that the trigger actions of one trigger can activate another trigger. (For further information on the restriction against cascading Select triggers, see [Circumstances When a Select Trigger Is Activated](#).)

The maximum number of triggers in a cascading series is 61: the initial trigger plus a maximum of 60 cascading triggers. When the number of cascading triggers in a series exceeds the maximum, the database server returns error number -748, with the following message:

```
Exceeded limit on maximum number of cascaded triggers.
```

The next example illustrates a series of cascading triggers that enforce referential integrity on the **manufact**, **stock**, and **items** tables in the **stores_demo** database. When a manufacturer is deleted from the **manufact** table, the first trigger, **del_manu**, deletes all the items of that manufacturer from the **stock** table. Each DELETE in the **stock** table activates a second trigger, **del_items**, that deletes all **items** of that manufacturer from the **items** table. Finally, each DELETE in the **items** table triggers SPL routine **log_order**, creating a record of any orders in the **orders** table that can no longer be filled.

```
CREATE TRIGGER del_manu
  DELETE ON manufact REFERENCING OLD AS pre_del
  FOR EACH ROW(DELETE FROM stock WHERE manu_code = pre_del.manu_code);
CREATE TRIGGER del_stock
  DELETE ON stock REFERENCING OLD AS pre_del
  FOR EACH ROW(DELETE FROM items WHERE manu_code = pre_del.manu_code);
CREATE TRIGGER del_items
  DELETE ON items REFERENCING OLD AS pre_del
  FOR EACH ROW(EXECUTE PROCEDURE log_order(pre_del.order_num));
```

When you are not using logging, referential integrity constraints on both the **manufact** and **stock** tables prohibit the triggers in this example from executing. When you use logging, however, the triggers execute successfully because constraint checking is deferred until all the trigger actions are complete, including the actions of cascading triggers. For more information about how constraints are handled when triggers execute, see [Constraint Checking](#).

The database server prevents loops of cascading triggers by not allowing you to modify the triggering table in any cascading trigger action, except with an UPDATE statement that does not modify any column that the triggering UPDATE statement updated, or with an INSERT statement. An INSERT trigger can define UPDATE trigger actions on the same table.

- [Constraint Checking](#)
- [Preventing Triggers from Overriding Each Other](#)

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Constraint Checking

When you use logging, the database server defers constraint checking on the triggering statement until after the statements in the triggered-action list execute. This is equivalent to executing a SET CONSTRAINTS ALL DEFERRED statement before executing the triggering statement. After the trigger action is completed, the database server effectively executes a SET CONSTRAINTS *constraint* IMMEDIATE statement to check the constraints that were deferred. This action allows you to write triggers so that the trigger action can resolve any constraint violations that the triggering statement creates. For more information, see [SET Database Object Mode statement](#).

Consider the following example, in which the table **child** has constraint **r1**, which references the table **parent**. You define trigger **trig1** and activate it with an INSERT statement. In the trigger action, **trig1** checks to see if **parent** has a row with the value of the current **cola** in **child**; if not, it inserts it.

```
CREATE TABLE parent (cola INT PRIMARY KEY);
CREATE TABLE child (cola INT REFERENCES parent CONSTRAINT r1);
CREATE TRIGGER trig1 INSERT ON child
  REFERENCING NEW AS new
  FOR EACH ROW
  WHEN((SELECT COUNT (*) FROM parent
        WHERE cola = new.cola) = 0)
-- parent row does not exist
  (INSERT INTO parent VALUES (new.cola));
```

When you insert a row into a table that is the child table in a referential constraint, the row might not exist in the parent table. The database server does not immediately return this error on a triggering statement. Instead, it allows the trigger action to resolve the constraint violation by inserting the corresponding row into the parent table. As the previous example shows, you can check within the trigger action to see whether the parent row exists, and if so, you can provide logic to bypass the INSERT action.

For a database without logging, the database server does not defer constraint checking on the triggering statement. In this case, the database server immediately returns an error if the triggering statement violates a constraint.

You cannot use the SET Transaction Mode statement in a trigger action. The database server checks this restriction when you activate a trigger, because the statement could occur inside a UDR.

Preventing Triggers from Overriding Each Other

When you activate multiple triggers with an UPDATE statement, a trigger can possibly override the changes that an earlier trigger made. If you do not want the trigger actions to interact, you can split the UPDATE statement into multiple UPDATE statements, each of which updates an individual column.

As another alternative, you can create a single update trigger for all columns that require a trigger action. Then, inside the trigger action, you can test for the column being updated and apply the actions in the desired order. This approach, however, is different from having the database server apply the actions of individual triggers, and it has the following disadvantages:

- If the triggering UPDATE statement sets a column to the current value, you cannot detect the UPDATE, so the trigger action is skipped. You might wish to execute the trigger action, even though the value of the column has not changed.
- If the trigger has a BEFORE action, it applies to all columns, because you cannot yet detect whether a column has changed.

Tables in Remote Databases

You cannot create triggers on tables or views that reside outside the current database. You can, however, define a trigger on a local table whose trigger action manipulates a table in another database of the local server instance, or a table in a database of another server instance.

The following example defines an Update trigger on the **newtab** table in the current database of the local Informix® server instance, **dbserver1**, to which the session is connected. Here the trigger action specifies an UPDATE operation on the **items** table of the **stores_demo** database of the remote **dbserver2** Informix server instance:

```
CREATE TRIGGER upd_nt UPDATE ON newtab
REFERENCING NEW AS post
FOR EACH ROW(UPDATE stores_demo@dbserver2:items
SET quantity = post.qty WHERE stock_num = post.stock
AND manu_code = post.mc);
```

In summary, triggers registered in the local database can support local, cross-database, and cross-server trigger actions:

- local trigger actions on a table in the local database
- cross-database trigger actions on a table in another database of the local server instance
- cross-server trigger actions on a table in a database of a remote server instance.

The cross-server triggered action of a trigger that is defined in a database of a remote server instance can be the event that activates one or more triggers in the local database, but in this case, triggered actions of the local trigger cannot be cross-server operations. If a SELECT, DELETE, INSERT, MERGE, or UPDATE statement from a remote database server is the event that activates a local trigger whose action specifies a table in a database of a remote server instance, the trigger actions fail.

For example, the following combination of trigger action and triggering statement results in an error when the triggering statement executes:

```
-- Trigger action from dbserver1 to dbserver3:
CREATE TRIGGER upd_nt UPDATE ON newtab
REFERENCING NEW AS post
FOR EACH ROW(UPDATE stores_demo@dbserver3:items
SET quantity = post.qty WHERE stock_num = post.stock
AND manu_code = post.mc);

-- Triggering statement from dbserver2:
UPDATE stores_demo@dbserver1:newtab
SET qty = qty * 2 WHERE s_num = 5
AND mc = 'ANZ';
```

The UPDATE statement above returns an error at run time, because a cross-server triggering event cannot trigger another cross-server action.

Important: As a security precaution, discretionary access privileges that a user holds only from a role cannot provide access to tables outside the current database through a view or through a trigger. Cross-database trigger actions and cross-server trigger actions require access privileges on the non-local database and table that were granted directly to the user, or granted to the PUBLIC group.

Logging and Recovery

You can create triggers for databases, with and without logging. If the trigger fails in a database that has transaction logging, the triggering statement and trigger actions are rolled back, as if the actions were an extension of the triggering statement, but the rest of the transaction is not rolled back.

In a database that does not have transaction logging, however, you cannot roll back when the triggering statement fails. In this case, you are responsible for maintaining data integrity in the database. The UPDATE, INSERT, or DELETE action of the triggering statement occurs before the trigger actions in the FOR EACH ROW section. If the trigger action fails for a database without logging, the application must restore the row that was changed by the triggering statement to its previous value.

If a trigger action calls a UDR, but the UDR terminates in an exception-handling section, any actions that modify data inside that section are rolled back with the triggering statement. In the following partial example, when the exception handler traps an error, it inserts a row into the table **logtab**:

```
ON EXCEPTION IN (-201)
  INSERT INTO logtab values (errno, errstr);
  RAISE EXCEPTION -201
END EXCEPTION;
```

When the RAISE EXCEPTION statement returns the error, however, the database server rolls back this INSERT because it is part of the trigger actions. If the UDR is executed outside a trigger action, the INSERT is not rolled back.

The UDR that implements a trigger action cannot contain any BEGIN WORK, COMMIT WORK, or ROLLBACK WORK statements. If the database has transaction logging, you must either begin an explicit transaction before the triggering statement, or the statement itself must be an implicit transaction. In any case, no other transaction-related statement is valid inside the UDR.

You can use triggers to enforce referential actions that the database server does not currently support. In a database without logging, you are responsible for maintaining data integrity when the triggering statement fails.

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INSTEAD OF Triggers on Views

Use INSTEAD OF triggers to define a specified action for the database server to perform when a trigger on a view is activated, rather than execute the triggering INSERT, DELETE, MERGE, or UPDATE statement.

Syntax

```
>>CREATE TRIGGER--trigger--INSTEAD OF--| Trigger on a View |-->
    .-ENABLED-----.
>--+-+-----+-+-----><
    '-DISABLED-'

Trigger on a View

|+-+INSERT ON--view--+-+-----+-+----->
| | '-REFERENCING NEW--+-+-----correlation-' |
| | '-AS-' |
|+-DELETE ON--view--+-+-----+-+-----+
| | '-REFERENCING--OLD--+-+-----correlation-' |
| | '-AS-' |
|+-UPDATE ON--view--+-+-----+-+-----+
| | +REFERENCING--OLD--+-+-----correlation--+-+
| | | '-AS-' | '-NEW--+-+-----correlation-' |
| | | '-AS-' |
| | '-REFERENCING NEW--+-+-----correlation-' |
| | | '-AS-' | '-OLD--+-+-----correlation-' |
| | | '-AS-' |

(1)
>--FOR EACH ROW--| INSTEAD OF Triggered Action |-----|
```

Notes:

1. See [The Action Clause of INSTEAD OF Triggers](#)

Element	Description	Restrictions	Syntax
<i>correlation</i>	Name that you declare here to qualify an old or new column value (as <i>correlation.column</i>) in a triggered action	Must be unique in this statement	Identifier
<i>trigger</i>	Name declared here for the trigger	Must be unique among the names of triggers in the database	Identifier
<i>view</i>	Name or synonym of the triggering view. Can include <i>owner.</i> qualifier.	The view or synonym must exist in the current database	Identifier

You can use the trigger action to update the tables underlying the view, in some cases updating an otherwise “non-updatable” view. You can also use INSTEAD OF triggers to substitute other actions when INSERT, DELETE, or UPDATE statements reference specific columns within the database.

In the optional REFERENCING clause of an INSTEAD OF UPDATE trigger, the *new* correlation name can appear before or after the *old* correlation name.

With Informix®, the same REFERENCING OLD and REFERENCING NEW syntax is supported in the CREATE FUNCTION and CREATE PROCEDURE statements for defining correlation names in trigger routines. A trigger routine can be invoked in the Action clause for INSTEAD OF triggers on the view that is specified in the FOR clause of the CREATE FUNCTION or CREATE PROCEDURE statement that defines the trigger routine.

The specified *view* is sometimes called the *triggering view*. The left-hand portion of this diagram (including the *view* specification) defines the *trigger event*. The rest of the diagram defines correlation names and the *trigger action*.

Notes:

1. See [INSERT statement](#)
2. See [DELETE statement](#)
3. See [UPDATE statement](#)
4. See [EXECUTE PROCEDURE statement](#)
5. See [EXECUTE FUNCTION statement](#)

This is not identical to the syntax of the trigger action for a trigger on a table, as described in the section [Triggered Action on a Table](#). Because no WHEN (*condition*) is supported, the same trigger action is executed whenever the INSTEAD OF trigger event is encountered, and only one action list can be specified, rather than a separate list for each *condition*.

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Restrictions on INSTEAD OF Triggers on Views

You must be either the owner of the *view* or have the DBA status to create an INSTEAD OF trigger on a view. The owner of a simple view (based on only one table) has Insert, Update, and Delete privileges. For information about the relationship between the privileges of the trigger owner and the privileges of other users, see [Privileges to Execute Trigger Actions](#).

If multiple tables underlie a view, only the owner of the view can create a trigger, but that owner can grant DML privileges on the view to other users.

An INSTEAD OF trigger defined on a view cannot violate the [Restrictions on Triggers](#) and must observe the following additional rules:

- You can define an INSTEAD OF trigger only on a view, not on a table.
- The view must be local to the current database.
- The view cannot be an updatable view WITH CHECK OPTION.
- No SELECT event or WHEN clause is valid in an INSTEAD OF trigger.
- No BEFORE nor AFTER action is valid in an INSTEAD OF trigger.
- No OF *column* clause is valid in an INSTEAD OF UPDATE trigger.
- Every INSTEAD OF trigger must specify FOR EACH ROW.
- Trigger routines called by INSTEAD OF triggers cannot reference savepoints.

A view can have any number of INSTEAD OF triggers defined for each type of event (INSERT, DELETE, or UPDATE).

The ON EXCEPTION statement of SPL has no effect when it is issued from the Action clause of an INSTEAD OF trigger.

Just as with triggers on tables, an INSTEAD OF trigger whose triggered action inserts a new serial value into a BIGSERIAL, SERIAL, or SERIAL8 column cannot update the `sqlca.sqlerrd[1]` field of the SQL Communication Area structure. The triggered INSERT operation can successfully increment the serial counter for the column, but the value of the `sqlca.sqlerrd[1]` field remains zero, rather than being reset to the serial value. The `sqlca.sqlerrd[1]` field can show the new serial value that you insert directly through an updatable view, but that field cannot show the action of an INSTEAD OF Insert trigger on a serial column.

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Updating Views

INSERT, DELETE, or UPDATE statements can directly modify a view only if all of the following are true of the SELECT statement that defines the view:

- All of the columns in the view are from a single table.
- No columns in the projection list are aggregate values.
- No UNIQUE or DISTINCT keyword is in the SELECT projection list.
- No GROUP BY clause nor UNION operator is in the view definition.
- The query selects no calculated values and no literal values.

By using INSTEAD OF triggers, however, you can circumvent these restrictions on the view, if the trigger action modifies the base table.

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CREATE TRUSTED CONTEXT statement

Use the CREATE TRUSTED CONTEXT statement to define a newtrusted-context object. This statement is an extension to the ANSI/ISO standard for the SQL language.

You must hold the database security administrator (DBSECADM) role to run this statement.

Syntax

```
>>-CREATE TRUSTED CONTEXT--context----->
>--+USER-----+--user----->
```


WITH USE FOR clause

The WITH USE FOR clause specifies that the trusted connection can be used by the specified authorization identifier. The same *user* name cannot appear more than once in this clause, which allows access by both the list of specified users and by PUBLIC.

For example, assume that a trusted-context object is defined that allows access by both `PUBLIC WITH AUTHENTICATION` and `joe WITHOUT AUTHENTICATION`. If the trusted-context object is used by `joe`, authentication is not required. If the trusted-context object is used by `george`, however, who has access only as a member of `PUBLIC`, authentication is required.

The WITH AUTHENTICATION attribute specifies that switching the current user on a trusted connection based on this trusted-context object to this user requires authentication. The WITHOUT AUTHENTICATION attribute specifies that switching the current user does not require authentication. The specifications for a user override the specifications for PUBLIC.

These attributes also affect whether authentication is required during client sessions with ODBC, JDBC, or ESQL/C connections, in which the SET SESSION AUTHORIZATION statement attempts to switch to a different user ID after a trusted connection has been established. The same attributes similarly affect whether authentication is required when switching the user during client sessions on trusted connections that IBM Data Server Driver for JDBC and SQLJ established, and on trusted connections established by IBM Data Server Provider for .NET.

DEFAULT ROLE attributes

A ROLE object specifies the user's role (and privileges) when using a trusted connection. A DEFAULT ROLE identifies a role that exists at the current server, and is used when a user does not have a user-specific role defined as part of the definition of the trusted-context object. The NO DEFAULT ROLE attribute will specify that the trusted-context object does not have a default role. The default is NO DEFAULT ROLE. The role explicitly specified for the user overrides any default role associated with the trusted-context object.

ENABLE and DISABLE keywords

The ENABLE keyword specifies that the trusted-context object is created in an enabled state.

The DISABLE keyword specifies that the new trusted-context object is created in a disabled state, and is not enabled for any new trusted connections that are established.

You cannot use the SET Database Object Mode statement of SQL to change the ENABLE or DISABLE attributes of trusted contexts. You must use the ALTER TRUSTED CONTEXT statement if you need to reset the ENABLED or DISABLED mode of a trusted-context.

Examples of trusted-context definitions

Example 1: Create a trusted-context object such that the current user on a trusted connection based on this trusted-context object can be switched to two different user IDs. When the current user of the connection is switched to `joe`, authentication is not required. However, authentication is required when the current user of the connection is switched to `bob`. Note that the trusted-context object has a default role called `MANAGER`. This implies that users working within the confines of this trusted-context object inherit the discretionary access privileges associated with the `MANAGER` role.

```
CREATE TRUSTED CONTEXT appserver
  USER wrjaibi
  DEFAULT ROLE MANAGER
  ENABLE
  ATTRIBUTES (ADDRESS '9.26.113.204')
  WITH USE FOR joe WITHOUT AUTHENTICATION,
         bob WITH AUTHENTICATION;
```

Example 2: Create a trusted-context object such that the current user of a trusted connection based on this trusted-context object can be switched to any user ID without authentication.

```
CREATE TRUSTED CONTEXT securerole
  USER pbird
  ENABLE
  ATTRIBUTES (ADDRESS 'example.ibm.com')
  WITH USE FOR PUBLIC WITHOUT AUTHENTICATION;
```

Related reference:

[ALTER TRUSTED CONTEXT statement](#)
[DROP TRUSTED CONTEXT statement](#)
[RENAME TRUSTED CONTEXT statement](#)

Related information:

[Trusted-context objects and trusted connections](#)

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CREATE USER statement (UNIX, Linux)

Use the CREATE USER statement to define internally authenticated users, or to map externally authenticated users to surrogate user properties required for access to resources.

This statement is an extension to the ANSI/ISO standard for the SQL language.

```
>>-CREATE----->
      .-ACCOUNT UNLOCK-.
>--+--DEFAULT USER WITH--+--+ Properties |-----+><
      |'-ACCOUNT LOCK---'|
      |'-USER--user--+-----+
      |               |'-ACCOUNT UNLOCK-.
      |'-WITH--+-----+--+--+ Properties |-'
      |               |'-PASSWORD--password-' |'-ACCOUNT LOCK---' |'-| Properties |-'

Properties

|--PROPERTIES----->
      .- ,----- .
      (1) V      |
>--+--UID--user_ID--GROUP--(------+surrog_group_ID+--+--)->
      |               |'-surrog_group---'|
      |'-USER--surrog_user--+-----+
      |               |               |
      |               | (1) V      |
      |'-GROUP--(------+surrog_group_ID+--+--)-'
      |               |'-surrog_group---'|

>--+-----+----->
      |'-HOME--"--directory--"'

>--+-----+-----|
      |               |
      |               | V      |
      |'-AUTHORIZATION--(------+DBSA-----+--+--)-'
      |               | +DBSSO-----+
      |               | +AAO-----+
      |               | '-BARGROUP--'
```

Notes:

1. Use this path no more than 16 times

Element	Description	Restrictions	Syntax
<i>directory</i>	Path name of directory where user files are stored.	Must be 255 bytes or fewer, and must conform to the rules of your operating system. The <i>directory</i> must also: <ul style="list-style-type: none"> • Belong to the mapped <i>user_ID</i> and <i>surrog_group_ID</i>. • Have read, write, and execute permissions for the owner. 	Quoted String
<i>password</i>	Password for internal authentication of <i>user</i> .	Must be 6 - 32 bytes.	Quoted String
<i>surrog_group</i>	Name of an existing operating system group (surrogate group) that has the permissions to which you want to map the <i>user</i> . The list of <i>surrog_group</i> values must be enclosed in parentheses.	Must be 32 bytes or fewer. You must use one of the surrogates that are specified in the <i>/etc/informix/allowed.surrogates</i> file.	Owner name
<i>surrog_group_ID</i>	Group identifier number (surrogate group) to which you want to map the <i>user</i> . The list of <i>surrog_group_id</i> value or values that you specify must be enclosed in parentheses.	The <i>surrog_group_ID</i> cannot be: <ul style="list-style-type: none"> • A group ID with server administrative privileges (DBSA, DBSSO, AAO, and BARGROUP) • Group 0 (root, sometimes referred to as wheel or system) • Group 80 on Mac OS X (admin) • A group ID associated with group bin or group sys You must use one of the surrogates that are specified in the <i>/etc/informix/allowed.surrogates</i> file.	Literal Number
<i>surrog_user</i>	Name of an existing OS user account (surrogate user) on the host computer that has the permissions to which you want to map <i>user</i> .	Must conform to the rules of your operating system. Must be one of the surrogates that are specified in file <i>/etc/informix/allowed.surrogates</i> file.	Owner name
<i>user</i>	Authorization identifier of the specific user that you are mapping to user properties.	Cannot be PUBLIC.	Owner name

Element	Description	Restrictions	Syntax
<i>user_ID</i>	User identifier number to which to map <i>user</i> .	Cannot be that of user root or of user informix . Must be one of the surrogates that are specified in file <code>/etc/informix/allowed.surrogates</code> .	Literal Number

Usage

Only a DBSA can run the CREATE USER statement. With a non-root installation, the user who installs the server is the equivalent of the DBSA, unless the user delegates DBSA privileges to a different user.

The USERMAPPING configuration parameter must be set to a value that enables support for mapped users before users defined by the CREATE USER statement can connect to the database server. A DBSA can issue the CREATE USER statement to map users to properties that correspond to the appropriate level of authorization.

You must also enter values in the SYSUSERMAP table of the **sysusers** database to map users with the appropriate user properties so that the mapped user statements of SQL to work correctly.

Execution of the CREATE USER statement can be audited with the CRUR audit code.

PASSWORD clause

For a root-privileged server, if an OS user is connecting and the USERMAPPING configuration parameter is unset, OS authentication occurs even though the user exists in the database. When the USERMAPPING parameter is set, internal user authentication takes precedence over OS authentication. Mapped users are authenticated internally or externally. When a user is created without a password, a mapped user is created. When a user is created with a password, an internally authenticated user is created with the properties from the operating system, unless an explicit PROPERTIES clause is also specified in the statement. When the CREATE USER statement contains both the PASSWORD clause and PROPERTIES clause, the user is an internally authenticated user, but has the surrogate properties that are specified in PROPERTIES clause. In this case, the surrogate user or group must also be listed in the `/etc/informix/allowed.surrogates` file.

PROPERTIES clause

The PROPERTIES clause can define a new user, and can optionally associate that user with surrogate properties that can include a group and a home directory. CREATE DEFAULT USER is a special case of the CREATE USER statement. The CREATE DEFAULT USER statement defines the properties that are set for the default user. After you define default user properties, you can create new users who have default user properties by omitting the PROPERTIES clause. Mapped users can connect to the database server with the surrogate user properties if they authenticate with pluggable authentication module (PAM), single sign-on (SSO), or internal authentication. Property values are not applicable to non-root installations but must be specified just like a root-privileged server. However, surrogate users and groups in non-root installations are not required in the `allowed.surrogates` file.

AUTHORIZATION clause

The AUTHORIZATION clause grants a subset of administrative privileges. The USERMAPPING configuration parameter must be set to ADMIN to enable this clause.

Note:

Use of this AUTHORIZATION clause (and of the AUTHORIZATION clause of the ALTER USER or GRANT ACCESS TO PROPERTIES statements) is not recommended. This syntax will not support role separation in a future release.

HOME directory clause

Specifying a directory for the user files with the HOME keyword is optional, but in some cases it is highly desirable. If you do not specify a home directory, an externally authenticated user has the same home directory as the surrogate user account on the host computer. If the surrogate user identity that does not have a set home directory, then creates a directory for user files in `$INFORMIXDIR/users`. In the latter case, the directory name in `$INFORMIXDIR/users` takes the form `uid.ID_number` (for example, `uid.101`).

ACCOUNT LOCK and ACCOUNT UNLOCK keywords

With the ACCOUNT LOCK and ACCOUNT UNLOCK keywords, the DBSA can toggle disabling and enabling the specified user's access to the database server.

Examples

Example 1: Create a mapped user:

The following statement creates a mapped user named **joe**.

```
CREATE USER joe;
```

If the user **joe** is an OS user, **joe** has the operating system properties that are associated with his user name.

If the user **joe** is not an OS user and if default user properties are defined, **joe** has the surrogate properties of the default user. If default user properties are not defined, an error is returned.

Example 2: Create an internally authenticated user:

The following statement creates an internally authenticated user named **joe** with a password of **joebar**:

```
CREATE USER joe WITH PASSWORD "joebar";
```

If the user **joe** is not an OS user and if default user properties are defined, **joe** has the surrogate properties of the default user. If default user properties are not defined, an error is returned

Example 3: Create an internally authenticated user with a locked account:

The following statement creates an internally authenticated user named **phil** with a locked account:

```
CREATE USER phil WITH PASSWORD "joebar" ACCOUNT LOCK;
```

If the user **phil** is not an OS user and if default user properties are defined, **phil** has the surrogate properties of the default user. If default user properties are not defined, an error is returned

Example 4: Create an internally authenticated user with specific properties:

The following statement creates an internally authenticated user named **mary** with a UID, a group, and a home directory:

```
CREATE USER mary WITH PASSWORD "joebar" PROPERTIES UID 44567
GROUP (1234) HOME "/home/pd/osuser";
```

Example 5: Create a mapped user with a surrogate user:

The following statement creates a mapped user named **bill** with a surrogate user name of **foo_os**:

```
CREATE USER bill WITH PROPERTIES user "foo_os";
```

The user **bill** has the properties of the operating system user **foo_os**.

Example 6: Create a default user:

The following statement creates a user, internally named PUBLIC, with the properties of the surrogate user **tmp**:

```
CREATE DEFAULT USER WITH PROPERTIES USER "tmp";
```

Other users created without surrogate properties will have these properties.

Related reference:

[ALTER USER statement \(UNIX, Linux\)](#)
[CREATE DEFAULT USER statement \(UNIX, Linux\)](#)
[DROP USER statement \(UNIX, Linux\)](#)
[RENAME USER statement \(UNIX, Linux\)](#)
[SET USER PASSWORD statement \(UNIX, Linux\)](#)

Related information:

[USERMAPPING configuration parameter \(UNIX, Linux\)](#)

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CREATE VIEW statement

Use the CREATE VIEW statement to create a new view that is based on one or more existing tables and views that reside in the database, or in another database of the local database server or of a different database server.

Syntax

```
>>-CREATE VIEW--+-+-----+--view--+-----+----->
              '-IF NOT EXISTS-'      '-owner-'

>--+-----+--AS----->
|      .~+-----+      |
|      V      |      |
+-+-----column+--+--+
'-OF TYPE row_type-'

(1)

>--| Subset of SELECT Statement |-----+-----><
                                '-WITH CHECK OPTION-'
```

Notes:

1. See [Subset of SELECT syntax valid in view definitions](#)

Element	Description	Restrictions	Syntax
<i>column</i>	Name that you declare here for a column in view. Default is a column name from Projection list of SELECT.	See Naming View Columns .	Identifier
<i>owner</i>	Owner of the view. If omitted, default is the user ID that issues the statement.	To specify another user ID requires DBA access privilege.	Owner name
<i>row_type</i>	Named-row type for typed view	Must already exist in the database	Data Type

Element	Description	Restrictions	Syntax
<i>view</i>	Name that you declare here for the view	Must be unique among view, table, sequence, and synonym names in the database.	Identifier

Usage

A *view* is a virtual table, defined by a SELECT statement. Except for the statements in the following list, you can specify the name or synonym of a view in any SQL statement where the name of a table is syntactically valid:

- ALTER FRAGMENT
- CREATE INDEX
- CREATE TABLE
- CREATE TRIGGER
- RENAME TABLE
- START VIOLATIONS TABLE
- STOP VIOLATIONS TABLE
- TRUNCATE
- UPDATE STATISTICS

You must specify the name of a view when you use the CREATE TRIGGER statement to define an INSTEAD OF trigger on a view, but the syntax and functionality are different from those of a trigger defined on a table.

[Updating Through Views](#) prohibits non-updatable views in INSERT, DELETE, or UPDATE statements (where other views are valid).

To create a view, you must have the Select privilege on all columns from which the view is derived. You can query a view as if it were a table, and in some cases, you can update it as if it were a table; but a view is not a table.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if a view of the specified name is already registered in the current database, or if the specified name is the identifier of a table, synonym, or sequence object in the current database.

The view consists of the set of rows and columns that the SELECT statement in the view definition returns each time you refer to the view in a query.

In some cases, the database server merges the SELECT statement of the user with the SELECT statement defining the view and executes the combined statements. In other cases, a query against a view might execute more slowly than expected, if the complexity of the view definition causes the database server to create a temporary table (referred to as a materialized view). For more information on materialized views, see the *IBM® Informix Performance Guide*.

The view reflects changes to the underlying tables, but with two exceptions:

- If a SELECT * specification defines the view, the view has only the columns that existed in the underlying tables when the view was defined by CREATE VIEW. Any new columns that are subsequently added to the underlying tables with the ALTER TABLE statement do not appear in the view.
- If a GRANT or REVOKE statement changes the discretionary access privileges on any table referenced in the view definition, the database server does not automatically apply those access privilege changes to the view.

To force modifications of the access privileges or schema of an underlying table to be applied to the view, you can use the DROP VIEW and CREATE VIEW statements of SQL to drop and recreate the view. You can also use the CREATE VIEW and CREATE TRIGGER statements to recreate, respectively, any dependent views or INSTEAD OF triggers that the DROP VIEW statement destroyed.

The view inherits the data types of the columns in the tables from which the view is derived. The database server determines data types of virtual columns from the nature of the expression.

The SELECT statement is stored in the **sysviews** system catalog table. When you subsequently refer to a view in another statement, the database server performs the defining SELECT statement while it executes the new statement.

In DB-Access, if you create a view outside the CREATE SCHEMA statement, you receive warnings if you use the **-ansi** flag or if you set the **DBANSIWARN** environment variable.

The following statement creates a view that is based on the **person** table. When you create a view like this, which has no OF TYPE clause, the view is referred to as an *untyped view*.

```
CREATE VIEW v1 AS SELECT * FROM person;
```

- [Typed Views](#)
- [Subset of SELECT syntax valid in view definitions](#)
Most SELECT statement syntax is supported in view definitions, with certain exceptions.
- [Union Views](#)
- [Naming View Columns](#)
- [Using a View in the SELECT Statement](#)
- [WITH CHECK OPTION Keywords](#)
- [Updating Through Views](#)

Related concepts:

[INSTEAD OF Triggers on Views](#)

[CREATE TRIGGER statement](#)

Related reference:

[CREATE TABLE statement](#)

[DROP VIEW statement](#)

[GRANT statement](#)

[REVOKE statement](#)

[SELECT statement](#)

[SET SESSION AUTHORIZATION statement](#)

Typed Views

You can create *typed views* if you have Usage privileges on the named-ROW type or if you are its owner or the DBA. If you omit the OF TYPE clause, rows in the view are considered untyped and default to an unnamed-ROW type.

Typed views, like typed tables, are based on a named-ROW type. Each column in the view corresponds to a field in the named-ROW type. The following statement creates a typed view that is based on the table **person**.

```
CREATE VIEW v2 OF TYPE person_t AS SELECT * FROM person;
```

To create a typed view, you must include an OF TYPE clause. When you create a typed view, the named-ROW type that you specify immediately after the OF TYPE keywords must already exist.

Subset of SELECT syntax valid in view definitions

Most SELECT statement syntax is supported in view definitions, with certain exceptions.

- You cannot create a view on a temporary table. The FROM clause of the SELECT clause of the view definition cannot include the name of a temporary table.
- Table objects referenced by the SELECT clause in CREATE VIEW statements can be permanent database tables, views, or derived tables. The query can reference a single table object, or can join two or more. These can be in the current database, in other databases of the local database server, or in databases of remote server instances. The SELECT statement can define derived tables in the FROM clause, using uncorrelated or correlated table references. These derived table definitions can include the **LATERAL** keyword, and can include lateral table and column references.
- Table objects referenced by the SELECT clause in CREATE VIEW statements can be permanent database tables, views, or derived tables. The query can reference a single table object, or can join two or more. These can be in the current database, in other databases of the local database server, or in databases of remote server instances. The SELECT statement can define derived tables in the FROM clause, using uncorrelated or correlated table references. These derived table definitions can include the **LATERAL** keyword, and can include lateral table and column references.
- If Select privileges are revoked from a user for a table that is referenced in the SELECT statement defining a view that the same user owns, then that view is automatically dropped by the database server, unless the view also includes columns from tables in another database.
- You cannot create a view on a table that is part of a typed-table hierarchy, if that table resides in a database of a different database server instance.
- Do not use display labels in the Select list of the Projection clause in a view definition. Display labels in the Projection clause are interpreted as column names.
- Hardcoded values should not be used in a view definition, but only in the WHERE clause of subsequent SELECT statements that query the view. If the values are not hardcoded in the view, the query optimizer can then always exclude those literal values and can complete the query in less time. But if the same values are hardcoded in the view, the query optimizer still must evaluate each literal value.
- The SELECT clause in the CREATE VIEW statement cannot include the SKIP, FIRST, or LIMIT keywords, or the INTO TEMP clause.

For complete information about SELECT statement syntax and usage, see [SELECT statement](#).

Union Views

A view that contains a UNION or UNION ALL operator in its SELECT statement is known as a *union view*. Certain restrictions apply to union views:

- If a CREATE VIEW statement defines a union view, or includes the INTERSECT, MINUS, or EXCEPT set operator, you cannot specify the WITH CHECK OPTION keywords in the CREATE VIEW statement.
- All restrictions that apply to UNION or UNION ALL set operations in stand-alone SELECT statements also apply to UNION and UNION ALL operations in the SELECT statement of a union view.
- Similarly, all other restrictions that apply to the INTERSECT, MINUS, or EXCEPT set operators in stand-alone SELECT statements also apply to those set operators in a combined SELECT statement that defines a view.

For a list of these restrictions, see [Restrictions on a Combined SELECT](#). For an example of a CREATE VIEW statement that defines a union view, see [Naming View Columns](#).

Naming View Columns

The number of columns that you specify in the *column* list must match the number of columns returned by the SELECT statement that defines the view. If you do not specify a list of columns, the view inherits the column names of the underlying tables. In the following example, the view **herostock** has the same column names as the columns in Projection clause of the SELECT statement:

```
CREATE VIEW herostock AS
  SELECT stock_num, description, unit_price, unit, unit_desc
  FROM stock WHERE manu_code = 'HRO';
```

You must specify at least one column name in the following circumstances:

- If you provide names for some of the columns in a view, then you must provide names for all the columns. That is, the column list must contain an entry for every column that appears in the view.
- If the SELECT statement returns an expression, the corresponding column in the view is called a *virtual* column. You must provide a name for a virtual column. In the following example, the user must specify the column parameter because the select list of the Projection clause of the SELECT statement contains an aggregate expression:

```
CREATE VIEW newview (firstcol, secondcol) AS
  SELECT sum(col_a), col_b FROM oldtab;
```

- You must also specify column names in cases where any of the selected columns have duplicate column names without the table qualifiers. For example, if both **orders.order_num** and **items.order_num** appear in the SELECT statement, the CREATE VIEW statement, must provide two separate column names to label them:

```
CREATE VIEW someorders (custnum, ocustnum, newprice) AS
  SELECT orders.order_num, items.order_num,
         items.total_price*1.5
  FROM orders, items
  WHERE orders.order_num = items.order_num
  AND items.total_price > 100.00;
```

Here **custnum** and **ocustnum** replace the two identical column names.

- The CREATE VIEW statement must also provide column names in the column list when the SELECT statement includes a UNION or UNION ALL operator and the names of the corresponding columns in the SELECT statements are not identical. For example, code in the following CREATE VIEW statement must specify the column list because the second column in the first SELECT statement has a different name from the second column in the second SELECT statement:

```
CREATE VIEW myview (col_a, col_b) AS
  SELECT col_x, col_y from firsttab
  UNION
  SELECT col_x, col_z from secondtab;
```

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Using a View in the SELECT Statement

You can define a view whose columns are based on other views, but you must abide by the restrictions on creating views that are discussed in the *IBM® Informix® Database Design and Implementation Guide*.

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WITH CHECK OPTION Keywords

The WITH CHECK OPTION keywords instruct the database server to ensure that all modifications that are made through the view to the underlying tables satisfy the definition of the view.

The following example creates a view that is named **palo_alto**, which uses all the information in the **customer** table for customers in the city of Palo Alto. The database server checks any modifications made to the **customer** table through **palo_alto** because the WITH CHECK OPTION keywords are specified.

```
CREATE VIEW palo_alto AS
  SELECT * FROM customer WHERE city = 'Palo Alto'
  WITH CHECK OPTION
```

You can insert into a view a row that does not satisfy the conditions of the view (that is, a row that is not visible through the view). You can also update a row of a view so that it no longer satisfies the conditions of the view. For example, if the view was created without the WITH CHECK OPTION keywords, you could insert a row through the view where the city is Los Altos, or you could update a row through the view by changing the city from Palo Alto to Los Altos.

To prevent such inserts and updates, you can add the WITH CHECK OPTION keywords when you create the view. These keywords ask the database server to test every inserted or updated row to ensure that it meets the conditions that are set by the WHERE clause of the view. The database server rejects the operation with an error if the row does not meet the conditions.

Even if the view was created with the WITH CHECK OPTION keywords, however, you can perform inserts and updates through the view to change columns that are not part of the view definition. A column is not part of the view definition if it does not appear in the WHERE clause of the SELECT statement that defines the view.

The CREATE VIEW statement fails with error -940 if you include the WITH CHECK OPTION keywords in a CREATE VIEW statement in which the UNION, INTERSECT, MINUS, or EXCEPT set operator combines two queries in the view definition.

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Updating Through Views

If a view is built on a single table, the view is *updatable* if the SELECT statement that defines the view does not contain any of the following elements:

- Columns in the projection list that are aggregate values
- Columns in the projection list that use the UNIQUE or DISTINCT keyword
- A GROUP BY clause
- A UNION operator
- A query that selects calculated or literal values.

You can DELETE from a view that selects calculated values from a single table, but INSERT and UPDATE operations are not valid on such views.

In an updatable view, you can update the values in the underlying table by inserting values into the view. If a view is built on a table that has a derived value for a column, however, that column is not updatable through the view. Other columns in the view, however, can be updated.

See also [Updating Views](#) for information about using INSTEAD OF triggers to update views that are based on more than one table or that include columns containing aggregates or other calculated values.

Important: You cannot update or insert rows in a remote table through views that were created using the WITH CHECK OPTION keywords.

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CREATE XADATASOURCE statement

Use the CREATE XADATASOURCE statement to create a new XA-compliant data source and create an entry for it in the **sysxdatasources** system catalog table. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-CREATE XADATASOURCE--+-----+--xa_source----->
                        '-IF NOT EXISTS-'
>--USING--xa_type-----><
```

Element	Description	Restrictions	Syntax
<i>xa_source</i>	Name that you declare here for the new XA data source	Must be unique among XA data source names in sysxdatasources	Identifier
<i>xa_type</i>	Name of an existing XA data source type	Must already exist in the database in the sysxasourcetypes system catalog table	Identifier

Usage

An XA-compliant data source is an external data source that complies with the X/Open DTP XA Standard for managing interactions between a transaction manager and a resource manager. To register XA-compliant data sources in the database requires two SQL statements:

- First create one or more XA-compliant data source types by using the CREATE XADATASOURCE TYPE statement.
- Then create one or more instances of XA-compliant data sources with the CREATE XADATASOURCE statement.

You can integrate transactions at the XA data source with the Informix® transaction, using a 2-phase commit protocol to ensure that transactions are uniformly committed or rolled back among multiple database servers, and manage multiple external XA data sources within the same global transaction. The CREATE XADATASOURCE statement is not supported on secondary servers within a high-availability cluster.

Any user can create an XA data source, which follows standard owner-naming rules, according to the ANSI-compliance status of the database. Only a database that uses transaction logging can support the X/Open DTP XA Standard.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if an XA data source of the specified name is already registered in the current database.

Both XA data source types and instances of XA data sources are specific to one database. To support distributed transactions, they must be created in each database that interacts with the external XA data source.

The following statement creates a new XA data source instance called **informix.NewYork** of type **informix.MQSeries**.

```
CREATE XADATASOURCE informix.NewYork USING informix.MQSeries;
```

SQL statements that are not valid in XA environments

The Informix database server issues error -701 when you attempt to execute any of the following statements within an X/Open distributed transaction-processing environment:

- CLOSE DATABASE
- CREATE DATABASE
- DROP DATABASE
- SET LOG
- SAVEPOINT
- RELEASE SAVEPOINT
- ROLLBACK TO SAVEPOINT

Within an XA environment, you can execute a single DATABASE statement after an **xa_open** call to specify a current database. After this database is selected, however, no subsequent DATABASE statement can be executed in the same session. If you attempt to execute a second DATABASE statement, the DATABASE statement fails with error -701.

Related reference:

[CREATE XADATASOURCE TYPE statement](#)

[DROP XADATASOURCE statement](#)

[DROP XADATASOURCE TYPE statement](#)

Related information:

[SYSXADATASOURCES](#)

[XA-compliant external data sources](#)

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CREATE XADATASOURCE TYPE statement

Use the CREATE XADATASOURCE TYPE statement to create a new XA-compliant data source type and create an entry for it in the **sysxasourcetypes** system catalog table. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-CREATE--XADATASOURCE TYPE--+-+-----+--xa_type----->
                                     '-IF NOT EXISTS-'
                                     .
                                     v ,-----+-----+
                                     (1) |
>--(----| Purpose Options |-----+-----><
```

Notes:

1. See [Purpose Options](#)

Element	Description	Restrictions	Syntax
<i>xa_type</i>	Name that you declare here for a new XA data source type	Must be unique among XA data source type names in the sysxasourcetypes system catalog table	Identifier

Usage

The CREATE XADATASOURCE TYPE statement adds an XA-compliant data source type to the database.

The CREATE XADATASOURCE TYPE statement is not supported on secondary servers within a high-availability cluster.

Any user can create an XA data source type, whose owner-naming rules depend on the ANSI-compliance status of the database. Only a database that uses transaction logging can support the X/Open DTP XA Standard.

To create a data source type, you must declare its name and specify *purpose functions* and *purpose values* as attributes of the XA source type. Most of the purpose options that follow the source type name associate columns in the **sysxasourcetypes** system catalog table with the name of a UDR.

If you include the optional IF NOT EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if an XA data source type of the specified name is already registered in the current database.

Both XA data source types and instances of XA data sources are specific to one database. To support distributed transactions, they must be created in each database that interacts with the external XA data source.

The following statement creates a new XA data source type called **MQSeries**, owned by user **informix**.

```
CREATE XADATASOURCE TYPE 'informix'.MQSeries(
    xa_flags      = 1,
    xa_version    = 0,
    xa_open       = informix.mqseries_open,
    xa_close      = informix.mqseries_close,
    xa_start      = informix.mqseries_start,
    xa_end        = informix.mqseries_end,
    xa_rollback   = informix.mqseries_rollback,
```

```

xa_prepare = informix.mqseries_prepare,
xa_commit  = informix.mqseries_commit,
xa_recover = informix.mqseries_recover,
xa_forget  = informix.mqseries_forget,
xa_complete = informix.mqseries_complete);

```

You need to provide one value or UDR name for each of the options listed above, but the sequence in which you list them is not critical. (The order of purpose options in this example corresponds to the order of column names in the **sysxasourcetypes** system catalog table.)

After this statement executes successfully, you can create instances of type **informix.MQSeries**. The following statement creates a new instance called **informix.MenloPark** of XA-compliant data source type **informix.MQSeries**:

```
CREATE XADATASOURCE informix.MenloPark USING informix.MQSeries;
```

Related reference:

[CREATE XADATASOURCE statement](#)

[DROP XADATASOURCE statement](#)

[DROP XADATASOURCE TYPE statement](#)

[Purpose Options](#)

Related information:

[XA-compliant external data sources](#)

[SYSXASOURCETYPES](#)

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DATABASE statement

Use the DATABASE statement to open an accessible database as the current database. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```

>>-DATABASE--database--+-----+-----><
      '-EXCLUSIVE-'

```

Element	Description	Restrictions	Syntax
<i>database</i>	Name of a database to which to connect	The database must exist	Database Name

Usage

You can use the DATABASE statement to select any database of your database server instance. To select a database on another database server, include the name of the database server with the database name:

```
DATABASE stores_demo@db_titinius;
```

You can also specify the database as a host variable that contains a valid database environment:

```
DATABASE db_varX;
```

Here the contents of **db_varX** must correspond to one of the formats in the [Database Name](#) syntax diagram.

If besides the name of the *database* you also provide the name of the current (or of another) database server instance, the database server name cannot include uppercase characters.

If the DATABASE statement specifies only a *database* name that corresponds to no database of the current server instance, the database server examines the **DBPATH** environment variable setting, and opens the specified database if a server is found. If no *database* is found, or if its server is offline, the DATABASE statement fails with an error. For more information, see the CONNECT statement topic [Only Database Specified](#).

Issuing the DATABASE statement when a database is already open closes the current database before opening the new one. Closing the current database releases any cursor resources that the database server holds, invalidating any cursors that you have declared up to that point. If the *user* specification was changed through a SET SESSION AUTHORIZATION statement, the original user name is restored when the new database is opened.

If a previous CONNECT statement has established an explicit connection to a database, and that connection is still your current connection, you cannot use the DATABASE statement (nor any SQL statement that creates an implicit connection) until after you use DISCONNECT to close the explicit connection.

The current user (or PUBLIC) must have the Connect privilege on the database that is specified in the DATABASE statement. The current user cannot have the same user name as an existing role in the database.

DATABASE is not a valid statement in multistatement PREPARE operations.

You can use the 'dbhostname' option to retrieve the host name of the database server to which a database client is connected. This option retrieves the physical computer name of the computer on which the database server is running. In the following example, the user enters the 'dbhostname' option of DBINFO in a SELECT statement to retrieve the host name of the database server instance to which **DB-Access** is connected:

```

SELECT DBINFO('dbhostname')
FROM systables
WHERE tabid = 1;

```

The following table shows the result of this query.

(constant)
rd_lab1

- [SQLCA.SQLWARN Settings Immediately after DATABASE Executes \(ESQL/C\)](#)
- [EXCLUSIVE keyword](#)

The EXCLUSIVE keyword opens the database in exclusive mode and prevents access by anyone but the current user. To allow others to access the database, you must first execute the CLOSE DATABASE statement and then reopen the database without the EXCLUSIVE keyword.

Related reference:

[CREATE DATABASE statement](#)
[SET SESSION AUTHORIZATION statement](#)
[DROP DATABASE statement](#)
[DISCONNECT statement](#)
[SET CONNECTION statement](#)
[CLOSE DATABASE statement](#)
[CONNECT statement](#)

Related information:

[Select a data model for your database](#)
[SQL Communications Area](#)
[Exception handling with the sqlca structure](#)

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SQLCA.SQLWARN Settings Immediately after DATABASE Executes (ESQL/C)

Immediately after DATABASE executes, you can identify characteristics of the specified database by examining warning flags in the **sqlca** structure.

- If the first field of **sqlca.sqlwarn** is blank, then no warnings were issued.
- The second **sqlca.sqlwarn** field is set to the letter **w** if the *database* that was opened supports transaction logging.
- The third field is set to **w** if *database* is an ANSI-compliant database.
- The fourth field is set to **w**.
- The fifth field is set to **w** if *database* converts all floating-point data to DECIMAL format. (System lacks FLOAT and SMALLFLOAT support.)
- The seventh field is set to **w** if *database* is the secondary server (that is, running in read-only mode) in a data-replication pair.
- The eighth field is set to **w** if *database* has **DB_LOCALE** set to a locale different from the **DB_LOCALE** setting on the client system.

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EXCLUSIVE keyword

The EXCLUSIVE keyword opens the database in exclusive mode and prevents access by anyone but the current user. To allow others to access the database, you must first execute the CLOSE DATABASE statement and then reopen the database without the EXCLUSIVE keyword.

The following statement opens the **stores_demo** database on the **training** database server in exclusive mode:

```
DATABASE stores_demo@training EXCLUSIVE;
```

If another user has already opened the specified database, exclusive access is denied, an error is returned, and no database is opened.

If you encounter this error, but you are unable to confirm that other users are connected to the database, your non-exclusive access might be caused by a sensor or task that is running in the Scheduler API. To temporarily disable the Scheduler, you can issue this SQL administration API command:

```
EXECUTE FUNCTION admin('scheduler shutdown');
```

After the **admin('scheduler shutdown')** routine has completed execution, retry the **DATABASE ... EXCLUSIVE** statement.

For more information on the Scheduler API commands, see your *IBM® Informix® Administrator's Guide*. For information about the privileges that you must hold to call SQL administration API functions, see your *IBM Informix Administrator's Reference*.

Related information:

[The Scheduler](#)
[SQL Administration API Overview](#)

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DEALLOCATE COLLECTION statement

Use the DEALLOCATE COLLECTION statement to release memory for a collection variable that was previously allocated with the ALLOCATE COLLECTION statement.

This statement is an extension to the ANSI/ISO standard for SQL. Use this statement with ESQL/C.

Syntax

```
>>-DEALLOCATE COLLECTION--:variable-----><
```

Element	Description	Restrictions	Syntax
<i>variable</i>	Name that identifies a typed or untyped collection variable for which to deallocate memory	Must be the name of the Informix® ESQL/C collection variable that has already been allocated	Name must conform to language-specific rules for names of variables

Usage

The DEALLOCATE COLLECTION statement frees all the memory that is associated with the Informix ESQL/C collection variable that *variable* identifies. You must explicitly release memory resources for a collection variable with DEALLOCATE COLLECTION. Otherwise, deallocation occurs automatically at the end of the program.

The DEALLOCATE COLLECTION statement releases resources for both typed and untyped collection variables.

Tip: The DEALLOCATE COLLECTION statement deallocates memory for Informix ESQL/C collection variables only. To deallocate memory for Informix ESQL/C row variables, use the DEALLOCATE ROW statement.

If you deallocate nonexistent collection variables or variables that are not Informix ESQL/C collection variables, you receive errors. After you deallocate a collection variable, you can use the ALLOCATE COLLECTION to reallocate resources and you can then reuse a collection variable.

This example shows how to deallocate resources with the DEALLOCATE COLLECTION statement for the untyped collection variable, **a_set**:

```
EXEC SQL BEGIN DECLARE SECTION;  
    client collection a_set;  
EXEC SQL END DECLARE SECTION;  
.  
.  
EXEC SQL allocate collection :a_set;  
.  
.  
EXEC SQL deallocate collection :a_set;
```

For a related example, see the related concept, Inserting into a Collection Cursor.

Related concepts:

[Inserting into a Collection Cursor](#)

Related reference:

[ALLOCATE COLLECTION statement](#)

[DEALLOCATE ROW statement](#)

Related information:

[Complex data types](#)

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DEALLOCATE DESCRIPTOR statement

Use the DEALLOCATE DESCRIPTOR statement to free a previously allocated, system-descriptor area. Use this statement with Informix® ESQL/C.

Syntax

This statement is an extension to the ANSI/ISO standard for the SQL language.

```
>>-DEALLOCATE DESCRIPTOR--+-'descriptor'-----><  
                        '-descriptor_var-'
```

Element	Description	Restrictions	Syntax
<i>descriptor</i>	Name of a system-descriptor area	Use single quotation marks. System-descriptor area must already be allocated	Quoted String
<i>descriptor_var</i>	Host variable that contains the name of a system-descriptor area	System-descriptor area must already be allocated, and the variable must already have been declared	Name must conform to language-specific rules

Usage

The DEALLOCATE DESCRIPTOR statement frees all the memory that is associated with the system-descriptor area that *descriptor* or *descriptor_var* identifies. It also frees all the item descriptors (including memory for data items in the item descriptors).

You can reuse a descriptor or descriptor variable after it is deallocated. Otherwise, deallocation occurs automatically at the end of the program.

If you deallocate a nonexistent descriptor or descriptor variable, an error results.

You cannot use the DEALLOCATE DESCRIPTOR statement to deallocate an **sqllda** structure. You can use it only to free the memory that is allocated for a system-descriptor area.

The following examples show valid DEALLOCATE DESCRIPTOR statements. The first line uses an embedded-variable name, and the second line uses a quoted string to identify the allocated system-descriptor area.

```
EXEC SQL deallocate descriptor :descname;
```

```
EXEC SQL deallocate descriptor 'desc1';
```

Related reference:

[GET DESCRIPTOR statement](#)

[SET DESCRIPTOR statement](#)

[ALLOCATE DESCRIPTOR statement](#)

[EXECUTE statement](#)

[DESCRIBE statement](#)

[DESCRIBE INPUT statement](#)

[DECLARE statement](#)

[FETCH statement](#)

[OPEN statement](#)

[PREPARE statement](#)

[PUT statement](#)

Related information:

[A system-descriptor area](#)

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DEALLOCATE ROW statement

Use the DEALLOCATE ROW statement to release memory for a ROW variable.

This statement is an extension to the ANSI/ISO standard for SQL. Use this statement with ESQL/C.

Syntax

```
>>-DEALLOCATE ROW--:variable-----><
```

Element	Description	Restrictions	Syntax
<i>variable</i>	Typed or untyped row variable	Must be declared and allocated	Language specific

Usage

DEALLOCATE ROW frees all the memory that is associated with the Informix® ESQL/C typed or untyped **row** variable that *variable* identifies. If you do not explicitly release memory resources with DEALLOCATE ROW, deallocation occurs automatically at the end of the program. To deallocate memory for the Informix ESQL/C collection variable, use the DEALLOCATE COLLECTION statement.

After you deallocate a ROW variable, you can use the ALLOCATE ROW statement to reallocate resources, and you can then reuse a ROW variable. The following example shows how to deallocate resources for the ROW variable, **a_row**, using the DEALLOCATE ROW statement:

```
EXEC SQL BEGIN DECLARE SECTION; row (a int, b int) a_row;
EXEC SQL END DECLARE SECTION;
. . .
EXEC SQL allocate row :a_row;
. . .
EXEC SQL deallocate row :a_row;
```

Related reference:

[DEALLOCATE COLLECTION statement](#)

[ALLOCATE ROW statement](#)

Related information:

[Select row-type data](#)

[Complex data types](#)

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DECLARE statement

Use the DECLARE statement of dynamic SQL to declare a cursor and to associate it with an SQL statement that returns a set of rows to an SPL or IBM® Informix® ESQL/C or routine.

Other Select or Function Options

Notes:

- | Element | Description | Restrictions | Syntax |
|-------------------------|--------------------------------------|---|----------------------------|
| <i>column</i> | Column to update with cursor | Must exist, but need not be listed in Select list of the Projection clause | Identifier |
| <i>cursor_id</i> | Name declared here for cursor | Must be unique in the routine among names of cursors and prepared objects (and in SPL, among variables) | Identifier |
| <i>cursor_id_var</i> | Variable holding <i>cursor_id</i> | Must have a character data type | Language-specific |
| <i>statement_id</i> | Name of prepared statement | Must have been declared by a PREPARE statement | Identifier |
| <i>statement_id_var</i> | Variable holding <i>statement_id</i> | Must have a character data type | Language-specific |

A *cursor* is an identifier that you associate with an SQL statement that returns a group of rows. The DECLARE statement associates the cursor with one of the following database objects:

- 306 Part VIII: SQL programming

The name of the collection variable appears in the FROM clause of a SELECT or the INTO clause of an INSERT. For more information, see [Associating a Cursor with a Prepared Statement](#).

DECLARE assigns an identifier to the cursor, specifies its uses, and directs the Informix ESQL/C preprocessor to allocate storage for it. DECLARE must precede any other statement that references the cursor during program execution.

The cursors and prepared objects that can exist concurrently in a single program are limited by available memory. To avoid exceeding the limit, use the FREE statement to release the resources of prepared statements or cursors that are no longer needed.

An ESQL/C program can consist of one or more source-code files. By default, the scope of reference of a cursor is global to a program, so a cursor that was declared in one source file can be referenced from a statement in another file. If you want to limit the scope of each cursor name to the file where it was declared, you must preprocess each file with the -local command-line option.

Multiple cursors can be declared for the same prepared statement identifier. For example, the following Informix ESQL/C example does not return an error:

```
EXEC SQL prepare id1 from 'select * from customer';
EXEC SQL declare x cursor for id1;
EXEC SQL declare y scroll cursor for id1;
EXEC SQL declare z cursor with hold for id1;
```

If you include the -ansi compilation flag (or if DBANSIWARN is set), warnings are generated for statements that use dynamic cursor names, dynamic statement identifiers, or statements that use collection-derived tables. Some error checking is performed at runtime, such as these typical checks:

- Invalid use of sequential cursors as scroll cursors
- Use of undeclared cursors
- Invalid cursor names or statement names (empty)

Checks for multiple declarations of a cursor of the same name are performed at compile time only if the cursor or statement is specified as an identifier. The following example uses a host variable to store the cursor name:

```
EXEC SQL declare x cursor for select * from customer;
. . .
strcpy("x", s);
EXEC SQL declare :s cursor for select * from customer;
```

A cursor uses the collating order that was in effect when the cursor was declared, even if this is different from the collation of the session at run time.

- [Overview of Cursor Types](#)
- [Select Cursor or Function Cursor](#)
- [Cursor Characteristics](#)
- [Associating a Cursor with a Prepared Statement](#)
- [Using Cursors with Transactions](#)
- [Declaring a Dynamic Cursor in an SPL Routine](#)

Use the DECLARE statement in an SPL routine to declare the name of a dynamic cursor, and to associate that cursor with the statement identifier of a prepared statement that the PREPARE statement has declared in the same SPL routine.

Related reference:

[FLUSH statement](#)
[CLOSE statement](#)
[GET DESCRIPTOR statement](#)
[UPDATE statement](#)
[SET AUTOFREE statement](#)
[SET DESCRIPTOR statement](#)
[INSERT statement](#)
[ALLOCATE DESCRIPTOR statement](#)
[SET DEFERRED PREPARE statement](#)
[DELETE statement](#)
[COMMIT WORK statement](#)
[EXECUTE statement](#)
[DESCRIBE statement](#)
[DESCRIBE INPUT statement](#)
[DEALLOCATE DESCRIPTOR statement](#)
[Collection-Derived Table](#)
[OPEN statement](#)
[FETCH statement](#)
[FREE statement](#)
[EXECUTE PROCEDURE statement](#)
[PREPARE statement](#)
[PUT statement](#)
[SELECT statement](#)
[FOREACH](#)

Related information:

[Declare a cursor](#)
[Modify data](#)
[A database cursor](#)

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Cursors are typically required for data manipulation language (DML) operations on more than one row of data (or on Informix® ESQL/C collection variables). You can declare the following types of cursors with the DECLARE statement:

- A *Select cursor* is a cursor associated with a SELECT statement.
- A *Function cursor* is a cursor associated with an EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement.
- An *Insert cursor* is a cursor associated with an INSERT statement.

Sections that follow describe each of these cursor types. Cursors can also have *sequential*, *scroll*, and *hold* characteristics (but an Insert cursor cannot be a scroll cursor). These characteristics determine the structure of the cursor; see [Cursor Characteristics](#). In addition, a Select or Function cursor can specify *read-only* or *update* mode. For more information, see [Select Cursor or Function Cursor](#).

Tip: Function cursors behave the same as Select cursors that are enabled as update cursors.

Besides associating a cursor directly with the text of an SQL statement, the FOR keyword of the DECLARE statement can be followed by the identifier of a prepared SQL statement, associating the cursor with the result set of an INSERT, SELECT, EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement that was prepared dynamically. This feature enables you to associate different SQL statements with the same cursor at different times. In this case, the type of cursor depends on the prepared SQL statement that the *statement_id* or *statement_id* variable specifies when the cursor is opened. (For more information, see [Associating a Cursor with a Prepared Statement](#).)

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Select Cursor or Function Cursor

When an SQL statement returns more than one group of values to the Informix® ESQL/C program, you must declare a cursor to save the multiple groups, or rows, of data and to access these rows one at a time. You must associate one of the following SQL statements with a cursor:

- If you associate a SELECT statement with a cursor, the cursor is called a *Select cursor*.
A Select cursor is a data structure that represents a specific location within the active set of rows that the SELECT statement retrieved.
- If you associate an EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement with a cursor, the cursor is called a *Function cursor*.
The Function cursor represents the columns or values that a user-defined function returns. Function cursors behave the same as Select cursors that are enabled as update cursors.

In Informix, for compatibility with legacy applications, if an SPL function was created with the CREATE PROCEDURE statement, you can create a Function cursor with the EXECUTE PROCEDURE statement. With external functions, you must use the EXECUTE FUNCTION statement.

When you associate a SELECT or EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement with a cursor, the statement can include an INTO clause. However, if you prepare the SELECT or EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement, you must omit the INTO clause in the PREPARE statement and use the INTO clause of the FETCH statement to retrieve the values from the Collection cursor.

A Select or Function cursor can scan returned rows of data and to move data row by row into a set of receiving variables, as the following steps describe:

1. DECLARE
Use DECLARE to define a cursor and associate it with a statement.
 2. OPEN
Use OPEN to open the cursor. The database server processes the query until it locates or constructs the first row of the active set.
 3. FETCH
Use FETCH to retrieve successive rows of data from the cursor.
 4. CLOSE
Use CLOSE to close the cursor when its active set is no longer needed.
 5. FREE
Use FREE to release the resources that are allocated for the cursor.
- [Using the FOR READ ONLY Option](#)
 - [Using the FOR UPDATE Option](#)
 - [Subset of INSERT Statement with a Sequential Cursor](#)
 - [Insert Cursor](#)

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Using the FOR READ ONLY Option

Use the FOR READ ONLY keywords to define a cursor as a read-only cursor. A cursor declared to be read-only cannot be used to update (or delete) any row that it fetches.

The need for the FOR READ ONLY keywords depends on whether your database is ANSI compliant or not ANSI compliant.

In a database that is not ANSI compliant, the cursor that the DECLARE statement defines is a read-only cursor by default, so you do not need to specify the FOR READ ONLY keywords if you want the cursor to be a read-only cursor. The only advantage of specifying the FOR READ ONLY keywords explicitly is for better program documentation.

In an ANSI-compliant database, the cursor associated with a SELECT statement through the DECLARE statement is an update cursor by default, provided that the SELECT statement conforms to all of the restrictions for update cursors listed in [Subset of SELECT statements associated with cursors](#). If you want a Select cursor

to be read-only, you must use the FOR READ ONLY keywords when you declare the cursor.

The database server can use less stringent locking for a read-only cursor than for an update cursor.

The following example creates a read-only cursor:

```
EXEC SQL declare z_curs cursor for
select * from customer_ansi
for read only;
```

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Using the FOR UPDATE Option

Use the FOR UPDATE option to declare an update cursor. You can use the update cursor to modify (update or delete) the current row.

In an ANSI-compliant database, you can use a Select cursor to update or delete data if the cursor was not declared with the FOR READ ONLY keywords and it follows the restrictions on update cursors that are described in [Subset of SELECT statements associated with cursors](#). You do not need to use the FOR UPDATE keywords when you declare the cursor.

The following example declares an update cursor:

```
EXEC SQL declare new_curs cursor for
select * from customer_notansi
for update;
```

In an update cursor, you can update or delete rows in the active set. After you create an update cursor, you can update or delete the currently selected row by using an UPDATE or DELETE statement with the WHERE CURRENT OF clause. The words CURRENT OF refer to the row that was most recently fetched; they take the place of the usual test expressions in the WHERE clause.

An update cursor lets you perform updates that are not possible with the UPDATE statement because the decision to update and the values of the new data items can be based on the original contents of the row. Your program can evaluate or manipulate the selected data before it decides whether to update. The UPDATE statement cannot interrogate the table that is being updated.

You can specify particular columns that can be updated. The columns need not appear in the Select list of the Projection clause.

- [Using FOR UPDATE with a List of Columns](#)
- [Locking with an Update Cursor](#)

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Using FOR UPDATE with a List of Columns

When you declare an update cursor, you can limit the update to specific columns by including the OF keyword and a list of columns. You can modify only those named columns in subsequent UPDATE statements. The columns need not be in the select list of the SELECT clause.

The next example declares an update cursor and specifies that this cursor can update only the **fname** and **lname** columns in the **customer_notansi** table:

```
EXEC SQL declare name_curs cursor for
select * from customer_notansi
for update of fname, lname;
```

By default, unless declared as FOR READ ONLY, a Select cursor in a database that is ANSI compliant is an update cursor, so the FOR UPDATE keywords are optional. If you want an update cursor to be able to modify only some of the columns in a table, however, you must specify these columns in the FOR UPDATE OF *column* list.

The principal advantage to specifying columns is documentation and preventing programming errors. (The database server refuses to update any other columns.) An additional advantage is improved performance, when the SELECT statement meets the following criteria:

- The SELECT statement can be processed using an index.
- The columns that are listed are not part of the index that is used to process the SELECT statement.

If the columns that you intend to update are part of the index that is used to process the SELECT statement, the database server keeps a list of each updated row, to ensure that no row is updated twice. If the OF keyword specifies which columns can be updated, the database server determines whether or not to keep the list of updated rows. If the database server determines that the work of keeping the list is unnecessary, performance improves. If you do not use the OF *column* list, the database server always maintains a list of updated rows, although the list might be unnecessary.

The following example contains Informix® ESQL/C code that uses an update cursor with a DELETE statement to delete the current row.

Whenever the row is deleted, the cursor remains between rows. After you delete data, you must use a FETCH statement to advance the cursor to the next row before you can refer to the cursor in a DELETE or UPDATE statement.

```
EXEC SQL declare q_curs cursor for
select * from customer where lname matches :last_name for update;

EXEC SQL open q_curs;
for (;;)
{
    EXEC SQL fetch q_curs into :cust_rec;
```

```

if (strcmp(SQLSTATE, "00", 2) != 0)
    break;

/* Display customer values and prompt for answer */
printf("\n%s %s", cust_rec.fname, cust_rec.lname);
printf("\nDelete this customer? ");
scanf("%s", answer);

if (answer[0] == 'y')
    EXEC SQL delete from customer where current of q_curs;
if (strcmp(SQLSTATE, "00", 2) != 0)
    break;
}
printf("\n");
EXEC SQL close q_curs;

```

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Locking with an Update Cursor

The FOR UPDATE keywords notify the database server that updating is possible and cause it to use more stringent locking than with a Select cursor. You declare an update cursor to let the database server know that the program might update (or delete) any row that it fetches as part of the SELECT statement. The update cursor employs *promotable* locks for rows that the program fetches. Other programs can read the locked row, but no other program can place a promotable lock (also called a *write lock*). Before the program modifies the row, the row lock is promoted to an exclusive lock.

It is possible to declare an update cursor with the WITH HOLD keywords, but the only reason to do so is to break a long series of updates into smaller transactions. You must fetch and update a particular row in the same transaction.

If an operation involves fetching and updating a large number of rows, the lock table that the database server maintains can overflow. The usual way to prevent this overflow is to lock the entire table that is being updated. If this action is impossible, an alternative is to update through a hold cursor and to execute COMMIT WORK at frequent intervals. You must plan such an application carefully, however, because COMMIT WORK releases all locks, even those that are placed through a hold cursor.

- [Locking with concurrent 4GL cursors in unlogged databases](#)

In databases that are created without transaction logging, a 4GL program can declare two Update cursors on the same table. But if the cursor that the second DECLARE statement defines is on a column that is also the key to an index on the table, the database server releases the lock that the first cursor held on the table.

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Locking with concurrent 4GL cursors in unlogged databases

In databases that are created without transaction logging, a 4GL program can declare two Update cursors on the same table. But if the cursor that the second DECLARE statement defines is on a column that is also the key to an index on the table, the database server releases the lock that the first cursor held on the table.

For Informix® 4GL programs in databases created without transaction logging,

- if the DECLARE statement places a lock on a table by defining a cursor,
- and another DECLARE statement defines a second cursor on the same table,
- and if the column referenced by the second cursor is also an index key,

then when the second cursor is declared on the indexed column, the database server automatically releases the lock associated with the first cursor. The lock that the first DECLARE statement created is typically not released, however, under the following circumstances:

- The database supports transaction logging.
- The column referenced by the second cursor is not indexed.
- The application is not an Informix 4GL program.

But there might be other scenarios in which a concurrent lock that the DECLARE statement created in a 4GL program could be released for reasons other than an index partition.

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Subset of INSERT Statement with a Sequential Cursor

As indicated in the diagram for [DECLARE statement](#), to create an Insert cursor, you associate a sequential cursor with a restricted form of the INSERT statement. The INSERT statement must include a VALUES clause; it cannot contain an embedded SELECT statement.

The following example contains Informix ESQL/C code that declares an Insert cursor:

```

EXEC SQL declare ins_cur cursor for
insert into stock values
(:stock_no, :manu_code, :descr, :u_price, :unit, :u_desc);

```

The Insert cursor simply inserts rows of data; it cannot be used to fetch data. When an Insert cursor is opened, a buffer is created in memory. The buffer receives rows of data as the program executes PUT statements. The rows are written to disk only when the buffer is full. You can flush the buffer (that is, to write its contents into the database) when it is less than full, using the CLOSE, FLUSH, or COMMIT WORK statements. This topic is discussed further under the CLOSE, FLUSH, and PUT statements.

You must close an Insert cursor to insert any buffered rows into the database before the program ends. You can lose data if you do not close the cursor properly. For a complete description of INSERT syntax and usage, see [INSERT statement](#).

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Insert Cursor

When you associate an INSERT statement with a cursor, the cursor is called an *Insert cursor*. An Insert cursor is a data structure that represents the rows that the INSERT statement is to add to the database. The Insert cursor simply inserts rows of data; it cannot be used to fetch data. To create an Insert cursor, you associate a cursor with a restricted form of the INSERT statement. The INSERT statement must include a VALUES clause; it cannot contain an embedded SELECT statement.

Create an Insert cursor if you want to add multiple rows to the database in an INSERT operation. An Insert cursor allows bulk insert data to be buffered in memory and written to disk when the buffer is full, as these steps describe:

1. Use DECLARE to define an Insert cursor for the INSERT statement.
2. Open the cursor with the OPEN statement. The database server creates the insert buffer in memory and positions the cursor at the first row of the insert buffer.
3. Copy successive rows of data into the insert buffer with the PUT statement.
4. The database server writes the rows to disk only when the buffer is full. You can use the CLOSE, FLUSH, or COMMIT WORK statement to flush the buffer when it is less than full. This topic is discussed further under the PUT and CLOSE statements.
5. Close the cursor with the CLOSE statement when the insert cursor is no longer needed. You must close an Insert cursor to insert any buffered rows into the database before the program ends. You can lose data if you do not close the cursor properly.
6. Free the cursor with the FREE statement. The FREE statement releases the resources that are allocated for an Insert cursor.

Using an Insert cursor is more efficient than embedding the INSERT statement directly. This process reduces communication between the program and the database server and also increases the speed of the insertions.

Insert cursors also have the sequential cursor characteristic. To create an Insert cursor, you associate a sequential cursor with a restricted form of the INSERT statement. (For more information, see [Insert Cursor](#).) The following example contains IBM® Informix® ESQL/C code that declares a sequential Insert cursor:

```
EXEC SQL declare ins_cur cursor for
insert into stock values
(:stock_no, :manu_code, :descr, :u_price, :unit, :u_desc);
```

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Cursor Characteristics

You can declare a cursor as a *sequential* cursor (the default), a *scroll* cursor (by using the SCROLL keyword), or a *hold* cursor (by using the WITH HOLD keywords). The SCROLL and WITH HOLD keywords are not mutually exclusive. Sections that follow explain these structural characteristics.

A Select or Function cursor can be either a sequential or a scroll cursor. An Insert cursor can only be a sequential cursor. In ESQL/C routines, Select, Function, and Insert cursors can optionally be hold cursors. (In SPL routines, all cursors are sequential cursors, but only Select cursors can be hold cursors.)

- [Creating a Sequential Cursor by Default](#)
- [Using the SCROLL Keyword to Create a Scroll Cursor](#)
- [Using the WITH HOLD keywords to create a hold cursor](#)
Use the WITH HOLD keywords to create a *hold cursor*. A hold cursor allows uninterrupted access to a set of rows across multiple transactions.
- [Subset of SELECT statements associated with cursors](#)
As indicated in the syntax diagram for the DECLARE statement, not all SELECT statements can be associated with a read-only or update cursor.
- [Examples of Cursors in Non-ANSI Compliant Databases](#)
- [Examples of Cursors in ANSI-Compliant Databases](#)

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Creating a Sequential Cursor by Default

If you use only the CURSOR keyword, you create a sequential cursor, which can fetch only the next row in sequence from the active set. The sequential cursor can read through the active set only once each time it is opened.

If you are using a sequential cursor for a Select cursor, on each execution of the FETCH statement, the database server returns the contents of the current row and locates the next row in the active set.

The following example creates a read-only sequential cursor in a database that is not ANSI compliant and an update sequential cursor in an ANSI-compliant database:

```
EXEC SQL declare s_cur cursor for
  select fname, lname into :st_fname, :st_lname
  from orders where customer_num = 114;
```

Insert cursors also have the sequential cursor characteristic. To create a Insert cursor, you associate a sequential cursor with a restricted form of the INSERT statement. (For more information, see [Insert Cursor](#).) The following example declares an Insert cursor:

```
EXEC SQL declare ins_cur cursor for
  insert into stock values
  (:stock_no, :manu_code, :descr, :u_price, :unit, :u_desc);
```

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Using the SCROLL Keyword to Create a Scroll Cursor

Use the SCROLL keyword to create a scroll cursor, which can fetch rows of the active set in any sequence.

The database server retains the active set of the cursor as a temporary table until the cursor is closed. You can fetch the first, last, or any intermediate rows of the active set as well as fetch rows repeatedly without having to close and reopen the cursor. (See FETCH.)

On a multiuser system, the rows in the tables from which the active-set rows were derived might change after the cursor is opened and a copy is made in the temporary table. If you use a scroll cursor within a transaction, you can prevent copied rows from changing either by setting the isolation level to Repeatable Read or by locking the entire table in share mode during the transaction. (See SET ISOLATION and LOCK TABLE.)

The following example creates a scroll cursor for a SELECT statement:

```
DECLARE sc_cur SCROLL CURSOR FOR SELECT * FROM orders;
```

You can create scroll cursors as Select and Function cursors but *not* as Insert cursors. Scroll cursors cannot be declared as FOR UPDATE.

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Using the WITH HOLD keywords to create a hold cursor

Use the WITH HOLD keywords to create a *hold cursor*. A hold cursor allows uninterrupted access to a set of rows across multiple transactions.

Ordinarily, all cursors close at the end of a transaction. A hold cursor does not close; it remains open after a transaction ends.

A hold cursor can be either a sequential cursor or (in ESQ/C) a scroll cursor.

The WITH HOLD keywords are valid in SPL routines only for Select cursors. For the syntax of the DECLARE statement in SPL routines, see [Declaring a Dynamic Cursor in an SPL Routine](#).

In ESQ/C, you can use the WITH HOLD keywords to declare Select and Function cursors (with the sequential attribute or the scroll attribute) and also to declare Insert cursors. These keywords follow the CURSOR keyword in the DECLARE statement. The following example creates a sequential hold cursor for a SELECT statement:

```
DECLARE hld_cur CURSOR WITH HOLD FOR
  SELECT customer_num, lname, city FROM customer;
```

You can use a select hold cursor as the following Informix® ESQ/C code example shows. This code fragment uses a hold cursor as a *master* cursor to scan one set of records and a sequential cursor as a *detail* cursor to point to records that are located in a different table. The records that the master cursor scans are the basis for updating the records to which the detail cursor points. The COMMIT WORK statement at the end of each iteration of the first WHILE loop leaves the hold cursor **c_master** open but closes the sequential cursor **c_detail** and releases all locks. This technique minimizes the resources that the database server must devote to locks and unfinished transactions, and it gives other users immediate access to updated rows.

```
EXEC SQL BEGIN DECLARE SECTION;
  int p_custnum, int save_status; long p_orddate;
EXEC SQL END DECLARE SECTION;

EXEC SQL prepare st_1 from
  'select order_date from orders where customer_num = ? for update';
EXEC SQL declare c_detail cursor for st_1;
EXEC SQL declare c_master cursor with hold for
  select customer_num from customer where city = 'Pittsburgh';

EXEC SQL open c_master;
if(SQLCODE==0) /* the open worked */
  EXEC SQL fetch c_master into :p_custnum; /* discover first customer */
while(SQLCODE==0) /* while no errors and not end of pittsburgh customers */
{
  EXEC SQL begin work; /* start transaction for customer p_custnum */
  EXEC SQL open c_detail using :p_custnum;
  if(SQLCODE==0) /* detail open succeeded */
    EXEC SQL fetch c_detail into :p_orddate; /* get first order */
  while(SQLCODE==0) /* while no errors and not end of orders */
  {
    EXEC SQL update orders set order_date = '08/15/94'
      where current of c_detail;
    if(status==0) /* update was ok */
```

```

EXEC SQL fetch c_detail into :p_orddate; /* next order */
}
if(SQLCODE==SQLNOTFOUND) /* correctly updated all found orders */
EXEC SQL commit work; /* make updates permanent, set status */
else /* some failure in an update */
{
save_status = SQLCODE; /* save error for loop control */
EXEC SQL rollback work;
SQLCODE = save_status; /* force loop to end */
}
if(SQLCODE==0) /* all updates, and the commit, worked ok */
EXEC SQL fetch c_master into :p_custnum; /* next customer? */
}
EXEC SQL close c_master;

```

Use either the CLOSE statement to close the hold cursor explicitly or the CLOSE DATABASE or DISCONNECT statements to close it implicitly. The CLOSE DATABASE statement closes all cursors.

Releases earlier than Version 9.40 of Informix do not support the PDQPRIORITY feature with cursors that were declared WITH HOLD.

- [Using an Insert Cursor with Hold](#)

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Using an Insert Cursor with Hold

If you associate a hold cursor with an INSERT statement, you can use transactions to break a long series of PUT statements into smaller sets of PUT statements. Instead of waiting for the PUT statements to fill the buffer and cause an automatic write to the database, you can execute a COMMIT WORK statement to flush the row buffer. With a hold cursor, COMMIT WORK commits the inserted rows but leaves the cursor open for further inserts. This method can be desirable when you are inserting a large number of rows, because pending uncommitted work consumes database server resources.

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Subset of SELECT statements associated with cursors

As indicated in the syntax diagram for the DECLARE statement, not all SELECT statements can be associated with a read-only or update cursor.

If the [DECLARE statement](#) includes the FOR READ ONLY or FOR UPDATE option, you must observe certain restrictions on the SELECT statement that is included in the DECLARE statement (either directly or as a prepared statement).

If the DECLARE statement includes the FOR READ ONLY option, the SELECT statement cannot have a FOR READ ONLY or FOR UPDATE option. (For a description of SELECT syntax and usage, see [SELECT statement](#).)

If the DECLARE statement includes the FOR UPDATE option, the SELECT statement must conform to the following restrictions:

- The statement can select data from only one table.
- The statement cannot include any aggregate functions.
- The statement cannot also include the FOR UPDATE keywords.
- The statement cannot include any of the following clauses or keywords: DISTINCT, EXCEPT, FOR READ ONLY, FOR UPDATE, GROUP BY, INTERSECT, INTO TEMP, MINUS, ORDER BY, UNION, or UNIQUE.

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Examples of Cursors in Non-ANSI Compliant Databases

In a database that is not ANSI compliant, a cursor associated with a SELECT statement is a read-only cursor by default. The following example declares a read-only cursor in a non-ANSI compliant database:

```

EXEC SQL declare cust_curs cursor for
select * from customer_notansi;

```

If you want to make it clear in the program code that this cursor is a read-only cursor, specify the FOR READ ONLY option as the following example shows:

```

EXEC SQL declare cust_curs cursor for
select * from customer_notansi for read only;

```

If you want this cursor to be an update cursor, specify the FOR UPDATE option in your DECLARE statement. This example declares an update cursor:

```

EXEC SQL declare new_curs cursor for
select * from customer_notansi for update;

```

If you want an update cursor to be able to modify only some columns in a table, you must specify those columns in the FOR UPDATE clause. The following example declares an update cursor that can update only the **fname** and **lname** columns in the **customer_notansi** table:

```
EXEC SQL declare name_curs cursor for
select * from customer_notansi for update of fname, lname;
```

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Examples of Cursors in ANSI-Compliant Databases

In an ANSI-compliant database, a cursor associated with a SELECT statement is an update cursor by default.

The following example declares an update cursor in an ANSI-compliant database:

```
EXEC SQL declare x_curs cursor for select * from customer_ansi;
```

To make it clear in the program documentation that this cursor is an update cursor, you can specify the FOR UPDATE option as in this example:

```
EXEC SQL declare x_curs cursor for
select * from customer_ansi for update;
```

If you want an update cursor to be able to modify only some of the columns in a table, you must specify these columns in the FOR UPDATE option. The following example declares an update cursor and specifies that this cursor can update only the **fname** and **lname** columns in the **customer_ansi** table:

```
EXEC SQL declare y_curs cursor for
select * from customer_ansi for update of fname, lname;
```

If you want a cursor to be a read-only cursor, you must override the default behavior of the DECLARE statement by specifying the FOR READ ONLY option in your DECLARE statement. The following example declares a read-only cursor:

```
EXEC SQL declare z_curs cursor for
select * from customer_ansi for read only;
```

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Associating a Cursor with a Prepared Statement

The PREPARE statement lets you assemble the text of an SQL statement at runtime and pass the statement text to the database server for execution. If you anticipate that a dynamically prepared SELECT, EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement that returns values could produce more than one row of data, the prepared statement must be associated with a cursor. (See PREPARE.)

The result of a PREPARE statement is a statement identifier (*statement id* or *id variable*), which is a data structure that represents the prepared statement text. To declare a cursor for the statement text, associate a cursor with the statement identifier.

You can associate a sequential cursor with any prepared SELECT or EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement. You cannot associate a scroll cursor with a prepared INSERT statement or with a SELECT statement that was prepared to include a FOR UPDATE clause.

After a cursor is opened, used, and closed, a different statement can be prepared under the same statement identifier. In this way, it is possible to use a single cursor with different statements at different times. The cursor must be redeclared before you use it again.

The following example contains Informix® ESQL/C code that prepares a SELECT statement and declares a sequential cursor for the prepared statement text. The statement identifier **st_1** is first prepared from a SELECT statement that returns values; then the cursor **c_detail** is declared for **st_1**.

```
EXEC SQL prepare st_1 from
'select order_date
  from orders where customer_num = ?';
EXEC SQL declare c_detail cursor for st_1;
```

If you want to use a prepared SELECT statement to modify data, add a FOR UPDATE clause to the statement text that you want to prepare, as the following Informix ESQL/C example shows:

```
EXEC SQL prepare sel_1 from
'select * from customer for update';
EXEC SQL declare sel_curs cursor for sel_1;
```

DDL operations that change the schema of a table can invalidate a cursor whose associated prepared statement or associated routine references the modified table, unless the prepared objects are recompiled, or unless the routine is reoptimized. For more information, see the section [DDL Operations on Tables Referenced by Cursors](#).

The DECLARE statement allows you to declare a cursor for the Informix ESQL/C collection variable. Such a cursor is called a *Collection cursor*. You use a collection variable to access the elements of a collection (SET, MULTISSET, LIST) column. Use a cursor when you want to access one or more elements in a collection variable.

The Collection-Derived Table segment identifies the collection variable for which to declare the cursor. For more information, see [Collection-Derived Table](#).

- [Select with a Collection-Derived Table](#)
- [Insert with a Collection-Derived Table](#)

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Select with a Collection-Derived Table

The diagram for [DECLARE statement](#) refers to this section.

To declare a Select cursor for a collection variable, include the Collection- Derived Table segment with the SELECT statement that you associate with the Collection cursor. A Select cursor allows you to select one or more elements *from* the collection variable. (For a description of SELECT syntax and usage, see [SELECT statement](#).)

When you declare a Select cursor for a collection variable, the DECLARE statement has the following restrictions:

- It cannot include the FOR READ ONLY keywords as cursor mode.
The Select cursor is an update cursor.
- It cannot include the SCROLL or WITH HOLD keywords.
The Select cursor must be a sequential cursor.

In addition, the SELECT statement that you associate with the collection cursor has the following restrictions:

- It cannot include the following clauses or options: WHERE, GROUP BY, ORDER BY, HAVING, INTO TEMP, and WITH REOPTIMIZATION.
- It cannot contain expressions in the projection list.
- If the collection contains elements of opaque, distinct, built-in, or other collection data types, the projection list must be an asterisk (*).
- Column names in the projection list must be simple column names, without qualifiers.
These columns cannot use the following syntax:

```
database@server:table.column --INVALID SYNTAX
```

- It *must* specify the name of the collection variable in the FROM clause.
You cannot specify an input parameter (the question-mark (?) symbol) for the collection variable. Likewise, you cannot use the virtual table format of the Collection-Derived Table segment.
- [Using a Select Cursor with a Collection Variable](#)

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Using a Select Cursor with a Collection Variable

A Collection cursor that includes a SELECT statement with the Collection- Derived Table clause provides access to the elements in a collection variable.

To select more than one element:

1. Create a client collection variable in your Informix® ESQL/C program.
2. Declare the Collection cursor for the SELECT statement with the DECLARE statement. To modify elements of the collection variable, declare the Select cursor as an update cursor with the FOR UPDATE keywords. You can then use the WHERE CURRENT OF clause of the DELETE and UPDATE statements to delete or update elements of the collection.
3. Open this cursor with the OPEN statement.
4. Fetch the elements from the Collection cursor with the FETCH statement and the INTO clause.
5. If necessary, perform any updates or deletes on the fetched data and save the modified collection variable in the collection column. Once the collection variable contains the correct elements, use the UPDATE or INSERT statement to save the contents of the collection variable in the actual collection column (SET, MULTISSET, or LIST).
6. Close the Collection cursor with the CLOSE statement.

This DECLARE statement declares a Select cursor for a collection variable:

```
EXEC SQL BEGIN DECLARE SECTION;  
    client collection set(integer not null) a_set;  
EXEC SQL END DECLARE SECTION;  
...  
EXEC SQL declare set_curs cursor for select * from table(:a_set);
```

For an extended code example that uses a Collection cursor for a SELECT statement, see [Fetching from a Collection Cursor](#).

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Insert with a Collection-Derived Table

To declare an Insert cursor for a collection variable, include the Collection- Derived Table segment in the INSERT statement associated with the Collection cursor. An Insert cursor can insert one or more elements in the collection. For a description of INSERT syntax and usage, see [INSERT statement](#).

The Insert cursor must be a sequential cursor. That is, the DECLARE statement cannot specify the SCROLL keyword.

When you declare an Insert cursor for a collection variable, the Collection- Derived Table clause of the INSERT statement *must* contain the name of the collection variable. You cannot specify an input parameter (the question-mark (?) symbol) for the collection variable. However, you can use an input parameter in the VALUES clause of the INSERT statement. This parameter indicates that the collection element is to be provided later by the FROM clause of the PUT statement.

A Collection cursor that includes an INSERT statement with the Collection- Derived Table clause allows you to insert more than one element into a collection variable.

To insert more than one element:

1. Create a client collection variable in your Informix ESQL/C program.
2. Declare the Collection cursor for the INSERT statement with the DECLARE statement.
3. Open the cursor with the OPEN statement.
4. Put the elements into the Collection cursor with the PUT statement and the FROM clause.
5. Once the collection variable contains all the elements, use the UPDATE statement or the INSERT statement on a table name to save the contents of the collection variable in a collection column (SET, MULTISET, or LIST).
6. Close the Collection cursor with the CLOSE statement.

This example declares an Insert cursor for the **a_set** collection variable:

```
EXEC SQL BEGIN DECLARE SECTION;
    client collection multiset(smallint not null) a_mset;
    int an_element;
EXEC SQL END DECLARE SECTION;
...
EXEC SQL declare mset_curs cursor for
    insert into table(:a_mset) values (?);
EXEC SQL open mset_curs;
while (1)
{
    ...
    EXEC SQL put mset_curs from :an_element;
    ...
}
```

To insert the elements into the collection variable, use the PUT statement with the FROM clause. For a code example that uses a Collection cursor for an INSERT statement, see [Inserting into a Collection Cursor](#).

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Using Cursors with Transactions

To roll back a modification, you must perform the modification within a transaction. A transaction in a database that is not ANSI compliant begins only when the BEGIN WORK statement is executed.

In an ANSI-compliant database, transactions are always in effect.

The database server enforces these guidelines for select and update cursors to ensure that modifications can be committed or rolled back properly:

- Open an insert or update cursor within a transaction.
- Include PUT and FLUSH statements within one transaction.
- Modify data (update, insert, or delete) within one transaction.

The database server lets you open and close a hold cursor for an update outside a transaction; however, you should fetch all the rows that pertain to a given modification and then perform the modification all within a single transaction. You cannot open and close a hold cursor or an update cursor outside a transaction.

The following example uses an update cursor within a transaction:

```
EXEC SQL declare q_curs cursor for
    select customer_num, fname, lname from customer
    where lname matches :last_name for update;
EXEC SQL open q_curs;
EXEC SQL begin work;
EXEC SQL fetch q_curs into :cust_rec; /* fetch after begin */
EXEC SQL update customer set lname = 'Smith'
    where current of q_curs;
/* no error */
EXEC SQL commit work;
```

When you update a row within a transaction, the row remains locked until the cursor is closed or the transaction is committed or rolled back. If you update a row when no transaction is in effect, the row lock is released when the modified row is written to disk. If you update or delete a row outside a transaction, you cannot roll back the operation.

In a database that uses transactions, you cannot open an Insert cursor outside a transaction unless it was also declared with the WITH HOLD keywords.

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Declaring a Dynamic Cursor in an SPL Routine

Use the DECLARE statement in an SPL routine to declare the name of a dynamic cursor, and to associate that cursor with the statement identifier of a prepared statement that the PREPARE statement has declared in the same SPL routine.

Dynamic cursors that the DECLARE statement of SQL can create in SPL routines are distinct from the direct sequential cursors that the FOREACH statement of SPL can create in SPL routines. (For the syntax and usage of direct sequential cursors, see [FOREACH](#).)

Syntax

The syntax of the DECLARE statement in SPL routines is a subset of the syntax that DECLARE supports in Informix® ESQL/C routines.

```
>>DECLARE-- cursor_id ---+-----+---FOR-- statement_id -><
                        | (1)
                        '----- WITH HOLD '
```

Notes:

1. Informix extension

Element	Description	Restrictions	Syntax
<i>cursor_id</i>	Name declared here for a new dynamic cursor	Must be unique among names of cursors, prepared statements, and SPL variables in the routine	Identifier
<i>statement_id</i>	Identifier of a single prepared SQL statement	Must have been declared in a PREPARE statement of the same SPL routine	Identifier

Usage

In UDRs written in the SPL language, the *statement_id* associated with the cursor must have been declared earlier in the same UDR by a PREPARE statement from the text of a single SQL statement of one of these statement types:

- EXECUTE FUNCTION
- EXECUTE PROCEDURE
- SELECT.

This prepared statement text that *statement_id* specifies can include question mark (?) symbols as placeholders for values that the user supplies at runtime, but these placeholders in the PREPARE statement can represent only data values, not SQL identifiers.

Dynamic cursors that the DECLARE statement can define in SPL routines resemble ESQL/C Select cursors or Function cursors in their functionality, but with these restrictions:

- Cursors that DECLARE defines in an SPL routine can be Select cursors or Function cursors, but they cannot be Insert cursors nor Collection cursors.
- The identifier of the cursor or of the prepared statement cannot be specified as an SPL variable, because in SPL, the identifiers of variables, cursors, and prepared objects all share the same namespace.
- By default, dynamic cursors of SPL are sequential. They cannot be scroll cursors.
- The semantics of dynamic cursors that you create with the WITH HOLD keywords are the same as for hold cursors that the FOREACH statement declares.
- The WITH HOLD keywords are valid in SPL routines only for Select cursors. If *statement_id* references the prepared text of an EXECUTE FUNCTION or EXECUTE PROCEDURE statement, the DECLARE statement fails with error -26056.
- The FOR UPDATE and FOR READ ONLY keywords that ESQL/C supports in DECLARE statements are not supported in SPL routines. Use the FOREACH statement of SPL to declare direct cursors that can emulate the functionality of ESQL/C update cursors. (But queries associated with direct cursors are defined when the UDR is compiled, rather than at runtime.)
- The DECLARE statement in SPL routines does not support SELECT operations on collection-derived tables.
- Syntax errors in DECLARE statements of SPL routines are reported at runtime, unlike syntax errors of ESQL/C, which are reported when the routine is compiled.

The names of the dynamic cursors that the DECLARE statement associates with a prepared statement in SPL routines can be referenced by the OPEN, CLOSE, FETCH, and FREE statements of dynamic SQL in the same SPL routine.

In the following program fragment, a cursor called **equi_noctis** is declared, opened, closed, and freed.

```
CREATE FUNCTION lente
  DEFINE first, last VARCHAR(30);
  . . .
  DATABASE stores_demo;
  LET first = "SELECT * FROM state";
  LET lsst = "WHERE code < ?";
  PREPARE stmt_1 FROM first || last;
  DECLARE equi_noctis FOR stmt_1;
  OPEN equi_noctis
  . . .
  CLOSE equi_noctis;
  FREE equi_noctis;
  FREE stmt_1;
  . . .
END FUNCTION;
```

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DELETE statement

Use the DELETE statement to delete one or more rows from a table, or to delete one or more elements from a collection variable of SPL or of Informix® ESQL/C.

Syntax

```
>>-DELETE-----+-----+-----+-----+-----+-----+-----+----->
      | (1) | (2) | | (1) |
      |-----| Optimizer Directives |-----' |-----'

>--+--+table-----+-----+-----+-----+-----+-----+-----+----->
      | +-view-----+ | (3) | |
      | |'-synonym-' |'-+-----+alias-----'|
      | |'-AS-' |
      | (1) | (4) |
      |-----+ONLY--(-+--+table -+--+)-+-----+-----+-----+-----+-----+-----+-----+----->
      | |'-synonym-' |
      | |'-| Collection-Derived Table |-----' |
      | (5) |

>--+-----+-----+-----+-----+-----+-----+-----+-----><
      | (1) | (6) | |
      |-----+-----+-----+-----+-----+-----+-----+-----+
      | (7) | (8) |
      |-----+-----+-----+-----+-----+-----+-----+-----+
      |-----WHERE CURRENT OF cursor_id-----|
```

Notes:

1. Informix extension
2. See [Optimizer Directives](#)
3. See [Declaring an alias for the table](#)
4. See [Using the ONLY keyword with typed tables](#)
5. See [Collection-Derived Table](#)
6. See [Using the WHERE Keyword to Specify a Condition](#)
7. ESQL/C and Stored Procedure Language only
8. See [Using the WHERE CURRENT OF Keywords \(ESQL/C, SPL\)](#)

Element	Description	Restrictions	Syntax
<i>alias</i>	Temporary name declared here for a table, view, or synonym.	The AS keyword must precede <i>alias</i> if WHERE is the identifier of <i>alias</i>	Identifier
<i>condition</i>	Logical criteria that deleted rows must satisfy	Cannot be a UDR nor a correlated subquery	Condition
<i>cursor_id</i>	Previously declared cursor	Must have been declared FOR UPDATE	Identifier
<i>synonym, table, view</i>	Synonym, table, or updatable view with rows to be deleted	The <i>table</i> or <i>view</i> (or <i>synonym</i> and the table or view to which it points) must exist	Database Object Name

Usage

Use the DELETE statement to remove any of the following types of database objects or program objects:

- A row in a table or in a view: a single row, a group of rows, or all rows
- An element in a column of a collection data type
- In a column of a named or unnamed ROW data type, a field, or all fields.

You can also use this statement to remove the values in one or more elements in Informix ESQL/C or SPL collection variables or ROW variables.

To execute the DELETE statement, you must hold the DBA access privilege on the database, or the Delete access privilege on the table.

If you specify a *view* name, the view must be updatable. For an explanation of an updatable view, see [Updating Through Views](#).

The DELETE statement cannot reference table objects that the CREATE EXTERNAL TABLE statement defined.

In a database with explicit transaction logging, any DELETE statement that you execute outside a transaction is treated as a single transaction.

In an ANSI-compliant database, data manipulation language (DML) statements are always in a transaction. You cannot execute a DELETE statement outside a transaction.

FROM clause

The FROM keyword that precedes the name of the target table is optional. To delete rows from a table named **from**, you can set the **DELIMIDENT** environment variable and use double quotation marks (") to delimit **"from"**:

```
DELETE "from";
```

Alternatively, you can qualify the name of the **from** table with the name of its owner:

```
DELETE zelaine.from;
```

Your SQL code will be easier for humans to read and to maintain, however, if you avoid declaring SQL keywords as identifiers of tables, views, or other database objects.

WHERE clause

If you use DELETE without a WHERE clause (to specify either a condition or the active set of the cursor), all rows in the table are deleted:

```
DELETE FROM tableZ;
```

It is typically more efficient, however, to use the TRUNCATE statement, rather than the DELETE statement, to remove all rows from a table.

In DB-Access, if you omit the WHERE clause while working at the SQL menu, DB-Access prompts you to verify that you want to delete all rows from a table. You do not receive a prompt if you execute DELETE within a command file.

Locking considerations

The database server locks each row affected by a DELETE statement within a transaction for the duration of the transaction. The locking granularity of the table can be PAGE level or ROW level.

Features that determine the locking granularity have this ascending order of precedence:

- The DEF_TABLE_LOCKMODE configuration parameter can set the default granularity for table locks to PAGE or to ROW.
- If the **IFX_TABLE_LOCKMODE** environment variable is set to PAGE or ROW, its setting overrides any DEF_TABLE_LOCKMODE default.
- The LOCK MODE clause of the CREATE TABLE statement overrides any default locking granularity for the new table.
- The LOCK MODE clause of the ALTER TABLE statement can reset the locking granularity to PAGE or to ROW for a table, overriding any of the settings above.
- The LOCK TABLE statement always locks the entire table, overriding any locking granularity specification listed above for the specified table.

When the locking granularity of the table is ROW, the database server acquires one lock for each row affected by the DELETE statement.

If the number of rows affected is very large, and the lock mode is ROW, you might exceed the limits that your operating system places on the maximum number of simultaneous locks. If this occurs, you can either reduce the scope of the DELETE statement, or you can use LOCK TABLE statement to lock the table in exclusive mode before you execute the DELETE statement.

- [Using the ONLY keyword with typed tables](#)
When the DELETE statement specifies a supertable, any qualifying rows that satisfy the WHERE clause are also deleted, by default, from all the subtables of the supertable within the table hierarchy. To restrict the scope of DELETE to the supertable, you must specify the **ONLY** keyword before the name or synonym of the supertable.
- [Considerations When Tables Have Cascading Deletes](#)
- [Using the WHERE Keyword to Specify a Condition](#)
- [Subqueries in the WHERE Clause of DELETE](#)
- [Declaring an alias for the table](#)
You can declare an alias for the table. The alias can reference the fully-qualified database object name of a local or remote table, view, or synonym.
- [Using the WHERE CURRENT OF Keywords \(ESQL/C, SPL\)](#)
- [Deleting Rows That Contain Opaque Data Types](#)
- [Deleting Rows That Contain Collection Data Types](#)
- [Data Types in Distributed DELETE Operations](#)
Distributed DELETE operations across tables in databases of different server instances can return only a subset of the data types that distributed DELETE operations can return from tables that are all in databases of the same Informix instance.
- [SQLSTATE Values in an ANSI-Compliant Database](#)
- [SQLSTATE Values in a Database That Is Not ANSI-Compliant](#)

Related reference:

[TRUNCATE statement](#)
[DECLARE statement](#)
[FETCH statement](#)
[GET DIAGNOSTICS statement](#)
[INSERT statement](#)
[OPEN statement](#)
[SELECT statement](#)
[UPDATE statement](#)
[Collection-Derived Table](#)
[MERGE statement](#)

Related information:

[Modify data through SQL programs](#)
[Create and use SPL routines](#)
[Complex data types](#)
[Data manipulation statements](#)

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Using the ONLY keyword with typed tables

When the DELETE statement specifies a supertable, any qualifying rows that satisfy the WHERE clause are also deleted, by default, from all the subtables of the supertable within the table hierarchy. To restrict the scope of DELETE to the supertable, you must specify the **ONLY** keyword before the name or synonym of the supertable.

In the following example, any rows whose **name** column has the value **johnson** will be deleted from the **super_tab** supertable. Any rows with **johnson** in their **name** column will persist, however, in the subtables of **super_tab**, because the **ONLY ()** clause restricts the DELETE operation to that supertable:

```
DELETE FROM ONLY(super_tab) -- scope excludes child tables
WHERE name = "johnson";
```

Warning: If you use the DELETE statement on a supertable and omit the ONLY keyword and the WHERE clause, all rows of the supertable and of all its subtables are deleted, as in the following example.

```
DELETE FROM super_tab; -- deletes all rows in the hierarchy
```

You cannot specify the ONLY keyword if you plan to use the WHERE CURRENT OF clause to delete the current row of the active set of a cursor.

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Considerations When Tables Have Cascading Deletes

When you use the ON DELETE CASCADE option of the REFERENCES clause of either the CREATE TABLE or ALTER TABLE statement, you specify that you want deletes to cascade from one table to another. For example, in the **stores_demo** database, the **stock** table contains the column **stock_num** as a primary key. The **catalog** and **items** tables each contain the column **stock_num** as foreign keys with the ON DELETE CASCADE option specified. When a delete is performed from the **stock** table, rows are also deleted in the **catalog** and **items** tables, which are referenced through the foreign keys.

To have DELETE actions cascade to a table that has a referential constraint on a parent table, you need the Delete privilege only on the parent table that you reference in the DELETE statement.

If a DELETE operation with no WHERE clause is performed on a table that one or more child tables reference with cascading deletes, Informix® deletes all rows from that table and from any affected child tables. (This resembles the effect of the TRUNCATE statement, but Informix does not support TRUNCATE operations on any table that has a child table referencing it.)

For an example of how to create a referential constraint that uses cascading deletes, see [Using the ON DELETE CASCADE Option](#).

- [Restrictions on DELETE When Tables Have Cascading Deletes](#)
- [Locking and Logging Implications of Cascading Deletes](#)

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Restrictions on DELETE When Tables Have Cascading Deletes

You cannot use a child table in a correlated subquery to delete a row from a parent table. If two child tables reference the same parent table, and one child specifies cascading deletes but the other child does not, then if you attempt to delete a row that applies to both child tables from the parent table, the delete fails, and no rows are deleted from the parent or child tables.

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Locking and Logging Implications of Cascading Deletes

During deletes, the database server places locks on all qualifying rows of the referenced and referencing tables.

Informix® requires transaction logging for cascading deletes. If logging is turned off in a database that is not ANSI-compliant, even temporarily, deletes do not cascade, because you cannot roll back any actions. For example, if a parent row is deleted, but the system fails before the child rows are deleted, the database will have dangling child records, in violation of referential integrity. After logging is turned back on, however, subsequent deletes cascade.

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Using the WHERE Keyword to Specify a Condition

Use the WHERE *condition* clause to specify which rows you want to delete from the table. The *condition* after the WHERE keyword is equivalent to the *condition* in the SELECT or UPDATE statement. For example, the next statement deletes all the rows of the **items** table where the order number is less than 1034:

```
DELETE FROM items WHERE order_num < 1034;
```

In DB-Access, if you include a WHERE clause that selects all rows in the table, DB-Access gives no prompt and deletes all rows.

If you are deleting from a supertable in a table hierarchy, a subquery in the WHERE clause cannot reference a subtable.

When deleting from a subtable, a subquery in the WHERE clause can reference the supertable only in SELECT ... FROM ONLY (*supertable*)... syntax.

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Subqueries in the WHERE Clause of DELETE

The FROM clause of a subquery in the WHERE clause of the DELETE statement can specify as a data source the same table or view that the FROM clause of the DELETE statement specifies. DELETE operations with subqueries that reference the same table object are supported only if all of the following conditions are true:

- The subquery either returns a single row, or else has no correlated column references.
- The subquery is in the DELETE statement WHERE clause, using Condition with Subquery syntax.
- Any SPL routines within the subquery cannot reference the table that is being modified.

Unless all of these conditions are satisfied, DELETE statements that include subqueries that reference the same table or view that the DELETE statement modifies return error -360.

The following example deletes from the **orders** table a subset of rows whose **paid_date** column value satisfies the condition in the WHERE clause. The WHERE clause specifies which rows to delete by applying the IN operator to the rows returned by a subquery that selects only the rows of the **orders** table where the **paid_date** value is earlier than the current date:

```
DELETE FROM orders WHERE paid_date IN
  (SELECT paid_date FROM orders WHERE paid_date < CURRENT );
```

This subquery includes only uncorrelated column references, because its only referenced column is in a table specified in its FROM clause. The requirements listed above are in effect, because the data source of the subquery is the same orders table that the FROM clause of the outer UPDATE statement specifies. The previous example illustrates Informix® support for uncorrelated subqueries in the WHERE clause of the DELETE statement, rather than how to write short SQL statements. The next example achieves the same result with simpler syntax:

```
DELETE orders WHERE paid_date < CURRENT;
```

The following example deletes from the **stock** table the row (or rows) with the largest **unit_price** value. The WHERE clause identifies which **unit_price** value is the largest by applying the equality operator to the result of a subquery that calls the built-in **MAX** aggregate function for the **unit_price** column values:

```
DELETE FROM stock WHERE unit_price =
  (SELECT MAX(unit_price) FROM stock );
```

If an enabled Select trigger is defined on a table that is the data source of a subquery in the WHERE clause of a DELETE statement that modifies the same table, executing that subquery within the DELETE statement does not activate the trigger.

A subquery in the DELETE statement can include the UNION or UNION ALL operators.

If the table that the outer DELETE statement modifies a typed table within a table hierarchy, Informix supports all of the following operations that use valid subqueries in the WHERE clause of DELETE:

- DELETE from parent table with subquery (SELECT from parent table)
- DELETE from parent table with subquery (SELECT from child table)
- DELETE from child table with subquery (SELECT from parent table)
- DELETE from child table with subquery (SELECT from child table).

See the [Condition with Subquery](#) topic for more information about the syntax of subqueries to return multiple rows as predicates in the WHERE clause of the DELETE statement.

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Declaring an alias for the table

You can declare an alias for the table. The alias can reference the fully-qualified database object name of a local or remote table, view, or synonym.

The alias is a temporary name that is not registered in the system catalog of the database, and that persists only while the DELETE statement is running.

If the name that you declare as the alias is the keyword WHERE, you must use the AS keyword to clarify the syntax:

```
DELETE stock AS where
  WHERE manu_code =
    (SELECT manu_code FROM where WHERE manu_code MATCHES 'H*');
```

Because **where** is a keyword of both the DELETE and SELECT statements, the previous example is not easy to read. The following example accesses a remote table without declaring an alias for the table:

```
DELETE overstock@cleveland:stock AS ocs
  WHERE manu_code =
    (SELECT manu_code FROM overstock@cleveland:stock
      WHERE manu_code MATCHES 'H*');
```

The next example is logically equivalent to the previous DELETE statement, but simplifies the notation by declaring **ocs** as alias that references the same table in the subquery"

```
DELETE overstock@cleveland:stock AS ocs
  WHERE manu_code =
    (SELECT manu_code FROM ocs WHERE manu_code MATCHES 'H*');
```

Using the WHERE CURRENT OF Keywords (ESQL/C, SPL)

The WHERE CURRENT OF clause deletes the current row of the active set of a cursor. When you include this clause, the DELETE statement removes the row of the active set at the current position of the cursor. After the deletion, no current row exists; you cannot use the cursor to delete or update a row until you reposition the cursor with a FETCH statement (in ESQL/C routines) or with a FOREACH statement (in SPL routines).

You access the current row of the active set of a cursor with an update cursor. Before you can use the WHERE CURRENT OF clause, you must first create an update cursor by using the FOREACH statement (in SPL) or the DECLARE statement with the FOR UPDATE clause (in Informix® ESQL/C). The *cursor_id* that follows the OF keyword cannot be declared, however, by the DECLARE statement in an SPL routine.

Unless they are declared with the FOR READ ONLY keywords, all Select cursors are potentially update cursors in an ANSI-compliant database. You can use the WHERE CURRENT OF clause with any Select cursor that was not declared with the FOR READ ONLY keywords.

You cannot use WHERE CURRENT OF if you are selecting from only one table in a table hierarchy. That is, this clause is not valid with the ONLY keyword.

The WHERE CURRENT OF clause can be used to delete an element from a collection by deleting the current row of the collection-derived table that a collection variable holds. For more information, see [Collection-Derived Table](#).

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Deleting Rows That Contain Opaque Data Types

Some opaque data types require special processing when they are deleted. For example, if an opaque data type contains spatial or multirepresentational data, it might provide a choice of how to store the data: inside the internal structure or, for large objects, in a smart large object.

To accomplish this process, call a user-defined support function called **destroy()**. When you use DELETE to remove a row that contains one of these opaque types, the database server automatically invokes **destroy()** for the opaque type. This function decides how to remove the data, regardless of where it is stored. For more information on the **destroy()** support function, see *IBM® Informix User-Defined Routines and Data Types Developer's Guide*.

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Deleting Rows That Contain Collection Data Types

When a row contains a column that is a collection data type (LIST, MULTISSET, or SET), you can search for a particular element in the collection, and delete the row or rows in which the element is found.

For example, the following statement deletes any rows from the **new_tab** table in which the **set_col** column contains the element `jimmy smith`:

```
DELETE FROM new_tab WHERE 'jimmy smith' IN set_col;
```

You can also use a collection variable to delete values in a collection column by deleting one or more individual elements in a collection. For more information, see [Collection-Derived Table](#) and the examples in [Database Name](#) and [Example of Deleting from a Collection](#).

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Data Types in Distributed DELETE Operations

Distributed DELETE operations across tables in databases of different server instances can return only a subset of the data types that distributed DELETE operations can return from tables that are all in databases of the same Informix® instance.

A DELETE statement (or any other SQL data-manipulation language statement) that accesses a database of another Informix instance can reference only the following data types:

- Built-in data types that are not opaque or complex
- BOOLEAN
- BSON
- JSON
- LVARCHAR
- DISTINCT of built-in types that are not opaque
- DISTINCT of BOOLEAN
- DISTINCT of BSON
- DISTINCT of JSON
- DISTINCT of LVARCHAR
- DISTINCT of the DISTINCT types in this list.

Cross-server distributed DELETE operations can support these DISTINCT types only if the DISTINCT types are cast explicitly to built-in types, and all of the DISTINCT types, their data type hierarchies, and their casts are defined exactly the same way in each participating database. Cross-server DML operations cannot reference a column or expression of a complex, large-object, nor user-defined opaque data type (UDT), nor of an unsupported DISTINCT type or built-in opaque type. For additional information about the data types that Informix supports in cross-server DML operations, see [Data Types in Cross-Server Transactions](#).

Distributed operations that access other databases of the local Informix instance, however, can access the same data types that are listed above for cross-server operations, and also the following additional data types:

- Most of the *built-in opaque data types*, as listed in [Data Types in Cross-Database Transactions](#)
- DISTINCT of the built-in types that are referenced in the line above
- DISTINCT of any of the data types that are listed in either of the two lines above
- Opaque user-defined data types (UDTs) that can be cast explicitly to built-in data types.

Cross-database DELETE operations can support these DISTINCT and opaque UDTs only if all the opaque and DISTINCT UDTs are cast explicitly to built-in types, and all of the opaque UDTs, DISTINCT types, data type hierarchies, and casts are defined exactly the same way in each of the participating databases. Distributed DELETE statements cannot access a database of another Informix instance unless both server instances support either a TCP/IP or an IPCSTR connection, as defined in their DBSERVERNAME or DBSERVERALIASES configuration parameters and in the **sqlhosts** information. This connection-type requirement applies to any communication between Informix instances, even if both database servers reside on the same computer.

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SQLSTATE Values in an ANSI-Compliant Database

If no rows satisfy the WHERE clause of a DELETE operation on a table in an ANSI-compliant database, the database server issues a warning. You can detect this warning condition in either of the following ways:

- The GET DIAGNOSTICS statement sets the **RETURNED_SQLSTATE** field to the value 02000. In an SQL API application, the **SQLSTATE** variable contains this same value.
- In an SQL API application, the **sqlca.sqlcode** and **SQLCODE** variables contain the value 100.

The database server also sets **SQLSTATE** and **SQLCODE** to these values if the DELETE . . . WHERE statement is part of a multistatement prepared object, and the database server returns no rows.

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SQLSTATE Values in a Database That Is Not ANSI-Compliant

In a database that is not ANSI compliant, the database server does not return a warning when it finds no rows satisfying the WHERE clause of a DELETE statement. In this case, the **SQLSTATE** code is 00000 and the **SQLCODE** code is zero (0). If the DELETE . . . WHERE is part of a multistatement prepared object, however, and no rows are returned, the database server does issue a warning. It sets **SQLSTATE** to 02000 and sets the **SQLCODE** value to 100.

For information on the ANSI/ISO-compliance status of values returned to the **SQLSTATE** variable, see the section [SQLSTATE Support for the ANSI/ISO Standard for SQL](#).

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DESCRIBE statement

Use the DESCRIBE statement to obtain information about output parameters and other features of a prepared object before you execute it.

Use this statement with Informix® ESQL/C. (See also [DESCRIBE INPUT statement](#).)

Syntax

```
>>-DESCRIBE--+-----+--+statement_id_var+----->
      '-OUTPUT-'  '-statement_id-----'

>--+--USING SQL DESCRIPTOR--+descriptor_var+-----><
      |               '-descriptor'---'      |
      '-INTO--+SQL DESCRIPTOR--+descriptor_var+--+-'
      |               '-descriptor'---'      |
      '-sqllda_pointer-----'

```

Element	Description	Restrictions	Syntax
<i>descriptor</i>	Name of a system-descriptor area	System-descriptor area must already be allocated	Quoted String

Element	Description	Restrictions	Syntax
<i>descriptor_var</i>	Host variable specifying a system-descriptor area	Must contain the name of an allocated system-descriptor area	Language-specific rules for names
<i>sqlda_pointer</i>	Pointer to an sqlda structure	Cannot begin with dollar (\$) sign or colon (:). An sqlda structure is required if dynamic SQL is used.	See the sqlda structure in the <i>IBM Informix ESQL/C Programmer's Manual</i>
<i>statement_id</i>	Statement identifier for a prepared SQL statement	Must be defined in a previous PREPARE statement	PREPARE statement; Identifier
<i>statement_id_var</i>	Host variable that contains the value of <i>statement_id</i>	Must be declared in a previous PREPARE statement	Language-specific rules for names

Usage

DESCRIBE can provide information at runtime about a prepared statement:

- The type of SQL statement that was prepared
- Whether an UPDATE or DELETE statement contains a WHERE clause
- For an EXECUTE, EXECUTE FUNCTION, EXECUTE PROCEDURE, INSERT, SELECT, or UPDATE statement, the DESCRIBE statement also returns the number, data types, and size of the output parameter values.
- For a SELECT statement, DESCRIBE also returns the name of the column or expression that the query returns.

With this information, you can write code to allocate memory to hold retrieved values and display or process them after they are fetched.

- [The OUTPUT Keyword](#)
- [Describing the Statement Type](#)
- [Checking for the Existence of a WHERE Clause](#)
- [Describing a Statement with Runtime Parameters](#)
- [Using the SQL DESCRIPTOR Keywords](#)
- [Using the INTO sqlda Pointer Clause](#)
- [Describing a Collection Variable](#)

The DESCRIBE statement can provide information about a collection variable when you use the USING SQL DESCRIPTOR or INTO clause. You must issue the DESCRIBE statement *after* you open the Select or Insert cursor, because the OPEN...USING statement specifies the name of the collection variable to use.

Related reference:

[GET DESCRIPTOR statement](#)

[SET DESCRIPTOR statement](#)

[INSERT statement](#)

[ALLOCATE DESCRIPTOR statement](#)

[SET DEFERRED PREPARE statement](#)

[DEALLOCATE DESCRIPTOR statement](#)

[DECLARE statement](#)

[DESCRIBE INPUT statement](#)

[EXECUTE statement](#)

[FETCH statement](#)

[OPEN statement](#)

[PREPARE statement](#)

[PUT statement](#)

[Collection-Derived Table](#)

Related information:

[Dynamic host variables](#)

[Dynamic-management structure](#)

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The OUTPUT Keyword

The OUTPUT keyword specifies that only information about output parameters of the prepared statement are stored in the **sqlda** descriptor area. If you omit this keyword, DESCRIBE can return input parameters, but only for INSERT statements (and for UPDATE, if the **IFX_UPDDESC** environment variable is set in the environment where the database server is initialized).

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Describing the Statement Type

The DESCRIBE statement takes a statement identifier from a PREPARE statement as input. When the DESCRIBE statement executes, the database server sets the value of the SQLCODE field of the **sqlca** to indicate the statement type (that is, the keyword with which the statement begins). If the prepared statement text contains more than one SQL statement, the DESCRIBE statement returns the type of the first statement in the text.

SQLCODE is set to zero to indicate a SELECT statement *without* an INTO TEMP clause. This situation is the most common. For any other SQL statement, SQLCODE is set to a positive integer. You can test the number against the constant names that are defined. In Informix® ESQL/C, the constant names are defined in the

sqltypes.h header file.

The DESCRIBE statement (and the DESCRIBE INPUT statement) use the SQLCODE field differently from any other statement, possibly returning a nonzero value when it executes successfully. You can revise standard error-checking routines to accommodate this behavior, if desired.

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Checking for the Existence of a WHERE Clause

If the DESCRIBE statement detects that a prepared statement contains an UPDATE or DELETE statement without a WHERE clause, the DESCRIBE statement sets the **sqlca.sqlwarn.sqlwarn4** variable to W.

When you do not specify a WHERE clause in either a DELETE or UPDATE statement, the database server performs the delete or update operation on the entire table. Check the **sqlca.sqlwarn.sqlwarn4** variable to avoid unintended global changes to your table.

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Describing a Statement with Runtime Parameters

If the prepared statement contains parameters for which the number of parameters or parameter data types is to be supplied at runtime, you can describe these input values. If the prepared statement text includes one of the following statements, the DESCRIBE statement returns a description of each column or expression that is included in the list:

- EXECUTE FUNCTION (or EXECUTE PROCEDURE)
- INSERT
- SELECT (without an INTO TEMP clause)
- UPDATE

In Informix®, the **IFX_UPDDESC** environment variable, as described in the *IBM® Informix Guide to SQL: Reference*, must be set before you can use DESCRIBE to obtain information about an UPDATE statement.

The description includes the following information:

- The data type of the column, as defined in the table
- The length of the column, in bytes
- The name of the column or expression

For a prepared INSERT or UPDATE statement, DESCRIBE returns only the dynamic parameters (those expressed with a question mark (?) symbol). Using the OUTPUT keyword, however, prevents these from being returned.

You can specify a destination for the returned information as a new or existing system-descriptor area, or as a pointer to an **sqllda** structure.

A system-descriptor area conforms to the X/Open standards.

Related information:

[IFX_UPDDESC environment variable](#)

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Using the SQL DESCRIPTOR Keywords

Use the USING SQL DESCRIPTOR clause to store the description of a prepared statement list in a previously allocated system-descriptor area.

Use the INTO SQL DESCRIPTOR clause to create a new system-descriptor structure and store the description of a statement list in that structure.

To describe one of the previously mentioned statements into a system-descriptor area, DESCRIBE updates the system-descriptor area in these ways:

- It sets the COUNT field in the system-descriptor area to the number of values in the statement list. An error results if COUNT is greater than the number of item descriptors in the system-descriptor area.
- It sets the TYPE, LENGTH, NAME, SCALE, PRECISION, and NULLABLE fields in the system-descriptor area.
If the column has an opaque data type, the database server sets the EXTTYPEID, EXTYPENAME, EXTYPELENGTH, EXTYPEOWNERLENGTH, and EXTYPEOWNERNAME fields of the item descriptor.
- It allocates memory for the DATA field for each item descriptor, based on the TYPE and LENGTH information.

After a DESCRIBE statement is executed, the SCALE and PRECISION fields contain the scale and precision of the column, respectively. If SCALE and PRECISION are set in the SET DESCRIPTOR statement, and TYPE is set to DECIMAL or MONEY, the LENGTH field is modified to adjust for the scale and precision of the decimal value. If TYPE is not set to DECIMAL or MONEY, the values for SCALE and PRECISION are not set, and LENGTH is unaffected.

You must modify system-descriptor-area information with SET DESCRIPTOR statements to show the address in memory that is to receive the described value. You can change the data type to another compatible type. This change causes data conversion to take place when data values are fetched.

You can use the system-descriptor area in prepared statements that support a USING SQL DESCRIPTOR clause, such as EXECUTE, FETCH, OPEN, and PUT.

The following examples show the use of a system descriptor in a DESCRIBE statement. In the first example, the system descriptor is a quoted string; in the second example, it is an embedded variable name.

```
main()
{
    ...
EXEC SQL allocate descriptor 'desc1' with max 3;
EXEC SQL prepare curs1 FROM 'select * from tab';
EXEC SQL describe curs1 using sql descriptor 'desc1';
}
EXEC SQL describe curs1 using sql descriptor :desc1var;
```

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Using the INTO sqllda Pointer Clause

Use the INTO *sqllda_pointer* clause to allocate memory for an **sqllda** structure and store its address in an **sqllda** pointer. The DESCRIBE statement fills in the allocated memory with descriptive information. Unlike the USING clause, the INTO clause creates new **sqllda** structures to store the output from DESCRIBE.

The DESCRIBE statement sets the **sqllda.sqlld** field to the number of values in the statement list. The **sqllda** structure also contains an array of data descriptors (**sqlvar** structures), one for each value in the statement list. After a DESCRIBE statement is executed, the **sqllda.sqllvar** structure has the **sqltype**, **sqllen**, and **sqlname** fields set.

If the column has an opaque data type, DESCRIBE...INTO sets the **sqlxid**, **sqltypename**, **sqltypelen**, **sqlownerlen**, and **sqlownername** fields of the item descriptor.

The DESCRIBE statement allocates memory for an **sqllda** pointer once it is declared in a program. The application program, however, must designate the storage area of the **sqllda.sqllvar.sqlldata** fields.

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Describing a Collection Variable

The DESCRIBE statement can provide information about a collection variable when you use the USING SQL DESCRIPTOR or INTO clause. You must issue the DESCRIBE statement *after* you open the Select or Insert cursor, because the OPEN...USING statement specifies the name of the collection variable to use.

The next Informix® ESQL/C code fragment dynamically selects the elements of the **:a_set** collection variable into a system-descriptor area called **desc1**:

```
EXEC SQL BEGIN DECLARE SECTION;
    client collection a_set;
    int i, set_count;
    int element_type, element_value;
EXEC SQL END DECLARE SECTION;

EXEC SQL allocate collection :a_set;
EXEC SQL allocate descriptor 'desc1';
EXEC SQL select set_col into :a_set from table1;
EXEC SQL prepare set_id from 'select * from table(?)'

EXEC SQL declare set_curs cursor for set_id;
EXEC SQL open set_curs using :a_set;
EXEC SQL describe set_id using sql descriptor 'desc1';

do
{
    EXEC SQL fetch set_curs using sql descriptor 'desc1';
    ...
    EXEC SQL get descriptor 'desc1' :set_count = count;
    for (i = 1; i <= set_count; i++)
    {
        EXEC SQL get descriptor 'desc1' value :i
            :element_type = TYPE;
        switch
        {
            case SQLINTEGER:
                EXEC SQL get descriptor 'desc1' value :i
                    :element_value = data;
                ...
        } /* end switch */
    } /* end for */
} while (SQLCODE == 0);

EXEC SQL close set_curs;
EXEC SQL free set_curs;
EXEC SQL free set_id;
EXEC SQL deallocate collection :a_set;
EXEC SQL deallocate descriptor 'desc1';
```

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DESCRIBE INPUT statement

Use the DESCRIBE INPUT statement to return input parameter information before a prepared statement is executed.

Use this statement with ESQL/C.

Syntax

```
>>-DESCRIBE INPUT--+-statement_var+----->
                        '-statement_id--'

>--+--USING--SQL DESCRIPTOR--+-'descriptor'--+-----><
|                               '-descriptor_var-' |
| '-INTO--+-SQL DESCRIPTOR--+-'descriptor'-----+-' |
|           |                               '-descriptor_var-' |
|           | (1)                                     |
|           | '-----sqllda_pointer-----' |
```

Notes:

1. Informix® extension

Element	Description	Restrictions	Syntax
<i>descriptor</i>	Name of a system-descriptor area	System-descriptor area must already be allocated	Quoted String
<i>descriptor_var</i>	Host variable specifying a system-descriptor area	Must contain the name of an allocated system-descriptor area	Language-specific rules for names
<i>sqllda_pointer</i>	Pointer to an sqllda structure	Cannot begin with dollar (\$) sign or colon (:). An sqllda structure is required if dynamic SQL is used.	See the sqllda structure in the <i>IBM Informix ESQL/C Programmer's Manual</i> .
<i>statement_id</i>	Statement identifier for a prepared SQL statement	Must be defined in a previously executed PREPARE statement	PREPARE statement ; PREPARE statement ; Identifier
<i>statement_var</i>	Host variable that contains the value of <i>statement_id</i>	Variable and <i>statement_id</i> both must be declared	Language-specific rules for names

Usage

The DESCRIBE INPUT and the DESCRIBE OUTPUT statements can return information about a prepared statement to an SQL Descriptor Area (**sqllda**):

- For a SELECT, EXECUTE FUNCTION (or PROCEDURE), INSERT, or UPDATE statement, the DESCRIBE statement (with no INPUT keyword) returns the number, data types, and size of the returned values, and the name of the column or expression.
- For a SELECT, EXECUTE FUNCTION, EXECUTE PROCEDURE, DELETE, INSERT, or UPDATE statement, the DESCRIBE INPUT statement returns all the input parameters of a prepared statement.

Tip: Informix versions earlier than 9.40 do not support the *INPUT* keyword. For compatibility with legacy applications, *DESCRIBE* without *INPUT* is supported. In new applications, you should use DESCRIBE INPUT statements to provide information about dynamic parameters in the WHERE clause, in subqueries, and in other syntactic contexts where the old form of DESCRIBE cannot provide information.

With this information, you can write code to allocate memory to hold retrieved values that you can display or process after they are fetched.

The **IFX_UPDESC** environment variable does not need to be set before you can use DESCRIBE INPUT to obtain information about an UPDATE statement.

- [Describing the Statement Type](#)
- [Checking for Existence of a WHERE Clause](#)
- [Describing a Statement with Dynamic Runtime Parameters](#)
- [Using the SQL DESCRIPTOR Keywords](#)
- [Using the INTO sqllda Pointer Clause](#)
- [Describing a Collection Variable](#)

The DESCRIBE INPUT statement can provide information about a collection variable if you use the INTO or USING SQL DESCRIPTOR clause.

Related reference:

[DESCRIBE statement](#)
[ALLOCATE DESCRIPTOR statement](#)
[DEALLOCATE DESCRIPTOR statement](#)
[DECLARE statement](#)
[EXECUTE statement](#)
[FETCH statement](#)
[GET DESCRIPTOR statement](#)
[OPEN statement](#)
[PREPARE statement](#)
[PUT statement](#)
[SET DESCRIPTOR statement](#)

Related information:

[Dynamic host variables](#)
[A system-descriptor area](#)

Describing the Statement Type

This statement takes a statement identifier from a PREPARE statement as input. After DESCRIBE INPUT executes, the SQLCODE field of the **sqlca** indicates the statement type (that is, the keyword with which the statement begins). If a prepared object contains more than one SQL statement, DESCRIBE INPUT returns the type of the first statement in the prepared text.

SQLCODE is set to zero to indicate a SELECT statement *without* an INTO TEMP clause. This situation is the most common. For any other SQL statement, SQLCODE is set to a positive integer. You can compare the number with the named constants that are defined in the **sqltypes.h** header file.

The DESCRIBE and DESCRIBE INPUT statements use SQLCODE differently from other statements, under some circumstances returning a nonzero value after successful execution. You can revise standard error-checking routines to accommodate this behavior, if desired.

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Checking for Existence of a WHERE Clause

If the DESCRIBE INPUT statement detects that a prepared object contains an UPDATE or DELETE statement without a WHERE clause, the database server sets the **sqlca.sqlwarn.sqlwarn4** variable to **W**.

When you do not specify a WHERE clause in either a DELETE or UPDATE statement, the database server performs the delete or update action on the entire table. Check the **sqlca.sqlwarn.sqlwarn4** variable after DESCRIBE INPUT executes to avoid unintended global changes to your table.

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Describing a Statement with Dynamic Runtime Parameters

If the prepared statement specifies a set of parameters whose cardinality or data types must be supplied at runtime, you can describe these input values. If the prepared statement text includes one of the following statements, the DESCRIBE INPUT statement returns a description of each column or expression that is included in the list:

- EXECUTE FUNCTION (or EXECUTE PROCEDURE)
- INSERT or SELECT
- UPDATE or DELETE

The description includes the following information:

- The data type of the column, as defined in the table
- The length of the column, in bytes
- The name of the column or expression
- Information about *dynamic parameters* (parameters that are expressed as question (?) mark symbols within the prepared statement)

If the database server cannot infer the data type of an expression parameter, the DESCRIBE INPUT statement returns SQLUNKNOWN as the data type.

You can specify a destination for the returned information as a new or existing system-descriptor area, or as a pointer to an **sqllda** structure.

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Using the SQL DESCRIPTOR Keywords

Specify INTO SQL DESCRIPTOR to create a new system-descriptor structure and store the description of a prepared statement list in that structure.

Use the USING SQL DESCRIPTOR clause to store the description of a prepared statement list in a previously allocated system-descriptor area. Executing the DESCRIBE INPUT . . . USING SQL DESCRIPTOR statement updates an existing system-descriptor area in the following ways:

- It allocates memory for the DATA field for each item descriptor, based on the TYPE and LENGTH information.
- It sets the COUNT field in the system-descriptor area to the number of values in the statement list. An error results if COUNT is greater than the number of item descriptors in the system-descriptor area.
- It sets the TYPE, LENGTH, NAME, SCALE, PRECISION, and NULLABLE fields in the system-descriptor area.

For columns of opaque data types, the DESCRIBE INPUT statement sets the EXTTYPEID, EXTYPENAME, EXTYPELENGTH, EXTYPEOWNERLENGTH, and EXTYPEOWNERNAME fields of the item descriptor.

After a DESCRIBE INPUT statement executes, the SCALE and PRECISION fields contain the scale and precision of the column, respectively. If SCALE and PRECISION are set in the SET DESCRIPTOR statement, and TYPE is set to DECIMAL or MONEY, the LENGTH field is modified to adjust for the decimal scale and

precision. If TYPE is not set to DECIMAL or MONEY, the values for SCALE and PRECISION are not set, and LENGTH is unaffected.

You must modify the system-descriptor-area information with the SET DESCRIPTOR statement to specify the address in memory that is to receive the described value. You can change the data type to another compatible type. This causes data conversion to take place when the data values are fetched.

You can also use the system-descriptor area in other statements that support a USING SQL DESCRIPTOR clause, such as EXECUTE, FETCH, OPEN, and PUT.

The following examples show the use of a system descriptor in a DESCRIBE statement. In the first example, the system descriptor is a quoted string; in the second example, it is an embedded variable name.

```
main()
{
    . . .
    EXEC SQL allocate descriptor 'desc1' with max 3;
    EXEC SQL prepare curs1 FROM 'select * from tab';
    EXEC SQL describe curs1 using sql descriptor 'desc1';
}
EXEC SQL describe curs1 using sql descriptor :desc1var;
```

A system-descriptor area conforms to the X/Open standards.

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Using the INTO sqllda Pointer Clause

The INTO *sqllda_pointer* clause allocates memory for an **sqllda** structure and store its address in an **sqllda** pointer. The DESCRIBE INPUT statement fills in the allocated memory with descriptive information.

The DESCRIBE INPUT statement sets the **sqllda.sqlld** field to the number of values in the statement list. The **sqllda** structure also contains an array of data descriptors (**sqlvar** structures), one for each value in the statement list. After a DESCRIBE statement is executed, the **sqllda.sqlvar** structure has the **sqltype**, **sqlllen**, and **sqlname** fields set.

If the column has an opaque data type, DESCRIBE INPUT . . . INTO sets the **sqlxid**, **sqltypename**, **sqltypelen**, **sqlownerlen**, and **sqlownername** fields of the item descriptor.

The DESCRIBE INPUT statement allocates memory for an **sqllda** pointer once it is declared in a program. The application program, however, must designate the storage area of the **sqllda.sqlvar.sqldata** fields.

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Describing a Collection Variable

The DESCRIBE INPUT statement can provide information about a collection variable if you use the INTO or USING SQL DESCRIPTOR clause.

You must execute the DESCRIBE INPUT statement *after* you open the Select or Insert cursor. Otherwise, DESCRIBE INPUT cannot get information about the collection variable because it is the OPEN . . . USING statement that specifies the name of the collection variable to use.

The next Informix® ESQL/C program fragment dynamically selects the elements of the **:a_set** collection variable into a system-descriptor area called **desc1**:

```
EXEC SQL BEGIN DECLARE SECTION;
    client collection a_set;
    int i, set_count;
    int element_type, element_value;
EXEC SQL END DECLARE SECTION;

EXEC SQL allocate collection :a_set;
EXEC SQL allocate descriptor 'desc1';
EXEC SQL select set_col into :a_set from table1;
EXEC SQL prepare set_id from
    'select * from table(?)';

EXEC SQL declare set_curs cursor for set_id;
EXEC SQL open set_curs using :a_set;
EXEC SQL describe set_id using sql descriptor 'desc1';do
{
    EXEC SQL fetch set_curs using sql descriptor 'desc1';
    . . .
    EXEC SQL get descriptor 'desc1' :set_count = count;
    for (i = 1; i <= set_count; i++)
    {
        EXEC SQL get descriptor 'desc1' value :i
            :element_type = TYPE;
        switch
        {
            case SQLINTEGER:
                EXEC SQL get descriptor 'desc1' value :i
                    :element_value = data;
                . . .
        } /* end switch */
    }
```

```

    } /* end for */
} while (SQLCODE == 0);

EXEC SQL close set_curs;
EXEC SQL free set_curs;
EXEC SQL free set_id;
EXEC SQL deallocate collection :a_set;
EXEC SQL deallocate descriptor 'desc1';

```

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DISCONNECT statement

Use the DISCONNECT statement to terminate a connection between an application and a database server.

Syntax

```

>>-DISCONNECT--+CURRENT-----+-----><
      | (1) |
+-----+ALL-----+
| -DEFAULT- |
| -+-'connection'----+
| -connection_var- |

```

Notes:

1. ESQL/C only

Element	Description	Restrictions	Syntax
<i>connection</i>	String that specifies a connection to terminate	Connection name that the CONNECT statement assigned	Quoted String
<i>connection_var</i>	Host variable that holds the name of a connection	Must be a fixed-length character data type	Language specific

Usage

DISCONNECT terminates a connection to a database server. If a database is open, it closes before the connection drops. Even if you made a connection to a specific database only, the connection to the database server is terminated by DISCONNECT. If DISCONNECT does not terminate the current connection, the connection context of the current environment is not changed.

DISCONNECT is not valid as statement text in a PREPARE statement.

In ESQL/C, if you disconnect with *connection* or *connection_var*, DISCONNECT generates an error if the specified connection is not a current or dormant connection.

- [DEFAULT Option](#)
- [Specifying the CURRENT Keyword](#)
- [When a Transaction is Active](#)
- [Disconnecting in a Thread-Safe Environment](#)
- [Specifying the ALL Option](#)

Related reference:

[DROP DATABASE statement](#)

[CONNECT statement](#)

[DATABASE statement](#)

[SET CONNECTION statement](#)

[CLOSE DATABASE statement](#)

Related information:

[The DISCONNECT ALL Statement](#)

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DEFAULT Option

DISCONNECT DEFAULT disconnects the default connection.

The *default connection* is one of the following connections:

- A connection established by the CONNECT TO DEFAULT statement
- An implicit default connection established by the DATABASE or CREATE DATABASE statement

You can use DISCONNECT to drop the default connection. If the DATABASE statement does not specify a database server, as in the following example, the default connection is made to the default database server:

```
EXEC SQL database 'stores_demo';
. . .
EXEC SQL disconnect default;
```

If the DATABASE statement specifies a database server, as the following example shows, the default connection is made to that database server:

```
EXEC SQL database 'stores_demo@mydbserver';
. . .
EXEC SQL disconnect default;
```

In either case, the DEFAULT option of DISCONNECT disconnects this default connection. For more information, see [The DEFAULT Connection Specification](#).

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Specifying the CURRENT Keyword

The DISCONNECT CURRENT statement terminates the current connection. For example, the DISCONNECT statement in the following program fragment terminates the current connection to the database server **mydbserver**:

```
CONNECT TO 'stores_demo@mydbserver';
. . .
DISCONNECT CURRENT;
```

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When a Transaction is Active

DISCONNECT generates an error during a transaction. The transaction remains active, and the application must explicitly commit it or roll it back. If an application terminates without issuing DISCONNECT (because of a system failure or program error, for example), active transactions are rolled back.

In an ANSI-compliant database, however, if no error is encountered while you exit from DB-Access in non-interactive mode without issuing the CLOSE DATABASE, COMMIT WORK, or DISCONNECT statement, the database server automatically commits any open transaction.

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Disconnecting in a Thread-Safe Environment

If you issue the DISCONNECT statement in a thread-safe Informix® ESQL/C application, keep in mind that an active connection can be disconnected only from within the thread in which it is active. Therefore, one thread cannot disconnect the active connection of another thread. The DISCONNECT statement generates an error if such an attempt is made.

Once a connection becomes dormant, however, any other thread can disconnect it unless an ongoing transaction is associated with the dormant connection that was established with the WITH CONCURRENT TRANSACTION clause of CONNECT. If the dormant connection was not established with the WITH CONCURRENT TRANSACTION clause, DISCONNECT generates an error when it tries to disconnect the connection.

For an explanation of connections in a thread-safe Informix ESQL/C application, see [SET CONNECTION statement](#).

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Specifying the ALL Option

Use the keyword ALL to terminate all connections established by the application up to that time. For example, the following DISCONNECT statement disconnects the current connection as well as all dormant connections:

```
DISCONNECT ALL;
```

In Informix® ESQL/C, the ALL keyword has the same effect on multithreaded applications that it has on single-threaded applications. Execution of the DISCONNECT ALL statement causes all connections in all threads to be terminated. However, the DISCONNECT ALL statement fails if any of the connections is in use or has an ongoing transaction associated with it. If either of these conditions is true, none of the connections is disconnected.

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DROP ACCESS_METHOD statement

Use the DROP ACCESS_METHOD statement to remove a previously defined primary or secondary access method from the database.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP--ACCESS_METHOD--+-----+--access_method----->
                        '-IF EXISTS-'

>--RESTRICT-----><
```

Element	Description	Restrictions	Syntax
<i>access_method</i>	Name of access method to drop	Must be registered in sysams system catalog table; cannot be a built-in access method	Identifier
<i>owner</i>	Owner of the access method	Must own the access method	Owner name

Usage

The RESTRICT keyword is required. You cannot drop an access method if virtual tables or indexes exist that use the access method. You must be the owner of the access method or have DBA privileges to drop an access method.

If a transaction is in progress, the database server waits to drop the access method until the transaction is committed or rolled back. No other users can execute the access method until the transaction has completed.

If you include the optional IF EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if no access method of the specified name is registered in the current database.

Example

For this example, suppose that an access method was created by this statement:

```
CREATE SECONDARY ACCESS_METHOD T_tree
(
    am_getnext = ttree_getnext,
    am_unique,
    am_cluster,
    am_sptype = 'S'
);
```

The following statement drops this access method:

```
DROP ACCESS_METHOD T_tree RESTRICT;
```

Details of existing access methods can be found in the **sysams** system catalog table with the following query:

```
SELECT am_name FROM informix.sysams;
```

Related concepts:

[Specifying RESTRICT Mode](#)

Related reference:

[ALTER ACCESS_METHOD statement](#)

[CREATE ACCESS_METHOD statement](#)

[GRANT statement](#)

Related information:

[Access methods](#)

[Access methods](#)

[Grant and limit access to your database](#)

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DROP AGGREGATE statement

Use the DROP AGGREGATE statement to drop a user-defined aggregate that you created with the CREATE AGGREGATE statement.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP AGGREGATE--+-----+--+-----+--aggregate----><
                        '-IF EXISTS-' '- owner --,-'
```

Element	Description	Restrictions	Syntax
<i>aggregate</i>	Name of the user-defined aggregate to be dropped	Must have been previously created with the CREATE AGGREGATE statement	Identifier
<i>owner</i>	Owner of the aggregate	Must own the aggregate	Owner name

Usage

Dropping a user-defined aggregate does not drop the support functions that you defined for the aggregate in the CREATE AGGREGATE statement. The database server does not track dependency of SQL statements on user-defined aggregates that you use in the statements. For example, you can drop a user-defined aggregate that is used in an SPL routine.

The following example drops the user-defined aggregate named **my_avg**:

```
DROP AGGREGATE my_avg;
```

If you include the optional IF EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if no aggregate with the specified name is registered in the current database.

Related reference:

[CREATE AGGREGATE statement](#)

Related information:

[SYSAGGREGATES](#)

[Create user-defined aggregates](#)

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DROP CAST statement

Use the DROP CAST statement to remove an existing cast from the database.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP CAST--+-+-----+----->
      '-IF EXISTS-'
>-- (--source_type--AS--target_type--) -----><
```

Element	Description	Restrictions	Syntax
<i>source_type</i>	Data type that the cast accepts as input	Must exist	Identifier ; Data Type
<i>target_type</i>	Data type returned by the cast	Must exist	Identifier ; Data Type

Usage

You must be owner of the cast or have the DBA privilege to use DROP CAST. Dropping a cast removes its definition from the **syscasts** system catalog table, so the cast cannot be invoked explicitly or implicitly. Dropping a cast has no effect on the user-defined function associated with the cast. Use the DROP FUNCTION statement to remove the user-defined function from the database.

Warning: Do not drop built-in casts, which user **informix** owns. These are required for automatic conversions between built-in data types.

A cast defined on a given data type can also be used on any DISTINCT types created from that source type. If you drop the cast, you can no longer invoke it for the DISTINCT types, but dropping a cast that is defined for a DISTINCT type has no effect on casts for its source type. When you create a DISTINCT type, the database server automatically defines an explicit cast from the DISTINCT type to its source type and another explicit cast from the source type to the DISTINCT type. When you drop the DISTINCT type, the database server automatically drops these two casts.

If you include the optional IF EXISTS keywords, the database server takes no action (rather than sending an error to the application) if no cast between the two specified data types is registered in the current database.

Example

A cast (like this one in the **superstores_demo** database) can be dropped with the DROP CAST statement:

```
DROP CAST (decimal(5,5) AS percent);
```

Details of existing casts can be found in the **syscasts** system catalog table the following SQL:

```
SELECT routine_name, class, argument_type, result_type FROM Syscasts;
```

Related reference:

[CREATE CAST statement](#)

[DROP FUNCTION statement](#)

Related information:

DROP DATABASE statement

Use the DROP DATABASE statement to delete an entire database, including all system catalog tables, objects, and data.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP DATABASE-----+---| Database Name |----->>
                        (1)
                        '-IF EXISTS-'
```

Notes:

1. See [Database Name](#)

Usage

The DROP DATABASE statement is an extension to the ANSI/ISO standard, which does not provide syntax for the destruction of a database.

The following statement drops the **stores_demo** database:

```
DROP DATABASE IF EXISTS stores_demo;
```

You must have the DBA privilege or be user **informix** to run the DROP DATABASE statement successfully. Otherwise, the database server issues an error message and does not drop the database.

Restrictions on the DROP DATABASE statement

You cannot drop the current database or a database that is currently being used by another user. All the current users of the database must first execute the CLOSE DATABASE statement before DROP DATABASE can be successful.

You cannot drop a tenant database with the DROP DATABASE statement. You must drop a tenant database by running the **admin()** or **task()** SQL administration API function with the **tenant drop** argument.

The DROP DATABASE statement attempts to create an implicit connection to the database that you intend to drop. If a previous CONNECT statement has established an explicit connection to another database, and that connection is still your current connection, the DROP DATABASE statement fails with error -1811. In this case, you must first use the DISCONNECT statement to close the explicit connection before you can execute the DROP DATABASE statement.

If you include the optional IF EXISTS keywords, the database server takes no action (rather than returning an error to the application) if no database of the specified name is managed by the database server instance to which you are connected.

The DROP DATABASE statement cannot appear in a multistatement PREPARE statement, nor within an SPL routine.

In a DROP DATABASE operation, the database server acquires a lock on each table in the database and holds the locks until the entire operation is complete. Configure your database server with enough locks to accommodate this fact.

For example, if the database to be dropped has 2500 tables, but fewer than 2500 locks were configured for your database server, the DROP DATABASE statement fails. For more information on how to configure the number of locks available to the database server, see the discussion of the LOCKS configuration parameter in your *IBM® Informix® Administrator's Reference*.

In DB-Access, use the DROP DATABASE statement with caution. DB-Access does not prompt you to verify that you want to delete the entire database.

In ESQ/C, you can use an unqualified database name in a program or host variable, or you can specify the fully-qualified *database@server* format. For example, the following statement drops the **stores_demo** database of a database server called **gibson95**:

```
EXEC SQL DROP DATABASE stores_demo@gibson95;
```

If this statement executes successfully, the **gibson95** database server instance continues to exist, but the **stores_demo** database of that database server no longer exists. For more information, see [Database Name](#).

Related reference:

[CREATE DATABASE statement](#)

[CLOSE DATABASE statement](#)

[CONNECT statement](#)

[DATABASE statement](#)

[DISCONNECT statement](#)

[DROP TABLE statement](#)

Related information:

[LOCKS configuration parameter](#)

DROP FUNCTION statement

Use the DROP FUNCTION statement to remove a user-defined function from the database. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP FUNCTION----->
      '-IF EXISTS-'

>--+-----function-----+-->
| '- owner --.-'          | .,-----, | |
|                          | V          | |
|                          | '---parameter_type---' |
|                          | (1) |
| '-SPECIFIC FUNCTION-----| Specific Name |-----'
|                          | '-IF EXISTS-'
```

Notes:

- 1. See [Specific Name](#)

Element	Description	Restrictions	Syntax
<i>function</i>	Name of the user-defined function to be dropped	Must exist (that is, be registered) in the database. If the name does not uniquely identify a function, you must enter one or more appropriate values for <i>parameter_type</i> .	Identifier
<i>parameter_type</i>	Data type of the parameter	The data type (or list of data types) must be the same data types (and specified in the same order) as in the CREATE FUNCTION statement that registered the function	Data Type

Usage

Dropping a user-defined function removes the text and executable versions of the function from the database. (Make sure to keep a copy of the function text somewhere outside the database, in case you need to re-create a function after it is dropped.)

If you do not know whether a UDR is a function or a procedure, you can drop it by using the DROP ROUTINE statement.

To use the DROP FUNCTION statement, you must be the owner of the user-defined function (and hold the Resource privilege on the database) or have the DBA privilege. You must also hold the Usage privilege on the programming language in which the UDR is written. To drop an external user-defined function, see also [Dropping an External Routine](#).

You cannot use the DROP ROUTINE, DROP FUNCTION, or DROP PROCEDURE statement to drop a protected routine. For more information about protected routines, see the description of the **sysprocedures** system catalog table in the *IBM® Informix Guide to SQL: Reference*.

You cannot drop an SPL function from within the same SPL function.

Informix® can resolve a function by its *specific name*, if the function definition declared a specific name. If you use the specific name in this statement, you must also use the keyword SPECIFIC, as in the following example:

```
DROP SPECIFIC FUNCTION compare_point;
```

Otherwise, if the *function* name is not unique within the database, you must specify enough *parameter_type* information to disambiguate the name. If you use parameter data types to identify a user-defined function, they follow the function name, as in the following example:

```
DROP FUNCTION compare (int, int);
```

But the database server returns an error if it cannot resolve an ambiguous function name whose signature differs from that of another function only in an unnamed ROW-type parameter. (This error cannot be anticipated by the database server when the ambiguous *function* is defined.)

If you include the optional IF EXISTS keywords, the database server takes no action (rather than issue an error) if the database server cannot find in the current database any function that matches what your DROP FUNCTION statement specifies.

Determine whether a function exists

Before you attempt to drop a user-defined function, you can check for its existence in the database by querying the system catalog. In the following example, the SELECT statement retrieves from the **sysprocedures** table any routines whose identifier is MyFunction:

```
SELECT * FROM sysprocedures WHERE procname = MyFunction;
```

If this query returns a single row, then a UDR called MyFunction is registered in the current database.
If this query returns no rows, you do not need to issue the DROP FUNCTION statement, but you might wish to verify that the WHERE clause specified the correct name, and that you are connected to the correct database.

If the query returns more than one row, then the routine name MyFunction is overloaded in the current database, and you need to examine the attributes of the MyFunction routines to determine which of them, if any, need to be unregistered by the DROP FUNCTION statement.

Examples

Most functions can be dropped using SQL statements similar to the following:

```
DROP FUNCTION best_month;
```

If you have more than one function with the same name, however, by using function overloading, the DROP FUNCTION statement must either specify the specific name of the function (if it has one), or the parameter list to uniquely identify it. For example, the **superstores_demo** database has two **last_contact** functions that were created with the following arguments:

```
CREATE FUNCTION last_contact(cust_name name_t) ...
```

and

```
CREATE FUNCTION last_contact(c_num INT) ...
```

To drop the second of these functions, use the following:

```
DROP FUNCTION last_contact(INT);
```

If the above functions had been created with the specific names **last_cname_contact** and **last_cnum_contact**, then to drop the second of these, issue the following statement:

```
DROP SPECIFIC FUNCTION last_cnum_contact;
```

Details of existing functions can be found in the **sysprocedures** system catalog table using SQL queries like the following:

```
SELECT procname, specificname, paramtypes
FROM sysprocedures ;
```

- [Dropping External Functions](#)

Related concepts:

[Overloading the Name of a Function](#)

Related reference:

[ALTER FUNCTION statement](#)

[CREATE FUNCTION statement](#)

[CREATE FUNCTION FROM statement](#)

[DROP PROCEDURE statement](#)

[DROP ROUTINE statement](#)

[EXECUTE FUNCTION statement](#)

[GRANT statement](#)

[CREATE PROCEDURE statement](#)

[DROP CAST statement](#)

[ALTER ROUTINE statement](#)

Related information:

[SYSPROCEDURES](#)

[A user-defined routine](#)

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Dropping External Functions

A user-defined function (UDF) written in C language or in the Java™ language is called an *external function*. External functions must include the External Routine Reference clause that specifies a shared-object filename. By default, only users to whom the DBSA has granted the built-in EXTEND role can create or drop an external function. You must also hold the Usage privilege on the external programming language in which the UDF is written. See the section [Granting the EXTEND Role](#) for additional information about the EXTEND role security feature. See the section [Language-Level Privileges](#) for the syntax of the USAGE ON LANGUAGE clause for the C language or for the Java language.

To remove the executable version of a C language routine from shared memory, call the **IFX_UNLOAD_MODULE** function. To replace the executable version of a C routine with another routine, call the **IFX_REPLACE_MODULE** function. Both of these built-in functions are described in [UDR Definition Routines](#).

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DROP INDEX statement

Use the DROP INDEX statement to remove an index.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP INDEX-----+-----+-----+-----index----->
          '-IF EXISTS-' '- owner -- . '
```

```
>--+-----+-----><
'-ONLINE-'
```

Element	Description	Restrictions	Syntax
<i>index</i>	Name of the index to be dropped	Must exist in the database	Identifier
<i>owner</i>	Name of index owner	Must own the index	Owner name

Usage

In a typical online transaction processing (OLTP) environment, concurrent applications are connected to the database server to perform DML operations. For every query, the optimizer chooses a plan that is based on existing indexes, distribution statistics, and directives. After numerous OLTP transactions, however, the chosen plan might no longer be the best plan for query execution. In this case, dropping an inefficient index can sometimes improve performance.

You must be the owner of the *index* or have the DBA privilege to use the DROP INDEX statement. The following example drops the index **o_num_ix** that **joeed** owns. The **stores_demo** database must be the current database:

```
DROP INDEX stores_demo:joeed.o_num_ix;
```

You cannot use the DROP INDEX statement to drop a unique constraint, nor to drop an index that supports a constraint; you must use the ALTER TABLE . . . DROP CONSTRAINT statement to drop the constraint. When you drop the constraint, the database server automatically drops any index that exists solely to support that constraint. If you attempt to use DROP INDEX to drop an index that is shared by a unique constraint, the database server renames the specified index in the **sysindexes** system catalog table, declaring a new name in this format:

```
[space]<tabid>_<constraint_id>
```

Here *tabid* and *constraint_id* are from the **systables** and **sysconstraints** system catalog tables, respectively. The **sysconstraints.idxname** column is then updated to something like: " 121_13" (where quotation marks show the leading blank space). If this index is a unique index with only referential constraints sharing it, the index is downgraded to a duplicate index after it is renamed.

In some contexts, an alternative to the DROP INDEX statement is the SET Database Object Mode statement, which can disable a specified index without removing it from the system catalog. For more information about this SQL statement, which can also enable an index that is currently disabled, see [SET Database Object Mode statement](#).

If you include the optional IF EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if no index of the specified name is registered in the current database.

Example

An index such as the one found in the *stores_demo* database can be dropped with:

```
DROP INDEX zip_ix;
```

If necessary, you can specify the index name as the fully qualified four-part object name (*database@instance:owner.indexname*), as in the following:

```
DROP INDEX stores_demo@prod:"informix".zip_ix ;
```

Details of existing functions can be found in the *sysprocedures* system catalog table, as in the following:

```
SELECT idxname FROM sysindices ;
```

- [The ONLINE keyword of DROP INDEX](#)

For indexes that were not defined with the IN TABLE keyword option, the DBA can reduce the risk of nonexclusive access errors, and can increase the availability of the indexed table, by including the ONLINE keyword as the last specification of the DROP INDEX statement. The ONLINE keyword instructs the database server to drop the index while minimizing the duration of an exclusive lock, so that the index can be dropped while concurrent users are accessing the table.

Related reference:

[RENAME INDEX statement](#)

[CREATE INDEX statement](#)

[ALTER TABLE statement](#)

[CREATE TABLE statement](#)

[CREATE TEMP TABLE statement](#)

[DROP OPCLASS statement](#)

Related information:

[Indexes and index performance considerations](#)

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The ONLINE keyword of DROP INDEX

For indexes that were not defined with the IN TABLE keyword option, the DBA can reduce the risk of nonexclusive access errors, and can increase the availability of the indexed table, by including the ONLINE keyword as the last specification of the DROP INDEX statement. The ONLINE keyword instructs the database server to drop the index while minimizing the duration of an exclusive lock, so that the index can be dropped while concurrent users are accessing the table.

After you issue the DROP INDEX ONLINE statement, the query optimizer does not consider using the specified index in subsequent query plans or cost estimates, and the database server does not support any other DDL operations on the indexed table, until after the specified index has been dropped. Query operations that were initiated prior to the DROP INDEX ONLINE statement, however, can continue to access the index until the queries are completed.

By default, the DROP INDEX ONLINE statement does not wait indefinitely for locks to be released. If one or more concurrent sessions hold locks on the table, the statement might fail with error -216 or -113 unless you first issue the SET LOCK MODE TO WAIT statement to specify an indefinite wait. Otherwise, DROP INDEX ONLINE uses the waiting period for locks that the DEADLOCK_TIMEOUT configuration parameter specifies, or that a previous SET LOCK MODE statement specified. To avoid locking errors, execute SET LOCK MODE TO WAIT (with no specified limit) before you attempt to drop an index online.

The indexed table in a DROP INDEX ONLINE statement can be permanent or temporary, logged or unlogged, and fragmented or non-fragmented. You cannot specify the ONLINE keyword, however, when you are dropping an index that has any of the following attributes:

- The following statement instructs the database server to drop online an index called **idx_01**:

For indexes defined with the `IN TABLE` keyword option, however, the indexed table remains locked for the duration of the `DROP INDEX ONLINE` operation. While the in-table index is being dropped, attempted access by other sessions to the locked table would fail with one or more of these errors:

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This statement is an extension to the ANSI/ISO standard for SQL.

```
>>-DROP OPCLASS--+-----+--+-----+--opclass----->
                '-IF EXISTS-'  '- owner -- . '
>--RESTRICT----->>
```

Element	Description	Restrictions	Syntax
<i>opclass</i>	Name of operator class to be dropped	Must have been created by a previous CREATE OPCLASS statement	Identifier
<i>owner</i>	Name of opclass owner	Must own the operator class	Owner name

The **RESTRICT** keyword causes **DROP OPERCLASS** to fail if the database contains indexes defined on the operator class that you plan to drop. Therefore, before you drop the operator class, you must use the **DROP INDEX** statement to drop any dependent indexes.

```
DROP OPCLASS abs btree ops RESTRICT
```

Related reference:
[CREATE OPCLASS statement](#)

DROP PROCEDURE statement

Use the DROP PROCEDURE statement to drop a user-defined procedure from the database. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP----->
>--+--PROCEDURE--+---+----+procedure-----++->
|      '-IF EXISTS-'   '|- owner --.' | |(1) -----function'| | .-,-----.| || 
|                        |              | |          v           | |    |
|                               (2)     |-(-(parameter_type+)-)| |    
'-SPECIFIC PROCEDURE--+-----+- Specific Name |-----'
               '-IF EXISTS-'
```

Notes:

1. Informix®-SPL language only
2. See [Specific Name](#)

Element	Description	Restrictions	Syntax
<i>function</i>	Name of a procedure or SPL function to drop	Must exist (that is, be registered) in the database	Identifier
<i>owner</i>	Name of UDR owner	Must own the procedure or SPL function	Owner name
<i>parameter_type</i>	The data type of the parameter	The data type (or list of data types) must be the same types (and in the same order) as those specified when the procedure was created	Identifier ; Data Type
<i>procedure</i>	Name of user-defined procedure to drop	Must exist (that is, be registered) in the database	Database Object Name

Usage

Dropping a user-defined procedure removes the text and executable version of the procedure from the database. You cannot drop an SPL procedure within the same SPL procedure.

You cannot use the DROP ROUTINE, DROP FUNCTION, or DROP PROCEDURE statement to drop a protected routine. For more information about protected routines, see the description of the **sysprocedures** system catalog table in the *IBM® Informix Guide to SQL: Reference*.

To use the DROP PROCEDURE statement, you must be the owner of the procedure and also hold the Resource privilege on the database, or have the DBA privilege. You must also hold the Usage privilege on the programming language in which the UDR is written. To drop an external user-defined procedure, see also [Dropping an External Procedure](#).

If the *function* or *procedure* name is not unique within the database, you must specify enough *parameter_type* information to disambiguate the name. If the database server cannot resolve an ambiguous UDR name whose signature differs from that of another UDR only in an unnamed ROW type parameter, an error is returned. (This error cannot be anticipated by the database server when the ambiguous *function* or *procedure* is defined.)

If you do not know whether a UDR is a user-defined procedure or a user-defined function, you can use the `DROP ROUTINE` statement. For more information, see [DROP ROUTINE statement](#).

For compatibility with earlier Informix versions, you can use this statement to drop an SPL function that CREATE PROCEDURE created. You can include parameter data types after the name of the procedure to identify the procedure:

```
DROP PROCEDURE compare(int, int);
```

If you use the specific name for the user-defined procedure, you must also use the keyword **SPECIFIC**, as in the following example:

```
DROP SPECIFIC PROCEDURE compare point;
```

If you include the optional IF EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if no procedure of the specified name is registered in the current database.

Determine whether a procedure exists

Before you attempt to drop a user-defined procedure, you can check for its existence in the database by querying the system catalog. In the following example, the `SELECT` statement retrieves from the `sysprocedures` table any routines whose identifier is `MyProcedure`:

```
SELECT * FROM sysprocedures WHERE procname = MyProcedure;
```


If this query returns a single row, then a UDR called `MyProcedure` is registered in the current database.

If this query returns no rows, you do not need to issue the `DROP PROCEDURE` statement, but you might wish to verify that the `WHERE` clause specified the correct name, and that you are connected to the correct database.

If the query returns more than one row, then the routine name `MyProcedure` is overloaded in the current database, and you need to examine the attributes of the `MyProcedure` routines to determine which of them, if any, need to be unregistered by the `DROP PROCEDURE` statement.

- [Dropping an External Procedure](#)

Related reference:

[DROP FUNCTION statement](#)
[CREATE PROCEDURE FROM statement](#)
[DROP ROUTINE statement](#)
[EXECUTE PROCEDURE statement](#)
[GRANT statement](#)
[CREATE PROCEDURE statement](#)
[ALTER ROUTINE statement](#)
[ALTER PROCEDURE statement](#)

Related information:

[SYSPROCEDURES](#)
[Create user-defined routines](#)

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Dropping an External Procedure

A user-defined procedure (UDP) written in C language or in the Java™ language is called an *external routine*. External routines must include the External Routine Reference clause that specifies a shared-object filename. By default, only users to whom the DBSA has granted the built-in `EXTEND` role can create or drop an external routine. You must also hold the `Usage` privilege on the external programming language in which the UDP is written. See the section [Granting the `EXTEND` Role](#) for additional information about the `EXTEND` role security feature. See the section [Language-Level Privileges](#) for the syntax of the `USAGE ON LANGUAGE` clause for the C language or for the Java language.

To remove the executable version of a C language procedure from shared memory, call the `IFX_UNLOAD_MODULE` function. To replace the executable version of a C routine with another routine, call the `IFX_REPLACE_MODULE` function. Both of these built-in functions are described in [UDR Definition Routines](#).

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DROP ROLE statement

Use the `DROP ROLE` statement to remove a user-defined role from the database.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP ROLE-----+-----+-----+role--+-----+-----><
      '-IF EXISTS-'   '-role'-'
```

Element	Description	Restrictions	Syntax
<i>role</i>	Name of the role to be dropped	Must be registered in the local database. When a <i>role</i> name is enclosed in quotation marks, it is case sensitive.	Owner name

Usage

Either the DBA or a user to whom the role was granted with the `WITH GRANT OPTION` keywords can issue the `DROP ROLE` statement. (Like a *user* name, a *role* is an authorization identifier, not a database object, so a *role* has no owner.)

If you include the optional `IF EXISTS` keywords, the database server takes no action (rather than sending an exception to the application) if no role of the specified name is registered in the current database.

After you drop a role, no user can grant or enable the dropped role, and any user who had been assigned the role loses its privileges (such as table-level privileges or routine-level privileges) when the role is dropped, unless the same privileges were granted to `PUBLIC` or to the user individually. If the dropped role was the default role of a user, the default role for that user becomes `NULL`.

The following statement drops the role **engineer**:

```
DROP ROLE engineer;
```

You cannot use the `DROP ROLE` statement to drop a built-in role, such as the `EXTEND` or `DBSECADM` roles of Informix®.

Related reference:

Related information:
[Access-management strategies](#)

DROP ROUTINE statement

Use the DROP ROUTINE statement to remove a user-defined routine (UDR) from the database.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP----->
>--+ROUTINE-+-----+--+--routine-+-----+--+<
|          '-IF EXISTS-' '- owner -- . '      | .-,------. | |
|                                              | v         | |
|                                              |'-(---parameter_type---)' |
|                                              |(1)           |
|'-SPECIFIC ROUTINE--+-----+--+ Specific Name |------'|
|          '-IF EXISTS-'
```

Notes:

1. See [Specific Name](#)

Element	Description	Restrictions	Syntax
<i>owner</i>	Name of UDR owner	Must own the UDR	Owner name
<i>parameter_type</i>	Data type of a parameter of <i>routine</i>	The data type (or list of data types) must be the same type (and specified in the same order) as in the UDR definition	Identifier ; Data Type
<i>routine</i>	Name of the UDR to drop	The UDR must exist (that is, be registered) in the database	Identifier

Usage

Dropping a UDR removes the text and executable versions of the UDR from the database. If you do not know whether a UDR is a user-defined function or a user-defined procedure, this statement instructs the database server to drop the specified user-defined function or user-defined procedure.

To use the DROP ROUTINE statement, you must be the owner of the UDR (and also hold the Resource privilege on the database), or you must have the DBA privilege. You must also hold the Usage privilege on the programming language in which the UDR is written. To drop an external user-defined routine, see also [Dropping an External Routine](#).

- Restrictions
- Dropping an External Routine

Related concepts:

Overloading the Name of a Function

Related reference:

DROP FUNCTION statement

DROP PROCEDURE statement

CREATE PROCEDURE statement

EXECUTE FUNCTION statement

CREATE FUNCTION statement

EXECUTE PROCEDURE statement

GRANT statement

ALTER ROUTINE statement

ALTER PROCEDURE statement

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Restrictions

You cannot drop an SPL routine from within the same SPL routine.

You cannot use the DROP ROUTINE, DROP FUNCTION, or DROP PROCEDURE statement to drop a protected routine. For more information about protected routines, see the description of the **sysprocedures** system catalog table in the *IBM® Informix® Guide to SQL: Reference*.

To use the DROP ROUTINE statement to unregister a UDR, the type of UDR cannot be ambiguous. The name of the UDR that you specify must refer to either a user-defined function or a user-defined procedure. If either of the following conditions exist, the database server returns an error:

- The name (and parameters) that you specify apply to both a user-defined procedure and a user-defined function,
- The *specific* name that you specify applies to both a user-defined procedure and a user-defined function.

If the *routine* name is not unique within the database, you must specify enough *parameter_type* information to disambiguate the name. If the database server cannot resolve an ambiguous routine name whose signature differs from that of another routine only in an unnamed ROW type parameter, an error is returned. (This error cannot be anticipated by the database server when the ambiguous *routine* is defined.)

If you use parameter data types to identify a UDR, they follow the UDR name, as in the following example:

```
DROP ROUTINE compare(INT, INT);
```

If you use the specific name for the UDR, you must also include the keyword SPECIFIC, as in the following example:

```
DROP SPECIFIC ROUTINE compare_point;
```

If you include the optional IF EXISTS keywords, the database server takes no action (rather than issues an error) if the database server cannot find in the current database any routine that matches what your DROP ROUTINE statement specifies.

Determining Whether a Routine Exists

Before you attempt to drop a user-defined routine, you can check for its existence in the database by querying the system catalog. In the following example, the SELECT statement retrieves from the **sysprocedures** table any routines whose identifier is **MyRoutine**:

```
SELECT * FROM sysprocedures WHERE procname = MyRoutine;
```

If this query returns a single row, then a UDR called **MyRoutine** is registered in the current database.

If this query returns no rows, you do not need to issue the DROP ROUTINE statement, but you might wish to verify that the WHERE clause specified the correct name, and that you are connected to the correct database.

If the query returns more than one row, then the routine name **MyRoutine** is overloaded in the current database, and you need to examine the attributes of the **MyRoutine** routines to determine which of them, if any, need to be unregistered by the DROP ROUTINE statement.

Related information:

[SYSPROCEDURES](#)

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Dropping an External Routine

A user-defined routine (UDR) written in C language or in the Java™ language is called an *external routine*. External routines must include the External Routine Reference clause that specifies a shared-object filename. By default, only users to whom the DBSA has granted the built-in EXTEND role can create or drop an external routine. You must also hold the Usage privilege on the external programming language in which the UDR is written. See the section [Granting the EXTEND Role](#) for additional information about the EXTEND security feature. See the section [Language-Level Privileges](#) for the syntax of the USAGE ON LANGUAGE clause for the C language or for the Java language.

To remove the executable version of a C language procedure from shared memory, call the **IFX_UNLOAD_MODULE** function. To replace the executable version of a C routine with another routine, call the **IFX_REPLACE_MODULE** function. Both of these built-in functions are described in [UDR Definition Routines](#).

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DROP ROW TYPE statement

Use the DROP ROW TYPE statement to remove an existing named ROW data type from the database.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP ROW TYPE-----+-----+-----+-----+row_type----->
      '-IF EXISTS-' '- owner --. '
>>-RESTRICT-----><
```

Element	Description	Restrictions	Syntax
<i>owner</i>	Authorization identifier of the owner of <i>row_type</i>	Must own <i>row_type</i>	Owner name
<i>row_type</i>	Name of an existing named ROW data type to be dropped	Must exist. See also the Usage section that follows.	Identifier; Data Type

Usage

The DROP ROW TYPE statement removes the entry for the specified *row_type* from the **sysxdtypes** system catalog table. You must be the owner of the specified named ROW data type or have the DBA privilege to execute the DROP ROW TYPE statement.

If you include the optional IF EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if no named ROW data type of the specified name is registered in the current database.

You cannot drop a named ROW data type if its name is in use in the database. The DROP ROW TYPE statement fails to destroy the specified ROW data type when any of the following conditions are true in the database:

- Any existing tables or columns are using the named ROW data type.
- The named ROW data type is a supertype in an inheritance hierarchy.
- A view is defined on a column of the named ROW data type.

Example of dropping a named ROW type

If the named ROW type **postal_t** is registered in the system catalog of the database, but none of the restrictions listed above apply, then the following statement destroys the ROW data type whose name is **postal_t**:

```
DROP ROW TYPE postal_t RESTRICT;
```

If this DROP ROW TYPE statement succeeds, the row in the system catalog where the named ROW type **postal_t** is registered is deleted from the **sysxdtypes** table.

To drop a named ROW-type column from the schema of a table without removing the corresponding ROW type database object from the system catalog, use the ALTER TABLE . . . DROP COLUMN statement.

The DROP ROW TYPE statement cannot drop unnamed ROW data types.

- [The RESTRICT Keyword](#)
The RESTRICT keyword is required with the DROP ROW TYPE statement. RESTRICT causes DROP ROW TYPE to fail if dependencies on *row_type* exist.

Related reference:

[CREATE ROW TYPE statement](#)

[CREATE DISTINCT TYPE statement](#)

[DROP TYPE statement](#)

Related information:

[System catalog tables](#)

[ROW data type, Named](#)

[User-defined data types](#)

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The RESTRICT Keyword

The RESTRICT keyword is required with the DROP ROW TYPE statement. RESTRICT causes DROP ROW TYPE to fail if dependencies on *row_type* exist.

The DROP ROW TYPE statement fails and returns an error message if any of the following conditions is true:

- The named ROW data type is used for an existing table or column.
Check the **sysables** and **syscolumns** system catalog tables to find out whether any tables or data types use the named ROW data type.
- The named ROW data type is the supertype in an inheritance hierarchy.
Look in the **sysinherits** system catalog table to see which named ROW data types have child types.

The following statement drops the named ROW data type **employee_t**:

```
DROP ROW TYPE employee_t RESTRICT
```

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DROP SECURITY statement

Use the DROP SECURITY statement to remove an existing security object from the current database. The object can be a security policy, security label, or a security label component.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP SECURITY----->  
.-RESTRICT-.
```

```
--+---+ LABEL +-----+ policy +-- label +-----+>>
|               '-IF EXISTS-'                |
| '-LABEL COMPONENT-+-----+ component-'      |
|               '-IF EXISTS-'                  |
|                                     .-RESTRICT-. |
| '-POLICY-+-----+ policy +-- CASCADE +-----+'
|               '-IF EXISTS-'
```

Element	Description	Restrictions	Syntax
<i>component</i>	Security label component to drop	Must exist in the database	Identifier
<i>label</i>	Security label to drop	Must exist in the database as a label of the specified <i>policy</i>	Identifier
<i>policy</i>	Security policy to drop	Must exist in the database	Identifier

Usage

Only DBSECADM can issue this statement. When the DROP SECURITY statement executes successfully, the database server deletes any rows that reference the name or the numeric identifier of the specified object from the tables of the system catalog, including these tables:

- **syssecpolicies** for security policies
- **sysseclabels** for security labels
- **sysseclabelcomponents** for security label components.

The keyword or keywords that follow the SECURITY keyword identify the type of security object that is being dropped.

- SECURITY POLICY *policy* specifies a security policy
- SECURITY LABEL *policy.label* specifies a security label
- SECURITY LABEL COMPONENT *component* specifies a security label component.

There is no SQL statement that selectively drops some elements of a security label component without destroying the entire component object. To remove only a subset of the elements of a security label component from the database, DBSECADM can use the `DROP SECURITY LABEL COMPONENT` statement to drop the component, and then redefine the dropped component, using the `CREATE SECURITY LABEL COMPONENT` statement, but without including any elements that are no longer needed. (An alternative is to drop all the security labels that include the deprecated elements, and then use the `CREATE SECURITY LABEL` statement to redefine new labels with the same components as the dropped labels, but without those elements. In this case, the deprecated elements persist in the database, but no security label uses them as values for their component.)

If you include the optional IF EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if no security object of the specified security object type and of the specified name is registered in the current database.

Examples

The following statement instructs the database server to drop the security label **witty**:

```
DROP SECURITY LABEL witty;
```

The statement fails if any column is protected by the **witty** label, or if any user holds this label.

The next example instructs the database server to drop the security label component **adhesive** from the database:

```
DROP SECURITY LABEL COMPONENT adhesive;
```

The statement fails if any security policy depends on the **adhesive** security label component.

The following example instructs the database server to drop the **best** security policy in CASCADE mode:

DROP SECURITY POLICY best CASCADE;

This statement fails if that policy is currently protecting any table. If this statement succeeds, however, it has the following additional effects because of the CASCADE specification:

- All security labels associated with the **best** security policy are also dropped.
- All exemptions from the **best** security policy are revoked.
- All security labels that were dropped because the **best** security policy was dropped are revoked from all users who hold those labels.
- [Dropping security objects in RESTRICT mode or in CASCADE mode](#)

Related reference:

RENAME SECURITY statement

ALTER SECURITY LABEL COMPONENT statement

CREATE SECURITY LABEL statement

CREATE SECURITY LABEL COMPONENT statement

CREATE SECURITY POLICY statement

CREATE TABLE statement

EXEMPTION Clause

SECURITY LABEL Clause

EXEMPTION Clause

SECURITY LABEL Clause

Related information:

Label-based access control

Dropping security objects in RESTRICT mode or in CASCADE mode

By default, the RESTRICT keyword is in effect when any security object is dropped. Only a security *policy* can be dropped in CASCADE mode. DBSECADM cannot drop a security policy in RESTRICT mode if any of the following conditions are true:

- A table is protected by that security policy
- A security label depends on that security policy
- A user has been granted an exemption from a rule of that security policy.

A security policy cannot be dropped in CASCADE mode if the policy is protecting any table. When a security policy is successfully dropped in CASCADE mode, the following security objects are also dropped or revoked:

- All the security labels that are associated with the dropped security policy
- All the security labels that were dropped are also revoked from the users who hold those labels
- All the exemptions from the dropped security policy are revoked.

A security label cannot be dropped in RESTRICT mode, which is the only supported mode for dropping labels, if any of the following conditions are true:

- A column is protected by that security label
- A user holds that security label.

A security label component cannot be dropped in RESTRICT mode, which is the only supported mode for dropping components, if any security policy depends on that security label component.

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DROP SEQUENCE statement

Use the DROP SEQUENCE statement to remove a sequence object from the database.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP SEQUENCE-+-----+-----+-----+---sequence-----><
                    '-IF EXISTS-'  '- owner -- . '
```

Element	Description	Restrictions	Syntax
<i>owner</i>	Name of sequence owner	Must own the sequence object	Owner name
<i>sequence</i>	Name of a sequence	Must exist in the current database	Identifier

Usage

This statement removes the *sequence* entry from the **syssequences** system catalog table. To drop a sequence, you must be its owner or have the DBA privilege on the database. In an ANSI-compliant database, you must qualify the name of the sequence with the name of its owner (*owner.sequence*) if you are not the owner.

If you include the optional IF EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if no sequence object of the specified name is registered in the current database.

If you drop a sequence, any synonyms for the name of the sequence are also dropped automatically by the database server.

You cannot use a synonym to specify the identifier of the *sequence* in the DROP SEQUENCE statement.

Examples

Suppose you had a sequence created with something code similar to the following:

```
CREATE SEQUENCE Invoice_Numbers
START 10000 INCREMENT 1 NOCYCLE ;
```

Such a sequence can be dropped using the following:

```
DROP SEQUENCE Invoice_Numbers;
```

Details of existing sequences can be found by joining the *syssequences* and *systables* system catalog tables as in the following:

```
SELECT t.tabname SeqName
FROM Syssequences s, Systables t
WHERE t.tabid = s.tabid ;
```

Related reference:

[ALTER SEQUENCE statement](#)
[CREATE SEQUENCE statement](#)
[RENAME SEQUENCE statement](#)
[GRANT statement](#)
[REVOKE statement](#)
[INSERT statement](#)
[SELECT statement](#)
[UPDATE statement](#)

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DROP SYNONYM statement

Use the DROP SYNONYM statement to unregister an existing synonym.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP SYNONYM--+-+-----+-----+-----+-----+-----+-----+-----><
                        '-IF EXISTS-' '- owner --.-'
                        '-synonym-----><
```

Element	Description	Restrictions	Syntax
<i>owner</i>	Owner of <i>synonym</i>	Must own <i>synonym</i>	Owner name
<i>synonym</i>	Synonym to be dropped	The synonym must exist in the current database.	Identifier

Usage

This removes the entries for the *synonym* from the **systables** and **syssynonyms** system catalog tables. You must own the *synonym* or have the DBA privilege to execute the DROP SYNONYM statement. Dropping a synonym has no effect on the table, view, or sequence object to which the synonym points.

If you include the optional IF EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if no synonym of the specified name is registered in the current database.

The following statement drops the synonym **nj_cust**, that user **cathyg** owns:

```
DROP SYNONYM cathyg.nj_cust;
```

DROP SYNONYM is not the only DDL operation that can unregister a synonym. If a table, view, or sequence is dropped, any synonyms that exist in the same database and that refer to that table, view, or sequence object are also dropped.

If a synonym in the current database refers to a dropped table or view in another database, however, that synonym remains registered in the system catalog until you explicitly drop it by using the DROP SYNONYM statement. You can create in the same database another table or view, and declare as its identifier the name of the dropped table or view. (If that is not the name of any table object in the current database, you can instead create a table, view, or sequence object in the current database, and declare as its name the identifier of the table or view that was dropped in the other database.) In either case, the old synonym now refers to the new table object. For a more complete discussion of synonym chaining, see the topic [Chaining Synonyms](#) in the CREATE SYNONYM statement description.

Related reference:

[ALTER SEQUENCE statement](#)
[CREATE SEQUENCE statement](#)
[CREATE SYNONYM statement](#)
[RENAME SEQUENCE statement](#)

Related information:

[SYSSYNONYMS](#)
[SYSSYNTABLE](#)
[SYSTABLES](#)

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DROP TABLE statement

Use the DROP TABLE statement to remove a table with its associated indexes and data. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP TABLE--+-+-----+-----+-----+-----+-----+-----+----->
                        '-IF EXISTS-' '- owner --.-' '-synonym-'
```

```

.-CASCADE-----
>--+----->
'-RESTRICT-'

```

Element	Description	Restrictions	Syntax
<i>owner</i>	Name of table owner	Must own the table	Owner name
<i>synonym</i>	Local synonym for a table that is to be dropped	The synonym and its table must exist, and USETABLENAME must not be set to 1	Identifier
<i>table</i>	Name of a table to drop	Must be registered in the systables system catalog table of the local database	Identifier

Usage

You must be the owner of the table or have the DBA privilege to use the DROP TABLE statement.

If you include the optional IF EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if no table of the specified name is registered in the current database.

If DROP TABLE statement is used with a synonym name, both the synonym and the table identified by the synonym are dropped along with any other synonyms that reference the same table.

You can prevent users from specifying a synonym in DROP table statements by setting the USETABLENAME environment variable. If USETABLENAME is set, an error results if any user attempts to specify DROP TABLE *synonym*.

You cannot drop a system catalog table.

If you issue a DROP TABLE statement, DB-Access does not prompt you to verify that you want to delete an entire table.

- [Effects of the DROP TABLE Statement](#)
- [Specifying CASCADE Mode](#)
- [Specifying RESTRICT Mode](#)
- [Dropping a Table That Contains Opaque Data Types](#)
- [Tables That Cannot Be Dropped](#)

Restrictions exist on the types of tables that you can drop.

Related reference:

[CREATE TABLE statement](#)
[CREATE TEMP TABLE statement](#)
[RENAME TABLE statement](#)
[ADD TYPE Clause](#)
[TRUNCATE statement](#)
[DROP DATABASE statement](#)
[DROP VIEW statement](#)
[DROP XADATASOURCE statement](#)
[DROP TRIGGER statement](#)

Related information:

[Data integrity](#)
[Use CREATE TABLE](#)

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Effects of the DROP TABLE Statement

Use the DROP TABLE statement with caution. When you remove a table, you also delete the data stored in it, the indexes or constraints on the columns (including all the referential constraints placed on its columns), any local synonyms assigned to it, any triggers created on it, and any access privileges granted on the table. You also drop all views based on the table and any violations and diagnostics tables associated with the table.

DROP TABLE does not remove any synonyms for the table that were created in an external database. To remove external synonyms for the dropped table, you must do so explicitly with the DROP SYNONYM statement.

If DROP TABLE statement is used with a synonym name, both the synonym and the table identified by the synonym are dropped along with any other synonyms that reference the same table.

You can prevent users from specifying a synonym in DROP TABLE statements by setting the **USETABLENAME** environment variable. If **USETABLENAME** is set, an error results if any user attempts to specify DROP TABLE *synonym*.

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Specifying CASCADE Mode

The CASCADE keyword in DROP TABLE removes related database objects, including referential constraints built on the table, views defined on the table, and any violations and diagnostics tables associated with the table.

If the table is the supertable in an inheritance hierarchy, CASCADE drops all of the subtables as well as the supertable.

The CASCADE mode is the default mode of the DROP TABLE statement. You can also specify this mode explicitly with the CASCADE keyword.

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Specifying RESTRICT Mode

The RESTRICT keyword can control the drop operation for supertables, for tables that have referential constraints and views defined on them, or for tables that have violations and diagnostics tables associated them. Using the RESTRICT option causes the drop operation to fail and an error message to be returned if any of the following conditions are true:

- Existing referential constraints reference *table*.
- Existing views are defined on *table*.
- Any violations tables or diagnostics tables are associated with *table*.
- The *table* is the supertable in an inheritance hierarchy.

Related reference:

[DROP ACCESS METHOD statement](#)

[DROP XADATASOURCE statement](#)

[DROP XADATASOURCE TYPE statement](#)

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Dropping a Table That Contains Opaque Data Types

Some opaque data types require special processing when they are deleted. For example, if an opaque type contains spatial or multi-representational data, it might provide a choice of how to store the data: inside the internal structure or, for large objects, in a smart large object.

The database server removes opaque types by calling a user-defined support function called **destroy()**. When you execute the DROP TABLE statement on a table whose rows contain an opaque type, the database server automatically invokes the **destroy()** function for the type. The **destroy()** function can perform certain operations on columns of the opaque data type before the table is dropped. For more information about the **destroy()** support function, see *IBM® Informix® User-Defined Routines and Data Types Developer's Guide*.

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Tables That Cannot Be Dropped

Restrictions exist on the types of tables that you can drop.

- You cannot drop any system catalog table.
- You cannot drop a table that is not in the current database.
- You cannot drop a violations table or a diagnostics table.

Before you can drop such a table, you must first issue a STOP VIOLATIONS TABLE statement on the base table with which the violations and diagnostics tables are associated.

The following example removes two tables in the current database. Both are owned by **joed**, the current user. Neither table has an associated violations or diagnostics table, nor a referential constraint or view defined on it.

```
DROP TABLE customer;  
DROP TABLE stores_demo@acctg:joed.state;
```

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DROP TRIGGER statement

Use the DROP TRIGGER statement to remove a trigger definition from the database.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP TRIGGER--+-+-----+-+-----+-+trigger-----><
```

```
'-IF EXISTS-' '- owner --,-'
```

Element	Description	Restrictions	Syntax
<i>owner</i>	Name of the owner of the trigger	Must own the trigger	Owner name
<i>trigger</i>	Name of the trigger to drop	The trigger must exist in the local database	Identifier

Usage

You must be the owner of the trigger or have the DBA privilege to drop the trigger. Dropping a trigger removes the text of the trigger definition and the executable trigger from the database. The row describing the specified trigger is deleted from the **systriggers** system catalog table.

If you include the optional IF EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if no trigger of the specified name is registered in the current database.

Dropping an INSTEAD OF trigger on a complex view (a view with columns from more than one table) revokes any privileges on the view that the owner of the trigger received automatically when creating the trigger, and also revokes any privileges that the owner of the trigger granted to other users. (Dropping a trigger on a simple view does not revoke any privileges.)

The following statement drops the **items_pct** trigger:

```
DROP TRIGGER items_pct;
```

If a DROP TRIGGER statement appears inside an SPL routine that is called by a data manipulation (DML) statement, the database server returns an error.

When multiple triggers are defined on the same table or view for the same triggering event, the order in which the triggers execute is not guaranteed. If you have a preferred sequence of execution, but the triggers are executing in some other sequence, you might wish to drop all of the triggers except the one that you want to run first, and then re-create the other triggers in the relative order in which you want them to execute, so that they are listed in the system catalog in the intended order of execution.

Related concepts:

[INSTEAD OF Triggers on Views](#)

[CREATE TRIGGER statement](#)

Related reference:

[DROP TABLE statement](#)

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DROP TRUSTED CONTEXT statement

Use the DROP TRUSTED CONTEXT statement to destroy a trusted-context object.

This statement is the Informix® extension to the ANSI/ISO standard for SQL. You must hold the database security administrator (DBSECADM) role to drop a trusted context.

Syntax

```
>>-DROP TRUSTED CONTEXT-- context-----><
```

Element	Description	Restrictions	Syntax
<i>context</i>	Trusted-context object to destroy.	Must exist on the current Informix database server instance.	Identifier

Usage

When the DROP TRUSTED CONTEXT statement executes successfully, the specified trusted context object is destroyed. All references to the *context* will be deleted from these tables in the **sysuser** database of the Informix database server instance:

- systtrustedcontext
- systcxattributes
- systcxusers.

If you drop the trusted context while trusted connections for this context are active, those connections remain trusted until they terminate, or until the next reuse attempt. If an attempt is made to switch the user on these trusted connections, however, an error is returned.

The following example of a DROP TRUSTED CONTEXT statement destroys the **cntx1** trusted-context object:

```
DROP TRUSTED CONTEXT cntx1;
```

This example fails if **cntx1** is not the name of a trusted-context object of the current database server instance.

Related reference:

DROP TYPE statement

Use the DROP TYPE statement to remove a user-defined distinct or opaque data type from the database. (You cannot use this statement to remove a built-in data type or a ROW data type.)

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP TYPE--+-+-----+---data_type----->
              '-IF EXISTS-' '- owner -- , '
>--RESTRICT-----><
```

Element	Description	Restrictions	Syntax
<i>data_type</i>	Name of distinct or opaque data type to be removed	Must be an existing user-defined DISTINCT or OPAQUE type in the local database. Cannot be a built-in data type.	Identifier
<i>owner</i>	Authorization identifier of the <i>data type</i> owner	Must own <i>data type</i>	Owner name

Usage

To drop a distinct or opaque data type with the DROP TYPE statement, you must be the owner of the data type or have the DBA privilege. When you use this statement, you remove the data type definition from the database (in the **sysxtdtypes** system catalog table). In general, this statement does not remove any definitions of casts or of support functions associated with that data type.

Important: When you drop a distinct type, the database server automatically drops the two explicit casts between the distinct type and the type on which it is based.

If you include the optional IF EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if no user-defined distinct or opaque data type of the specified name is registered in the current database.

The DROP TYPE statement fails with an error if you attempt to drop a built-in data type, such as the built-in opaque BOOLEAN or LVARCHAR type, or the built-in distinct IDSSECURITYLABEL type.

Do not confuse the DROP TYPE statement with the [DROP ROW TYPE statement](#), which can only destroy named ROW types, including ROW types within data type hierarchies.

You cannot drop a distinct or opaque type if the database contains any casts, columns, or user-defined functions whose definitions reference the data type.

The following statement destroys the **new_type** data type:

```
DROP TYPE new_type RESTRICT;
```

Related reference:

[CREATE OPAQUE TYPE statement](#)
[CREATE DISTINCT TYPE statement](#)
[CREATE ROW TYPE statement](#)
[DROP ROW TYPE statement](#)
[CREATE TABLE statement](#)

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DROP USER statement (UNIX, Linux)

Use the DROP USER statement to remove an internal user.

This statement is an extension to the ANSI/ISO standard for the SQL language.

Syntax

```
>>-DROP USER--user-----><
```

Element	Description	Restrictions	Syntax
<i>user</i>	Authorization identifier of a specific user that you are dropping.	Must be an existing authorization identifier	Owner name

Usage

Only a DBSA can run the DROP USER statement. With a non-root installation, the user who installs the server is the equivalent of the DBSA, unless the user delegates DBSA privileges to a different user.

It is recommended that you do not run the DROP USER statement while the specified user is active on a connection.

Execution of the DROP USER statement can be audited with the DRUR audit code.

Example

The following statement drops the user **bill**:

```
DROP USER bill;
```

Related reference:

[CREATE USER statement \(UNIX, Linux\)](#)

[ALTER USER statement \(UNIX, Linux\)](#)

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DROP VIEW statement

Use the DROP VIEW statement to remove a view from the database.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP VIEW--+-----+--+-----+--+view--+----->
      '-IF EXISTS-' '- owner -- . ' '-synonym-'

      .-CASCADE-----
>--+--+-----+--+-----+-----><
      '-RESTRICT-'
```

Element	Description	Restrictions	Syntax
<i>owner</i>	Name of view owner	Must own the view	Owner name
<i>synonym</i>	Synonym for a view that this statement drops	The <i>synonym</i> and the view to which it points must exist in the local database	Identifier
<i>view</i>	Name of a view to drop	Must exist in systables	Identifier

Usage

To drop a view, you must be the owner or have the DBA privilege.

When you drop a view, you also drop any other views and INSTEAD OF triggers whose definitions depend on that view. (You can also specify this default behavior explicitly with the CASCADE keyword.)

If you include the optional IF EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if no view of the specified name is registered in the current database.

When you include the RESTRICT keyword in the DROP VIEW statement, the drop operation fails if any other existing views are defined on *view*; otherwise, these dependent views would be unregistered by the DROP VIEW operation.

You can query the **sysdepend** system catalog table to determine which views, if any, depend on another view.

The following statement drops the view that is named **cust1**:

```
DROP VIEW cust1
```

Related reference:

[CREATE VIEW statement](#)

[DROP TABLE statement](#)

Related information:

[Views](#)

DROP XADATASOURCE statement

Use the DROP XADATASOURCE statement to drop a previously defined XA-compliant data source from the system catalog of the database.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP--XADATASOURCE--+-----+--xa_source--RESTRICT-----><
      '-IF EXISTS-'
```

Element	Description	Restrictions	Syntax
<i>xa_source</i>	The XA-compliant data source to drop	Must be present in the sysxdatasources system catalog table	Identifier

Usage

The RESTRICT keyword is required. You must be the owner of the XA data source or hold DBA privileges to drop an access method.

The DROP XADATASOURCE statement is not supported on secondary servers within a high-availability cluster.

If you include the optional IF EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if no XA data source of the specified name is registered in the current database.

The following statement drops the XA data source instance called **NewYork** that is owned by user **informix**.

```
DROP XADATASOURCE informix.NewYork RESTRICT;
```

You cannot drop an access method if it is being used in a transaction that is currently open. If an XA data source has been registered with a transaction that is not complete, you can drop the data source only after the database is closed or the session ends.

Related concepts:

[Specifying RESTRICT Mode](#)

Related reference:

[CREATE XADATASOURCE TYPE statement](#)

[CREATE XADATASOURCE statement](#)

[DROP TABLE statement](#)

[DROP XADATASOURCE TYPE statement](#)

Related information:

[XA-compliant external data sources](#)

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DROP XADATASOURCE TYPE statement

Use the DROP XADATASOURCE TYPE statement to drop a previously defined XA-compliant data source type from the database.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-DROP--XADATASOURCE TYPE--+-----+--xa_type--RESTRICT---><
      '-IF EXISTS-'
```

Element	Description	Restrictions	Syntax
<i>xa_type</i>	Name of the XA data source type to be dropped	Must be present in the sysxasourcetypes system catalog table	Identifier

Usage

The RESTRICT keyword is required. You cannot unregister an XA data source type if virtual tables or indexes exist that use the data source. You must be user **informix** or have DBA privileges to drop an XA data source type.

The DROP XADATASOURCE TYPE statement is not supported on secondary servers within a high-availability cluster.

The following statement drops an XA data source type called **MQSeries®** owned by user **informix**:

```
DROP XADATASOURCE TYPE informix.MQSeries RESTRICT;
```

You cannot drop an XA data source type until after all the XA data source instances that use that data source type have been dropped.

If you include the optional IF EXISTS keywords, the database server takes no action (rather than sending an exception to the application) if no XA data source type of the specified name is registered in the current database.

Related concepts:

[Specifying RESTRICT Mode](#)

Related reference:

[CREATE XADATASOURCE TYPE statement](#)

[CREATE XADATASOURCE statement](#)

[DROP XADATASOURCE statement](#)

Related information:

[XA-compliant external data sources](#)

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EXECUTE statement

Use the EXECUTE statement to run a previously prepared statement or a multiple-statement prepared object.

Use this statement with Informix® ESQL/C.

Syntax

```
>>-EXECUTE--+-stmt_id-----+-----+----->
          '-stmt_id_var-' |          (1) |
                   '-| INTO Clause |-----'

>-+-----+-----+-----><
|          (2) |
'-| USING Clause |-----'
```

Notes:

1. See [INTO Clause](#)
2. See [USING Clause](#)

Element	Description	Restrictions	Syntax
stmt_id	Identifier of a prepared SQL statement	Must have been declared in a previous PREPARE statement	Identifier
stmt_id_var	Host variable containing the identifier of a prepared statement	Must exist and must contain a statement identifier that a previous PREPARE statement declared, and must be of a character data type	PREPARE statement

Usage

The EXECUTE statement passes a prepared SQL statement to the database server for execution. The following example shows an EXECUTE statement within the Informix ESQL/C program:

```
EXEC SQL PREPARE del_1 FROM
  'DELETE FROM customer WHERE customer_num = 119';
EXEC SQL EXECUTE del_1;
```

Once prepared, an SQL statement can be executed as often as needed.

After you release the database server resources (using a FREE statement), you cannot use the statement identifier with a DECLARE cursor or with the EXECUTE statement until you prepare the statement again.

If the statement contained question mark (?) placeholders, use the USING clause to provide specific values for them before execution. For more information, see the [USING Clause](#).

You can execute any prepared statement except those in the following list:

- A prepared SELECT statement that returns more than one row
When you use a prepared SELECT statement to return multiple rows of data, you must use a cursor to retrieve the data rows. As an alternative, you can EXECUTE a prepared SELECT INTO TEMP statement to achieve the same result.

For more information on cursors, see [DECLARE statement](#).
- A prepared EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement for an SPL function that returns more than one row
When you prepare an EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement to invoke an SPL function that returns multiple rows, you must use a cursor to retrieve the data rows.

For more information on how to execute a SELECT or an EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement, see [PREPARE statement](#).

- [Scope of Statement Identifiers](#)
- [Restrictions with the INTO Clause](#)

If you execute a prepared SELECT statement that returns more than one row, or execute a prepared EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement for an SPL function that returns more than one group of return values, you receive an error message. In addition, if you prepare and declare a statement and then attempt to execute that statement, you receive an error message.

- [Replacing Placeholders with Parameters](#)
- [Saving Values In Host or Program Variables](#)
- [Saving Values in a System-Descriptor Area](#)
- [Saving Values in an sqlca Structure \(ESOL/C\)](#)
- [The sqlca Record and EXECUTE](#)
- [Returned SQLCODE Values with EXECUTE](#)
- [Supplying Parameters Through Host or Program Variables](#)
- [Supplying Parameters Through a System Descriptor](#)
- [Supplying Parameters Through an sqlca Structure \(ESOL/C\)](#)

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Element	Description	Restrictions	Syntax
<i>descriptor_var</i>	Host variable that identifies a system-descriptor area	System-descriptor area must already be allocated	Language specific
<i>indicator_var</i>	Host variable that receives a return code if corresponding <i>parameter_var</i> is NULL value, or if truncation occurs	Cannot be DATETIME or INTERVAL data type	Language specific
<i>output_var</i>	Host variable whose contents replace a question-mark (?) placeholder in a prepared statement	Must be a character data type	Language specific
<i>sqlda_pointer</i>	Pointer to an sqlda structure that defines data type and memory location of values to replace a question-mark (?) placeholder in a prepared object	Cannot begin with a dollar sign (\$) or a colon (:) symbol. An sqlda structure is required with dynamic SQL	DESCRIBE INPUT statement

This closely resembles the syntax of the [USING Clause](#).

The INTO clause provides a concise and efficient alternative to more complicated and lengthy syntax. In addition, by placing values into variables that can be displayed, the INTO clause simplifies and enhances your ability to retrieve and display data values. For example, if you use the INTO clause, you do not need to use a cursor to retrieve values from a table.

You can store the returned values in output variables, in output SQL descriptors, or in output **sqlda** pointers.

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Restrictions with the INTO Clause

If you execute a prepared SELECT statement that returns more than one row, or execute a prepared EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement for an SPL function that returns more than one group of return values, you receive an error message. In addition, if you prepare and declare a statement and then attempt to execute that statement, you receive an error message.

You cannot select a NULL value from a table column and place that value into an output variable. If you know in advance that a table column contains a NULL value, after you select the data, check the indicator variable that is associated with the column to determine if the value is NULL.

To use the INTO clause with the EXECUTE statement:

1. Declare the output variables that the EXECUTE statement uses.
2. Use PREPARE to prepare your SELECT statement or to prepare your EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement.
3. Use the EXECUTE statement, with the INTO clause, to execute your SELECT statement or to execute your EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement.

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Replacing Placeholders with Parameters

You can specify any of the following items to replace the question-mark placeholders in a prepared statement before you execute it:

- A host variable name (if the number and data type of the parameters are known at compile time)
- A system descriptor that identifies a system descriptor area
- A descriptor that is a pointer to an **sqlda** structure

Sections that follow describe each of these options for specifying parameters.

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Saving Values In Host or Program Variables

If you know the number of return values to be supplied at runtime and their data types, you can define the values that the SELECT or EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement returns as host variables in your program. Use these host variables with the INTO keyword, followed by the names of the variables. These variables are matched with the return values in a one-to-one correspondence, from left to right.

You must supply one variable name for each value that the SELECT or EXECUTE FUNCTION (or EXECUTE PROCEDURE) returns. The data type of each variable must be compatible with the corresponding returned value from the prepared statement.

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Saving Values in a System-Descriptor Area

If you do not know the number of return values to be supplied at runtime or their data types, you can associate output values with a system-descriptor area. A system-descriptor area describes the data type and memory location of one or more values.

A system-descriptor area conforms to the X/Open standards.

To specify a system-descriptor area as the location of output values, use the INTO SQL DESCRIPTOR clause of the EXECUTE statement. Each time that the EXECUTE statement is run, the values that the system-descriptor area describes are stored in the system-descriptor area.

The following example shows how to use the system-descriptor area to execute prepared statements in IBM® Informix® ESQL/C:

```
EXEC SQL allocate descriptor 'desc1';
...
sprintf(sel_stmt, "%s %s %s",
        "select fname, lname from customer",
        "where customer_num =",
        cust_num);
EXEC SQL prepare sell from :sel_stmt;
EXEC SQL execute sell into sql descriptor 'desc1';
```

The COUNT field corresponds to the number of values that the prepared statement returns. The value of COUNT must be less than or equal to the value of the occurrences that were specified when the system-descriptor area was allocated with the ALLOCATE DESCRIPTOR statement.

You can obtain the value of a field with the GET DESCRIPTOR statement and set the value with the SET DESCRIPTOR statement.

For more information, refer to the discussion of the system-descriptor area in the *IBM Informix ESQL/C Programmer's Manual*.

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Saving Values in an sqlda Structure (ESQL/C)

If you do not know the number of output values to be returned at runtime or their data types, you can associate output values from an **sqlda** structure. An **sqlda** structure lists the data type and memory location of one or more return values. To specify an **sqlda** structure as the location of return values, use the INTO DESCRIPTOR clause of the EXECUTE statement. Each time the EXECUTE statement is run, the database server places the returns values that the **sqlda** structure describes into the **sqlda** structure.

The next example uses an **sqlda** structure to execute a prepared statement:

```
struct sqlda *pointer2;
...
sprintf(sel_stmt, "%s %s %s",
        "select fname, lname from customer",
        "where customer_num =",
        cust_num);
EXEC SQL prepare sell from :sel_stmt;
EXEC SQL describe sell into pointer2;
EXEC SQL execute sell into descriptor pointer2;
```

The **sqlda.sqld** value specifies the number of output values that are described in occurrences of **sqlvar**. This number must correspond to the number of values that the SELECT or EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement returns.

For more information, refer to the **sqlda** discussion in the *IBM® Informix ESQL/C Programmer's Manual*.

This example uses the INTO clause with an EXECUTE statement in Informix® ESQL/C:

```
EXEC SQL prepare sell from 'select fname, lname from customer
where customer_num =123';
EXEC SQL execute sell into :fname, :lname using :cust_num;
```

The next example uses the INTO clause to return multiple rows of data:

```
EXEC SQL BEGIN DECLARE SECTION;
int customer_num =100;
char fname[25];
EXEC SQL END DECLARE SECTION;

EXEC SQL prepare sell from 'select fname from customer
where customer_num=?';
for ( ;customer_num < 200; customer_num++)
{
    EXEC SQL execute sell into :fname using customer_num;
    printf("Customer number is %d\n", customer_num);
    printf("Customer first name is %s\n\n", fname);
}
```

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The sqlca Record and EXECUTE

After an EXECUTE statement, the **sqlca** can reflect two results:

- The **sqlca** can reflect an error within the EXECUTE statement.
For example, when an UPDATE ...WHERE statement in a prepared statement processes zero rows, the database server sets **sqlca** to 100.

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You can create a system-descriptor area that describes the data type and memory location of one or more values and then specify the descriptor in the USING SQL DESCRIPTOR clause of the EXECUTE statement.

The COUNT field corresponds to the number of dynamic parameters in the prepared statement. The value of COUNT must be less than or equal to the number of item descriptors that were specified when the system-descriptor area was allocated with the ALLOCATE DESCRIPTOR statement.

```
EXEC SQL execute prep_stmt using sql descriptor 'desc1';
```

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```
EXEC SQL execute prep_stmt using descriptor pointer2;
```

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This statement is an extension to the ANSI/ISO standard for SQL.

```
>>-EXECUTE FUNCTION----->
>-+function--+(-+-----+--)(1) (3)-----| INTO Clause |----->
      | (1) | | . , ----- . |
      |-----SPL_var-| | V | (2) | |
      |-----Argument-----+|
>-+-----+-----<
      | (5) | (6) |
      |-----WITH TRIGGER REFERENCES-----|
```

1. Stored Procedure Language only
2. See [Arguments](#)
3. ESQL/C only
4. See [INTO Clause](#)
5. Trigger functions only
6. See [The WITH TRIGGER REFERENCES Keywords](#)

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Element	Description	Restrictions	Syntax
<i>function</i>	Name of a user-defined function to execute	Must be registered in the database	Database Object Name
<i>SPL_var</i>	Variable that contains the name of an SPL routine to be executed	Must be a CHAR, VARCHAR, NCHAR, or NVARCHAR data type that contains the non-NULL name of an existing SPL function	Identifier

Usage

The EXECUTE FUNCTION statement invokes a user-defined function (UDF), with arguments, and specifies where the results are to be returned.

An external C or Java™ language function returns exactly one value.

An SPL function can return one or more values.

You cannot use the EXECUTE FUNCTION statement to invoke any type of user-defined procedure that returns no value. Instead, use the EXECUTE PROCEDURE or EXECUTE ROUTINE statement to execute procedures.

You must have the Execute privilege on the user-defined function.

For more information, see [GRANT statement](#).

In ANSI/ISO-compliant databases that support implicit transactions, the EXECUTE FUNCTION statement does not, by default, begin a new transaction. SQL statements within the invoked function, however, can begin a new transaction.

- [Negator Functions and Their Companions](#)
- [How the EXECUTE FUNCTION Statement Works](#)
- [Data Variables](#)
- [INTO Clause with Indicator Variables \(ESQL/C\)](#)
- [INTO Clause with Cursors](#)
- [Alternatives to PREPARE ... EXECUTE FUNCTION ... INTO](#)
- [Dynamic Routine-Name Specification of SPL Functions](#)

Related concepts:

[Overloading the Name of a Function](#)

Related reference:

[DROP FUNCTION statement](#)

[CREATE PROCEDURE statement](#)

[CALL](#)

[CREATE FUNCTION statement](#)

[CREATE FUNCTION FROM statement](#)

[DROP ROUTINE statement](#)

[EXECUTE PROCEDURE statement](#)

[FOREACH](#)

[Arguments](#)

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Negator Functions and Their Companions

If a UDF that returns a BOOLEAN value has a companion function, any user who executes the function must have the Execute privilege on both the function and on its companion. For example, if a function has a negator function, any user who executes the function must have the Execute privilege on both the function and its negator. In addition, the companion function must have the same owner as its negator function.

For information on how to designate a UDF as the companion to its negator function, see [NEGATOR](#).

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How the EXECUTE FUNCTION Statement Works

For a user-defined function (UDF) to be executed with the EXECUTE FUNCTION statement, the following conditions must exist:

- The qualified function name or the function signature (the function name with its parameter list) must be unique within the name space or database.
- The function must exist in the current database.

If EXECUTE FUNCTION specifies fewer arguments than the user-defined function expects, the unspecified arguments are said to be *missing*. Missing arguments are initialized to their corresponding parameter default values, if these were defined. The syntax of specifying default values for parameters is described in [Routine Parameter List](#).

EXECUTE FUNCTION returns an error under the following conditions:

- EXECUTE FUNCTION specifies more arguments than the UDF expects.
- One or more arguments are missing and do not have default values.

- If the *function* name is not unique within the database, you must specify enough *parameter_type* information to disambiguate the name. See the section [Arguments](#) for more information about how to specify parameters when invoking a function.

The *specific name* of an external UDR is valid in some DDL statements, but is not valid in contexts where you invoke the function.

If Informix® cannot resolve an ambiguous function name whose signature differs from the signature of another routine only in an unnamed-ROW type parameter, an error is returned. (This error cannot be anticipated by the database server when the ambiguous function is defined.)

INTO Clause

```

INTO Clause
      .-+-----+-.
      |v|-----+|
|--INTO--+data_var--+-----+--+--+--+
      | |         | (1) |-----+--indicator_var--+
      | |         |     |         | (2) |         |
      | |         |     |         |-----$-----+
      | |         |     |         |'-INDICATOR-'|
      | |         |     |         |-----+
      |'-data_structure-----+

```

Notes:

1. ESQL/C only
2. Informix extension

Element	Description	Restrictions	Syntax
<i>data_structure</i>	Structure that was declared as a host variable	Individual elements of structure must be compatible with the data types of the returned values	Language specific
<i>data_var</i>	Variable to receive the value that a user-defined function returns	See Data Variables .	Language specific
<i>indicator_var</i>	Program variable to store a return code if the corresponding <i>data_var</i> receives a NULL value	Use an indicator variable if the value of the corresponding <i>data_var</i> might be NULL	Language specific

You must include an INTO clause with EXECUTE FUNCTION to specify the variables that receive the values that a user-defined function returns. If the function returns more than one value, the values are returned into the list of variables in the order in which you specify them.

If the EXECUTE FUNCTION statement stands alone (that is, it is not part of a DECLARE statement and does not use the INTO clause), it must execute a noncursor function. A noncursor function returns only one row of values. The following example shows a SELECT statement in IBM® Informix ESQL/C:

```
EXEC SQL EXECUTE FUNCTION
    cust_num(fname, lname, company_name) INTO :c_num;
```

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Data Variables

If you issue EXECUTE FUNCTION within an ESLQ/C program, *data_var* must be a host variable. Within an SPL routine, *data_var* must be an SPL variable.

If you issue EXECUTE FUNCTION within a CREATE TRIGGER statement, *data_var* must be a column name in the triggering table or in another table.

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INTO Clause with Indicator Variables (ESQL/C)

You should use an indicator variable if the possibility exists that data returned from the user-defined function is NULL. For more information about indicator variables, see the *IBM® Informix® ESQL/C Programmer's Manual*.

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INTO Clause with Cursors

If EXECUTE FUNCTION calls a UDF that returns more than one row of values, it must execute a cursor function. A cursor function can return one or more rows of values and must be associated with a Function cursor to execute.

If the SPL function returns more than one row or a collection data type, you must access the rows or collection elements with a cursor.

To return more than one row of values, an external function (one written in the C or Java™ language) must be defined as an iterator function. For more information on iterator functions, see the *IBM Informix DataBlade API Programmer's Guide*.

In an SPL routine, if a SELECT returns more than one row, you must use the FOREACH statement to access the rows individually. The INTO clause of the SELECT statement can store the fetched values. For more information, see [FOREACH](#).

To return more than one row of values, an SPL function must include the WITH RESUME keywords in its RETURN statement. For more information on how to write SPL functions, see the *IBM Informix Guide to SQL: Tutorial*.

In IBM® Informix® ESQL/C programs, the DECLARE statement can declare a Function cursor and the FETCH statement can return rows individually from the cursor. You can put the INTO clause in the EXECUTE FUNCTION or in the FETCH statement, but you cannot put it in both. The following IBM Informix ESQL/C code examples show different ways you can use the INTO clause:

- Using the INTO clause in the EXECUTE FUNCTION statement:

```
EXEC SQL declare f_curs cursor for
    execute function get_orders(customer_num)
    into :ord_num, :ord_date;
EXEC SQL open f_curs;
while (SQLCODE == 0)
    EXEC SQL fetch f_curs;
EXEC SQL close f_curs;
```

- Using the INTO clause in the FETCH statement:

```
EXEC SQL declare f_curs cursor for
    execute function get_orders(customer_num);
EXEC SQL open f_curs;
while (SQLCODE == 0)
    EXEC SQL fetch f_curs into :ord_num, :ord_date;
EXEC SQL close f_curs;
```

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Alternatives to PREPARE ... EXECUTE FUNCTION ... INTO

In ESQL/C, you cannot prepare an EXECUTE FUNCTION statement that includes the INTO clause. For similar functionality, however, follow these steps:

1. Prepare the EXECUTE FUNCTION statement with no INTO clause.
2. Declare a Function cursor for the prepared statement.
3. Open the cursor.
4. Execute the FETCH statement with an INTO clause to fetch the returned values into program variables.

Alternatively, you can do the following:

1. Declare a cursor for the EXECUTE FUNCTION statement without first preparing the statement, and include the INTO clause in the EXECUTE FUNCTION when you declare the cursor.
2. Open the cursor.
3. Fetch the returned values from the cursor without using the INTO clause of the FETCH statement.

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Dynamic Routine-Name Specification of SPL Functions

Dynamic routine-name specification simplifies the writing of an SPL function that calls another SPL routine whose name is not known until runtime. To specify the name of an SPL routine in the EXECUTE FUNCTION statement, instead of listing the explicit name of an SPL routine, you can use an SPL variable to hold the routine name. For more information about how to execute SPL functions dynamically, see the *IBM® Informix® Guide to SQL: Tutorial*.

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EXECUTE IMMEDIATE statement

Use the EXECUTE IMMEDIATE statement to perform tasks equivalent to what the PREPARE, EXECUTE, and FREE statements accomplish, but as a single operation.

Use this Dynamic SQL statement with IBM® Informix® ESQL/C and SPL.

Syntax

- PREPARE
- PUT
- SELECT
- SET AUTOFREE
- SET CONNECTION
- SET DEFERRED_PREPARE
- SET DESCRIPTOR
- WHENEVER

For EXECUTE PROCEDURE, this restriction applies only to calls that return one or more values.

The only form of the SELECT statement that EXECUTE IMMEDIATE supports as statement text is `SELECT ... INTO TEMP table`. For the syntax of the INTO TEMP table clause in SELECT statements, see [INTO table clauses](#).

In addition, ESQL/C cannot use the EXECUTE IMMEDIATE statement to execute the following statements in text that contains multiple SQL statements that are separated by semicolons:

- CLOSE DATABASE
- CREATE DATABASE
- DATABASE
- DROP DATABASE
- SELECT (except SELECT INTO TEMP)

The EXECUTE IMMEDIATE statement cannot process SQL statement text that includes question mark (?) symbols as placeholders. Use the PREPARE statement and either a cursor or the EXECUTE statement to execute a dynamically constructed SELECT statement.

(In SPL routines, the EXECUTE IMMEDIATE statement can execute only a single SQL statement. If the specification that immediately follows the IMMEDIATE keyword evaluates to a list of multiple SQL statements, or by a NULL value, or text that is not a valid SQL statement, the database server issues a runtime error.)

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Restrictions on Valid Statements

The following restrictions apply to the statements contained in the character expression, quoted string, or statement variable that immediately follows the EXECUTE IMMEDIATE keywords:

- The SQL statement cannot contain a host-language comment.
- Names of host-language variables are not recognized as such in prepared text.
The only identifiers that you can use are names registered in the system catalog of the current database, such as table names and column names.
- The statement cannot reference a host-variable list or a descriptor; it must not contain any question-mark (?) placeholders, which are allowed with a PREPARE statement.
- The text must not include any embedded SQL statement prefix, such as the dollar sign (\$) or the keywords EXEC SQL.
Although it is not required, the SQL statement terminator (;) can be included in the statement text.
- A SELECT or INSERT statement specified within the EXECUTE IMMEDIATE statement cannot contain a Collection-Derived Table clause.
EXECUTE IMMEDIATE cannot process input host variables, which are required for a collection variable. Use the EXECUTE statement or a cursor to process prepared accesses to collection variables.

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Handling Exceptions from EXECUTE IMMEDIATE Statements

If the Informix® ESQL/C parser detects a syntax error when the EXECUTE IMMEDIATE statement is compiled, it issues a compilation error, and no executable UDR is produced until the syntax is corrected and recompiled. If the parser accepts the EXECUTE IMMEDIATE syntax and the UDR compiles successfully, but an exception occurs during a call to the UDR when the EXECUTE IMMEDIATE statement is executing, the database server issues an error at runtime. Runtime errors can be trapped by the WHENEVER statement, or by some other exception-handling mechanism in the program logic of the UDR.

For routines written in the SPL language, SQL expressions are evaluated at runtime, not when the routine is compiled or optimized. If an expression that follows the IMMEDIATE keyword specifies invalid SQL statement text, Informix issues a runtime exception, rather than a compilation error. After any runtime error condition in an SPL routine, program control passes to the ON EXCEPTION statement block (if this is defined); otherwise, execution of the UDR terminates abnormally, and an error is returned to the calling context. For information on how to handle runtime errors in SPL routines, see the descriptions of the SPL statement [ON EXCEPTION](#). (See also the built-in SQL function **SQLCODE**.)

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Examples of the EXECUTE IMMEDIATE Statement

The following ESQL/C examples show EXECUTE IMMEDIATE statements in Informix® ESQL/C. Both examples use host variables that contain a CREATE DATABASE statement.


```

sprintf(cdb_text1, "create database %s", usr_db_id);
EXEC SQL execute immediate :cdb_text1;

sprintf(cdb_text2, "create database %s", usr_db_id2);
EXEC SQL execute immediate :cdb_text2;

```

The next example shows an SPL program fragment that declares local SPL variables and assigns to them portions of the text of two DDL statements. It then issues an EXECUTE IMMEDIATE statement to drop a table called **DYN_TAB**, specifying the DROP TABLE statement text in an SPL variable. The second EXECUTE IMMEDIATE statement in this example creates a table of the same name, in this case specifying the CREATE TABLE statement text in a character expression that concatenates the contents of two SPL variables.

```

CREATE PROCEDURE myproc()
DEFINE COLS    VARCHAR(22);
DEFINE CRTOPER VARCHAR(16);
DEFINE DRPOPER VARCHAR(16);
DEFINE TABNAME VARCHAR(16);
DEFINE QRYSTR  VARCHAR(100);
...
LET CRTOPER = "CREATE TABLE ";
LET DRPOPER = "DROP TABLE ";
LET TABNAME = "DYN_TAB";
LET COLS = "(ID INT, NAME CHAR(20))";
LET QRYSTR = DRPOPER || TABNAME;
EXECUTE IMMEDIATE QRYSTR;

EXECUTE IMMEDIATE CRTOPER || TABNAME || COLS;

END PROCEDURE;

```

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EXECUTE PROCEDURE statement

Use the EXECUTE PROCEDURE statement to invoke a user-defined procedure or a built-in routine. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```

>>-EXECUTE PROCEDURE----->
>--+procedure-----+(-+-----+)->
| (1) | | .,----- |
+-----SPL_var--+ | V | (2) | |
'-function-----' '----| Argument |-----'
>--+-----+----->
| (1) | | .,----- |
|-----INTO-----output_var--+
>--+-----+-----><
| (3) | |
|-----WITH TRIGGER REFERENCES-

```

Notes:

1. Stored Procedure Language only
2. See [Arguments](#)
3. Trigger routines only

Element	Description	Restrictions	Syntax
<i>function</i>	SPL routine to execute	Must exist	Database Object Name
<i>output_var</i>	Host variable or program variable that receives the returned value from UDR	In the context of a CREATE TRIGGER statement, must contain column names in the triggering table or in another table	Language specific
<i>procedure</i>	User-defined procedure to execute	Must exist	Database Object Name
<i>SPL_var</i>	Variable that contains the name of the SPL routine to execute	Must be a character data type that contains the non-NULL name of an SPL routine.	Identifier

Usage

The EXECUTE PROCEDURE statement invokes a user-defined procedure and specifies its arguments.

For compatibility with earlier Informix® versions, you can use the EXECUTE PROCEDURE statement to execute an SPL function that the CREATE PROCEDURE statement defined.

If the EXECUTE PROCEDURE statement returns more than one row, the result set must be processed within a FOREACH loop of an SPL routine, or else accessed through a cursor of an ESQL/C routine.

In ANSI/ISO-compliant databases that support implicit transactions, the EXECUTE PROCEDURE statement does not, by default, begin a new transaction. SQL statements within the invoked procedure, however, can begin a new transaction.

- [Causes of Errors](#)
EXECUTE PROCEDURE returns an error under the following conditions.
- [Using the INTO Clause](#)
Use the INTO clause to specify where to store the values that the SPL function returns.
- [The WITH TRIGGER REFERENCES Keywords](#)
You must include the WITH TRIGGER REFERENCES keywords when you use the EXECUTE PROCEDURE statement to invoke a trigger procedure.
- [Dynamic Routine-Name Specification of SPL Procedures](#)
Dynamic routine-name specification simplifies the writing of an SPL routine that calls another SPL routine whose name is not known until runtime.

Related concepts:

[INSTEAD OF Triggers on Views](#)

[CREATE TRIGGER statement](#)

Related reference:

[DROP PROCEDURE statement](#)

[CREATE PROCEDURE statement](#)

[EXECUTE FUNCTION statement](#)

[CREATE FUNCTION statement](#)

[GRANT statement](#)

[CALL](#)

[FOREACH](#)

[LET](#)

[DROP ROUTINE statement](#)

[Arguments](#)

[DECLARE statement](#)

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Causes of Errors

EXECUTE PROCEDURE returns an error under the following conditions.

- It has more arguments than the called procedure expects.
- One or more arguments that do not have default values are missing.
- The fully-qualified procedure name or the routine signature is not unique.
- No procedure with the specified name or signature is found.
- In a distributed transaction, a UDR that is running on a subordinate participating server calls a remote procedure on another server instance

For example, the following statement fails with an error:

```
EXECUTE PROCEDURE ifx_unload_module
('C:\usr\apps\opaque_types\circle.dll');
```

This built-in procedure requires a second argument, as explained in the topic [IFX_UNLOAD_MODULE Function](#).

If the *procedure* name is not unique within the database, you must specify enough *parameter_type* information to disambiguate the name. See [Arguments](#) for additional information about how to specify parameters when invoking a procedure. (The *specific name* of an external UDR is valid in DDL statements, but is not valid in contexts where you invoke the procedure.)

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Using the INTO Clause

Use the INTO clause to specify where to store the values that the SPL function returns.

If an SPL function returns more than one value, the values are returned into the list of variables in the order in which you specify them. If an SPL function returns more than one row or a collection data type, you must access the rows or collection elements with a cursor.

You cannot prepare an EXECUTE PROCEDURE statement that has an INTO clause. For more information, see [Alternatives to PREPARE ... EXECUTE FUNCTION ... INTO](#).

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The WITH TRIGGER REFERENCES Keywords

You must include the WITH TRIGGER REFERENCES keywords when you use the EXECUTE PROCEDURE statement to invoke a trigger procedure.

A trigger procedure is an SPL routine that EXECUTE PROCEDURE can invoke only from the FOR EACH ROW section of the Action clause of a trigger definition. Such procedures must include the REFERENCING clause and the FOR clause in the CREATE PROCEDURE statement that defined the procedure. This REFERENCING

clause declares names for correlated variables that the procedure can use to reference the *old* column value in the row when the trigger event occurred, or the *new* value of the column after the row was modified by the trigger. The FOR clause specifies the table or view on which the trigger is defined.

- [Example of Invoking a Trigger Procedure](#)

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Example of Invoking a Trigger Procedure

The following example defines three tables and a trigger procedure that references one of these tables in its FOR clause:

```
CREATE TABLE tab1 (col1 INT,col2 INT);
CREATE TABLE tab2 (col1 INT);
CREATE TABLE temptab1
(old_col1 INT, new_col1 INT, old_col2 INT, new_col2 INT);

/* The following procedure is invoked from an INSERT trigger in this example.
*/
CREATE PROCEDURE proc1()
REFERENCING OLD AS o NEW AS n FOR tab1;

IF (INSERTING) THEN -- INSERTING Boolean operator
    LET n.col1 = n.col1 + 1; -- You can modify new values.
    INSERT INTO temptab1 VALUES (0,n.col1,1,n.col2);
END IF

IF (UPDATING) THEN -- UPDATING Boolean operator
    -- you can access relevant old and new values.
    INSERT INTO temptab1 values(o.col1,n.col1,o.col2,n.col2);
END IF

if (SELECTING) THEN -- SELECTING Boolean operator
    -- you can access relevant old values.
    INSERT INTO temptab1 VALUES(o.col1,0,o.col2,0);
END IF

if (DELETING) THEN -- DELETING Boolean operator
    DELETE FROM temptab1 WHERE temptab1.col1 = o.col1;
END IF

END PROCEDURE;
```

This example illustrates that the triggered action can be a different DML operation from the triggering event. Although this procedure inserts a row when an Insert trigger calls it, and deletes a row when a Delete trigger calls it, it also performs INSERT operations if it is called by a Select trigger or by an Update trigger. The **proc1()** trigger procedure in this example uses Boolean conditional operators that are valid only in trigger routines. The INSERTING operator returns true only if the procedure is called from the FOR EACH ROW action of an INSERT trigger. This procedure can also be called from other triggers whose trigger event is an UPDATE, SELECT, or DELETE. statement, because the UPDATING, SELECTING and DELETING operators return true (t) if the procedure is invoked in the triggered action of the corresponding type of triggering event.

The following statement defines an Insert trigger on **tab1** that calls **proc1()** from the FOR EACH ROW section as its triggered action, and perform an INSERT operation that activates this trigger:

```
CREATE TRIGGER ins_trig_tab1 INSERT ON tab1 REFERENCING NEW AS post
FOR EACH ROW(EXECUTE PROCEDURE proc1() WITH TRIGGER REFERENCES);
```

Note that the REFERENCING clause of the trigger declares a correlation name for the NEW value that is different from the correlation name that the trigger procedure declared. These names do not need to match, because the correlation name that was declared in the trigger procedure has that procedure as its scope of reference. The following statement activates the **ins_trig_tab1** trigger, which executes the **proc1()** procedure.

```
INSERT INTO tab1 VALUES (111,222);
```

Because the trigger procedure increments the new value of **col1** by 1, the value inserted is (112, 222), rather than the value that the triggering event specified.

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Dynamic Routine-Name Specification of SPL Procedures

Dynamic routine-name specification simplifies the writing of an SPL routine that calls another SPL routine whose name is not known until runtime.

To specify the name of an SPL routine in the EXECUTE PROCEDURE statement, instead of listing the explicit name of an SPL routine, you can use an SPL variable to hold the routine name.

If the SPL variable names an SPL routine that returns a value (an SPL function), include the INTO clause of EXECUTE PROCEDURE to specify a *receiving variable* (or variables) to hold the value (or values) that the SPL function returns. For more information on how to execute SPL procedures dynamically, see the *IBM® Informix® Guide to SQL: Tutorial*.

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FETCH statement

Use the FETCH statement to move a cursor to a new row in the active set and to retrieve the row values from memory.

Use this statement with Informix® ESQL/C and with SPL.

Syntax

```
>>FETCH----->  
      (1)   (2) .-NEXT-----  
>-+-----+-----+----->  
      +-PRIOR-----+  
      +-PREVIOUS-----+  
      +-FIRST-----+  
      +-LAST-----+  
      +-CURRENT-----+  
      |               |  
      |             . - + - .  
      +-RELATIVE--+---+-position_num_var-++--|  
      |           |       '-position_num----'| |  
      |           |       '-position_num-----'| |  
      +-ABSOLUTE--+row_position_var-+-----+'  
                  '-row_position-----'  
  
      (1)   (2)  
>-+-----cursor_id_var-+----->  
    '-cursor_id-----'  
  
      (1)   (2)  
>-+-----+-----+-----+-----+-----+-----+-----<  
    |         '-USING--+SQL DESCRIPTOR--+ descriptor '+'-'|  
    |         |                 '-descriptor_var-' |  
    |         |-DESCRIPTOR--sqlda_pointer-----' |  
    |         .-,-----+-----+-----+-----+-----+-----|  
    |         V  
    |-INTO--+output_var-+-----+-----+-----+-----+-----|  
    |         |                (2)                        | | |
    |         |        '+-----+INDICATOR-+-indicator_var-' | |  
    |         |              | (1)                   | |  
    |         |            '----- : -'              | |  
    |         (2)                                     | |  
    |         '+-----data structure-----'          |
```

Notes:

1. Informix extension
2. ESQL/C only

Element	Description	Restrictions	Syntax
<i>cursor_id</i>	Cursor to retrieve rows	Must be open	Identifier
<i>cursor_id_var</i>	Host variable storing <i>cursor_id</i>	Must be character data type	Language specific
<i>data_structure</i>	Structure as a host variable	Must store fetched values	Language specific
<i>descriptor</i>	System-descriptor area	Must have been allocated	Quoted String
<i>descriptor_var</i>	Host variable storing <i>descriptor</i>	Must be allocated	Language specific
<i>indicator_var</i>	Host variable for return code if <i>output_var</i> can be NULL value	See Using Indicator Variables .	Language specific
<i>output_var</i>	Host variable for fetched value	Must store value from row	Language specific
<i>position_num</i>	Position relative to current row	Value 0 fetches current row	Literal Number
<i>position_num_var</i>	Host variable (= <i>position_num</i>)	Value 0 fetches current row	Language specific
<i>row_position</i>	Ordinal position in active set	Must be an integer >1	Literal Number
<i>row_position_var</i>	Host variable (= <i>row_position</i>)	Must be 1 or greater	Language specific
<i>sqllda_pointer</i>	Pointer to an sqllda structure	Cannot begin with \$ nor :	See ESQL/C .

Usage

Except as noted, sections that follow describe how to use the FETCH statement in Informix ESQL/C routines. For information about the more restricted syntax and semantics of the FETCH statement in SPL routines, see [Fetching from Dynamic Cursors in SPL Routines](#).

How the database server creates, stores, and fetches members of the active set of rows depends on whether the cursor was declared as a sequential cursor or as a scroll cursor. All cursors that the FETCH statement can reference in SPL routines are sequential cursors.

In X/Open mode, if a cursor-direction value (such as `NEXT` or `RELATIVE`) is specified, a warning message is issued, indicating that the statement does not conform to X/Open standards.

- [FETCH with a Sequential Cursor](#)
- [FETCH with a Scroll Cursor](#)
- [How the Database Server Implements Scroll Cursors](#)
- [Specifying Where Values Go in Memory](#)
- [Using the INTO Clause](#)
- [Using Indicator Variables](#)
- [When the INTO Clause of FETCH is Required](#)
- [Using a System-Descriptor Area \(X/Open\)](#)
- [Using sqllda Structures](#)

You can use a pointer to an **sqllda** structure to store output values when you do not know the number of values or their data types that a `SELECT` or `EXECUTE FUNCTION` (or `EXECUTE PROCEDURE`) statement returns.

- [Fetching a Row for Update](#)
- [Fetching from a Collection Cursor](#)
- [Checking the Result of FETCH](#)

You can use the **SQLSTATE** variable to check the result of each `FETCH` statement. The database server sets the **SQLSTATE** variable after each SQL statement. If a row is returned successfully, the **SQLSTATE** variable contains the value `00000`. If no row is found, the database server sets the **SQLSTATE** code to `02000`, which indicates no data found, and the current row is unchanged. The following conditions set the **SQLSTATE** code to `02000`, indicating no data found:

Related reference:

[CLOSE statement](#)
[GET DESCRIPTOR statement](#)
[SET AUTOFREE statement](#)
[SET DESCRIPTOR statement](#)
[ALLOCATE DESCRIPTOR statement](#)
[DELETE statement](#)
[EXECUTE statement](#)
[DESCRIBE statement](#)
[DESCRIBE INPUT statement](#)
[DEALLOCATE DESCRIPTOR statement](#)
[Collection-Derived Table](#)
[OPEN statement](#)
[DECLARE statement](#)
[PREPARE statement](#)
[SET DEFERRED PREPARE statement](#)

Related information:

[Fetch rows](#)
[Fetch elements from the select cursor](#)
[A fetch array](#)

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FETCH with a Sequential Cursor

A sequential cursor can fetch only the next row in sequence from the active set. The only option available is the default option, `NEXT`. A sequential cursor can read through a table only once each time the table is opened. The following Informix® ESQL/C example illustrates the `FETCH` statement with a sequential cursor:

```
EXEC SQL FETCH seq_curs INTO :fname, :lname;  
EXEC SQL FETCH NEXT seq_curs INTO :fname, :lname;
```

When the program opens a sequential cursor, the database server processes the query to the point of locating or constructing the first row of data. The goal of the database server is to tie up as few resources as possible.

Because the sequential cursor can retrieve only the next row, the database server can frequently create the active set one row at a time.

On each `FETCH` operation, the database server returns the contents of the current row and locates the next row. This one-row-at-a-time strategy is not possible if the database server must create the entire active set to determine which row is the first row (as would be the case if the `SELECT` statement included an `ORDER BY` clause).

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FETCH with a Scroll Cursor

These Informix® ESQL/C examples illustrate the `FETCH` statement with a scroll cursor:

```
EXEC SQL fetch previous q_curs into :orders;  
EXEC SQL fetch last q_curs into :orders;  
EXEC SQL fetch relative -10 q_curs into :orders;  
printf("Which row? ");  
scanf("%d", &row_num);  
EXEC SQL fetch absolute :row_num q_curs into :orders;
```

A scroll cursor can fetch any row in the active set, either by specifying an absolute row position or a relative offset. Use the following cursor-position options to specify a particular row that you want to retrieve.

Keyword

Effect

NEXT

Retrieves next row in active set

PREVIOUS

Retrieves previous row in active set

PRIOR

Retrieves previous row in active set (Synonymous with PREVIOUS.)

FIRST

Retrieves the first row in active set

LAST

Retrieves the last row in active set

CURRENT

Retrieves the current row in active set (the same row as returned by the previous FETCH statement from the scroll cursor)

RELATIVE

Retrieves *n*th row, relative to the current cursor position in the active set, where *position_num* (or *position_num_var*) supplies *n*. A negative value indicates the *n*th row prior to the current cursor position. If *position_num* = 0, the current row is fetched.

ABSOLUTE

Retrieves *n*th row in active set, where *row_position_var* (or *row_position*) = *n*. Absolute row positions are numbered from 1.

Tip: Do not confuse row-position values with **rowid** values. A **rowid** value is based on the position of a row in its table and remains valid until the table is rebuilt. A row-position value (a value that the ABSOLUTE keyword retrieves) is the relative position of the row in the current active set of the cursor; the next time the cursor is opened, different rows might be selected.

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How the Database Server Implements Scroll Cursors

Because it cannot anticipate which row the program will ask for next, the database server must retain all the rows in the active set until the scroll cursor closes. When a scroll cursor opens, the database server implements the active set as a temporary table, although it might not populate this table immediately.

The first time a row is fetched, the database server copies it into the temporary table as well as returning it to the program.

When a row is fetched for the second time, it can be taken from the temporary table. This scheme uses the fewest resources, in case the program abandons the query before it fetches all the rows. Rows that are never fetched are usually not copied from the database, or are saved in a temporary table.

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Specifying Where Values Go in Memory

Each value from the select list of the query or the output of the executed user-defined function must be returned into a memory location. You can specify these destinations in one of the following ways:

- Use the INTO clause of a SELECT statement.
- Use the INTO clause of an EXECUTE Function (or EXECUTE PROCEDURE) statement.
- Use the INTO clause of a FETCH statement.
- Use a system-descriptor area.
- Use an **sqllda** structure.

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Using the INTO Clause

If you associate a SELECT or EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement with a Function cursor, the statement can contain an INTO clause to specify variables to receive the returned values. You can use this method only when you write the SELECT, EXECUTE FUNCTION, or EXECUTE PROCEDURE statement as part of the cursor declaration; see [DECLARE statement](#). In this case, the FETCH statement cannot contain an INTO clause.

The following example uses the INTO clause of the SELECT statement to specify program variables in Informix ESQL/C:

```
EXEC SQL declare ord_date cursor for
  select order_num, order_date, po_num
    into :o_num, :o_date, :o_po;
EXEC SQL open ord_date;
EXEC SQL fetch next ord_date;
```

If you prepare a SELECT statement, the SELECT *cannot* include the INTO clause so you must use the INTO clause of the FETCH statement.

When you create a SELECT statement dynamically, you cannot use an INTO clause because you cannot name host variables in a prepared statement.

If you are certain of the number and data type of values in the projection list, you can use an INTO clause in the FETCH statement. If user input generated the query, however, you might not be certain of the number and data type of values that are being selected. In this case, you must use either a system descriptor or else a pointer to an **sqllda** structure.

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Using Indicator Variables

Use an indicator variable if the returned data might be null.

The *indicator_var* parameter is optional, but use an indicator variable if the possibility exists that the value of *output_var* is NULL.

If you specify the indicator variable without the INDICATOR keyword, you cannot put a blank space between *output_var* and *indicator_var*.

For information about rules for placing a prefix before the *indicator_var*, see the *IBM® Informix® ESQL/C Programmer's Manual*.

The host variable cannot be a DATETIME or INTERVAL data type.

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When the INTO Clause of FETCH is Required

When SELECT or EXECUTE FUNCTION (or EXECUTE PROCEDURE) omits the INTO clause, you must specify a data destination when a row is fetched.

For example, to dynamically execute a SELECT or EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement, the SELECT or EXECUTE FUNCTION (or EXECUTE PROCEDURE) cannot include its INTO clause in the PREPARE statement. Therefore, the FETCH statement must include an INTO clause to retrieve data into a set of variables. This method lets you store different rows in different memory locations.

You can fetch into a program-array element only by using an INTO clause in the FETCH statement. If you use a program array, you must list both the array name and a specific element of the array in *data_structure*. When you are declaring a cursor, do not refer to an array element within the SQL statement.

Tip: If you are certain of the number and data type of values in the select list of the Projection clause, you can use an INTO clause in the FETCH statement.

In the following Informix® ESQL/C example, a series of complete rows is fetched into a program array. The INTO clause of each FETCH statement specifies an array element as well as the array name:

```
EXEC SQL BEGIN DECLARE SECTION;
char wanted_state[2];
short int row_count = 0;
struct customer_t{
{
    int    c_no;
    char   fname[15];
    char   lname[15];
} cust_rec[100];
EXEC SQL END DECLARE SECTION;

main()
{
    EXEC SQL connect to 'stores_demo';
    printf("Enter 2-letter state code: ");
    scanf ("%s", wanted_state);
    EXEC SQL declare cust cursor for
        select * from customer where state = :wanted_state;
    EXEC SQL open cust;
    EXEC SQL fetch cust into :cust_rec[row_count];
    while (SQLCODE == 0)
    {
        printf("\n%s %s", cust_rec[row_count].fname,
            cust_rec[row_count].lname);
        row_count++;
        EXEC SQL fetch cust into :cust_rec[row_count];
    }
    printf ("\n");
    EXEC SQL close cust;
    EXEC SQL free cust;
}
```

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Using a System-Descriptor Area (X/Open)

You can use a system-descriptor area to store output values when you do not know the number of return values or their data types that a SELECT or EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement returns at runtime. A system-descriptor area describes the data type and memory location of one or more return values, and conforms to the X/Open standards.

The keywords `USING SQL DESCRIPTOR` introduce the name of the system-descriptor area into which you fetch the contents of a row or the return values of a user-defined function. You can then use the `GET DESCRIPTOR` statement to transfer the values that the `FETCH` statement returns from the system-descriptor area into host variables.

The following example shows a valid `FETCH...USING SQL DESCRIPTOR` statement:

```
EXEC SQL allocate descriptor 'desc';
...
EXEC SQL declare selcurs cursor for
  select * from customer where state = 'CA';
EXEC SQL describe selcurs using sql descriptor 'desc';
EXEC SQL open selcurs;
while (1)
{
  EXEC SQL fetch selcurs using sql descriptor 'desc';
}
```

You can also use an **sqlda** structure to supply parameters dynamically.

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Using sqlda Structures

You can use a pointer to an **sqlda** structure to store output values when you do not know the number of values or their data types that a `SELECT` or `EXECUTE FUNCTION` (or `EXECUTE PROCEDURE`) statement returns.

This structure contains data descriptors that specify the data type and memory location for one selected value. The keywords `USING DESCRIPTOR` introduce the name of the pointer to the **sqlda** structure.

Tip: If you know the number and data types of all values in the select list, you can use an `INTO` clause in the `FETCH` statement. For more information, see [When the INTO Clause of FETCH is Required](#).

To specify an **sqlda** structure as the location of parameters:

1. Declare an **sqlda** pointer variable.
2. Use the `DESCRIBE` statement to fill in the **sqlda** structure.
3. Allocate memory to hold the data values.
4. Use the `USING DESCRIPTOR` clause of `FETCH` to specify the **sqlda** structure as the location into which you fetch the returned values.

The following example shows a `FETCH USING DESCRIPTOR` statement:

```
struct sqlda *sqlda_ptr;
...
EXEC SQL declare selcurs2 cursor for
  select * from customer where state = 'CA';
EXEC SQL describe selcurs2 into sqlda_ptr;
...
EXEC SQL open selcurs2;
while (1)
{
  EXEC SQL fetch selcurs2 using descriptor sqlda_ptr;
}
...
```

The **sqlvar** value specifies the number of output values that are described in occurrences of the **sqlvar** structures of the **sqlda** structure. This number must correspond to the number of values returned from the prepared statement.

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Fetching a Row for Update

The `FETCH` statement does not ordinarily lock a row that is fetched. Thus, another process can modify (update or delete) the fetched row immediately after your program receives it. A fetched row is locked in the following cases:

- When you set the isolation level to Repeatable Read, each row that you fetch is locked with a read lock until the cursor closes or until the current transaction ends. Other programs can also read the locked rows.
- When you set the isolation level to Cursor Stability, the current row is locked.
- In an ANSI-compliant database, an isolation level of Repeatable Read is the default; you can set it to something else.
- When you are fetching through an update cursor (one that is declared `FOR UPDATE`), each row you fetch is locked with a promotable lock. Other programs can read the locked row, but no other program can place a promotable or write lock; therefore, the row is unchanged if another user tries to modify it using the `WHERE CURRENT OF` clause of an `UPDATE` or `DELETE` statement.

When you modify a row, the lock is upgraded to a write lock and remains until the cursor is closed or the transaction ends. If you do not modify the row, the behavior of the database server depends on the isolation level you have set. The database server releases the lock on an unchanged row as soon as another row is fetched, unless you are using Repeatable Read isolation. (See [SET ISOLATION statement](#).)

Important: You can hold locks on additional rows even when Repeatable Read isolation is not in use or is unavailable. Update the row with unchanged data to hold it locked while your program is reading other rows. You must evaluate the effect of this technique on performance in the context of your application, and you must be aware of the increased potential for deadlock.

When you use explicit transactions, be sure that a row is both fetched and modified within a single transaction; that is, both the `FETCH` statement and the subsequent `UPDATE` or `DELETE` statement must fall between a `BEGIN WORK` statement and the next `COMMIT WORK` statement.

Fetching from a Collection Cursor

A Collection cursor allows you to access the individual elements of Informix® ESQL/C collection variables. To declare a Collection cursor, use the DECLARE statement and include the Collection-Derived Table segment in the SELECT statement that you associate with the cursor. After you open the collection cursor with the OPEN statement, the cursor allows you to access the elements of the collection variable.

To fetch elements, one at a time, from a Collection cursor, use the FETCH statement and the INTO clause. The FETCH statement identifies the Collection cursor that is associated with the collection variable. The INTO clause identifies the host variable that holds the element value that is fetched from the Collection cursor. The data type of the host variable in the INTO clause must match the element type of the collection.

Suppose you have a table called **children** with the following structure:

```
CREATE TABLE children
(
  age          SMALLINT,
  name         VARCHAR(30),
  fav_colors   SET (VARCHAR(20) NOT NULL),
)
```

The following Informix ESQL/C code fragment shows how to fetch elements from the **child_colors** collection variable:

```
EXEC SQL BEGIN DECLARE SECTION;
  client collection child_colors;
  varchar one_favorite[21];
  char child_name[31] = "marybeth";
EXEC SQL END DECLARE SECTION;
EXEC SQL allocate collection :child_colors;
/* Get structure of fav_colors column for untyped
 * child_colors collection variable */
EXEC SQL select fav_colors into :child_colors
  from children
  where name = :child_name;
/* Declare select cursor for child_colors collection
 * variable */
EXEC SQL declare colors_curs cursor for
  select * from table(:child_colors);
EXEC SQL open colors_curs;
do
{
  EXEC SQL fetch colors_curs into :one_favorite;
  ...
} while (SQLCODE == 0)
EXEC SQL close colors_curs;
EXEC SQL free colors_curs;
EXEC SQL deallocate collection :child_colors;
```

After you fetch a collection element, you can modify the element with the UPDATE or DELETE statements. For more information, see the UPDATE and DELETE statements in this document. You can also insert new elements into the collection variable with an INSERT statement. For more information, see the INSERT statement.

Checking the Result of FETCH

You can use the **SQLSTATE** variable to check the result of each FETCH statement. The database server sets the **SQLSTATE** variable after each SQL statement. If a row is returned successfully, the **SQLSTATE** variable contains the value 00000. If no row is found, the database server sets the **SQLSTATE** code to 02000, which indicates *no data found*, and the current row is unchanged. The following conditions set the **SQLSTATE** code to 02000, indicating *no data found*:

- The active set contains no rows.
- You issue a FETCH NEXT statement when the cursor points to the last row in the active set or points past it.
- You issue a FETCH PRIOR or FETCH PREVIOUS statement when the cursor points to the first row in the active set.
- You issue a FETCH RELATIVE *n* statement when no *n*th row exists in the active set.
- You issue a FETCH ABSOLUTE *n* statement when no *n*th row exists in the active set.

The database server copies the **SQLSTATE** code from the **RETURNED_SQLSTATE** field of the system-diagnostics area. Client-server communication protocols of Informix®, such as SQLI and DRDA, support **SQLSTATE** code values. For a list of these codes, and for information about how to get the message text, see [Using the SQLSTATE Error Status Code](#). You can use the GET DIAGNOSTICS statement to examine the **RETURNED_SQLSTATE** field directly. The system-diagnostics area can also contain additional error information.

You can also use **SQLCODE** variable of the SQL Communications Area (**sqlca**) to determine the same results.

Fetching from Dynamic Cursors in SPL Routines

Use the FETCH statement in an SPL routine to retrieve the next row of the active set of a specified dynamic cursor into an ordered list of SPL variables that were declared in the same SPL routine.

Syntax

The syntax of the FETCH statement in SPL routines is a subset of the syntax that FETCH supports in Informix ESQL/C routines.

```

      .- ,------.
      v |
>>-FETCH-- cursor_id --INTO--- output_var --+-----><

```

Element	Description	Restrictions	Syntax
<i>cursor_id</i>	Name of a dynamic cursor	Must be open and must have been declared in the same SPL routine	Identifier
<i>output_var</i>	An SPL variable to store a fetched value from the row	Must have been declared locally or globally in the calling context, and must be of a data type compatible with the fetched column value	Identifier

Just as in ESQL/C routines, the list of output variables must correspond in number, order, and data type with column values that the SQL statement associated with the rows returned by the specified cursor.

All SPL cursors are sequential cursors. Your UDR must include logic to detect the end of the active set of the cursor, because the NOTFOUND condition does not automatically raise an exception in SPL.

The built-in **SQLCODE** function, which can only be called from SPL routines, can return the status code of a FETCH operation.

All other restrictions of ESQL/C on FETCH statements that reference sequential Select or Function cursors also apply to FETCH operations in SPL.

The FETCH statement in SPL routines does not support the following ESQL/C features:

- cursor names specified as host variables
- positional specifications or positional keywords (which require scroll cursors)
- the USING clause with descriptors or with **sqllda** pointers.

In the SPL language, indicator variables are not needed. If the FETCH operation retrieves a NULL value, the SPL variable that receives that fetched value is set to NULL.

The FETCH statement can reference only dynamic cursors that the DECLARE statement defined. The *cursor_id* cannot specify the name of a direct cursor that the FOREACH statement of SPL declared.

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FLUSH statement

Use the FLUSH statement to force rows that a PUT statement buffered to be written to the database.

Syntax

```

>>-FLUSH--+-cursor_id-----+-----><
          '-cursor_id_var-'

```

Element	Description	Restrictions	Syntax
<i>cursor_id</i>	Name of a cursor	Must have been declared	Identifier
<i>cursor_id_var</i>	Host variable that holds the value of <i>cursor_id</i>	Must be a character data type	Language specific

Usage

Use this statement, which is an extension to the ANSI/ISO standard for SQL, with Informix® ESQL/C.

The PUT statement adds a row to a buffer, whose content is written to the database when the buffer is full. Use the FLUSH statement to force the insertion when the buffer is not full.

If the program terminates without closing the cursor, the buffer is left unflushed. Rows placed into the buffer since the last flush are lost. Do not expect the end of the program to close the cursor and flush the buffer automatically. The following example shows a FLUSH statement that operates on a cursor called **icurs**:

```
FLUSH icurs
```

Example

The following example assumes that a function named *next_cust* returns either information about a new customer or null data to signal the end of input:

```
EXEC SQL BEGIN WORK;
EXEC SQL OPEN new_custs;

while (SQLCODE == 0)
```

```

{
    next_cust();
    if(the_company == NULL)
        break;

    EXEC SQL PUT new_custs;
}

if(SQLCODE == 0) /* if no problem with PUT */
{
    EXEC SQL FLUSH new_custs;
    /* write any rows left */

    if(SQLCODE == 0) /* if no problem with FLUSH */
        EXEC SQL COMMIT WORK; /* commit changes */
}
else
    EXEC SQL ROLLBACK WORK; /* else undo changes */

```

The code in this example calls *next_cust* repeatedly. When it returns non-null data, the **PUT** statement sends the returned data to the row buffer. When the buffer fills, the rows it contains are automatically sent to the database server. The loop normally ends when *next_cust* has no more data to return.

- [Error Checking FLUSH Statements](#)

Related reference:

[CLOSE statement](#)
[DECLARE statement](#)
[OPEN statement](#)
[PREPARE statement](#)
[INSERT statement](#)

Related information:

[An insert cursor](#)
[Exception handling with the sqlca structure](#)

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Error Checking FLUSH Statements

The SQL Communications Area (**sqlca**) structure contains information on the success of each FLUSH statement and the number of rows that are inserted successfully. The result of each FLUSH statement is described in the fields of the **sqlca**: **sqlca.sqlcode**, **SQLCODE**, and **sqlca.sqlerrd[2]**.

When you use data buffering with an Insert cursor, you do not discover errors until the buffer is flushed. For example, an input value that is incompatible with the data type of the column for which it is intended is discovered only when the buffer is flushed. When an error is discovered, any rows in the buffer that are located after the error are *not* inserted; they are lost from memory.

The **SQLCODE** field is set either to an error code or to zero (0) if no error occurs. The third element of the **SQLERRD** array is set to the number of rows that are successfully inserted into the database:

- If a block of rows is successfully inserted into the database, **SQLCODE** is set to zero (0) and **SQLERRD** to the count of rows.
- If an error occurs while the FLUSH statement is inserting a block of rows, **SQLCODE** shows which error, and **SQLERRD** contains the number of rows that were successfully inserted. (Uninserted rows are discarded from the buffer.)

Tip: When you encounter an **SQLCODE** error, a corresponding **SQLSTATE** error value also exists. Client-server communication protocols of Informix®, such as SQLI and DRDA, support **SQLSTATE** code values. For a list of these codes, and for information about how to get the message text, see [Using the SQLSTATE Error Status Code](#).

To count the number of rows actually inserted into the database as well as the number not yet inserted

1. Prepare two integer variables, for example, **total** and **pending**.
2. When the cursor opens, set both variables to 0.
3. Each time a PUT statement executes, increment both **total** and **pending**.
4. Whenever a FLUSH statement executes or the cursor is closed, subtract the third field of the **SQLERRD** array from **pending**.

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FREE statement

Use the FREE statement to release resources that are allocated to a prepared statement or to a cursor.

Syntax

```

>>-FREE--+cursor_id-----+-----><
      +-statement_id-----+
      | (1)                  |
      '-----+cursor_id_var-----'
              '-statement_id_var-'

```

Notes:

1. ESQL/C only

Element	Description	Restrictions	Syntax
<i>cursor_id</i>	Name of a cursor	Must have been declared	Identifier
<i>cursor_id_var</i>	Host variable that holds the value of <i>cursor_id</i>	Must be a character data type	Language specific
<i>statement_id</i>	Identifier of a prepared SQL statement	Must be defined in a previous PREPARE statement	PREPARE statement
<i>statement_id_var</i>	Host variable that stores the name of a prepared object	Must be declared as a character data type.	PREPARE statement

Usage

Use this statement, which is an extension to the ANSI/ISO standard for SQL, with Informix® ESQL/C or with SPL.

FREE releases the resources that the database server and (for ESQL/C) the application-development tool allocated for a prepared statement or for a cursor.

If you declared a cursor for a prepared statement, FREE *statement_id* (or *statement_id_var*) releases only the resources in the application development tool; the cursor can still be used. The resources in the database server are released only when you free the cursor.

If you prepared a statement (but did not declare a cursor for it), FREE *statement_id* (or FREE *statement_id_var*) releases the resources in both the application development tool and the database server.

After you free a statement, you cannot execute it or declare a cursor for it until you prepare it again.

The following Informix ESQL/C example shows the sequence of statements that is used to free an implicitly prepared statement:

```
EXEC SQL prepare sel_stmt from 'select * from orders';
...
EXEC SQL free sel_stmt;
```

The following Informix ESQL/C example shows the sequence of statements that are used to release the resources of an explicitly prepared statement. The first FREE statement in this example frees the cursor. The second FREE statement in this example frees the prepared statement.

```
sprintf(demoselect, "%s %s",
"select * from customer ",
"where customer_num between 100 and 200");
EXEC SQL prepare sel_stmt from :demoselect;
EXEC SQL declare sel_curs cursor for sel_stmt;
EXEC SQL open sel_curs;
...
EXEC SQL close sel_curs;
EXEC SQL free sel_curs;
EXEC SQL free sel_stmt;
```

If you declared a cursor for a prepared statement, freeing the cursor releases only the resources in the database server. To release the resources for the statement in the application-development tool, use FREE *statement_id* (or FREE *statement_id_var*). If a cursor is not declared for a prepared statement, freeing it releases the resources in both the application-development tool and the database server. For an ESQL/C example of a FREE statement that frees a cursor, see the previous example.

After a cursor is freed, it cannot be opened until it is declared again. The cursor should be explicitly closed before it is freed.

When an SPL routine completes execution, the database server automatically releases any resources that had been allocated to the cursor or to prepared statements by PREPARE or DECLARE statements in the routine, if these have not already been released by the FREE statement.

The FREE statement in SPL routines cannot reference the *cursor_id* of a direct cursor that the FOREACH statement of SPL can declare.

Related reference:

[CLOSE statement](#)
[SET AUTOFREE statement](#)
[EXECUTE IMMEDIATE statement](#)
[OPEN statement](#)
[DECLARE statement](#)
[EXECUTE statement](#)
[PREPARE statement](#)

Related information:

[Free prepared statements](#)

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GET DESCRIPTOR statement

Use the GET DESCRIPTOR statement to read from a system descriptor area.

Syntax

```

>>-GET DESCRIPTOR--+-descriptor_var+----->
      '-descriptor '--'

>--+-total_items_var-- = -COUNT-----+-->
      |
      |      .-.-.-.-.-.
      |      V
      |      '-VALUE--+-item_num_var+----| Described Item Information |+-'
      |      '-item_num-----'

Described Item Information

|--field_var-- = --+-DATA-----+-----|
      | +-IDATA-----+
      | +-ILENGTH---+
      | +-INDICATOR--+
      | +-ITYPE-----+
      | +-LENGTH----+
      | +-NAME-----+
      | +-NULLABLE---+
      | +-PRECISION--+
      | +-SCALE-----+
      | '-TYPE-----'
      | (1)
      |-----+-EXTYPEID-----+
      |      +-EXTYPELENGTH-----+
      |      +-EXTYPENAME-----+
      |      +-EXTYPEOWNERLENGTH--+
      |      +-EXTYPEOWNERNAME---+
      |      +-SOURCEID-----+
      |      '-SOURCETYPE-----'

```

Notes:

1. Informix® extension

Element	Description	Restrictions	Syntax
<i>descriptor</i>	Quoted string that identifies a system-descriptor area (SDA)	System-descriptor area must already have been allocated	Quoted String
<i>descriptor_var</i>	Variable that stores <i>descriptor</i> value	Same restrictions as <i>descriptor</i>	Language specific
<i>field_var</i>	Host variable to receive the contents of a field from an SDA	Must be of type that can receive value of a specified SDA field	Language specific
<i>item_num</i>	Unsigned ordinal number of an item described in the SDA	$0 \leq \text{item_num} \leq (\text{number of item descriptors in the SDA})$	Literal Number
<i>item_num_var</i>	Host variable storing <i>item_num</i>	Must be an integer data type	Language specific
<i>total_items_var</i>	Host variable storing the number of items described in the SDA	Must be an integer data type	Language specific

Usage

Use this statement with Informix ESQ/C.

Use the GET DESCRIPTOR statement to accomplish any of the following tasks:

- Determine how many items are described in a system-descriptor area.
- Determine the characteristics of each column or expression that is described in the system-descriptor area.
- Copy a value from the system-descriptor area into a host variable after a FETCH statement.

You can use GET DESCRIPTOR after you describe EXECUTE FUNCTION, INSERT, SELECT, or UPDATE statements with the DESCRIBE . . . USING SQL DESCRIPTOR statement.

The host variables that you reference in the GET DESCRIPTOR statement must be declared in the BEGIN DECLARE SECTION of a program.

If an error occurs during the assignment of a value to any specified host variable, the contents of the host variable are undefined.

Examples

The following ESQ/C example shows how to use a GET DESCRIPTOR statement with a host variable to determine how many items are described in the system-descriptor area called desc1: GET DESCRIPTOR

```

main()
{
    EXEC SQL BEGIN DECLARE SECTION;
        int h_count;
    EXEC SQL END DECLARE SECTION;

    EXEC SQL allocate descriptor 'desc1' with max 20;

    /* This section of program would prepare a SELECT or INSERT
    * statement into the s_id statement id.

```

```
*/
```

```
EXEC SQL describe s_id using sql descriptor 'desc1';  
EXEC SQL get descriptor 'desc1' :h_count = count;
```

The following ESQL/C example uses GET DESCRIPTOR to obtain data type information from the demodesc system-descriptor area:

```
EXEC SQL get descriptor 'demodesc' value  
:index :type = TYPE,  
:len = LENGTH,  
:name = NAME;  
printf("Column %d: type = %d, len = %d, name = %s\n",  
index, type, len, name);
```

The following ESQL/C example shows how you can copy data from the DATA field into a host variable (result) after a fetch. For this example, it is predetermined that all returned values are the same data type:

```
EXEC SQL get descriptor 'demodesc' :desc_count = count;  
...  
EXEC SQL fetch democursor using sql descriptor 'demodesc';  
for (i = 1; i <= desc_count; i++)  
{  
    if (sqlca.sqlcode != 0) break;  
    EXEC SQL get descriptor 'demodesc' value :i :result = DATA;  
    printf("%s ", result);  
}  
printf("\n");
```

- [Using the COUNT Keyword](#)
- [Using the VALUE Clause](#)
- [Using LENGTH or ILENGTH](#)
- [Describing an Opaque-Type Column](#)
- [Describing a Distinct-Type Column](#)

Related reference:

[ALLOCATE DESCRIPTOR statement](#)
[DEALLOCATE DESCRIPTOR statement](#)
[DECLARE statement](#)
[DESCRIBE statement](#)
[EXECUTE statement](#)
[FETCH statement](#)
[OPEN statement](#)
[PREPARE statement](#)
[PUT statement](#)
[SET DESCRIPTOR statement](#)
[DESCRIBE INPUT statement](#)

Related information:

[The GET DESCRIPTOR statement](#)
[SYSXTDTYPES](#)

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Using the COUNT Keyword

Use the COUNT keyword to determine how many items are described in the system-descriptor area.

The following Informix® ESQL/C example shows how to use a GET DESCRIPTOR statement with a host variable to determine how many items are described in the system-descriptor area called **desc1**:

```
main()  
{  
EXEC SQL BEGIN DECLARE SECTION;  
int h_count;  
EXEC SQL END DECLARE SECTION;  
  
EXEC SQL allocate descriptor 'desc1' with max 20;  
  
/* This section of program would prepare a SELECT or INSERT  
* statement into the s_id statement id.  
*/  
EXEC SQL describe s_id using sql descriptor 'desc1';  
  
EXEC SQL get descriptor 'desc1' :h_count = count;  
...  
}
```

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Using the VALUE Clause

Use the VALUE clause to obtain information about a described column or expression or to retrieve values that the database server returns in a system descriptor area.

The *item_num* must be greater than zero (0) but not greater than the number of item descriptors that were specified when the system-descriptor area was allocated with the ALLOCATE DESCRIPTOR statement.

- [Using the VALUE Clause After a DESCRIBE](#)
- [Using the VALUE Clause After a FETCH](#)
- [Fetching a NULL Value](#)

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Using the VALUE Clause After a DESCRIBE

After you describe a SELECT, EXECUTE FUNCTION (or EXECUTE PROCEDURE), INSERT, or UPDATE statement, the characteristics of each column or expression in the select list of the SELECT statement, the characteristics of the values returned by the EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement, or the characteristics of each column in an INSERT or UPDATE statement are returned to the system-descriptor area. Each value in the system-descriptor area describes the characteristics of one returned column or expression.

The following Informix® ESQ/C example uses GET DESCRIPTOR to obtain data type information from the **demodesc** system-descriptor area:

```
EXEC SQL get descriptor 'demodesc' value :index
      :type = TYPE,
      :len = LENGTH,
      :name = NAME;
printf("Column %d: type = %d, len = %d, name = %s\n",
      index, type, len, name);
```

The value that the database server returns into the TYPE field is a defined integer. To evaluate the data type that is returned, test for a specific integer value. For additional information about integer data type values, see [Setting the TYPE or ITYPE Field](#).

In X/Open mode, the X/Open code is returned to the TYPE field. You cannot mix the two modes because errors can result. For example, if a particular data type is not defined under X/Open mode but is defined for IBM® Informix products, executing a GET DESCRIPTOR statement can result in an error.

In X/Open mode, a warning message appears if ILENGTH, IDATA, or ITYPE is used. It indicates that these fields are not standard X/Open fields for a system-descriptor area.

If the TYPE of a fetched value is DECIMAL or MONEY, the database server returns the precision and scale information for a column into the PRECISION and SCALE fields after a DESCRIBE statement is executed. If the TYPE is *not* DECIMAL or MONEY, the SCALE and PRECISION fields are undefined.

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Using the VALUE Clause After a FETCH

Each time your program fetches a row, it must copy the fetched value into host variables so that the data can be used. To accomplish this task, use a GET DESCRIPTOR statement after each fetch of each value in the select list. If three values exist in the select list, you need to use three GET DESCRIPTOR statements after each fetch (assuming you want to read all three values). The item numbers for each of the three GET DESCRIPTOR statements are 1, 2, and 3.

The following Informix® ESQ/C example shows how you can copy data from the DATA field into a host variable (**result**) after a fetch. For this example, it is predetermined that all returned values are the same data type:

```
EXEC SQL get descriptor 'demodesc' :desc_count = count;
...
EXEC SQL fetch democursor using sql descriptor 'demodesc';
for (i = 1; i <= desc_count; i++)
{
    if (sqlca.sqlcode != 0) break;
    EXEC SQL get descriptor 'demodesc' value :i :result = DATA;
    printf("%s ", result);
}
printf("\n");
```

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Fetching a NULL Value

When you use GET DESCRIPTOR after a fetch, and the fetched value is NULL, the INDICATOR field is set to -1 to indicate the NULL value. The value of DATA is undefined if INDICATOR indicates a NULL value. The host variable into which DATA is copied has an unpredictable value.

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Using LENGTH or ILENGTH

If your DATA or IDATA field contains a character string, you must specify a value for LENGTH. If you specify LENGTH=0, LENGTH is automatically set to the maximum length of the string. The DATA or IDATA field might contain a literal character string or a character string that is derived from a character variable of CHAR or VARCHAR data type. This provides a method to determine the length of a string in the DATA or IDATA field dynamically.

If a DESCRIBE statement precedes a GET DESCRIPTOR statement, LENGTH is automatically set to the maximum length of the character field that is specified in your table.

This information is identical for ILENGTH. Use ILENGTH when you create a dynamic program that does not comply with the X/Open standard.

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Describing an Opaque-Type Column

The DESCRIBE statement sets the following item-descriptor fields when the column to fetch has an opaque type as its data type:

- The EXTTYPEID field stores the extended ID for the opaque type. This integer is the value in the corresponding **extended_id** column of the **sysxdtypes** system catalog table.
- The EXTTYPENAME field stores the name of the opaque type. This character value is the value in the **name** column of the row with the matching **extended_id** value in the **sysxdtypes** system catalog table.
- The EXTTYPELENGTH field stores the length of the opaque-type name. This integer is the length of the data type name (in bytes).
- The EXTTYPEOWNERNAME field stores the name of the opaque-type owner. This character value is the value in the **owner** column of the row with the matching **extended_id** value in the **sysxdtypes** system catalog table.
- The EXTTYPEOWNERLENGTH field stores the length of the value in the EXTTYPEOWNERNAME field. This integer is the length, in bytes, of the name of the owner of the opaque type.

Use these field names with the GET DESCRIPTOR statement to obtain information about an opaque column.

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Describing a Distinct-Type Column

The DESCRIBE statement sets the following item-descriptor fields when the column to fetch has a distinct type as its data type:

- The SOURCEID field stores the extended identifier for the source data type. This integer has the value of the **source** column for the row of the **sysxdtypes** system catalog table whose **extended_id** value matches that of the distinct data type. This field is set only if the source data type is an opaque data type.
- The SOURCETYPE field stores the data type constant for the source data type. This value is the data type constant (from the **sqltypes.h** file) for the data type of the source type for the DISTINCT data type. The codes for the SOURCETYPE field are listed in the description of the TYPE field in the SET DESCRIPTOR statement. (For more information, see [Setting the TYPE or ITYPE Field](#).) This integer value must correspond to the value in the **type** column for the row of the **sysxdtypes** system catalog table whose **extended_id** value matches that of the DISTINCT data type.

Use these field names with the GET DESCRIPTOR statement to obtain information about a distinct-type column.

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GET DIAGNOSTICS statement

Use the GET DIAGNOSTICS statement to return diagnostic information about the most recently executed SQL statement.

Syntax

```
>>-GET DIAGNOSTICS--+| Statement Clause |----->>
|                                     (1) |
|                                     (2) |
'-| EXCEPTION Clause |-----'
```

Notes:

1. See [Statement Clause](#)
2. See [EXCEPTION Clause](#)

Usage

Use this statement with Informix® ESQL/C.

The GET DIAGNOSTICS statement retrieves specified status information that the database server records in a structure called the *diagnostics area*. Using GET DIAGNOSTICS does not change the contents of the diagnostics area.

The GET DIAGNOSTICS statement uses one of the following two clauses:

- The Statement clause returns count and overflow information about errors and warnings that the most recent SQL statement generates.
 - The EXCEPTION clause provides specific information about errors and warnings that the most recent SQL statement generates.
- [Using the SQLSTATE Error Status Code](#)
 - [Statement Clause](#)
 - [EXCEPTION Clause](#)
 - [The Contents of the SERVER_NAME Field](#)
 - [The contents of the CONNECTION_NAME field](#)
The CONNECTION_NAME field contains connection information that depends on the previously executed CONNECT, SET CONNECTION, DISCONNECT, or DISCONNECT ALL statement.
 - [Using GET DIAGNOSTICS for Error Checking](#)
GET DIAGNOSTICS returns values from various fields in the diagnostics area. For each field in the diagnostics area that you wish to access, you must supply a host variable of a compatible data type.

Related reference:

[DELETE statement](#)

Related information:

[SQLSTATE value](#)

[Dealing with errors](#)

[Exception handling with SQLSTATE](#)

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Using the SQLSTATE Error Status Code

When an SQL statement executes, an error status code is automatically generated. This code represents success, failure, warning, or no data found. This error status code is stored in a built-in variable called **SQLSTATE**.

- [Class and Subclass Codes](#)
- [SQLSTATE Support for the ANSI/ISO Standard for SQL](#)
- [List of SQLSTATE Codes](#)
- [Using SQLSTATE in Applications](#)

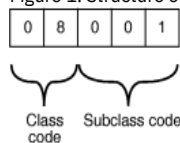
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Class and Subclass Codes

The **SQLSTATE** status code is a five-character string that can contain only digits and uppercase letters.

The first two characters of the **SQLSTATE** status code indicate a class. The last three characters of the **SQLSTATE** code indicate a subclass. [Figure 1](#) shows the structure of the **SQLSTATE** code. This example uses the value 08001, where 08 is the class code and 001 is the subclass code. The value 08001 represents the error unable to connect with database environment.

Figure 1. Structure of the SQLSTATE Code



The following table is a quick reference for interpreting class code values.

SQLSTATE Class Code Value

Outcome

- | | |
|------|----------------------|
| 00 | Success |
| 01 | Success with warning |
| 02 | No data found |
| > 02 | Error or warning |

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SQLSTATE Support for the ANSI/ISO Standard for SQL

All status codes returned to the **SQLSTATE** variable are ANSI-compliant except in the following cases:

- **SQLSTATE** codes with a class code of 01 and a subclass code that begins with an I are Informix®-specific warning messages.
- **SQLSTATE** codes with a class code of IX and any subclass code are Informix-specific error messages.
- **SQLSTATE** codes whose class code begins with a digit in the range 5 to 9 or with an uppercase letter in the range I to Z indicate conditions that are currently undefined by the ANSI/ISO standard for SQL. The only exception is that **SQLSTATE** codes whose class code is IX are Informix-specific error messages.

Client-server communication protocols of Informix, such as SQLI and DRDA, support these **SQLSTATE** code values.

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List of SQLSTATE Codes

This table describes the class codes, subclass codes, and the meaning of all valid warning and error codes associated with the **SQLSTATE** variable.

Class	Subclass	Meaning
00	000	Success.
01	000	Success with warning.
01	002	Disconnect error. Transaction rolled back.
01	003	NULL value eliminated in set function.
01	004	String data, right truncation.
01	005	Insufficient item descriptor areas.
01	006	Privilege not revoked.
01	007	Privilege not granted.
01	I01	Database has transactions.
01	I03	ANSI-compliant database selected.
01	I04	IBM® Informix® database server selected.
01	I05	Float to decimal conversion was used.
01	I06	Informix extension to ANSI-compliant syntax.
01	I07	UPDATE or DELETE statement does not have a WHERE clause.
01	I08	An ANSI keyword was used as a cursor name.
01	I09	Cardinalities of the projection list and of the INTO list are not equal.
01	I10	Database server running in secondary mode.
01	I11	Dataskip is turned on.
02	000	No data found.
07	000	Dynamic SQL error.
07	001	USING clause does not match dynamic parameters.
07	002	USING clause does not match target specifications.
07	003	Cursor specification cannot be executed.
07	004	USING clause is required for dynamic parameters.
07	005	Prepared statement is not a cursor specification.
07	006	Restricted data type attribute violation.
07	008	Invalid descriptor count.
07	009	Invalid descriptor index.
08	000	Connection exception.
08	001	Database server rejected the connection.
08	002	Connection name in use.
08	003	Connection does not exist.
08	004	Client unable to establish connection.
08	006	Transaction rolled back.
08	007	Transaction state unknown.
08	S01	Communication failure.

Class	Subclass	Meaning
0A	000	Feature not supported.
0A	001	Multiple server transactions.
21	000	Cardinality violation.
21	S01	Insert value list does not match column list.
21	S02	Degree of derived table does not match column list.
22	000	Data exception.
22	001	String data, right truncation.
22	002	NULL value, no indicator parameter.
22	003	Numeric value out of range.
22	005	Error in assignment.
22	027	Data exception trim error.
22	012	Division by zero (0).
22	019	Invalid escape character.
22	024	Unterminated string.
22	025	Invalid escape sequence.
23	000	Integrity constraint violation.
24	000	Invalid cursor state.
25	000	Invalid transaction state.
2B	000	Dependent privilege descriptors still exist.
2D	000	Invalid transaction termination.
26	000	Invalid SQL statement identifier.
2E	000	Invalid connection name.
28	000	Invalid user-authorization specification.
33	000	Invalid SQL descriptor name.
34	000	Invalid cursor name.
35	000	Invalid exception number.
37	000	Syntax error or access violation in PREPARE or EXECUTE IMMEDIATE.
3C	000	Duplicate cursor name.
40	000	Transaction rollback.
40	003	Statement completion unknown.
42	000	Syntax error or access violation.
S0	000	Invalid name.
S0	001	Base table or view table already exists.
S0	002	Base table not found.
S0	011	Index already exists.
S0	021	Column already exists.
S1	001	Memory allocation failure.
IX	000	Informix reserved error message.

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Using SQLSTATE in Applications

You can use a built-in variable, called **SQLSTATE**, which you do not need to declare in your program. **SQLSTATE** contains the status code, essential for error handling, which is generated every time your program executes an SQL statement. **SQLSTATE** is created automatically. You can examine the **SQLSTATE** variable to determine whether an SQL statement was successful. If the **SQLSTATE** variable indicates that the statement failed, you can execute a GET DIAGNOSTICS statement to obtain additional error information.

For an example of how to use an **SQLSTATE** variable in a program, see [Using GET DIAGNOSTICS for Error Checking](#).

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Statement Clause

Statement Clause

```
.-----  
V      |  
|-----status_var-- = --+--ROW_COUNT--+-----|  
                        +-NUMBER-----+  
                        '-MORE-----'
```

Element	Description	Restrictions	Syntax
status_var	Host variable to receive status information about the most recent SQL statement for the specified status field name	Must match data type of the field	Language specific

When retrieving count and overflow information, GET DIAGNOSTICS can deposit the values of the three statement fields into a corresponding host variable. The host-variable data type must be the same as that of the requested field. The following keywords represent these three fields.

Field Name Keyword	Field Data Type	Field Contents	ESQL/C Host Variable Data Type
MORE	Character	Y or N	char[2]
NUMBER	Integer	1 to 35,000	int
ROW_COUNT	Integer	0 to 999,999,999	int

- [Using the MORE Keyword](#)
- [Using the ROW_COUNT Keyword](#)
- [Using the NUMBER Keyword](#)

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Using the MORE Keyword

Use the MORE keyword to determine if the most recently executed SQL statement resulted in the following actions by the database server:

- Stored all the exceptions that it detected in the diagnostics area
If so, GET DIAGNOSTICS returns a value of N.
- Detected more exceptions than it stored in the diagnostics area
If so, GET DIAGNOSTICS returns a value of Y. (The value of MORE is always N.)

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Using the ROW_COUNT Keyword

The ROW_COUNT keyword returns the number of rows the most recently executed DML statement processed. ROW_COUNT counts these rows:

- Inserted into a table
- Updated in a table
- Deleted from a table

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Using the NUMBER Keyword

The NUMBER keyword returns the number of exceptions that the most recently executed SQL statement raised. The NUMBER field can hold a value from 1 to 35,000, depending on how many exceptions are counted.

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EXCEPTION Clause

Exception Clause

```
|--EXCEPTION--+-exception_num+----->
```

```

'-exception_var-'

.-----
V
>-----information-- = +-CLASS_ORIGIN-----+-----|
                        +-CONNECTION_NAME---+
                        +-INFORMIX_SQLCODE---+
                        +-MESSAGE_LENGTH-----+
                        +-MESSAGE_TEXT-----+
                        +-RETURNED_SQLSTATE--+
                        +-SERVER_NAME-----+
                        '-SUBCLASS_ORIGIN---'

```

Element	Description	Restrictions	Syntax
<i>exception_num</i>	Number of exceptions	Integer in range 1 to 35,000	Literal Number
<i>exception_var</i>	Variable storing <i>exception_num</i>	Must be SMALLINT or INT	Language specific
<i>information</i>	Host variable to receive the value of a specified exception field	Data type must match that of the specified field	Language specific

The *exception_num* literal indicates one of the exception values from the number of exceptions that the NUMBER field in the Statement clause returns.

When retrieving exception information, GET DIAGNOSTICS writes the values of each of the seven fields into corresponding host variables. These fields are located in the diagnostics area and are derived from an exception raised by the most recent SQL statement.

The host-variable data type must be the same as that of the requested field. The following table describes the seven exception information fields.

Field Name Keyword	Field Data Type	Field Contents	ESQL/C Host Variable Data Type
RETURNED_SQLSTATE	Character	SQLSTATE value	char[6]
INFORMIX_SQLCODE	Integer	Informix®-specific status code	int4
CLASS_ORIGIN	Character	String	char[255]
SUBCLASS_ORIGIN	Character	String	char[255]
MESSAGE_TEXT	Character	String	char[255]
MESSAGE_LENGTH	Integer	Numeric value	int
SERVER_NAME	Character	String	char[255]
CONNECTION_NAME	Character	String	char[255]

The application specifies the exception by number, using either an unsigned integer or an integer host variable (an exact numeric with a scale of 0). An exception with a value of 1 corresponds to the **SQLSTATE** value set by the most recent SQL statement other than GET DIAGNOSTICS. The association between other exception numbers and other exceptions raised by that SQL statement is undefined. Thus, no set order exists in which the diagnostic area can be filled with exception values. You always get at least one exception, even if the **SQLSTATE** value indicates success.

If an error occurs within the GET DIAGNOSTICS statement (that is, if an invalid exception number is requested), the Informix internal **SQLCODE** and **SQLSTATE** variables are set to the value of that exception. In addition, the GET DIAGNOSTICS fields are undefined.

- [Using the RETURNED_SQLSTATE Keyword](#)
- [Using the INFORMIX_SQLCODE Keyword](#)
- [Using the CLASS_ORIGIN Keyword](#)
- [Using the SUBCLASS_ORIGIN Keyword](#)
- [Using the MESSAGE_TEXT Keyword](#)
- [Using the MESSAGE_LENGTH Keyword](#)
- [Using the SERVER_NAME Keyword](#)

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Using the RETURNED_SQLSTATE Keyword

The RETURNED_SQLSTATE keyword returns the **SQLSTATE** value that describes the exception.

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Using the INFORMIX_SQLCODE Keyword

The INFORMIX_SQLCODE keyword returns the Informix®-specific status code. The same value is also available in the global **SQLCODE** variable. For more information, see the discussion of the **SQLCODE** variable in the *IBM® Informix ESQL/C Programmer's Manual*.

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Using the CLASS_ORIGIN Keyword

Use the CLASS_ORIGIN keyword to retrieve the class portion of the RETURNED_SQLSTATE value. If the ISO standard for SQL defines the class, the value of CLASS_ORIGIN is equal to ISO 9075. Otherwise, the value returned by CLASS_ORIGIN is defined by Informix® and cannot be ISO 9075. The terms ANSI SQL and ISO SQL are synonymous.

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Using the SUBCLASS_ORIGIN Keyword

The SUBCLASS_ORIGIN keyword returns data on the RETURNED_SQLSTATE subclass. (This value is ISO 9075 if the ISO standard defines the subclass.)

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Using the MESSAGE_TEXT Keyword

The MESSAGE_TEXT keyword returns the message text of the exception (for example, an error message).

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Using the MESSAGE_LENGTH Keyword

The MESSAGE_LENGTH keyword returns the length in bytes of the current message text string.

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Using the SERVER_NAME Keyword

The SERVER_NAME keyword returns the name of the database server associated with a CONNECT or DATABASE statement. GET DIAGNOSTICS updates the SERVER_NAME field when any of the following events occur:

- A CONNECT statement successfully executes.
- A SET CONNECTION statement successfully executes.
- A DISCONNECT statement successfully terminates the current connection.
- A DISCONNECT ALL statement fails.

The SERVER_NAME field is not updated, however, after these events:

- A CONNECT statement fails.
- A DISCONNECT statement fails (but this does not include the DISCONNECT ALL statement).
- A SET CONNECTION statement fails.

The SERVER_NAME field retains the value set in the previous SQL statement. If any of the preceding conditions occur on the first SQL statement that executes, the SERVER_NAME field is blank.

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The Contents of the SERVER_NAME Field

The SERVER_NAME field contains different information after you execute the following statements.

Executed Statement

SERVER_NAME Field Contents

CONNECT

Contains the name of the database server to which you connect or fail to connect. Field is blank if you do not have a current connection or if you make a default connection.

DATABASE

Contains the name of the database server on which the specified database resides.

DISCONNECT

Contains the name of the database server from which you disconnect or fail to disconnect. If you disconnect and then you execute a DISCONNECT statement for a connection that is not current, the SERVER_NAME field remains unchanged.

DISCONNECT ALL

Sets the field to blank if the statement executes successfully. If the statement fails, SERVER_NAME contains the names of all the database servers from which you did not disconnect. (This information does not mean that the connection still exists.)

SET CONNECTION

Contains the name of the database server to which you switch or fail to switch

If CONNECT succeeds, SERVER_NAME is set to one of the following values:

- The **INFORMIXSERVER** value (if the connection is to a default database server, because CONNECT specified no database server)
- The name of the database server (if the connection is to a specific database server)
- [Using the CONNECTION_NAME Keyword](#)
- [When the CONNECTION_NAME Keyword Is Updated](#)
- [When the CONNECTION_NAME Is Not Updated](#)

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Using the CONNECTION_NAME Keyword

Use the CONNECTION_NAME keyword to return the name of the connection specified in your CONNECT or SET CONNECTION statement.

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When the CONNECTION_NAME Keyword Is Updated

GET DIAGNOSTICS updates the CONNECTION_NAME field when the following situations occur:

- A CONNECT statement successfully executes.
- A SET CONNECTION statement successfully executes.
- A DISCONNECT statement successfully executes at the current connection.
GET DIAGNOSTICS fills the CONNECTION_NAME field with blanks because no current connection exists.
- A DISCONNECT ALL statement fails.

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When the CONNECTION_NAME Is Not Updated

The CONNECTION_NAME field is not updated in the following cases:

- A CONNECT statement fails.
- A DISCONNECT statement fails (but this does not include the DISCONNECT ALL statement).
- A SET CONNECTION statement fails.

The CONNECTION_NAME field retains the value set in the previous SQL statement. If any of the preceding conditions occurs on the first SQL statement that executes, the CONNECTION_NAME field is blank.

An implicit connection has no name. After a DATABASE statement successfully creates an implicit connection, the CONNECTION_NAME field is blank.

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The contents of the CONNECTION_NAME field

The CONNECTION_NAME field contains connection information that depends on the previously executed CONNECT, SET CONNECTION, DISCONNECT, or DISCONNECT ALL statement.

The CONNECTION_NAME field contains different information after you execute the following statements.

Executed Statement

CONNECTION_NAME Field Contents

CONNECT

Contains the name, as specified in the CONNECT statement, of the connection to which you connect or fail to connect. The field is blank for no current connection or a default connection.

SET CONNECTION

Contains the name, as specified in the SET CONNECTION statement, of the connection to which you switch or fail to switch.

DISCONNECT

Contains the name, as specified in the DISCONNECT statement, of the connection from which you disconnect or fail to disconnect. If you disconnect successfully, and then execute a DISCONNECT statement for a connection that is not current, the CONNECTION_NAME field remains unchanged.

DISCONNECT ALL

Contains no information if the DISCONNECT ALL statement executes successfully. If the statement does not execute successfully, the CONNECTION_NAME field contains the names of all the connections specified in your CONNECT statements from which you did not disconnect. This information does not mean, however, that the connection still exists.

If CONNECT is successful, CONNECTION_NAME takes one of these values:

- The name of the database environment as specified in the CONNECT statement if the CONNECT statement does not include the AS clause
- The name of the connection (the identifier that was declared after the AS keyword) if the CONNECT statement includes the AS clause

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Using GET DIAGNOSTICS for Error Checking

GET DIAGNOSTICS returns values from various fields in the diagnostics area. For each field in the diagnostics area that you wish to access, you must supply a host variable of a compatible data type.

The following example illustrates how to use the GET DIAGNOSTICS statement to display error information. The example shows the Informix® ESQL/C error display routine called **disp_sqlstate_err()**:

```
void disp_sqlstate_err()
{
    int j;
    EXEC SQL BEGIN DECLARE SECTION;
        int exception_count;
        char overflow[2];
        int exception_num=1;
        char class_id[255];
        char subclass_id[255];
        char message[255];
        int messlen;
        char sqlstate_code[6];
        int i;
    EXEC SQL END DECLARE SECTION;
    printf("-----");
    printf("-----\n");
    printf("SQLSTATE: ");
    printf("SQLCODE: %d\n", SQLCODE);
    printf("\n");
    EXEC SQL get diagnostics :exception_count = NUMBER,
        :overflow = MORE;
    printf("EXCEPTIONS: Number=%d\t", exception_count);
    printf("More? %s\n", overflow);
    for (i = 1; i <= exception_count; i++)
    {
        EXEC SQL get diagnostics exception :i
            :sqlstate_code = RETURNED_SQLSTATE,
            :class_id = CLASS_ORIGIN, :subclass_id = SUBCLASS_ORIGIN,
            :message = MESSAGE_TEXT, :messlen = MESSAGE_LENGTH;
        printf("-----\n");
        printf("EXCEPTION %d: SQLSTATE=%s\n", i, sqlstate_code);
        message[messlen-1] = '\0';
        printf("MESSAGE TEXT: %s\n", message);
        j = stleng(class_id);
        while((class_id[j] == '\0') ||
            (class_id[j] == ' '))
            j--;
        class_id[j+1] = '\0';
        printf("CLASS ORIGIN: ");
        j = stleng(subclass_id);
        while((subclass_id[j] == '\0') ||
            (subclass_id[j] == ' '))
            j--;
        subclass_id[j+1] = '\0';
        printf("SUBCLASS ORIGIN: ");
    }
    printf("-----");
    printf("-----\n");
}
```

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GRANT statement

Use the GRANT statement to assign access privileges and roles to users and to other roles. Users who hold the DBSECADM role can use this statement to assign user security labels and exemptions from label-based access control (LBAC) security rules.


```
>>-GRANT----->
(1)
>--+--+--+ Database-Level Privileges |-----TO--+PUBLIC-----+--+><
| | | | | (3) | | | | | |
| | | '-DEFAULT ROLE--| Role Name |-----' | V | | | |
| | | | | | | | | | |
| | | | | (3) | | | | |
| | | '+--+| Role Name |-----| TO Options |-----' | |
| | | | | | | | | | |
| | | | | (4) | | | | |
| | | | | Security Administration Options |-----+
| | | | | (5) | | | | |
| | | | | Surrogate User Properties |-----'
| | | | | (6) | | | | |
| | | '+--+| Table-Level Privileges |-----+--+| TO Options |-'
| | | | | (1) | | | | |
| | | | | (7) | | | | |
| | | | | Routine-Level Privileges |-----+
| | | | | (8) | | | | |
| | | | | Language-Level Privileges |-----+
| | | | | (9) | | | | |
| | | | | Type-Level Privileges |-----+
| | | | | (10) | | | | |
| | | | | Sequence-Level Privileges |-----'
```

TO Options

```

V |
|-----'user'-----+--+--+--+--+
| | | | | '-WITH GRANT OPTION-' | | '-AS--'grantor'-
| | | | | V | | | | |
| | | | | '+--+|role'-----+
| | | | | +- 'user'--+
| | | | | '-PUBLIC-'
```

Notes:

1. Informix® extension
2. See [Database-Level Privileges](#)
3. See [Role Name](#)
4. See [Security Administration Options](#)
5. See [Surrogate user properties \(UNIX, Linux\)](#)
6. See [Table-Level Privileges](#)
7. See [Routine-Level Privileges](#)
8. See [Language-Level Privileges](#)
9. See [Type-Level Privileges](#)
10. See [Sequence-Level Privileges](#)

Element	Description	Restrictions	Syntax
<i>grantor</i>	Authorization identifier of a user who can use REVOKE to cancel the effects of this GRANT statement. If AS clause is omitted, default is login name of user issuing this statement	Must be valid <i>user</i> name (not a <i>role</i> name). On Windows, the <i>user</i> name cannot exceed 20 bytes. On other platforms, the limit is 32 bytes.	Owner name
<i>role</i>	Name of an existing role to which you grant one or more access privileges, or to which you assign another role	Must exist in the database	Owner name
<i>user</i>	Authorization identifier of a user to whom you grant one or more access privileges, or to whom you assign a role	Same as for <i>grantor</i>	Owner name

Usage

The GRANT statement extends to other users specific discretionary access privileges or LBAC labels and exceptions that would normally accrue only to the DBA or to the creator of an object. Subsequent GRANT statements do not affect privileges that have already been granted to a user.

You can use the GRANT statement for operations like the following:

- Authorize others to use or administer a database that you create
- Allow others to view, alter, or drop a table, synonym, view or a sequence object that you create
- Allow others to use a data type or the SPL language, or to execute a user-defined routine (UDR) that you create
- Assign a role and its privileges to users, or to PUBLIC, or to another role
- Assign a default role to one or more users or to PUBLIC
- If you hold the DBSECADM role, assign LBAC security labels or exemptions from rules of LBAC security policies to users,

You can grant privileges to a previously created role or to a built-in role. You can grant a role to PUBLIC, to individual users, or to another role.

If you enclose *grantor*, *role*, or *user* in quotation marks, the name is case sensitive and is stored exactly as you typed it. In an ANSI-compliant database, if you do not use quotation marks as delimiters, the name is stored in uppercase letters.

On Windows only, the database server does not support *user* name that consists of more than 20 characters.

Privileges that you grant remain in effect until you cancel them with a REVOKE statement. Only the grantor of a privilege can revoke that privilege. The grantor is the person who issues the GRANT statement, unless the AS *grantor* clause transfers the right to revoke those privileges to another user.

Only the owner of an object or a user to whom privileges were explicitly granted with the WITH GRANT OPTION keywords can grant privileges on an object. Having DBA privileges is not sufficient. As DBA, however, you can grant a privilege on behalf of another user by using the AS *grantor* clause. For privileges on database objects whose owner is not a user recognized by the operating system (for example, user **informix**), the AS *grantor* clause is useful.

The keyword PUBLIC extends the specified privilege or role to the PUBLIC group of all users who connect to the database. If you intend to restrict privileges that PUBLIC already holds to only a subset of users, you must first revoke those privileges from PUBLIC.

To grant privileges on one or more fragments of a table that has been fragmented by expression, see [GRANT FRAGMENT statement](#).

- [Database-Level Privileges](#)
- [Table-Level Privileges](#)
- [Table Reference](#)
- [Type-Level Privileges](#)
- [Routine-Level Privileges](#)

When you create a user-defined routine (UDR), you become owner of the UDR and you automatically receive the Execute privilege on that UDR.

- [Language-Level Privileges](#)
Informix also supports *language-level privileges*, which specify the programming languages of UDRs that users who have been granted Usage privileges for a given language can register in the database.

- [Sequence-Level Privileges](#)
- [Role Name](#)
- [WITH GRANT OPTION keywords](#)

The WITH GRANT OPTION keywords convey the privilege or role to a *user* with the right to grant the same privileges or role to other users.

- [AS grantor clause](#)
When you grant discretionary access privileges to other users, roles, or to PUBLIC, by default you are the one who can revoke those privileges. The AS *grantor* clause lets you establish another user as the source of the privileges that you are granting.

- [Security Administration Options](#)
- [Surrogate user properties \(UNIX, Linux\)](#)

Use the ACCESS TO PROPERTIES clause of the GRANT statement to map users to surrogate user properties required for access to resources.

Related concepts:

[Overloading the Name of a Function](#)

Related reference:

[DROP ACCESS_METHOD statement](#)

[INFO statement](#)

[ALTER ACCESS_METHOD statement](#)

[DROP SEQUENCE statement](#)

[ALTER SEQUENCE statement](#)

[CREATE ACCESS_METHOD statement](#)

[CREATE DATABASE statement](#)

[CREATE ROW TYPE statement](#)

[CREATE SEQUENCE statement](#)

[DROP FUNCTION statement](#)

[DROP PROCEDURE statement](#)

[SET SESSION AUTHORIZATION statement](#)

[CREATE PROCEDURE statement](#)

[CREATE VIEW statement](#)

[EXECUTE PROCEDURE statement](#)

[DROP ROUTINE statement](#)

[GRANT FRAGMENT statement](#)

[CREATE SCHEMA statement](#)

[SET ROLE statement](#)

[RENAME SEQUENCE statement](#)

[DROP ROLE statement](#)

[REVOKE statement](#)

[REVOKE FRAGMENT statement](#)

[CREATE ROLE statement](#)

Related information:

[Grant privileges](#)

[Grant and revoke privileges in applications](#)

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Database-Level Privileges

Database-level access privileges affect access to a database. Only individual users, rather than roles, can hold database privileges.

```
|--+-CONNECT--+-+-----|
+-RESOURCE-+-
'-DBA-----'
```

When you create a database with the CREATE DATABASE statement, you are the owner and automatically receive all database-level privileges.

The database remains inaccessible to any other users until you, as DBA, grant database privileges to them.

As database owner, you also receive table-level privileges on all tables in the database automatically. For more information about table-level privileges, see [Table-Level Privileges](#).

Recommendation: Only user **informix** can modify system catalog tables directly. Except as noted specifically in your database server documentation, however, do not use DML statements to insert, delete, or update rows of system catalog tables directly, because modifying data in these tables can destroy the integrity of the database.

When database-level privileges conflict with table-level privileges, the more restrictive privileges take precedence.

Database access levels are, from lowest to highest, Connect, Resource, and DBA. Use the corresponding keyword to grant a level of access privilege.

Privilege	Effect
CONNECT	<p>Lets you query and modify data You can modify the database schema if you own the database object that you intend to modify. Any user with the Connect privilege can perform the following operations:</p> <ul style="list-style-type: none"> • Connect to the database with the CONNECT statement or another connection statement • Execute SELECT, INSERT, UPDATE, and DELETE statements, provided the user has the necessary table-level privileges • Create views, provided the user has the Select privilege on the underlying tables • Create synonyms • Create temporary tables and create indexes on the temporary tables • Alter or drop a table or an index, provided the user owns the table or index (or has Alter, Index, or References privileges on the table) • Grant privileges on a table or view, provided the user owns the table (or was given privileges on the table with the WITH GRANT OPTION keywords)
RESOURCE	<p>Lets you extend the structure of the database In addition to the capabilities of the Connect privilege, the holder of the Resource privilege can perform the following functions:</p> <ul style="list-style-type: none"> • Create new tables • Create new indexes • Create new UDRs • Create new data types
DBA	<p>Has all the capabilities of the Resource privilege and can perform the following additional operations:</p> <ul style="list-style-type: none"> • Grant any database-level privilege, including the DBA privilege, to another user • Grant any table-level privilege to another user or to a role • Grant a role to a user or to another role • Revoke a privilege whose grantor you specify as the <i>revoker</i> in the AS clause of the REVOKE statement • Restrict the Execute privilege to DBAs when registering a UDR • Execute the SET SESSION AUTHORIZATION statement • Create any database object • Create tables, views, and indexes, designating another user as owner of these objects • Alter, drop, or rename database objects, regardless of who owns them • Execute the DROP DISTRIBUTIONS option of the UPDATE STATISTICS statement • Execute DROP DATABASE and RENAME DATABASE statements

User **informix** has the privilege required to alter the tables of the system catalog, including the **systables** table.

The following example uses the PUBLIC keyword to grant the Connect privilege on the currently active database to all users:

```
GRANT CONNECT TO PUBLIC;
```

You cannot grant database-level privileges to a role. Only individual users or PUBLIC can hold database-level privileges.

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Table-Level Privileges

When you create a table with the CREATE TABLE statement, you are the table owner and automatically receive all table-level privileges. You cannot transfer ownership to another user, but you can grant table-level privileges to another user or to a role. (See, however, [RENAME TABLE statement](#), which can change both the name and the ownership of a table.)

A user with the database-level DBA privilege automatically receives all table-level privileges on every table in that database.

```
Table-Level Privileges
.-PRIVILEGES-.
```

```
>--ON-+-+-----+--+table-+-+-----+
      '-owner-- . '   +-view----+
                        '-synonym-'
```

1. Informix® extension

Element	Description	Restrictions	Syntax
<i>column</i>	Column on which the References, Select, or Update privilege is granted. Default scope is all columns of <i>table</i> , <i>view</i> , or <i>synonym</i> .	Must be a column of the <i>table</i> , <i>view</i> , or <i>synonym</i>	Identifier
<i>owner</i>	Name of the user who owns the <i>table</i> , <i>view</i> , or <i>synonym</i>	Must be a valid authorization identifier	Owner name
<i>synonym, table, view</i>	Synonym, table, or view on which privileges are granted.	Must exist in the current database	Identifier

The GRANT statement can list one or more of the following keywords to specify the table privileges that you grant to the same users or roles.

Privilege	Effect
INSERT	Lets you insert rows
DELETE	Lets you delete rows
SELECT	Lets you access any column in SELECT statements. You can restrict the Select privilege to one or more columns by listing the columns.
UPDATE	Lets you access any column in UPDATE statements. You can restrict the Update privilege to one or more columns by listing the columns.
REFERENCES	Lets you define referential constraints on columns. You must have the Resource privilege to take advantage of the References privilege. (You can add, however, a referential constraint during an ALTER TABLE statement without holding the Resource privilege on the database.) You need only the References privilege to indicate cascading deletes. You do not need the Delete privilege to place cascading deletes on a table. You can restrict the References privilege to one or more columns by listing the columns.
INDEX	Lets you create permanent indexes. You must have the Resource privilege to use the Index privilege. (Any user with the Connect privilege can create an index on temporary tables.)
ALTER	Lets you add or delete columns, modify column data types, add or delete constraints, change the locking mode of the table from PAGE to ROW, or add or drop a corresponding ROW data type for your table. It also lets you enable or disable indexes, constraints and triggers, as described in SET Database Object Mode statement . You must have the Resource privilege to use the Alter privilege. In addition, you also need the Usage privilege for any user-defined data type affected by the ALTER TABLE statement.
UNDER	Lets you create sub-tables under a typed table.
ALL	Provides all privileges listed above. The PRIVILEGES keyword is optional.

You can narrow the scope of a Select, Update, or References privilege by specifying the columns to which the privilege applies.

Specify the keyword PUBLIC as *user* if you intend the GRANT statement to apply to all users.

Some simple examples that follow illustrate how to give table-level privileges with the GRANT statement.

The following statement grants the privilege to delete and select values in any column in the table **customer** to users **mary** and **john**. It also grants the Update privilege, but only for columns **customer_num**, **fname**, and **lname**:

```
GRANT DELETE, SELECT, UPDATE (customer_num, fname, lname)
ON customer TO mary, john;
```

To grant the same privileges as those above to all authorized users, use the keyword `PUBLIC` as the following example shows:

```
GRANT DELETE, SELECT, UPDATE (customer_num, fname, lname)
ON customer TO PUBLIC;
```

For example, suppose a user named **mary** has created a typed table named **tab1**. By default, only user **mary** can create subtables under the **tab1** table. If **mary** wants to grant the ability to create subtables under the **tab1** table to a user named **john**, **mary** must enter the following GRANT statement:

```
GRANT UNDER ON tab1 TO john;
```

After receiving the Under privilege on table **tab1**, user **john** can create one or more subtables under **tab1**.

- Effect of the ALL Keyword

Effect of the ALL Keyword

The ALL keyword grants all possible table-level privileges to the specified user. If any or all of the table-level privileges do not exist for the grantor, the GRANT statement with the ALL keyword succeeds (in the sense of **SQLCODE** being set to zero, even if the possible privileges are an empty set for the grantor on the table). In this case, however, the following **SQLSTATE** warning is returned:

01007 - Privilege not granted.

For example, assume that user **ted** has the Select and Insert privileges on the **customer** table with the authority to grant those privileges to other users.

User **ted** wants to grant all table-level privileges to user **tania**. So user **ted** issues the following GRANT statement:

```
GRANT ALL ON customer TO tania;
```

This statement executes successfully but returns **SQLSTATE** code 01007 for the following reasons:

- The statement succeeds in granting the Select and Insert privileges to user **tania** because user **ted** has those privileges and the right to grant those privileges to other users.
- The other privileges implied by the ALL keyword were not grantable by user **ted** and, therefore, were not granted to user **tania**.

If you grant all table-level privileges with the ALL keyword, the privileges includes the Under privilege only if the table is a typed table. The grant of ALL privileges does not include the Under privilege if the table is not based on a ROW type.

If the table owner grants ALL privileges on a traditional relational table and later changes that table to a typed table, the table owner must explicitly grant the Under privilege to allow other users to create subtables under it.

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Table Reference

You grant table-level privileges directly by specifying the name or an existing synonym of a table or of a view, which you can qualify with the *owner* name.

Table Reference

```
|--+-----+--+view-----+-----|
  '-owner-- . ' +-table---+
                    '-synonym-'
```

Element	Description	Restrictions	Syntax
<i>owner</i>	Name of the user who owns the <i>table</i> , <i>view</i> , or <i>synonym</i>	Must be a valid authorization identifier	Owner name
<i>synonym, table, view</i>	Synonym, table, or view on which privileges are granted	The <i>table</i> , <i>view</i> , or <i>synonym</i> must exist in the database	Identifier

The object on which you grant privileges must reside in the current database.

For table objects that the CREATE EXTERNAL TABLE statement has registered in the current database, the Select privilege and the Insert privilege are supported, but no other table or column access privileges can be granted or revoked.

In an ANSI-compliant database, if *owner* is not enclosed between quotation marks, the database stores the owner name in lowercase letters.

- [Privileges on Tables and Synonyms](#)
- [Privileges on a View](#)

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Privileges on Tables and Synonyms

In an ANSI-compliant database, if you create a table, only you, its owner, have any table-level privileges until you explicitly grant them to others.

When you create a table in a database that is *not* ANSI compliant, however, PUBLIC receives Select, Insert, Delete, Under, and Update privileges for that table and its synonyms. (The **NODEFDAC** environment variable, when set to *yes*, prevents PUBLIC from automatically receiving these table-level privileges.)

To allow access only to some users, or only on some columns in a database that is not ANSI compliant, you must explicitly revoke the privileges that PUBLIC receives by default, and then grant only the privileges that you intend. For example, this series of statements grants privileges on the entire **customer** table to users **john** and **mary**, but restricts PUBLIC access to the Select privilege on only four of the columns in that table:

```
REVOKE ALL ON customer FROM PUBLIC;
GRANT ALL ON customer TO john, mary;
```

```
GRANT SELECT (fname, lname, company, city) ON customer TO PUBLIC;
```

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Privileges on a View

You must have at least the Select privilege on a table or columns to create a view on that table. For views that reference only tables in the current database, if the owner of a view loses the Select privilege on any base table underlying the view, the view is dropped.

You have the same privileges for the view that you have for the table or tables contributing data to the view. For example, if you create a view from a table to which you have only Select privileges, you can select data from your view but you cannot delete or update data. For information on how to create a view, see [CREATE VIEW statement](#).

When you create a view, PUBLIC does not automatically receive any privileges for a view that you create. Only you have access to table data through that view. Even users who have privileges on the base table of the view do not automatically receive privileges for the view.

You can grant (or revoke) privileges on a view only if you are the owner of the underlying base tables, or if you received these privileges on the base table with the right to grant them (specified by the WITH GRANT OPTION keywords). You must explicitly grant those privileges within your authority, because PUBLIC does not automatically receive any privileges on a view when it is created.

The creator of a view can explicitly grant Select, Insert, Delete, and Update privileges for the view to other users or to a role. You cannot grant Index, Alter, Under, or References privileges on a view (nor can you specify the ALL keyword for views, because ALL confers Index, References, and Alter privileges).

When a GRANT or REVOKE statement changes the discretionary access privileges on any table referenced in the definition of an existing view, the database server does not automatically apply those privilege modifications to the view. To apply the new table access privileges to a view that depends on that table, you can use the DROP VIEW and CREATE VIEW statements to drop and recreate the view.

In this case, if the definitions of other views reference the view that you drop, or if INSTEAD OF triggers are defined on that view, you can also use CREATE VIEW and CREATE TRIGGER statements to recreate, respectively, the dependent views and the INSTEAD OF triggers that the DROP VIEW statement destroyed.

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Type-Level Privileges

You can specify two privileges on data types that are not built-in data types:

- The Usage privilege on a user-defined data type
- The Under privilege on a named ROW type

Type-Level Privileges

```
| --+--USAGE ON TYPE--type_name-----+-----|  
| '-UNDER ON TYPE--row_type_name-'
```

Element	Description	Restrictions	Syntax
<i>row_type_name</i>	Named ROW type on which the Under privilege is granted	Named ROW data type must exist	Identifier ; Data Type
<i>type_name</i>	User-defined type on which the Usage privilege is granted	User-defined data type must exist.	Identifier ; Data Type

To see what privileges exist on user-defined data types, check the **sysxdtypes** system catalog table for the *owner* of each UDT, and the **sysxdttypeauth** system catalog table for any other users or roles that hold privileges on UDTs. See the *IBM® Informix® Guide to SQL: Reference* for information on the system catalog tables.

For all the *built-in data types*, however, these access privileges are automatically available to PUBLIC and cannot be revoked.

- [USAGE Privilege](#)
- [UNDER Privilege](#)

Related information:

[System catalog tables](#)

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USAGE Privilege

You own any user-defined data type (UDT) that you create. As owner, you automatically receive the Usage privilege on that data type and can grant the Usage privilege to others so that they can reference the type name or data of that type in SQL statements. DBAs can also grant the Usage privilege for UDTs.

The following example grants user **mark** access privileges to use the **widget** user-defined type:

```
GRANT USAGE ON TYPE widget TO mark;
```

If you grant Usage privilege to a user (or to a role) that has Alter privileges, that grantee can add a column to a table that contains values of your UDT.

Without privileges from the GRANT statement, any user can issue SQL statements that reference built-in data types. In contrast, a user must receive an explicit Usage privilege from a GRANT statement to use a distinct data type, even if the distinct type is based on a built-in type.

For more information about user-defined types, see [CREATE OPAQUE TYPE statement](#), [CREATE DISTINCT TYPE statement](#), the discussion of data types in the *IBM® Informix® Guide to SQL: Reference* and the *IBM Informix Database Design and Implementation Guide*.

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UNDER Privilege

You own any named ROW type that you create. If you want other users to be able to create subtypes under this named ROW type, you must grant to these users the Under privilege on your named ROW type.

For example, suppose that you create a ROW type named **rtype1**:

```
CREATE ROW TYPE rtype1 (cola INT, colb INT);
```

If you want another user named **kathy** to be able to create a subtype under this named ROW type, you must grant the Under privilege on this named ROW type to user **kathy**:

```
GRANT UNDER ON ROW TYPE rtype1 TO kathy;
```

Now user **kathy** can create another ROW type under the **rtype1** ROW type, even though **kathy** is not the owner of the **rtype1** ROW type:

```
CREATE ROW TYPE rtype2 (colc INT, cold INT) UNDER rtype1;
```

For more about named ROW types, see [CREATE ROW TYPE statement](#), and the discussion of data types in the *IBM® Informix® Guide to SQL: Reference* and the *IBM Informix Database Design and Implementation Guide*.

Related information:

[ROW Data Types](#)

[Named row types](#)

[Unnamed row types](#)

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Routine-Level Privileges

When you create a user-defined routine (UDR), you become owner of the UDR and you automatically receive the Execute privilege on that UDR.

The Execute privilege allows you to invoke the UDR with an EXECUTE FUNCTION or EXECUTE PROCEDURE statement, whichever is appropriate, or with a CALL statement in an SPL routine. The Execute privilege also allows you to use a user-defined function in an expression, as in this example:

```
SELECT * FROM table WHERE in_stock(partnum) < 20;
```

For users, roles, or members of the PUBLIC group who need the Execute privilege on a given UDR, the GRANT statement supports the following syntax:

Routine-Level Privileges

```
--EXECUTE ON----->

>--+SPL_routine-----+--+|
| +-PROCEDURE--+routine--(-+-----+--+)-+|
| +-FUNCTION--+          |          (1) |   | |
| '-ROUTINE---'          | '-| Routine Parameter List |-----' |
|                               (2)      |   |
| '-SPECIFIC--+ROUTINE-----| Specific Name |-----'         |
| +-FUNCTION--+          |          |   |
| '-PROCEDURE-'          |          |   |
```

Notes:

1. See [Routine Parameter List](#)
2. See [Specific Name](#)

Element	Description	Restrictions	Syntax
<i>routine</i>	A user-defined routine	Must exist	Identifier
<i>SPL_routine</i>	An SPL routine	Must be unique in the database	Identifier

The following statement grants Execute privilege on the **delete_order** routine to user **finn**:

```
GRANT EXECUTE ON ROUTINE delete_order TO finn;
```

Whether you must grant the Execute privilege explicitly depends on the following conditions:

- If you have DBA-level privileges, you can use the DBA keyword of CREATE FUNCTION or CREATE PROCEDURE to restrict the default Execute privilege to users with the DBA privilege. You must explicitly grant the Execute privilege on that UDR to users who do not have the DBA privilege.
- If you have the Resource database-level privilege but not the DBA privilege, you cannot use the DBA keyword when you create a UDR:
 - When you create a UDR in a database that is *not* ANSI compliant, PUBLIC can execute that UDR. You do not need to issue a GRANT statement for other users to receive the Execute privilege.
 - Setting the **NODEFDAC** environment variable to *yes* prevents PUBLIC from executing the UDR until you explicitly grant the Execute privilege.
- In an ANSI-compliant database, the creator of a UDR must explicitly grant the Execute privilege on the UDR for other users to be able to execute it.

In Informix®, if two or more UDRs have the same name, use a keyword from this list to specify which of those UDRs a user list can execute.

Keyword

UDR that the User Can Execute

SPECIFIC

The UDR identified by *specific name*

FUNCTION

Any function with the specified *routine name* (and parameter types that match *routine parameter list*, if specified)

PROCEDURE

Any procedure with the specified *routine name* (and parameter types that match *routine parameter list*, if specified)

ROUTINE

Functions or procedures with the specified *routine name* (and parameter types that match *routine parameter list*, if specified)

If both a user-defined function and a user-defined procedure of Informix have the same name and the same list of parameter data types, you can grant the Execute privilege to both with the keyword ROUTINE.

To limit the Execute privilege to one routine among several that have the same identifier, use the FUNCTION, PROCEDURE, or SPECIFIC keyword.

To limit the Execute privilege to a UDR that accepts certain data types as arguments, include the routine parameter list or use the SPECIFIC keyword to introduce the specific name of a UDR.

If an external function has a negator function, you must grant the Execute privilege on both the external function and on its negator function before other users can execute the external function.

A user must hold the Usage privilege on the language in which the user-defined routine is written to register a UDR with the CREATE FUNCTION, CREATE FUNCTION FROM, CREATE PROCEDURE, CREATE PROCEDURE FROM, or CREATE ROUTINE FROM statement. For more information on the requirements to register a UDR, see [Privileges necessary for using CREATE FUNCTION](#).

- [Granting the Execute privilege to PUBLIC](#)
The GRANT statement supports syntax for granting access to the PUBLIC group, which includes all users who hold the Connect privilege on the database.
- [Revoking the Execute privilege from PUBLIC](#)
The REVOKE statement supports the following syntax for revoking access to the specified routine from the PUBLIC group, which includes all users who hold the Connect privilege on the database.

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Granting the Execute privilege to PUBLIC

The GRANT statement supports syntax for granting access to the PUBLIC group, which includes all users who hold the Connect privilege on the database.

```
GRANT EXECUTE TO PUBLIC
```

```
>>-GRANT--Routine level privileges----->
```

```
>--TO--PUBLIC--+-----+-----><
               '-AS--'--grantor--'-'
```

Element	Description	Restrictions	Syntax
<i>grantor</i>	Owner of the UDR	Cannot be a role	Owner name

This statement enables everyone in the PUBLIC group to execute the specified routine. It overrides the NODEFDAC environment variable, if that is set to prevent the PUBLIC group from receiving Execute privilege on the routine by default. This statement also enables users who do not hold the DBA privilege to execute the specified routine, whether that routine was created with the DBA keyword.

Only users who hold the DBA privilege can specify the AS *grantor* clause. The specified grantor must be the owner of the specified routine, as listed in the **owner** column of the **sysprocedures** system catalog table. The grantor cannot be the name of a role or the PUBLIC keyword.

In an ANSI-compliant database, the AS *grantor* clause is required, rather than optional, if the DBA who issues the GRANT EXECUTE statement is not the owner of the specified routine.

Only the user specified in the optional AS *grantor* clause can use the REVOKE statement of SQL to revoke the Execute privilege from the PUBLIC group

The user specified in the optional AS *grantor* clause can use the REVOKE statement to revoke the Execute privilege from the PUBLIC group.

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Revoking the Execute privilege from PUBLIC

The REVOKE statement supports the following syntax for revoking access to the specified routine from the PUBLIC group, which includes all users who hold the Connect privilege on the database.

```
REVOKE EXECUTE TO PUBLIC

>>-GRANT--Routine level privileges----->

>--FROM--PUBLIC--+-----+-----><
      '-AS--'--revoker--'-'
```

Element	Description	Restrictions	Syntax
<i>revoker</i>	Owner of the UDR	Cannot be a role	Owner name

This statement prevents the PUBLIC group from receiving Execute privileges on the specified routine by default. (Individual users who hold the DBA privilege, however, or who own the routine, or who were granted Execute privilege on the routine individually or through a role, are not affected by this statement.)

Only users who hold the DBA privilege can specify the AS *revoker* clause. The specified revoker must be the owner of the specified routine, as listed in the **owner** column of the **sysprocedures** system catalog table. The name cannot be the name of a role or the PUBLIC keyword.

In an ANSI-compliant database, the AS *revoker* clause is required, rather than optional, if the DBA who issues the REVOKE EXECUTE statement is not the owner of the specified routine.

In databases where the PUBLIC group holds Execute privilege on owner-privileged routines by default, the REVOKE EXECUTE ON PUBLIC statement must be successfully executed before the discretionary access privilege to execute the specified routine can be granted to a subset of users or to one or more roles. Otherwise, only users with the DBA privilege or the owner of the routine can start it.

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Language-Level Privileges

Informix® also supports *language-level privileges*, which specify the programming languages of UDRs that users who have been granted Usage privileges for a given language can register in the database.

This is the syntax of the USAGE ON LANGUAGE clause for granting Usage privileges on a programming language:

```
Language-Level Privileges

|--USAGE ON LANGUAGE--+--SPL--+-----+-----|
      +-C-----+
      '-JAVA-'
```

The SPL, C, and JAVA keywords can specify a programming language in the USAGE ON LANGUAGE clause. Each GRANT USAGE ON LANGUAGE statement can specify no more than one programming language. By default, Usage privilege on SPL is granted to PUBLIC.

When a user executes the CREATE FUNCTION or CREATE PROCEDURE statement to register a UDR that is written in the SPL, C, or Java™ language, the database server verifies that the user has the Usage privilege on the language in which the UDR is written. If the IFX_EXTEND_ROLE configuration parameter has enabled the built-in EXTEND role, only users who also hold that role can register or drop UDRs written in the C language or in the Java language, even if the users hold USAGE ON LANGUAGE privileges for those languages.

The GRANT USAGE ON LANGUAGE statement can grant Usage privilege on a programming language to a restricted group of users. The following example grants Usage privileges on the C language to a user-defined role named **developers**:

```
GRANT USAGE ON LANGUAGE C TO developers;
```

If the preceding example executes successfully, users who hold the **developers** role as their current role can create or drop C routines (if they also hold the EXTEND role, or if the IFX_EXTEND_ROLE parameter is set to 0 or to OFF).

For information on other access privileges that these statements require, see [CREATE FUNCTION statement](#) and [CREATE PROCEDURE statement](#).

- [Usage Privilege in Stored Procedure Language](#)

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Usage Privilege in Stored Procedure Language

The Usage privilege on SPL is granted to PUBLIC by default. Only user **informix**, the DBA, or a user who was granted the Usage privilege WITH GRANT OPTION can grant the Usage privilege on SPL to another user.

In the following example, assume that the default Usage privilege on SPL was revoked from PUBLIC and the DBA wants to grant the Usage privilege on SPL to the role named **developers**:

```
GRANT USAGE ON LANGUAGE SPL TO developers;
```

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Sequence-Level Privileges

Although Informix® implements sequence objects as tables, only a subset of table-level privileges (page [Table-Level Privileges](#)) can be granted on a sequence. You can grant the Select or Alter privilege (or both) on a sequence:

Sequence-Level Privileges

```
(1)
|---+ALL-----+---+ON--+-----+---+sequence+---+|
| .,-----+---+ |      '-owner.-'  '-synonym-----'
| V      (1)  | |
|---+SELECT-----+---+|
|---+ALTER-----+---+|
```

Notes:

1. Informix extension

Element	Description	Restrictions	Syntax
<i>owner</i>	Owner of sequence (or owner of <i>synonym</i>)	Must be the owner	Owner name
<i>sequence</i>	Sequence on which to grant privileges	Must exist	Identifier
<i>synonym</i>	Synonym for a sequence object	Must exist	Identifier

The sequence object must exist in the current database. You can qualify the *sequence* or *synonym* identifier with a valid *owner* name, but the name of a remote *database* (or *database@server*) is not valid as a qualifier. You can include the WITH GRANT OPTION keywords when you grant ALTER, SELECT, or ALL to a user or to PUBLIC (but not to a role) as privileges on a sequence object.

- [Alter Privilege](#)
- [Select Privilege](#)
- [ALL Keyword](#)
- [The User List](#)

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Alter Privilege

You can grant the Alter privilege on a sequence to another user or to a role. The Alter privilege enables a specified user or role to modify the definition of a sequence with the ALTER SEQUENCE statement or to rename the sequence with the RENAME SEQUENCE statement.

The following statement grants the Alter privilege to user **mark** on the **cust_seq** sequence object:

```
GRANT ALTER ON cust_seq TO mark;
```

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Select Privilege

You can grant the Select privilege on a sequence to another user or to a role. The Select privilege enables a specified user or role to use *sequence.CURRVAL* and *sequence.NEXTVAL* expressions in SQL statements to read and to increment (respectively) the value of a sequence.

The following statement grants the Select privilege to user **mark** on the **cust_seq** sequence object:

```
GRANT SELECT ON cust_seq TO mark;
```

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ALL Keyword

You can specify the ALL keyword to grant both Alter and Select privileges on a sequence object to another user or to a role, or to a list of users or roles.

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The User List

You can grant privileges to an individual user or to a list of users. You can also specify the PUBLIC keyword to grant privileges to all users.

User List

```
|---+--PUBLIC-----+-----|
|  .-----+-----+-----|
|  V             |  |
|---+--user-----+---+---|
|  'user'-----+---+---|
```

Element	Description	Restrictions	Syntax
<i>user</i>	Login name of a user to whom you are granting privilege or granting a role	Must be a valid authorization identifier	Owner name

The following example grants the Insert table-level privilege on **table1** to the user **mary** in a database that is not ANSI-compliant:

```
GRANT INSERT ON table1 TO mary;
```

In an ANSI-compliant database, if you do not include quotation marks as delimiters around *user*, the name of the user is stored in uppercase letters.

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Role Name

You can use the GRANT statement to associate a list of one or more users (or all users, using the PUBLIC keyword) with a *role* name that can describe what they do. After you declare and grant a role, access privileges that you grant to that role are thereby granted to all users who are currently associated with that role.

Role Name

```
|---+--role-----+-----|
|  'role'-----+-----|
```

Element	Description	Restrictions	Syntax
<i>role</i>	Role that is granted, or to which a privilege or another role is granted	Must exist. If enclosed between quotation marks, <i>role</i> is case sensitive.	Owner name

You can also grant an existing role to another role. This action gives whatever privileges the granted role possesses to all users who have the receiving role.

- [Granting a Role to a User or to Another Role](#)
- [Granting privileges to a role](#)

You can grant table-level and routine-level access privileges to a role if you have the authority to grant these same privileges to login names or to PUBLIC. You can also grant type-level privileges to a role. A role cannot hold database-level privileges.

- [Granting a Default Role](#)
- [Granting the EXTEND Role](#)

If the IFX_EXTEND_ROLE configuration parameter is set to ON or to 1, only users who hold the EXTEND role (and who also hold the Resource privilege on the database and the Usage privilege on the programming language in which the UDR is written) can create or drop UDRs that are written in the C or Java™ external languages that can support shared libraries.

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Granting a Role to a User or to Another Role

You must register a role in the database before the role can be used in a GRANT statement. For more information, see [CREATE ROLE statement](#).

A DBA has the authority to grant a new role to another user. If a user receives a role WITH GRANT OPTION, that user can grant the role to other users or to another role. Users keep a role that was granted to them until the REVOKE statement breaks the association between their login names and the role name.

Important: The CREATE ROLE and GRANT statements do not activate the role. A non-default role has no effect until SET ROLE enables it. The grantor or the grantee of a role can issue the SET ROLE statement.

The following example shows the actions required to grant and activate the role **payables** to a group of employees who perform account payable functions. First the DBA creates role **payables**, then grants it to **maryf**.

```
CREATE ROLE payables;
GRANT payables TO maryf WITH GRANT OPTION;
```

The DBA or **maryf** can activate the role with the following statement:

```
SET ROLE payables;
```

User **maryf** has the WITH GRANT OPTION authorization to grant **payables** to other employees who pay accounts.

```
GRANT payables TO charly, gene, marvin, raoul;
```

If you grant privileges for one role to another role, the recipient role has the combined set of privileges that have been granted to both roles. The following example grants the role **petty_cash** to the role **payables**:

```
CREATE ROLE petty_cash;  
SET ROLE petty_cash;  
GRANT petty_cash TO payables;
```

After all of these statements execute successfully, if user **raoul** uses the SET ROLE statement to make **payables** his current role, then (aside from the effects of any REVOKE operations) he holds the following combined set of access privileges:

- The privileges granted to the **payables** role
- The privileges granted to the **petty_cash** role
- The privileges granted individually to **raoul**
- The privileges granted to PUBLIC

If you attempt to grant a role to yourself, either directly or indirectly, the database server generates an error. (For an important exception to this rule, however, see the description of the [DBSECADM Clause](#).)

The database server also generates an error if you include the WITH GRANT OPTION keywords in a GRANT statement that assigns a role to another role.

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Granting privileges to a role

You can grant table-level and routine-level access privileges to a role if you have the authority to grant these same privileges to login names or to PUBLIC. You can also grant type-level privileges to a role. A role cannot hold database-level privileges.

Important: The scope of a user-defined role (and of discretionary access privileges that the GRANT statement assigns to the role) is the current database. When the GRANT DEFAULT ROLE or SET ROLE statement activates a role, the role and its privileges take effect in the current database only. As a security precaution, discretionary access privileges that a user receives only from a role cannot provide access to tables outside the current database through a view or through the action of a trigger.

The syntax is more restricted for granting privileges to a role than to a user:

- You can specify the AS *grantor* clause.
In this way, whoever has the role can revoke these same privileges. For more information, see [AS grantor clause](#).
- You cannot include the WITH GRANT OPTION clause.
A role cannot, in turn, grant the same access privileges to another user.

This example grants Insert privilege on the **supplier** table to the role **payables**:

```
GRANT INSERT ON supplier TO payables;
```

Anyone who has been granted the **payables** role, and who successfully activates it by issuing the SET ROLE statement, can now insert rows into **supplier**.

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Granting a Default Role

The DBA or the owner of the database (by default, user **informix**) can define a *default role* for one or more users or for PUBLIC with the GRANT DEFAULT ROLE statement. A default role is activated when the user connects to the database. The SET ROLE statement is not required to activate a default role.

Default roles are useful if users access databases through client applications that cannot modify access privileges nor set roles.

A default role can specify a set of access privileges to all the users who are assigned that role, as in the following example:

```
CREATE ROLE accounting;  
GRANT ALTER, INSERT, SELECT ON stock TO accounting;  
GRANT DEFAULT ROLE accounting TO mary, asok, vlad;
```

The last statement provides users **mary**, **asok**, and **vlad** with **accounting** as their default role. If any of these users connects to a database, that user activates whatever privileges the **accounting** role holds, in addition to any privileges that the user already possesses as an individual or as PUBLIC.

The role must already exist and the user must have the access privileges to set the role. If the role has not previously been granted to a user, it is granted as part of setting the default role.

If no default role is defined for a user nor for PUBLIC, then no role is set, and the existing privileges of the user are in effect.

The following example shows how the default role can be assigned to all users:

```
DATABASE hrdb;  
CREATE ROLE emprole;  
GRANT CONNECT TO PUBLIC;  
GRANT SELECT ON emptab TO emprole;  
GRANT emprole TO PUBLIC;  
GRANT DEFAULT ROLE emprole TO PUBLIC;
```

Note: Using GRANT DEFAULT ROLE is an alternative to issuing the SET ROLE statement in the **sysdbopen()** procedure. Default roles defined using the **sysdbopen()** procedure, however, have precedence over any other role when a user establishes a connection. Changing the default role for a user or for PUBLIC only affects new database connections. Existing connection continue to run under currently assigned roles. If one default role was granted to *user*, and another default role was granted to PUBLIC, the default role granted to *user* takes precedence at connection time.

A default role cannot be assigned to another role. Because roles are not defined across databases, the default role must be assigned for each database. No options besides the *user-list* are valid after the TO keyword in the GRANT DEFAULT ROLE statement. The database server issues an error if you attempt to include the AS *grantor* clause or the WITH GRANT OPTION clause.

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Granting the EXTEND Role

If the IFX_EXTEND_ROLE configuration parameter is set to ON or to 1, only users who hold the EXTEND role (and who also hold the Resource privilege on the database and the Usage privilege on the programming language in which the UDR is written) can create or drop UDRs that are written in the C or Java™ external languages that can support shared libraries.

The Database Server Administrator (DBSA), by default user **informix**, can grant the EXTEND role to one or more users or to PUBLIC with the GRANT EXTEND TO *user-list* statement.

Because EXTEND is a built-in role, the SET ROLE statement is not required for the EXTEND role to have this effect. It is sufficient for a user to hold the EXTEND role without using SET ROLE to enable it.

For example, suppose that user **max** holds Resource privileges on the database, and has also been granted Usage privilege on the C language by the GRANT USAGE ON LANGUAGE C statement. The following statement grants the EXTEND role to user **max**:

```
GRANT EXTEND TO 'max' ;
```

This statement enables user **max** to create or drop UDRs that are written in the C language, without requiring **max** to issue the SET ROLE EXTEND statement. (Here the quotation marks preserve the lowercase letters in the authorization identifier **max**.) Before user **max** can create or drop UDRs written in the Java language, however, the TO clause of a valid GRANT USAGE ON LANGUAGE JAVA statement must specify either 'max', or PUBLIC, or the name of a user-defined role that **max** holds (and that **max** has used the SET ROLE statement to specify as his current role).

In databases for which this security feature is not needed, the DBSA can disable this restriction on who can create or drop external UDRs by setting the IFX_EXTEND_ROLE configuration parameter to OFF or to 0 in the ONCONFIG file. When IFX_EXTEND_ROLE is set to OFF or to 0, any user who holds the Resource privilege (and also holds the Usage privilege on the programming language in which the UDR is written) can create or drop external UDRs.

Resource privileges on the database and Usage privilege on the external language are required for any user to create or drop an external UDR, regardless of the IFX_EXTEND_ROLE configuration parameter setting, or whether the user holds the EXTEND role. User **informix**, the DBA, or any user who has received Usage privileges WITH GRANT OPTION can grant Usage privileges on the SPL, C, and Java languages to PUBLIC. See [Database-Level Privileges](#) for information about granting the Resource privilege. See [Language-Level Privileges](#) for information about granting Usage privileges on programming languages.

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WITH GRANT OPTION keywords

The WITH GRANT OPTION keywords convey the privilege or role to a *user* with the right to grant the same privileges or role to other users.

You create a chain of privileges that begins with you and extends to *user* as well as to whomever *user* subsequently conveys the right to grant privileges. If you include WITH GRANT OPTION, you can no longer control the dissemination of privileges.

The following example grants the Alter and Select privileges to user **mark** on the **cust_seq** sequence object, with the ability to grant those privileges to others:

```
GRANT ALL ON cust_seq TO mark WITH GRANT OPTION;
```

If you revoke from *user* the privilege that you granted using the WITH GRANT OPTION keyword, you sever the chain of privileges. That is, when you revoke privileges from *user*, you automatically revoke the privileges of all users who received privileges from *user* or from the chain that *user* created (unless *user*, or the users who received privileges from *user*, were granted the same set of privileges by someone else).

The following examples illustrate this situation. You, as the owner of the table **items**, issue the following statements to grant access to user **mary**:

```
REVOKE ALL ON items FROM PUBLIC;
GRANT SELECT, UPDATE ON items TO mary WITH GRANT OPTION;
```

User **mary** uses her privilege to grant users **cathy** and **paul** access to the table:

```
GRANT SELECT, UPDATE ON items TO cathy;
GRANT SELECT ON items TO paul;
```

Later you revoke the access privileges for user **mary** on the **items** table:

```
REVOKE SELECT, UPDATE ON items FROM mary;
```

This single statement effectively revokes all privileges on the **items** table from users **mary**, **cathy**, and **paul**. If you want to create a chain of privileges with another user as the source of the privilege, use the AS *grantor* clause.

In Informix®, the WITH GRANT OPTION keywords are valid only for users. They are not valid when a role is the grantee of a privilege or of another role. You cannot specify WITH GRANT OPTION in a statement that grants a privilege to the PUBLIC group.

The Database Server Administrator cannot include the WITH GRANT OPTION keywords in the GRANT EXTEND or GRANT DBSECADM statements. The DBSA cannot delegate to another user the authorization to grant the built-in EXTEND or DBSECADM roles. If more than one user needs either of these authorizations, they should be included in the **DBSA** group when the database server is installed.

In addition to the GRANT DBSECADM statement, none of the other security administration options of the GRANT statement support the WITH GRANT OPTION keywords. For more information about these statements and their syntax, see [Security Administration Options](#).

Related concepts:

[DBA Keyword and Privileges on the Procedure](#)

[DBA keyword and Execute privilege on the created function](#)

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AS grantor clause

When you grant discretionary access privileges to other users, roles, or to PUBLIC, by default you are the one who can revoke those privileges. The AS *grantor* clause lets you establish another user as the source of the privileges that you are granting.

When you use the AS *grantor* clause, the login provided in the AS *grantor* clause replaces your login in the appropriate system catalog table. You can use this clause only if you have the DBA privilege on the database.

After you use this clause, only the specified *grantor* can revoke the effects of the current GRANT operation. Even a DBA cannot revoke a privilege unless that DBA is listed in the system catalog table as the user who granted the privilege.

The following example illustrates this situation. You are the DBA and you grant all privileges on the **items** table to user **tom** with the right to grant all privileges:

```
REVOKE ALL ON items FROM PUBLIC;  
GRANT ALL ON items TO tom WITH GRANT OPTION;
```

The next example illustrates a different situation. You also grant Select and Update privileges to user **jim**, but you specify that the privileges are granted as user **tom**. (The records of the database server in the **systabauth** system catalog table show that user **tom** is the grantor of those privileges, rather than you.)

```
GRANT SELECT, UPDATE ON items TO jim AS tom;
```

Later, you decide to revoke privileges on the **items** table from user **tom**, so you issue the following statement:

```
REVOKE ALL ON items FROM tom;
```

If instead, however, you try to revoke privileges from user **jim** with a similar statement, the database server returns an error, as the next example shows:

```
REVOKE SELECT, UPDATE ON items FROM jim;
```

```
580: Cannot revoke permission.
```

You receive an error because the database server record shows the original grantor as user **tom**, and you cannot revoke the privilege. Although you are the DBA, you cannot revoke a privilege that another user granted.

The AS *grantor* clause is not valid in the GRANT DEFAULT ROLE statement.

For contexts where the AS *grantor* clause is required, rather than optional, see [Granting the Execute privilege to PUBLIC](#).

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Security Administration Options

In conjunction with the REVOKE statement, the GRANT statement supports the discretionary access control (DAC) data security feature of Informix® by specifying which users or roles hold privileges that are required to access the database or objects within the database.

The Security Administration Options of the GRANT statement, like their counterparts for the REVOKE statement, support an additional set of data security features, called label-based access control (LBAC). These features enable Informix to allow or withhold access to protected data on the basis of a comparing a row security label or column security label that is contained in the data object to the user security label and other credentials that have been granted to the user who is seeking access.

Security Administration Options

```
      (1)  
|---+| DBSECADM Clause |-----+|  
|      |      (2)      |  
+---+| EXEMPTION Clause |-----+|  
|      |      (3)      |  
+---+| SECURITY LABEL Clause |-----+|  
|      |      (4)      |  
+---+| SETSESSIONAUTH Clause |-----+|
```

1. See [DBSECADM Clause](#)
2. See [EXEMPTION Clause](#)
3. See [SECURITY LABEL Clause](#)
4. See [SETSESSIONAUTH Clause](#)

- Only the Database Server Administrator (DBSA), by default user **informix**, or (on UNIX) a member of the **DBSA** group, or (on Windows) a member of the **Informix-Admin** group, can use the GRANT DBSECADM statement to grant the DBSECADM role.
- Only a user who holds the DBSECADM role can issue the GRANT EXEMPTION, GRANT SECURITY LABEL, or GRANT SETSESSIONAUTH statements, or the corresponding REVOKE statements.

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DBSECADM Clause

Element	Description	Restrictions	Syntax
<i>user</i>	User to whom the role is to be granted	Must be the authorization identifier of a user	Owner name

- ALTER SECURITY LABEL COMPONENT
- CREATE SECURITY LABEL
- CREATE SECURITY LABEL COMPONENT
- CREATE SECURITY POLICY
- DROP SECURITY LABEL
- DROP SECURITY LABEL COMPONENT
- DROP SECURITY POLICY
- RENAME SECURITY LABEL
- RENAME SECURITY LABEL COMPONENT
- RENAME SECURITY POLICY

- ALTER TABLE ... ADD SECURITY POLICY
- ALTER TABLE ... ADD ... IDSECURITYLABEL [DEFAULT *label*]
- ALTER TABLE ... ADD ... [COLUMN] SECURED WITH
- ALTER TABLE ... DROP SECURITY POLICY
- ALTER TABLE ... MODIFY ... [COLUMN] SECURED WITH
- ALTER TABLE ... MODIFY ... DROP COLUMN SECURITY
- CREATE TABLE ... COLUMN SECURED WITH
- CREATE TABLE ... IDSECURITYLABEL [DEFAULT *label*]
- CREATE TABLE ... SECURITY POLICY

- GRANT EXEMPTION
- GRANT SECURITY LABEL
- GRANT SETSESSIONAUTH
- REVOKE EXEMPTION
- REVOKE SECURITY LABEL
- REVOKE SETSESSIONAUTH

The **USER** keyword that can follow the **TO** keyword is optional, and has no effect, but any authorization identifier that the DBSA specifies in the **GRANT DBSECADM** statement must be the identifier of an individual user, rather than the identifier of a role, or the **PUBLIC** group.

The *user* can be the DBSA who issues this **GRANT DBSECADM** statement. This is an important exception to the general restriction that the **TO** clause of the **GRANT** statement (like the **FROM** clause in the **REVOKE** statements) cannot explicitly reference the authorization identifier of the user who issues the statement. Unlike other roles, access privileges, user security labels, and exemptions on rules that the **GRANT** statement can specify, you can grant the **DBSECADM** role to yourself, if you are user **informix**, or a member of the DBSA group, or (on Windows if you are a member of the **Informix-Admin** group).

In the following example, the DBSA grants the **DBSECADM** role to user **niccolo**:

```
GRANT DBSECADM TO niccolo;
```

If this statement executes successfully, user **niccolo** can perform the LBAC operations listed above, provided that **niccolo** also holds sufficient discretionary access privileges on the database and on the database objects that those SQL statements reference.

After a user is granted the **DBSECADM** role, only the DBSA can revoke it.

For a discussion of LBAC security objects, see your IBM® Informix Security Guide.

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EXEMPTION Clause

The **GRANT EXEMPTION** statement modifies the security credentials of the specified user (or list of users) by disabling one or all of the rules of a specified security policy.

EXEMPTION Clause

```
|--EXEMPTION ON RULE--+-IDSLBACREADARRAY-----+----->
                        +-IDSLBACREADTREE-----+
                        +-IDSLBACREADSET-----+
                        +-IDSLBACWRITEARRAY-----+
                        |                         |
                        |                         +-WRITEDOWN--+ |
                        |                         '-WRITEUP---' |
                        +-IDSLBACWRITESET-----+
                        +-IDSLBACWRITETREE-----+
                        '-ALL-----'

                        .-,-----
                        v      |
>--FOR--policy--TO--+-+--user--+-+-----|
                    '-USER--'
```

Element	Description	Restrictions	Syntax
<i>policy</i>	The security policy from which the exemption is granted	Must exist in the database	Identifier
<i>user</i>	User to whom the exemption is to be granted	Must be the authorization identifier of a user	Owner name

Only a user who holds the **DBSECADM** role can issue the **GRANT EXEMPTION** statement.

- [Rules on Which Exemptions Are Granted](#)
- [Security Policies and Grantees of Exemptions](#)

Related reference:

[RENAME SECURITY statement](#)

[DROP SECURITY statement](#)

[CREATE SECURITY LABEL statement](#)

[CREATE SECURITY LABEL COMPONENT statement](#)

[ALTER SECURITY LABEL COMPONENT statement](#)

[CREATE SECURITY POLICY statement](#)

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Rules on Which Exemptions Are Granted

The keyword that follows the **ON** keyword specifies the predefined LBAC access rule of the security policy (whose identifier follows the **FOR** keyword) for which an exemption is granted. The access rule for which exemption is granted does not apply when a table that is protected by the specified security policy is accessed by a user to whom the exemption is granted. For descriptions of the predefined rules for read access and for write access that are associated with a security policy, see the section [Rules Associated with a Security Policy](#).

The following keywords of the **GRANT EXEMPTION** statement identify specific **IDSLBACRULES** rules from which this statement can exempt users:

- **IDSLBACREADARRAY** exempts the user from the **IDSLBACREADARRAY** rule for the specified security policy. That rule requires that each array component of the user security label must be greater than or equal to the corresponding array component of the data row security label.

- In the following example, DBSECADM grants an exemption from all of the rules of the **MegaCorp** security policy to users **manoj** and **sam**:

GRANT EXEMPTION ON RULE ALL FOR MegaCorp TO manoj, sam;

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An exemption applies only to the rules of the security policy whose name follows the FOR keyword. A protected table can have multiple security labels, but no more than one security policy.

The GRANT EXEMPTION statement fails with an error if the specified policy does not exist in the database.

The `USER` keyword that can follow the `TO` keyword is optional, and has no effect, but any authorization identifier specified in the `GRANT EXEMPTION` statement must be the identifier of an individual user, rather than the identifier of a role. This *user* cannot be the `DBSECADM` who issues the same `GRANT EXEMPTION` statement.

In the following example, DBSECADM grants an exemption to user **lynette** from rule **IDSLBACREADARRAY** of the **MegaCorp** security policy:

GRANT EXEMPTION ON RULE IDSLBACREADARRAY FOR MegaCorp TO lynette;

This exemption bypasses the read access rules for all array components of security labels of the specified policy.

When the GRANT EXEMPTION statement successfully grants an exemption to a user, the database server updates the **syssecpolicyexemptions** table of the system catalog to register the new exemption (or multiple exemptions, if several users are listed after the TO keyword).

For a discussion of LBAC security objects, see your Informix®.

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The GRANT SECURITY LABEL statement grants a security label to a user or to a list of users.

[illegible]

Element	Description	Restrictions	Syntax
<i>label</i>	Name of an existing security label	Must exist as a label for the specified security <i>policy</i>	Identifier
<i>policy</i>	The security policy of this <i>label</i>	Must already exist in the database	Identifier
<i>user</i>	User to whom the label is to be granted	Must be the authorization identifier of a user	Owner name

Only a user who holds the DBSECADM role can issue the GRANT SECURITY LABEL statement.

A security label is a database object that is always associated with a security policy. That policy defines the set of valid security components that make up the security label. The label stores a set of one or more values for each component of the security policy.

The DBSECADM can associate a security label with the following entities:

- A column of a database table, which a *column security label* can protect
- A row of a database table, which a *row security label* can protect
- A user, whose *user security label* (and any exemptions from rules of the security policy that have been granted to the user) are called the *security credentials* of the user.

When a user who holds a security label for a specific security policy attempts to access a row that is protected by a row security label of the same security policy, the database server compares the sets of values in the user security label and in the row security label to determine whether the user should be allowed access to the data. Similarly, LBAC takes into account the user security label and the column security label in determining whether the credentials of the user should allow access to the protected column.

The GRANT SECURITY LABEL statement is the mechanism by which DBSECADM associates a user with a security label. (Data values in a protected table are associated with a row security label or with a column security label by options to the CREATE TABLE or ALTER TABLE statements that only DBSECADM can execute, rather than by the GRANT SECURITY LABEL statement.)

The USER keyword that can follow the TO keyword is optional, and has no effect, but any authorization identifier specified in the GRANT SECURITY LABEL statement must be the identifier of an individual user, rather than of a role.

- [Access Specifications](#)
- [Rules for User Security Labels](#)
- [Examples of Granting User Security Labels](#)

Related reference:

[RENAME SECURITY statement](#)

[DROP SECURITY statement](#)

[CREATE SECURITY LABEL statement](#)

[CREATE SECURITY LABEL COMPONENT statement](#)

[ALTER SECURITY LABEL COMPONENT statement](#)

[CREATE SECURITY POLICY statement](#)

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Access Specifications

The list of users to whom the security label is granted can optionally be followed by keywords that specify the type of access to data that the security policy of the label protects

- FOR WRITE ACCESS
These keywords restrict the label to the write access rules of **IDSLBACRULES**, namely **IDLSBACWRITEARRAY**, **IDLSBACWRITASET**, and **IDLSBACWRITETREE**. These rules affect INSERT, DELETE, and UPDATE operations on protected data.
- FOR READ ACCESS
These keywords restrict the label to the read access rules of **IDSLBACRULES**, namely **IDLSBACWREADARRAY**, **IDLSBACREADSET**, and **IDLSBACREADTREE**. These rules affect SELECT, DELETE, and UPDATE operations on protected data.
- FOR ALL ACCESS
These keywords apply the label to all of the read and write access rules that are listed above. If the GRANT SECURITY LABEL statement includes no FOR ... ACCESS specification, this option takes effect as the default.

For more information about these **IDSLBACRULES** rules for label-based read and write access, see [Rules Associated with a Security Policy](#). For information about exemptions to these rules that can be granted for a specific security policy, see [Rules on Which Exemptions Are Granted](#).

If a user is granted a different security label for read access than for write access, then the values given for the security label components must follow these rules:

- For security label components of type ARRAY, the value must be the same in both security labels.
- For security label components of type SET, the values given in the security label used for WRITE access must be a subset of the values given in the security label used for READ access. If all of the values are the same, this is interpreted as being a subset, and is allowed.
- For security label components of type TREE, every element in the tree component of the security label for write access must be either an element or a descendent of an element in the tree component of the security label for read access.

In summary, when DBSECADM attempts to grant a security label for read access to a user who already holds a security label for write access, or vice versa, the read label cannot be more restrictive than the write label. Otherwise, the GRANT SECURITY LABEL statement fails with an error.

A user can be granted no more than two labels for the same security policy. If two labels are granted for the same policy, one label must be for read access and the other for write access. If DBSECADM attempts to grant a security label for read access to a user who already holds a security label for read access that is based on the same security policy, the GRANT SECURITY LABEL statement fails with an error. A similar failure result if both labels are for write access and are on the same security policy.

In both of these cases, the first security label must be revoked explicitly by the REVOKE SECURITY LABEL statement before a second label can be granted for the same access mode and the same security policy. The only exception to this rule is if both labels specify the same values for component elements, because in this case both security labels are functionally identical, and no error is issued.

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Rules for User Security Labels

The following rules affect security labels that are granted to users by the GRANT SECURITY LABEL statement:

- The user cannot be the DBSECADM who issues this GRANT SECURITY LABEL statement.
- A user without a security label has a NULL or zero label. A user with no security label cannot access data in a protected table, unless the user holds the necessary exemptions on the policy.
- By default, the IDSECURITYLABEL column of a protected table cannot have NULL values. A user with no security label cannot insert data into a table with row protection, even if the user has been granted the necessary exemptions on the security policy, unless the row label is explicitly specified in the INSERT statement. For details of how to specify a security label explicitly in the INSERT statement, see [Security Label Support Functions](#).
- User security labels have no effect on the following types of database tables, because these tables cannot be protected by a security policy:
 - Virtual Table Interface tables,
 - tables with Virtual Index Interface indexes,
 - tables in a typed-table hierarchy,
 - temporary tables.

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Examples of Granting User Security Labels

The following three statements create three security label components called **level**, **compartments**, and **groups** respectively:

```
CREATE SECURITY LABEL COMPONENT
  level ARRAY ['TS','S','C','U'];

CREATE SECURITY LABEL COMPONENT
  compartments SET {'A','B','C','D'};

CREATE SECURITY LABEL COMPONENT
  groups TREE ('G1' ROOT,
              'G2' UNDER ROOT,
              'G3' UNDER ROOT);
```

The following statement creates a security policy called **secPolicy** based on the three components above:

```
CREATE SECURITY POLICY secPolicy COMPONENTS
  level, compartments, groups;
```

The following statement creates a security label called **secLabel1**:

```
CREATE SECURITY LABEL secPolicy.secLabel1
  COMPONENT level 'S',
  COMPONENT compartments 'A', 'B',
  COMPONENT groups 'G2';
```

The following statement creates a security label called **secLabel2**:

```
CREATE SECURITY LABEL secPolicy.secLabel2
  COMPONENT level 'S',
  COMPONENT compartments 'B',
  COMPONENT groups 'G2';
```

The following statement creates a security label called **secLabel3**:

```
CREATE SECURITY LABEL secPolicy.secLabel3
  COMPONENT level 'S',
  COMPONENT compartments 'A',
  COMPONENT groups 'G3';
```

The following statement creates a security label called **secLabel4**:

```
CREATE SECURITY LABEL secPolicy.secLabel4
  COMPONENT level 'TS',
  COMPONENT compartments 'A',
  COMPONENT groups 'G1';
```

The following statement grants a security label for read access to user **sam**:

```
GRANT SECURITY LABEL secPolicy.secLabel1
  TO sam FOR READ ACCESS;
```

The following statement grants a security label for write access to user **sam**. This statement succeeds because it satisfies the rules given above.

```
GRANT SECURITY LABEL secPolicy.secLabel2
  TO sam FOR WRITE ACCESS;
```

The following statement grants a security label for read access to user **lynette**:

```
GRANT SECURITY LABEL secPolicy.secLabel1
  TO lynette FOR READ ACCESS;
```

The following statement attempts to grant a security label for write access to user **sam**. This statement fails because it violates the rule with respect to the tree component.

```
GRANT SECURITY LABEL secPolicy.secLabel3
TO sam FOR WRITE ACCESS;
```

The following statement attempts to grant a security label for write access to user **sam**. This statement fails because it violates the rule with respect to the array component.

```
GRANT SECURITY LABEL secPolicy.secLabel4
TO sam FOR WRITE ACCESS;
```

When the GRANT SECURITY LABEL statement successfully grants a security label to a user, the database server updates the **sysseclabelauth** table of the system catalog to register the new holder of the security label.

For a discussion of LBAC security objects, see your IBM® Informix® Security Guide

Related information:

[Label-based access control](#)

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SETSESSIONAUTH Clause

The GRANT SETSESSIONAUTH statement grants the SETSESSIONAUTH privilege to one or more users or roles. This privilege allows the holder to use the SET SESSION AUTHORIZATION statement to set the session authorization to PUBLIC or to any one of a list of specified users.

SETSESSIONAUTH Clause

```
|-- SETSESSIONAUTH ON--++ PUBLIC-----+----->
      | .,-----+-----+-----+
      | V         |         |         |
      |-----+---user--+-----+
      |'-USER-'
      |
      | .,-----+-----+
      | V         |         |
      |-----+---user--+-----+
      |'-USER-'
      |-----+---role--+-----+
      |'-ROLE-'
```

Element	Description	Restrictions	Syntax
<i>role</i>	Role to which the privilege is to be granted	Must be the authorization identifier of a role	Owner name
<i>user</i>	After the TO keyword, a user to whom the privilege is to be granted. After the ON keyword, a user whose identity the grantee can specify in the SET AUTHORIZATION statement.	Must be the authorization identifier of a user	Owner name

Only a user who holds the DBSECADM role can grant the SETSESSIONAUTH privilege. Both the SETSESSIONAUTH privilege and the DBA privilege are required to execute the SET AUTHORIZATION statement.

The user or PUBLIC specification that follows the ON keyword specifies whose identity the grantee of the SETSESSIONAUTH privilege can take while using SET SESSION AUTHORIZATION statement. This can be a user or PUBLIC but not a role. If PUBLIC is specified, then the grantee of the privilege can assume the identity of any database user.

The USER and ROLE keywords that can follow the TO keyword are optional. Neither the *user* nor the *role* can be the holder of the DBSECADM role who issues the GRANT SETSESSIONAUTH statement. The TO clause cannot specify PUBLIC as the grantee.

The following example grants to user **sam** the ability to set the session authorization to users **lynette** and **manoj**:

```
GRANT SETSESSIONAUTH ON lynette, manoj TO sam;
```

The next example grants to user **lynette** the ability to set the session authorization to PUBLIC:

```
GRANT SETSESSIONAUTH ON PUBLIC TO lynette;
```

Only a user who holds the DBSECADM role can revoke the SETSESSIONAUTH privilege. For a discussion of LBAC security objects, see your IBM® Informix® Security Guide

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Surrogate user properties (UNIX, Linux)

Use the ACCESS TO PROPERTIES clause of the GRANT statement to map users to surrogate user properties required for access to resources.

Note:

Only a DBSA can map externally authenticated users to valid surrogate user properties. If the USERMAPPING configuration parameter is set to enable support for mapped users, a DBSA issues the GRANT ACCESS TO PROPERTIES statement to map users to properties that correspond to the appropriate level of authorization.

Mapped users can connect to with the surrogate user properties if they authenticate with a pluggable authentication module (PAM) or single sign-on (SSO).

ACCESS TO PROPERTIES Clause

```
--ACCESS TO---+PUBLIC-----+---PROPERTIES----->
      | .,----- . |
      | V          | |
      |-----user---+-'

(1) V          |
>---+UID--user_ID-- ,--GROUP-- (-----+group_ID--+---)-----+-->
      | '-----group_name-' |
      | -USER--OS_user_name--+-----+-----+-----+-----+ |
      | |                      | .,----- . |
      | |                      | (1) V          |
      | |                      | - ,--GROUP-- (-----+group_ID--+---) -'
      | |                      | '-----group_name-' |

>---+-----+-----+-----+-----+-----+-----+-----+----->
      | -HOME--"-directory--"- |

>---+-----+-----+-----+-----+-----+-----+-----+-----|
      | |                      | .,----- . |
      | |                      | V          |
      | |                      | - ,--AUTHORIZATION-- (-----privilege-----) -'
```

Notes:

1. Use this path no more than 16 times

Element	Description	Restrictions	Syntax
<i>directory</i>	Path name of directory where user files are stored.	Length cannot exceed 255 bytes, and must conform to the rules of your operating system. The <i>directory</i> must also: <ul style="list-style-type: none"> • Belong to the mapped <i>user_ID</i> and <i>group_ID</i> • Have read, write, and execute permissions for the owner • Not have PUBLIC write permissions 	Quoted String
<i>group_ID</i>	Group identifier number to which you want to map <i>user</i> . The list of <i>group_id</i> value or values that you specify must be enclosed in parentheses. .	The <i>group_ID</i> cannot be: <ul style="list-style-type: none"> • A group ID with server administrative privileges (DBSA, DBSSO, AAO, and BARGROUP) • Group 0 (root, sometimes referred to as wheel or system) • Group 80 on Mac OS X (admin) • A group ID associated with group bin or group sys The <i>group ID</i> must be present in /etc/informix/allowed.surrogates file.	Literal Number
<i>group_name</i>	Name of an existing operating system group having the permissions to which you want to map <i>user</i> . The list of <i>group_name</i> values must be enclosed in parentheses.	Length cannot exceed 32 bytes. The group name must be present in /etc/informix/allowed.surrogates file.	Owner name
<i>privilege</i>	Administrative privilege to assign <i>user</i> . Valid values are as follows: <ul style="list-style-type: none"> • DBSA • DBSSO • AAO • BARGROUP The <i>privilege</i> value or values must be enclosed in parentheses.	The USERMAPPING configuration parameter must be set to ADMIN to grant server administrative privileges with the AUTHORIZATION keyword.	Quoted String
<i>user</i>	Authorization identifier of a specific user that you are mapping to user properties.	Must be an authenticated authorization identifier	Owner name

Element	Description	Restrictions	Syntax
<i>user_ID</i>	User identifier number to which you want to map <i>user</i> .	<i>user_ID</i> cannot be the one that belongs to user root or user informix . The user ID must be present in <i>/etc/informix/allowed.surrogates</i> file.	Literal Number
<i>OS_user_name</i>	Name of an existing OS user account on the host computer having the permissions to which you want to map <i>user</i> .	Must conform to the rules of your operating system . The user name must be present in <i>/etc/informix/allowed.surrogates</i> file.	Owner name

Usage

The best practice is to map *user* to a specific OS user name that is reserved as a surrogate user identity only. You can add groups associated with the surrogate user identity with the GROUP keyword, and change the home directory with the HOME keyword. If the operating system administrator has specified acceptable surrogates in the */etc/informix/allowed.surrogates* file, you can only map users to those specified OS users or groups.

If you map *user* to a user ID number, then remember to not create a user account on the host computer with the same number.

The USERMAPPING configuration parameter must be set to ADMIN in order to assign *user* a server administrative privilege with the ADMINISTRATOR keyword.

Note:

Use of this AUTHORIZATION clause (and of the AUTHORIZATION clause of the ALTER USER, CREATE USER, or CREATE DEFAULT USER statements) is not recommended. Different syntax will support role separation in a future release.

The PUBLIC and AUTHORIZATION keywords cannot be used together in the same statement, because the PUBLIC group cannot be granted server administrator privileges.

Specifying a directory for the user files with the HOME keyword is optional, but in some cases it is highly recommended. When an externally authenticated user is mapped to a surrogate user name but no HOME directory is specified in the GRANT ACCESS TO statement, then the mapped user has the same home directory as the user account on the host computer. When a user is mapped to a surrogate user identity with no set home directory, then creates a directory for user files in \$INFORMIXDIR/users. In the latter case, the directory name in \$INFORMIXDIR/users takes the form uid.*ID_number* (for example, uid.101).

Examples

The syntax and explanations in this section are examples for the following environment, where the acronym GID abbreviates *group ID number*, and the acronym UID abbreviates *user ID number*:

- There is a user **fred** with an OS account on the host computer. User **fred** has database server access with UID 3000, GID 3000 (**users**), auxiliary group 200 (**staff**), and home directory */home/fred*.
- On the same computer, there exists an OS account for user **dbuser**. This account is locked so that **dbuser** cannot log in. The **dbuser** account exists only for the purpose of surrogate user mapping. It has UID 3050, GID 4000 (**ifx_user**), and home directory */home/dbuser*.
- The group **ifx_user** has GID 4000, with users **bill** and **eileen**.
- The administrator setting up mapped users knows that there is no entry for UID 101 in */etc/passwd* (or its equivalent) and no entry for GID 10011 or 10101 in */etc/group* (or its equivalent) .
- User **bob** does not have OS account on the host computer but can authenticate through PAM or LDAP. The database server is configured to accept authentication through the PAM or LDAP module.
- The USERMAPPING parameter in the onconfig file is set to ADMIN.

Mapping an externally authenticated user to a surrogate user name:

The administrator maps **bob** to the database server access privileges that already exist for user **fred** by issuing the following GRANT statement:

```
GRANT ACCESS TO bob PROPERTIES USER fred;
```

Granting access to all externally authenticated users:

In this environment, the purpose of the user **dbuser** account on the host computer is to grant database server access to mapped users. In a situation where there are many mapped users and they do not need to know about the user files created in the home directory, the administrator might find it efficient and sufficiently secure to map PUBLIC to the **dbuser** surrogate user identity. The administrator can map all authenticated users (PUBLIC) to the privileges established for **dbuser** with the following GRANT ACCESS statement:

```
GRANT ACCESS TO PUBLIC PROPERTIES USER dbuser;
```

Note: The mapping of PUBLIC to a surrogate user identity is designed for mapped users who do not create or are not concerned with user files on the home directory, such as a consumer who is accessing databases on a retail Web site. If you want to map users concerned with the functioning of the database server to a surrogate user identity like **dbuser**, it is recommended to map these users individually with a designated home directory, as in the following example:

```
GRANT ACCESS TO bob PROPERTIES USER dbuser HOME "/home/dbuser/bob";
```

Mapping an externally authenticated user to a UID-GID pair:

The administrator maps **bob** to a surrogate user identity that consists of a UID-GID pair that enables database server access by running the following statement:

```
GRANT ACCESS TO bob PROPERTIES UID 101, GROUP (10011);
```

Because no specific directory was specified, a directory under \$INFORMIXDIR/users will be created with the name uid.101 and this path will be used as the home directory. The UID 101 and GROUP (10011) are anonymous because they do not have entries in the respective */etc* directories that designate UIDs and GIDs that can access .

Alternatively, the administrator can map **bob** to a surrogate user identity that is a combination of an anonymous UID and to an explicit group, such as in the following example:

```
GRANT ACCESS TO bob PROPERTIES 101, GROUP (ifx_user);
```

Because the **ifx_user** group has members **bill** and **eileen**, the group is not anonymous.

Mapping an externally authenticated user to a surrogate user identity that has server administrative privileges:

In the following example, the administrator grants DBSA privileges to **bob**:

```
GRANT ACCESS TO bob PROPERTIES USER fred, GROUP (ifx_user), AUTHORIZATION (dbsa);
```

User **bob** is assigned UID 3000 (**fred**) and GIDs 3000 (**users**), 200 (**staff**), and the extra group 1000 (**ifx_user**). The administrative role granted to **bob** could be different by replacing **dbsa** with a different privilege (DBSSO, AAO, or BARGROUP). If the USERMAPPING parameter were set to BASIC in the `onconfig` file, then **bob** would not be granted DBSA privileges by this statement. If USERMAPPING were set to OFF, then **bob** would not be able to connect to the database server at all.

Examples

The following GRANT statements are examples of valid ACCESS TO PROPERTIES clauses, using hypothetical values. These examples do not represent the entire syntax and possible semantics of the ACCESS TO PROPERTIES clause.

- GRANT ACCESS TO bob PROPERTIES USER fred;
- GRANT ACCESS TO PUBLIC PROPERTIES USER dbuser;
- GRANT ACCESS TO bob PROPERTIES USER dbuser HOME "/home/dbuser/bob";
- GRANT ACCESS TO bob PROPERTIES UID 101, GROUP (10011);
- GRANT ACCESS TO bob PROPERTIES 101, GROUP (ifx_user);
- GRANT ACCESS TO bob PROPERTIES USER fred, GROUP (ifx_user), AUTHORIZATION (DBSA);

Related concepts:

[Revoking database server access from mapped users \(UNIX, Linux\)](#)

Related information:

[Mapped user surrogates in the allowed surrogates file \(UNIX, Linux\)](#)

[Specifying surrogates for mapped users \(UNIX, Linux\)](#)

[onmode -cache surrogates: Cache the allowed surrogates file](#)

[USERMAPPING configuration parameter \(UNIX, Linux\)](#)

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GRANT FRAGMENT statement

Use the GRANT FRAGMENT statement to assign privileges on table fragments in the local database if the table is fragmented by expression.

Syntax

```

>>-GRANT FRAGMENT--| Fragment-Level Privileges |----->>
                                     (1)
                                     .-,-----
                                     V          |
>>-ON--+-+-----+-+table--(----fragment--+-)----->>
      |-'owner'--.-'
>>-TO--+-+PUBLIC-----+-+-----+-+-----+-+-----+-+><
      | | .-,----- | | '-WITH GRANT OPTION-' | | '-AS--'grantor'-'
      | | V          | | |
      | | '----'user'--+-' | |
      | | .-,----- | |
      | | V          | |
      | | '---'role'--+-' | |

```

Notes:

1. See [Fragment-Level Privileges](#)

Element	Description	Restrictions	Syntax
<i>fragment</i>	Name of a fragment	Must exist; cannot be delimited by quotation marks	Identifier
<i>grantor</i>	User who can revoke the privileges	Same as for <i>user</i>	Owner name
<i>owner</i>	User who owns <i>table</i>	Must be owner of <i>table</i>	Owner name
<i>role</i>	Role to receive privileges	Must exist in sysusers	Owner name
<i>table</i>	Fragmented table on which fragment privileges are granted	Must exist and must be fragmented by expression	Identifier

Element	Description	Restrictions	Syntax
<i>user</i>	User to whom privileges are to be granted	Must be a valid authorization identifier	Owner name

Usage

This statement is an extension to the ANSI/ISO standard for SQL.

Use the GRANT FRAGMENT statement to grant to users (or roles) any of the Insert, Update, and Delete access privileges on individual fragments of a table. The GRANT FRAGMENT statement is valid only for tables that are fragmented according to an expression-based distribution scheme. For an explanation of this type of fragmentation strategy, see [Expression Distribution Scheme](#).

- [Fragment-Level Privileges](#)
- [Granting Privileges to One User or a List of Users](#)
- [Granting One Privilege or a List of Privileges](#)
- [WITH GRANT OPTION Clause](#)
- [AS grantor Clause](#)

Related reference:

[GRANT statement](#)
[REVOKE FRAGMENT statement](#)
[REVOKE statement](#)

Related information:

[Table-level privileges](#)

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Fragment-Level Privileges

The keyword or keywords that follow the FRAGMENT keyword specify *fragment-level privileges*, which are a logical subset of table-level privileges:

Fragment-Level Privileges

```
|---+ALL-----+-----|
| .-+-----+ |
| V      | |
|---+INSERT---+---|
|      +---DELETE---+
|      +---UPDATE---|
```

These keywords correspond to the following fragment-level privileges:

Keyword

Effect on Grantee

ALL

Receives Insert, Delete, and Update privileges on the fragment

INSERT

Can insert rows into the fragment

DELETE

Can delete rows from the fragment

UPDATE

Can update rows in the fragment and in any columns.

- [Definition of Fragment-Level Authorization](#)
- [Effect of Fragment-Level Authorization in Statement Validation](#)
- [Duration of Fragment-Level Privileges](#)
- [Specifying Fragments](#)
- [The TO Clause](#)

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Definition of Fragment-Level Authorization

In an ANSI-compliant database, the owner implicitly receives all table-level privileges on a newly created table, but no other users receive privileges.

A user who has table privileges on a fragmented table has the privileges implicitly on all fragments of the table. These privileges are not recorded in the **sysfragauth** system catalog table.

When a fragmented table is created in a database that is not ANSI compliant, the table owner implicitly receives all table-level privileges on the table, and other users (that is, PUBLIC) receive all fragment-level privileges by default. The privileges granted to PUBLIC are explicitly recorded in the **sysstabauth** system catalog table.

If you use the REVOKE statement to withdraw existing table-level privileges, however, you can then use the GRANT FRAGMENT statement to restore specified table-level privileges to users, roles, or PUBLIC on some subset of the fragments.

Whether or not the database is ANSI compliant, you can use the GRANT FRAGMENT statement to grant explicit Insert, Update, and Delete privileges on one or more fragments of a table that is fragmented by expression. The privileges that the GRANT FRAGMENT statement grants are explicitly recorded in the **sysfragauth** system catalog table.

The Insert, Update, and Delete privileges that are conferred on table fragments by the GRANT FRAGMENT statement are collectively known as *fragment-level privileges* or *fragment-level authority*.

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Effect of Fragment-Level Authorization in Statement Validation

Fragment-level privilege enables users to execute INSERT, DELETE, and UPDATE data manipulation language (DML) statements on table fragments, even if the grantees lack Insert, Update, and Delete privileges on the table as a whole. Users who lack the table privileges can insert, delete, and update rows in authorized fragments because of the algorithm by which the database server validates DML statements. This algorithm consists of the following checks:

1. When a user executes an INSERT, DELETE, or UPDATE statement, the database server first checks whether the user has the table privileges necessary for the operation attempted. If the table privileges exist, the statement continues processing.
2. If the table privileges do not exist, the database server checks whether the table is fragmented by expression. If the table is not fragmented by expression, the database server returns an error to the user. This error indicates that the user does not have the privilege to execute the statement.
3. If the table is fragmented by expression, the database server checks whether the user holds the fragment privileges necessary for the attempted operation. If the user holds the required fragment privileges, the database server continues to process the statement. If the fragment privileges do not exist, the database server returns an error to the user. This error indicates that the user does not have the privilege to execute the statement.

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Duration of Fragment-Level Privileges

The duration of fragment-level privileges is tied to the duration of the fragmentation strategy for the table as a whole.

If you drop a fragmentation strategy by means of a DROP TABLE statement or by the INIT, DROP, or DETACH clauses of an ALTER FRAGMENT statement, you also drop any privileges that exist for the affected fragments. Similarly, if you drop a fragment of a table, you also drop any privileges that exist for the fragment.

Tables that are created as a result of a DETACH or INIT clause of an ALTER FRAGMENT statement do not keep the privileges that the former fragment or fragments had when they were part of the fragmented table. Instead, such tables assume the default table privileges.

If a table on which fragment privileges are defined is changed to a table with a round-robin strategy or some other expression strategy, the fragment privileges are also dropped, and the table assumes the default table privileges.

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Specifying Fragments

You can specify one fragment or a comma-separated list of fragments, with the name (or list of names) enclosed between parentheses that immediately follow the ON *table* specification. You cannot use quotation marks to delimit fragment names. The database server issues an error if you include no fragment, or if no fragment of the specified table matches a fragment that you list.

Each *fragment* must be referenced by its name. If you did not declare an explicit identifier when you created the fragment, its name defaults to the name of the dbspace in which it resides.

After a dbspace is renamed successfully by the onspaces utility, only the new name is valid. Informix® automatically updates existing fragmentation strategies in the system catalog to substitute the new dbspace name, but you must specify the new name in GRANT FRAGMENT statement to reference a fragment whose default name is the name of a renamed dbspace.

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The TO Clause

The list of one or more users or roles that follows the TO keyword identifies the grantees. You can specify the PUBLIC keyword to grant the specified fragment-level privileges to all users.

You cannot use GRANT FRAGMENT to grant fragment-level privileges to yourself, either directly or through roles.

If you enclose *user* or *role* in quotation marks, the name is case sensitive and is stored exactly as you typed it. In an ANSI-compliant database, if you do not use quotation marks around *user* or around *role*, the name is stored in uppercase letters.

The following statement grants the Insert, Update, and Delete privileges on the fragment of the **customer** table in **part1** to user **larry**:

```
GRANT FRAGMENT ALL ON customer (part1) TO larry;
```

The following statement grants the Insert, Update, and Delete privileges on the fragments of the **customer** table in **part1** and **part2** to user **millie**:

```
GRANT FRAGMENT ALL ON customer (part1, part2) TO millie;
```

To grant privileges on all fragments of a table to the same user or users, you can use the GRANT statement instead of the GRANT FRAGMENT statement. You can also use the GRANT FRAGMENT statement for this purpose.

Assume that the **customer** table is fragmented by expression into three fragments, and these fragments reside in the dbspaces named **part1**, **part2**, and **part3**. You can use either of the following statements to grant the Insert privilege on all fragments of the table to user **helen**:

```
GRANT FRAGMENT INSERT ON customer (part1, part2, part3) TO helen;
```

```
GRANT INSERT ON customer TO helen;
```

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Granting Privileges to One User or a List of Users

You can grant fragment-level privileges to a single user or to a list of users.

The following statement grants the Insert, Update, and Delete privileges on the fragment of the **customer** table in **part3** to user **oswald**:

```
GRANT FRAGMENT ALL ON customer (part3) TO oswald;
```

The following statement grants the Insert, Update, and Delete privileges on the fragment of the **customer** table in **part3** to users **jerome** and **hilda**:

```
GRANT FRAGMENT ALL ON customer (part3) TO jerome, hilda;
```

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Granting One Privilege or a List of Privileges

When you specify fragment-level privileges in a GRANT FRAGMENT statement, you can specify one privilege, a list of privileges, or all privileges.

The following statement grants the Update privilege on the fragment of the **customer** table in **part1** to user **ed**:

```
GRANT FRAGMENT UPDATE ON customer (part1) TO ed;
```

The following statement grants the Update and Insert privileges on the fragment of the **customer** table in **part1** to user **susan**:

```
GRANT FRAGMENT UPDATE, INSERT ON customer (part1) TO susan;
```

The following statement grants the Insert, Update, and Delete privileges on the fragment of the **customer** table in **part1** to user **harry**:

```
GRANT FRAGMENT ALL ON customer (part1) TO harry;
```

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WITH GRANT OPTION Clause

As in other GRANT statements, the WITH GRANT OPTION keywords specify that the grantee can grant the same fragment-level privileges to other users. WITH GRANT OPTION is not valid if the TO clause specifies a *role* as grantee. For additional information, see [WITH GRANT OPTION keywords](#).

The following statement grants the Update privilege on the fragment of the **customer** table in **part3** to user **george** and also gives george the right to grant the Update privilege on the same fragment to other users:

```
GRANT FRAGMENT UPDATE ON customer (part3) TO george WITH GRANT OPTION;
```

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AS grantor Clause

The AS *grantor* clause of the GRANT FRAGMENT statement can specify the grantor of the privilege. You can use this clause only if you have the DBA privilege on the database. When you include the AS *grantor* clause, the database server lists the user or role who is specified as *grantor* as the grantor of the privilege in the **grantor** column of the **sysfragauth** system catalog table.

In the next example, the DBA grants the Delete privilege on the fragment of the **customer** table in the **part3** fragment to user **martha**, and uses the AS *grantor* clause to specify that user **jack** is listed in **sysfragauth** as the grantor of the privilege:

```
GRANT FRAGMENT DELETE ON customer (part3) TO martha AS jack;
```

One effect of the *AS grantor* clause in the previous example is that user **jack** can execute the REVOKE FRAGMENT statement to cancel the Delete fragment-level privilege that **martha** holds, if this GRANT FRAGMENT statement were the only source of the fragment authority of **martha** on the **customer** rows in **part3**.

- [Omitting the AS grantor Clause](#)

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Omitting the AS grantor Clause

When GRANT FRAGMENT does not include the *AS grantor* clause, the user who issues the statement is the default grantor of the specified fragment privileges.

In the next example, the user grants the Update privilege on the fragment of the **customer** table in **part3** to user **fred**. Because this statement does not specify the *AS grantor* clause, the user who issues the statement is listed by default as the grantor of the privilege in the **sysfragauth** system catalog table.

```
GRANT FRAGMENT UPDATE ON customer (part3) TO fred;
```

If you omit the *AS grantor* clause of GRANT FRAGMENT, or if you specify your own login name as the *grantor*, you can later use the REVOKE FRAGMENT statement to revoke the privilege that you granted to the specified user. For example, if you grant the Delete privilege on the fragment of the **customer** table in **part3** to user **martha** but specify user **jack** as the grantor of the privilege, user **jack** can revoke that privilege from user **martha**, but you cannot revoke that privilege from user **martha**.

The DBA, or the owner of the fragment, can use the *AS* clause of the REVOKE FRAGMENT statement to revoke privileges on the fragment.

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INFO statement

Use the INFO statement to list the names of all the user-defined tables in the current database, or to display information about a specific table.

Syntax

This statement is an extension to the ANSI/ISO standard for SQL. You can use this statement only with DB-Access.

```
>>-INFO--+-TABLES-----+-----><
      '-++-COLUMNS-+-----FOR--table-'
      |  +-INDEXES-+      |
      |  '-STATUS--'      |
      +-+-PRIVILEGES-+-+
      |  '-ACCESS-----' |
      |  '-FRAGMENTS--+-' |
      |  '-REFERENCES--'  |
```

Element	Description	Restrictions	Syntax
<i>table</i>	Table about which you seek information	Must exist	Database Object Name

Usage

The INFO TABLES statement lists the names of all the user-defined tables in the current database. Other keywords that can immediately follow the INFO keyword instruct DB-Access to display various attributes of the *table* whose name follows the FOR keyword. To display information from more than one keyword option, issue multiple INFO statements.

The keyword options that the INFO statement supports can display the following information:

- **TABLES Keyword**
Use TABLES (with no FOR clause) to list the identifier of every table in the current database, not including system catalog tables. Each user-defined table is listed in one of the following formats:
 - If you are the owner of the **cust_calls** table, it appears as **cust_calls**.
 - If you are not the owner of the **cust_calls** table, the authorization identifier of the owner precedes the table name, such as **'june'.cust_calls**.
- **COLUMNS Keyword**
Use COLUMNS to display the names and data types of the columns in the specified table, showing for each column whether NULL values are allowed.
- **INDEXES Keyword**
Use INDEXES to display the name, owner, and type of each index of the specified table, the clustered status, and listing the indexed columns.
- **FRAGMENTS Keyword**
Use FRAGMENTS to display the fragmentation strategy and the names of the dbspaces storing the fragments of a fragmented table. If the table is fragmented with an expression-based distribution scheme, the INFO statement also shows the expressions.
- **ACCESS or PRIVILEGES Keyword**

Use ACCESS or PRIVILEGES to display the discretionary access privileges currently held by users, roles, and the PUBLIC group for the specified table. (These two keywords are synonyms in this context.)

- **REFERENCES Keyword**

Use REFERENCES to display the References access privilege for users who can define referential constraints on the columns of the specified table. For database-level privileges, use a SELECT statement to query the **sysusers** system catalog table.

- **STATUS Keyword**

Use STATUS to display information about the owner, row length, number of rows and columns, creation date, and the status of audit trails for the specified table.

An alternative to using the INFO statement of SQL is to use the **Info** command of the **SQL** menu or of the **Table** menu of DB-Access to display the same and additional information.

Examples

Use the following example to list the user tables in a database:

```
INFO TABLES;
```

To display information about a specific table, use the syntax:

```
INFO info_keyword FOR table
```

Here *table* is the table name and *info_keyword* is one of the seven keyword options, besides TABLES, to the INFO statement. For example, to display the names of the columns of the table **customer**, use this statement:

```
INFO COLUMNS FOR customer;
```

This example produces the following output:

Column name	Type	Nulls
customer_num	serial	no
fname	char (15)	yes
lname	char (15)	yes
company	char (20)	yes
address1	char (20)	yes
address2	char (20)	yes
city	char (15)	yes
state	char (2)	yes
zipcode	char (5)	yes
phone	char (18)	yes

Related reference:

[GRANT statement](#)

[REVOKE statement](#)

Related information:

[Display table information](#)

[The Query-language option](#)

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INSERT statement

Use the INSERT statement to insert one or more new rows into a table or view, or to insert one or more elements into an SQL or Informix® ESQL/C collection variable.

Syntax

```
>>INSERT----->
(1)
>--+INTO--+synonym+-----+VALUES Clause |-----+><
|      +-view---+ | .-,-----+ |      (2) | | | |
|      '-table---' | V          | +- EXECUTE Routine Clause |-----+ |
|      |          | '-(---column+---)' |      (3) | | |
|      |          |      '-| Subset of SELECT Statement |-----' |
|      |          |      '-external+-----+-----'
|      |          | .-,-----+ |      (3) | |
|      |          | V          |      '-| Subset of SELECT Statement |-----'
|      |          | '-(---column+---)' |
|      |          |      (6) |      (7) |
|      +-----+INTO--+ Collection-Derived Table |-----| Field Options |-----'
|      |      (4) (5) |
|      '-AT position-----'

Field Options

|-----+-----+VALUES Clause |-----+
(1)
```

```
| .-,----- . | | (3) |
| V | | | '-| Subset of SELECT Statement |-----'
'---field+--'
```

Notes:

1. See [VALUES Clause](#)
2. See [Execute Routine Clause](#)
3. See [Subset of SELECT Statement](#)
4. Stored Procedure Language only
5. ESQ/C only
6. See [Collection-Derived Table](#)
7. Informix extension

Element	Description	Restrictions	Syntax
<i>column</i>	Column to receive new value	See Specifying Columns .	Identifier
<i>external</i>	External table into which to insert data	Must exist	Database Object Name
<i>field</i>	Field of a named or unnamed ROW data type	Must already be defined in the database	CREATE ROW TYPE statement
<i>position</i>	Position at which to insert an element of a LIST data type	Literal integer or an INT or SMALLINT type SPL variable.	Literal Number
<i>synonym, table, view</i>	Table, view, or synonym in which to insert data	Synonym or view and the table to which it points must exist	Database Object Name

Usage

To insert data into a table, you must either own the table or have the Insert privilege for the table (see [GRANT statement](#)). To insert data into a view, you must have the required Insert privilege, and the view must meet the requirements explained in [Inserting Rows Through a View](#).

If the table or view has data integrity constraints, the inserted rows must meet the constraint criteria. If they do not, the database server returns an error. If the checking mode is set to IMMEDIATE, all specified constraints are checked at the end of each INSERT statement. If the checking mode is set to DEFERRED, all specified constraints are *not* checked until the transaction is committed.

- [Specifying Columns](#)
- [Using the AT Clause \(ESQ/C, SPL\)](#)
- [Inserting Rows Through a View](#)
- [Inserting Rows with a Cursor](#)
- [Inserting Rows into a Database Without Transactions](#)
- [Inserting Rows into a Database with Transactions](#)
- [VALUES Clause](#)
- [Execute Routine Clause](#)

You can specify the EXECUTE FUNCTION statement (or the EXECUTE PROCEDURE statement) to insert values that a user-defined function returns

Related reference:

[DROP SEQUENCE statement](#)
[ALTER SEQUENCE statement](#)
[UPDATE statement](#)
[LOAD statement](#)
[Literal Row](#)
[CLOSE statement](#)
[DECLARE statement](#)
[DESCRIBE statement](#)
[EXECUTE statement](#)
[FLUSH statement](#)
[FOREACH](#)
[OPEN statement](#)
[PREPARE statement](#)
[PUT statement](#)
[SELECT statement](#)
[DELETE statement](#)
[RENAME SEQUENCE statement](#)
[Collection-Derived Table](#)
[MERGE statement](#)

Related information:

[The INSERT statement](#)
[Create and use SPL routines](#)
[Data manipulation statements](#)
[Complex data types](#)

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Specifying Columns

If you do not explicitly specify one or more columns, data is inserted into columns using the column order that was established when the table was created or last altered. The column order is listed in the **syscolumns** system catalog table.

In Informix® ESQL/C, you can use the DESCRIBE statement with an INSERT statement to identify the column order and the data type of the columns in a table.

The number of columns specified in the INSERT INTO clause must equal the number of values supplied in the VALUES clause or by the SELECT statement, either implicitly or explicitly. If you specify a column list, the columns receive data in the order in which you list the columns. The first value following the VALUES keyword is inserted into the first column listed, the second value is inserted into the second column listed, and so on.

If you omit a column from the column list, and the column does not have a default value associated with it, the database server places a NULL value in the column when the INSERT statement is executed.

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Using the AT Clause (ESQL/C, SPL)

Use the AT clause to insert LIST elements at a specified position in a collection variable. By default, Informix® adds a new element at the end of a LIST collection.

If you specify a position greater than the number of elements in the list, the database server adds the element to the end of the list. You must specify a position value of at least 1 because the first element in the list is at position 1.

The following SPL example inserts a value at a specific position in a list:

```
CREATE PROCEDURE test3()  
  DEFINE a_list LIST(SMALLINT NOT NULL);  
  SELECT list_col INTO a_list FROM table1 WHERE id = 201;  
  INSERT AT 3 INTO TABLE(a_list) VALUES( 9 );  
  UPDATE table1 VALUES list_col = a_list WHERE id = 201;  
END PROCEDURE;
```

Suppose that before this INSERT, **a_list** contained the elements {1, 8, 4, 5, 2}. After this INSERT, **a_list** contains the elements {1, 8, 9, 4, 5, 2}. The new element 9 was inserted at position 3 in the list. For more information on inserting values into collection variables, see [Collection-Derived Table](#).

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Inserting Rows Through a View

You can insert data through a *single-table* view if you have the Insert privilege on the view. To do this, the defining SELECT statement can select from only one table, and it cannot contain any of the following components:

- DISTINCT keyword
- GROUP BY clause
- Derived value (also referred to as a virtual column)
- Aggregate value

Columns in the underlying table that are unspecified in the view receive either a default value or a NULL value if no default is specified. If one of these columns has no default value, and a NULL value is not allowed, the INSERT fails.

You can use data-integrity constraints to prevent users from inserting values into the underlying table that do not fit the view-defining SELECT statement. For further information, see [WITH CHECK OPTION Keywords](#).

You can insert rows through a *single-table* or a *multiple-table* view if an INSTEAD OF trigger specifies valid INSERT operations in its Action clause. See [INSTEAD OF Triggers on Views](#) for information on how to create INSTEAD OF triggers that insert through views.

If several users are entering sensitive information into a single table, the built-in USER function can limit their view to only the specific rows that each user inserted. The following example contains a view and an INSERT statement that achieves this effect:

```
CREATE VIEW salary_view AS  
  SELECT lname, fname, current_salary FROM salary WHERE entered_by = USER;  
  
INSERT INTO salary VALUES ('Smith', 'Pat', 75000, USER);
```

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Inserting Rows with a Cursor

In Informix® ESQL/C, if you associate a cursor with an INSERT statement, you must use the OPEN, PUT, and CLOSE statements to carry out the INSERT operation. For databases that have transactions but are not ANSI-compliant, you must issue these statements within a transaction.

If you are using a cursor that is associated with an INSERT statement, the rows are buffered before they are written to the disk. The insert buffer is flushed under the following conditions:

- The buffer becomes full.

- A FLUSH statement executes.
- A CLOSE statement closes the cursor.
- In a database that is not ANSI-compliant, an OPEN statement implicitly closes and then reopens the cursor.
- A COMMIT WORK statement ends the transaction.

When the insert buffer is flushed, the client processor performs appropriate data conversion before it sends the rows to the database server. When the database server receives the buffer, it converts any user-defined data types and then begins to insert the rows one at a time into the database. If an error is encountered while the database server inserts the buffered rows into the database, any buffered rows that follow the last successfully inserted rows are discarded.

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Inserting Rows into a Database Without Transactions

If you are inserting rows into a database with no transaction logging, you must take explicit action to restore inserted rows if the operation fails. For example, if INSERT fails after entering some rows, the successfully inserted rows remain in the table. You cannot recover automatically from a failed insert into a database for which no transaction log exists

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Inserting Rows into a Database with Transactions

If you are inserting rows into a database and you are using explicit transactions, use the ROLLBACK WORK statement to undo the INSERT. If you do not execute BEGIN WORK before the INSERT, and the INSERT fails, the database server automatically rolls back any data modifications made since the beginning of the INSERT. If you are using an explicit transaction, and the INSERT fails, the database server automatically undoes the effects of the INSERT.

In an ANSI-compliant database, transactions are implicit, and all database modifications take place within a transaction. In this case, if an INSERT statement fails, use the ROLLBACK WORK statement to undo the insertions.

Tables that you create with the RAW logging type are not logged. Thus, raw tables are not recoverable, even if the database uses logging.

Rows that you insert with a transaction remain locked until the end of the transaction. The end of a transaction is either a COMMIT WORK statement, where all modifications are made to the database, or a ROLLBACK WORK statement, where none of the modifications are made to the database. If many rows are affected by a *single* INSERT statement, you can exceed the maximum number of simultaneous locks permitted. To prevent this situation, either insert fewer rows per transaction, or lock the page (or the entire table) before you execute the INSERT statement.

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VALUES Clause

The VALUES clause can specify values to insert into one or more columns. When you use the VALUES clause, you can insert only one row at a time.

Each value that follows the VALUES keyword is assigned to the corresponding column listed in the INSERT INTO clause (or in column order, if a list of columns is not specified). If you are inserting a quoted string into a column, the maximum length that can be inserted without error is 256 bytes.

VALUES Clause

```
|--VALUES----->

. ,-----
v |
>--(-----input_var-----+-----)-----|
| | | (1) | |
| | +-----:--indicator_var--+ |
| | | (2) | |
| | '-----$--indicator_var-' |
+-+--NULL-----+--+
| +-USER-----+ |
| | | (3) | | | |
| +-| Quoted String |-----+ |
| | | (4) | |
| +-| Literal Number |-----+ |
| | | (2) | | (5) | |
| +-----| Constant Expression |-----+ |
| | | (6) | |
| '-| Column Expression |-----' |
| | | (7) | |
| '-+| Literal Collection |-----' |
| | | (8) | |
| +-| Literal Row |-----+ |
| | | (9) | |
| +-| Expression |-----+ |
| +- 'literal_Boolean'-----+ |
```

'-literal_opaque-----'

Notes:

1. ESQL/C only
2. Informix® extension
3. See [Quoted String](#)
4. See [Literal Number](#)
5. See [Constant Expressions](#)
6. See [Column Expressions](#)
7. See [Literal Collection](#)
8. See [Literal Row](#)
9. See [Expression](#)

Element	Description	Restrictions	Syntax
<i>indicator_var</i>	Variable to show if SQL statement returns NULL to <i>input_var</i>	See the <i>IBM® Informix ESQL/C Programmer's Manual</i> .	Language specific
<i>input_var</i>	Variable that holds value to insert. This can be a collection variable.	Can contain any value option of VALUES clause	Language specific
<i>literal_opaque</i>	Literal representation for an opaque data type	Must be recognized by the input support function of the opaque data type	See documentation of the opaque type.
<i>literal_Boolean</i>	Literal representation of a BOOLEAN value as a single character	Either 't' (TRUE) or 'f' (FALSE)	Quoted String

In Informix ESQL/C, if you use an *input_var* variable to specify the value, you can insert character strings longer than 256 bytes into a table.

For the keywords and the types of literal values that are valid in the VALUES clause, refer to [Constant Expressions](#).

- [Considering Data Types](#)
- [Inserting Values into Serial Columns](#)
- [Inserting Values into Opaque-Type Columns](#)
- [Inserting Values into Collection Columns](#)
- [Inserting Values into ROW-Type Columns](#)
- [Data Types in Distributed INSERT Operations](#)

Distributed INSERT operations across tables in databases of different server instances can return only a subset of the data types that distributed INSERT operations can return from tables that are all in databases of the same Informix instance.

- [Using Expressions in the VALUES Clause](#)
- [Inserting NULL Values](#)
- [Inserting Values into Protected Tables](#)
- [Truncated CHAR Values](#)
- [Subset of SELECT Statement](#)

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Considering Data Types

The value that the INSERT statement puts into a column does not need to be of the same data type as the column that receives it. These two data types, however, must be compatible. Two data types are *compatible* if the database server has some way to cast one data type to another. A *cast* is the mechanism by which the database server converts one data type to another.

The database server makes every effort to perform data conversion. If the data cannot be converted, the INSERT operation fails. Data conversion also fails if the target data type cannot hold the value that is specified. For example, you cannot insert the integer 123456 into a column defined as a SMALLINT data type because this data type cannot hold a number that large.

For a summary of the casting that the database server provides, see the *IBM® Informix® Guide to SQL: Reference*. For information on how to create a user-defined cast, see the CREATE CAST statement in this document and *IBM Informix User-Defined Routines and Data Types Developer's Guide*.

In a database that uses a nondefault locale, if the **GL_DATETIME** environment variable has a nondefault setting, the **USE_DTEENV** environment variable must be set to 1 before the INSERT statement can correctly insert localized DATETIME values into a database table, or into a view, or into an EXTERNAL table object.

Related information:

[Data Type Casting and Conversion](#)

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Inserting Values into Serial Columns

You can insert successive numbers, explicit values, or explicit values that reset the value in a SERIAL, BIGSERIAL, or SERIAL8 column:

- To insert a consecutive serial value
Specify a zero (0) for the serial column in the INSERT statement. In this case, the database server assigns the next highest value.

- To insert an explicit value
Specify the nonzero value after first verifying that it does not duplicate one already in the table. If the serial column is uniquely indexed or has a unique constraint, and your value duplicates one already in the table, an error results. If the value is greater than the current maximum value, you will create a gap in the series.
- To create a gap in the series (that is, to reset the serial value)
Specify a positive value that is greater than the current maximum value in the column.

Alternatively, you can use the MODIFY clause of the ALTER TABLE statement to reset the next value of a serial column.

For more information, see [Altering the Next Serial Value](#).

NULL values are not valid in serial columns.

In Informix®, inserting a serial value into a table that is part of a table hierarchy updates all tables in the hierarchy that contain the serial counter with the value that you insert. You can express this value either as zero (0) for the next highest value, or as a specific positive integer.

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Inserting Values into Opaque-Type Columns

Informix® supports INSERT operations that specify literal values of opaque data types as quoted strings in the VALUES clause. You can use this syntax to insert values of opaque UDTs into columns of tables in the local database, or into columns of tables in other databases of the local instance.

Some opaque data types require special processing when they are inserted. For example, if an opaque data type contains spatial or multirepresentational data, it might provide a choice of how to store the data: inside the internal structure or, for large objects, in a smart large object.

This is accomplished by calling a user-defined support function called **assign()**. When you execute INSERT on a table whose rows contains one of these opaque types, the database server automatically invokes the **assign()** function for the type. The **assign()** function can make the decision of how to store the data. For more information about the **assign()** support function, see *IBM® Informix User-Defined Routines and Data Types Developer's Guide*.

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Inserting Values into Collection Columns

You can use the VALUES clause to insert values into a collection column. For more information, see [Collection Constructors](#).

For example, suppose you define the **tab1** table as follows:

```
CREATE TABLE tab1
(
  int1 INTEGER,
  list1 LIST(ROW(a INTEGER, b CHAR(5)) NOT NULL),
  dec1 DECIMAL(5,2)
);
```

The following INSERT statement inserts a row into **tab1**:

```
INSERT INTO tab1 VALUES
(
  10,
  LIST(ROW(1, 'abcde'),
        ROW(POW(3,3), '=27'),
        ROW(ROUND(ROOT(126)), '=11')),
  100
);
```

The collection column, **list1**, in this example, has three elements. Each element is an unnamed row type with an INTEGER field and a CHAR(5) field. The first element is composed of two literal values, an integer (1) and a quoted string (abcde). The second and third elements also use a quoted string to indicate the second field, but specify the value for the first field with an expression.

Regardless of what method you use to insert values into a collection column, you cannot insert NULL elements into the column. Thus expressions that you use cannot evaluate to NULL. If the collection that you are attempting to insert contains a NULL element, the database server returns an error.

You can also use a collection variable to insert the values of one or more collection elements into a collection column. For more information, see [Collection-Derived Table](#).

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Inserting Values into ROW-Type Columns

Use the VALUES clause to insert values into a named or unnamed ROW type column, as in the following example:

```
CREATE ROW TYPE address_t
(
  street CHAR(20),
  city CHAR(15),
  state CHAR(2),
  zipcode CHAR(9)
);
CREATE TABLE employee
(
  name ROW ( fname CHAR(20), lname CHAR(20)),
  address address_t
);
```

The next example inserts literal values in the **name** and **address** columns:

```
INSERT INTO employee VALUES
(
  ROW('John', 'Williams'),
  ROW('103 Baker St', 'Tracy', 'CA', 94060)::address_t
);
```

INSERT uses ROW constructors to generate values for the **name** column (an unnamed ROW data type) and the **address** column (a named ROW data type). When you specify a value for a named ROW data type, you must use the CAST AS keywords or the double colon (::) operator, with the name of the ROW data type, to cast the value to the named ROW data type.

For the syntax of ROW constructors, see [Constructor Expressions](#) in the Expression segment. For information on literal values for named ROW and unnamed ROW data types, see [Literal Row](#).

When you use a ROW variable in the VALUES clause, the ROW variable must contain values for each field value. For more information, see [Inserting into a Row Variable \(ESQL/C, SPL\)](#).

You can use Informix® ESQL/C host variables to insert *nonliteral* values in two ways:

- An entire ROW type into a column. Use a **row** variable in the VALUES clause to insert values for all fields in a ROW column at one time.
- Individual fields of a ROW type. To insert nonliteral values in a ROW-type column, insert the elements into a **row** variable and then specify the **collection** variable in the SET clause of an UPDATE statement.

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Data Types in Distributed INSERT Operations

Distributed INSERT operations across tables in databases of different server instances can return only a subset of the data types that distributed INSERT operations can return from tables that are all in databases of the same Informix® instance.

An INSERT statement (or any other SQL data-manipulation language statement) that accesses a database of another Informix instance can reference only the following data types:

- Built-in data types that are not opaque or complex
- BOOLEAN
- BSON
- JSON
- LVARCHAR
- DISTINCT of built-in types that are not opaque
- DISTINCT of BOOLEAN
- DISTINCT of BSON
- DISTINCT of JSON
- DISTINCT of LVARCHAR
- DISTINCT of the DISTINCT types in this list.

Cross-server distributed INSERT operations can support these DISTINCT types only if the DISTINCT types are cast explicitly to built-in types, and all of the DISTINCT types, their data type hierarchies, and their casts are defined exactly the same way in each participating database.

Cross-server DML operations cannot reference a column or expression of a complex, large-object, nor user-defined data type (UDT), nor of an unsupported DISTINCT or built-in opaque type. For additional information about the data types that Informix supports in cross-server DML operations, see [Data Types in Cross-Server Transactions](#).

Distributed operations that access other databases of the local Informix instance, however, can access the cross-server data types that are listed above, and also the following data types:

- Most of the *built-in opaque data types*, as listed in [Data Types in Cross-Database Transactions](#)
- DISTINCT of the built-in types that are referenced in the line above
- DISTINCT of any of the data types that are listed in either of the two lines above
- Opaque user-defined data types (UDTs) that can be cast explicitly to built-in data types.

Cross-database INSERT operations can support these DISTINCT and opaque UDTs only if all the opaque UDTs and DISTINCT types are cast explicitly to built-in types, and all of the opaque UDTs, DISTINCT types, data type hierarchies, and casts are defined exactly the same way in each participating database.

Distributed INSERT transactions cannot access the database of another Informix instance unless both servers define TCP/IP or IPCSTR connections in their DBSERVERNAME or DBSERVERALIASES configuration parameters and in the **sqlhosts** file or SQLHOSTS registry subkey. The requirement, that both participating servers support the same type of connection (either TCP/IP or else IPCSTR), applies to any communication between Informix instances, even if both reside on the same computer.

Using Expressions in the VALUES Clause

With IBM® Informix®, you can insert any type of expression except a column expression into a column. For example, you can insert built-in functions that return the current date, date and time, login name of the current user, or database server name where the current database resides.

The TODAY keyword returns the system date. The CURRENT or SYSDATE keyword returns the system date and time. The USER or CURRENT_USER keyword returns a string that contains the login account name of the current user. The SITENAME or DBSERVERNAME keyword returns the database server name where the current database resides. The following example uses built-in functions to insert data:

```
INSERT INTO cust_calls (customer_num, call_dtime, user_id,
                      call_code, call_descr)
VALUES (212, CURRENT, USER, 'L', '2 days');
```

For more information, see [Expression](#).

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Inserting NULL Values

When you execute the INSERT statement, the database server inserts a NULL value into any column for which you provide no value, as well as for all columns that have no default values and that are not listed explicitly. You also can specify the NULL keyword in the VALUES clause to indicate that a column should be assigned a NULL value.

The following example inserts values into three columns of the **orders** table:

```
INSERT INTO orders (orders_num, order_date, customer_num) VALUES (0, NULL, 123);
```

In this example, a NULL value is explicitly entered in the **order_date** column, and all other columns of the **orders** table that are *not* explicitly listed in the INSERT INTO clause are also filled with NULL values.

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Inserting Values into Protected Tables

In a database that uses label-based access control (LBAC), the INTO clause of the INSERT statement can reference a table that is protected by a security policy if the user holds sufficient credentials for the security policy of the label that protects the table, as well as holding the Insert privilege on the table.

A user who holds no security label, however, cannot insert data into a table that has LBAC row protection, even if the user has been granted the required exemptions from rules of the security policy, unless the row label of the protected table is specified in the VALUES clause of the INSERT statement. Data manipulation language statements can provide the row label of a protected table by calling any of three built-in functions whose first argument specifies the name of the security policy, and whose additional arguments are one of the following:

- name of the security label
- name of the IDSSecurityLabel column in the table.
- names of the security policy components in the label and the values of their elements

For example, the following INSERT statement calls the built-in **SECLABEL_BY_NAME** function in order to insert a new row into a table called **tab002** that is protected by a row label called **Decca** of the **MegaCorp** security policy:

```
INSERT INTO tab002
VALUES (SECLABEL_BY_NAME('Megacorp', 'Decca'), 45, 'A.C. Debussy');
```

Whether this INSERT operation succeeds depends on whether the security credentials of the user are sufficient, relative to the component values of the **Decca** label, to enable write access to the **tab002** table.

For additional examples of INSERT statements that access protected tables by calling **SECLABEL_BY_NAME** or similar built-in functions, see [Security Label Support Functions](#). For general information about LBAC security policies, security labels, read and write access rules, and exemptions from those rules, see your IBM® Informix® Security Guide.

Related information:

[Label-based access control](#)

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Truncated CHAR Values

In a database that is not ANSI-compliant, if you assign a value to a CHAR(*n*) column or variable and the length of that value exceeds *n* characters, the database server truncates the last characters without raising an error. For example, suppose that you define this table:

```
CREATE TABLE tab1 (col_one CHAR(2);
```

The database server truncates the data values in the following INSERT statements to "jo" and "sa" respectively, but does not return a warning:

```
INSERT INTO tab1 VALUES ("john");
INSERT INTO tab1 VALUES ("sally");
```

Thus, in a database that is not ANSI-compliant, the semantic integrity of data for a CHAR(*n*) column or variable is not enforced when the value inserted or updated exceeds the declared length *n*. (But in an ANSI-compliant database, the database server issues error -1279 when truncation of character data occurs.)

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Subset of SELECT Statement

As indicated in the [INSERT statement](#) syntax diagram, not all clauses and options of the SELECT statement are available for you to use in a query within an INSERT statement. The following SELECT clauses and options are not supported in an INSERT statement:

- FIRST and LIMIT
- INTO TEMP, INTO RAW, and INTO STANDARD result table options
- UNION, UNION ALL, INTERSECT, MINUS, and EXCEPT set operators.

In an ANSI-compliant database, if this statement has a WHERE clause that does not return rows, **sqlca** returns SQLNOTFOUND (100).

If an INSERT statement that is part of a multistatement prepared object inserts no rows, **sqlca** returns SQLNOTFOUND (100) for both ANSI-compliant databases and databases that are not ANSI-compliant. In databases that are not ANSI-compliant, **sqlca** returns zero (0) if no rows satisfy the WHERE clause.

In Informix, if you are inserting values into a supertable in a table hierarchy, the subquery can reference a subtable. If you are inserting values into a subtable in a table hierarchy, the subquery can reference the supertable if it references only the supertable. That is, the subquery must use the SELECT...FROM ONLY (*supertable*) syntax.

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Execute Routine Clause

You can specify the EXECUTE FUNCTION statement (or the EXECUTE PROCEDURE statement) to insert values that a user-defined function returns

```
.

Execute Routine Clause

|--EXECUTE--+--PROCEDURE--+----->
      '-FUNCTION--function---'

>--(-----+--)->-----|
| .,-----+-----|
| V          (1) | |
|---| Argument |-----|
```

Notes:

1. See [Arguments](#)

Element	Description	Restrictions	Syntax
<i>function, procedure</i>	User-defined function or procedure to insert the data	Must exist	Database Object Name

When you use a user-defined function to insert column values, the return values of the function must have a one-to-one correspondence with the listed columns. That is, each return value

- must be of a data type the same or compatible with the corresponding *column*,
- and its order among return values must match the *column*'s order in the column list.

For backward compatibility, Informix® can use the EXECUTE PROCEDURE keywords to execute an SPL function that was created with the CREATE PROCEDURE statement.

If the called SPL routine scans or updates the target table of the INSERT statement, the database returns an error. That is, the SPL routine cannot select data from the table into which you are inserting rows.

If a called SPL routine contains certain SQL statements, the database server returns an error. For information on which SQL statements cannot be used in an SPL routine that is called within a data manipulation statement, see [Restrictions on SPL Routines in Data-Manipulation Statements](#).

- [Number of Values Returned by SPL, C, and Java Functions](#)
- [Inserting into a Row Variable \(ESQL/C, SPL\)](#)
- [Using INSERT as a Dynamic Management Statement](#)

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Number of Values Returned by SPL, C, and Java Functions

An SPL function can return one or more values. Make sure that the number of returned values matches the number of columns in the table or the number of columns in the column list of the INSERT statement. These columns must have data types that are compatible with the values that the SPL function returns.

An external function written in the C or Java™ language can only return *one* value. Make sure that you specify only one column in the column list of the INSERT statement. This column must have a compatible data type with the value that the external function returns. The external function can be an iterator function.

The following example shows how to insert data into a temporary table called **result_tmp** in order to output to a file the results of a user-defined function (**f_one**) that returns multiple rows:

```
CREATE TEMP TABLE result_tmp( ... );
INSERT INTO result_tmp EXECUTE FUNCTION f_one();
UNLOAD TO 'file' SELECT * FROM foo_tmp;
```

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Inserting into a Row Variable (ESQL/C, SPL)

The INSERT statement does not support a row variable in the Collection- Derived-Table segment. You can use the UPDATE statement, however, to insert new field values into a row variable. For example, the following Informix® ESQL/C code fragment inserts a new row into the **rectangles** table (which [Inserting Values into ROW-Type Columns](#) defines):

```
EXEC SQL BEGIN DECLARE SECTION;
    row (x int, y int, length float, width float) myrect;
EXEC SQL END DECLARE SECTION;

...
EXEC SQL update table(:myrect)
    set x=7, y=3, length=6, width=2;
EXEC SQL insert into rectangles values (12, :myrect);
```

For more information, see [Updating a Row Variable \(ESQL/C\)](#).

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Using INSERT as a Dynamic Management Statement

In Informix® ESQL/C, you can use the INSERT statement to handle situations where you need to write code that can insert data whose structure is unknown at the time you compile. For more information, refer to the dynamic management section of the *IBM® Informix ESQL/C Programmer's Manual*.

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LOAD statement

Use the LOAD statement to insert data from an operating-system file into an existing table or view.

Syntax

Only DB-Access supports the LOAD statement.

```
>>-LOAD FROM--'filename'--+-----+----->
                        '-DELIMITER--'delimiter'-'

>--INSERT INTO--+--table--+-----+-----><
      +-view-----+ | .------+ |
      '-synonym-' | V |
                  '-(----column+--)-'
```

Element	Description	Restrictions	Syntax
<i>column</i>	Column to receive data values from <i>filename</i>	See INSERT INTO Clause .	Identifier
<i>delimiter</i>	Character to separate data values in each line of the load file. Default <i>delimiter</i> is the pipe (|) symbol.	See DELIMITER Clause .	Quoted String
<i>filename</i>	Path and filename of file to read. Default pathname is current directory	See LOAD FROM File .	Specific to operating system rules

Element	Description	Restrictions	Syntax
<i>synonym, table, view</i>	Synonym for the table in which to insert data from <i>filename</i>	<i>Synonym</i> and <i>table</i> or <i>view</i> to which it points must exist	Database Object Name

Usage

This statement is an extension to the ANSI/ISO standard for SQL. You can use this statement only with DB-Access.

The LOAD statement appends new rows to the table. It does not overwrite existing data. You cannot add a row that has the same key as an existing row.

To use the LOAD statement, you must have Insert privileges for the table where you want to insert data. For information on database-level and table-level privileges, see the [GRANT statement](#).

In a database that uses a nondefault locale, if the **GL_DATETIME** environment variable has a nondefault setting, the **USE_DTEENV** environment variable must be set to 1 before the LOAD statement can correctly insert localized DATETIME values into a database table, or into a view, or into an object that the CREATE EXTERNAL TABLE statement defined. For more information on the **GL_DATETIME**, **GL_DATE**, **DBTIME**, and **USE_DTEENV** environment variables, refer to the *IBM® Informix GLS User's Guide*.

- [LOAD FROM File](#)
The LOAD FROM file contains the data to be loaded into the specified table or view. The default pathname for the load file is the current directory.
- [Loading Simple Large Objects](#)
- [Loading Smart Large Objects](#)
- [Loading Complex Data Types](#)
- [Loading Opaque-Type Columns](#)
- [DELIMITER Clause](#)
- [INSERT INTO Clause](#)
Use the INSERT INTO clause to specify the table, synonym, or view in which to load the new data.

Related reference:

[UNLOAD statement](#)

[INSERT statement](#)

Related information:

[The LOAD and UNLOAD statements](#)

[Load and unload data](#)

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LOAD FROM File

The LOAD FROM file contains the data to be loaded into the specified table or view. The default pathname for the load file is the current directory.

You can use the file that the UNLOAD statement creates as the LOAD FROM file. (See [UNLOAD TO File](#) for a description of how values of various data types are represented within the UNLOAD TO file.)

If you do not include a list of columns in the INSERT INTO clause, the fields in the file must match the columns that are specified for the table in number, order, and data type.

Each line of the file must have the same number of fields. You must define field lengths that are less than or equal to the length that is specified for the corresponding column. Specify only values that can convert to the data type of the corresponding column. The following table indicates how the database server expects you to represent the data types in the LOAD FROM file (when you use the default locale, U.S. English).

Type of Data	Input Format
blank	One or more blank characters between delimiters You can include leading blanks in fields that do not correspond to character columns.
BOOLEAN	A <i>t</i> or <i>T</i> indicates a TRUE value, and an <i>f</i> or <i>F</i> indicates a FALSE value.
COLLECTIONS	Collection must have its values surrounded by braces ({ }) and a field delimiter separating each element. For more information, see Loading Complex Data Types .
DATE	Character string in the following format: <i>mm/dd/year</i> You must state the month as a two-digit number. You can use a two-digit number for the year if the year is in the 20th century. (You can specify another century algorithm with the DBCENTURY environment variable.) The value must be an actual date; for example, February 30 is illegal. You can use a different date format if you indicate this format with the GL_DATE or DBDATE environment variable. For more information about environment variables, see the <i>IBM® Informix® Guide to SQL: Reference</i> and the <i>IBM Informix GLS User's Guide</i> .
DECIMAL, MONEY, FLOAT	Value that can include a leading and/or trailing currency symbol and thousands and decimal separators Your locale files or the DBMONEY environment variable can specify a currency format.
NULL	Nothing between the delimiters
ROW types (named or unnamed)	ROW type must have its values surrounded by parentheses and a field delimiter that separates each element. For more information, see Loading Complex Data Types .
Simple large objects (TEXT, BYTE)	TEXT and BYTE columns are loaded directly from the LOAD TO file. For more information, see Loading Simple Large Objects .

Type of Data	Input Format
Smart large objects (CLOB, BLOB)	CLOB and BLOB columns are loaded from a separate operating-system file. The field for the CLOB or BLOB column in the LOAD FROM file contains the name of this separate file. For more information, see Loading Smart Large Objects .
Time	Character string in <i>year-month-day hour:minute:second.fraction</i> format. You cannot use data type keywords or qualifiers for DATETIME or INTERVAL values. The year must be a 4-digit number, and the month must be a 2-digit number. The DBTIME or GL_DATETIME environment variable can specify other end-user formats.
User-defined data formats (opaque types)	Associated opaque type must have an import support function defined if special processing is required to copy the data in the LOAD FROM file to the internal format of the opaque type. An import binary support function might also be required for data in binary format. The LOAD FROM file data must be in the format that the import or import binary support function expects. The associated opaque type must have an assign support function if special processing is required before writing the data in the database. See Loading Opaque-Type Columns .

For more information on **DB*** environment variables, refer to the *IBM Informix Guide to SQL: Reference*. For more information on **GL*** environment variables, refer to the *IBM Informix GLS User's Guide*.

If you are using a nondefault locale, the formats of DATE, DATETIME, MONEY, and numeric column values in the LOAD FROM file must be compatible with the formats that the locale supports for these data types. For more information, see the *IBM Informix GLS User's Guide*.

The following example shows the contents of an input file named **new_custs**:

```
0|Jeffery|Padgett|Wheel Thrills|3450 El Camino|Suite 10|Palo Alto|CA|94306||
0|Linda|Lane|Palo Alto Bicycles|2344 University||Palo Alto|CA|94301|
(415) 323-6440
```

This data file conveys the following information:

- Indicates a serial field by specifying a zero (0)
- Uses the pipe (|), the default delimiter
- Assigns NULL values to the **phone** field for the first row and the **address2** field for the second row. The NULL values are shown by two delimiters with nothing between them.

The following statement loads the values from the **new_custs** file into the **customer** table that **jason** owns:

```
LOAD FROM 'new_custs' INSERT INTO jason.customer;
```

If you include any of the following special characters as part of the value of a field, you must precede the character with a backslash (\) escape symbol:

- Backslash
- Delimiter
- Newline character anywhere in the value of a VARCHAR or NVARCHAR column
- Newline character at end of a value for a TEXT value

Do not use the backslash character (\) as a field separator. It serves as an escape character to inform the LOAD statement that the next character is to be interpreted as part of the data, rather than as having special significance.

Fields that correspond to character columns can contain more characters than the defined maximum allows for the field. The extra characters are ignored.

If you are loading files that contain VARCHAR data types, note the following information:

- If you give the LOAD statement data in which the character fields (including VARCHAR) are longer than the column size, the excess characters are disregarded.
- Use the backslash (\) to escape embedded delimiter and backslash characters in all character fields, including VARCHAR.
- Do not use the following characters as delimiting characters in the LOAD FROM file: digits (0 to 9), the letters a to f, and A to F, the backslash (\) character, or the NEWLINE (CTRL-J) character.

Related information:

[Environment variables in Informix products](#)

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Loading Simple Large Objects

The database server loads simple large objects (BYTE and TEXT columns) directly from the LOAD FROM file. Keep the following restrictions in mind when you load BYTE and TEXT data:

- You cannot have leading and trailing blanks in BYTE fields.
- Use the backslash (\) to escape the special significance of literal delimiter and backslash characters in TEXT fields.
- Data being loaded into a BYTE column must be in ASCII-hexadecimal form. BYTE columns cannot contain preceding blanks.
- Do not use the following characters as delimiting characters in the LOAD FROM file: digits (0 to 9), the letters a to f, and A to F, the backslash (\) character, or the NEWLINE (CTRL-J) character.

For loading TEXT columns in a non-default locale, the database server handles any required code-set conversions for the data. See also the *IBM® Informix® GLS User's Guide*.

If you are unloading files that contain BYTE or TEXT data types, objects smaller than 10 kilobytes are stored temporarily in memory. You can adjust the 10-kilobyte setting to a larger setting with the **DBBLOBBUF** environment variable. Simple large objects that are larger than the default or the setting of **DBBLOBBUF** are stored in a temporary file. For more information about the **DBBLOBBUF** environment variable, see the *IBM Informix Guide to SQL: Reference*.

Loading Smart Large Objects

The database server loads smart large objects (BLOB and CLOB columns) from a separate operating-system file on the client computer. For information on the structure of this file, see [Unloading Smart Large Objects](#).

In a LOAD FROM file, a CLOB or BLOB column value appears as follows:

`start_off,length,client_path`

In this format, *start_off* is the starting offset (in hexadecimal) of the smart-large-object value within the client file, *length* is the length (in hexadecimal) of the BLOB or CLOB value, and *client_path* is the pathname for the client file. No blank spaces can appear between these values.

For example, to load a CLOB value that is 512 bytes long and is at offset 256 in the `/usr/apps/clob9ce7.318` file, the database server expects the CLOB value to appear as follows in the LOAD FROM file:

`|100,200,/usr/apps/clob9ce7.318|`

If the whole client file is to be loaded, a CLOB or BLOB column value appears as follows in the LOAD FROM file:

`client_path`

For example, to load a CLOB value that occupies the entire file `/usr/apps/clob9ce7.318`, the database server expects the CLOB value to appear as follows in the LOAD FROM file:

`|/usr/apps/clob9ce7.318|`

In DB-Access, the USING clause is valid within files executed from DB-Access. In interactive mode, DB-Access prompts you for a password, so the USING keyword and *validation_var* are not used.

For CLOB columns, the database server handles any required code-set conversions for the data. See also the *IBM® Informix® GLS User's Guide*.

Loading Complex Data Types

In a LOAD FROM file, complex data types appear as follows:

- Collections are introduced with the appropriate constructor (SET, MULTISSET, or LIST), and their elements are enclosed in braces (`{ }`) and separated with a comma, as follows:

`constructor{val1 , val2 , ... }`

For example, to load the SET values `{1, 3, 4}` into a column whose data type is `SET(INTEGER NOT NULL)`, the corresponding field of the LOAD FROM file appears as:

`|SET{1 , 3 , 4}|`

- Row types (named and unnamed) are introduced with the ROW constructor and their fields are enclosed with parentheses and separated with a comma, as follows:

`ROW(val1 , val2 , ...)`

For example, to load the ROW values `(1, 'abc')`, the corresponding field of the LOAD FROM file appears as:

`|ROW(1 , abc)|`

Loading Opaque-Type Columns

Some opaque data types require special processing when they are inserted. For example, if an opaque data type contains spatial or multirepresentational data, it might provide a choice of how to store the data: inside the internal structure or, for large objects, in a smart large object.

This processing is accomplished by calling a user-defined support function called **`assign()`**. When you execute the LOAD statement on a table whose rows contain one of these opaque types, the database server automatically invokes the **`assign()`** function for the type. The **`assign()`** function can make the decision of how to store the data. For more information about the **`assign()`** support function, see the *IBM® Informix® User-Defined Routines and Data Types Developer's Guide*.

DELIMITER Clause

Use the DELIMITER clause to specify the delimiter that separates the data contained in each column in a row in the input file. You can specify TAB (CTRL-I) or a blank space (= ASCII 32) as the delimiter symbol. You cannot use the following items as the delimiter symbol:

- Backslash (\)
- NEWLINE character (CTRL-J)
- Hexadecimal numbers (0 to 9, a to f, A to F)

If you omit this clause, the database server checks the **DBDELIMITER** environment variable. For information about how to set the **DBDELIMITER** environment variable, see the *IBM® Informix® Guide to SQL: Reference*.

If the **DBDELIMITER** environment variable has not been set, the default delimiter is the pipe (|).

The following example specifies the semicolon (;) as the delimiting character. The example uses Windows file-naming conventions.

```
LOAD FROM 'C:\data\loadfile' DELIMITER ';'
INSERT INTO orders;
```

Related information:

[DBDELIMITER environment variable](#)

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INSERT INTO Clause

Use the INSERT INTO clause to specify the table, synonym, or view in which to load the new data.

You must specify the column names only if one of the following conditions is true:

- You are not loading data into all columns.
- The input file does not match the default order of the columns (the order specified when the table was created).

The INTO clause cannot specify a table object that the CREATE EXTERNAL TABLE statement defined.

The following example identifies the **price** and **discount** columns as the only columns in which to add data. The example uses Windows file naming conventions.

```
LOAD FROM 'C:\tmp\prices' DELIMITER ','
INSERT INTO norman.worktab(price,discount)
```

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LOCK TABLE statement

Use the LOCK TABLE statement to control access to a table by other processes.

Syntax

```
>>-LOCK TABLE-----+---table-----IN--+--SHARE-----+----->
                        '-owner.-' '-synonym-' '-EXCLUSIVE-'
>>-MODE-----><
```

Element	Description	Restrictions	Syntax
<i>owner</i>	Owner of <i>synonym</i> or <i>table</i>	Must be the owner of the specified object	Owner name
<i>synonym</i>	Synonym for the table to be locked	Synonym and the table to which it points must exist	Identifier
<i>table</i>	Table to be locked	See first paragraph of Usage .	Identifier

Usage

This statement is an extension to the ANSI/ISO standard for SQL.

You can use LOCK TABLE to lock a table if either of the following is true:

- You are the owner of the table.
- You have Select privilege on the table or on a column in the table, either from a direct grant or from a grant to PUBLIC or to your current role.

The LOCK TABLE statement fails if the table is already locked in EXCLUSIVE mode by another process, or if you request an EXCLUSIVE lock while another user has locked the same table in SHARE mode.

The SHARE keyword locks a table in *shared mode*. Shared mode gives other processes *read* access to the table but denies *write* access. Other processes cannot update or delete data if a table is locked in shared mode.

The EXCLUSIVE keyword locks a table in *exclusive mode*. This mode denies other processes both read and write access to the table. Exclusive-mode locking automatically occurs during the following statements:

- ALTER FRAGMENT
- ALTER INDEX
- ALTER TABLE
- CREATE INDEX
- DROP INDEX
- RENAME COLUMN
- RENAME TABLE
- START VIOLATIONS TABLE
- STOP VIOLATIONS TABLE
- TRUNCATE

The ONLINE keyword in some DDL operations

During certain ALTER FRAGMENT, DROP INDEX, and CREATE INDEX operations, including the ONLINE keyword can reduce the risk of run time errors when a concurrent session attempts to access the same table. For more information about the locking behavior of DDL statements that support the ONLINE keyword option, see these topics:

- [Using the ONLINE keyword in ATTACH operations](#)
- [Using the ONLINE keyword in DETACH operations](#)
- [Using the ONLINE keyword in MODIFY operations](#)
- [The ONLINE keyword of CREATE INDEX](#)
- [The ONLINE keyword of DROP INDEX](#)

LOCK TABLE statement behavior on secondary servers

You can set an exclusive lock on a table from an updatable secondary server in a high-availability cluster. For exclusive mode locks requested from a secondary server, sessions can read the table but not update it. This behavior is similar to shared access mode on a secondary server; that is, when one session has an exclusive lock on a given table, no other session can obtain a shared or exclusive lock on that table.

On read-only secondary servers, the session issuing the LOCK TABLE statement does not lock the table and the database server does not return an error to the client.

Shared mode locks in a cluster behave the same as for a standalone server. After a LOCK TABLE statement runs successfully, users can read the table but cannot modify it until the lock is released.

- [Concurrent Access to Tables with Shared Locks](#)
- [Concurrent Access to Tables with Exclusive Locks](#)
- [Databases with transaction logging](#)
- [Databases without transaction logging](#)
- [Locking Granularity](#)

Related reference:

[ADD TYPE Clause](#)
[BEGIN WORK statement](#)
[COMMIT WORK statement](#)
[ROLLBACK WORK statement](#)
[SET ISOLATION statement](#)
[SET LOCK MODE statement](#)
[UNLOCK TABLE statement](#)

Related information:

[Concurrency and locks](#)

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Concurrent Access to Tables with Shared Locks

After the LOCK TABLE statement that specifies the IN SHARE MODE keywords executes successfully, other users can read the table but cannot modify its data until the lock is released. In databases that support transaction logging, the SELECT statement can implicitly place a shared lock on each tables that is listed in the FROM clause, in order to prevent other users from modifying those tables until the query is committed or rolled back.

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Concurrent Access to Tables with Exclusive Locks

After the LOCK TABLE statement with the IN EXCLUSIVE MODE option executes successfully, no other user can obtain a lock on the specified table. When you attempt a DDL operation on that table, however, you might receive RSAM error -106 if the same table is being accessed by a concurrent session (for example, by opening a cursor). This error can also affect implicit locks that certain DDL statements place on tables automatically.

This is possible because table locks do not preclude table access. An exclusive lock prevents other users from obtaining a lock, but it cannot prevent them from opening the table for write operations that wait for the exclusive lock to be released, or for Dirty Read operations on the table. You can set the **IFX_DIRTY_WAIT** environment variable to specify that the DDL operation wait for a specified number of seconds for Dirty Read operations to commit or rollback.

When one or more rows in a table are locked by an exclusive lock, the effect on other users partly depends on their transaction isolation level. Other users in all isolation levels except the Dirty Read isolation level might encounter locking errors, such as transactions that fail because the lock was not released within a specified time limit, or a deadlock situation.

On tables where row-level locking affects some of the rows, the risk of locking conflicts can be reduced by enabling transactions to read the most recently committed version of the data in the row-level locked table, rather than waiting for the transaction that holds the lock on that row to be committed or rolled back. This can be accomplished in several different ways, including these:

- From an individual session, issue this SQL statement

```
SET ISOLATION TO COMMITTED READ LAST COMMITTED;
```

- For all sessions using Committed Read or Read Committed isolation levels, set the USELASTCOMMITTED configuration parameter to 'ALL' or to 'COMMITTED READ', or else issue the SET ENVIRONMENT USELASTCOMMITTED statement with 'ALL' or 'COMMITTED READ' as the session environment option.
- For all sessions using Dirty Read or Read Uncommitted isolation levels, set the USELASTCOMMITTED configuration parameter to 'ALL' or to 'DIRTY READ', or else issue the SET ENVIRONMENT USELASTCOMMITTED statement with 'ALL' or 'DIRTY READ' as the session environment option.
- For users for whom a *user.sysdbopen()* procedure is defined in the database, the DBA can define that procedure to include the SET ENVIRONMENT USELASTCOMMITTED statement with 'ALL' or 'COMMITTED READ' as the session environment option, and also issue the SET ISOLATION statement to set Committed Read as the isolation level.
- For users for whom no *user.sysdbopen()* procedure exists in the database, the DBA can define a PUBLIC.*sysdbopen* procedure that specifies the same SET ENVIRONMENT USELASTCOMMITTED and SET ISOLATION statements.

This LAST COMMITTED isolation feature is useful only when row-level locking is in effect, rather than when another session holds an exclusive lock on the entire table. This feature is disabled for the specified table when LOCK TABLE applies a table-level lock. See [The LAST COMMITTED Option to Committed Read](#) for more information about this LAST COMMITTED feature for concurrent access to tables in which some rows are locked by exclusive locks, and for restrictions on the kinds of tables that can support this feature.

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Databases with transaction logging

If your database was created with transaction logging, the LOCK TABLE statement succeeds only if it executes within a transaction. You must issue a BEGIN WORK statement before you can execute a LOCK TABLE statement.

Transactions are implicit in an ANSI-compliant database. The LOCK TABLE statement succeeds if the specified table is not already locked by another process.

The following guidelines apply to the use of the LOCK TABLE statement within transactions:

- You cannot lock system catalog tables.
- You cannot switch between shared and exclusive table locking within a transaction. For example, once you lock the table in shared mode, you cannot upgrade the lock mode to exclusive.
- If you issue a LOCK TABLE statement before you access a row in the table, and PDQ is not in effect, no row locks are set for the table. In this way, you can override row-level locking and avoid exceeding the maximum number of locks that are defined in the database server configuration. (But if PDQ is in effect, you might run out of locks with error -134 unless the LOCKS parameter of your ONCONFIG file specifies a large enough number of locks.)
- All row and table locks release automatically after a transaction is completed. The UNLOCK TABLE statement fails in a database that uses transaction logging.
- The same user can explicitly use LOCK TABLE to lock up to 32 tables concurrently. (Use SET ISOLATION to specify an appropriate isolation level, such as Repeatable Read, if you need to lock rows from more than 32 tables during a single transaction.)

The following example shows how to change the locking mode of a table in a database that was created with transaction logging:

```
BEGIN WORK;
LOCK TABLE orders IN EXCLUSIVE MODE;
...
COMMIT WORK;
BEGIN WORK;
LOCK TABLE orders IN SHARE MODE;
...
COMMIT WORK;
```

Warning: It is recommended that you not use nonlogging tables in a transaction. If you need to use a nonlogging table in a transaction, either lock the table in exclusive mode or set the isolation level to Repeatable Read to prevent concurrency problems.

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Databases without transaction logging

In a database that was created without transaction logging (by omitting the WITH LOG keywords in the CREATE DATABASE statement), table locks that were set by the LOCK TABLE statement are released after any of the following events:

- An UNLOCK TABLE statement executes.
- The user closes the database.
- The user exits from the application.

To change the lock mode on a table, release the lock with the UNLOCK TABLE statement and then issue a new LOCK TABLE statement.

The following example shows how to change the lock mode of a table in an unlogged database:

```
LOCK TABLE orders IN EXCLUSIVE MODE;  
. . .  
UNLOCK TABLE orders;  
. . .  
LOCK TABLE orders IN SHARE MODE;
```

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Locking Granularity

The default granularity for locking a table is at the *page* level, or whatever you specify (either PAGE or ROW) in the **IFX_TABLE_LOCKMODE** environment variable, or if that is not set, by setting DEF_TABLE_LOCKMODE in the ONCONFIG file. The LOCK MODE clause of the CREATE TABLE or ALTER TABLE statement can override the default locking granularity by specifying PAGE or ROW. Only row-level locks support the LAST COMMITTED feature of Informix®.

The LOCK TABLE statement, however, always locks the entire table, overriding any other locking granularity specification for the table.

In all of these contexts, the term "lock mode" means the *locking granularity*. In the context of the SET LOCK MODE statement, however, "lock mode" refers to the behavior of the database server when a process attempts to access a row or a table that another process has locked.

Related reference:

[SET LOCK MODE statement](#)

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MERGE statement

Use the MERGE statement to transfer data from a source table into a target table by combining UPDATE or DELETE operations with INSERT operations in a single SQL statement. You can also use this statement to join the source and target tables, and then perform only UPDATE operations, only DELETE operations, or only INSERT operations on the target table.

The MERGE statement supports the ANSI/ISO standard for SQL with Informix® extensions.

Syntax

```
>>-MERGE--+-+-----+-- INTO--+-target_table--+--+-----+-->  
| .,----- . | +-target_view----+ '-+-----alias-'>  
| V | | | '-target_synonym-' '-AS-'>  
|---directive--+>  
  
>--USING--+-source_table-----+--+-----+----->  
+-source_view-----+ '-+-----alias-'>  
|-(--source_subquery--)-' '-AS-'>  
  
>--+-----+--ON--condition----->  
| .,----- . |>  
| V | | |>  
|-(---derived_column+---)-'>  
  
(1)  
>--+-----| Insert Clause |-----+-----><  
| (1) |>  
|-----+--| Update Clause |+-'>  
|-'| Delete Clause |-'>  
  
Update Clause  
  
(2)  
|--WHEN MATCHED THEN UPDATE--| SET Clause |-----|>  
  
Delete Clause  
  
|--WHEN MATCHED THEN DELETE-----|>  
  
Insert Clause  
  
(3)  
|--WHEN NOT MATCHED THEN INSERT--+-----+--| VALUES Clause |-----|>
```

```

|      .-.-.-.-.      |
|      v              |
|  '-(-----column+---)'

```

Notes:

1. Use this path no more than once
2. See [SET Clause](#)
3. See [VALUES Clause](#)

Element	Description	Restrictions	Syntax
<i>alias</i>	A temporary name that you declare here for the <i>target</i> or <i>source</i> table object	The source and target aliases must be different. If potentially ambiguous, the AS keyword must precede <i>alias</i> .	Identifier
<i>column</i>	A column in the target object into which to insert source data	This must exist in the target object	Identifier
<i>condition</i>	A Boolean condition to apply to rows in the join of the <i>source</i> and <i>target</i> tables	This can reference data values in the <i>source</i> and <i>target</i> objects	Condition
<i>derived_column</i>	A name that you declare here if the source object is a derived table	The SET and VALUES clauses can reference this name.	Identifier
<i>directive</i>	A query optimizer directive	The directive must be valid.	Optimizer Directives
<i>source_table, source_view, source_subquery</i>	A table (or the result of a query) containing data to be relocated	Object must exist. See also Restrictions on Source and Target Tables .	Database Object Name; SELECT statement
<i>target_table, target_view, target_synonym</i>	The name or synonym of a table or updatable view in which to insert, update, or delete data	See Restrictions on Source and Target Tables .	Database Object Name

Usage

The MERGE statement of Informix is a data manipulation language (DML) statement that joins a source table object with a target table or view. The *condition* that you specify after the ON keyword determines which rows from the source object are used in UPDATE or DELETE operations on the target, and which rows are used in INSERT operations on the target. The MERGE statement does not modify its source object.

The condition must be followed by the WHEN MATCHED THEN keywords of the Delete or the Update clause, or by the WHEN NOT MATCHED THEN keywords of the Insert clause, or by both the Update (or Delete) and Insert clauses.

- If you specify both the Update clause and the Insert clause, the MERGE statement can perform both INSERT and UPDATE operations on the target object.
- If you specify both the Delete clause and the Insert clause, the MERGE statement can perform both INSERT and DELETE operations on the target object.
- If you specify no Insert clause, no INSERT operations are performed, but the Update clause must specify an UPDATE operation (or else the Delete clause must specify a DELETE operation) on the target object for source rows that match the condition.
- If you specify no Update clause and no Delete clause, no UPDATE or DELETE operations are performed, but the Insert clause must specify an INSERT operation on the target object for source rows that do not match the condition.

The MERGE statement fails with an error if no Delete clause, no Update clause, and no Insert clause is specified.

The MERGE statement can have the following effects on the target object:

- If the Update clause is included, the MERGE statement updates rows in the target table or view according to the specifications of the SET clause with data from rows in the source table for which the condition evaluates to true.
- If the Delete clause is included, the MERGE statement deletes from the target table or view the rows for which the condition evaluates to true.
- If the Insert clause is included, the MERGE statement inserts new rows into the target table or view according to the specifications of the VALUES clause with data from rows in the source table for which the condition evaluates to false.

A single MERGE statement, however, can have no more than two of these three effects, because the Delete clause and the Update clause are mutually exclusive.

For operations on large tables, make sure that these resources are available on your system:

- A sufficient number of locks
- Sufficient temporary dbspace storage for the intermediate join results
- Sufficient dbspace storage for the results of the MERGE statement.

In a high-availability cluster configuration, you can issue the MERGE statement from a primary server or from an updatable secondary server.

Optimizer Directives and Subqueries

You can optionally specify one or more query optimizer directives after the MERGE keyword, such as access method directives, join order directives, and join method directives to specify how the source and target tables are joined. The goal-oriented directives like EXPLAIN and AVOID_EXECUTE are also valid in the MERGE statement.

Within the MERGE statement, subqueries can also include optimizer directives to control other aspects of the execution plan. Subqueries are valid in the following contexts in the MERGE statement:

- In the *condition* of the ON clause
- In the SET clause of the Update clause
- In the VALUES clause of the Insert clause

- In the USING clause if it specifies a source query, which can include a subquery in any context where the SELECT statement supports a subquery.

The MERGE statement fails with an error, however, if it includes a subquery that references the target table.

In a database that supports external directives, the query optimizer can also apply external directives to the outer join of the source and target tables, or to subqueries within the MERGE statement.

The ON Condition

The *condition* that follows the ON keyword specifies a join filter for the source and target table objects. This ON clause filter determines the matched rows and unmatched rows in the MERGE statement, based on the outer join of the target and source tables.

- If the MERGE statement includes the Update clause, and the ON clause condition evaluates to true, then the corresponding rows are updated in the target.
- If the MERGE statement includes the Delete clause, and the ON clause condition evaluates to true, then the corresponding rows are deleted from the target.
- If the MERGE statement includes the Insert clause, and the ON clause condition evaluates to false, then the corresponding source rows are inserted into the target.

Update operations of the MERGE statement on rows that match the condition obey the UPDATE statement rules for the SET clause. For details of the syntax for specifying the updated values in the target table, see [SET Clause](#).

Delete operations of MERGE on rows that match the condition obey the DELETE statement rules. For details of deleting values from the target table, see [Using the WHERE Keyword to Specify a Condition](#).

Insert operations on rows that do not match the condition obey the INSERT statement rules for the VALUES clause. For details of the syntax for specifying the inserted values in the target table, see [VALUES Clause](#).

Error Handling

If an error occurs while the MERGE statement is executing, the entire statement is rolled back.

For databases that support transaction logging, you can include error-handling logic that includes the ROLLBACK TO SAVEPOINT statement in a transaction that includes the MERGE statement and that defines one or more savepoints. After a partial rollback of the transaction to a savepoint, the effects of the INSERT, DELETE, or UPDATE operations of the MERGE statement persist in the target table if the MERGE statement precedes the savepoint in the lexical order of statements for that savepoint level of the transaction. The effects of MERGE are rolled back, however, if the MERGE statement follows the specified savepoint within the transaction.

In an ANSI-compliant database, data manipulation language (DML) statements are always in a transaction. These databases do not support the MERGE statement outside a transaction.

Constraint Checking

Enabled data-integrity constraints on the target object are enforced in MERGE operations.

- If the checking mode is set to DEFERRED, the constraints are not checked until after the transaction is committed.
- If the constraint-checking mode for the target table is set to IMMEDIATE, then unique and referential constraints are checked after all the UPDATE (or DELETE) and INSERT operations are complete. The NOT NULL and check constraints are checked during the UPDATE, DELETE, and INSERT operations.

For information on setting the constraint-checking mode, see the topic [SET Transaction Mode statement](#).

If a referential constraint on the target table was defined with the ON DELETE CASCADE keywords, the DELETE clause of the MERGE statement also performs cascading deletes on rows of child tables of the target table.

A Delete merge fails, however, if an enabled referential constraint has established a parent-child relationship between the target and source tables, if the constraint was defined with the ON DELETE CASCADE keywords. The MERGE statement cannot perform cascading deletes on rows of its source table. For more information, see the topic [Restrictions on DELETE When Tables Have Cascading Deletes](#).

If the START VIOLATIONS statement has defined an active violations table on the target table, then the MERGE statement can have the following effects on the target, violations, and diagnostic tables:

- The conforming rows in the target table that match the join condition are either deleted or updated.
- The target table also receives the conforming unmatched rows that MERGE successfully inserts.
- The violation table receives the nonconforming rows.
- A diagnostic table receives information about why the nonconforming rows failed to satisfy a constraint or a unique index during operations of the MERGE statement on the target table.

To enable a violations table and a diagnostic table on the target table, the SET Database Object Mode statement must set the constraints or unique indexes of the target table to ENABLED or FILTERING mode. For more information, see the topics [Relationship to the SET Database Object Mode statement](#) and [SET Database Object Mode statement](#).

Using the MERGE Statement with Triggers

The target object can be a table on which an Update, Delete, or Insert trigger is defined. If both an Update trigger and an Insert trigger (or both a Delete trigger and an Insert trigger) are enabled on the target table, MERGE can act as the triggering event for both triggers, if the MERGE statement performs both UPDATE (or DELETE) and INSERT operations on the target.

If the MERGE statement includes operations that activate both Update (or Delete) and Insert triggers, the BEFORE trigger actions of both triggers are executed when the MERGE operation starts. Similarly, the AFTER trigger actions of both triggers are executed at the end of the MERGE operation. The FOR EACH ROW trigger actions are activated for each row processed.

Just as for any DML statement, the database server treats all the triggers that are activated by the same MERGE statement as a single trigger, and the resulting trigger action is the merged-action list. All the rules that govern a trigger action apply to the merged list as one list, and no distinction is made between the two original triggers. For more information, see [Actions of Multiple Triggers](#).

The target object, however, cannot be a view on which an enabled INSTEAD OF trigger is defined. Before you can use that view as the target of a MERGE statement, you must disable or drop the INSTEAD OF trigger.

In the definition of a trigger, the MERGE statement cannot be specified directly as a triggered action. An SPL trigger routine that is called in a triggered action, however, can issue the MERGE statement.

Security Policies and Secure Auditing

If the source object or any of its columns is protected by a label-based access control (LBAC) security policy, the user who issues the MERGE statement must have a security label (or must hold a security policy exemption) that provides sufficient credentials to read the source table in MERGE operations.

If the target object or any of its columns is protected by a label-based security policy, the user who issues the MERGE statement must have a security label (or must hold a security policy exemption) that provides sufficient credentials to write in the target object columns that the SET clause or the VALUES clause specifies, or to delete rows from the target that include protected data.

If both the source and the target table are protected, they must be protected by the same security policy. The MERGE statement cannot join tables that are protected by different LBAC security policies.

On Informix instances that use the secure-auditing facility to record activity that could potentially alter or reveal data or the auditing configuration, no specific audit event mnemonic is defined in audit trails for the MERGE statement:

- Activities specified by the Delete clause are recorded as DELETE events.
- Activities specified by the Insert clause are recorded as INSERT events.
- Activities specified by the Update clause are recorded as UPDATE events.
- [Restrictions on Source and Target Tables](#)
Which table objects can be the source or target of the MERGE statement depends on attributes of the table object, and on what access privileges are held by the user who issues the MERGE statement.
- [Handling Duplicate Rows](#)
While MERGE is executing, the same row in the target table cannot be updated or deleted more than once. No attempt is made to update or delete any row in the target that did not already exist before the MERGE statement was executed. That is, there are no updates or deletes of rows that the same MERGE statement inserted into the target.
- [Examples of MERGE Statements](#)
Examples in this section include MERGE statements that illustrate join conditions and various DML operations on the result set of the join.

Related reference:

[DELETE statement](#)

[INSERT statement](#)

[UPDATE statement](#)

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Restrictions on Source and Target Tables

Which table objects can be the source or target of the MERGE statement depends on attributes of the table object, and on what access privileges are held by the user who issues the MERGE statement.

The target table must be local to the database to which the current session is connected, but you can specify a remote table as the source table, or in subqueries of the SET clause for UPDATE operations, and in subqueries of the VALUES clause for INSERT operations.

Sections that follow identify additional restrictions on the source and target tables.

Restrictions on the Source Table

The source object can be the name or synonym of a STANDARD, RAW, TEMP, EXTERNAL, or collection-derived table, or a view. It can be in the same database as the target object, or in a different database of the local Informix® instance, or it can be a remote table that is managed by a different Informix instance.

If the source is a collection-derived table that is defined by the result of a query, the USING clause can declare names for derived columns that the SET and VALUES clauses of the MERGE statement can reference.

The user who issues the MERGE statement must hold the Connect access privilege (or a higher privilege) on the database of the source object, and must also hold the Select privilege (or a higher privilege) on the source object. The user can be granted these access privileges individually, or can hold them as a member of the PUBLIC group, or through the current or default role of the user, if the role or PUBLIC holds those privileges.

If the source object or any of its columns is protected by a label-based security policy, the user who issues the MERGE statement must have a security label (or must hold a security policy exemption) that provides sufficient credentials to read the source object. If the credentials of the user are insufficient to read protected columns, according to the standard label-based access control (LBAC) rules, then the MERGE statement can process only a subset of the source data. If this subset is empty, the MERGE statement cannot insert any values from the source object into the target table.

The following restrictions apply to the source table object:

- The source cannot be a view on which an enabled SELECT trigger is defined.
- The source cannot be a typed table in the same table hierarchy as the target table.

- In a Delete merge, the source cannot have a child-table relationship with the target, as defined by an enabled referential constraint, if that constraint was defined with the ON DELETE CASCADE keywords. (Child-table relationships have no effect on the Delete merge, however, unless a target table constraint specifies cascading deletes.)

Restrictions on the Target Table

The target table object must be in a database of the same Informix instance to which the current session is connected. It can be the name or synonym of a STANDARD, RAW, or TEMP table, or an updatable view. If the target is a supertable within a table hierarchy, the Delete clause also deletes the corresponding rows in all the subtables of the target table.

The user who issues the MERGE statement must hold the Connect access privilege (or a higher privilege) on the database of the target object, and must also hold the Insert privilege and the Update or Delete privilege on the target object, if the MERGE statement includes the corresponding Insert, Update, or Delete clause.

The following restrictions apply to the target table of the MERGE statement. If that table has any of the following attributes, the MERGE operation returns an error.

- The target cannot be a typed table in the same table hierarchy as the source table.
- The target cannot be a Virtual Table Interface (VTI) table.
- The target cannot be an object that the CREATE EXTERNAL TABLE statement defined.
- The target cannot be in a database of a remote Informix instance.
- The target cannot be a system catalog table.
- The target cannot be a view on which an enabled INSTEAD OF trigger is defined.
- The target cannot be a read-only view.
- The target cannot be a pseudo-table (a memory-resident object in a system database, such as the **sysmaster** or **sysadmin** databases).
- The target cannot be a data source of any subquery of the same MERGE statement, including subqueries in the ON clause, in the SET clause, or in the VALUES clause.
- If the MERGE statement includes the DELETE clause, the target cannot have a parent-table relationship with the source table, if this relationship is defined by an enabled referential constraint that specifies the ON DELETE CASCADE keywords.

Restriction on the combined row length

The source table and the target table in the MERGE statement cannot have a total combined row length (= row size of source table + row size of target table) greater than 32,767 bytes. Otherwise, the MERGE statement fails with an error, as in the following example:

```
CREATE TABLE t1
(f1 INT,
 f2 VARCHAR(10),
 lv1 LVARCHAR(5000),
 lv2 LVARCHAR(4000),
 lv3 LVARCHAR(8000));

CREATE TABLE t2
(f1 INT,
 f2 VARCHAR(10),
 lv1 LVARCHAR(5000),
 lv2 LVARCHAR(4000),
 lv3 LVARCHAR(8000));

INSERT INTO t1 (f1,f2) VALUES (1,'t1 1');
INSERT INTO t1 (f1,f2) VALUES (2,'t1 2');
INSERT INTO t1 (f1,f2) VALUES (3,'t1 3');
INSERT INTO t1 (f1,f2,lv1) VALUES (7,'t1 7',
'loooooooooooooooooooooong');

INSERT INTO t2 (f1,f2) VALUES (3,'t2 3');
INSERT INTO t2 (f1,f2) VALUES (4,'t2 4');
INSERT INTO t2 (f1,f2) VALUES (5,'t2 5');
INSERT INTO t2 (f1,f2) VALUES (6,'t2 6');

MERGE INTO t2 AS o USING t1 AS n ON o.f1 = n.f1
WHEN NOT MATCHED THEN INSERT ( o.f1,o.f2)
VALUES ( n.f1,n.f2);
```

The MERGE statement above fails, because the sum of the row lengths of the source and target tables exceeds the upper limit of 32,767 bytes.

For MERGE operations that include only the INSERT clause (but no DELETE clause nor UPDATE clause), you can circumvent this row length limit by replacing the MERGE statement with INSERT INTO ... SELECT statements. For the same tables and data values in the MERGE example above, the following INSERT statements run successfully:

```
INSERT INTO t2(f1, f2)
SELECT t1.f1, t1.f2 FROM t1
WHERE NOT EXISTS
(SELECT f1, f2 FROM t2
WHERE t2.f1 = t1.f1);

INSERT INTO t2(f1,f2)
SELECT t1.f1, t1.f2 FROM t1
LEFT JOIN t2 ON t1.f1 = t2.f1
WHERE t2.f1 IS NULL;
```

After the two INSERT INTO ... SELECT operations, table **t2** contains what the row size restriction prevented the previous MERGE example from returning.

Restrictions on distributed MERGE statements

If the source and target tables are not in the same database, both databases must satisfy the compatibility requirements for cross-database and cross-server DML operations:

- Both databases must be of release versions that support all the data types in the source table and in the target table.
- If one database is ANSI-compliant, the other must also be ANSI-compliant.
- If one database is not ANSI-compliant but uses explicit transaction logging, the other must also support explicit transaction logging. (In this case, their buffered or unbuffered logging modes need not match.)
- If one database does not support transaction logging, the other also must not.
- Both databases must have the same NLSCASE sensitivity setting.

A distributed MERGE statement cannot, for example, specify a source table in a case-sensitive database and a target table in a database created as NLSCASE INSENSITIVE, whether or not either table includes NCHAR or NVARCHAR columns.

Distributed MERGE transactions cannot access the database of another Informix instance unless both servers define TCP/IP or IPCSTR connections in their DBSERVERNAME or DBSERVERALIASES configuration parameters and in the `sqlhosts` file or SQLHOSTS registry subkey. The requirement, that both participating servers support the same type of connection (either TCP/IP or else IPCSTR), applies to any communication between Informix instances, even if both reside on the same computer.

Data types valid in distributed MERGE statements

When the source table and the target tables are in the same database, MERGE statements can access all the data-type categories that the [Data Type](#) topics describe, including BYTE and TEXT objects, OPAQUE and DISTINCT types, complex types, and user-defined types (UDTs).

A MERGE statement whose source table is in a database of another Informix server instance, however, is subject to the restrictions on column data types in other distributed data manipulation language (DML) operations. A cross-server MERGE statement can reference columns with only the following subset of data types:

- Built-in data types that are not opaque or complex
- BOOLEAN
- BSON
- JSON
- LVARCHAR
- DISTINCT of built-in types that are not opaque
- DISTINCT of BOOLEAN
- DISTINCT of BSON
- DISTINCT of JSON
- DISTINCT of LVARCHAR
- DISTINCT of the DISTINCT types in this list.

Cross-server distributed MERGE operations can support these DISTINCT types only if the DISTINCT types are cast explicitly to built-in types, and all of the DISTINCT types, their data type hierarchies, and their casts are defined exactly the same way in the source database and in the target database.

Cross-server operations can also return the IDSSECURITYLABEL data type from a table protected by row-level LBAC security, if the user issuing the MERGE statement holds sufficient LBAC credentials. Accessing a table protected only by column-level LBAC security requires similar credentials, but in that case the table has no IDSSECURITYLABEL column.

Cross-server DML operations cannot reference a column or expression of a complex, large-object, nor user-defined data type (UDT), nor of an unsupported DISTINCT or built-in opaque type. For additional information about the data types that Informix supports in cross-server DML operations, see [Data Types in Cross-Server Transactions](#).

Distributed MERGE operations in which the source table and the target table are in a different databases of the same Informix server instance can access the same data types that are listed above for cross-server MERGE statements. They can also access the following additional data types that are not supported in cross-server MERGE operations:

- Most of the *built-in opaque data types*, as listed in [Data Types in Cross-Database Transactions](#)
- DISTINCT of the built-in types that are referenced in the line above
- DISTINCT of any of the data types that are listed in either of the two lines above
- Opaque UDTs that can be cast explicitly to built-in data types.

Cross-database INSERT operations can support these DISTINCT and opaque UDTs only if all the opaque UDTs and DISTINCT types are cast explicitly to built-in types, and all of the opaque UDTs, DISTINCT types, data type hierarchies, and casts are defined exactly the same way in each participating database.

If the target and source tables are in different databases, whether of the same server instance or of different server instances, the MERGE statement fails if it references a table, view, or synonym that includes a column of any of the following opaque or complex data types:

- IMPEXP, IMPEXPBIN, LOLIST, or SENDRECV built-in opaque type
- DISTINCT of any of those opaque data types
- Any complex type, including COLLECTION, LIST, MULTISSET, or SET, and named or unnamed ROW types.

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Handling Duplicate Rows

While MERGE is executing, the same row in the target table cannot be updated or deleted more than once. No attempt is made to update or delete any row in the target that did not already exist before the MERGE statement was executed. That is, there are no updates or deletes of rows that the same MERGE statement inserted into the target.

The following example of the MERGE statement uses the transaction table **new_sale** as the source table from which to insert or update rows in the fact table **sale**. The join condition in this example tests whether the **new_sale.cust_id** column value matches the **sale.cust_id** column value.

```

MERGE INTO sale USING new_sale AS n
ON sale.cust_id = n.cust_id
WHEN MATCHED THEN UPDATE

```

```
SET sale.salecount = sale.salecount + n.salecount
WHEN NOT MATCHED THEN INSERT (cust_id, salecount)
VALUES (n.cust_id, n.salecount);
```

To execute this MERGE statement, the database server joins the target and source tables, and then applies the specified equality condition to process the result of the join:

- For rows that satisfy the condition (because the **sale.cust_id** value matches the **new_sale.cust_id** value), MERGE updates the **sale.salecount** column value, according to the SET clause specification.
- For rows that do not satisfy the condition (because no row in the **sale** table has the same **cust_id** value as **new_sale.cust_id**), MERGE inserts new rows containing the **new_sale.cust_id** and **new_sale.salecount** values into the **sale** table, according to the VALUES clause specification.

For the MERGE statement in the previous example, suppose that the **sale** target table contains the two records and that the **new_sale** source table contains the three records.

Table 1. Records in 'sale' Table

cust_id	sale_count
Tom	129
Julie	230

Table 2. Records in 'new_sale' Table

cust_id	sale_count
Tom	20
Julie	3
Julie	10

When merging **new_sale** into **sale** by specifying the expression `sale.cust_id = new_sale.cust_id` as the matching condition, the MERGE statement returns an error, because it attempts to update one of the records in the **sale** target table more than once.

Data Types in Distributed MERGE Operations

If the source table or view (or any table object referenced in the source query) specifies a table object in a database of a Informix® instance other than the local instance that manages the database of the target table, the MERGE statement can access columns of only the following data types in the remote database:

- Built-in data types that are not opaque
- BOOLEAN
- LVARCHAR
- DISTINCT of the built-in data types that are not opaque
- DISTINCT of BOOLEAN
- DISTINCT of LVARCHAR
- DISTINCT of any DISTINCT data type that appears in this list.

Cross-server distributed MERGE operations can support these DISTINCT types only if the DISTINCT types are cast explicitly to built-in types, and all of the DISTINCT types, their data type hierarchies, and their casts are defined exactly the same way in each participating database. For additional information about the data types that Informix supports in cross-server DML operations, see [Data Types in Cross-Server Transactions](#).

MERGE operations cannot access a database of another Informix instance unless both server instances support either a TCP/IP or an IPCSTR connection, as defined in their DBSERVERNAME or DBSERVERALIASES configuration parameters and in the **sqlhosts** file or SQLHOSTS registry subkey. This connection-type requirement applies to any communication between Informix instances, even if both database servers reside on the same computer.

Distributed MERGE operations that access table objects in other databases of the local Informix instance, however, can access all of the cross-server data types in the preceding list, and these additional data types:

- Most built-in opaque data types, as listed in [Data Types in Cross-Database Transactions](#)
- DISTINCT of the same built-in opaque types
- DISTINCT of any of the data types in either of the two preceding lines
- Opaque user-defined data types (UDTs) that are explicitly cast to built-in data types.

The MERGE statement also supports Distributed Relational Database Architecture™ (DRDA) protocols in common client APIs. For the Informix data types that MERGE can return from a remote database through DRDA protocols, see the *IBM® Informix Administrator's Guide* for lists of the Informix data types that are supported (and that are not supported) by DRDA.

Related information:

[SQL and supported and unsupported data types](#)

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Examples of MERGE Statements

Examples in this section include MERGE statements that illustrate join conditions and various DML operations on the result set of the join.

Examples

The following MERGE statement includes the Update and Insert clauses, and uses an equality predicate as the join condition:

```

MERGE INTO customer c
  USING ext_customer e
  ON c.customer_num=e.customer_num
WHEN MATCHED THEN
  UPDATE SET c.fname = e.fname,
             c.lname = e.lname,
             c.company = e.company,
             c.address1 = e.address1,
             c.address2 = e.address2,
             c.city = e.city,
             c.state = e.state,
             c.zipcode = e.zipcode,
             c.phone = e.phone
WHEN NOT MATCHED THEN
  INSERT (c.fname, c.lname, c.company, c.address1, c.address2,
         c.city, c.state, c.zipcode, c.phone)
  VALUES
    (e.fname, e.lname, e.company, e.address1, e.address2,
     e.city, e.state, e.zipcode, e.phone);

```

The next example specifies multiple predicates in the ON clause:

```

MERGE INTO customer c
  USING ext_customer e
  ON c.customer_num=e.customer_num
  AND c.fname=e.fname AND c.lname=e.lname
WHEN MATCHED THEN
  UPDATE SET c.fname = e.fname,
             c.lname = e.lname,
             c.company = e.company,
             c.address1 = e.address1,
             c.address2 = e.address2,
             c.city = e.city,
             c.state = e.state,
             c.zipcode = e.zipcode,
             c.phone = e.phone
WHEN NOT MATCHED THEN
  INSERT
    (c.fname, c.lname, c.company, c.address1, c.address2,
     c.city, c.state, c.zipcode, c.phone)
  VALUES
    (e.fname, e.lname, e.company, e.address1, e.address2,
     e.city, e.state, e.zipcode, e.phone);

```

The following MERGE statement performs an Update join, with no Insert clause:

```

MERGE INTO customer c
  USING ext_customer e
  ON c.customer_num=e.customer_num
WHEN MATCHED THEN
  UPDATE SET c.fname = e.fname,
             c.lname = e.lname,
             c.company = e.company,
             c.address1 = e.address1,
             c.address2 = e.address2,
             c.city = e.city,
             c.state = e.state,
             c.zipcode = e.zipcode,
             c.phone = e.phone ;

```

The following MERGE statement includes only the Delete clause after the join condition:

```

MERGE INTO customer c
  USING ext_customer e
  ON c.customer_num=e.customer_num
  WHEN MATCHED THEN
    DELETE ;

```

The next MERGE example includes only the Insert clause:

```

MERGE INTO customer c
  USING ext_customer e
  ON c.customer_num=e.customer_num AND c.fname=e.fname
  AND c.lname=e.lname
WHEN NOT MATCHED THEN
  INSERT
    (c.fname, c.lname, c.company, c.address1, c.address2,
     c.city, c.state, c.zipcode, c.phone)
  VALUES
    (e.fname, e.lname, e.company, e.address1, e.address2,
     e.city, e.state, e.zipcode, e.phone);

```

The next example illustrates that the WHEN MATCHED and WHEN NOT MATCHED specifications can appear in any order:

```

MERGE INTO customer c
  USING ext_customer e
  ON c.customer_num=e.customer_num AND c.fname=e.fname AND c.lname=e.lname
WHEN NOT MATCHED THEN
  INSERT
    (c.fname, c.lname, c.company, c.address1, c.address2,
     c.city, c.state, c.zipcode, c.phone)
  VALUES

```

```

        (e.fname, e.lname, e.company, e.address1, e.address2,
         e.city, e.state, e.zipcode, e.phone)
WHEN MATCHED THEN UPDATE
    SET c.fname = e.fname,
        c.lname = e.lname,
        c.company = e.company,
        c.address1 = e.address1,
        c.address2 = e.address2,
        c.city = e.city,
        c.state = e.state,
        c.zipcode = e.zipcode,
        c.phone = e.phone ;

```

The following MERGE statement specifies as its source a derived table that the query in the USING clause defines:

```

MERGE INTO customer c
  USING (SELECT * from ext_customer e1, orders e2
        WHERE e1.customer_num=e2.customer_num ) e
  ON c.customer_num=e.customer_num AND c.fname=e.fname
  AND c.lname=e.lname
  WHEN NOT MATCHED THEN
    INSERT (c.fname, c.lname, c.company, c.address1, c.address2,
            c.city, c.state, c.zipcode, c.phone)
    VALUES (e.fname, e.lname, e.company, e.address1, e.address2,
            e.city, e.state, e.zipcode, e.phone)
  WHEN MATCHED THEN
    UPDATE SET c.fname = e.fname,
              c.lname = e.lname,
              c.company = e.company,
              c.address1 = e.address1,
              c.address2 = e.address2,
              c.city = e.city,
              c.state = e.state,
              c.zipcode = e.zipcode,
              c.phone = e.phone ;

```

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OPEN statement

Use the OPEN statement to activate a cursor.

Syntax

```

>>-OPEN--+cursor_id-----+----->
      |  (1)  (2)           |
      |-----cursor_id_var-'
>--+-----+----->
      |      .-----      |
      |      V              |
      |-USING--+parameter_var+-----+
      |      (2)           |
      |-----SQL DESCRIPTOR--+descriptor '---DESCRIPTOR--sqlda_pointer-'
      |-----descriptor_var-'
>--+-----+-----><
      |  (1)  (2)           |
      |-----WITH REOPTIMIZATION-'

```

Notes:

1. Informix® extension
2. ESQL/C only

Element	Description	Restrictions	Syntax
<i>cursor_id</i>	Name of a cursor	Must have been declared by the DECLARE statement	Identifier
<i>cursor_id_var</i>	Host variable = <i>cursor_id</i>	Must be a character data type	Language specific
<i>descriptor</i>	Name of a system-descriptor area	Must have been allocated	Quoted String
<i>descriptor_var</i>	Host variable that identifies the system-descriptor area	System-descriptor area must have been allocated	Quoted String
<i>parameter_var</i>	Host variable whose contents replace a question (?) mark placeholder in a prepared SQL statement	Must be a character or collection data type	Language specific
<i>sqlda_pointer</i>	Pointer to sqlda structure defining data type and memory location of values to replace question (?) marks in a prepared statement	Cannot begin with a dollar (\$) sign nor with a colon (:). You must use an sqlda structure with dynamic SQL statements.	DESCRIBE statement

Usage

Use this statement with Informix ESQL/C or with SPL.

A *cursor* is an identifier associated with an SQL statement that returns an ordered set of values. The OPEN statement activates a cursor that the DECLARE statement defined.

Cursor can be classified by their associated SQL statements:

- A *Select cursor*: a cursor that is associated with a SELECT statement
- A *Function cursor*: a cursor that is associated with the EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement
- An *Insert cursor*: a cursor that is associated with the INSERT statement
- A *Collection cursor*: a Select or Insert cursor that operates on a collection variable.

In UDRs written in the SPL language, the OPEN statement can reference only Select or Function cursors, and these must specify the identifier of the cursor, rather than a variable that stores the *cursor_id*. The OPEN statement cannot reference a direct cursor that the FOREACH statement of SPL has declared.

The specific actions that the database server takes differ, depending on the statement with which the cursor is associated. In ESQL/C, when you associate one of the previous statements with a cursor directly (that is, you do not prepare the statement and associate the statement identifier with the cursor), the OPEN statement implicitly prepares the statement. (This is not a feature of OPEN in SPL routines, where the DECLARE statement associates a cursor with the identifier of an existing prepared statement, rather than directly with SQL statement text.)

In an ANSI-compliant database, you receive an error code if you try to open a cursor that is already open.

- [Opening a Select Cursor](#)
- [Opening an Update Cursor Inside a Transaction](#)
- [Opening a Function Cursor](#)
- [Reopening a Select or Function Cursor](#)
- [Errors Associated with Select and Function Cursors](#)
- [Opening an Insert Cursor \(ESQL/C\)](#)
- [Opening a Collection Cursor \(ESQL/C\)](#)
- [USING Clause](#)
- [Specifying a System Descriptor Area \(ESQL/C\)](#)
- [Specifying a Pointer to an sqlda Structure \(ESQL/C\)](#)
- [Using the WITH REOPTIMIZATION Option \(ESQL/C\)](#)
- [Relationship Between OPEN and FREE](#)
- [DDL Operations on Tables Referenced by Cursors](#)

Related reference:

[FLUSH statement](#)
[CLOSE statement](#)
[GET DESCRIPTOR statement](#)
[UPDATE statement](#)
[SET AUTOFREE statement](#)
[SET DESCRIPTOR statement](#)
[INSERT statement](#)
[ALLOCATE DESCRIPTOR statement](#)
[SET DEFERRED PREPARE statement](#)
[DELETE statement](#)
[DESCRIBE statement](#)
[DESCRIBE INPUT statement](#)
[DEALLOCATE DESCRIPTOR statement](#)
[DECLARE statement](#)
[EXECUTE statement](#)
[FETCH statement](#)
[FREE statement](#)
[PREPARE statement](#)
[PUT statement](#)

Related information:

[Retrieve multiple rows](#)
[A system-descriptor area](#)
[An sqlda structure](#)

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Opening a Select Cursor

When you open either a Select cursor or an update cursor that is created with the SELECT... FOR UPDATE syntax, the SELECT statement is passed to the database server with any values that are specified in the USING clause. The database server processes the query to the point of locating or constructing the first row of the active set. The following example illustrates a simple OPEN statement in Informix® ESQL/C:

```
EXEC SQL declare s_curs cursor for select * from orders;  
EXEC SQL open s_curs;
```

An SPL routine cannot reference an update cursor in the OPEN statement.

Opening an Update Cursor Inside a Transaction

If you are working in a database with explicit transactions, you must open an update cursor within a transaction. This requirement is waived if you declared the cursor using the WITH HOLD option.

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Opening a Function Cursor

When you open a Function cursor, the EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement is passed to the database server with any values that are specified in the USING clause.

The values in the USING clause are passed as arguments to the user-defined function. This user-defined function must be declared to accept values. (If the statement was previously prepared, the statement was passed to the database server when it was prepared.) The database server executes the function to the point where it returns the first set of values.

The following example illustrates a simple OPEN statement in Informix® ESQL/C:

```
EXEC SQL declare s_curs cursor for
      execute function new_func(arg1,arg2)
      into :ret_val1, :ret_val2;
EXEC SQL open s_curs;
```

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Reopening a Select or Function Cursor

The database server evaluates the values that are specified in the USING clause of the OPEN statement only when it opens a Select cursor or Function cursor. While the cursor is open, subsequent changes to program variables in the USING clause do not change the active set of the cursor.

In a database that is ANSI-compliant, you receive an error code if you try to open a cursor that is already open.

In a database that is not ANSI-compliant, a subsequent OPEN statement closes the cursor and then reopens it. When the database server reopens the cursor, it creates a new active set, based on the current values of the variables in the USING clause. If the variables have changed since the previous OPEN statement, reopening the cursor can generate an entirely different active set.

Even if the values of the variables are unchanged, the values in the active set can be different, as in the following situations:

- If the user-defined function takes a different execution path from the previous OPEN statement on a Function cursor
- If data in the table was modified since the previous OPEN statement on a Select cursor

The database server can process most queries dynamically, without pre-fetching all rows when it opens the Select or Function cursor. Therefore, if other users are modifying the table at the same time that the cursor is being processed, the active set might reflect the results of these actions.

For some queries, the database server evaluates the entire active set when it opens the cursor. These queries include those with the following features:

- Queries that require sorting: those with an ORDER BY clause or with the DISTINCT or UNIQUE keyword
- Queries that require hashing: those with a join or with the GROUP BY clause

For these queries, any changes that other users make to the table while the cursor is being processed are not reflected in the active set.

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Errors Associated with Select and Function Cursors

Because the database server is seeing the query for the first time, it might detect errors. In this case, it does not actually return the first row of data, but it resets the **SQLCODE** variable and the **sqlca.sqlcode** field of the **sqlca**. The value is either negative or zero, as the following table describes.

Code Value

Significance

Negative

An error was detected in the SELECT statement

Zero

The SELECT statement is valid

Unlike ESQL/C routines, SPL routines do not have direct access to the **sqlca** structure. An ESQL/C routine must invoke the built-in **SQLCODE** function explicitly to access the return code of the SELECT, EXECUTE FUNCTION, or EXECUTE PROCEDURE statement associated with the cursor that OPEN references.

If the SELECT, SELECT...FOR UPDATE, EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement is valid, but no rows match its criteria, the first FETCH statement returns a value of 100 (SQLNOTFOUND), meaning that no rows were found.

Tip: When you encounter an **SQLCODE** error, a corresponding **SQLSTATE** error value also exists. For information about how to view the message text, refer to [Using the SQLSTATE Error Status Code](#).

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Opening an Insert Cursor (ESQL/C)

When you open an Insert cursor, the cursor passes the INSERT statement to the database server, which checks the validity of the keywords and column names. The database server also allocates memory for an insert buffer to hold new data. (See [DECLARE statement](#).)

An OPEN statement for a cursor that is associated with an INSERT statement cannot include a USING clause.

- [Example of Opening an Insert Cursor](#)
- [Reopening an Insert Cursor](#)

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Example of Opening an Insert Cursor

The following Informix® ESQL/C example illustrates an OPEN statement with an Insert cursor:

```
EXEC SQL prepare s1 from
    'insert into manufact values ('npr', 'napier')';
EXEC SQL declare in_curs cursor for s1;
EXEC SQL open in_curs;
EXEC SQL put in_curs;
EXEC SQL close in_curs;
```

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Reopening an Insert Cursor

When you reopen an Insert cursor that is already open, you effectively flush the insert buffer; any rows that are stored in the insert buffer are written into the database table. The database server first closes the cursor, which causes the flush and then reopens the cursor. For information about how to check errors and count inserted rows, see [Error Checking](#).

In an ANSI-compliant database, you receive an error code if you try to open a cursor that is already open.

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Opening a Collection Cursor (ESQL/C)

You can declare both Select and Insert cursors on collection variables. Such cursors are called *Collection cursors*. You must use the OPEN statement to activate these cursors.

Use the name of a collection variable in the USING clause of the OPEN statement. For more information on the use of OPEN ... USING with a collection variable, see [Fetching from a Collection Cursor](#) and [Inserting into a Collection Cursor](#).

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USING Clause

The USING clause is required when the cursor is associated with a prepared statement that includes question-mark (?) placeholders, as follows:

- A SELECT statement with input parameters in its WHERE clause
- An EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement with input parameters as arguments to its user-defined function
- An INSERT statement with input parameters in its VALUES clause (in ESQL/C).

In SPL routines, you must specify these parameters as SPL variables.

In ESQL/C, you can supply values for these parameters in one of the following ways:

- You can specify one or more host variables.
- You can specify a system-descriptor area.

- You can specify a pointer to an **sqlda** structure.

For more information, see [PREPARE statement](#).

If you know the number and the order of parameters to be supplied at runtime and their data types, you can define the parameters that are needed by the statement as host variables in your program. You pass parameters to the database server positionally, by opening the cursor with the USING keyword, followed by the names of the variables in their sequential order. These variables are matched with the SELECT or EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement question-mark (?) placeholders in a one-to-one correspondence, from left to right.

You cannot include indicator variables of ESQL/C in the list of variables. To use an indicator variable, you must include the SELECT or EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement text as part of the DECLARE statement, rather than the identifier of a prepared statement.

You must supply one host variable name for each placeholder. The data type of each variable must be compatible with the corresponding type that the prepared statement requires. The following Informix® ESQL/C code fragment opens a Select cursor and specifies host variables in the USING clause:

```

sprintf (select_1, "%s %s %s %s %s",
"SELECT o.order_num, sum(total price)",
"FROM orders o, items i",
"WHERE o.order_date > ? AND o.customer_num = ?",
"AND o.order_num = i.order_num",
"GROUP BY o.order_num");
EXEC SQL prepare statement_1 from :select_1;
EXEC SQL declare q_curs cursor for statement_1;
EXEC SQL open q_curs using :o_date, :o.customer_num;

```

The following example illustrates the USING clause of the OPEN statement with an EXECUTE FUNCTION statement in the Informix ESQL/C code fragment:

```

strcpy ("EXECUTE FUNCTION one_func(?, ?)", exfunc_stmt);
EXEC SQL prepare exfunc_id from :exfunc_stmt;
EXEC SQL declare func_curs cursor for exfunc_id;
EXEC SQL open func_curs using :arg1, :arg2;

```

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Specifying a System Descriptor Area (ESQL/C)

If you do not know the number of parameters to be supplied at runtime or their data types, you can associate input values from a system-descriptor area. A system-descriptor area describes the data type and memory location of one or more values to replace question-mark (?) placeholders.

A system-descriptor area conforms to the X/Open standards.

Use the SQL DESCRIPTOR keywords to introduce the name of a system descriptor area as the location of the parameters.

The COUNT field in the system-descriptor area corresponds to the number of dynamic parameters in the prepared statement. The value of COUNT must be less than or equal to the number of item descriptors that were specified when the system-descriptor area was allocated with the ALLOCATE DESCRIPTOR statement. You can obtain the value of a field with the GET DESCRIPTOR statement and set the value with the SET DESCRIPTOR statement.

The following example shows the OPEN ... USING SQL DESCRIPTOR statement:

```

EXEC SQL allocate descriptor 'desc1';
...
EXEC SQL open selcurs using sql descriptor 'desc1';

```

As the example indicates, the system descriptor area must be allocated before you reference it in the OPEN statement.

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Specifying a Pointer to an sqlda Structure (ESQL/C)

If you do not know the number of parameters to be supplied at runtime, or their data types, you can associate input values from an **sqlda** structure. An **sqlda** structure lists the data type and memory location of one or more values to replace question-mark (?) placeholders.

Use the DESCRIPTOR keyword to introduce a pointer to the **sqlda** structure as the location of the parameters.

The **sqlda** value specifies the number of input values that are described in occurrences of **sqlvar**. This number must correspond to the number of dynamic parameters in the prepared statement.

- [Example of Specifying a Pointer to an sqlda Structure](#)

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Example of Specifying a Pointer to an sqlda Structure

The following example shows an OPEN ... USING DESCRIPTOR statement:


```
struct sqlda *sdp;  
...  
EXEC SQL open selcurs using descriptor sdp;
```

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Using the WITH REOPTIMIZATION Option (ESQL/C)

Use the WITH REOPTIMIZATION keywords to reoptimize your query plan. When you prepare SELECT, EXECUTE FUNCTION, or EXECUTE PROCEDURE statements, the database server uses a query plan to optimize the query. If you later modify the data associated with the prepared statement, you can compromise the effectiveness of the query plan for that statement. In other words, if you change the data, you might deoptimize your query. To ensure optimization of your query, you can prepare the statement again, or open the cursor again using the WITH REOPTIMIZATION option.

You should generally use the WITH REOPTIMIZATION option, because it provides the following advantages over preparing a statement again:

- Rebuilds only the query plan, rather than the entire statement
- Uses fewer resources
- Reduces overhead
- Requires less time

The WITH REOPTIMIZATION option forces the database server to optimize the query-design plan before it processes the OPEN cursor statement.

The following examples use the WITH REOPTIMIZATION keywords:

```
EXEC SQL open selcurs using descriptor sdp with reoptimization;
```

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Relationship Between OPEN and FREE

The database server allocates resources to prepared statements and open cursors. If you execute a `FREE statement_id` or `FREE statement_id_var` statement, you can still open the cursor associated with the freed statement ID. If you release resources with a `FREE cursor_id` or `FREE cursor_id_var` statement, however, you cannot use the cursor unless you declare the cursor again.

Similarly, if you use the SET AUTOFREE statement for one or more cursors, when the program closes the specific cursor, the database server automatically frees the cursor-related resources. In this case, you cannot use the cursor unless you declare the cursor again.

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DDL Operations on Tables Referenced by Cursors

Various DDL statements can drop, rename, or alter the schema of a table that is referenced directly (or indirectly, by the identifier of a prepared statement) in the DECLARE statement that defines a cursor. Subsequent OPEN operations on the cursor might fail with error -710, or might produce unexpected results. Changing the number of columns or the data type of a column has this effect, and the user typically must reissue the DESCRIBE statement, the PREPARE statement, and (for cursors associated with routines) the UPDATE STATISTICS statement for any SPL routines that reference a table whose schema has been modified.

These restrictions do not apply, however, if an index is added or dropped when automatic recompilation is enabled for prepared objects and for SPL routines that reference tables that ALTER TABLE, CREATE INDEX, or DROP INDEX operations have modified. This is the default behavior of Informix®. For more information about enabling or disabling automatic recompilation after schema changes, see the description of the IFX_AUTO_REPREPARE option to the SET ENVIRONMENT statement. For more information about the AUTO_REPREPARE configuration parameter, see your *IBM® Informix Administrator's Reference*.

When the AUTO_REPREPARE configuration parameter and the IFX_AUTO_REPREPARE session environment variable are set to disable recompilation of prepared objects, however, adding an index to a table that is referenced directly or indirectly in a DECLARE statement can similarly invalidate the associated cursor. Subsequent OPEN statements that specify the invalid cursor fail, even if they include the WITH REOPTIMIZATION keywords. If an index is added to the table that is associated with a cursor while automatic recompilation is disabled, you must prepare the statement again and declare the cursor again before you can open the cursor. For cursors associated with calls to SPL routines, you must run the UPDATE STATISTICS statement for routines that reference tables to which an index has been added or dropped. You cannot simply reopen a cursor that is based on a prepared statement that is no longer valid.

Related information:

[AUTO_REPREPARE configuration parameter](#)

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OUTPUT statement

Use the OUTPUT statement to send the results of a query to an operating-system file or to a program.

Syntax

```
>>-OUTPUT TO--+-filename-----+--+-----+----->
          '-PIPE program-' '-WITHOUT HEADINGS-'

          (1)
>--| SELECT Statement |-----><
```

Notes:

1. See [SELECT statement](#)

Element	Description	Restrictions	Syntax
<i>filename</i>	Path and filename where query results are written. The default path is the current directory.	Can specify a new or existing file. If the file exists, query results overwrite the current contents of the file.	Must conform to the rules of your operating system.
<i>program</i>	Name of a program to receive the query results as input	Program must exist, must be known to the operating system, and must be able to read the results of a query.	Must conform to the rules of your operating system.

Usage

The OUTPUT statement writes query results in an operating-system file, or pipes query results to another program. You can optionally specify whether column headings are omitted from the query output. This statement is an extension to the ANSI/ISO standard for SQL. You can use this statement only with DB-Access.

- [Sending Query Results to a File](#)
- [Displaying Query Results Without Column Headings](#)
- [Sending Query Results to Another Program](#)

Related reference:

[SELECT statement](#)
[UNLOAD statement](#)

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Sending Query Results to a File

To send the results of a query to an operating-system file, specify the full pathname for the file. If the file already exists, the output overwrites the current contents.

The following examples show how to send the result of a query to an operating-system file. The example uses UNIX file naming conventions.

```
OUTPUT TO /usr/april/query1
SELECT * FROM cust_calls WHERE call_code = 'L'
```

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Displaying Query Results Without Column Headings

To display the results of a query without column headings, use the WITHOUT HEADINGS keywords.

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Sending Query Results to Another Program

You can use the keyword PIPE to send the query results to another program, as the following example shows:

```
OUTPUT TO PIPE more
SELECT customer_num, call_dtime, call_code
FROM cust_calls;
```

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PREPARE statement

Use the PREPARE statement to parse, validate, and generate an execution plan for one or more SQL statements at runtime.

Syntax

```
>>-PREPARE--+statement_id-----+--FROM----->
      | (1) |
      '-----statement_id_var-'

>--+ ' statement_text '-----><
      | (1) |
      +-----statement_var--+
      | (2) |
      '-----char_expression-'
```

Notes:

1. ESQ/C only
2. SPL only

Element	Description	Restrictions	Syntax
<i>char_expression</i>	Expression that evaluates to the text of a single SQL statement	Statement must be a SELECT, EXECUTE FUNCTION, or EXECUTE PROCEDURE	Expression
<i>statement_id</i>	Identifier declared here for the prepared object	Must be unique in the routine among names of cursors and prepared objects (and in SPL, among variables)	Identifier
<i>statement_id_var</i>	Host variable storing <i>statement_id</i>	Must have been previously declared as a character data type	Language specific
<i>statement_text</i>	Text of the SQL statement(s) to prepare	See Preparing Multiple SQL Statements and Statement Text .	Quoted String .
<i>statement_var</i>	Host variable storing the text of one or more SQL statements	Must be a character data type. Not valid if the SQL statement(s) contains the Collection-Derived Table segment.	Language specific

Usage

Use this statement in ESQ/C or SPL routines.

The PREPARE statement enables your program to assemble the text of one (or for ESQ/C, more than one) SQL statement at runtime, to declare an identifier for the resulting *prepared object*, and to make it executable. This dynamic form of SQL is accomplished in three steps:

1. The PREPARE statement accepts statement text as input, either as a quoted string, or an ESQ/C character variable, or (in SPL) as the value to which a character expression evaluates. Statement text can contain question-mark (?) placeholders to represent values that are to be defined when the statement is executed.
2. The OPEN statement (and in ESQ/C routines, the EXECUTE statement) can supply the required input values and execute the prepared statement once or many times.
3. Resources allocated to the prepared statement can be released later using the FREE statement.

For more information about the replacement of placeholders in prepared statements with runtime values, see the section [Preparing Statements That Receive Parameters](#).

The same collating order that is current when you create a prepared object is also used when that object is executed, even if the execution-time collation of the session (or of **DB_LOCALE**) is different.

- [Restrictions](#)
- [Declaring a Statement Identifier](#)
- [Releasing a Statement Identifier](#)
- [Statement Text](#)
- [Preparing and Executing User-Defined Routines](#)
- [Restricted Statements in Single-Statement Prepares](#)
- [Preparing Statements When Parameters Are Known](#)
- [Preparing Statements That Receive Parameters](#)
- [Preparing Statements with SQL Identifiers](#)
- [Preparing Multiple SQL Statements](#)
- [Using Prepared Statements for Efficiency](#)

Related concepts:

[Overloading the Name of a Function](#)

Related reference:

[FLUSH statement](#)

[GET DESCRIPTOR statement](#)

[CREATE PROCEDURE statement](#)

[SET AUTOFREE statement](#)

[SET DESCRIPTOR statement](#)

[INSERT statement](#)

[ALLOCATE DESCRIPTOR statement](#)

[SET DEFERRED PREPARE statement](#)

[EXECUTE IMMEDIATE statement](#)

[EXECUTE statement](#)

[DESCRIBE statement](#)

[DESCRIBE INPUT statement](#)

Restrictions

The number of prepared objects in a single program is limited by available memory. These include statement identifiers declared in PREPARE statements (*statement_id* or *statement_id_var*) and declared cursors. To avoid exceeding the limit, use the FREE statement to release some statements or cursors.

In SPL routines, a prepared object can include the text of no more than one SQL statement, and that statement must be either an EXECUTE FUNCTION, EXECUTE PROCEDURE, or SELECT statement, but the SELECT statement cannot include the INTO *variable*, INTO TEMP, or FOR UPDATE clause.

An expression that specifies the statement text in an SPL routine must evaluate to a CHAR, LVARCHAR, NCHAR, NVARCHAR, or VARCHAR data type. You must explicitly cast to one of these types an expression of any other text data type, such as a UDT.

For restrictions in ESQL/C routines on the SQL statements in the character string, see [Restricted Statements in Single-Statement Prepares](#) and [Restricted Statements in Multistatement Prepared Objects](#).

Declaring a Statement Identifier

PREPARE sends the statement text to the database server, which analyzes the statement text. If the text contains no syntax errors, the database server translates it to an internal form. This translated statement is saved for later execution in a data structure that the PREPARE statement allocates. The name of the structure is the value that is assigned to the statement identifier in the PREPARE statement. Subsequent SQL statements can refer to the structure by using the same statement identifier that was used in the PREPARE statement.

A subsequent FREE statement releases the database server resources that were allocated to the statement. After you release these resources with FREE, you cannot use the statement identifier in a DECLARE statement or (in ESQL/C) with the EXECUTE statement until you prepare the statement again.

The database server resources for the prepared objects that an SPL routine defines are released automatically when the routine exits.

- [Scope of Statement Identifiers](#)

Scope of Statement Identifiers

An ESQL/C program can consist of one or more source-code files. By default, the scope of reference of a statement identifier is global to the program. Therefore, a statement identifier that is prepared in one file can be referenced from another file.

In a multiple-file program, if you want to limit the scope of reference of a statement identifier to the file in which it is prepared, preprocess all the files with the **-local** command-line option.

Releasing a Statement Identifier

A statement identifier can represent only one SQL statement or (in ESQL/C) one semicolon-separated list of SQL statements at a time. A new PREPARE statement can specify an existing statement identifier if you want to bind the identifier to a different SQL statement text.

The PREPARE statement supports dynamic statement-identifier names, which allow you to prepare a statement identifier as an identifier or (in ESQL/C) as a host variable of a data type that can contain a character string. The first example that follows shows a statement identifier that was specified as a host variable. The second specifies a statement identifier as a character string.

```
stcopy ("query2", stmtid);  
EXEC SQL prepare :stmtid from 'select * from customer';  
  
EXEC SQL prepare query2 from 'select * from customer';
```

The variable must be a character data type. In C, it must be declared as **char**.

In an SPL routine, statement identifiers that the PREPARE statement declares are automatically defined in the local scope. Do not attempt to declare a statement identifier as having local or global scope. A statement identifier defined in one SPL routine is not visible to any other SPL routine that the same session calls. SPL statement identifiers share the same namespace as SPL variables and cursor names.

Statement Text

Statement text can be specified in the PREPARE statement

- as a quoted string
- or as text that is stored in an ESQL/C program variable
- or (in SPL routines) as a character expression.

The following restrictions apply to the statement text:

- The text can contain only SQL statements. It cannot contain statements or comments from the host programming language.
- The text can contain comments preceded by a double hyphen (--), or that are enclosed in braces ({}) or in C-style slash and asterisk (/* */) delimiters. These symbols introduce or enclose SQL comments. For more information on SQL comment symbols, see [How to Enter SQL Comments](#).
- The text can contain either a single SQL statement or (in ESQL/C routines) a series of statements that are separated by semicolon (;) symbols. For a list of SQL statements that cannot be prepared, see [Restricted Statements in Single-Statement Prepares](#). For more information on how to prepare multiple SQL statements, see [Preparing Multiple SQL Statements](#).
- The text cannot include an embedded SQL statement prefix or terminator, such as a dollar sign (\$) or the words EXEC SQL.
- Host-language variables are not recognized as such in prepared text. Therefore, you cannot prepare a SELECT (or EXECUTE FUNCTION or EXECUTE PROCEDURE) statement that includes an INTO clause, because the INTO clause requires a host-language variable.
- The only identifiers that you can use are names that are defined in the database, such as names of tables and columns. For more information on how to use identifiers in statement text, see [Preparing Statements with SQL Identifiers](#).
- Use a question mark (?) as a placeholder to indicate where data is supplied when the statement executes, as in this Informix® ESQL/C example:

```
EXEC SQL prepare new_cust from
      'insert into customer(fname,lname) values(?,?)';
```

For more information on how to use question marks as placeholders, see [Preparing Statements That Receive Parameters](#).

If the prepared statement contains the Collection-Derived Table segment or the Informix ESQL/C collection variable, some additional limitations exist on how you can assemble the text for the PREPARE statement. For information about dynamic SQL, see the *IBM Informix ESQL/C Programmer's Manual*. SPL routines cannot use dynamic SQL statements to process prepared statements that contain the Collection-Derived Table segment.

- [Example of a PREPARE statement in an SPL routine](#)
The IBM® Informix SPL language supports single-statement prepared objects.

Example of a PREPARE statement in an SPL routine

The IBM® Informix® SPL language supports single-statement prepared objects.

For example, the following SQL and SPL statements perform these tasks:

1. Create the **cities** table.
2. Populates the **cities** table with four rows of data.
3. Creates the **order_city** SPL routine that defines a prepared statement and a cursor to query the **cities** table:

```
CREATE TABLE cities -- defines a table
(
  id INT,
  city_name CHAR(50)
);

INSERT INTO cities VALUES (1, 'Chicago');
INSERT INTO cities VALUES (2, 'New York');
INSERT INTO cities VALUES (3, 'San Francisco');
INSERT INTO cities VALUES (4, 'Atlanta');

UPDATE STATISTICS HIGH;

CREATE PROCEDURE order_city() -- defines a UDR
RETURNING INT, CHAR(50);
DEFINE c_num INT;
DEFINE c_name CHAR(50);
DEFINE c_query VARCHAR(250);
LET c_query =
  "SELECT id, city_name FROM cities ORDER BY city_name;";

PREPARE c_stmt FROM c_query;
DECLARE c_cur CURSOR FOR c_stmt;

OPEN c_cur ;
```

```

while (1 = 1)
  FETCH c_cur INTO c_num, c_name;
  IF (SQLCODE != 100) THEN
    RETURN c_num, c_name WITH RESUME;
  ELSE
    EXIT;
  END IF
END WHILE

CLOSE c_cur;
FREE c_cur;
FREE c_stmt;

END PROCEDURE;

```

The following SQL statement invokes the **order_city** routine:

```
EXECUTE PROCEDURE order_city();
```

If the **order_city** function is called from the **dbaccess** utility, this output is displayed:

```

(expression) (expression)

      4 Atlanta
      1 Chicago
      2 New York
      3 San Francisco

```

For an overview with detailed examples of how to create and use prepared objects and Dynamic SQL in SPL routines, see this IBM developerWorks® article: [Dynamic SQL support in Informix Dynamic Server Stored Procedure Language](#)

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Preparing and Executing User-Defined Routines

The way to prepare a user-defined routine (UDR) depends on whether the UDR is a user-defined procedure or a user-defined function:

- To prepare a user-defined procedure, prepare the EXECUTE PROCEDURE statement that executes the procedure. To execute the prepared procedure, use the EXECUTE statement.
- To prepare a user-defined function, prepare the EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement that executes the function. You cannot include the INTO clause of EXECUTE FUNCTION (or EXECUTE PROCEDURE) in the PREPARE statement.

How to execute a prepared user-defined function depends on whether it returns only one group or multiple groups of values. Use the EXECUTE statement for user-defined functions that return only one group of values.

To execute user-defined functions that return more than one group of return values, you must associate the EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement with a cursor.

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Restricted Statements in Single-Statement Prepares

In general, you can prepare any data manipulation language (DML) statement.

In Informix®, you can prepare any single SQL statement except for the following statements:

- ALLOCATE COLLECTION
- ALLOCATE DESCRIPTOR
- ALLOCATE ROW
- CLOSE
- CONNECT
- CREATE FUNCTION FROM
- CREATE PROCEDURE FROM
- CREATE ROUTINE FROM
- DEALLOCATE COLLECTION
- DEALLOCATE DESCRIPTOR
- DEALLOCATE ROW
- DECLARE
- DESCRIBE
- DISCONNECT
- EXECUTE
- EXECUTE IMMEDIATE
- FETCH
- FLUSH
- FREE
- GET DESCRIPTOR

- GET DIAGNOSTICS
- INFO
- LOAD
- OPEN
- OUTPUT
- PREPARE
- PUT
- SET AUTOFREE
- SET CONNECTION
- SET DEFERRED_PREPARE
- SET DESCRIPTOR
- UNLOAD
- WHENEVER

You can prepare a SELECT statement. If SELECT includes the INTO TEMP clause, an ESQL/C program can execute the prepared statement with an EXECUTE statement. If it does not include the INTO TEMP clause, the statement returns rows of data. Use DECLARE, OPEN, and FETCH cursor statements to retrieve the rows.

In ESQL/C, a prepared SELECT statement can include a FOR UPDATE clause. This clause is used with the DECLARE statement to create an update cursor. The next example shows a SELECT statement with a FOR UPDATE clause in Informix ESQL/C:

```
sprintf(up_query, "%s %s %s",
        "select * from customer ",
        "where customer_num between ? and ? ",
        "for update");
EXEC SQL prepare up_sel from :up_query;
EXEC SQL declare up_curs cursor for up_sel;
EXEC SQL open up_curs using :low_cust, :high_cust;
```

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Preparing Statements When Parameters Are Known

In some prepared statements, all necessary information is known at the time the statement is prepared. The following example in Informix® ESQL/C shows two statements that were prepared from constant data:

```
sprintf(redo_st, "%s %s",
        "drop table worktl; ",
        "create table worktl (wtc serial, wtv float) ");
EXEC SQL prepare redotab from :redo_st;
```

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Preparing Statements That Receive Parameters

In some statements, parameters are unknown when the statement is prepared because a different value can be inserted each time the statement is executed. In these statements, you can use a question-mark (?) placeholder where a parameter must be supplied when the statement is executed.

The PREPARE statements in the following Informix® ESQL/C examples show some uses of question-mark (?) placeholders:

```
EXEC SQL prepare s3 from
    'select * from customer where state matches ?';
EXEC SQL prepare in1 from 'insert into manufact values (?, ?, ?)';
sprintf(up_query, "%s %s",
        "update customer set zipcode = ?"
        "where current of zip_cursor");
EXEC SQL prepare update2 from :up_query;
EXEC SQL prepare exfunc from
    'execute function func1 (?, ?)';
```

You can use a placeholder to defer evaluation of a value until runtime only for an expression, but not for an SQL identifier, except as noted in [Preparing Statements with SQL Identifiers](#).

The following example of the Informix ESQL/C code fragment prepares a statement from a variable that is named **demoquery**. The text in the variable includes one question-mark (?) placeholder. The prepared statement is associated with a cursor and, when the cursor is opened, the USING clause of the OPEN statement supplies a value for the placeholder:

```
EXEC SQL BEGIN DECLARE SECTION;
    char queryvalue [6];
    char demoquery [80];
EXEC SQL END DECLARE SECTION;

EXEC SQL connect to 'stores_demo';
sprintf(demoquery, "%s %s",
        "select fname, lname from customer ",
        "where lname > ? ");
EXEC SQL prepare quid from :demoquery;
EXEC SQL declare democursor cursor for quid;
```

```
stcopy("C", queryvalue);
EXEC SQL open democursor using :queryvalue;
```

The USING clause is available in both OPEN statements that are associated with a cursor and EXECUTE statements (all other prepared statements).

You can use a question-mark (?) placeholder to represent the name of the Informix ESQL/C or SPL collection variable.

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Preparing Statements with SQL Identifiers

In general, you must specify SQL identifiers explicitly in the statement text when you prepare the statement. In a few special cases, however, you can use the question-mark (?) placeholder for an SQL identifier:

- For the database name in the DATABASE statement.
- For the dbspace name in the IN *dbspace* clause of the CREATE DATABASE statement.
- For the cursor name in statements that use cursor names.

- [Obtaining SQL Identifiers from User Input](#)

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Obtaining SQL Identifiers from User Input

If a prepared statement requires identifiers, but the identifiers are unknown when you write the prepared statement, you can construct a statement that receives SQL identifiers from user input.

The following Informix® ESQL/C example prompts the user for the name of a table and uses that name in a SELECT statement. Because this name is unknown until runtime, the number and data types of the table columns are also unknown. Therefore, the program cannot allocate host variables to receive data from each row in advance. Instead, this program fragment describes the statement into an **sqlda** descriptor and fetches each row with the descriptor. The fetch puts each row into memory locations that the program provides dynamically.

If a program retrieves all the rows in the active set, the FETCH statement would be placed in a loop that fetched each row. If the FETCH statement retrieves more than one data value (column), another loop exists after the FETCH, which performs some action on each data value:

```
#include <stdio.h>
EXEC SQL include sqllda;
EXEC SQL include sqltypes;
char *malloc( );

main()
{
    struct sqlda *demodesc;
    char tablename[19];
    int i;
    EXEC SQL BEGIN DECLARE SECTION;
    char demoselect[200];
    EXEC SQL END DECLARE SECTION;

    /* This program selects all the columns of a given tablename.
       The tablename is supplied interactively. */

    EXEC SQL connect to 'stores_demo';
    printf( "This program does a select * on a table\n" );
    printf( "Enter table name: " );
    scanf( "%s", tablename );
    sprintf(demoselect, "select * from %s", tablename );

    EXEC SQL prepare iid from :demoselect;
    EXEC SQL describe iid into demodesc;

    /* Print what describe returns */

    for ( i = 0; i < demodesc->sqlld; i++ )
        prsqllda (demodesc->sqlvar + i);

    /* Assign the data pointers. */

    for ( i = 0; i < demodesc->sqlld; i++ )
    {
        switch (demodesc->sqlvar[i].sqltype & SQLTYPE)
        {
            case SQLCHAR:
                demodesc->sqlvar[i].sqltype = CCHARTYPE;
                /* make room for null terminator */
                demodesc->sqlvar[i].sqlllen++;
                demodesc->sqlvar[i].sqldata =
                    malloc( demodesc->sqlvar[i].sqlllen );
                break;
```



```

    case SQLSMINT:      /* fall through */
    case SQLINT:        /* fall through */
    case SQLSERIAL:
        demodesc->sqlvar[i].sqltype = CINTTYPE;
        demodesc->sqlvar[i].sqldata =
            malloc( sizeof( int ) );
        break;
    /* And so on for each type. */
}

/* Declare and open cursor for select . */
EXEC SQL declare d_curs cursor for iid;
EXEC SQL open d_curs;

/* Fetch selected rows one at a time into demodesc. */
for( ; ; )
{
    printf( "\n" );
    EXEC SQL fetch d_curs using descriptor demodesc;
    if ( sqlca.sqlcode != 0 )
        break;
    for ( i = 0; i < demodesc->sqld; i++ )
    {
        switch (demodesc->sqlvar[i].sqltype)
        {
            case CCHARTYPE:
                printf( "%s: \"%s\n", demodesc->sqlvar[i].sqlname,
                    demodesc->sqlvar[i].sqldata );
                break;
            case CINTTYPE:
                printf( "%s: %d\n", demodesc->sqlvar[i].sqlname,
                    *((int *) demodesc->sqlvar[i].sqldata) );
                break;
            /* And so forth for each type... */
        }
    }
}
EXEC SQL close d_curs;
EXEC SQL free d_curs;
/* Free the data memory. */

for ( i = 0; i < demodesc->sqld; i++ )
    free( demodesc->sqlvar[i].sqldata );
free( demodesc );

printf ( "Program Over.\n" );
}

prsqlda(sp)
{
    struct sqlvar_struct *sp;
    {
        printf ( "type = %d\n", sp->sqltype );
        printf ( "len = %d\n", sp->sqllen );
        printf ( "data = %lx\n", sp->sqldata );
        printf ( "ind = %lx\n", sp->sqlind );
        printf ( "name = %s\n", sp->sqlname );
    }
}

```

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Preparing Multiple SQL Statements

In ESQL/C, you can execute several SQL statements as one action if you include them in the same PREPARE statement. Multistatement text is processed as a unit; actions are not treated sequentially. Therefore, multistatement text cannot include statements that depend on actions that occur in a previous statement in the text. For example, you cannot create a table and insert values into that table in the same prepared statement block.

If a statement in a multistatement prepare returns an error, the whole prepared statement stops executing. The database server does not execute any remaining statements. In most situations, compiled products return error-status information on the error, but do not indicate which statement in the text causes an error. You can use the `sqlca.sqlerrd[4]` field in the `sqlca` to find the offset of the errors.

In a multistatement prepare, if no rows are returned from a WHERE clause in the following statements, the database server returns `SQLNOTFOUND (100)`:

- UPDATE ... WHERE ...
- SELECT INTO TEMP ... WHERE ...
- INSERT INTO ... WHERE ...
- DELETE FROM ... WHERE ...

In the next example, four SQL statements are prepared into a single Informix® ESQL/C string called **query**. Individual statements are delimited with semicolons.

A single PREPARE statement can prepare the four statements for execution, and a single EXECUTE statement can execute the statements that are associated with the **qid** statement identifier:

```

sprintf (query, "%s %s %s %s %s %s %s",
    "update account set balance = balance + ? ",
    "where acct_number = ?;",
    "update teller set balance = balance + ? ",
    "where teller_number = ?;",
    "update branch set balance = balance + ? ",
    "where branch_number = ?;",
    "insert into history values (?, ?);";
EXEC SQL prepare qid from :query;

EXEC SQL begin work;
EXEC SQL execute qid using
    :delta, :acct_number, :delta, :teller_number,
    :delta, :branch_number, :timestamp, :values;
EXEC SQL commit work;

```

Here the semicolons (;) are required as SQL statement-terminator symbols between each SQL statement in the text that **query** holds.

- [Restricted Statements in Multistatement Prepared Objects](#)

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Restricted Statements in Multistatement Prepared Objects

In addition to the statements listed as exceptions in [Restricted Statements in Single-Statement Prepares](#), you cannot use the following statements in the text of a multiple-statement prepared object:

- CLOSE DATABASE
- CREATE DATABASE
- DATABASE
- DROP DATABASE
- RENAME DATABASE
- SELECT (*with one exception*)

The following types of statements are also not valid in a multistatement prepare:

- Statements that can cause the current database to close during the execution of the multistatement sequence
- Statements that include references to TEXT or BYTE host variables

In general, you cannot use the SELECT statement in a multistatement prepare. The only form of the SELECT statement allowed in a multistatement prepare is a SELECT statement with an INTO temporary table clause.

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Using Prepared Statements for Efficiency

To increase performance efficiency, you can use the PREPARE statement and an EXECUTE statement in a loop to eliminate overhead that redundant parsing and optimizing cause. For example, an UPDATE statement that is located within a WHILE loop is parsed each time the loop runs. If you prepare the UPDATE statement outside the loop, the statement is parsed only once, eliminating overhead and speeding statement execution. The following example shows how to prepare Informix® ESQL/C statements to improve performance:

```

EXEC SQL BEGIN DECLARE SECTION;
    char disc_up[80];
    int cust_num;
EXEC SQL END DECLARE SECTION;
main()
{
    sprintf(disc_up, "%s %s", "update customer ",
        "set discount = 0.1 where customer_num = ?");
    EXEC SQL prepare up1 from :disc_up;
    while (1)
    {
        printf("Enter customer number (or 0 to quit): ");
        scanf("%d", &cust_num);
        if (cust_num == 0)
            break;
        EXEC SQL execute up1 using :cust_num;
    }
}

```

Like the SQL statement cache, prepared statements can reduce how often the same query plan is reoptimized, thereby conserving resources in some contexts. The section [Prepared Statements and the Statement Cache](#) discusses the use of prepared DML statements, cursors, and the SQL statement cache as combined or alternative techniques for improving query performance.

- [DDL Operations on Tables Referenced in Prepared Objects](#)

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If the buffer has no room for the new row when the statement executes, the buffered rows are written to the database in a block, and the buffer is emptied. As a result, some PUT statement executions cause rows to be written to the database, and some do not. You can use the FLUSH statement to write buffered rows to the database without adding a new row. The CLOSE statement writes any remaining rows before it closes an Insert cursor.

If the current database uses explicit transactions, you must execute a PUT statement within a transaction.

The following example uses a PUT statement in Informix® ESQL/C:

```
EXEC SQL prepare ins_mcode from
    'insert into manufact values(?,?)';
EXEC SQL declare mcode cursor for ins_mcode;
EXEC SQL open mcode;
EXEC SQL put mcode from :the_code, :the_name;
```

The PUT statement is not an X/Open SQL statement. Therefore, you get a warning message if you compile a PUT statement in X/Open mode.

- [Supplying Inserted Values](#)
- [Using the USING Clause](#)
- [Inserting into a Collection Cursor](#)
- [Writing Buffered Rows](#)
- [Error Checking](#)

Related reference:

[CLOSE statement](#)
[GET DESCRIPTOR statement](#)
[SET DESCRIPTOR statement](#)
[INSERT statement](#)
[ALLOCATE DESCRIPTOR statement](#)
[EXECUTE statement](#)
[DESCRIBE statement](#)
[DESCRIBE INPUT statement](#)
[DEALLOCATE DESCRIPTOR statement](#)
[Collection-Derived Table](#)
[OPEN statement](#)
[DECLARE statement](#)

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Supplying Inserted Values

The values in the inserted row can come from one of the following sources:

- Constant values that are written into the INSERT statement
- Program variables that are named in the INSERT statement
- Program variables in the FROM clause of the PUT statement
- Values that are prepared in memory addressed by an **sqllda** structure or a system-descriptor area and then specified in the USING clause of the PUT statement

The system descriptor area or **sqllda** structure that *descriptor* or *sqllda_pointer* references must define a data type and memory location of each value that corresponds to a question-mark (?) placeholder in a prepared INSERT statement.

- [Using Constant Values in INSERT](#)
- [Naming Program Variables in INSERT](#)
- [Naming Program Variables in PUT](#)

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Using Constant Values in INSERT

The VALUES clause lists the values for the inserted columns. One or more of these values can be constants (that is, numbers or character strings).

When *all* the inserted values are constants, the PUT statement has a special effect. Instead of creating a row and putting it in the buffer, the PUT statement merely increments a counter. When you use a FLUSH or CLOSE statement to empty the buffer, one row and a repetition count are sent to the database server, which inserts that number of rows. In the following Informix® ESQL/C example, 99 empty customer records are inserted into the **customer** table. Because all values are constants, no disk output occurs until the cursor closes. (The constant zero for **customer_num** causes generation of a SERIAL value.) The following example inserts 99 empty customer records into the customer table:

```
int count;
EXEC SQL declare fill_c cursor for
    insert into customer(customer_num) values(0);
EXEC SQL open fill_c;
for (count = 1; count <= 99; ++count)
    EXEC SQL put fill_c;
EXEC SQL close fill_c;
```

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Naming Program Variables in INSERT

When you associate the INSERT statement with a cursor (in the DECLARE statement), you create an Insert cursor. In the INSERT statement, you can name program variables in the VALUES clause. When each PUT statement is executed, the contents of the program variables at that time are used to populate the row that is inserted into the buffer.

If you are creating an Insert cursor (using DECLARE with INSERT), you must use only program variables in the VALUES clause. Variable names are not recognized in the context of a prepared statement; you associate a prepared statement with a cursor through its statement identifier.

The following Informix® ESQL/C example illustrates the use of an Insert cursor. The code includes the following statements:

- The DECLARE statement associates a cursor called **ins_curs** with an INSERT statement that inserts data into the **customer** table. The VALUES clause specifies a data structure that is called **cust_rec**; the Informix ESQL/C preprocessor converts **cust_rec** to a list of values, one for each component of the structure.
- The OPEN statement creates a buffer.
- A user-defined function (not defined within this example) obtains customer information from user input and stores it in **cust_rec**.
- The PUT statement composes a row from the current contents of the **cust_rec** structure and sends it to the row buffer.
- The CLOSE statement inserts into the **customer** table any rows that remain in the row buffer and closes the Insert cursor:

```
int keep_going = 1;
EXEC SQL BEGIN DECLARE SECTION
    struct cust_row { /* fields of a row of customer table */ } cust_rec;
EXEC SQL END DECLARE SECTION
EXEC SQL declare ins_curs cursor for
    insert into customer values (:cust_rec);
EXEC SQL open ins_curs;
while ( (sqlca.sqlcode == 0) && (keep_going) )

{
keep_going = get_user_input(cust_rec); /* ask user for new customer */
if (keep_going) /* user did supply customer info */
{
    cust_rec.customer_num = 0; /* request new serial value */
    EXEC SQL put ins_curs;
}
if (sqlca.sqlcode == 0) /* no error from PUT */
    keep_going = (prompt_for_y_or_n("another new customer") == 'Y')
}
EXEC SQL close ins_curs;
```

Use an indicator variable if the data to be inserted might be NULL.

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Naming Program Variables in PUT

When the INSERT statement is prepared (see [PREPARE statement](#)), you cannot use program variables in its VALUES clause, but you can represent values by a question-mark (?) placeholder. List the program variables in the FROM clause of the PUT statement to supply the missing values.

The following Informix® ESQL/C example lists host variables in a PUT statement:

```
char answer [1] = 'y';
EXEC SQL BEGIN DECLARE SECTION;
    char ins_comp[80];
    char u_company[20];
EXEC SQL END DECLARE SECTION;

main()
{
    EXEC SQL connect to 'stores_demo';
    EXEC SQL prepare ins_comp from
        'insert into customer (customer_num, company) values (0, ?)';
    EXEC SQL declare ins_curs cursor for ins_comp;
    EXEC SQL open ins_curs;

    while (1)
    {
        printf("\nEnter a customer: ");
        gets(u_company);
        EXEC SQL put ins_curs from :u_company;
        printf("Enter another customer (y/n) ? ");
        if (answer = getch() != 'y')
            break;
    }
    EXEC SQL close ins_curs;
    EXEC SQL disconnect all;
}
```

Indicator variables are optional, but you should use an indicator variable if the possibility exists that *output_var* might contain a NULL value. If you specify the indicator variable without the INDICATOR keyword, you cannot put a blank space between *output_var* and *indicator_var*.

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Using the USING Clause

If you do not know the number of parameters to be supplied at runtime or their data types, you can associate input values from a system-descriptor area or an **sqlda** structure. Both of these descriptor structures describe the data type and memory location of one or more values to replace question-mark (?) placeholders.

Each time the PUT statement executes, the values that the descriptor structure describes are used to replace question-mark (?) placeholders in the INSERT statement. This process is similar to using a FROM clause with a list of variables, except that your program has full control over the memory location of the data values.

- [Specifying a System-Descriptor Area](#)
- [Specifying an sqlda Structure](#)

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Specifying a System-Descriptor Area

The SQL DESCRIPTOR option specifies the name of a system-descriptor area.

The **COUNT** field in the system-descriptor area corresponds to the number of dynamic parameters in the prepared statement. The value of **COUNT** must be less than or equal to the number of item descriptors that were specified when the system-descriptor area was allocated with the ALLOCATE DESCRIPTOR statement. You can obtain the value of a field with the GET DESCRIPTOR statement and set the value with the SET DESCRIPTOR statement.

A system-descriptor area conforms to the X/Open standards.

The following Informix® ESQL/C example shows how to associate values from a system-descriptor area:

```
EXEC SQL allocate descriptor 'desc1';
...
EXEC SQL put selcurs using sql descriptor 'desc1';
```

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Specifying an sqlda Structure

Use the **DESCRIPTOR** option to introduce the name of a pointer to an **sqlda** structure. The following Informix® ESQL/C example shows how to associate values from an **sqlda** structure:

```
EXEC SQL put selcurs using descriptor pointer2;
```

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Inserting into a Collection Cursor

A Collection cursor allows you to access the individual elements of a collection variable. To declare a Collection cursor, use the DECLARE statement and include the Collection-Derived Table segment in the INSERT statement that you associate with the cursor. Once you open the Collection cursor with the OPEN statement, the cursor can put elements in the collection variable.

To put elements, one at a time, into the Insert cursor, use the PUT statement and the FROM clause. The PUT statement identifies the Collection cursor that is associated with the collection variable. The FROM clause identifies the element value to be inserted into the cursor. The data type of any host variable in the FROM clause must match the element type of the collection.

Important: The collection variable stores the elements of the collection. However, it has no intrinsic connection with a database column. Once the collection variable contains the correct elements, you must then save the variable into the actual collection column with the INSERT or UPDATE statement.

Suppose you have a table called **children** with the following schema:

```
CREATE TABLE children
(
    age      SMALLINT,
    name     VARCHAR(30),
    fav_colors SET(VARCHAR(20) NOT NULL)
);
```

The following Informix® ESQL/C program fragment shows how to use an Insert cursor to put elements into a collection variable called **child_colors**:

```
EXEC SQL BEGIN DECLARE SECTION;
    client collection child_colors;
```

```

char *favorites[]
(
    "blue",
    "purple",
    "green",
    "white",
    "gold",
    0
);
int a = 0;
char child_name[21];
EXEC SQL END DECLARE SECTION;

EXEC SQL allocate collection :child_colors;

/* Get structure of fav_colors column for untyped
 * child_colors collection variable */
EXEC SQL select fav_colors into :child_colors
from children where name = :child_name;
/* Declare insert cursor for child_colors collection
 * variable and open this cursor */
EXEC SQL declare colors_curs cursor for
insert into table(:child_colors)
values (?);
EXEC SQL open colors_curs;
/* Use PUT to gather the favorite-color values
 * into a cursor */
while (fav_colors[a])
{
    EXEC SQL put colors_curs from :favorites[:a];
    a++;
    ...
}
/* Flush cursor contents to collection variable */
EXEC SQL flush colors_curs;
EXEC SQL update children set fav_colors = :child_colors;

EXEC SQL close colors_curs;
EXEC SQL deallocate collection :child_colors;

```

After the FLUSH statement executes, the collection variable, **child_colors**, contains the elements {"blue", "purple", "green", "white", "gold"}. The UPDATE statement at the end of this program fragment saves the new collection into the **fav_colors** column of the database. Without this UPDATE statement, the new collection would not be added to the collection column.

Related reference:

[ALLOCATE COLLECTION statement](#)
[DEALLOCATE COLLECTION statement](#)

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Writing Buffered Rows

To open an Insert cursor, the OPEN statement creates an insert buffer. The PUT statement puts a row into this insert buffer. The buffered rows are inserted into the database table as a block only when necessary; this process is called *flushing the buffer*. The buffer is flushed after any of the following events:

- Buffer is too full to hold the new row at the start of a PUT statement.
- A FLUSH statement executes.
- A CLOSE statement closes the cursor.
- An OPEN statement specifies an already open cursor, closing it before reopening it. (This implicit CLOSE statement flushes the buffer.)
- A COMMIT WORK statement executes.
- Buffer contains BYTE or TEXT data (flushed after a single PUT statement).

If the program terminates without closing an Insert cursor, the buffer remains unflushed. Rows that were inserted into the buffer since the last flush are lost. Do not rely on the end of the program to close the cursor and flush the buffer.

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Error Checking

The **sqlca** structure contains information on the success of each PUT statement as well as information that lets you count the rows that were inserted. The result of each PUT statement is contained in the following fields of the **sqlca**: **sqlca.sqlcode**, **SQLCODE**, and **sqlca.sqlerrd[2]**.

Data buffering with an Insert cursor means that errors are not discovered until the buffer is flushed. For example, an input value that is incompatible with the data type of the column for which it is intended is discovered only when the buffer is flushed. When an error is discovered, buffered rows that were not inserted before the error are *not* inserted; they are lost from memory.

The **SQLCODE** field is set to 0 if no error occurs; otherwise, it is set to an error code. The third element of the **sqlerrd** array is set to the number of rows that were successfully inserted into the database:

- If any row is put into the insert buffer, but *not* written to the database, **SQLCODE** and **sqlerrd** are set to 0 (**SQLCODE** because no error occurred, and **sqlerrd** because no rows were inserted).
- If a block of buffered rows is written to the database during the execution of a PUT statement, **SQLCODE** is set to 0 and **sqlerrd** is set to the number of rows that was successfully inserted into the database.
- If an error occurs while the buffered rows are written to the database, **SQLCODE** indicates the error, and **sqlerrd** contains the number of successfully inserted rows. (The uninserted rows are discarded from the buffer.)

Tip: When you encounter an **SQLCODE** error, a **SQLSTATE** error value also exists. See the GET DIAGNOSTICS statement for details of how to obtain the message text.

To count the number of pending and inserted rows in the database

1. Prepare two integer variables (for example, **total** and **pending**).
2. When the cursor is opened, set both variables to 0.
3. Each time a PUT statement executes, increment both **total** and **pending**.
4. Whenever a PUT or FLUSH statement executes or the cursor closes, subtract the third field of the **SQLERRD** array from **pending**.

At any time, (**total** - **pending**) represents the number of rows actually inserted. If no statements fail, **pending** contains zero after the cursor is closed. If an error occurs during a PUT, FLUSH, or CLOSE statement, the value that remains in **pending** is the number of uninserted (discarded) rows.

Related Statements

Related statements: [ALLOCATE DESCRIPTOR statement](#), [CLOSE statement](#), [DEALLOCATE DESCRIPTOR statement](#), [FLUSH statement](#), [DECLARE statement](#), [GET DESCRIPTOR statement](#), [OPEN statement](#), [PREPARE statement](#), and [SET DESCRIPTOR statement](#)

For a task-oriented discussion of the PUT statement, see the *IBM Informix Guide to SQL: Tutorial*.

For more information about error checking, the system-descriptor area, and the **sqllda** structure, see the *IBM Informix ESQL/C Programmer's Manual*.

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RELEASE SAVEPOINT statement

Use the RELEASE SAVEPOINT statement to destroy a specified savepoint. The RELEASE SAVEPOINT statement is compliant with the ANSI/ISO standard for SQL.

Syntax

```
>>--RELEASE SAVEPOINT--savepoint-----><
```

Element	Description	Restrictions	Syntax
<i>savepoint</i>	Name of the savepoint to be destroyed	Must exist in the current savepoint level	Identifier

Usage

Restriction: After this statement executes successfully, rollback to the specified savepoint (or to any other savepoint between the RELEASE SAVEPOINT statement and the specified savepoint) is no longer possible.

The RELEASE SAVEPOINT statement destroys the specified savepoint. Any savepoints set between that savepoint and the RELEASE SAVEPOINT statement in the current savepoint level are also destroyed. Any other savepoints, however, that were set earlier than the specified savepoint in the current savepoint level continue to be active.

The RELEASE SAVEPOINT statement fails with an error in the following contexts:

- No SQL transaction is open.
- No savepoint with the specified name exists in the current savepoint level.
- The statement is part of a triggered action.
- The statement is part of an XA transaction.
- The autocommit transaction mode of the client API is enabled.
- The statement is part of a cross-server distributed SQL transaction in which one of the participating database servers does not support savepoints.
- The statement is issued within a UDR that is invoked within a DML statement.

The identifier of any savepoint that RELEASE SAVEPOINT destroys can be reused in a subsequent SAVEPOINT statement of the same savepoint level, even if the released savepoint was set by a SAVEPOINT statement that included the UNIQUE keyword.

Because savepoints are program objects, not database objects, the RELEASE SAVEPOINT statement has no direct effect on the database or on its system catalog tables. RELEASE SAVEPOINT can affect user tables and the system catalog indirectly, however, if it changes the scope of a subsequent ROLLBACK TO SAVEPOINT operation that cancels uncommitted changes to the database within a different portion of the current savepoint level, as the next example illustrates.

The following program fragment sets and then releases a savepoint called `sp45`:

```
BEGIN WORK;
CREATE DATABASE third_base IN db3 WITH BUFFERED LOG;
SAVEPOINT sp46;
CREATE TABLE tab1 ( col1 INT, col2 CHAR(24));
```



```

SAVEPOINT sp45 UNIQUE;
...
CREATE TABLE tab2 ( col1 INT8, col2 LVARCHAR(24000));
SAVEPOINT sp44;
...
RELEASE SAVEPOINT sp45;
ROLLBACK TO SAVEPOINT;

```

The effect of the RELEASE SAVEPOINT statement in this example is to destroy two savepoints, `sp45` and `sp44`. If the only remaining savepoint in the current savepoint level is `sp46`, the subsequent ROLLBACK TO SAVEPOINT statement cancels the DDL statements that created **tab1** and **tab2**, and any DML operations on those tables that preceded the ROLLBACK statement. The rollback does not, however, cancel the CREATE DATABASE statement that created the **third_base** database. Without the RELEASE SAVEPOINT statement, the CREATE TABLE statement that created **tab1** would not have been cancelled, because Informix® would have treated **sp44** as the default savepoint that the TO SAVEPOINT clause of the ROLLBACK statement references.

Related reference:

[SAVEPOINT statement](#)

[ROLLBACK WORK statement](#)

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RENAME COLUMN statement

Use the RENAME COLUMN statement to change the name of a column. The RENAME COLUMN statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```

>>-RENAME COLUMN--+-----+--table--.--old_column----->
                    '-owner,-'

>--TO--new_column-----><

```

Element	Description	Restrictions	Syntax
<i>new_column</i>	Name that you declare here to replace <i>old_column</i>	Must be unique among column names in <i>table</i> . See also How Triggers Are Affected .	Identifier
<i>old_column</i>	Column to rename	Must exist within table	Identifier
<i>owner</i>	Owner of the table	Must be the owner of table	Owner name
<i>table</i>	Table that contains <i>old_column</i>	Must be registered in the current database	Identifier

Usage

You can rename a column of a table if any of the following conditions are true:

- You own the table or have Alter privilege on the table.
- You have the DBA privilege on the database.

The column can be in a table object that the CREATE EXTERNAL TABLE statement defined.

Example

The following example assigns the new name of `c_num` to the `customer_num` column in the `customer` table:

```
RENAME COLUMN customer.customer_num TO c_num;
```

- [How Views and Check Constraints Are Affected](#)
- [How Triggers Are Affected](#)

Related concepts:

[CREATE TRIGGER statement](#)

Related reference:

[RENAME TABLE statement](#)

[ALTER TABLE statement](#)

[CREATE TABLE statement](#)

[CREATE VIEW statement](#)

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How Views and Check Constraints Are Affected

If you rename a column that appears in a view, the text of the view definition in the **sysviews** system catalog table is updated to reflect the new column name. If you rename a column that appears in a check constraint, the text of the check constraint in the **syschecks** system catalog table is updated to reflect the new column name.

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How Triggers Are Affected

If you rename a column that appears within the definition a trigger, it is replaced with the new name only in the following instances:

- When it appears as part of a correlation name inside the FOR EACH ROW action clause of a trigger
- When it appears as part of a correlation name in the INTO clause of an EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement
- When it appears as a triggering column in the UPDATE clause

When the trigger executes, if the database server encounters a column name that no longer exists in the table, an error is returned.

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RENAME CONSTRAINT statement

Use the RENAME CONSTRAINT statement to rename the constraint. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-RENAME CONSTRAINT--+-+-----+----->
                        '-owner.-'

>--old_constraint--TO--new_constraint-----><
```

Element	Description	Restrictions	Syntax
<i>new_constraint</i>	New name that you declare here for <i>old_constraint</i>	Name must be unique to the database	Identifier
<i>old_constraint</i>	Constraint name that <i>new_constraint</i> replaces	Must exist, but it cannot be a constraint on a system catalog table	Identifier
<i>owner</i>	Owner of <i>old_constraint</i>	Must be the owner of <i>old_constraint</i>	Owner name

Usage

You can rename a constraint if any of the following is true:

- You are the owner of the constraint.
- You have the DBA privilege on the database.

When you rename a constraint, the database server changes the constraint name in the **sysconstraints** and **sysobjstate** system catalog tables.

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RENAME DATABASE statement

Use the RENAME DATABASE statement to change the name of a database. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-RENAME DATABASE--+-+-----+----->
                        '-owner.-'

>--old_database--TO--new_database-----><
```

Element	Description	Restrictions	Syntax
<i>new_database</i>	New name that you declare here for <i>old_database</i>	Must be unique among database names of the current database server; must not be opened by any user when this statement is issued	Database Name

Element	Description	Restrictions	Syntax
<i>old_database</i>	Name that <i>new_database</i> replaces	Must exist on current database server, but it cannot be the name of the current database Cannot be a tenant database.	Database Name
<i>owner</i>	Owner of <i>old_database</i>	Must be the owner of the database	Owner name

Usage

You can rename a database if any of the following is true:

- You created the database.
- You have the DBA privilege on the database.
- The database is not a tenant database. Tenant databases cannot be renamed.

The RENAME DATABASE statement fails with error -9874, however, if the specified database contains any of the following objects:

- a virtual table
- a virtual index
- an R-tree index
- a DataBlade that references the current name of the database in a user-defined primary access method or in a user-defined secondary access method.

You can only rename databases of the database server to which you are currently connected.

You cannot rename a database from inside an SPL routine.

Related reference:

[CREATE DATABASE statement](#)

Related information:

[Update JAR file names](#)

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RENAME INDEX statement

Use the RENAME INDEX statement to change the name of an existing index. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-RENAME INDEX--+-+-----+-+old_index--TO--new_index-----><
      '-owner.-'
```

Element	Description	Restrictions	Syntax
<i>new_index</i>	New name that you declare here for the index	Name must be unique to the database (or to the session, if <i>old_index</i> is on a temporary table)	Identifier
<i>old_index</i>	Index name that <i>new_index</i> replaces	Must exist, but it cannot be any of the following: <ul style="list-style-type: none"> • An index on a system catalog table • A Virtual-Index Interface (VII) 	Identifier
<i>owner</i>	Owner of index	Must be the owner of <i>old_index</i>	Owner name

Usage

You can rename an index if you are the owner of the index or have the DBA privilege on the database.

When you rename an index, the database server changes the index name in the **sysindexes**, **sysconstraints**, **sysobjstate**, and **sysfragments** system catalog tables. (But for an index on a temporary table, no system catalog tables are updated.)

You can rename a system-generated index that implements a primary-key or foreign-key constraint. When you rename a system-generated index, the index is not automatically dropped if you drop the corresponding constraint. The name of a system-generated index consists of a white space, a number, an underscore, and a number. Omit the white space at the beginning of the system-generated index name in the RENAME INDEX statement. For example, to rename an index that is named " 100_1" to idx1, run the following statement:

```
RENAME INDEX 100_1 TO idx1;
```

You can include the owner name before the system-generated index name, for example:

```
RENAME INDEX jmm.100_1 TO idx1;
```

Indexes on system catalog tables cannot be renamed.

By default, SPL routines that use the renamed index are reoptimized when they are next executed after the index is renamed. When automatic recompilation is disabled, however, SPL routines that use the renamed index are automatically recompiled on their next use if the renamed index is associated with a directly referenced table. If the table is only referenced indirectly, however, execution can fail with error -710. For more information about enabling or disabling automatic recompilation after changes to the schema of a referenced table, see the [IFX_AUTO_REPREPARE session environment option](#). For more information about the AUTO_REPREPARE configuration parameter, see your *IBM® Informix® Administrator's Reference*.

Related reference:

[ALTER INDEX statement](#)
[CREATE INDEX statement](#)
[DROP INDEX statement](#)

Related information:

[Reoptimizing SPL routines](#)

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RENAME SECURITY statement

Use the RENAME SECURITY statement to change the name of an existing security object. The object can be a security policy, or a security label, or a security label component.

Syntax

```
>>-RENAME SECURITY--+-POLICY-----+----->
      +-LABEL--policy--.-+
      '-LABEL COMPONENT--'

>--old_name--TO--new_name-----><
```

Element	Description	Restrictions	Syntax
<i>new_name</i>	New name that you declare here for the security object	Must be unique among identifiers of security objects in the database, and must be different from <i>old_name</i>	Identifier
<i>old_name</i>	Current® name that <i>new_name</i> replaces	Must exist in the database as the identifiers of a security object	Identifier
<i>policy</i>	Security policy of the <i>old_name</i> label	Must be the security policy for which <i>old_name</i> is a security label	Identifier

Usage

This statement is an extension to the ANSI/ISO standard for SQL.

Only DBSECADM can issue this statement. The RENAME SECURITY statement replaces the *old_name* with the specified *new_name* in the table of the system catalog in which the renamed security object is registered:

- **syssecpolicies.secpolicyname** for security policies
- **sysseclabels.seclabelname** for security labels
- **sysseclabelcomponents.compname** for security label components.

This statement does not, however, change the numeric value of the **syssecpolicies.secpolicyid**, **sysseclabels.seclabelid**, nor **sysseclabelcomponents.compoid** of the renamed security object.

The keyword or keywords that follow the SECURITY keyword identify the type of security object that is being renamed. In the following example, the new identifier **honesty** replaces **best** as the name of a security policy:

```
RENAME SECURITY POLICY best TO honesty;
```

In the following example, the new identifier **transparent** replaces **opaque** as the name of a label for the **honesty** security policy:

```
RENAME SECURITY LABEL honesty.opaque TO transparent;
```

In the next example, the new identifier **accountant** replaces **architect** as the name of a security label component:

```
RENAME SECURITY LABEL COMPONENT architect TO accountant;
```

Related reference:

[ALTER SECURITY LABEL COMPONENT statement](#)
[ALTER TABLE statement](#)
[CREATE SECURITY LABEL statement](#)
[CREATE SECURITY LABEL COMPONENT statement](#)
[CREATE SECURITY POLICY statement](#)
[CREATE TABLE statement](#)
[DROP SECURITY statement](#)
[EXEMPTION Clause](#)
[SECURITY LABEL Clause](#)
[EXEMPTION Clause](#)

RENAME SEQUENCE statement

Use the RENAME SEQUENCE statement to change the name of a sequence. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-RENAME SEQUENCE--+-+-----+----->
                        '-owner.-'

>--old_sequence--TO--new_sequence-----><
```

Element	Description	Restrictions	Syntax
<i>new_sequence</i>	New name that you declare here for an existing sequence	Must be unique among the names of sequences, tables, views, and synonyms in the database	Identifier
<i>old_sequence</i>	Current® name of a sequence	Must exist in the current database	Identifier
<i>owner</i>	Owner of the sequence	Must be the owner of the sequence	Owner name

Usage

To rename a sequence, you must be the owner of the sequence, have the ALTER privilege on the sequence, or have the DBA privilege on the database.

You cannot use a synonym to specify the name of the sequence.

In a database that is not ANSI compliant, the name of *new_sequence* (or in an ANSI-compliant database, the combination of *owner.new_sequence*) must be unique among sequences, tables, views, and synonyms in the database.

Related reference:

[DROP SEQUENCE statement](#)
[ALTER SEQUENCE statement](#)
[CREATE SEQUENCE statement](#)
[CREATE SYNONYM statement](#)
[DROP SYNONYM statement](#)
[GRANT statement](#)
[REVOKE statement](#)
[INSERT statement](#)
[UPDATE statement](#)
[SELECT statement](#)
[NEXTVAL and CURRVAL Operators](#)

RENAME TABLE statement

Use the RENAME TABLE statement to change the name of a table. The RENAME TABLE statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-RENAME TABLE--+-+-----+---old_table--TO--new_table-----><
                        '-owner.-'
```

Element	Description	Restrictions	Syntax
<i>new_table</i>	New name for <i>old_table</i>	Must be unique among the names of sequences, tables, views, and synonyms in the database	Identifier
<i>old_table</i>	Name that <i>new_table</i> replaces	Must be the name (not the synonym) of a table that is registered in the current database	Identifier
<i>owner</i>	Current® owner of the table	Must be the owner of the table.	Owner name

Usage

To rename a table, you must be the owner of the table, or have the ALTER privilege on the table, or have the DBA privilege on the database.

An error occurs if *old_table* is a synonym, rather than the name of a table.

The *old_table* can be an object that the CREATE EXTERNAL TABLE statement defined.

The renamed table remains in the current database. You cannot use the RENAME TABLE statement to move a table from the current database to another database, nor to rename a table that resides in another database.

You cannot change the table *owner* by renaming the table. An error occurs if you try to specify an *owner*. qualifier for the new name of the table.

When the table owner is changed, you must specify both the old owner and new owner.

In an ANSI-compliant database, if you are not the owner of *old_table*, you must specify *owner.old_table* as the old name of the table.

If *old_table* is referenced by a view in the current database, the view definition is updated in the **sysviews** system catalog table to reflect the new table name. For further information on the **sysviews** system catalog table, see the *IBM® Informix® Guide to SQL: Reference*.

If *old_table* is a triggering table, the database server takes these actions:

- Replaces the name of the table in the trigger definition but does not replace the table name where it appears inside any triggered actions
- Returns an error if the new table name is the same as a correlation name in the REFERENCING clause of the trigger definition

When the trigger executes, the database server returns an error if it encounters a table name for which no table exists.

Using RENAME TABLE to Reorganize a Table

The RENAME TABLE statement can be a useful alternative to the ALTER TABLE statement when you need to reorganize the schema of an existing table. Suppose, for example, that you decide to change the order of columns in the **items** table of the **stores** demonstration database. You can reorganize the **items** table to move the **quantity** column from the fifth position to the third position by following these steps:

1. Create a new table, **new_table**, that contains the column **quantity** in the third position.
2. Fill the table with data from the current **items** table.
3. Drop the old **items** table.
4. Rename **new_table** with the identifier **items**.

The following example uses the RENAME TABLE statement as the last step:

```
CREATE TABLE new_table
(
  item_num      SMALLINT,
  order_num     INTEGER,
  quantity      SMALLINT,
  stock_num     SMALLINT,
  manu_code     CHAR(3),
  total_price   MONEY(8)
);
INSERT INTO new_table
  SELECT item_num, order_num, quantity, stock_num,
         manu_code, total_price FROM items;
DROP TABLE items;
RENAME TABLE new_table TO items;
```

Related reference:
[ALTER TABLE statement](#)
[CREATE TABLE statement](#)
[DROP TABLE statement](#)
[RENAME COLUMN statement](#)
Related information:
[SYSVIEWS](#)

RENAME TRUSTED CONTEXT statement

Use the RENAME TRUSTED CONTEXT statement to change the name of a trusted-context object.

This statement is an extension to the ANSI/ISO standard for SQL. You must hold the database security administrator (DBSECADM) role to rename a trusted context.

Syntax

```
>>-RENAME TRUSTED CONTEXT--old_name--TO--new_name-----><
```

Element	Description	Restrictions	Syntax
---------	-------------	--------------	--------

Element	Description	Restrictions	Syntax
<i>old_name</i>	Trusted context identifier that <i>new_name</i> replaces	Must be an existing trusted-context object of the database server	Identifier
<i>new_name</i>	New name that you declare here for the trusted context	Must be a one-part name, without qualifiers. It cannot begin with the characters "SYS" and must not identify a trusted context that already exists on the database server.	Identifier

Usage

The *new_name* and the *old_name* cannot include qualifiers, such as *owner*, *database*, or *dbserver*.

After the RENAME TRUSTED CONTEXT statement successfully executes, all references to the *old_name* will be replaced by *new_name* in these tables in the **sysuser** database of the Informix® database server instance:

- systustedcontext
- systcxattributes
- systcxusers.

In addition, applications that attempt to establish a connection to the database by referencing the *old_name* will fail, unless the *old_name* has been declared as the identifier of a new trusted-context object.

If you rename the trusted context while trusted connections for this context are active, those connections remain trusted until they terminate, or until the next reuse attempt. If an attempt is made to switch the user on these trusted connections, however, an error is returned.

The following example of a complete RENAME TRUSTED CONTEXT statement replaces the security-object identifier **cntx1** with **cntx2** as the new name for the **cntx1** trusted context:

```
RENAME TRUSTED CONTEXT cntx1 TO cntx2;
```

This example fails under either of the following circumstances:

- if **cntx1** is not the name of a trusted-context object of the current database server instance,
- or if **cntx2** is already the name of an existing trusted-context object of the same database server.

Related reference:

[ALTER TRUSTED CONTEXT statement](#)
[CREATE TRUSTED CONTEXT statement](#)
[DROP TRUSTED CONTEXT statement](#)

Related information:

[Trusted-context objects and trusted connections](#)

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RENAME USER statement (UNIX, Linux)

Use the RENAME USER statement to change the name of an internal user of a non-root installation of the database server.

This statement is an extension to the ANSI/ISO standard for the SQL language.

Syntax

```
>>-RENAME USER--old_name--TO--new_name-----><
```

Element	Description	Restrictions	Syntax
<i>old_name</i>	Authorization identifier of a specific user that you are renaming.	Must be an existing authorization identifier	Owner name
<i>new_name</i>	Authorization identifier of a specific user.	Cannot be an existing authorization identifier	Owner name

Usage

Only a DBSA can run the RENAME USER statement. With a non-root installation, the user who installs the server is the equivalent of the DBSA, unless the user delegates DBSA privileges to a different user.

Do not rename a user while the user is active on a connection. Running the statement does not transfer any database or table level privileges granted to the old user name to the new user name.

Execution of the RENAME USER statement can be audited with the RNUR audit code.

You must also enter values in the SYSUSERMAP table of the **sysusers** database to map users with the appropriate user properties so that the mapped user statements of SQL to work correctly.

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Element	Description	Restrictions	Syntax
<i>revoker</i>	Authorization identifier of the grantor of the privileges to be revoked	Must be grantor of the specified privileges	Owner name
<i>role</i>	Role from which you revoke another role	Must exist	Owner name
<i>user</i>	User whose role (or default role) you cancel	Must exist	Owner name

Usage

To cancel privileges on one or more fragments of a table that has been fragmented by expression, see [REVOKE FRAGMENT statement](#).

You can revoke privileges if any of the following conditions is true for the privileges that you are attempting to revoke on some database object:

- You granted them and did not designate another user as grantor.
- The GRANT statement specified you as grantor.
- You are revoking privileges from PUBLIC on an object that you own, and those privileges were granted by default when you created the object.
- You have database-level DBA privileges and you specify in the AS clause the name of a user who was grantor of the privilege.

The REVOKE statement can cancel any of the following access privileges or roles that a user, or PUBLIC, or a role currently holds:

- Privileges on the database (but a role cannot hold database-level privileges)
- Privileges on a table, synonym, view, or sequence object
- Privileges on a user-defined data type (UDT), a user-defined routine (UDR), or on the SPL language
- A non-default role, or the default role of PUBLIC or of a user.

You cannot revoke privileges from yourself. You cannot revoke grantor status from another user. To revoke a privilege that was granted to another user by the AS *grantor* clause of the GRANT statement, you must have the DBA privilege, and you must use the AS clause to specify that user as *revoker*.

Delimiting *revoker*, *role*, and *user* identifiers

The REVOKE statement syntax diagram is simplified, because

- the quotation-mark delimiters that can enclose the *revoker*, *role*, or *user* names are optional,
- and you can also substitute double (") quotation marks for single (') quotation marks to delimit those identifiers. Both delimiters must be the same character.

If you enclose *revoker*, *role*, or *user* in quotation marks, the name is case sensitive, and the database server stores it in the system catalog exactly as you enter it in the REVOKE statement. For example, the following statement revokes the DBA privilege from user **sam**.

```
REVOKE DBA FROM "sam";
```

If another user who holds the DBA privilege has the authorization identifier **sam**, she would not be affected by the REVOKE example, because her case sensitive user name does not match the delimited name. In a database that was not created as MODE ANSI, however, the following example revokes the DBA privilege of both users **sam** and **Sam**:

```
REVOKE DBA FROM sam;
```

In an ANSI-compliant database, if you do not use quotation marks as delimiters, that identifier is stored in uppercase letters.

In locales that support letter case, authorization identifiers for distinct users or roles that differ only in letter case might produce unexpected results, if GRANT and REVOKE statements use both delimited and undelimited *user* and *role* specifications to manage access privileges.

- [Revoking database server access from mapped users \(UNIX, Linux\)](#)
Use the REVOKE ACCESS FROM statement to remove surrogate user properties from specific mapped users.
- [Database-level privileges](#)
Three concentric layers of database-level privileges, Connect, Resource, and DBA, authorize increasing power over database access and control. Only a user with the DBA privilege can grant or revoke database-level privileges.
- [Table-Level Privileges](#)
- [Effect of Uncommitted Transactions](#)
- [Type-Level Privileges](#)
- [Routine-Level Privileges](#)
- [Language-Level Privileges](#)
To register or drop a UDR written in the SPL, C, or Java languages, a user must hold the Usage privilege on the programming language in which the routine is written.
- [Sequence-Level Privileges](#)
- [User List](#)
- [Role Name](#)
- [Revoking privileges granted WITH GRANT OPTION](#)
If you revoke from *user* privileges or a role that you granted using the WITH GRANT OPTION keywords, you sever the chain of privileges granted by that *user*.
- [The AS Clause](#)
Without the AS clause, the user who executes the REVOKE statement must be the grantor of the privilege that is being revoked. The DBA or the owner of the object can use the AS clause to specify another user (who must be the grantor of the privilege) as the revoker of the privileges.
- [Controlling the Scope of REVOKE with the RESTRICT Option](#)
- [Security Administration Options](#)

Related concepts:

[Overloading the Name of a Function](#)

Related reference:

[INFO statement](#)
[DROP SEQUENCE statement](#)
[ALTER SEQUENCE statement](#)
[CREATE ACCESS_METHOD statement](#)
[CREATE ROW TYPE statement](#)
[CREATE SEQUENCE statement](#)
[SET SESSION AUTHORIZATION statement](#)
[CREATE PROCEDURE statement](#)
[CREATE VIEW statement](#)
[SET ROLE statement](#)
[RENAME SEQUENCE statement](#)
[DROP ROLE statement](#)
[GRANT statement](#)
[GRANT FRAGMENT statement](#)
[REVOKE FRAGMENT statement](#)
[CREATE ROLE statement](#)
Related information:
[Grant privileges](#)
[Label-based access control](#)
[Grant and revoke privileges in applications](#)

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Revoking database server access from mapped users (UNIX, Linux)

Use the REVOKE ACCESS FROM statement to remove surrogate user properties from specific mapped users.

Only user **informix** or a DBSA can run the REVOKE ACCESS FROM statement.

The REVOKE ACCESS FROM statement does not affect any access privileges of the user account name that accesses the database server through an OS-level account on the host computer.

Example:

User **informix** or a DBSA can run the following statement on a system that supports mapped users, and one of the mapped users is user **bob**:

```
REVOKE ACCESS FROM bob;
```

This statement entirely removes the access of user **bob** to the database server, except when one or both of the following is true:

- PUBLIC is mapped to surrogate user properties. In this case, user **bob** still retains the same access privileges that the PUBLIC group holds.
- User **bob** is also a user account on the host computer with database server access.

Related reference:

[Surrogate user properties \(UNIX, Linux\)](#)

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Database-level privileges

Three concentric layers of database-level privileges, Connect, Resource, and DBA, authorize increasing power over database access and control. Only a user with the DBA privilege can grant or revoke database-level privileges.

Database-Level Privileges

```
|---+DBA-----+-----|
|+-RESOURCE-+-|
|'-CONNECT--'|
```

Because of the hierarchical organization of the privileges (as outlined in the privilege definitions that are described later in this section), if you revoke either the Resource or the Connect privilege from a user with the DBA privilege, the statement has no effect. If you revoke the DBA privilege from a user who has the DBA privilege, the user retains the Connect privilege on the database. To deny database access to a user with the DBA or Resource privilege, you must first revoke the DBA or the Resource privilege and then revoke the Connect privilege in a separate REVOKE statement.

Similarly, if you revoke the Connect privilege from a user who has the Resource privilege, the statement has no effect. If you revoke the Resource privilege from a user, the user retains the Connect privilege on the database.

Only users or PUBLIC can hold database-level privileges. You cannot revoke these privileges from a role, because a role cannot hold database level privileges.

The following table lists the keyword for each database-level privilege.

Privilege	Effect
-----------	--------


```
>--+-table-----+-----+
      +-view----+
          '-synonym-'
```

1. Informix® extension

In one REVOKE statement, you can list one or more of the following keywords to specify the privileges on the specified table to be revoked from the users or roles.

See also [Table-Level Privileges](#).

If user **ted** holds the same privileges through a role or as PUBLIC, however, this REVOKE operation does not prevent **ted** from exercising the Update privilege.

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You can use combinations of REVOKE and GRANT to replace PUBLIC with specific users as grantees, and to remove table-level privileges on some columns.

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If a table owner grants a privilege to PUBLIC, the owner cannot revoke the same privilege from any specific user. For example, assume PUBLIC has default Select privileges on your **customer** table. Suppose that you issue the following statement in an attempt to exclude **ted** from accessing your table:

This statement results in ISAM error message 111, `No record found`, because the system catalog tables (`syscolauth` or `sysstabauth`) contain no table-level privilege entry for a user named **ted**. This REVOKE operation does not prevent **ted** from keeping all the table-level privileges given to PUBLIC on the **customer** table.

```
REVOKE INDEX, ALTER ON customer FROM PUBLIC;  
GRANT INDEX, ALTER ON customer TO mary;
```

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Restricting Access to Specific Columns

Unlike GRANT, the REVOKE statement has no syntax to specify privileges on a subset of columns in a table. To revoke the Select, Update, or References privilege on a column from a user, you must revoke the privilege for all the columns of the table. To provide access to some of the columns on which you previously had granted privileges, issue a new GRANT statement to restore the appropriate privilege on specific columns.

The next example cancels Select privileges for PUBLIC on certain columns:

```
REVOKE SELECT ON customer FROM PUBLIC;  
GRANT SELECT (fname, lname, company, city) ON customer TO PUBLIC;
```

In the next example, **mary** first receives the ability to reference four columns in **customer**, then the table owner restricts references to two columns:

```
GRANT REFERENCES (fname, lname, company, city) ON customer TO mary;  
REVOKE REFERENCES ON customer FROM mary;  
GRANT REFERENCES (company, city) ON customer TO mary;
```

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Effect of the ALL Keyword

The ALL keyword revokes all table-level privileges. If any or all of the table-level privileges do not exist for the revokee, REVOKE with the ALL keyword executes successfully but returns the following **SQLSTATE** code:

```
01006--Privilege not revoked
```

For example, assume that user **hal** has the Select and Insert privileges on the **customer** table. User **jocelyn** wants to revoke all table-level privileges from user **hal**. So user **jocelyn** issues the following REVOKE statement:

```
REVOKE ALL ON customer FROM hal;
```

This statement executes successfully but returns **SQLSTATE** code 01006. The **SQLSTATE** warning is returned because both of the following are true:

- The statement succeeds in revoking the Select and Insert privileges from user **hal** because user **hal** had those privileges.
- **SQLSTATE** code 01006 is returned because user **hal** lacked other privileges implied by the ALL keyword, but these privileges were not revoked.

The ALL keyword instructs the database server to revoke everything possible, including nothing. If the user from whom privileges are revoked has no privileges on the table, the REVOKE ALL statement still succeeds, because it revokes everything possible from the user (in this case, no privileges at all).

- [Effect of the ALL Keyword on UNDER Privilege](#)

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Effect of the ALL Keyword on UNDER Privilege

If you revoke ALL privileges on a typed table, the Under privilege is included in the privileges that are revoked. If you revoke ALL privileges on a table that is not based on a ROW type, the Under privilege is not included among the privileges that are revoked. (The Under privilege can be granted only on a typed table.)

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Effect of Uncommitted Transactions

The REVOKE statement places an exclusive row lock on the entry in the **systables** system catalog table for the table on which privileges are revoked. This lock is not released until the transaction that contains the REVOKE statement terminates. When another transaction attempts to prepare a SELECT statement against this table while the first transaction is open, the concurrent transaction fails, because the **systables** row for the specified table remains exclusively locked. The attempt to prepare the SELECT statement cannot succeed until after the first transaction is either committed or rolled back.

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Type-Level Privileges

You can revoke two privileges on data types:

- The Usage privilege on a user-defined data type
- The Under privilege on a named ROW type

Type-Level Privileges

```
|---+--USAGE ON TYPE--type_name--+-----|
|'-UNDER ON TYPE--row_type--'|
```

Element	Description	Restrictions	Syntax
<i>row_type</i>	Named ROW type for which to revoke Under privilege	Must exist	Data Type, p. Data Type
<i>type_name</i>	User-defined type for which to revoke Usage privilege	Must exist	Data Type, p. Data Type

- [Usage Privilege](#)
- [Under Privilege](#)

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Usage Privilege

Any user can reference a built-in data type in an SQL statement, but not a DISTINCT data type that is based on a built-in data type. The creator of a user-defined data type or a DBA must explicitly grant the Usage privilege on the UDT, including a DISTINCT data type based on a built-in data type.

REVOKE with the USAGE ON TYPE keywords removes the Usage privilege that you granted earlier to another user, to PUBLIC, or to a role.

The following statement revokes from user **mark** the privilege of using the **widget** user-defined type:

```
REVOKE USAGE ON TYPE widget FROM mark;
```

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Under Privilege

You own any named ROW data type that you create. If you want other users to be able to create subtypes under this named ROW type, you must grant these users the Under privilege on your named ROW type. If you later want to remove the ability of these users to create subtypes under the named ROW type, you must revoke the Under privilege from these users. A REVOKE statement with the UNDER ON TYPE keywords removes the Under privilege that you granted earlier to these users.

For example, suppose that you created a ROW type named **rtype1**:

```
CREATE ROW TYPE rtype1 (cola INT, colb INT);
```

If you want another user named **kathy** to be able to create a subtype under this named ROW type, you must grant the Under privilege on this named ROW type to user **kathy**:

```
GRANT UNDER ON TYPE rtype1 TO kathy;
```

Now user **kathy** can create another ROW type under the **rtype1** ROW type even though **kathy** is not the owner of the **rtype1** ROW type:

```
CREATE ROW TYPE rtype2 (colc INT, cold INT) UNDER rtype1;
```

If you later want to remove the ability of user **kathy** to create subtypes under the **rtype1** ROW type, enter the following statement:

```
REVOKE UNDER ON TYPE rtype1 FROM kathy;
```

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Routine-Level Privileges

If you revoke the Execute privilege on a UDR from a user, that user can no longer execute that UDR in any way. For details of how a user can execute a UDR, see [Routine-Level Privileges](#).

Routine-Level Privileges

```
|---EXECUTE ON----->

>--+--SPL_routine-----+--+
| +-+PROCEDURE--+--routine--(-+-----+--+)+--+
| | +-FUNCTION--+--| (1) | | |
| | '-ROUTINE---' | '-| Routine Parameter List |-----' |
| | | (2) | |
```

```
'-SPECIFIC---ROUTINE-----| Specific Name |-----'
+-FUNCTION--+
'-PROCEDURE-'
```

Notes:

1. See [Routine Parameter List](#)
2. See [Specific Name](#)

Element	Description	Restrictions	Syntax
<i>routine</i>	A user-defined routine	Must exist	Identifier
<i>SPL_routine</i>	An SPL routine	Must be unique in the database	Identifier

In an ANSI-compliant database, the *owner* name must qualify the *routine* name, unless the user who issues the REVOKE statement is the owner of the routine.

The following example cancels the Execute privilege of user **mark** on the **delete_order** routine that is owned by **luke**:

```
REVOKE EXECUTE ON ROUTINE luke.delete_order FROM mark;
```

In Informix®, any negator function for which you grant the Execute privilege requires a separate, explicit, REVOKE statement.

When you create a UDR under any of the following circumstances, PUBLIC is not granted Execute privilege by default. Therefore you must explicitly grant the Execute privilege before you can revoke it:

- You create the UDR in an ANSI-compliant database.
- You have DBA privilege and specify DBA after the CREATE keyword to restrict the Execute privilege to users with the DBA database-level privilege.
- The **NODEFDAC** environment variable is set to *yes* to prevent the PUBLIC group from receiving any access privileges by default that are not explicitly granted.

Setting **NODEFDAC** to *yes* also prevents PUBLIC from receiving table access privileges by default when a new table is created in a database that was not created as mode ANSI. The **NODEFDAC** setting, however, cannot prevent the PUBLIC group from being granted the same privileges by a user who holds the necessary access privileges on the new UDR or on the new table.

If you create a UDR with none of the above conditions in effect, however, PUBLIC can execute your UDR without the GRANT EXECUTE statement. To limit who can execute your UDR, revoke Execute privilege FROM PUBLIC, and grant it to users (see [User List](#)) or roles (see [Role Name](#)).

In Informix, if two or more UDRs have the same name, use a keyword from this list to specify which of those UDRs a user list can no longer execute.

Keyword

UDR for Which Execution by the User is Prevented

SPECIFIC

The UDR identified by *specific name*

FUNCTION

Any function with the specified *routine name* (and parameter types that match *routine parameter list*, if specified)

PROCEDURE

Any procedure with the specified *routine name* (and parameter types that match *routine parameter list*, if specified)

ROUTINE

Functions or procedures with the specified *routine name* (and parameter types that match *routine parameter list*, if specified)

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Language-Level Privileges

To register or drop a UDR written in the SPL, C, or Java™ languages, a user must hold the Usage privilege on the programming language in which the routine is written.

This is the syntax of the USAGE ON LANGUAGE clause for specifying a language-level privilege to revoke:

Language-Level Privileges

```
|--USAGE ON LANGUAGE---SPL---|
+-C-----+
'-JAVA-'
```

Each REVOKE USAGE ON LANGUAGE statement can specify no more than one programming language.

When a user registers a UDR that is written in the SPL, C, or Java language, the database server verifies that the user has the Usage privilege on the language in which the UDR is written. If the user does not, the CREATE FUNCTION or CREATE PROCEDURE statement fails with an error. If the IFX_EXTEND_ROLE configuration parameter has enabled the built-in EXTEND role, only users who also hold that role can register or drop UDRs written in the C language or in the Java language, even if the users hold USAGE ON LANGUAGE privileges for those languages.

To revoke the Usage privilege on a programming language from a user or role, issue a REVOKE statement that includes the USAGE ON LANGUAGE keywords and a keyword that specifies the programming language. If this statement succeeds, any user or role that you specify in the FROM clause can no longer register UDRs that are written in the specified language. For example, if you revoke the default Usage privilege on SPL from PUBLIC, the ability to create SPL routines is taken away from all users (except those who have been individually granted the Usage privilege on the SPL language, or who hold that Usage privilege through a role:

```
REVOKE USAGE ON LANGUAGE SPL FROM PUBLIC;
```

You can issue a GRANT USAGE ON LANGUAGE statement to restore Usage privilege on SPL to a restricted group, such as to the role named **developers**:

```
GRANT USAGE ON LANGUAGE SPL TO developers;
```

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Sequence-Level Privileges

Although Informix® implements sequence objects as tables, only the following subset of the table privileges (as described in [Table-Level Privileges](#)) can be granted or revoked on a sequence:

- Select privilege
- Alter privilege

Use the following syntax to specify privileges to revoke on a sequence object:

Sequence-Level Privileges

```
|---+ALL-----+--ON--+-----+--+sequence+-----|
| .,-----, |      '- 'owner.' -' '- 'synonym--'
| V          | |
|---+ALTER--+--+
|---SELECT---
```

Element	Description	Restrictions	Syntax
<i>owner</i>	Owner of the sequence or of its synonym	Must be the owner	Owner name
<i>sequence</i>	Sequence on which to revoke privileges	Must exist	Identifier
<i>synonym</i>	Synonym for a sequence object	Must point to a sequence	Identifier

The sequence must reside in the current database. (You can qualify the *sequence* or *synonym* identifier with a valid *owner* name, but the name of a remote *database* (or *database@server*) is not valid as a qualifier.) Syntax to revoke sequence-level privileges is an extension to the ANSI/ISO standard for SQL.

- [Alter Privilege](#)
- [Select Privilege](#)
- [ALL Keyword](#)

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Alter Privilege

You can revoke the Alter privilege on a sequence from another user, from PUBLIC, or from a role. The Alter privilege enables a specified user or role to modify the definition of a sequence with the ALTER SEQUENCE statement or to rename the sequence with the RENAME SEQUENCE statement.

The following REVOKE statement cancels any Alter privilege that was granted individually to user **mark** on the **cust_seq** sequence object:

```
REVOKE ALTER ON cust_seq FROM mark;
```

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Select Privilege

You can revoke the Select privilege on a sequence from another user, from PUBLIC, or from a role. Select privilege enables a user or role to use the *sequence.CURRVAL* and *sequence.NEXTVAL* in SQL statements to access and to increment the value of a sequence.

The following REVOKE statement cancels any Select privilege that was granted individually to user **mark** on the **cust_seq** sequence object:

```
REVOKE SELECT ON cust_seq FROM mark;
```

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ALL Keyword

You can use the ALL keyword to revoke both Alter and Select privileges from another user, from PUBLIC, or from a role.

The following example cancels any Alter and Select privileges that user **mark** holds on the **cust_seq** sequence object:

```
REVOKE ALL ON cust_seq FROM mark;
```


Whether **mark** can still access **cust_seq** after this statement executes depends on whether the user still holds Alter or Select privileges on **cust_seq** that were granted to PUBLIC, or if he holds a role to which unrevoked privileges on **cust_seq** have been granted.

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User List

The authorization identifiers (or the PUBLIC keyword) that follow the FROM keyword of REVOKE specify who loses the revoked privileges or revoked roles. If you use the PUBLIC keyword as the user list, the REVOKE statement revokes the specified privileges or roles from PUBLIC, thereby revoking them from all users to whom the privileges or roles have not been explicitly granted, or who do not hold some other role through which they have received the role or privilege.

The *user list* can consist of the authorization identifier of a single user or of multiple users, separated by commas. If you use the PUBLIC keyword as the user list, the REVOKE statement revokes the specified privileges from all users.

User List

```
|---+PUBLIC-----+-----|
| .,----- . |
| V          | |
|---+user---+---+
|-'user'-|
```

Element	Description	Restrictions	Syntax
<i>user</i>	Login name of a user whose privilege or role you are revoking	Must be a valid authorization identifier	Owner name

Spell the user names in the list exactly as they were spelled in the GRANT statement. You can optionally use quotation marks around each user name in the list to preserve the lettercase. In an ANSI-compliant database, if you do not use quotation marks to delimit *user*, the name of the user is stored in uppercase letters unless the **ANSIOWNER** environment variable was set to 1 before the database server was initialized.

When you specify login names, you can use the REVOKE statement and the GRANT statement to secure various types of database objects selectively. For examples, see [When to Use REVOKE Before GRANT](#).

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Role Name

Only the DBA or a user who was granted a role WITH GRANT OPTION can revoke a role or its privileges. Users cannot revoke roles from themselves.

Role Name

```
|---+ 'role'---+-----|
|-'role---|
```

Element	Description	Restrictions	Syntax
<i>role</i>	A role with one of these attributes: <ul style="list-style-type: none">• Loses an existing privilege or role• Is lost by a user or by another role	Must exist. If enclosed between quotation marks, <i>role</i> is case sensitive.	Owner name

Immediately after the REVOKE keyword, the name of a *role* specifies a role to be revoked from the user list. After the FROM keyword, however, the name of a *role* specifies a role from which access privilege (or another role) is to be revoked. The same FROM clause can include both *user* and *role* names if no other REVOKE options conflict with the *user* or *role* specifications. Syntax to revoke privileges on a role or from a role are extensions to the ANSI/ISO standard for SQL.

When you include a *role* after the FROM keyword of the REVOKE statement, the specified privilege (or another role) is revoked from that role, but users who have that role retain any privileges or roles that were granted to them individually.

If you enclose *role* between quotation marks, the name is case sensitive and is stored exactly as you typed it. In an ANSI-compliant database, if you do not use quotation marks as delimiters, the *role* is stored in uppercase letters.

When you revoke a role that was granted to a user with the WITH GRANT OPTION keywords, you revoke both the role and the option to grant it.

The following examples show the effects of REVOKE *role*:

- Remove users or remove another role from inclusion in the specified role:

```
REVOKE accounting FROM mary;
REVOKE payroll FROM accounting;
```

- Remove one or more access privileges from a role:

```
REVOKE UPDATE ON employee FROM accounting;
```

When you revoke table-level privileges from a role, you cannot include the RESTRICT or CASCADE keywords.

- [Revoking a Default Role](#)
- [Revoking the EXTEND Role](#)

The REVOKE EXTEND FROM *user-list* statement cancels the EXTEND role of the specified users. In databases where the IFX_EXTEND_ROLE configuration parameter is enabled, revoking this role prevents the specified users from creating or dropping external UDRs. Whether or not a user holds the EXTEND role has no effect on creating or dropping UDRs written in the SPL language.

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Revoking a Default Role

The DBA or the owner of the database can define a *default role* for one or more users or for PUBLIC with the GRANT DEFAULT ROLE statement. Unlike a non-default role, which does not take effect until the SET ROLE statement activates the role, a default role takes effect automatically when the user connects to the database. The default role can specify a set of access privileges for all the users who are granted that default role. Conversely, the REVOKE DEFAULT ROLE statement cancels the current default role as the default role for the specified *user-list*, as in the following program fragment:

```
CREATE ROLE accounting;
GRANT USAGE ON LANGUAGE SPL TO accounting;
GRANT ALL PRIVILEGES ON receivables TO accounting;
GRANT DEFAULT ROLE accounting TO mary;
. . .
REVOKE DEFAULT ROLE FROM mary;
```

The last statement removes from user **mary** any access privileges that she holds only through her default role. In this example, the default role was **accounting**, but because at a given point in time there can be only one default role for an individual user (or for the PUBLIC group), the name of the default role is not specified in the REVOKE DEFAULT ROLE statement. If **mary** issues the SET ROLE DEFAULT statement, it has no effect until she is granted some new default role.

After you execute REVOKE DEFAULT ROLE specifying one or more users or PUBLIC, any privileges that those users held only through the default role are cancelled. (But this statement does not revoke any privileges that were granted to a user individually, or privileges that were granted to a user through another role, or privileges that PUBLIC holds.)

After REVOKE DEFAULT ROLE successfully cancels the default role of *user*, the default role of *user* becomes NULL, and the default role information is removed from the system catalog. (In this context, NULL and NONE are synonyms.)

No warning is issued if REVOKE DEFAULT ROLE specifies a user who has not been granted a default role.

No options besides the *user-list* are valid after the FROM keyword in the REVOKE DEFAULT ROLE statement.

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Revoking the EXTEND Role

The REVOKE EXTEND FROM *user-list* statement cancels the EXTEND role of the specified users. In databases where the IFX_EXTEND_ROLE configuration parameter is enabled, revoking this role prevents the specified users from creating or dropping external UDRs. Whether or not a user holds the EXTEND role has no effect on creating or dropping UDRs written in the SPL language.

Only the Database Server Administrator (DBSA), by default user **informix**, can grant the built-in EXTEND role to one or more users or to PUBLIC by issuing the GRANT EXTEND TO *user-list* statement. (Because EXTEND is a built-in role, a user who holds it does not need to activate it with the SET ROLE statement, and the DROP ROLE statement cannot destroy the EXTEND role.)

If the IFX_EXTEND_ROLE configuration parameter is set to ON or to 1, users who do not hold the EXTEND role cannot create or drop UDRs that are written in the C or Java™ languages, both of which support shared libraries. The following example revokes the EXTEND role from user **max**:

```
REVOKE EXTEND FROM 'max' ;
```

This prevents user **max** from creating or dropping external UDRs, even if **max** is the owner of a UDR that he subsequently attempts to drop.

In databases for which this security feature is not needed, the DBSA can disable this restriction on who can create or drop external UDRs by setting the IFX_EXTEND_ROLE parameter to OFF or to 0 in the ONCONFIG file. But whether IFX_EXTEND_ROLE is enabled or disabled, users who create or drop external UDRs must also hold the following access privileges:

- Either the Resource privilege or the DBA privilege on the database in which the UDR is registered.
- The Usage privilege on the external programming language in which the UDR is written,

See [Database-level privileges](#) for information about the Resource privilege. See [Language-Level Privileges](#) for the syntax of the GRANT USAGE ON LANGUAGE C and the GRANT USAGE ON LANGUAGE JAVA statements of SQL.

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Revoking privileges granted WITH GRANT OPTION

If you revoke from *user* privileges or a role that you granted using the WITH GRANT OPTION keywords, you sever the chain of privileges granted by that *user*.

Thus, when you revoke privileges from users or from a role, you also revoke the same privilege resulting from GRANT statements in the following contexts:

- Issued by your grantee
- Allowed because your grantee specified the WITH GRANT OPTION clause
- Allowed because subsequent grantees granted the same privilege or role using the WITH GRANT OPTION clause

The WITH GRANT OPTION clause is only valid in GRANT statements that assign privileges to specific users. The grantee cannot be the PUBLIC group or a role.

The following examples show the revocation of privileges. Suppose you, as the owner of the table **items**, issue the following statements to grant access privileges to user **mary**:

```
REVOKE ALL ON items FROM PUBLIC;  
GRANT SELECT, UPDATE ON items TO mary WITH GRANT OPTION;
```

User **mary** then uses her new privilege to grant users **cathy** and **paul** access to the **items** table:

```
GRANT SELECT, UPDATE ON items TO cathy;  
GRANT SELECT ON items TO paul;
```

Later you revoke privileges on the **items** table from user **mary**:

```
REVOKE SELECT, UPDATE ON items FROM mary;
```

This single statement effectively revokes all privileges on the **items** table from users **mary**, **cathy**, and **paul**.

The CASCADE keyword has the same effect as this default condition.

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The AS Clause

Without the AS clause, the user who executes the REVOKE statement must be the grantor of the privilege that is being revoked. The DBA or the owner of the object can use the AS clause to specify another user (who must be the grantor of the privilege) as the revoker of the privileges.

For example, if user **falstaff** is the owner of table **CONS_table**, and has granted

The AS clause provides the only mechanism by which discretionary access privileges can be revoked on a database object whose *owner* is an authorization identifier, such as **informix**, that is not also a valid user account known to the operating system.

For contexts where the AS *revoker* clause is required, rather than optional, see [Revoking the Execute privilege from PUBLIC](#).

- [Effect of CASCADE Keyword on UNDER Privileges](#)

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Effect of CASCADE Keyword on UNDER Privileges

If you revoke the Under privilege on a typed table with the CASCADE option, the Under privilege is removed from the specified user, and any subtables created under the typed table by that user are dropped from the database.

If you revoke the Under privilege on a named ROW type with the CASCADE option when that data type is in use, the REVOKE fails. This exception to the default behavior of the CASCADE option occurs because the database server supports the DROP ROW TYPE statement with the RESTRICT keyword only.

For example, assume that user **jeff** creates a ROW type named **rtype1** and grants the Under privilege on that ROW type to user **mary**. User **mary** now creates a ROW type named **rtype2** under ROW type **rtype1** and grants the Under privilege on ROW type **rtype2** to user **andy**. Then user **andy** creates a ROW type named **rtype3** under ROW type **rtype2**.

If user **jeff** now tries to revoke the Under privilege on ROW type **rtype1** from user **mary** with the CASCADE option, the REVOKE statement fails, because ROW type **rtype2** is still in use by ROW type **rtype3**.

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Controlling the Scope of REVOKE with the RESTRICT Option

The RESTRICT keyword causes the REVOKE statement to fail when any of the following dependencies exist:

- A view depends on a Select privilege that you are attempting to revoke.
- A foreign-key constraint depends on a References privilege that you attempt to revoke.
- You attempt to revoke a privilege from a user who subsequently granted this privilege to another user or to a role.

REVOKE does not fail if it specifies a user who has the right to grant the privilege to others but has not exercised that right. For example, assume that user **clara** specifies WITH GRANT OPTION when she grants the Select privilege on the **customer** table to user **ted**. Further assume that user **ted**, in turn, grants the Select

privilege on the **customer** table to user **tania**. The following statement that **clara** issued has no effect, because **ted** has used his authority to grant the Select privilege:

```
REVOKE SELECT ON customer FROM ted RESTRICT;
```

In contrast, if user **ted** does not grant the Select privilege to **tania** or to any other user, the same REVOKE statement succeeds. Even if **ted** does grant the Select privilege to another user, either of the following statements succeeds:

```
REVOKE SELECT ON customer FROM ted CASCADE;  
REVOKE SELECT ON customer FROM ted;
```

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Security Administration Options

In conjunction with the GRANT statement, the REVOKE statement supports the discretionary access control (DAC) data security feature of Informix® by specifying which users or roles hold privileges that are required to access the database or objects within the database.

The Security Administration Options of the REVOKE statement, like their counterparts for the GRANT statement, support an additional set of data security features, called label-based access control (LBAC). These features enable Informix to allow or withhold access to protected data on the basis of a comparing a row security label or column security label that is contained in the data object to the user security label and other credentials that have been granted to the user who is seeking access.

Security Administration Options

```
          (1)  
|---+| DBSECADM Clause |-----+-----|  
|    |                |          |  
+---+ EXEMPTION Clause |-----+  
|    |                |          |  
+--- SECURITY LABEL Clause |-----+  
|    |                |          |  
+--- SETSESSIONAUTH Clause |-----+  
          (2)          (3)          (4)
```

Notes:

1. See [DBSECADM Clause](#)
2. See [EXEMPTION Clause](#)
3. See [SECURITY LABEL Clause](#)
4. See [SETSESSIONAUTH Clause](#)

Use of these REVOKE statement security administration options is restricted:

- Only the Database Server Administrator (DBSA), by default user **informix**, can use the REVOKE DBSECADM statement to revoke the DBSECADM role.
- Only a user who holds the DBSECADM role can issue the REVOKE EXEMPTION, REVOKE SECURITY LABEL, or REVOKE SETSESSIONAUTH statements.

- [DBSECADM Clause](#)
- [EXEMPTION Clause](#)
- [SECURITY LABEL Clause](#)
- [SETSESSIONAUTH Clause](#)

The REVOKE SETSESSIONAUTH statement revokes the SETSESSIONAUTH privilege from one or more users or roles. The SETSESSIONAUTH privilege allows users who also hold the DBA privilege to use the SET SESSION AUTHORIZATION statement to set the session authorization to one of a set of specified users.

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DBSECADM Clause

The REVOKE DBSECADM statement prevents the user to whom the DBSECADM role was granted from issuing DDL statements that can create, alter, rename, or drop security objects, including security policies, security labels, and security components.

DBSECADM Clause

```
          .-+-----+  
          |          |  
|--- DBSECADM FROM---+---user-+-----|  
          +-----+  
          '-USER-'
```

Element	Description	Restrictions	Syntax
<i>user</i>	User from whom the role is to be revoked	Must be the authorization identifier of a user	Owner name

The DBSECADM role is a built-in role that only the DBSA can revoke. Unlike user-defined roles, whose scope is the database in which the role is created, the scope of the DBSECADM role is all of the databases of the Informix® instance. It is not necessary for DBSA to reissue the REVOKE DBSECADM statement in other

databases of the same server.

Only a user who holds the DBSECADM role can issue the following SQL statements that create or modify security objects:

- ALTER SECURITY LABEL COMPONENT
- CREATE SECURITY LABEL
- CREATE SECURITY LABEL COMPONENT
- CREATE SECURITY POLICY
- DROP SECURITY LABEL
- DROP SECURITY LABEL COMPONENT
- DROP SECURITY POLICY
- RENAME SECURITY LABEL
- RENAME SECURITY LABEL COMPONENT
- RENAME SECURITY POLICY

Only a user who holds the DBSECADM role can use the following SQL statements to reference tables that are protected by a security policy:

- ALTER TABLE ... ADD SECURITY POLICY
- ALTER TABLE ... ADD ... IDSSECURITYLABEL [DEFAULT *label*]
- ALTER TABLE ... ADD ... [COLUMN] SECURED WITH
- ALTER TABLE ... DROP SECURITY POLICY
- ALTER TABLE ... MODIFY ... [COLUMN] SECURED WITH
- ALTER TABLE ... MODIFY ... DROP COLUMN SECURITY
- CREATE TABLE ... COLUMN SECURED WITH
- CREATE TABLE ... IDSSECURITYLABEL [DEFAULT *label*]
- CREATE TABLE ... SECURITY POLICY

The following GRANT and REVOKE statements also cannot be issued by a user who does not hold the DBSECADM role:

- GRANT EXEMPTION
- GRANT SECURITY LABEL
- GRANT SETSESSIONAUTH
- REVOKE EXEMPTION
- REVOKE SECURITY LABEL
- REVOKE SETSESSIONAUTH

The USER keyword that can follow the FROM keyword is optional, and has no effect, but any authorization identifier that the DBSA specifies in the REVOKE DBSECADM statement must be the identifier of an individual user, rather than the identifier of a role. The *user* cannot be the DBSA who issues this REVOKE DBSECADM statement.

In the following example, the DBSA cancels the DBSECADM role of user **niccolo**:

```
REVOKE DBSECADM FROM niccolo;
```

If this statement executes successfully, user **niccolo** can no longer perform the operations listed above. After the DBSECADM role is revoked, only the DBSA can grant it again to the user from whom it was revoked.

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EXEMPTION Clause

The REVOKE EXEMPTION statement modifies the security credentials of the specified user (or list of users) by enabling one or all of the rules of a specified security policy from which the user had been exempt.

EXEMPTION Clause

```
|--EXEMPTION ON RULE--++IDSLBACREADARRAY-----+----->
      +-IDSLBACREADTREE-----+
      +-IDSLBACREADSET-----+
      +-IDSLBACWRITEARRAY-----+
      |               +-WRITEDOWN--+ |
      |               '-WRITEUP---' |
      +-IDSLBACWRITESET-----+
      +-IDSLBACWRITETREE-----+
      '-ALL-----'
      .-,-,-----,
      V               |
>--FOR--policy--FROM--++user-+-----|
      '-USER-'
```

Element	Description	Restrictions	Syntax
<i>policy</i>	Security policy for which the exemption is revoked	Must exist in the database	Identifier
<i>user</i>	User to whom the exemption is to be revoked	Must be the authorization identifier of a user	Owner name

Only a user who holds the DBSECADM role can issue the REVOKE EXEMPTION statement.

- [Rules on Which Exemptions Are Revoked](#)
- [Security Policies and Grantees of Exemptions](#)

Related reference:

[RENAME SECURITY statement](#)

[DROP SECURITY statement](#)

[CREATE SECURITY LABEL statement](#)

[CREATE SECURITY LABEL COMPONENT statement](#)

[ALTER SECURITY LABEL COMPONENT statement](#)

[CREATE SECURITY POLICY statement](#)

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Rules on Which Exemptions Are Revoked

The keyword that follows the ON keyword specifies the predefined access rule of the security policy (whose identifier follows the FOR keyword) for which an exemption is cancelled. The access rule for which exemption is revoked applies when a table that is protected by the specified policy is accessed by a user from whom the exemption is revoked. For descriptions of the predefined rules for read access and for write access that are associated with a security policy, see the section [Rules Associated with a Security Policy](#).

The following keywords of the REVOKE EXEMPTION statement identify specific **IDSLBACRULES** rules that this statement can apply to formerly exempt users:

- **IDSLBACREADARRAY** applies to the user the **IDSLBACREADARRAY** rule for the specified security policy. For a user with no exemption, this rule requires that each array component of the user security label must be greater than or equal to the corresponding array component of the data row security label.
- **IDSLBACREADSET** applies to the user the **IDSLBACREADSET** rule for the specified security policy. For a user with no exemption, this rule requires that each set component of the user security label must include the set component of the data row security label.
- **IDSLBACREADTREE** applies to the user the **IDSLBACREADTREE** rule for the specified security policy. For a user with no exemption, this rule requires that each tree component of the user security label must include at least one of the elements in the tree component of the data row security label, or else an ancestor of one such element.
- **IDSLBACWRITEARRAY WRITEDOWN** exempts the user from one aspect of the **IDSLBACWRITEARRAY** rule for the specified security policy. The user who loses this exemption cannot write to a row protected by a label that includes an array component level below the level in the label of the user.
- **IDSLBACWRITEARRAY WRITEUP** exempts the user from one aspect of the **IDSLBACWRITEARRAY** rule for the specified security policy. The user who loses this exemption cannot write to a row protected by a label that includes an array component level above the level in the label of the user.
- **IDSLBACWRITEARRAY** (with no **WRITEDOWN** or **WRITEUP** keyword) applies to the user the **IDSLBACWRITEARRAY** rule for the specified security policy. The user who loses this exemption cannot write to a row whose array component level is above or below the level in the label of the user.
- **IDSLBACWRITESSET** applies to the user the **IDSLBACWRITESSET** rule for the specified security policy. For a user with no exemption, that rule requires that each set component of the user security label must include the set component of the data row security label.
- **IDSLBACWRITETREE** applies to the user the **IDSLBACWRITETREE** rule for the specified security policy. For a user with no exemption, that rule requires that each tree component of the user security label must include at least one of the elements in the tree component of the data row security label, or the ancestor of one such element.
- ALL revokes an exemption from all **IDSLBACRULES** rules for the specified security policy.

In the following example, DBSECADM revokes an exemption from all of the rules of the **MegaCorp** security policy from users **manoj** and **sam**:

```
REVOKE EXEMPTION ON RULE ALL FOR MegaCorp FROM manoj, sam;
```

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Security Policies and Grantees of Exemptions

An exemption applies only to the rules of a single security policy, whose name follows the FOR keyword. Because a protected table can have multiple security labels, but no more than one security policy, revocation of an exemption can prevent a user with insufficient security credentials from accessing data in tables that are protected by the specified security policy.

The REVOKE EXEMPTION statement fails with an error if the specified policy does not exist in the database.

The USER keyword that can follow the FROM keyword is optional, and has no effect, but any authorization identifier specified in the REVOKE EXEMPTION statement must be the identifier of an individual user, rather than the identifier of a role. This *user* cannot be the DBSECADM who issues the same REVOKE EXEMPTION statement.

In the following example, DBSECADM revokes an exemption from user **lynette** for rule **IDSLBACREADARRAY** of the **MegaCorp** security policy:

```
REVOKE EXEMPTION ON RULE IDSLBACREADARRAY FOR MegaCorp FROM lynette;
```

This exemption restores the read access rules for all array components for subsequent read operations that user **lynette** attempts on tables protected by security labels of the specified policy.

When the REVOKE EXEMPTION statement successfully cancels an exemption of a user, the database server updates the **syssecpolicyexemptions** table of the system catalog to unregister the revoked exemption (or multiple exemptions, if several users are listed after the FROM keyword).

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SECURITY LABEL Clause

The REVOKE SECURITY LABEL statement cancels a security label (or all the security labels of a specified security policy) held by one or more users.

SECURITY LABEL Clause

```
|-- SECURITY LABEL--policy--label+----->
      '- * --'

      .-
      V | .-FOR ALL ACCESS-----
>--FROM-----+user+-----+-----|
      '-USER-' | '-FOR READ ACCESS-' |
                +-----+
                '-FOR WRITE ACCESS-'
```

Element	Description	Restrictions	Syntax
<i>label</i>	Name of an existing security label	Must exist as a label for the specified security <i>policy</i>	Identifier
<i>policy</i>	The security policy of this <i>label</i>	Must already exist in the database	Identifier
<i>user</i>	User from whom the label is revoked	Must be the authorization identifier of a user	Owner name

Only a user who holds the DBSECADM role can issue the REVOKE SECURITY LABEL statement.

A security label is a database object that is always associated with a security policy. That policy defines the set of valid security components that make up the security label. The label stores a set of one or more values for each component of the security policy.

The DBSECADM can associate a security label with the following entities:

- A column of a database table, which a *column security label* can protect
- A row of a database table, which a *row security label* can protect
- A user, whose *user security label* (and any exemptions from rules of the security policy that have been granted to the user) are called the *security credentials* of the user.

When a user who holds a security label for a specific security policy attempts to access a row that is protected by a row security label of the same security policy, the database server compares the sets of values in the user security label and in the row security label in determining whether or not the user should be allowed to access the data. Similarly, LBAC takes into account the user security label and the column security label in determining whether or not the credentials of the user should be allowed to access a protected column.

The GRANT SECURITY LABEL and REVOKE SECURITY LABEL statements enable DBSECADM to control the association of a user with a label. (Data values in a protected table are associated with a row security label or with a column security label by options to the CREATE TABLE or ALTER TABLE statements that only DBSECADM can execute, rather than by the GRANT SECURITY LABEL statement.)

Immediately following the LABEL keyword, the asterisk (***) symbol in the *policy.** specification instructs the database server to revoke every security label of the *policy*. If instead of an asterisk you specify *policy.label*, that *label* must be the name of a security label of the specified *policy*. In this case, if the statement is successful, only that security label is revoked from the user list.

The USER keyword that can follow the FROM keyword is optional, but any authorization identifier specified in the REVOKE SECURITY LABEL statement must be the identifier of an individual user, rather than the identifier of a role.

- [Access Specifications](#)
- [Examples of Revoking User Security Labels](#)

Related reference:

[RENAME SECURITY statement](#)

[DROP SECURITY statement](#)

[CREATE SECURITY LABEL statement](#)

[CREATE SECURITY LABEL COMPONENT statement](#)

[ALTER SECURITY LABEL COMPONENT statement](#)

[CREATE SECURITY POLICY statement](#)

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Access Specifications

The list of users from whom the security label is revoked can optionally be followed by keywords that specify the type of access to data that the security policy of the label protects

- FOR WRITE ACCESS
These keywords restrict the label to the write access rules of **IDSLBACRULES**, namely **IDSLBACWRITEARRAY**, **IDSLBACWRITASET**, and **IDSLBACWRITETREE**.
- FOR READ ACCESS
These keywords restrict the label to the read access rules of **IDSLBACRULES**, namely **IDSLBACWREADARRAY**, **IDSLBACREADSET**, and **IDSLBACREADTREE**.
- FOR ALL ACCESS

These keywords apply the label to all of the read and write access rules that are listed above. If the REVOKE SECURITY LABEL statement includes no FOR ... ACCESS specification, this option takes effect as the default.

For more information about these **IDSLBACRULES** rules for label-based read and write access, see [Rules Associated with a Security Policy](#). For information about exemptions to these rules that can be granted for a specific security policy, see [Rules on Which Exemptions Are Revoked](#).

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Examples of Revoking User Security Labels

The following three statements create three security label components called **level**, **compartments**, and **groups** respectively:

```
CREATE SECURITY LABEL COMPONENT
  level ARRAY ['TS','S','C','U'];

CREATE SECURITY LABEL COMPONENT
  compartments SET {'A','B','C','D'};

CREATE SECURITY LABEL COMPONENT
  groups TREE ('G1' ROOT,
              'G2' UNDER ROOT,
              'G3' UNDER ROOT);
```

The following statement creates a security policy called **secPolicy** based on the three components above:

```
CREATE SECURITY POLICY secPolicy COMPONENTS
  level, compartments, groups;
```

The following statement creates a security label called **secLabel1**:

```
CREATE SECURITY LABEL secPolicy.secLabel1
  COMPONENT level 'S',
  COMPONENT compartments 'A', 'B',
  COMPONENT groups 'G2';
```

The following statement grants this security label for read access to user **sam**:

```
GRANT SECURITY LABEL secPolicy.secLabel1
  TO sam FOR READ ACCESS;
```

The following statement revokes the security label for read access from user **sam**.

```
REVOKE SECURITY LABEL secPolicy.secLabel1
  FROM sam FOR READ ACCESS;
```

When the REVOKE SECURITY LABEL statement successfully cancels a security label that was held by a user, the database server updates the **sysseclabelauth** table of the system catalog to remove the user from the list of those who hold that security label.

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SETSESSIONAUTH Clause

The REVOKE SETSESSIONAUTH statement revokes the SETSESSIONAUTH privilege from one or more users or roles. The SETSESSIONAUTH privilege allows users who also hold the DBA privilege to use the SET SESSION AUTHORIZATION statement to set the session authorization to one of a set of specified users.

Syntax

SETSESSIONAUTH Clause

```
|-- SETSESSIONAUTH ON--+- PUBLIC-----+----->
                        | .,-----+-----+-----+
                        | V,-----+-----+-----+
                        | '-----+-----+-----+
                        | '-USER-'  '-"--user--"'
                        |
                        | .,-----+-----+-----+
                        | V,-----+-----+-----+
>-- FROM--+-+-----+-----+-----+-----+-----+
           | '-USER-'  '-"--user--"'
           | '-+-----+-----+-----+-----+-----+
           | '-ROLE-'  '-"--role--"'
```

Element	Description	Restrictions	Syntax
<i>role</i>	Role from which the privilege is to be revoked	Must be the authorization identifier of a role	Owner name

Element	Description	Restrictions	Syntax
<i>user</i>	After the FROM keyword, a user from whom the privilege is to be revoked. After the ON keyword, a user whose identity the grantee can specify in the SET AUTHORIZATION statement.	Must be the authorization identifier of a user	Owner name

Only a user who holds the DBSECADM role can revoke the SETSESSIONAUTH privilege.

The user or PUBLIC specification that follows the ON keyword specifies whose identity the grantee of the SETSESSIONAUTH privilege is no longer able to assume while using the SET SESSION AUTHORIZATION statement. This can be a user or PUBLIC, but not a role. If PUBLIC is specified, then the grantee of the privilege no longer has the ability to assume the identity of an arbitrary database user.

The USER and ROLE keywords that can follow the FROM keyword are optional. Neither the *user* nor the *role* can be the holder of the DBSECADM role who issues the REVOKE SETSESSIONAUTH statement. The FROM clause cannot specify PUBLIC.

Examples of the REVOKE SETSESSIONAUTH statement

Suppose that GRANT SETSESSIONAUTH statements issued by a user who holds the DBSECADM role had made the following assignments of the SETSESSIONAUTH privilege in the current database:

```
GRANT SETSESSIONAUTH ON lynette, manoj TO sam;
GRANT SETSESSIONAUTH ON PUBLIC TO lynette;
```

- The first example above enables user **sam** to set the session authorization to users **lynette** and **manoj**.
- The second example enables user **lynette** to set the session authorization to the PUBLIC group, or to set it to the authorization identifier of any user (but not to any role).

Both the SETSESSIONAUTH privilege and the DBA privilege are required to execute the SET AUTHORIZATION statement.

If user **sam** holds the DNA and SETSESSIONAUTH privileges, he could issue the following statement:

```
SET SESSION AUTHORIZATION TO 'lynette';
```

Now **sam** has assumed the identity of user **lynette**, including the discretionary access control (DAC) and label-based access control (LBAC) credentials of user **lynette**. User **sam** can also use this SET SESSION AUTHORIZATION statement in an API that supports Informix® trusted contexts to switch the user ID on a trusted connection. Because a previous example enabled user **lynette** to set the session authorization to any user, that is now a capability of **sam** during this session, where **sam** has assumed the identity of **lynette**.

The following example, however, revokes from user **sam** the ability to set the session authorization to users **lynette** and **manoj**:

```
REVOKE SETSESSIONAUTH ON lynette, manoj FROM sam;
```

Now the previous SET SESSION AUTHORIZATION example would fail, because this REVOKE SETSESSIONAUTH statement excludes **lynette** and **manoj** from the authorization identifiers that user **sam** can assume.

The next example revokes from user **lynette** the ability to set the session authorization to PUBLIC:

```
REVOKE SETSESSIONAUTH ON PUBLIC FROM USER lynette;
```

The PUBLIC scope of the SETSESSIONAUTH privilege that this example revokes had enabled user **lynette** (and user **sam** under the login name of **lynette** in the previous SET SESSION AUTHORIZATION example) to assume the access privileges and security credentials of any user specified by **lynette** in the SET SESSION AUTHORIZATION statement.

Delimiting user and role identifiers

If you enclose *user* or *role* in double (") or single (') quotation marks, the identifier is case sensitive, and the database server stores it in the system catalog exactly as you enter it in the REVOKE statement. The following REVOKE statement has the same effect as the previous example for user **lynette** whose authorization identifier includes no uppercase characters:

```
REVOKE SETSESSIONAUTH ON PUBLIC FROM USER "lynette";
```

Suppose that another user also holds the SETSESSIONAUTH privilege on the PUBLIC group, and that her authorization identifier is **Lynette**, with an initial uppercase character. Because her authorization identifier does not match the case sensitive FROM USER "lynette" specification, this example has no effect on her SETSESSIONAUTH privilege on the identifier of any user in the PUBLIC group. The undelimited FROM lynette previous example, however, revokes SETSESSIONAUTH from both **lynette** and **Lynette**.

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REVOKE FRAGMENT statement

Use the REVOKE FRAGMENT statement to revoke from one or more users or roles the Insert, Update, or Delete fragment-level privileges that were granted on individual fragments of a table that has been fragmented by expression. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```

(1)
>>-REVOKE FRAGMENT--| Fragment-Level Privileges |----->
>-ON--table--+-----+--FROM----->
      |      .-,-----      |

```


When you include a *role* in the FROM clause of REVOKE FRAGMENT, the specified fragment privilege is revoked from that role. Users who have that role, however, retain any fragment privileges they hold that were granted to them individually or to PUBLIC.

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Fragment-Level Privileges

The keyword or keywords that follow the FRAGMENT keyword specify *fragment-level privileges*, which are a logical subset of table-level privileges:

Fragment-Level Privileges

```
|---+--ALL-----+-----|
| | | | |
| | V | |
|---+--INSERT---+---|
|---+--DELETE---+---|
|---+--UPDATE---+---|
```

You can revoke fragment-level privileges individually or in combination. The following keywords specify the fragment-level privileges that you can revoke.

Keyword

Effect

INSERT

Prevents the user from inserting rows in the fragment

DELETE

Prevents the user from deleting rows in the fragment

UPDATE

Prevents the user from updating rows in the fragment

ALL

Cancels Insert, Delete, and Update privileges on a fragment

If you specify the ALL keyword in a REVOKE FRAGMENT statement, the specified users and roles lose all fragment-level privileges that they currently possess on the specified fragments. For example, assume that a user currently has the Update privilege on one fragment of a table. If you use the ALL keyword to revoke all current privileges on this fragment from this user, the user loses the Update privilege that he or she had on this fragment.

For the distinction between fragment-level and table-level privileges, see the sections [Definition of Fragment-Level Authorization](#) and [Effect of Fragment-Level Authorization in Statement Validation](#).

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The AS Clause

Without the AS clause, the user who executes the REVOKE statement must be a grantor of the privilege that is being revoked. The DBA or the owner of the fragment can use the AS clause to specify another user (who must be the grantor of the privilege) as the revoker of privileges on a fragment.

The AS clause provides the only mechanism by which privileges can be revoked on a fragment whose *owner* is an authorization identifier that is not a valid user account known to the operating system.

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Examples of the REVOKE FRAGMENT Statement

Examples that follow are based on the **customer** table. They all assume that the **customer** table is fragmented by expression into three fragments named **part1**, **part2**, and **part3**.

- [Revoking Privileges on One Fragment](#)
- [Revoking Privileges on More Than One Fragment](#)
- [Revoking Privileges from More Than One User](#)
- [Revoking Privileges Without Specifying Fragments](#)

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Revoking Privileges on One Fragment

The following statement revokes the Update privilege on the fragment of the **customer** table in **part1** from user **ed**:

```
REVOKE FRAGMENT UPDATE ON customer (part1) FROM ed;
```

The following statement revokes the Update and Insert privileges on the fragment of the **customer** table in **part1** from user **susan**:

```
REVOKE FRAGMENT UPDATE, INSERT ON customer (part1) FROM susan;
```

The following statement revokes all privileges currently granted to user **harry** on the fragment of the **customer** table in **part1**:

```
REVOKE FRAGMENT ALL ON customer (part1) FROM harry;
```

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Revoking Privileges on More Than One Fragment

The following statement revokes all privileges currently granted to user **millie** on the fragments of the **customer** table in **part1** and **part2**:

```
REVOKE FRAGMENT ALL ON customer (part1, part2) FROM millie;
```

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Revoking Privileges from More Than One User

The following statement revokes all privileges currently granted to users **jerome** and **hilda** on the fragment of the **customer** table in **part3**:

```
REVOKE FRAGMENT ALL ON customer (part3) FROM jerome, hilda;
```

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Revoking Privileges Without Specifying Fragments

The following statement revokes all current privileges from user **mel** on all fragments for which this user currently has privileges:

```
REVOKE FRAGMENT ALL ON customer FROM mel;
```

Related Statements

Related statements: [GRANT FRAGMENT statement](#) and [REVOKE statement](#)

For a discussion of fragment-level and table-level privileges, see the section [Fragment-Level Privileges](#). See also the *IBM® Informix® Database Design and Implementation Guide*.

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ROLLBACK WORK statement

Use the ROLLBACK WORK statement to cancel all or part of the current transaction intentionally, undoing any changes that occurred since the beginning of the transaction, or between the ROLLBACK WORK statement and a specified or default savepoint.

Syntax

```
.-WORK-.
>>-ROLLBACK--+-+-----+-----><
               '-TO SAVEPOINT--+-+-----+-'
               '-savepoint--'
```

Element	Description	Restrictions	Syntax
<i>savepoint</i>	Name of the savepoint that delimits the scope of the rollback	Must exist in the current transaction.	Identifier

Usage

The ROLLBACK WORK statement is valid only in databases that support transaction logging. Only logged operations can be rolled back. Use ROLLBACK WORK only at the end of a multistatement operation.

The ROLLBACK WORK statement restores the database to its state that existed before the cancelled portion of the transaction began.

In a database that is not ANSI-compliant, the `BEGIN WORK` statement starts a transaction. You can end a transaction with the `COMMIT WORK` statement or cancel all or part of the transaction with the `ROLLBACK WORK` statement. If you issue the `ROLLBACK WORK` statement when no transaction is pending in a database that is not ANSI-compliant, Informix® issues an error.

In an ANSI-compliant database, multistatement transactions are implicit. You do not need to mark the beginning of a transaction with the `BEGIN WORK` statement. You only need to mark the end of each transaction with a `COMMIT WORK` statement or cancel the transaction with a `ROLLBACK WORK` statement. If you issue the `ROLLBACK WORK` statement when no transaction is pending, the statement is accepted but has no effect.

The `ROLLBACK WORK` statement restores the database to the state that existed before the cancelled portion of the transaction began. Unless you include the `TO SAVEPOINT` keywords, `ROLLBACK WORK` cancels the entire transaction.

The `ROLLBACK WORK` statement releases all row and table locks that the cancelled transaction holds.

In Informix ESQL/C and SPL, the `ROLLBACK WORK` statement closes all open cursors except those that are declared as *hold cursors* by including the `WITH HOLD` keywords. Hold cursors remain open after a transaction is committed or rolled back.

If you use the `ROLLBACK WORK` statement within an SPL routine that the `WHENEVER` statement calls, specify `WHENEVER SQLERROR CONTINUE` and `WHENEVER SQLWARNING CONTINUE` before the `ROLLBACK WORK` statement. This step prevents the program from looping if the `ROLLBACK WORK` statement encounters an error or a warning.

If a program terminates abnormally, the current transaction is implicitly rolled back.

- [WORK Keyword](#)
- [TO SAVEPOINT Clause](#)

Related reference:

[COMMIT WORK statement](#)

[LOCK TABLE statement](#)

[BEGIN WORK statement](#)

[UNLOCK TABLE statement](#)

[RELEASE SAVEPOINT statement](#)

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WORK Keyword

The `WORK` keyword is optional in a `ROLLBACK WORK` statement. The following two statements are equivalent:

```
ROLLBACK;
```

```
ROLLBACK WORK;
```

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TO SAVEPOINT Clause

The optional `TO SAVEPOINT` clause specifies a partial rollback. This clause can restrict the scope of the rollback to the operations of the current savepoint level between the `ROLLBACK` statement and the specified or default savepoint. If no *savepoint* is specified after the `SAVEPOINT` keyword, the rollback ends at the most recently set savepoint within the current savepoint level.

When the `ROLLBACK WORK TO SAVEPOINT` statement executes successfully, any effects of DDL and DML statements that preceded the savepoint persist, but changes to the schema of the database or to its data values by statements that follow the savepoint are cancelled. Any locks acquired by these cancelled statements persist, but are released at the end of the transaction. Any savepoints between the specified savepoint and the `ROLLBACK` statement are destroyed, but the savepoint referenced by the `ROLLBACK` statement (and any savepoints that precede the referenced savepoint) continue to exist. Program control passes to the statement that immediately follows the `ROLLBACK` statement.

If the `TO SAVEPOINT` clause is omitted, the `ROLLBACK` statement rolls back the entire transaction, and all savepoints within the transaction are released.

If the specified *savepoint* does not exist in the current transaction, the database server issues an exception.

The `TO SAVEPOINT` clause is not valid in a `ROLLBACK` statement that immediately follows the `TRUNCATE` statement. In this case, the attempted partial rollback fails with an error. To cancel uncommitted changes that the `TRUNCATE` statement has made to a table, issue `ROLLBACK WORK` as the next statement, but with no `TO SAVEPOINT` clause.

The following program fragment rolls back part of the current transaction to a savepoint called **pt109**:

```
BEGIN WORK;
DROP TABLE tab03;
CREATE TABLE tab03 (col1 CHAR(24), col2 DATE);
SAVEPOINT pt108;
...
INSERT INTO tab03 VALUES ('First day of autumn', '09/23/2012');
SAVEPOINT pt109;
...
DELETE FROM tab03 WHERE col2 < '12/09/2009';
SAVEPOINT pt110;
```

```
...  
ROLLBACK TO SAVEPOINT pt109;
```

The ROLLBACK statement in this example has these effects:

- Cancels the DML operation that deleted any rows with **col2** date values earlier than December 9, 2009.
- Releases savepoint **pt110**, and any other savepoints between **pt109** and the ROLLBACK statement.
- Cancels any other changes to the database by operations that follow savepoint **pt109** in the lexical order of SQL statements within the current transaction.

Savepoint **pt108**, however, is not released, because it was set earlier than **pt109** in the transaction. Not cancelled by this partial rollback are the effects of any uncommitted DDL or DML operations of the transaction before savepoint **pt109** was set, including the creation of table **tab03** and the INSERT operation that added a row to that table. These persist after the partial rollback, pending the possibility of another partial rollback to a savepoint, and the eventual commitment or rollback of the entire transaction.

Related Statements

Related statements: [BEGIN WORK statement](#), [COMMIT WORK statement](#), [RELEASE SAVEPOINT statement](#), and [SAVEPOINT statement](#).

For a discussion of transactions and ROLLBACK WORK, see the *IBM® Informix® Guide to SQL: Tutorial*.

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SAVE EXTERNAL DIRECTIVES statement

Use the SAVE EXTERNAL DIRECTIVES statement to create external optimizer directives for a specified query, and save the directives in the database. These directives are applied automatically to subsequent instances of the same query. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
          .-----  
          v       |  
>>-SAVE EXTERNAL DIRECTIVES---directive-+---ACTIVE---+----->  
                                     +-INACTIVE--+  
                                     '-TEST ONLY-'  
  
>--FOR--query-----><
```

Element	Description	Restrictions	Syntax
<i>directive</i>	Optimizer directive valid for <i>query</i>	Must be valid for the query and delimited by comment indicators	Optimizer Directives
<i>query</i>	Text of a valid SELECT statement	NULL string is not valid	SELECT statement

Usage

SAVE EXTERNAL DIRECTIVES associates one or more optimizer directives with a query, and stores a record of this association in the **sysdirectives** system catalog table, for subsequent use with queries that match the specified query string. This statement establishes an association between the list of optimizer directives and the text of a query, but it does not execute the specified query.

If the SAVE EXTERNAL DIRECTIVES statement specifies more than one optimizer directive, use the blank character (ASCII 32) as the separator between consecutive directives, as in the following example:

```
SAVE EXTERNAL DIRECTIVES /*+ USE_INDEX */ /*+ ORDERED */ ACTIVE FOR  
SELECT * FROM systables;
```

Unlike in a query, comma (,) is not a valid separator in the directives list of SAVE EXTERNAL DIRECTIVES statements.

Only the DBA or user **informix** can execute SAVE EXTERNAL DIRECTIVES. Optimizer directives that it stores in the database are called *external directives*.

- [External optimizer directives](#)
External directives that the SAVE EXTERNAL DIRECTIVES statement associates with the text of a query can improve performance in some queries for which the default behavior of the query optimizer is not satisfactory.
- [Enabling or disabling external directives for a session](#)
- [The directive Specification](#)
- [The ACTIVE, INACTIVE, and TEST ONLY Keywords](#)
- [The query Specification](#)

Related reference:

[SET STATEMENT CACHE statement](#)
[Optimizer Directives](#)

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External optimizer directives

External directives that the `SAVE EXTERNAL DIRECTIVES` statement associates with the text of a query can improve performance in some queries for which the default behavior of the query optimizer is not satisfactory.

External optimizer directives are similar to inline optimizer directives that are embedded within a query. However, unlike inline directives, external directives can be applied without revising or recompiling existing applications.

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Enabling or disabling external directives for a session

Informix® ignores external directives if the `EXT_DIRECTIVES` parameter is set to 0 in the configuration file or the `EXTDIRECTIVES` keyword in the `SET ENVIRONMENT` statement is set to 0, `OFF`, or `off` during a session.

In addition, the client system can disable external directives for its current session when the `IFX_EXTDIRECTIVES` environment variable is set to 0.

The following table shows whether external directives are disabled (OFF) or enabled (ON) for various combinations of valid `IFX_EXTDIRECTIVES` settings on the client system and valid `EXT_DIRECTIVES` configuration parameter settings on Informix:

Table 1. Combinations of `IFX_DIRECTIVES` settings and `EXT_DIRECTIVES` configuration parameter settings

IFX_EXTDIRECTIVES setting on client system	EXT_DIRECTIVES = 0	EXT_DIRECTIVES = 1	EXT_DIRECTIVES = 2
IFX_EXTDIRECTIVES not set	OFF	OFF	ON
IFX_EXTDIRECTIVES = 1	OFF	ON	ON
IFX_EXTDIRECTIVES = 0	OFF	OFF	OFF

If `EXT_DIRECTIVES` is set to 1 or 2 when the database server is initialized, then the server is enabled for external directives. Individual sessions can enable or disable external directives by setting **IFX_EXTDIRECTIVES**, as the table shows. Any settings other than 1 or 2 are interpreted as zero, disabling this feature.

When external directives are enabled, the status of individual external directives is specified by the `ACTIVE`, `INACTIVE`, or `TEST ONLY` keywords. (But only queries on which directives are effective can benefit from external directives.)

You can also use the `EXTDIRECTIVES` option of the `SET ENVIRONMENT` statement to enable or disable external directives during a session. What you specify using the `EXTDIRECTIVES` option overwrites the external directive value that is specified in the `EXT_DIRECTIVES` configuration parameter in the `ONCONFIG` file.

To overwrite the value for enabling or disabling the external directive in the `ONCONFIG` file and:

- To enable the external directives during a session, specify 1, `on`, or `ON` as the value for `SET ENVIRONMENT EXTDIRECTIVES`.
- To disable the external directives during a session, specify 0, `off`, or `OFF` as the value for `SET ENVIRONMENT EXTDIRECTIVES`.

To enable the default values specified in the `EXT_DIRECTIVES` configuration parameter and in the client-side `IFX_EXTDIRECTIVES` environment variable during a session, specify `DEFAULT` as the value for the `EXTDIRECTIVES` option of the `SET ENVIRONMENT` statement.

For more information on using the `EXTDIRECTIVES` option of the `SET ENVIRONMENT` statement, see [SET ENVIRONMENT statement](#).

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The directive Specification

Each *directive* specification in the `SAVE EXTERNAL DIRECTIVES` statement must follow the syntax of the Optimizer Directives segment, as described in [Optimizer Directives](#), except that if you specify more than one directive, you must separate them in the directives list by a blank character, rather than by a comma (,) symbol, as in the following example:

```
SAVE EXTERNAL DIRECTIVES /*+ AVOID_INDEX (table1 index1)*/ /*+ FULL(table1) */
  ACTIVE FOR
    SELECT /*+ INDEX( table1 index1 ) */ col1, col2
    FROM table1, table2 WHERE table1.col1 = table2.col1;
```

This example associates `AVOID_INDEX` and `FULL` directives with the specified query. The inline `INDEX` directive is ignored by the query optimizer when the external directives are applied to a query that matches the `SELECT` statement.

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The ACTIVE, INACTIVE, and TEST ONLY Keywords

You must include one of the `ACTIVE`, `INACTIVE`, or `TEST ONLY` keyword options to enable, disable, or restrict the scope of external directives:

- If external directives are enabled, the `ACTIVE` keyword applies the list of directives to any subsequent query that matches the *query* string.

- The INACTIVE keyword causes Informix® to ignore the directive. (It is associated with the query in **sysdirectives**, but it is dormant, with no effect.)
- If external directives are enabled, the TEST ONLY keywords apply the directives only to matching queries that the DBA or user **informix** executes. Queries by any other users cannot use TEST ONLY external directives.

An INACTIVE directive has no effect unless the DBA or user **informix** changes the **sysdirectives.active** system catalog column value from zero (INACTIVE) to one (ACTIVE) or two (TEST ONLY) for that directive. External directives do not have SQL identifiers, but the DBA can reference the **sysdirectives.id** column in an UPDATE statement to specify which external directive to update.

Alternatively, the DBA or user **informix** can delete an INACTIVE or TEST ONLY row from **sysdirectives** and use the SET EXTERNAL DIRECTIVES statement to redefine the deleted directive, but now specifying the ACTIVE keyword. This can give other users access to TEST ONLY directives that the DBA has validated.

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The query Specification

The *query* specification that follows the FOR keyword in SAVE EXTERNAL DIRECTIVES must specify the syntax of a valid SELECT statement, as described in [SELECT statement](#). If the *query* text also includes any inline optimizer directives, the inline directives are ignored when external directives are applied to the query.

When external directives are enabled and the **sysdirectives** system catalog table is not empty, the database server compares every query with the *query* text of every ACTIVE external directive, and for queries executed by the DBA or user **informix**, with every TEST ONLY external directive. If an external directive has been applied to a query, output from the SET EXPLAIN statement indicates “EXTERNAL DIRECTIVES IN EFFECT” for that query.

The purpose of external directives is to improve the performance of queries that match the *query* string, but the use of such directives can potentially slow other queries, if the query optimizer must compare the *query* strings of a large number of active external directives with the text of every SELECT statement. For this reason, recommends that the DBA not allow the **sysdirectives** table to accumulate more than a few ACTIVE rows. (Another way to avoid unintended performance impact on other queries is to disable this feature.)

If more than one SET EXTERNAL DIRECTIVES statements associate active external directives with the same query, the effect is unpredictable, because the optimizer uses the first sysdirectives row whose *query* string matches the query.

Related Statements

For information about optimizer directives and their syntax, see the segment “Optimizer Directives” in [Optimizer Directives](#).

For information about the **sysdirectives** table and the **IFX_EXTDIRECTIVES** environment variable, see the *IBM® Informix Guide to SQL: Reference*.

Related information:

[IFX_EXTDIRECTIVES environment variable](#)

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SAVEPOINT statement

Use the SAVEPOINT statement to declare the name of a new savepoint within the current SQL transaction, and to set the position of the new savepoint within the lexical order of SQL statements within the transaction. The SAVEPOINT statement is compliant with the ANSI/ISO standard for SQL.

Syntax

```
>>-SAVEPOINT--savepoint--+-----+-----><
      | (1) |
      '-----UNIQUE--'
```

Notes:

1. Informix® extension

Element	Description	Restrictions	Syntax
<i>savepoint</i>	Name declared here for the new savepoint	Cannot be the name of an existing unique savepoint in the same savepoint level	Identifier

Usage

You can use the SAVEPOINT statement in SQL transactions to support error handling with DB-Access and in SPL, C, and Java™ routines. You can define savepoint to partition a single complex transaction into smaller logical subsets of its component SQL statements. Within that transaction, the subset of statements that follow each savepoint can be rolled back more efficiently than if you had used multiple COMMIT WORK and ROLLBACK WORK statements in multiple transactions.

The SAVEPOINT statement sets the specified savepoint at the current position in the lexical order of statements within the current transaction. After the SAVEPOINT statement executes successfully, subsequent ROLLBACK TO SAVEPOINT statements that reference this savepoint can cancel any uncommitted changes to the database from logged DML or DDL operations in the current transaction that follow the new savepoint but precede the ROLLBACK TO SAVEPOINT statement.

If an existing savepoint in the same transaction has the same name that the `SAVEPOINT` statement specifies, the existing savepoint is destroyed, unless one of the following conditions is true:

- The existing savepoint was set in a different savepoint level.
- The existing savepoint name was declared with the `UNIQUE` keyword option. In this case, the `SAVEPOINT` statement fails with an error, unless the existing `UNIQUE` savepoint was set in a different savepoint level.

Destroying a savepoint to reuse its name for another savepoint is not the same as releasing the savepoint. Reusing a savepoint name destroys only one savepoint. Releasing a savepoint with the `RELEASE SAVEPOINT` statement releases the specified savepoint and all savepoints that have been subsequently set.

The `UNIQUE` option

This optional keyword specifies that the application does not intend to reuse the name of this savepoint in another `SAVEPOINT` statement while this savepoint is active within the current savepoint level.

If a savepoint already exists that was set with the same name and with the `UNIQUE` keyword within the current savepoint level, the `SAVEPOINT` statement fails with an error, and the existing savepoint is not destroyed.

Savepoint levels

Informix supports the construct of nested savepoint levels. A single SQL transaction can have multiple savepoint levels. New savepoint levels are automatically created for the duration of execution of an SPL routine or an external UDR. Recursive calls to the same SPL routine or UDR also increment the savepoint level of the current transaction.

A savepoint level ends when the UDR in which it was created finishes execution. When a savepoint level ends, all savepoints within it are automatically released. Any DDL or DML modifications are inherited by the parent savepoint level (that is, by the savepoint level within which the one that just ended was created), and are subject to any savepoint-related statements that are issued against the parent savepoint level.

The following rules apply to actions within a savepoint level:

- Savepoints can only be referenced within the savepoint level in which they are established. You cannot release, destroy, or roll back to a savepoint established outside of the current savepoint level.
- The uniqueness of savepoint names is only enforced within the current savepoint level. The names of savepoints that are active in other savepoint levels can be reused in the current savepoint level without affecting those savepoints in other savepoint levels.

Savepoints in distributed SQL transactions

Savepoints are valid in cross-database distributed SQL transactions of a single Informix instance that supports transactions if all of the participating databases support transaction logging. Savepoints are also supported in cross-server SQL transactions, including operations in high-availability clusters, if all of the participating Informix instances support savepoints, and all of the databases that are accessed in the transaction use logging.

If any of the participating database servers in a cross-server transaction does not support savepoints, however, and a connection is established between a coordinator that can support savepoints and a subordinate server that cannot, any `ROLLBACK TO SAVEPOINT` statement within the distributed transaction fails with an error.

Persistence of savepoints

Savepoints are position markers within SQL transactions, not database objects. An existing savepoint **S** is destroyed by any of the following events within the same transaction:

- A `COMMIT WORK` or `ROLLBACK WORK` (without the `TO SAVEPOINT` clause) statement is executed.
- A `RELEASE SAVEPOINT` statement is executed that specifies **S** in the same savepoint level.
- A `ROLLBACK TO SAVEPOINT` or `RELEASE SAVEPOINT` statement is executed that specifies a savepoint that was established earlier than **S** in the same savepoint level.
- A `SAVEPOINT` statement specifies the same name as **S** in the same savepoint level, and **S** was not created with the `UNIQUE` keyword.

Restrictions on savepoints

Savepoints and savepoint levels are not supported in the following contexts:

- in databases that do not support transaction logging
- in triggered actions
- in XA global transactions
- in applications or UDRs where the `AUTOCOMMIT` connection attribute is enabled.

In addition, the `SAVEPOINT` statement (like the `RELEASE SAVEPOINT` and `ROLLBACK WORK TO SAVEPOINT` statements) is not valid in UDRs that are invoked within DML statements, as in the following example:

```
SELECT first_1 foo() FROM systables;
```

Here the `foo()` routine cannot set a savepoint.

Related Statements

Related statements: [COMMIT WORK statement](#), [RELEASE SAVEPOINT statement](#), and [ROLLBACK WORK statement](#)

[BEGIN WORK statement](#)
[RELEASE SAVEPOINT statement](#)

LECT statement

Rows or values that satisfy the specified search criteria of the query are called *qualifying* rows or values. What the query retrieves to its calling context, after applying any additional logical conditions, is called the *result set* of the query. This result set can be empty.

```

>>--SELECT--| Select Options |-----
V
|-----|
>-----|
| (1) |-----|
| '+-UNION--+-----+-----SELECT--| Select Options |-'
| | '-ALL-' |
| '+-INTERSECT-----+
| '+-MINUS-----'
| '-EXCEPT-'
|-----|
>-----|
| (2) | | (3) |
| '-| ORDER BY Clause |-----' '-| LIMIT Clause |-----'
|-----|
>-----|
| (4) | (5) |-----|
| '+-FOR READ ONLY-----+-----|
| | (6) |-----| (7) |
| | '------FOR UPDATE-----+-----|
| | | |
| | | V | |
| | '-OF---column-----'
|-----|
>-----|
| (4) | (8) |
| '------| INTO Table Clause |-----'
|-----|
Select options
|-----|
| (4) | (9) |
| '------| Optimizer Directives |-----'
|-----|
(10)
>-----| Projection Clause |-----|
|-----|
(13)
>-----| FROM Clause |-----|
| (11) | (12) |
| '------| INTO Clause |-----'
|-----|
>-----|
| (4) | (14) |
| '------| GRID Clause |-----'
|-----|
>-----|
| (15) | | (16) |
| '-| WHERE Clause |-----' '-| Hierarchical Clause |-----'
|-----|
>-----|
| (17) | | (18) |
| | GROUP BY Clause |-----' | | HAVING Clause |-----'
|-----|

```

1. See [Set operators in combined queries](#)
2. See [ORDER BY Clause](#)
3. See [LIMIT Clause](#)
4. Informix extension
5. See [FOR READ ONLY Clause](#)
6. Informix SQL/C only
7. See [FOR UPDATE Clause](#)
8. See [INTO table clauses](#)
9. See [Optimizer Directives](#)

10. See [Projection Clause](#)
11. Informix ESQL/C and SPL routines only
12. See [INTO Clause](#)
13. See [FROM Clause](#)
14. See [GRID clause](#)
15. See [WHERE clause of SELECT](#)
16. See [Hierarchical Clause](#)
17. See [GROUP BY Clause](#)
18. See [HAVING Clause](#)

Element	Description	Restrictions	Syntax
<i>column</i>	Name of a column that can be updated after a FETCH	Must be in a FROM clause table, but does not need to be in the select list of the Projection clause	Identifier

Usage

The SELECT statement can return data from tables in the current database, or in another database of the current database server, or in a database of another database server. Only the SELECT keyword, the Projection clause, and the FROM clause are required specifications.

For hierarchical queries that include the CONNECT BY clause, the FROM clause can specify only a single table that must reside in the local database of the Informix database server instance to which the current session is connected.

For queries that include the GRID clause, the instances of each table that the FROM clause specifies must have the same schema, the same database locale, and the same code set on every node that the GRID clause specifies.

The SELECT statement can reference no more than one external table that the CREATE EXTERNAL TABLE statement has defined. In complex queries, this external table can be specified only in the outermost query. You cannot reference an external table in a subquery.

You need the Connect access privilege on the database to execute a query, as well as the Select privilege on the table objects from which the query retrieves rows.

The SELECT statement can include various basic clauses, which are identified in the following list.

Clause	Effect
Optimizer Directives	Specifies how the query should be implemented
Projection Clause	Specifies a list of items to be read from the database
INTO Clause	Specifies variables to receive the result set
FROM Clause	Specifies the data sources of Projection clause items
Aliases for Tables or Views	Temporary names for tables or columns in a query
Table expressions	Define derived tables as query data sources
Lateral derived tables	Define correlated table references in a query
The ONLY Keyword	Excludes child tables as data sources in queries of typed tables
Iterator Functions	Functions repeatedly returning values as a data source
ANSI Joins	Join queries compliant with ISO/ANSI syntax standards
Informix-Extension Outer Joins	Query syntax based on implicit LEFT OUTER joins
GRID clause	Specifies the nodes that store the tables of a grid query
Using the ON Clause	Specifies join conditions as pre-join filters
WHERE clause of SELECT	Sets conditions on qualifying rows and post-join filters
Hierarchical Clause	Sets conditions for queries of hierarchical data
GROUP BY Clause	Combines groups of rows into summary results
HAVING Clause	Sets conditions on the summary results
ORDER BY Clause	Sorts qualifying rows according to column values
ORDER SIBLINGS BY Clause	Sorts hierarchical data for siblings at every level
LIMIT Clause	Limits how many qualifying rows can be returned
FOR UPDATE Clause	Enables updating of the result set after a FETCH
FOR READ ONLY Clause	Disables updating of the result set after a FETCH
INTO TEMP clause	Puts the result set into a temporary table
INTO EXTERNAL clause	Stores the query result set in an external table
INTO STANDARD and INTO RAW Clauses	Stores the query result set in a permanent database table
UNION Operator	Combines the result sets of two SELECT statements and optionally discards duplicate rows
INTERSECT Operator	Returns distinct common rows from two query result sets
MINUS operator	Returns distinct rows that only the first of two queries return.

- [Projection Clause](#)
The Projection clause (sometimes called the *Select clause*) specifies a list of database objects or expressions to retrieve, and can set restrictions on qualifying rows. (The *select list* is sometimes also called the *projection list*.)
- [INTO Clause](#)
Use the INTO clause in SPL routines or Informix ESQL/C programs to specify the program variables or host variables to receive data that the SELECT statement retrieves.
- [FROM Clause](#)
The FROM clause of the SELECT statement lists table objects from which to retrieve data.
- [GRID clause](#)
Use the GRID clause to specify the scope of a cross-server query whose data sources are tables of database servers that are nodes of a grid.
- [WHERE clause of SELECT](#)
The WHERE clause can specify join conditions for Informix-extension joins, post-join filters for ANSI-compliant joins, and for search criteria on data values.
- [Hierarchical Clause](#)
The Hierarchical clause sets the conditions for recursive queries on a table object in which a hierarchy of parent-child dependencies exists among the rows. SELECT statements that include this clause are called *hierarchical queries*.
- [GROUP BY Clause](#)
Use the GROUP BY clause to produce a single row of results for each group. A *group* is a set of rows that have the same values for each column (or column expression) that is referenced in this clause.
- [HAVING Clause](#)
Use the HAVING clause to apply one or more qualifying conditions to groups or to the entire result set.
- [Set operators in combined queries](#)
The set operators UNION, UNION ALL, INTERSECT, and MINUS can manipulate the result sets of two queries that specify the same number of columns in the Projection clause, and that have compatible data types in the corresponding columns of both queries.
- [ORDER BY Clause](#)
The ORDER BY clause sorts query results by specified columns or expressions.
- [LIMIT Clause](#)
The LIMIT clause can restrict the result set of the query to some maximum number of rows. If this clause specifies a value smaller than the number of qualifying rows, the query returns only a subset of the rows that satisfy the selection criteria.
- [FOR UPDATE Clause](#)
Use the FOR UPDATE clause in ESQL/C applications and in DB-Access when you intend to update the values returned by a prepared SELECT statement when the values are fetched.
- [FOR READ ONLY Clause](#)
Use the FOR READ ONLY keywords to specify that the Select cursor declared for the SELECT statement is a read-only cursor. A read-only cursor is a cursor that cannot modify data.
- [INTO table clauses](#)
Use the INTO Table clauses to create a new temporary, permanent, or external table to receive the data that the SELECT statement retrieves.

Related reference:

[DROP SEQUENCE statement](#)
[ALTER SEQUENCE statement](#)
[CREATE TEMP TABLE statement](#)
[UPDATE statement](#)
[CREATE VIEW statement](#)
[OUTPUT statement](#)
[Literal Row](#)
[INSERT statement](#)
[DELETE statement](#)
[UNLOAD statement](#)
[RENAME SEQUENCE statement](#)
[Collection-Derived Table](#)
[DECLARE statement](#)

Related information:

[Compose SELECT statements](#)
[Handle character data](#)
[Complex data types](#)

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Projection Clause

The Projection clause (sometimes called the *Select clause*) specifies a list of database objects or expressions to retrieve, and can set restrictions on qualifying rows. (The *select list* is sometimes also called the *projection list*.)

This syntax fragment is part of the [SELECT statement](#).

Projection Clause

```

|-----+----->
|          (1) |
|'-SKIP--+-offset-+-'
|          '-off_var-'
|
>-----+----->
|          (1) |
|'---+-FIRST-+-max-+-'
|          '-LIMIT-'   '-max_var-'

```

Notes:

name is in scope only while the SELECT statement is executing.

Related reference:

[Expression](#)

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Restricting return values with the SKIP, LIMIT, and FIRST options

You can use the SKIP, LIMIT, and FIRST options to restrict the number of return values. The SKIP option excludes the first specified number of return values. The LIMIT and FIRST options set the maximum number of return values.

There is no default value for the *max* or *offset* parameters of the FIRST, LIMIT, or SKIP options. If no integer or integer variable follows the FIRST, LIMIT, or SKIP keyword, the database server interprets that keyword as a column identifier. If no data source in the FROM clause has a column with that name, the query fails with an error.

You can use these features in cross-server distributed queries only if all of the participating database server instances support the SKIP, LIMIT, and FIRST options.

SKIP option

The SKIP *offset* option specifies the number of qualifying rows to exclude, for *offset* an integer in the SERIAL8 range, counting from the first qualifying row.

The following example retrieves the values from all rows except the first 10 rows:

```
SELECT SKIP 10 a, b FROM tab1;
```

You can also use a host variable to specify how many rows to exclude. In an SPL routine, you can use an input parameter or a local variable to provide this value. You can also use the SKIP option to restrict the result sets of prepared SELECT statements, of UNION queries, in queries whose result set defines a collection-derived table, and in the events and actions of triggers.

The SKIP option is not valid in the following contexts:

- In the definition of a view
- In nested SELECT statements
- In subqueries, except for table expressions in the FROM clause.

FIRST option

The FIRST *max* option specifies that the result set includes no more than *max* rows (or exactly *max*, if *max* is not greater than the number of qualifying rows). Any additional rows that satisfy the selection criteria are not returned. If there are fewer than *max* qualifying rows, the sorted and unsorted query results always include the same rows, but typically not in the same order.

The following example retrieves at most 10 rows from table **tab1**:

```
SELECT FIRST 10 a, b FROM tab1;
```

You can use a host variable or the value of an SPL input parameter in a local variable to specify *max*.

The FIRST keyword is also valid in queries that include table expressions in the FROM clause. The following example returns the first 8 qualifying rows, in their order of retrieval from the table expression in the FROM clause of the outer query:

```
SELECT * FROM (SELECT FIRST 8 coll  
FROM tab1 WHERE coll > 50 );
```

The next example applies the FIRST option to the result of a UNION expression:

```
SELECT FIRST 10 a, b FROM tab1 UNION SELECT a, b FROM tab2;
```

The FIRST option is not valid in any of the following contexts:

- In the definition of a view
- In nested SELECT statements
- In subqueries, except for subqueries that specify table expressions in the FROM clause
- In a singleton SELECT (where *max* = 1) within an SPL routine
- Where embedded SELECT statements are used as expressions

Instead of the FIRST or LIMIT option in the Projection clause, you can instead include the LIMIT clause after the Projection clause and the optional ORDER BY clause. For more information on the LIMIT clause, see [LIMIT Clause](#).

LIMIT option

LIMIT is a keyword synonym for the FIRST keyword in the Projection clause. However, you cannot substitute LIMIT for FIRST in other syntactic contexts where FIRST is valid, such as in the FETCH statement.

Combining the SKIP option and the FIRST or LIMIT option

If a Projection clause with the SKIP *offset* option also includes a *max* limit that the FIRST or LIMIT option specifies, the query result set begins with the row whose ordinal position among qualifying rows is (*offset* + 1), rather than with the first row that satisfies the selection criteria.

If no ORDER BY clause sorts the retrieved rows, the row in position (*offset* + *max*) is the last row in the result set, unless there are fewer than (*offset* + *max*) qualifying rows. The following example ignores the first 50 qualifying rows in table **tab1**, but returns a result set of at most 10 rows, beginning with the fifty-first row:

```
SELECT SKIP 50 FIRST 10 a, b FROM tab1;
```

The SELECT clause in the next example uses the SKIP and FIRST options to insert no more than five rows from table **tab1** into table **tab2**, beginning with the eleventh row:

```
INSERT INTO tab2 SELECT SKIP 10 FIRST 5 * FROM tab1;
```

- [Sorting results from SKIP, LIMIT, or FIRST queries](#)

When you combine the ORDER BY clause with the SKIP, LIMIT, or FIRST options in a query, the ORDER BY clause can affect which qualifying rows are in the result set.

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Sorting results from SKIP, LIMIT, or FIRST queries

When you combine the ORDER BY clause with the SKIP, LIMIT, or FIRST options in a query, the ORDER BY clause can affect which qualifying rows are in the result set.

Queries that combine the SKIP and the FIRST or LIMIT options with the ORDER BY clause impose a unique order on the qualifying rows. Successive queries that increment the *offset* value by the value of *max* can partition the results into distinct subsets of *max* rows. This capability can support web applications that require a fixed page size, without requiring cursor management.

Using FIRST or LIMIT with ORDER BY

For a query that includes the FIRST or LIMIT option or the LIMIT clause and an ORDER BY clause, the qualifying rows that are returned in their sort-key order might not be the same result set that the query without ORDER BY returned in the order of retrieval.

With an ORDER BY clause, you can retrieve the first *max* qualifying rows. For example, the following query finds the ten highest-paid employees:

```
SELECT FIRST 10 name, salary FROM emp ORDER BY salary DESC;
```

You can use the FIRST option in a query whose result set defines collection-derived table (CDT) within the FROM clause of another SELECT statement. The following query specifies a CDT that has no more than ten rows:

```
SELECT *
FROM TABLE(MULTISET(SELECT FIRST 10 * FROM employees
ORDER BY employee_id) vt(x,y), tab2
WHERE tab2.id = vt.x;
```

Using SKIP and ORDER BY

For a query in which the SKIP option defines an integer *offset* of qualifying rows that are ignored before the first returned row, the order of retrieval determines which rows are omitted from the query result if the ORDER BY clause is absent. However, if the ORDER BY clause is included the *offset* is applied to the sorted rows. Whether sorted in ascending or descending order, these rows that are excluded based on their sort-key value are generally uncorrelated with the qualifying rows that are excluded based on their order of retrieval, unless the query result set is empty.

When you use the SKIP option in a query with an ORDER BY clause, you can exclude the first *offset* rows that have the lowest values according to the ORDER BY criteria. You can also use SKIP to exclude rows with the highest values, if the ORDER BY clause includes the DESC keyword. For example, the following query returns all rows of the **orders** table, except for the fifty oldest orders:

```
SELECT SKIP 50 * FROM orders ORDER BY order_date;
```

Here the result set is empty if there are fewer than 50 rows in the **orders** table. An *offset* of zero (0) is not invalid, but in that case the SKIP option does nothing.

The following example query contains a collection subquery that performs the following actions:

- retrieves only the eleventh through fifteenth rows from **tab3** as a collection-derived table,
- sorts those five rows by the ascending order of their value in column **a**,
- and stores this result set in a temporary table.

```
SELECT * FROM TABLE (MULTISET (SELECT SKIP 10 FIRST 5 a FROM tab3
ORDER BY a)) INTO TEMP;
```

The following INSERT statement includes a collection subquery whose results define a collection-derived table. The rows are ordered by the value in column **a**, and are inserted into table **tab1**.

```
INSERT INTO tab1 (a) SELECT *
FROM TABLE (MULTISET (SELECT SKIP 10 FIRST 5 a
FROM tab3 ORDER BY a));
```

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Controlling duplicate return values

You can apply the ALL, UNIQUE, or DISTINCT keywords to indicate whether duplicate values are returned, if any exist. If you do not specify any of these keywords in the Projection clause, all qualifying rows are returned by default.

ALL

Default. Specifies that all qualifying rows are returned, regardless of whether duplicates exist.

DISTINCT

Excludes duplicates of qualifying rows from the result set

UNIQUE

Excludes duplicate. UNIQUE is a synonym for DISTINCT, as an extension to the ANSI/ISO standard.

For example, the next query returns all the unique ordered pairs of values from the **stock_num** and **manu_code** columns in rows of the **items** table. If several rows have the same pair of values, that pair appears only once in the result set:

```
SELECT DISTINCT stock_num, manu_code FROM items;
```

For information on how the database server identifies duplicate NCHAR and NVARCHAR values in a database that has the NLCASE INSENSITIVE property, see [NCHAR and NVARCHAR expressions in case-insensitive databases](#).

You can specify the DISTINCT or UNIQUE keyword of the SELECT statement no more than once in each level of a query or subquery. The following example uses DISTINCT in both the query and in the subquery:

```
SELECT DISTINCT stock_num, manu_code FROM items
WHERE order_num = (SELECT DISTINCT order_num FROM orders
WHERE customer_num = 120);
```

The example above is valid, because DISTINCT is used no more than once in each of the SELECT statements.

If a query includes the DISTINCT or UNIQUE keyword (rather than the ALL keyword or no keyword) in the Projection clause whose Select list also includes an aggregate function whose argument list begins with the DISTINCT or UNIQUE keyword, the database server issues an error, as in the following example: .

```
SELECT DISTINCT COUNT(DISTINCT ship_weight)
FROM orders;
```

That is, it is not valid in the same query for both the Projection clause and for an aggregate function to restrict the result set to unique values. (In the example above, replacing either of the DISTINCT keyword with UNIQUE would not avoid this error.)

Queries with multiple aggregate expressions

If the Projection clause does not specify the DISTINCT or UNIQUE keyword of the SELECT statement, the query can include multiple built-in aggregate functions that each includes the DISTINCT or UNIQUE keyword as the first specification in the argument list, as in the following example:

```
SELECT COUNT (DISTINCT customer_num),
COUNT (UNIQUE order_num),
AVG (DISTINCT ship_charge) FROM orders;
```

Support for multiple DISTINCT or UNIQUE aggregate expressions in the same level of a query applies to built-in aggregate functions, but not to user-defined aggregate (UDA) functions that the CREATE AGGREGATE statement defined. The database server issues an error if the argument lists of more than one UDA expression in the same query begin with the DISTINCT or UNIQUE keywords.

- [Duplicate rows in NLSCASE INSENSITIVE databases](#)

In a database that was created with the NLSCASE INSENSITIVE option, columns and expressions of NCHAR or NVARCHAR data types make no distinction between upper case and lower case letters, so that strings of these data types that have the same sequence of characters, but with letter case variants, evaluate as duplicates.

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Duplicate rows in NLSCASE INSENSITIVE databases

In a database that was created with the NLSCASE INSENSITIVE option, columns and expressions of NCHAR or NVARCHAR data types make no distinction between upper case and lower case letters, so that strings of these data types that have the same sequence of characters, but with letter case variants, evaluate as duplicates.

Queries that include the ALL, DISTINCT, or UNIQUE keywords might return results different from what the same query returns from a case-sensitive database into which the same character string values had been loaded. For example, the NVARCHAR strings "aCe", "ACE", and "AcE" evaluate as identical in databases that have the NLSCASE INSENSITIVE property, but the same three strings are processed as distinct values in case-sensitive databases.

Strings of type CHAR, LVARCHAR, and VARCHAR, however, are processed identically in NLSCASE SENSITIVE and in NLSCASE INSENSITIVE databases by queries that use the ALL, DISTINCT, or UNIQUE keywords to include or exclude duplicate rows. For more information about databases with the NLSCASE INSENSITIVE property, see [Specifying NLSCASE case sensitivity](#) and [NCHAR and NVARCHAR expressions in case-insensitive databases](#).

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Data Types in Distributed Queries

Queries whose only data sources are tables and views in the local database to which the session is connected can return values from columns or expressions of any built-in or user-defined data type that is registered in the local database. Queries that reference tables or views in other databases are called *distributed queries*, and the data types that they can access are a subset of the data types that Informix® supports in local queries.

Among distributed queries, the restrictions on data types depend on the number of participating database servers.

- If all the databases that the query accesses are databases of the same Informix instance, the query is called a *cross-database* distributed query.
- If the query accesses databases of multiple Informix instances, the query is called a *cross-server* distributed query.

In both types of distributed queries, all participating databases must have the same ANSI/ISO-compliance status. A cross-server distributed query can use both the SKIP and FIRST options if all participating servers support the SKIP option; otherwise the query fails with an error. More generally, all cross-server operations require that the participating database server instances support the SQL syntax that specifies the operation.

For additional information about distributed queries, see the *IBM® Informix Database Design and Implementation Guide*.

- [Data Types in Cross-Database Transactions](#)

A query that accesses tables in more than one database of the local server instance can return only a subset of the SQL data types that a local query can return from tables in the local database. Similarly, a cross-server distributed query on tables in databases of more than one server instance has additional restrictions on returned data types.

- [Data Types in Cross-Server Transactions](#)

A distributed query (or any other distributed DML operation or function call) across databases of two or more Informix instances cannot return complex or large-object data types, nor most user-defined data types (UDTs) or opaque data types.

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Data Types in Cross-Database Transactions

A query that accesses tables in more than one database of the local server instance can return only a subset of the SQL data types that a local query can return from tables in the local database. Similarly, a cross-server distributed query on tables in databases of more than one server instance has additional restrictions on returned data types.

Distributed queries (and other distributed DML operations or function calls) that access only databases of the local Informix® instance can access data types of the following categories:

- The *built-in data types* that are not opaque, including these:
 - BIGINT
 - BIGSERIAL
 - BYTE
 - CHAR
 - DATE
 - DATETIME
 - DECIMAL
 - FLOAT
 - INT
 - INTERVAL
 - INT8
 - MONEY
 - NCHAR
 - NVARCHAR
 - SERIAL
 - SERIAL8
 - SMALLFLOAT
 - SMALLINT
 - TEXT
 - VARCHAR
- Most *built-in opaque data types*, including these:
 - BLOB
 - BSON
 - BOOLEAN
 - CLIENTBINVAL
 - CLOB
 - IFX_LO_SPEC
 - IFX_LO_STAT
 - INDEXKEYARRAY
 - JSON
 - LVARCHAR
 - POINTER
 - RTNPARAMTYPES,
 - SELFUNCARGS
 - STAT
 - XID
- User-defined types (UDTs) that are cast explicitly to any of the built-in types that are listed above
- DISTINCT of any of the built-in types in the preceding list.

Distributed operations across databases of the local Informix instance can return UDTs and DISTINCT types based on built-in data types only if all the UDTs and DISTINCT types are cast explicitly to built-in data types.

All the opaque UDTs, DISTINCT types, data type hierarchies, and casts must have exactly the same definitions in each database that participates in the distributed query. For queries or other DML operations in cross-database UDRs that use the data types listed above as parameters or as returned data types, the UDR must also have the same definition in each participating database.

A cross-database distributed query (or any other cross-database DML operation) fails with an error if it references a table, view, or synonym in another database of the local Informix instance that includes a column of any of the following data types:

- LOLIST
- IMPEXP
- IMPEXPBIN
- SENDRECV
- DISTINCT of any of the built-in opaque data types that are listed above.
- Complex types (named or unnamed ROW, COLLECTION, LIST, MULTISET, or SET)
- DISTINCT of ROW.

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Data Types in Cross-Server Transactions

A distributed query (or any other distributed DML operation or function call) across databases of two or more Informix® instances cannot return complex or large-object data types, nor most user-defined data types (UDTs) or opaque data types.

A distributed query (or any other distributed DML operation or function call) across databases of two or more Informix instances cannot return complex or large-object data types, nor most user-defined data types (UDTs) or opaque data types. Cross-server distributed queries, DML operations, and function calls can return only the following atomic data types, where *atomic* excludes the complex data types:

- Any non-opaque atomic built-in data type
- BOOLEAN
- BSON
- JSON
- LVARCHAR
- DISTINCT of non-opaque built-in types
- DISTINCT of BOOLEAN
- DISTINCT of BSON
- DISTINCT of JSON
- DISTINCT of LVARCHAR
- DISTINCT of any of the DISTINCT types that appear above in this list.

A cross-server distributed query can support DISTINCT data types only if both of the following conditions are true for every DISTINCT type in the query:

- The DISTINCT data type is explicitly cast to one of the atomic built-in types above,
- The DISTINCT type, its data type hierarchy, and its casts are defined exactly the same way in each database that participates in the distributed query.

For queries or other DML operations in cross-server UDRs (user-defined routines) that use the data types in the preceding list as parameters or as returned data types, the UDR must also have the same definition in every participating database.

Cross-server queries of protected tables

The built-in DISTINCT data type IDSECURITYLABEL, which stores security label objects, can be accessed in cross-server and cross-database operations on protected data by users who hold sufficient security credentials for the same label-based access control (LBAC) security policy. Like local operations on protected data, distributed queries that access remote tables protected by a security policy can return only the qualifying rows that **IDSLBACRULES** allow, after the database server has compared the security label that secures the data with the security credentials of the user who issues the query.

For additional information about the data types that Informix supports in cross-server DML operations, see [Data Types in Distributed Queries](#). For information about the table hierarchies of the DISTINCT data types that are valid in cross-server operations, see [DISTINCT Types in Distributed Operations](#).

Built-in data types not valid in cross-server queries

A cross-server query (or any other cross-server DML operation) fails with an error if it references a table, view, or synonym in a database of another Informix instance that includes a column of any of the following data types:

- BLOB
- BYTE
- CLIENTBINVAL
- CLOB
- IFX_LO_SPEC
- IFX_LO_STAT
- INDEXKEYARRAY
- POINTER
- RTNPARAMTYPES
- SELFUNCARGS
- STAT
- TEXT
- XID
- User-defined OPAQUE types

- Complex types (named or unnamed ROW, COLLECTION, LIST, MULTISET, or SET)
- DISTINCT of any of the opaque or complex data types that are listed above.

Requirements for participating database servers and databases

Cross-server operations require that all participating database server instances support the SQL syntax that specifies the operation.

Cross-server queries cannot access the database of another Informix instance unless both servers define TCP/IP or IPCSTR connections in their DBSERVERNAME or DSERVERALIAS configuration parameters and in the **sqlhosts** information. The requirement that both participating servers support the same type of connection (either TCP/IP or else IPCSTR) applies to any communication between Informix instances, even if both reside on the same computer.

For the SQL syntax to reference objects in databases of remote server instances that are not part of an Informix grid, see [Specifying a Database Object in a Cross-Server Query](#). For information about grid queries, see [GRID clause](#).

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Expressions in the Select List

You can use any basic type of expression (column, constant, built-in function, aggregate function, and user-defined routine), or combination thereof, in the select list. The expression types are described in [Expression](#). Sections that follow present examples of simple expression in the select list.

You can combine simple numeric expressions by connecting them with arithmetic operators for addition, subtraction, multiplication, and division. If you combine a column expression and an aggregate function, however, you must include the column expression in the GROUP BY clause. (See also [Dependencies between the GROUP BY and Projection clauses](#).)

In general, you cannot use variables (for example, host variables in an ESQL/C application) in the select list by themselves. A variable is valid in the select list, however, if an arithmetic or concatenation operator connects it to a constant.

In a FOREACH SELECT statement, you cannot use SPL variables in the select list, by themselves or with column names, when the tables in the FROM clause are remote tables. You can use SPL variables by themselves or with a constant in the select list only when the tables in the FROM clause are local tables.

In distributed queries of Informix®, values in expressions (and returned by expressions) are restricted, as [Data Types in Cross-Server Transactions](#) describes. Any UDRs whose return values are used as expressions in other databases of the same Informix instance must be defined in each participating database.

The Boolean operator NOT is not valid in the Projection clause.

- [Selecting Columns](#)
- [Selecting Constants](#)
- [Selecting Built-In Function Expressions](#)
- [Selecting Aggregate Function Expressions](#)

An aggregate function returns one value for a set of queried rows. This value depends on the set of rows that the WHERE clause of the SELECT statement qualifies. In the absence of a WHERE clause, the aggregate functions take on values that depend on all the rows that the FROM clause forms.

- [Selecting OLAP window expressions](#)

You can include OLAP window expressions in the select list of the Projection clause.

- [Selecting correlated aggregates in subqueries](#)

In a subquery, an aggregate expression with a column operand that was declared in a parent query block is called a *correlated aggregate*. The column operand is called a *correlated column reference*.

- [Selecting User-Defined Function Expressions](#)
- [Selecting Expressions That Use Arithmetic Operators](#)
- [Selecting ROW Fields](#)

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Selecting Columns

Column expressions are the most commonly used expressions in a SELECT statement. For a complete description of the syntax and use of column expressions, see [Column Expressions](#). The following examples use column expressions in the Projection clause:

```
SELECT orders.order_num, items.price FROM orders, items;
SELECT customer.customer_num cnum, company FROM customer;
SELECT catalog_num, stock_num, cat_advert [1,15] FROM catalog;
SELECT lead_time - 2 UNITS DAY FROM manufact;
```

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Selecting Constants

If you include a constant expression in the projection list, the same value is returned for each row that the query returns (except when the constant expression is **NEXTVAL**). For a complete description of the syntax and use of constant expressions, see [Constant Expressions](#). Examples that follow show constant expressions within a select list:

```
SELECT 'The first name is', fname FROM customer;
SELECT TODAY FROM cust_calls;
SELECT SITENAME FROM systables WHERE tabid = ;1
SELECT lead_time - 2 UNITS DAY FROM manufact;
SELECT customer_num + LENGTH('string') from customer;
```

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Selecting Built-In Function Expressions

A built-in function expression uses a function that is evaluated for each row in the query. All built-in function expressions require arguments. This set of expressions contains the time functions and the length function when they are used with a column name as an argument. The following examples show built-in function expressions within the select list of the Projection clause:

```
SELECT EXTEND(res_dtime, YEAR TO SECOND) FROM cust_calls;
SELECT LENGTH(fname) + LENGTH(lname) FROM customer;
SELECT HEX(order_num) FROM orders;
SELECT MONTH(order_date) FROM orders;
```

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Selecting Aggregate Function Expressions

An aggregate function returns one value for a set of queried rows. This value depends on the set of rows that the WHERE clause of the SELECT statement qualifies. In the absence of a WHERE clause, the aggregate functions take on values that depend on all the rows that the FROM clause forms.

Examples that follow show aggregate functions in a projection list:

```
SELECT SUM(total_price) FROM items WHERE order_num = 1013;
SELECT COUNT(*) FROM orders WHERE order_num = 1001;
SELECT MAX(LENGTH(fname) + LENGTH(lname)) FROM customer;
```

If the Projection clause does not specify the DISTINCT or UNIQUE keyword of the SELECT statement, however, the query can include one or more aggregate functions that include the DISTINCT or UNIQUE keyword as the first specification of the argument lists:

```
SELECT SUM(DISTINCT total_price) FROM items WHERE order_num = 1013;
SELECT COUNT(DISTINCT *) FROM orders WHERE order_num = 1001;
SELECT MAX(LENGTH(fname) + LENGTH(UNIQUE lname)) FROM customer;
```

The database server issues an error, however, if both the Projection clause and an aggregate function expression specify the DISTINCT or UNIQUE keyword in the same query.

Aggregate expressions in grid queries

For grid queries that include aggregate function expressions, you must specify the GRID clause in a subquery, if the value of the aggregate expression that each grid server calculates is a quotient whose denominator varies across the participating grid servers.

SQL aggregate expressions and OLAP window aggregates

Do not confuse SQL aggregate functions with the On-Line Analytical Processing (OLAP) window aggregation functions, which are a different category of functions.

When an aggregate function expression is immediately followed by the OVER clause, the database server attempts to interpret it as an OLAP aggregation function. Some OLAP aggregation functions have the same names (and support a subset of the same syntax) as SQL aggregate functions, but the two types of functions have different behavior.

An SQL aggregate function can be nested inside an OLAP aggregation function. For example, the following query is valid in a context where **dollars** is a column in the sales **table**:

```
SELECT AVG(SUM(dollars)) OVER() FROM sales;
```

In the example above, the SUM function is an SQL aggregate function and the containing AVG function is an OLAP window function. The order of query processing dictates that OLAP functions are always calculated after grouping and aggregation operations but before the final ORDER BY operation.

Related concepts:

[Aggregate expressions in grid queries](#)

Related reference:

[OLAP aggregation function expressions](#)

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Selecting OLAP window expressions

You can include OLAP window expressions in the select list of the Projection clause.

The On-Line Analytical Processing (OLAP) functions can return ranking, row numbering, and aggregate function information for the entire result set of a query or subquery, or for partitioned subsets of the qualifying rows that the OLAP window defines. You can use OLAP specifications to define moving windows within a partition of the result set for examining dimensions of the data, and identifying patterns, trends, and exceptions within data sets.

A query that includes OLAP window expressions returns the rows in the result set of the query, and the results of the OLAP window functions, if those functions return anything.

An OLAP window aggregate function expression can be the argument to another OLAP window aggregate function. OLAP window aggregates cannot, however, be arguments to non-analytic aggregate functions.

Related reference:

[OLAP window expressions](#)

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Selecting correlated aggregates in subqueries

In a subquery, an aggregate expression with a column operand that was declared in a parent query block is called a *correlated aggregate*. The column operand is called a *correlated column reference*.

SELECT statements and other DML statements can include subqueries with aggregate expressions whose operands reference columns that were declared in a parent query block. When a subquery contains an aggregate with a correlated column reference, the database server evaluates that aggregate in the parent query block where the correlated column reference was declared.

If an aggregate expression in a subquery contains correlated references to columns from more than one parent query block, the correlated aggregate is evaluated in the parent that is nearest to the subquery in the lexical order of query blocks.

Examples of aggregates with correlated column references

In the following example, the database server evaluates the correlated aggregate `COUNT(n.j)` in the parent query block, which declared the table alias `n` that appears in the correlated column reference of the subquery:

```
CREATE TABLE tab(i INT);
CREATE TABLE tab2(j INT);
. . .
SELECT m.i,
       (SELECT COUNT(n.j)
        FROM tab2 WHERE j=15) AS o
FROM tab m, tab2 n GROUP BY 1;
```

The only exception to the rule illustrated above occurs when the correlated aggregate is an argument to an aggregate in the parent query block. In this scenario, the aggregate is evaluated in the subquery, if the correlated column reference comes from the same query block where the outer aggregate is specified. The next example illustrates nested aggregates:

```
SELECT m.i,
       SUM((SELECT SUM(n.j)
            FROM tab2 WHERE j=15)) AS o
FROM tab m, tab2 n GROUP BY 1;
```

When the database server identifies the aggregate in the subquery above as a nested aggregate, it evaluates the inner `SUM(n.j)` aggregate in the subquery, if the outer aggregate is in the same query block where the table alias in the `n.j` column reference was declared.

A correlated aggregate in a subquery can include multiple correlated references to columns in the parent query block, as in the following example:

```
SELECT A.tabid,
       (SELECT SUM(B.collength * A.rowsize)
        FROM syscolumns B WHERE B.tabid = A.tabid)
FROM systables A WHERE A.tabid = 1;
```

During execution of the statement above, the correlated aggregate

```
SUM(B.collength * A.rowsize)
```

is evaluated in the subquery.

In all other cases, the database server treats an aggregate operating on a column of a table in a parent query block as a correlated aggregate.

Important: This behavior for evaluating correlated aggregate expressions was not fully supported in Informix 12.10.xC4 or 11.70.xC8, nor in earlier release versions.

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Selecting User-Defined Function Expressions

User-defined functions extend the range of functions that are available to you and allow you to perform a subquery on each row that you select.

The following example calls the `get_orders()` user-defined function for each `customer_num` and displays the returned value under the `n_orders` label:

```
SELECT customer_num, lname, get_orders(customer_num) n_orders
FROM customer;
```

If an SPL routine in a SELECT statement contains certain SQL statements, the database server returns an error. For information on which SQL statements cannot be used in an SPL routine that is called within a query, see [Restrictions on SPL Routines in Data-Manipulation Statements](#).

For the complete syntax of user-defined function expressions, see [User-Defined Functions](#).

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Selecting Expressions That Use Arithmetic Operators

You can combine numeric expressions with arithmetic operators to make complex expressions. You cannot combine expressions that contain aggregate functions with column expressions. These examples show expressions that use arithmetic operators within a select list in the Projection clause:

```
SELECT stock_num, quantity*total_price FROM customer;
SELECT price*2 doubleprice FROM items;
SELECT count(*)+2 FROM customer;
SELECT count(*)+LENGTH('ab') FROM customer;
```

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Selecting ROW Fields

You can select a specific field of a named or unnamed ROW type column with *row.field* notation, using a period (.) as a separator between the *row* and *field* names. For example, suppose you have the following table structure:

```
CREATE ROW TYPE one (a INTEGER, b FLOAT);
CREATE ROW TYPE two (c one, d CHAR(10));
CREATE ROW TYPE three (e CHAR(10), f two);
```

```
CREATE TABLE new_tab OF TYPE two;
CREATE TABLE three_tab OF TYPE three;
```

The following examples show expressions that are valid in the select list:

```
SELECT t.c FROM new_tab t;
SELECT f.c.a FROM three_tab;
SELECT f.d FROM three_tab;
```

You can also enter an asterisk (*) in place of a field name to signify that all fields of the ROW-type column are to be selected.

For example, if the **my_tab** table has a ROW-type column named **rowcol** that contains four fields, the following SELECT statement retrieves all four fields of the **rowcol** column:

```
SELECT rowcol.* FROM my_tab;
```

You can also retrieve all fields from a row-type column by specifying only the column name. This example has the same effect as the previous query:

```
SELECT rowcol FROM my_tab;
```

You can use *row.field* notation not only with ROW-type columns but with expressions that evaluate to ROW-type values. For more information, see [Column Expressions](#) in the Expression segment.

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Declaring a Display Label

You can declare a display label for any column or column expression in the select list of the Projection clause. This temporary name is in scope only while the SELECT statement is executing.

In DB-Access, a display label appears as the heading for that column in the output of the SELECT statement.

In Informix® ESQ/C, the value of *display_label* is stored in the **sqlname** field of the **sqlda** structure. For more information on the **sqlda** structure, see the *IBM Informix ESQ/C Programmer's Manual*.

If your display label is an SQL keyword, use the AS keyword to clarify the syntax. For example, to use UNITS, YEAR, MONTH, DAY, HOUR, MINUTE, SECOND, or FRACTION as display labels, use the AS keyword with the display label. The following statement uses AS with **minute** as a display label:

```
SELECT call_dtime AS minute FROM cust_calls;
```

For the keywords of SQL, see [Keywords of SQL for IBM Informix](#).

If you use the INTO Table clause to create a temporary or permanent table to store the query results, you must declare a display label for any database object or expression in the select list that is not a simple column expression. The display label is used as the name of the column in the temporary or permanent table.

If you are using the SELECT statement to define a view, do not use display labels. Specify the desired label names in the CREATE VIEW column list instead.

sqlwarn structure, see the *IBM® Informix ESQL/C Programmer's Manual*.

- [INTO Clause with Cursors](#)
If the SELECT statement returns more than one row, you must use a cursor in a FETCH statement to fetch the rows individually. You can put the INTO clause in the FETCH statement rather than in the SELECT statement, but you should not put it in both.
- [Preparing a SELECT ... INTO Query](#)
- [Using Array Variables with the INTO Clause](#)

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INTO Clause with Cursors

If the SELECT statement returns more than one row, you must use a cursor in a FETCH statement to fetch the rows individually. You can put the INTO clause in the FETCH statement rather than in the SELECT statement, but you should not put it in both.

The following Informix® ESQL/C code examples show different ways you can use the INTO clause. As both examples show, first you must use the DECLARE statement to declare a cursor.

The following example show how to use the INTO clause in the SELECT statement:

```
EXEC SQL declare q_curs cursor for
select lname, company
into :p_lname, :p_company
from customer;
EXEC SQL open q_curs;
while (SQLCODE == 0)
EXEC SQL fetch q_curs;
EXEC SQL close q_curs;
```

The following statement shows how to use the INTO clause in a FETCH statement:

```
EXEC SQL declare q_curs cursor for
select lname, company from customer;
EXEC SQL open q_curs;
while (SQLCODE == 0)
EXEC SQL fetch q_curs into :p_lname, :p_company;
EXEC SQL close q_curs;
```

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Preparing a SELECT ... INTO Query

In Informix® ESQL/C, you cannot prepare a query that has an INTO clause. You can prepare the query without the INTO clause, declare a cursor for the prepared query, open the cursor, and then use the FETCH statement with an INTO clause to fetch the cursor into the program variable.

Alternatively, you can declare a cursor for the query without first preparing the query and include the INTO clause in the query when you declare the cursor. Then open the cursor and fetch the cursor without using the INTO clause of the FETCH statement.

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Using Array Variables with the INTO Clause

In Informix® ESQL/C, if you use a DECLARE statement with a SELECT statement that contains an INTO clause, and the variable is an array element, you can identify individual elements of the array with integer literals or variables. The value of the variable that is used as a subscript is determined when the cursor is declared; the subscript variable subsequently acts as a constant.

The following Informix ESQL/C code example declares a cursor for a SELECT ... INTO statement using the variables **i** and **j** as subscripts for the array **a**. After you declare the cursor, the INTO clause of the SELECT statement is equivalent to INTO a[5], a[2].

```
i = 5
j = 2
EXEC SQL declare c cursor for
select order_num, po_num into :a[i], :a[j] from orders
where order_num =1005 and po_num =2865;
```

You can also use program variables in the FETCH statement to specify an element of a program array in the INTO clause. The program variables are evaluated at each fetch, rather than when you declare the cursor.

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FROM Clause

This syntax fragment is part of the [SELECT statement](#).

```

|--FROM-->
. ,
| |
V V V (1) | |
>+--+--+--+ ANSI Tables +---+ ANSI Joins +-----+--+--+
| '-(-' ')--' |
| . ,
| V |
+--+--+ ANSI Tables +--+--+
| '-| Other Tables |- ' (2) (3) |
| '-----,-- Informix OUTER Join Clause -----'
| (4)
| '-| Lateral derived table |-----'

```

```
|-----+--synonym-----|-----+-----| |
|   +table-----+         |           |(5)|
|   +view-----+         | '+----+alias-----'|
| '-ONLY--+-(table )-+-'    | '-AS-'          |
|       '-(synonym)-'      |                   |
|(2)                        |(6)                |
|-----+| Collection Derived Table |-----+-----|
|        |                         |               |
|        | Iterator                 |               |
|        |                         |               |
```

```
|--external--+-----+
|      |          (5)    |
|      +-+-+alias-----+'
|      |-AS-'           |   .-,-----'
|                   V     |
|                   '-(---derived_column+--)'-
(8)                        (9)
+-----| Collection Subquery |--)-----+
+(-subquery-)-----+
|                                     |
|                                     (5)   .-,-----'
|                                     V       |
|--++-+table--+-----+--+--++-+alias-(---derived_column+--)'-
| +view----+             | -AS-'
| '-synonym-'            |
| (2)                (10)        (11) |
| '-----ONLY--(+-----+table--+)--'+
|                 '-synonym-'
```

1. See [ANSI Joins](#)
2. Informix extension
3. See [Informix-Extension Outer Joins](#)
4. See [Lateral derived tables](#)
5. See [Aliases for Tables or Views](#)
6. See [Collection-Derived Table](#)
7. See [Iterator Functions](#)
8. Informix extension
9. See [Collection Subquery](#)
10. Must specify a supertable within a typed table hierarchy
11. See [The ONLY Keyword](#)

Every SELECT statement requires the FROM clause, whether or not any data source is required. If your query uses the database server to evaluate an expression that requires no data source, the FROM clause can reference any existing table in the current database on which you hold sufficient access privileges, as in the

following example:

```
SELECT ATANH(SQRT(POW(4,2) + POW(5,2))) FROM systables;
```

- [Aliases for Tables or Views](#)
You can declare an alias for a table or view in the FROM clause. If you do so, you must use the alias to refer to the table or view in other clauses of the SELECT statement. You can also use aliases to make the query shorter.
- [Table expressions](#)
A *table expression* (sometimes called a *derived table*) is the name of a table or view, or a specification that evaluates to a set of rows. These rows are typically the result of a query that is embedded in a nested SELECT statement, or in some other SQL statement.
- [Lateral derived tables](#)
The LATERAL keyword must immediately precede any query in the FROM clause that defines a derived table, if that query references any other table or column that appears earlier in the same FROM clause than the query that defines the derived table.
- [Restrictions on External Tables in Joins and Subqueries](#)
- [The ONLY Keyword](#)
If the FROM clause includes a permanent table that is a supertable within a typed table hierarchy, the query returns the qualifying rows from both the supertable and from its subtables by default, unless you specify the ONLY keyword.
- [Selecting from a Collection Variable](#)
The SELECT statement in conjunction with the Collection-Derived Table segment allows you to select elements from a collection variable.
- [Selecting from a Row Variable \(ESQL/C\)](#)
The SELECT statement can include the Collection-Derived Table segment to select one or more fields from a **row** variable.
- [Iterator Functions](#)
The FROM clause can include a call to an iterator function to specify the source for a query. An *iterator function* is a user-defined function that returns to its calling SQL statement multiple times, each time returning at least one value.
- [ANSI Joins](#)
If the FROM clause specifies more than one table reference, the query can join rows from several tables or views. A *join condition* specifies a relationship between at least one column from each table to be joined. Because the columns in a join condition are being compared, they must have compatible data types.
- [Informix-Extension Outer Joins](#)
The Informix-extension syntax for outer joins begins with an implicit left outer join. That is, you begin the Informix-extension outer join with the OUTER keyword.

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Aliases for Tables or Views

You can declare an alias for a table or view in the FROM clause. If you do so, you must use the alias to refer to the table or view in other clauses of the SELECT statement. You can also use aliases to make the query shorter.

The following examples show typical uses of the FROM clause. The first query selects all the columns and rows from the **customer** table. The second query uses a join between the **customer** and **orders** table to select all the customers who have placed orders.

```
SELECT * FROM customer;
SELECT fname, lname, order_num FROM customer, orders
WHERE customer.customer_num = orders.customer_num;
```

The next example is equivalent to the second query in the preceding example, but it declares aliases in the FROM clause and uses them in the WHERE clause:

```
SELECT fname, lname, order_num FROM customer c, orders o
WHERE c.customer_num = o.customer_num;
```

Aliases (sometimes called *correlation names*) are especially useful with a self-join. For more information about self-joins, see [Specifying a Join in the WHERE Clause](#). In a self-join, you must list the table name twice in the FROM clause and declare a different alias for each of the two instances of the table name.

If you use a potentially ambiguous word as an alias (or as a display label), you must begin its declaration with the keyword AS. This keyword is required if you use any of the keywords ORDER, FOR, AT, GROUP, HAVING, INTO, NOT, UNION, WHERE, WITH, CREATE, or GRANT as an alias for a table or view.

The database server would issue an error if the next example did not include the AS keyword to indicate that **not** is a display label, rather than an operator:

```
CREATE TABLE t1(a INT);
SELECT a AS not FROM t1;
```

If you do not declare an alias for a collection-derived table, the database server assigns an implementation-dependent name to it.

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Table expressions

A *table expression* (sometimes called a *derived table*) is the name of a table or view, or a specification that evaluates to a set of rows. These rows are typically the result of a query that is embedded in a nested SELECT statement, or in some other SQL statement.

Table expressions can have the following syntax. These options are a subset of the table options in the ANSI Table Reference and the Other Table Reference in the [FROM Clause](#).

Table expression

```

>>+-table_object-----+-----><
+-(--subquery--)-----+
| (1) (2) |
+-----| Collection-Derived Table |-----+
| (1) (3) |
+-(-| Collection Subquery |--)-----+
| (4) |
+-| Lateral derived table |-----+
| (1) (5) |
'-----| Iterator |-----'

```

Notes:

1. Informix® extension
2. See [Collection-Derived Table](#)
3. See [Collection Subquery](#)
4. See [Lateral derived tables](#)
5. See [Iterator Functions](#)

Element	Description	Restrictions	Syntax
<i>subquery</i>	Nested query whose results are available to the outer query	See Usage notes below	SELECT statement
<i>table_object</i>	Name, synonym, or alias of a table, view, or EXTERNAL table	Must exist, or must reference a derived table that the SELECT statement creates	Identifier or Database Object Name

Usage

Table expressions can be simple or complex:

- Simple table expressions
A *simple* table expression is one whose underlying query can be folded into the main query while preserving the correctness of the query result.
- Complex table expressions
A *complex* table expression is one whose underlying query cannot be folded into the main query while preserving the correctness of the query result. The database server materializes such table expressions into a temporary table that is used in the main query. Subqueries in the FROM clause that specify aggregates, set operators, or the ORDER BY clause are implemented as complex table expressions, which typically require more resources of the database server than simple table expressions.

In either case, the table expression is evaluated as a general SQL query and its results can be thought of as a logical table. This logical table and its columns can be used just like an ordinary base table, but it is not persistent. It exists only during the execution of the query that references it.

Restrictions on table expressions

Table expressions have the same syntax as general SELECT statements, but with most of the restrictions that apply to subqueries in other contexts. A table expression cannot include the SELECT INTO clause that explicitly creates a result table.

does not support Generalized Key indexes. It supports table expressions in the triggered actions of CREATE TRIGGER statements, and as the triggering event of a Select trigger. also supports the ORDER BY clause in table expressions.

supports iterator functions as FROM clause table expressions. The CALL statement of SPL, however, cannot invoke an iterator TABLE function within a subquery in the FROM clause.

Apart from these restrictions, any valid SQL query can be a table expression. A table expression can be nested within another table expression and can include tables and views in its definition. You can use table expressions in CREATE VIEW statements to define views.

Correlated subqueries and derived tables

A *correlated subquery* is a subquery that refers to a column of a table that is not listed in its FROM clause. Conversely, any subquery that references only columns in tables that are listed in its FROM clause is an *uncorrelated subquery*.

In the following example, the uncorrelated subquery that defines a derived table in its FROM clause contains a correlated subquery in its WHERE clause:

```

SELECT * FROM (SELECT * FROM t1
WHERE a IN (SELECT b FROM t2 WHERE t1.a = t2.b));

```

Here the subquery in the first WHERE clause is a correlated subquery, because it references column **a** of table **t1**, but its FROM clause specifies only table **t2**. In FROM clause table expressions, IBM® Informix also supports the ORDER BY clause, which is not valid in subqueries outside the FROM clause. Columns or expressions that are specified by the ORDER BY clause in a table expression need not be included in the Projection clause.

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Lateral derived tables


```

SELECT * FROM (SELECT * FROM t) AS s WHERE t.a = s.b;

SELECT * FROM (SELECT * FROM t) AS s, (SELECT * FROM u) AS v WHERE s.a = v.b;

SELECT * FROM (SELECT SKIP 2 col1 FROM tab1 WHERE col1 > 50 ORDER BY col1 DESC);

SELECT * FROM (SELECT col1,col3 FROM tab1
WHERE col1 < 50 GROUP BY col1,col3 ORDER BY col3 ) vtab(vcol0,vcol1);

SELECT * FROM (SELECT * FROM t WHERE t.a = 1) AS s,
OUTER
(SELECT * FROM u WHERE u.b = 2 GROUP BY 1) AS v WHERE s.a = v.b;

SELECT * FROM (SELECT a AS colA FROM t WHERE t.a = 1) AS s,
OUTER
(SELECT b AS colB FROM u WHERE u.b = 2 GROUP BY 1) AS v
WHERE s.colA = v.colB;

CREATE VIEW vu AS SELECT * FROM (SELECT * FROM t);

SELECT * FROM ((SELECT * FROM t) AS r) AS s;

```

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Restrictions on External Tables in Joins and Subqueries

When you use external tables in joins or subqueries, the following restrictions apply:

- No more than one external table is valid in a query.
- The external table cannot be the outer table in an outer join.
- For subqueries that cannot be converted to joins, you can use an external table in the main query, but not in the subquery.
- You cannot do a self-join on an external table.

For more information on subqueries, see your *IBM® Informix® Performance Guide*.

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The ONLY Keyword

If the FROM clause includes a permanent table that is a supertable within a typed table hierarchy, the query returns the qualifying rows from both the supertable and from its subtables by default, unless you specify the ONLY keyword.

For the SELECT statement to return rows from the supertable only, you must include the ONLY keyword immediately before the supertable name in the FROM clause, and you must enclose the identifier or synonym of the supertable within parentheses, as in this example:

```
SELECT * FROM ONLY (super_tab);
```

The data sources for this query do not include the subtables of **super_tab**.

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Selecting from a Collection Variable

The SELECT statement in conjunction with the Collection-Derived Table segment allows you to select elements from a collection variable.

The Collection-Derived Table segment identifies the collection variable from which to select the elements. (See [Collection-Derived Table](#).)

To modify the contents of a column of a collection data type, you can use the SELECT statement with a collection variable in various ways:

- You can select the contents (if any) of a collection column into a collection variable.
You can assign the data type of the column to a collection variable of type COLLECTION (that is, an untyped collection variable).
- You can select the contents from a collection variable to determine the data that you might want to update.
- You can select the contents from a collection variable INTO another variable in order to update certain collection elements.
The INTO clause identifies the variable for the element value that is selected from the collection variable. The data type of the host variable in the INTO clause must be compatible with that of the corresponding collection element.
- You can use a Collection cursor to select one or more elements from the Informix® ESQ/C collection variable.
For more information, including restrictions on the SELECT statement, see [Associating a Cursor with a Prepared Statement](#).
- You can use a Collection cursor to select one or more elements from an SPL collection variable.
For more information, including restrictions on the SELECT statement, see [Using a SELECT ... INTO Statement](#).

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```
> +-----+-----+  
      '-+-+--table-+-+-----+---+'  
          |         .,------.|   |  
          |        V             |   |  
          '|----column--+--)'
```

Notes:

1. Informix® extension
2. See [Routine Parameter List](#)

Element	Description	Restrictions	Syntax
<i>column</i>	Name declared here for a virtual column in <i>table</i>	Must be unique among <i>column</i> names in <i>table</i> , and cannot include qualifiers.	Identifier
<i>iterator</i>	Name of the iterator function	Must be registered in the database	Identifier
<i>table</i>	Name declared here for virtual table holding the <i>iterator</i> result set	Cannot include qualifiers	Identifier

The keyword **FUNCTION** (or **PROCEDURE**) was required in releases earlier than Informix 10.5. These keyword extensions to the ANSI/ISO standard for SQL are optional in this release, and have no effect. The following two query specifications, which specify **fibGen()** as an iterator function, are equivalent:

```
SELECT * FROM TABLE FUNCTION ( fibGen(10));
SELECT * FROM TABLE ( fibGen(10));
```

The *table* can only be referenced within the context of this query. After the SELECT statement terminates, the virtual table no longer exists.

The number of columns must match the number of values returned by the iterator. An external function can return no more than one value (but that can be of a collection data type). An SPL routine can return multiple values.

The database server issues error -595, however, if any argument to the iterator *table* function is an aggregate expression.

To reference the virtual *table* columns in other parts of the SELECT statement, for example, in the WHERE clause or HAVING clause, you must declare its name and the virtual column names in the FROM clause. You do not need to declare the *table* name or *column* names in the FROM clause if you use the asterisk notation in the Select list of the Projection clause:

```
SELECT * FROM ...
```

For more information and examples of using iterator functions in queries, see *IBM® Informix User-Defined Routines and Data Types Developer's Guide*.

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ANSI Joins

If the FROM clause specifies more than one table reference, the query can join rows from several tables or views. A *join condition* specifies a relationship between at least one column from each table to be joined. Because the columns in a join condition are being compared, they must have compatible data types.

This syntax fragment is part of the [FROM Clause](#).

ANSI Joins

[illegible]

| (6) |
'-(-| Collection Subquery |-----)-----|

Notes:

- 1. See [FROM Clause](#)
- 2. See [Aliases for Tables or Views](#)
- 3. See [Relational Operator](#)
- 4. See [Function Expressions](#)
- 5. See [Condition](#)
- 6. See [Collection Subquery](#)
- 7. See [Using the ON Clause](#)

Element	Description	Restrictions	Syntax
alias	Temporary alternative name declared in the FROM clause for a table or view	See Aliases for Tables or Views	Identifier
column	Column of a table or view to be joined	Must exist in the table or view	Identifier
synonym, table, view	Name of a synonym, table, or view to be joined in the query	Synonym and the table or view to which it points must exist. Must include appropriate qualifiers.	Database Object Name
subquery	Embedded query	Cannot contain the FIRST or the ORDER BY clause	SELECT statement

You must use the same form of join syntax (either Informix® extension or ANSI-compliant) for all of the outer joins in the same query block. When you use the ANSI-compliant join syntax, you must also specify the join condition in the ON clause.

Rows from the tables or views are *joined* when there is a match between the values of specified columns. When the columns to be joined have the same name, you must qualify each column name with its data source. If you join a table to itself, you must list the table name twice in the FROM clause and assign it two different table aliases. Then use the aliases to qualify the column names.

By default, the order in which the database server joins tables and views is independent of the order in which they are referenced in the FROM clause. To force the order in which table objects are joined to match the FROM clause order, you can specify the ORDERED optimizer directive after the SELECT keyword. For more information, see the section [Join-Order Directive](#).

Join-method optimizer directives that you specify for an ANSI-compliant joined query are ignored, but are listed under *Directives Not Followed* in the explain output file.

Multiple join specifications require parentheses around the original table and join segment

The ANSI-Joined Table segment must be enclosed between parentheses if it is immediately followed by another join specification. For example, the first of the following two queries returns an error; the second query is valid:

```
SELECT * FROM (T1 LEFT JOIN T2) CROSS JOIN T3 ON (T1.c1 = T2.c5)
WHERE (T1.c1 < 100); -- Ambiguous order of operations;

SELECT * FROM (T1 LEFT JOIN T2 ON (T1.c1 = T2.c5)) CROSS JOIN T3
WHERE (T1.c1 < 100); -- Unambiguous order of operations;
```

The following valid query specifies nested LEFT OUTER joins of table expressions within the FROM clause of the outer SELECT statement:

```
SELECT * FROM
( (SELECT C1,C2 FROM T3) AS VT3(V31,V32)
LEFT OUTER JOIN
  ( (SELECT C1,C2 FROM T1) AS VT1(VC1,VC2)
LEFT OUTER JOIN
  (SELECT C1,C2 FROM T2) AS VT2(VC3,VC4)
ON VT1.VC1 = VT2.VC3)
ON VT3.V31 = VT2.VC3);
```

Join keyword definitions

In an ANSI-compliant join that specifies the LEFT, RIGHT, or FULL keywords in the FROM clause, the OUTER keyword is optional.

Table 1. Join keywords

FROM Clause Keywords	Corresponding Result Set
CROSS JOIN	The Cartesian product, which is all possible paired combinations that include one row from each of the joined tables.
INNER JOIN	All the rows in a table that have one or more matching rows in the other table (or tables). The unmatched rows are discarded.

FROM Clause Keywords	Corresponding Result Set
LEFT OUTER JOIN	All the rows of the first table reference and the qualifying rows from the second table reference The LEFT keyword specifies a join that treats the first table reference as the dominant table in the join. In a left outer join, the subordinate part of the outer join appears to the right of the keyword that begins the outer join specification. The result set includes all the rows that an INNER join returns, plus all rows that would otherwise have been discarded from the dominant table.
RIGHT OUTER JOIN	The qualifying rows from the first table reference and all the rows of the second table reference The RIGHT keyword specifies a join that treats the second table reference as the dominant table in the join. In a right outer join, the subordinate part of the outer join appears to the left of the keyword that begins the outer join specification. The result set includes all the rows that an INNER join returns, plus all rows that would otherwise have been discarded from the dominant table.
FULL OUTER JOIN	The union of all rows from an INNER join of the two tables, and of all rows of each table that have no match in the other table (using NULL values in the selected columns of the other table)

- [Using the ON Clause](#)

Related concepts:

[Default name and location of the explain output file on UNIX](#)

[Default name and location of the output file on Windows](#)

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Using the ON Clause

Use the ON clause to specify the join condition and any expressions as optional join filters.

The following example from the **stores_demo** database illustrates how the join condition in the ON clause combines the **customer** and **orders** tables:

```
SELECT c.customer_num, c.company, c.phone, o.order_date
FROM customer c LEFT JOIN orders o
ON c.customer_num = o.customer_num;
```

The following table shows part of the joined **customer** and **orders** tables.

customer_num	company	phone	order_date
101	All Sports Supplies	408-789-8075	05/21/2008
102	Sports Spot	415-822-1289	NULL
103	Phil's Sports	415-328-4543	NULL
104	Play Ball!	415-368-1100	05/20/2008
—	—	—	—

In an outer join, the join filters (expressions) that you specify in the ON clause determine which rows of the subordinate table join to the dominant (or outer) table. The dominant table, by definition, returns all its rows in the joined table. That is, a join filter in the ON clause has no effect on the dominant table.

If the ON clause specifies a join filter on the dominant table, the database server joins only those dominant table rows that meet the criterion of the join filter to rows in the subordinate table. The joined result contains all rows from the dominant table. Rows in the dominant table that do not meet the criterion of the join filter are extended with NULL values for the subordinate columns.

The following example from the **stores_demo** database illustrates the effect of a join filter in the ON clause:

```
SELECT c.customer_num, c.company, c.phone, o.order_date
FROM customer c LEFT JOIN orders o
ON c.customer_num = o.customer_num
AND c.company <> "All Sports Supplies";
```

The row that contains All Sports Supplies remains in the joined result.

customer_num	company	phone	order_date
101	All Sports Supplies	408-789-8075	NULL
102	Sports Spot	415-822-1289	NULL
103	Phil's Sports	415-328-4543	NULL
104	Play Ball!	415-368-1100	05/20/2008
—	—	—	—

Even though the order date for customer number 101 is 05/21/2008 in the **orders** table, the effect of placing the join filter (`c.company <> "All Sports Supplies"`) prevents this row in the dominant **customer** table from being joined to the subordinate **orders** table. Instead, a NULL value for **order_date** is extended to the row of All Sports Supplies.

Applying a join filter to a base table in the subordinate part of an outer join can improve performance. For more information, see your *IBM® Informix® Performance Guide*.

- [Specifying a Post-Join Filter](#)

- [Using a Join as the Dominant or Subordinate Part of an Outer Join](#)

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Specifying a Post-Join Filter

When you use the ON clause to specify the join, you can use the WHERE clause as a post-join filter. The database server applies the post-join filter of the WHERE clause to the results of the outer join.

The following example illustrates the use of a post-join filter. This query returns data from the **stores_demo** database. Suppose you want to determine which items in the catalog are not being ordered. The next query creates an outer join of the data from the **catalog** and **items** tables and then determines which catalog items from a specific manufacturer (HRO) have not sold:

```
SELECT c.catalog_num, c.stock_num, c.manu_code, i.quantity
FROM catalog c LEFT JOIN items i
ON c.stock_num = i.stock_num AND c.manu_code = i.manu_code
WHERE i.quantity IS NULL AND c.manu_code = "HRO";
```

The WHERE clause contains the post-join filter that locates the rows of HRO items in the catalog for which nothing has been sold.

When you apply a post-join filter to a base table in the dominant or subordinate part of an outer join, you might improve performance. For more information, see your *IBM® Informix® Performance Guide*.

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Using a Join as the Dominant or Subordinate Part of an Outer Join

With the ANSI join syntax, you can nest joins. You can use a join as the dominant or subordinate part of an outer or inner join.

Suppose you want to modify the previous query (the post-join filter example) to get more information that will help you determine whether to continue carrying each unsold item in the catalog. You can modify the query to include information from the **stock** table so that you can see a short description of each unsold item with its cost:

```
SELECT c.catalog_num, c.stock_num, s.description, s.unit_price,
s.unit_descr, c.manu_code, i.quantity
FROM (catalog c INNER JOIN stock s
ON c.stock_num = s.stock_num
AND c.manu_code = s.manu_code)
LEFT JOIN items i
ON c.stock_num = i.stock_num
AND c.manu_code = i.manu_code
WHERE i.quantity IS NULL
AND c.manu_code = "HRO";
```

In this example, an inner join between the **catalog** and **stock** tables forms the dominant part of an outer join with the **items** table.

For additional examples of outer joins, see the *IBM® Informix® Guide to SQL: Tutorial*.

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Informix-Extension Outer Joins

The Informix®-extension syntax for outer joins begins with an implicit left outer join. That is, you begin the Informix-extension outer join with the OUTER keyword.

This syntax fragment is part of the [FROM Clause](#).

Informix OUTER Clause

|--OUTER----->

```
>--+--+| (1)
| | | ANSI Tables |-----|
| | | (1) |
| | | 'Other Tables |-----'
| | | .,-----|
| | | V V (1) | V (2) |
| | | '-----| Informix OUTER Clause |-----'
| | | (1) |
| | | 'Other Tables |-----'
| | | .,-----| | | | |
| | | V (2) | V (1) |
| | | '-----| Informix OUTER Clause |-----| ANSI Tables |-----|
| | | (1) |
```

Notes:

1. See [FROM Clause](#)
2. Informix extension

The following example uses the OUTER keyword to create an outer join that lists all customers and their orders, regardless of whether they have placed orders:

```
SELECT c.customer_num, c.lname, o.order_num FROM customer c,
       OUTER orders o WHERE c.customer_num = o.customer_num;
```

This example returns all the rows from the **customer** table with the rows that match in the **orders** table. If no record for a customer appears in the **orders** table, the returned **order_num** column for that customer has a NULL value.

If you have a complex outer join, that is, the query has more than one outer join, you must either embed the additional outer join or joins in parentheses, as the syntax diagram shows, or establish join conditions, or relationships, between the dominant table and each subordinate table in the WHERE clause.

When an expression or a condition in the WHERE clause relates two subordinate tables, you must use parentheses around the joined tables in the FROM clause to enforce dominant-subordinate relationships, as in this example:

```
SELECT c.company, o.order_date, i.total_price, m.manu_name
FROM customer c,
     OUTER (orders o, OUTER (items i, OUTER manufact m))
WHERE c.customer_num = o.customer_num
     AND o.order_num = i.order_num
     AND i.manu_code = m.manu_code;
```

When you omit parentheses around the subordinate tables in the FROM clause, you must establish join conditions between the dominant table and each subordinate table in the WHERE clause. If a join condition is between two subordinate tables, the query fails.

The following example, however, successfully returns a result

- that joins the dominant **customer** table with the subordinate **orders** table,
- and joins the dominant **customer** table with the subordinate **cust_calls** table:

```
SELECT c.company, o.order_date, c2.call_descr
FROM customer c, OUTER orders o, OUTER cust_calls c2
WHERE c.customer_num = o.customer_num
     AND c.customer_num = c2.customer_num;
```

The IBM® Informix Guide to SQL: Tutorial has examples of complex outer joins.

Restrictions on Informix-extension outer joins

If you use this Informix-extension syntax for an outer join, all of the following restrictions apply to the same SELECT statement:

- You must use Informix-extension syntax for all outer joins in a single query block.
- You must include the join condition in the WHERE clause.
- You cannot begin another outer join with the LEFT JOIN or the LEFT OUTER JOIN keywords.
- You cannot define a lateral table reference or include the LATERAL keyword.
- Within the Informix-extension outer join, the Table Reference syntax segment cannot include a lateral table reference that is declared in the same SELECT statement.

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GRID clause

Use the GRID clause to specify the scope of a cross-server query whose data sources are tables of database servers that are nodes of a grid.

The GRID clause is not valid unless the session is connected to a database within an existing grid. A grid can be created by using appropriate **cdr** commands and **ifx_grid** routines of the Enterprise Replication facility.

This syntax is an extension to the ANSI/ISO standard for the SQL language.

This syntax fragment is part of the [SELECT statement](#).

GRID clause

```
|--GRID--++-----+--'--grid--++--'-----|
      '-ALL-'      '-region-'
```

Element	Description	Restrictions	Syntax
<i>grid</i>	Name of the grid that is in scope for this query	Must exist and must be defined by the cdr define grid command	Identifier
<i>region</i>	Name of the region that is in scope for this query	Must exist and must be defined by the cdr define region command	Identifier

Usage

Any SELECT statement that explicitly or implicitly includes the GRID clause is called a *grid query*. The result of a grid query are qualifying rows from a logical UNION or UNION ALL of each table in the FROM clause across tables with the same names and the same schema in every grid server. This union can include tables across all nodes in the grid, or across a subset of those grid nodes, called a *region*.

Note: The tables that the FROM clause of a grid query specifies must all have the same schema and must meet other requirements that this topic identifies. Because of these restrictions, not all Informix grids can support grid queries.

The optional ALL keyword

If the optional ALL keyword immediately follows the GRID keyword, the result of the grid query is a logical UNION ALL. meaning that the result set of the grid query can include duplicate rows. Otherwise, if you omit the ALL keyword, only distinct values are returned from the logical UNION of the results from each participating grid server.

SET ENVIRONMENT statement options for grid queries

Two options to the SET ENVIRONMENT statement can define a default GRID clause, so that any subsequent SELECT statements with no GRID clause is interpreted as grid query that includes the default GRID clause:

SET ENVIRONMENT SELECT_GRID

This statement can specify a grid or region as the default scope of subsequent grid queries that return the union of unique qualifying rows. The GRID clause can omit the grid or region name for grid queries that return UNION results for the specified default nodes.

SET ENVIRONMENT SELECT_GRID_ALL

This statement can specify a grid or region as the default scope of subsequent grid queries that return the union of all qualifying rows, including duplicates. The GRID clause can omit the grid or region name for grid queries that return UNION ALL results for the specified default nodes.

While either of these options to the SET ENVIRONMENT statement is enabled, the SQL parser applies the current default GRID clause to every SELECT statement in the session that does not include an explicit GRID clause. No more than one default GRID clause can be in effect during the same session at the same point in time. When either option is in effect, using the SET ENVIRONMENT statement to set the other keyword option, or to reset the same keyword option for a different grid or region disables the previously set default.

You can also disable the default GRID clause by issuing either of these SQL statements:

```
SET ENVIRONMENT SELECT_GRID DEFAULT;
SET ENVIRONMENT SELECT_GRID_ALL DEFAULT;
```

Each of the statements above prevents the database server from interpreting every subsequent query in the current session as a grid query. Unless you define a new default GRID clause in the same session, any subsequent SELECT statement must include an explicit GRID clause to run as a grid query. While either the SELECT_GRID session environment option for UNION queries or the SELECT_GRID_ALL session environment option for UNION ALL queries has specified a default grid or region as the scope of grid queries in the current session, you can omit the GRID clause in grid queries on the nodes of that grid or region, as in the following example, where **tab1** and **tab2** are tables that have the same schema, locale, and code set on every grid server within the **region_03** subset of a grid:

```
SET ENVIRONMENT SELECT_GRID 'region_03'
SELECT * FROM tab1;
SELECT * FROM tab2;
```

The two queries above are executed as if you had explicitly specified this GRID clause:

```
SELECT * FROM tab1 GRID 'region_03';
SELECT * FROM tab2 GRID 'region_03';
```

No more than one of the SELECT_GRID and SELECT_GRID_ALL session environment options to the SET ENVIRONMENT statement can be enabled for the current user session at the same point in time. When either option is in effect, using the SET ENVIRONMENT statement to set the other keyword option, or to reset the same keyword option for a different grid or region disables the previously set default.

The following SQL statements replace the previous default GRID clause by defining a different default GRID clause that combines the UNION ALL results from participating grid servers in a different region, the **region_04** subset of a grid:

```
SET ENVIRONMENT SELECT_GRID_ALL 'region_04'
SELECT * FROM tab1;
SELECT * FROM tab2;
```

Those two queries will be executed as if you had specified this GRID clause:

```
SELECT * FROM tab1 GRID ALL 'region_04';
SELECT * FROM tab2 GRID ALL 'region_04';
```

By default, a grid query fails if the database server that issues the grid query cannot connect to one or more of the nodes within the grid or region that the explicit or default GRID clause specifies. Another session environment variable that the SET ENVIRONMENT statement can enable can return partial results from a grid query, even if some grid servers in the specified grid or region are unavailable:

SET ENVIRONMENT GRID_NODE_SKIP

This statement can enable processing of a grid query to continue when one or more of the grid servers is unavailable.

If you issue the SQL statement

```
SET ENVIRONMENT GRID_NODE_SKIP ON;
```

the database server ignores any node which is not available, and returns qualifying rows from the participating grid servers. You can identify any skipped nodes by invoking the `ifx_gridquery_skipped_nodes()` function.

Another function, `ifx_gridquery_skipped_node_count()`, can be used to detect how many nodes were skipped. For more information about these functions, see the .

Tables in the FROM clause of grid queries

Only permanent database tables are valid in the FROM clause of a grid query. They must be defined as grid tables by running the `cdr change gridtable` command.

The following table objects are not supported:

- Synonyms or views on tables, except for tables in the **sysmaster** database
- Table objects that the CREATE EXTERNAL TABLE statement defined
- Tables that are qualified by the name of a database server or grid server
- Tables on which a concurrent ALTER TABLE, ALTER FRAGMENT, or ALTER INDEX operation is being performed
- Tables that have a different schema from other tables of the same name in databases of participating grid servers
- Tables in databases that were not created with the same database locale and code set
- Tables in databases whose settings for the SQL_LOGICAL_CHAR configuration parameter or the DELIMIDENT or GL_USEGLU environment variables are not the same across all databases participating in the grid query.

In addition, the projection list of a grid query cannot include any column or expression whose data type is not supported in cross-server queries. The unsupported data types include all complex or large-object types, and some user-defined types (UDTs) and opaque types.

The same restrictions that apply to DISTINCT data types in distributed DML operations across databases of the same Informix instance also apply to DISTINCT data types in grid queries. For a discussion of the data types that are valid in distributed queries, see the topics [Data Types in Cross-Server Transactions](#) and [DISTINCT Types in Distributed Operations](#).

Additional restrictions on grid queries

The user executing the grid query must be a valid user on all nodes within the grid or region.

A grid query cannot be a subquery that contains references to its outer query.

The grid query cannot reference any of the following among its specifications:

- A subquery (but the grid query itself can be a subquery of an outer query that it does not reference)
- A join operation across grid servers
- Connection requests that result in cross-server joins
- A procedure or function that does not exist on all participating grid servers.

Neither the UNION nor UNION ALL set operators, nor the INTERSECT, MINUS, or EXCEPT set operators, are valid in a grid query block.

The GRID clause should not be included in SELECT statements outside a grid context. For more information about grids, see the [SET ENVIRONMENT statement](#) and the .

Related reference:

[SELECT GRID session environment option](#)
[SELECT GRID ALL session environment option](#)
[GRID NODE SKIP session environment option](#)

Related information:

[ifx_grid_connect\(\) procedure](#)
[cdr define region](#)
[cdr delete region](#)
[cdr change gridtable](#)
[cdr remaster gridtable](#)
[ifx_node_id\(\) function](#)
[ifx_node_name\(\) function](#)
[ifx_gridquery_skipped_nodes\(\) function](#)
[ifx_gridquery_skipped_node count\(\) function](#)
[ifx_grid_release\(\) function](#)
[ifx_grid_remove\(\) function](#)
[Grid queries](#)

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WHERE clause of SELECT

The WHERE clause can specify join conditions for Informix®-extension joins, post-join filters for ANSI-compliant joins, and for search criteria on data values.

This syntax fragment is part of the [SELECT statement](#).

WHERE Clause

```
|--WHERE----->
      .-Logical_Operator-----
      V                (1)      |
```

```

>-----+| Condition |-----+-----+
|          (2)          |
+-| Join |-----+
|          (3)          |
+-| Function Expression |-----+
+-| (subquery) |-----+
|          (4)          |
+-| (-| Collection Subquery |-----) |
|          (5)          |
+-| Statement Local Variable Expressions |-----+

```

Notes:

1. See [Condition](#)
2. See [Specifying a Join in the WHERE Clause](#)
3. See [Function Expressions](#)
4. See [Collection Subquery](#)
5. See [Statement-Local Variable Expressions](#)

Element	Description	Restrictions	Syntax
<i>Logical_ Operator</i>	Combines two conditions	Valid options are <i>logical union</i> (= OR or OR NOT) or <i>logical intersection</i> (= AND or AND NOT)	Conditions with AND or OR
<i>subquery</i>	Embedded query	Cannot include the FIRST or ORDER BY keywords	SELECT statement

- [Using a Condition in the WHERE Clause](#)
- [Specifying a Join in the WHERE Clause](#)
You join two tables by creating a relationship in the WHERE clause between at least one column from one table and at least one column from another. The join creates a temporary composite table where each pair of rows (one from each table) that satisfies the join condition is linked to form a single row.

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Using a Condition in the WHERE Clause

You can use these simple conditions or comparisons in the WHERE clause:

- Relational-operator condition
- IN or BETWEEN . . . AND
- IS NULL or IS NOT NULL
- LIKE or MATCHES

You also can use a SELECT statement within the WHERE clause; this is called a *subquery*. The following WHERE clause operators are valid in a subquery:

- IN or EXISTS
- ALL, ANY, or SOME

For more information, see [Condition](#).

In the WHERE clause, an aggregate function is not valid unless it is part of a subquery or is on a correlated column originating from a parent query, and the WHERE clause is in a subquery within a HAVING clause.

- [Relational-Operator Condition](#)
- [IN Condition](#)
- [BETWEEN Condition](#)
- [Using IS NULL and IS NOT NULL Conditions](#)
- [LIKE or MATCHES Condition](#)
- [IN Subquery](#)
With the IN subquery, more than one row that satisfies the IN or NOT IN condition can be returned, but only one column can be returned.
- [EXISTS Subquery](#)
From the EXISTS subquery, rows that satisfy EXISTS conditions in one or more columns can be returned. (Similarly, the NOT EXISTS subquery can return rows that satisfy NOT EXISTS conditions in one or more columns.)
- [ALL, ANY, SOME Subqueries](#)

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Relational-Operator Condition

A relational-operator condition is satisfied if the expressions on each side of the operator fulfill the relation that the operator specifies. The following statements use the greater than (>) and equal (=) relational operators:

```

SELECT order_num FROM orders
WHERE order_date > '6/04/08';
SELECT fname, lname, company
FROM customer
WHERE city[1,3] = 'San';

```

Single quotation marks are required around 'San' because the substring is from a character column. See the [Relational-Operator Condition](#).

Blank strings and empty strings in the WHERE clause

For LVARCHAR, NVARCHAR, or VARCHAR columns, queries with a WHERE clause specifying equality of the column value to an empty string (

```
WHERE varlength_col = ''
```

) return the same result set as an otherwise identical query in which the WHERE clause specifies equality to a string of blank (ASCII 32) characters.

For example, if `varlength_col` is of type VARCHAR, NVARCHAR, or LVARCHAR, the following WHERE clause examples are all functionally equivalent to a WHERE clause that specifies equality to an empty string:

```
WHERE varlength_col = ''
WHERE varlength_col = ' '
WHERE varlength_col = ' '
```

Thus, for the built-in variable-length character data types, the WHERE clause makes no distinction between an empty string and a string consisting entirely of one or more blank characters. (Note, however, that the query filter

```
WHERE varlength_col IS NULL
```

is not equivalent to the previous WHERE clause examples, and returns a different result set if any `varlength_col` value is NULL.)

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IN Condition

The IN condition is satisfied when the expression to the left of the IN keyword is included in the list of values to the right of the keyword.

The following examples show the IN condition:

```
SELECT lname, fname, company FROM customer
WHERE state IN ('CA','WA', 'NJ');
SELECT * FROM cust_calls
WHERE user_id NOT IN (USER );
```

For more information, see the [IN Subquery](#).

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BETWEEN Condition

The BETWEEN condition is satisfied when the value to the left of BETWEEN is in the inclusive range of the two values on the right of BETWEEN. The first two queries in the following example use literal values after the BETWEEN keyword. The third query uses the built-in CURRENT function and a literal interval to search for dates between the current day and seven days earlier.

```
SELECT stock_num, manu_code FROM stock
WHERE unit_price BETWEEN 125.00 AND 200.00;
SELECT DISTINCT customer_num, stock_num, manu_code
FROM orders, items
WHERE order_date BETWEEN '6/1/07' AND '9/1/07';
SELECT * FROM cust_calls WHERE call_dtime
BETWEEN (CURRENT - INTERVAL(7) DAY TO DAY) AND CURRENT;
```

For more information, see the [BETWEEN Condition](#).

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Using IS NULL and IS NOT NULL Conditions

The IS NULL condition is satisfied if the specified *column* contains a NULL value, or if the specified *expression* evaluates to NULL.

If you use the IS NOT NULL predicate, the condition is satisfied when the *column* contains a value that is not NULL, or when the *expression* does not evaluate to NULL. The following example selects the order numbers and customer numbers for which the order has not been paid:

```
SELECT order_num, customer_num FROM orders
WHERE paid_date IS NULL;
```

For a complete description of the IS NULL and IS NOT NULL operators, see the [IS NULL and IS NOT NULL Conditions](#).

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LIKE or MATCHES Condition

The LIKE or MATCHES condition is satisfied if either of the following is true:

- The value of the column that precedes the LIKE or MATCHES keyword matches the pattern that the quoted string specifies. You can use wildcard characters in the string.
- The value of the column that precedes the LIKE or MATCHES keyword matches the pattern that is specified by the column that follows the LIKE or MATCHES keyword. The value of the column on the right serves as the matching pattern in the condition.

The following examples use a backslash (\) as the default escape character. The default escape character is set by the DEFAULTESCCHAR configuration parameter or the DEFAULTESCCHAR session environment option.

The following SELECT statement returns all rows in the **customer** table in which the **lname** column begins with the literal string 'Baxter'. Because the string is a literal string, the condition is case sensitive.

```
SELECT * FROM customer WHERE lname LIKE 'Baxter%';
```

The next SELECT statement returns all rows in the **customer** table in which the value of the **lname** column matches the value of the **fname** column:

```
SELECT * FROM customer WHERE lname LIKE fname;
```

The following examples use the LIKE condition with a wildcard. The first SELECT statement finds all stock items that are some kind of ball. The second SELECT statement finds all company names that contain a percent (%) sign. Backslash (\) is used as the default escape character for the percent (%) sign wildcard. The third SELECT statement uses the ESCAPE option with the LIKE condition to retrieve rows from the **customer** table in which the **company** column includes a percent (%) sign. The z is used as an escape character for the percent (%) sign:

```
SELECT stock_num, manu_code FROM stock
WHERE description LIKE '%ball';
SELECT * FROM customer WHERE company LIKE '%\%%';
SELECT * FROM customer WHERE company LIKE '%z%%' ESCAPE 'z';
```

The following examples use MATCHES with a wildcard in SELECT statements. The first SELECT statement finds all stock items that are some kind of ball. The second SELECT statement finds all company names that contain an asterisk (*). The backslash (\) is used as the default escape character for a literal asterisk (*) character. The third statement uses the ESCAPE option with the MATCHES condition to retrieve rows from the **customer** table where the **company** column includes an asterisk (*). The z character is specified as an escape character for the asterisk (*) character:

```
SELECT stock_num, manu_code FROM stock
WHERE description MATCHES '*ball';
SELECT * FROM customer WHERE company MATCHES '*\***';
SELECT * FROM customer WHERE company MATCHES '*z***' ESCAPE 'z';
```

For information about the supported data types of operands in LIKE or MATCHES expressions, see the topic [LIKE and MATCHES Condition](#).

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IN Subquery

With the IN subquery, more than one row that satisfies the IN or NOT IN condition can be returned, but only one column can be returned.

This example shows the use of a NOT IN subquery in a SELECT statement:

```
SELECT DISTINCT customer_num FROM orders
WHERE order_num NOT IN
(SELECT order_num FROM items
WHERE stock_num = 1);
```

For additional information, see the [IN Condition](#).

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EXISTS Subquery

From the EXISTS subquery, rows that satisfy EXISTS conditions in one or more columns can be returned. (Similarly, the NOT EXISTS subquery can return rows that satisfy NOT EXISTS conditions in one or more columns.)

The following example of a SELECT statement with a NOT EXISTS subquery returns the stock number and manufacturer code for every item that has never been ordered (and is therefore not listed in the **items** table).

It is appropriate to use a NOT EXISTS subquery in this SELECT statement because you need the correlated subquery to test both **stock_num** and **manu_code** in the **items** table.

```
SELECT stock_num, manu_code FROM stock
WHERE NOT EXISTS
(SELECT stock_num, manu_code FROM items
```



```
WHERE stock.stock_num = items.stock_num AND
       stock.manu_code = items.manu_code);
```

The preceding example would work equally well if you use a `SELECT *` in the subquery in place of the column names, because you are testing for the existence of a row or rows.

For additional information, see the [EXISTS Subquery condition](#).

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ALL, ANY, SOME Subqueries

The following examples return the order number of all orders that contain an item whose total price is greater than the total price of every item in order number 1023. The first `SELECT` uses the `ALL` subquery, and the second `SELECT` produces the same result by using the `MAX` aggregate function.

```
SELECT DISTINCT order_num FROM items
WHERE total_price > ALL (SELECT total_price FROM items
WHERE order_num = 1023);
```

```
SELECT DISTINCT order_num FROM items
WHERE total_price > SELECT MAX(total_price) FROM items
WHERE order_num = 1023);
```

The following `SELECT` statements return the order number of all orders that contain an item whose total price is greater than the total price of at least one of the items in order number 1023. The first `SELECT` statement uses the `ANY` keyword, and the second `SELECT` statement uses the `MIN` aggregate function:

```
SELECT DISTINCT order_num FROM items
WHERE total_price > ANY (SELECT total_price FROM items
WHERE order_num = 1023);
```

```
SELECT DISTINCT order_num FROM items
WHERE total_price > (SELECT MIN(total_price) FROM items
WHERE order_num = 1023);
```

You can omit the keywords `ANY`, `ALL`, or `SOME` in a subquery if the subquery returns exactly one value. If you omit `ANY`, `ALL`, or `SOME`, and the subquery returns more than one value, you receive an error. The subquery in the next example returns only one row, because it uses an aggregate function:

```
SELECT order_num FROM items
WHERE stock_num = 9 AND quantity =
(SELECT MAX(quantity) FROM items WHERE stock_num = 9);
```

See also [ALL, ANY, and SOME Subqueries](#).

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Specifying a Join in the WHERE Clause

You join two tables by creating a relationship in the `WHERE` clause between at least one column from one table and at least one column from another. The join creates a temporary composite table where each pair of rows (one from each table) that satisfies the join condition is linked to form a single row.

This syntax fragment is part of the [WHERE clause of SELECT](#).

Join

```
(1)
|---+-----+---column---| Relational Operator |----->
'--| Data Source |--'

>---+-----+---column-----|
'--| Data Source |--'
```

Data Source

```
|---+alias .---+-----|
+-external .--+
+-table .----+
+-view .-----+
'-synonym .--'
```

Notes:

1. See [Relational Operator](#)

Element	Description	Restrictions	Syntax
<i>alias</i>	Temporary alternative name declared in the <code>FROM</code> clause for a table or view	See the Self joins section; FROM Clause	Identifier
<i>column</i>	Column of a table or view to be joined	Must exist in the table or view	Identifier

Element	Description	Restrictions	Syntax
<i>external</i>	External table from which to retrieve data	External table must exist. Must include appropriate qualifiers.	Database Object Name
<i>synonym, table, view</i>	Name of a synonym, table, or view to be joined in the query	Synonym and the table or view to which it points must exist. Must include appropriate qualifiers.	Database Object Name

Rows from the tables or views are *joined* when there is a match between the values of specified columns. When the columns to be joined have the same name, you must qualify each column name with its data source. You can create two-table joins, multiple-table joins, self-joins, and outer joins (Informix-extension syntax).

Two-table joins

The following example shows a two-table join:

```
SELECT order_num, lname, fname FROM customer, orders
WHERE customer.customer_num = orders.customer_num;
```

Multi-table joins

A multiple-table join is a join of more than two tables. Its structure is similar to the structure of a two-table join, except that you have a join condition for more than one pair of tables in the WHERE clause. When columns from different tables have the same name, you must qualify the column name with its associated table or table alias, as in *table.column*.

The following multiple-table join yields the company name of the customer who ordered an item as well as its stock number and manufacturer code:

```
SELECT DISTINCT company, stock_num, manu_code
FROM customer c, orders o, items i
WHERE c.customer_num = o.customer_num
AND o.order_num = i.order_num;
```

Self joins

You can join a table to itself. To do so, you must list the table name twice in the FROM clause and assign it two different table aliases. Use the aliases to refer to each of the *two* tables in the WHERE clause. The next example is a self-join on the **stock** table. It finds pairs of stock items whose unit prices differ by a factor greater than 2.5. The letters *x* and *y* are each aliases for the **stock** table.

```
SELECT x.stock_num, x.manu_code, y.stock_num, y.manu_code
FROM stock x, stock y WHERE x.unit_price > 2.5 * y.unit_price;
```

Informix-extension outer joins

The next outer join lists the company name of the customer and all associated order numbers, if the customer has placed an order. If not, the company name is still listed, and a NULL value is returned for the order number.

```
SELECT company, order_num FROM customer c, OUTER orders o
WHERE c.customer_num = o.customer_num;
```

For the syntax of outer joins, see [Informix-Extension Outer Joins](#).

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Hierarchical Clause

The Hierarchical clause sets the conditions for recursive queries on a table object in which a hierarchy of parent-child dependencies exists among the rows. SELECT statements that include this clause are called *hierarchical queries*.

The table object on which the hierarchical query operates must be specified in the FROM clause of the SELECT statement. The table object is typically a self-referencing table in which one or more columns acts as a foreign key constraint for another column (or for a subset of the columns) in the same table.

A hierarchical query operates on rows in which one or more column values correspond to nodes within a logical structure of parent-child relationships. If parent rows have multiple children, sibling relationships exist among child rows of the same parent. These relationships might reflect, for example, the reporting structure among employees and managers within the divisions and management levels of an organization.

The syntax that this clause supports is an extension to the ANSI/ISO standard for SQL. This syntax fragment is part of the [SELECT statement](#).

Hierarchical Clause

```

|-----+-----| CONNECT BY Clause |-----|
|          (1) |
|-----+-----|
| START WITH Clause |-----|

```

Notes:

1. See [START WITH Clause](#)
2. See [CONNECT BY Clause](#)

The table object on which the hierarchical query operates must be specified in the FROM clause of the SELECT statement. The table object can be any of the following table objects:

- A table or updateable view
- A temporary table
- A table in another database of the same Informix instance to which the session is connected
- A derived table that is the result of a query
- A table that is protected by a label-based access control (LBAC) security policy
- A table with column level encryption or row level encryption
- A synonym for any of the other table objects.

The following table objects are not supported in the FROM clause of a hierarchical query:

- A join of two or more tables
- A view that is not updatable
- A table in a database of a remote Informix instance
- An external table that the CREATE EXTERNAL TABLE statement defined
- A sequence object.

Informix supports sequence objects in the projection list of hierarchical queries, in the WHERE clause, and in other contexts where an expression is valid in SELECT statements, but not in the hierarchical query clause.

The hierarchical clause is valid in correlated subqueries and in uncorrelated subqueries.

Hierarchical queries can include all types of optimizer directives, with these exceptions:

- Join-order directives
- Join-method directives

Hierarchical queries do not support the Parallel Database Query (PDQ) feature of Informix.

The Hierarchical clause can specify recursive queries on a table whose rows describe a hierarchy of parent-child relationships.

- The hierarchy can be a simple hierarchy, such as the reporting structure of an organization in which every node that is not the root reports to a single node at higher level within the hierarchy. (In the LBAC security feature of Informix, a security label component of type TREE has the logical structure of a simple hierarchy.)
- The Hierarchical clause can query data hierarchies of more complex topologies, in which nodes have many-to-many relationships, and in which a child node can be the ancestor of its parent. For information about using the Hierarchical clause to query a table that has cycles within the data hierarchy, see [CONNECT BY Clause](#).

Important: Hierarchical queries are most efficient for data sets in which parent-child dependencies in the table have the logical topology of a simple graph. If the self-referencing table includes more than one independent hierarchy for the same set of columns, or if any child row is also an ancestor of its parent, see [Dependency patterns that are not a simple graph](#).

Note: The Hierarchical clause is unrelated to table hierarchies, in which a hierarchy of parent-child relationships exist among the schemas of a set of typed tables. Similarly, the hierarchy of a set of DISTINCT data types that all derive from a common base type resembles a data hierarchy, but is unrelated to the Hierarchical clause, where the hierarchy exists in parent-child dependencies between data entities, rather than relationships among data types.

SQL Syntax Specific to Hierarchical Queries

Besides the START WITH, CONNECT BY, and CONNECT NOCYCLE BY keywords that specify the conditions for recursive queries of a table that contains hierarchical data, hierarchical queries also support syntax tokens that are valid only in hierarchical queries, and that cannot be used in SELECT statements that have no CONNECT BY clause. Syntax tokens specific to hierarchical queries include two operators, three pseudocolumns, and a built-in function:

- **CONNECT_BY_ROOT** operator
This operator can return an expression for the root ancestor of its operand.
- **PRIOR** operator
This operator can reference a returned value from the previous recursive step (where "step" refers to an iteration of the recursive query).
- **LEVEL** pseudocolumn
This pseudocolumn returns an integer, indicating which step of the recursive query returned a row within the hierarchy.
- **CONNECT_BY_ISCYCLE** pseudocolumn
This pseudocolumn can indicate whether a row has a child row that is also its ancestor.
- **CONNECT_BY_ISLEAF** pseudocolumn
This pseudocolumn can indicate whether a row has any children among the rows that the query returns.
- **SYS_CONNECT_BY_PATH** function
This function can construct and return a string that represents the path from a specified row to the root of the hierarchy
- **SIBLINGS** keyword in the ORDER BY clause
The ORDER SIBLINGS BY clause can sort returned rows for siblings of the same parent at every level.

A *pseudocolumn* is a built-in identifier that the SQL parser can recognize in specific contexts, and that shares the same namespace as columns and variables. These pseudocolumns and the SYS_CONNECT_BY_PATH function are typically specified in the Projection clause of the SELECT statement, but the LEVEL pseudocolumn and the PRIOR operator can be specified in the Hierarchical clause.

For details of the syntax and semantics of these tokens that support only hierarchical queries, see [Conditions in the CONNECT BY Clause](#) and [ORDER SIBLINGS BY Clause](#).

Overview of Hierarchical Queries

The clauses of a SELECT statement that includes the Hierarchical clause are processed in the following sequence:

1. FROM clause (for only a single table object in the current database)
2. Hierarchical clause
3. WHERE clause (without join predicates)
4. GROUP BY clause
5. HAVING clause
6. Projection clause
7. ORDER BY clause

The ORDER BY SIBLING option of the ORDER BY clause can order the set of rows that are children of the same parent.

A subquery that includes the Hierarchical clause returns the intermediate result set in a partial order, where the rows produced in iteration (n+1) for a specific hierarchy immediately follow the row in iteration (n) that produced them. However, specifying an ORDER BY clause, a GROUP BY or HAVING clause, or the DISTINCT or UNIQUE keyword in the Projection clause destroys that partial order.

The Hierarchical clause follows the WHERE clause in the lexical sequence of SELECT statement clauses, but the WHERE clause predicates are processed on the result of the Hierarchical clause. The WHERE clause cannot specify join predicates if the SELECT statement includes the Hierarchical clause, but the table object that is specified in the FROM clause can be the result set of a query that joins one or more tables.

Any SELECT statement that includes a hierarchical-query-clause is called a hierarchical query, which performs a recursive series of queries on the table that the FROM clause specifies:

1. The optional START WITH clause can specify a condition. Any rows that satisfy this condition are returned as the first intermediate result set of the hierarchical query.
2. The next step applies the condition that is specified in the CONNECT BY clause to the table. Any rows that satisfy that condition are returned as the second intermediate result set.
3. The next step applies the CONNECT BY condition to the table. Any rows that are returned comprise the third intermediate result set.
4. The CONNECT BY clause runs queries recursively to produce successive intermediate result sets, until an iteration yields an empty result set.
5. The hierarchical SELECT statement then combines all of the intermediate result sets of the preceding recursive steps, producing the final result set of the Hierarchical clause.
6. The predicates of the WHERE clause are then applied to this set of rows that the Hierarchical clause retrieved, and the remaining clauses of the SELECT statement are then applied in the order listed.

After the START WITH and CONNECT BY clauses return all of the intermediate result sets, you can use the ORDER SIBLINGS BY clause to sort the sibling rows that have the same parent for every level within the hierarchy. For more information, see [ORDER SIBLINGS BY Clause](#).

You can use output from the SET EXPLAIN statement to view the execution path of a hierarchical query.

The Hierarchical clause provides an efficient alternative to using the Node database extension to retrieve information from hierarchical data sets

Example of a Hierarchical Data Set

In several topics that follow, SQL code examples that illustrate hierarchical queries are based on hierarchic data in the following **employee** table, whose rows contains information about employees within an organizational hierarchy. The **mgrid** column shows the employee identifier (**empid**) of the manager to whom the employee reports:

```
CREATE TABLE employee(  
    empid INTEGER NOT NULL PRIMARY KEY,  
    name VARCHAR(10),  
    salary DECIMAL(9, 2),  
    mgrid INTEGER  
);
```

Data values for the 17 rows in the **employee** table are these.

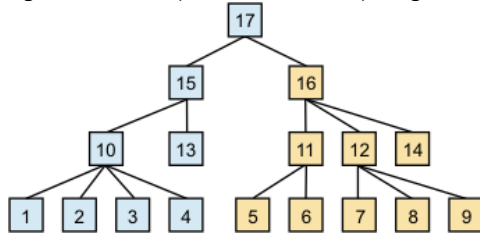
```
INSERT INTO employee VALUES ( 1, 'Jones', 30000, 10);  
INSERT INTO employee VALUES ( 2, 'Hall', 35000, 10);  
INSERT INTO employee VALUES ( 3, 'Kim', 40000, 10);  
INSERT INTO employee VALUES ( 4, 'Lindsay', 38000, 10);  
INSERT INTO employee VALUES ( 5, 'McKeough', 42000, 11);  
INSERT INTO employee VALUES ( 6, 'Barnes', 41000, 11);  
INSERT INTO employee VALUES ( 7, 'O'Neil', 36000, 12);  
INSERT INTO employee VALUES ( 8, 'Smith', 34000, 12);  
INSERT INTO employee VALUES ( 9, 'Shoeman', 33000, 12);  
INSERT INTO employee VALUES (10, 'Monroe', 50000, 15);  
INSERT INTO employee VALUES (11, 'Zander', 52000, 16);  
INSERT INTO employee VALUES (12, 'Henry', 51000, 16);  
INSERT INTO employee VALUES (13, 'Aaron', 54000, 15);  
INSERT INTO employee VALUES (14, 'Scott', 53000, 16);  
INSERT INTO employee VALUES (15, 'Mills', 70000, 17);  
INSERT INTO employee VALUES (16, 'Goyal', 80000, 17);  
INSERT INTO employee VALUES (17, 'Urbassek', 95000, NULL);
```

Each pair of **empid** and **mgrid** values express referential relationships that the recursive iterations of a query with an appropriate CONNECT BY condition can correctly assemble into a hierarchy.

Here the NULL value in the **mgrid** column in the last row shows that employee **Urbassek**, whose **empid** value is 17 is the root node of this reporting hierarchy.

The following diagram illustrates the four levels of the reporting hierarchy (with nodes that show the **empid** values) for the **employee** table data:

Figure 1. Relationships of Elements in a Reporting Hierarchy



- [START WITH Clause](#)
The optional START WITH clause specifies a condition. The row that satisfies this condition becomes the root for beginning the recursive operations of the CONNECT BY clause in hierarchical queries.
- [CONNECT BY Clause](#)
The CONNECT BY clause specifies conditions for performing recursive operations in hierarchical queries.
- [Conditions in the CONNECT BY Clause](#)
Besides expressions and operators that are valid in Boolean conditions and in general SQL expressions, the *condition* that is specified in CONNECT BY clause supports two more syntax constructs, the PRIOR operator and the LEVEL pseudocolumn that are valid only in SELECT statements that include the Hierarchical clause.
- [Dependency patterns that are not a simple graph](#)
You can run a recursive hierarchical query on a data set that includes complex dependencies, such as multiple root nodes, or multiple parent nodes for child nodes. However, cycling might occur and more records might be returned, based on hierarchical data tree structures.

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START WITH Clause

The optional START WITH clause specifies a condition. The row that satisfies this condition becomes the root for beginning the recursive operations of the CONNECT BY clause in hierarchical queries.

The START WITH clause is an extension to the ANSI/ISO standard for SQL. This syntax fragment is part of the [Hierarchical Clause](#).

START WITH Clause

```

      (1)
|--START WITH--| Condition |-----|

```

Notes:

1. See [Condition](#)

Usage

The START WITH clause specifies a search condition that the CONNECT BY clause uses for the first iteration of its recursive actions. If you omit the START WITH clause, the CONNECT BY clause treats every row as the root of the hierarchy for the initial set of intermediate results.

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CONNECT BY Clause

The CONNECT BY clause specifies conditions for performing recursive operations in hierarchical queries.

The CONNECT BY clause is an extension to the ANSI/ISO standard for SQL. This syntax fragment is part of the [Hierarchical Clause](#).

CONNECT BY Clause

```

      (1)
|--CONNECT BY--+-----+--| Condition |-----|
      '-NOCYCLE-'

```

Notes:

1. See [Condition](#)

Usage

If you include the START WITH clause, the search condition that it specifies is applied in producing the first intermediate result set for the hierarchical query. This consists of the rows of the table specified in the FROM clause for which the START WITH condition is true.

If the START WITH clause is omitted, no START WITH condition is available as a filter, and the first intermediate result set is the entire set of rows in the table that the FROM clause specifies.

The CONNECT BY clause produces successive intermediate result sets by applying the CONNECT BY search condition until this recursive process terminates when an iteration yields an empty result set.

The NOCYCLE Keyword

Rows returned by recursive queries of the CONNECT BY clause must be part of a simple hierarchy. SELECT statements that include the Hierarchical clause fail with an error if the query returns a row that is both the ancestor and the descendant of another node. This topology is called a cycle.

You can include the NOCYCLE keyword between the CONNECT BY keywords and the condition specification of the CONNECT BY clause to filter out any rows that would otherwise cause the hierarchical query to fail with error -26079 because of a cycle in an intermediate result set.

For example, for the hierarchical data set of the **employee** table that is described in the topic [Hierarchical Clause](#), the following UPDATE statement introduces a cycle for the employees whose **empid** values are 5 and 17:

```
UPDATE employee SET mgrid = 5 WHERE name = 'Urbassek';
```

After the hierarchical data set has been modified by the UPDATE statement above, the following query (which omits the NOCYCLE keyword) fails:

```
SELECT empid, name, mgrid, CONNECT_BY_ISLEAF leaf
FROM employee
START WITH name = 'Goyal'
CONNECT BY PRIOR empid = mgrid;
```

Error -26079 is issued when the last CONNECT BY step detects that employee **McKeough** is part of a loop:

empid	name	mgrid	leaf
16	Goyal	17	0
14	Scott	16	1
12	Henry	16	0
9	Shoeman	12	1
8	Smith	12	1
7	O'Neil	12	1
11	Zander	16	0
6	Barnes	11	1
5	McKeough	11	0

```
26079: CONNECT BY query resulted in a loop/cycle.
Error in line 8
Near character position 28
```

You can include the NOCYCLE keyword between the CONNECT BY keywords and the *condition* specification of the CONNECT BY clause to filter out any rows that would otherwise cause the hierarchical query to fail with error -26079 because of a cycle in an intermediate result set. The following query differs from the query that failed by including the CONNECT_BY_ISCYCLE pseudocolumn in the Projection clause, and by including the NOCYCLE keyword in the CONNECT BY clause.

```
SELECT empid, name, mgrid, CONNECT_BY_ISLEAF leaf, CONNECT_BY_ISCYCLE cycle
FROM employee
START WITH name = 'Goyal'
CONNECT BY NOCYCLE PRIOR empid = mgrid;
```

empid	name	mgrid	leaf	cycle
16	Goyal	17	0	0
14	Scott	16	1	0
12	Henry	16	0	0
9	Shoeman	12	1	0
8	Smith	12	1	0
7	O'Neil	12	1	0
11	Zander	16	0	0
6	Barnes	11	1	0
5	McKeough	11	0	0
17	Urbassek	5	0	1
15	Mills	17	0	0
13	Aaron	15	1	0
10	Monroe	15	0	0
4	Lindsay	10	1	0
3	Kim	10	1	0
2	Hall	10	1	0
1	Jones	10	1	0

17 row(s) retrieved.

Because the NOCYCLE keyword enabled the CONNECT BY clause to continue processing after the cycle was detected, **Urbassek** was returned from the CONNECT BY step that had failed in the previous example, and processing continued until all of the rows in the data set had been returned. In the output display above, **leaf** is an alias for the CONNECT_BY_ISLEAF pseudocolumn, and **cycle** is an alias for the CONNECT_BY_ISCYCLE pseudocolumn, with both aliases declared in the Projection clause. In these results, **Urbassek** is marked in the **cycle** column as the cause of the loop.

The result set above implies that the cycle can be removed from the **employee** table by changing the **mgrid** value in the row that had identified **McKeough** as the manager of **Urbassek**:

```
UPDATE employee SET mgrid = NULL WHERE empid = 17;
```

Conditions in the CONNECT BY Clause

Besides expressions and operators that are valid in Boolean conditions and in general SQL expressions, the *condition* that is specified in CONNECT BY clause supports two more syntax constructs, the PRIOR operator and the LEVEL pseudocolumn that are valid only in SELECT statements that include the Hierarchical clause.

The PRIOR Operator

The PRIOR unary operator can be included in the CONNECT BY clause with a column name as its operand. PRIOR can be used to distinguish column references to the result of the most recent previous recursive step of the CONNECT BY clause from column references to the current result set. The column name immediately follows this right-associative operator, as in the following syntax fragment:

```
CONNECT BY mgrid = PRIOR empid
```

Here the CONNECT BY condition is satisfied by those rows in which the manager specified in the **mgrid**, column matches the employee value was in the **empid** column in the previous iteration.

The PRIOR operator can be applied to expressions more complex than column names. The following condition uses an arithmetic expression as the operand of PRIOR:

```
CONNECT BY PRIOR (salary - 10000) = salary
```

The PRIOR operator can be included more than once in the same CONNECT BY condition. See also the topic [Hierarchical Clause](#), which provides an example of a hierarchical query that uses the PRIOR operator in a condition of the CONNECT BY clause.

The LEVEL Pseudocolumn

A *pseudocolumn* is a keyword of SQL that shares the same namespace as column names, and that is valid in some contexts where a column expression is valid.

LEVEL is a pseudocolumn that returns the ordinal number of the recursive step in the Hierarchic clause that returned the row. For all the rows returned by the START WITH clause, LEVEL return the value 1. Rows that are returned by applying the first iteration of the CONNECT BY clause return 2. Rows that are returned by successive iterations of the CONNECT BY have LEVEL values incremented by 1, so that LEVEL = (N + 1) indicates a row that the Nth CONNECT BY iteration returned. The data type of the LEVEL column is INTEGER.

The following example of a hierarchical query specifies LEVEL in the select list of the Projection clause:

```
SELECT name, LEVEL FROM employee START WITH name = 'Goyal'
CONNECT BY PRIOR empid = mgrid;
```

The query returns these results:

name	level
Goyal	1
Zander	2
McKeough	3
Barnes	3
Henry	2
O'Neil	3
Smith	3
Shoeman	3
Scott	2

```
9 row(s) retrieved.
```

LEVEL can be included in the Projection clause of SELECT statements that include the Hierarchical clause, and in the *condition* of the CONNECT BY clause.

The LEVEL pseudocolumn is not valid, however, in the following contexts:

- A SELECT statement that has no CONNECT BY clause
- The START WITH *condition* of the Hierarchical clause
- An operand of the CONNECT_BY_ROOT operator
- An argument to the SYS_CONNECT_BY_PATH function.

Additional Syntax Valid Only in Hierarchical Queries

The following syntax tokens support hierarchical queries, and are valid only in hierarchical queries. Unlike the PRIOR operator and the LEVEL pseudocolumn, however, they are not valid in the Hierarchical clause:

- The CONNECT_BY_ISCYCLE pseudocolumn
- The CONNECT_BY_ISLEAF pseudocolumn
- The CONNECT_BY_ROOT unary operator
- The SYS_CONNECT_BY_PATH() function of SQL.

The CONNECT_BY_ISCYCLE Pseudocolumn

CONNECT_BY_ISCYCLE is a pseudocolumn that returns a 1 if the row would cycle at the next level in the hierarchy. That is, the row has an immediate child that is also an ancestor given the search-condition that is specified in the CONNECT BY clause. If the row does not directly cause a cycle, the column returns 0. A value other than 0 is only possible when NOCYCLE is specified in the CONNECT BY clause. The data type of this column is INTEGER.

The following UPDATE statement creates a loop in the data hierarchy of the **employee** table:

```
UPDATE employee SET mgrid = 5 WHERE empid = 17;
```

The following hierarchical query includes the CONNECT_BY_ISCYCLE pseudocolumn in the Projection clause, but the CONNECT BY clause throws an error in the step where it encounters the loop that the UPDATE statement created.

```
SELECT empid,
       name,
       mgrid,
       CONNECT_BY_ISLEAF leaf,
       CONNECT_BY_ISCYCLE cycle
FROM employee
START WITH name = 'Goyal'
CONNECT BY PRIOR empid = mgrid;
```

```
665: Internal error on semantics -
CONNECT_BY_ISCYCLE is used without NOCYCLE parameter..
Error in line 1
Near character position 72
```

This query avoids the -655 error by specifying the NOCYCLE in the CONNECT BY clause that throws an error in the step where it encounters the loop that the UPDATE statement created.

```
SELECT empid, name, mgrid,
       CONNECT_BY_ISLEAF leaf, CONNECT_BY_ISCYCLE cycle
FROM employee
START WITH name = 'Goyal'
CONNECT BY NOCYCLE PRIOR empid = mgrid;
```

For the results of this query, see the example in the description of the NOCYCLE keyword in the topic [CONNECT BY Clause](#).

The CONNECT_BY_ISCYCLE pseudocolumn is not valid in the following contexts:

- A SELECT statement that has no CONNECT BY clause
- The START WITH or CONNECT BY clause
- An operand of the CONNECT_BY_ROOT operator
- An argument to the SYS_CONNECT_BY_PATH function

The CONNECT_BY_ISLEAF Pseudocolumn

CONNECT_BY_ISLEAF is a pseudocolumn that returns a 1 if the row is a leaf in the hierarchy as defined by the CONNECT BY clause. A node is a *leaf node* if it has no children in the query result hierarchy (not in the actual data hierarchy). If the row is not a leaf the column returns 0. The data type of the column is INTEGER.

The following hierarchical query specifies the CONNECT_BY_ISLEAF pseudocolumn in the Projection clause, and declares **leaf** as an alias for that column, which shows in the DB-Access display of the result set:

```
SELECT empid, name, mgrid, CONNECT_BY_ISLEAF leaf
FROM employee
START WITH name = 'Goyal'
CONNECT BY PRIOR empid = mgrid;
```

empid	name	mgrid	leaf
16	Goyal	17	0
14	Scott	16	1
12	Henry	16	0
9	Shoeman	12	1
8	Smith	12	1
7	O'Neil	12	1
11	Zander	16	0
6	Barnes	11	1
5	McKeough	11	1

9 row(s) retrieved.

The CONNECT_BY_ROOT Operator

For every row in the hierarchy, the CONNECT_BY_ROOT unary operator accepts as its operand an expression that evaluates to a row that is a node of the hierarchy. CONNECT_BY_ROOT returns the expression for the root ancestor of its operand. This syntax fragment is part of the [Hierarchical Clause](#).

CONNECT_BY_ROOT Operator

```
|--CONNECT_BY_ROOT--expression-----|
```

The *expression* operand can be any SQL expression, but it must not contain any hierarchical query token, including the following tokens:

- The CONNECT_BY_ROOT or PRIOR unary operators
- The CONNECT_BY_ISCYCLE, CONNECT_BY_ISLEAF, or LEVEL pseudocolumns
- The SYS_CONNECT_BY_PATH function.

The return data type of this right-associative operator is the data type of the specified expression.

The hierarchical query in the following example returns rows from the **employee** table that include both the identifying number of the manager to whom the employee reports directly, and also the name of the manager at the root of the hierarchy for this query.

empid	name	mgrid	topboss
16	Goyal	17	Goyal
14	Scott	16	Goyal
12	Henry	16	Goyal
9	Shoeman	12	Goyal
8	Smith	12	Goyal
7	O'Neil	12	Goyal
11	Zander	16	Goyal
6	Barnes	11	Goyal
5	McKeough	11	Goyal

The `CONNECT_BY_ROOT` operator is not valid in the following contexts:

- ## The SYS_CONNECT_BY_PATH Function

This is the calling syntax for SYS_CONNECT_BY_PATH to return a string for a specified row at LEVEL N. This syntax fragment is part of the [Hierarchical Clause](#).

```

      .-,-,-----
      V                                     |
|--SYS_CONNECT BY PATH--(---string_expression--,'--format_string--'+---)

```

The expressions in arguments to `SYS_CONNECT_BY_PATH` must not include any hierarchical query construct, including the following constructs:

- | | |
|-----------|---------|
| empid | 12 |
| name | Henry |
| mgrid | 16 |
| hierarchy | /Henry |
| empid | 9 |
| name | Shoeman |

These rows are listed in the order in which they were retrieved:

- The START WITH clause returned the **Henry** row at the root of this hierarchy.
- The first step of the CONNECT BY clause returned three rows, corresponding to the three employees who report to **Henry**.
- The next CONNECT BY step returned no rows, because the **Shoeman**, **Smith**, and **O'Neil** rows that returned by the previous step are all leaf nodes within this hierarchy, for which the PRIOR empid = mgrid condition evaluates to false.

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Dependency patterns that are not a simple graph

The CONNECT BY clause cannot analyze data sets that include cycles where some child nodes are identified as ancestors of their parent node. If your data set includes cycles, the cycles might be artifacts of rows that contain invalid data.

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GROUP BY Clause

This syntax fragment is part of the [SELECT statement](#).

```

--GROUP BY--+-+-----+-----+-----+
|            | |'-table_object--'| |column| |-----|
|            | | (1)              | |      | |-----|
|            | |'-select number-'| |      | |-----|

```

Notes:

1. Informix extension

Element	Description	Restrictions	Syntax
<i>col_alias</i>	Alias for a column name	Must have been declared in the Projection clause	Identifier
<i>column</i>	Group rows by the value of this column (or of this expression)	See Dependencies between the GROUP BY and Projection clauses.	Identifier , Expression
<i>select_number</i>	Integer specifying the ordinal position of a column or expression in the select list of the Projection clause	See the Select numbers section.	Literal Number
<i>table_object</i>	Name, synonym, or alias of the table or view containing <i>column</i>	Must exist and must be specified in the FROM clause	Identifier

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In an NLSCASE INSENSITIVE database, collation and string comparisons on NCHAR and NVARCHAR data disregard lettercase differences, so that the database server treats case variants among strings composed of same sequence letters as duplicates. For queries that group data on NCHAR or NVARCHAR columns, if some of the qualifying rows differ only in letter case, the number of groups will be smaller than from the same query on the same data set in a case-sensitive database. For more information on data processing in databases that were created with the NLSCASE INSENSITIVE property, see [Duplicate rows in NLSCASE INSENSITIVE databases](#) and [NCHAR and NVARCHAR expressions in case-insensitive databases](#).

In a column listed in a GROUP BY clause, each row that contains a NULL value belongs to a single group. That is, all NULL values are grouped together.

Select numbers

You can use one or more integers in the GROUP BY clause to stand for column expressions. In the next example, the first SELECT statement uses select numbers for **order_date** and **paid_date - order_date** in the GROUP BY clause. You can group only by a combined expression using the select numbers.

In the second SELECT statement, you cannot replace the 2 with the arithmetic expression **paid_date - order_date**:

```
SELECT order_date, COUNT(*), paid_date - order_date
FROM orders GROUP BY 1, 3;
SELECT order_date, paid_date - order_date
FROM orders GROUP BY order_date, 2;
```

- [Dependencies between the GROUP BY and Projection clauses](#)

The GROUP BY clause restricts what the Projection clause can specify. If you include a GROUP BY clause, each *column* in the select list of the Projection clause must also be referenced in the GROUP BY clause. Some column data types and column expressions that are valid in the Projection clause, however, cannot be referenced in the GROUP BY clause.

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Dependencies between the GROUP BY and Projection clauses

The GROUP BY clause restricts what the Projection clause can specify. If you include a GROUP BY clause, each *column* in the select list of the Projection clause must also be referenced in the GROUP BY clause. Some column data types and column expressions that are valid in the Projection clause, however, cannot be referenced in the GROUP BY clause.

If a column expression in the select list is only the column name or alias, you must use its name or its alias in the GROUP BY clause, if none of the restrictions below apply to the column. If a column is combined with another column by an arithmetic operator, you can choose to group the query result set in either of two ways:

- By the names or aliases of the individual columns,
- or else by the combined expression using the *select number*, a literal integer that specifies the ordinal position of that expression within the select list of the Projection clause.

The following restrictions, however, prevent some columns and expressions from being included in the GROUP BY clause, or can prevent the query from including the GROUP BY clause.

- Constant expressions are not valid in the GROUP BY clause.
- You cannot include a ROWID in a GROUP BY clause.
- If the Projection clause includes a BYTE or TEXT column or a BYTE or TEXT column expression, the query cannot include the GROUP BY clause.
- If the Projection clause includes a column of a user-defined data type, the column cannot be used in a GROUP BY clause unless the UDT can use the built-in bit-hashing function. Any UDT that cannot use the built-in bit-hashing function must be created with the CANNOTHASH modifier, which tells the database server that the UDT cannot be used in a GROUP BY clause.

The following section identifies restrictions on the GROUP BY clause when the Projection clause includes aggregate expressions or time expressions.

Columns in aggregate expressions and time expressions

If you specify an aggregate function and one or more column expressions in the select list of a query that includes the GROUP BY clause, the GROUP BY clause must list the name or the alias of each column in the select list that is not used as part of an aggregate or of a time expression. The query fails with error -321, however, if the GROUP BY clause includes a select number corresponding to the ordinal position of an aggregate expression within the select list.

If an OLAP window function is specified in the Projection clause of a query that includes the GROUP BY clause, all column references within the OLAP window function must also be included in the GROUP BY clause. The database server issues an error, however, if any of the columns referenced in the GROUP BY clause are operands of an aggregate expression or of a time expression.

The GROUP BY clause in the following example specifies one column that is not in an aggregate expression. Here the **total_price** column must not be in the GROUP BY list, because it appears in the Projection clause as the argument to an aggregate function.

```
SELECT order_num, COUNT(*), SUM(total_price)
FROM items GROUP BY order_num;
```

During execution of this query, the COUNT and SUM aggregates are applied to each **order_num** group, rather than calculating the number of orders and the sum of their **total_price** values across the set of all rows in the **items** table.

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HAVING Clause

Use the HAVING clause to apply one or more qualifying conditions to groups or to the entire result set.

This syntax fragment is part of the [SELECT statement](#).

HAVING Clause

```
                (1)  
|--HAVING--| Condition |-----|
```

Notes:

1. See [Condition](#)

In the following examples, each condition compares one calculated property of the group with another calculated property of the group or with a constant. The first SELECT statement uses a HAVING clause that compares the calculated expression `COUNT (*)` with the constant 2. The query returns the average total price per item on all orders that have more than two items.

The second SELECT statement lists customers and the call months for customers who have made two or more calls in the same month:

```
SELECT order_num, AVG(total_price) FROM items  
  GROUP BY order_num HAVING COUNT(*) > 2;  
SELECT customer_num, EXTEND (call_dtime, MONTH TO MONTH)  
  FROM cust_calls GROUP BY 1, 2 HAVING COUNT(*) > 1;
```

You can use the HAVING clause to place conditions on the GROUP BY column values as well as on calculated values. This example returns **cust_code** and **customer_num**, **call_dtime**, and groups them by **call_code** for all calls that have been received from customers with **customer_num** less than 120:

```
SELECT customer_num, EXTEND (call_dtime), call_code  
  FROM cust_calls GROUP BY call_code, 2, 1  
  HAVING customer_num < 120;
```

The HAVING clause generally complements a GROUP BY clause. If you omit the GROUP BY clause, the HAVING clause applies to all rows that satisfy the query, and all rows in the table make up a single group. The following example returns the average price of all the values in the table, as long as more than ten rows are in the table:

```
SELECT AVG(total_price) FROM items HAVING COUNT(*) > 10;
```

Because conditions in the WHERE clause cannot include aggregate expressions, you can use the HAVING clause to apply conditions with aggregates to the entire result set of a query, as in the example above.

The condition in the HAVING clause cannot include a DISTINCT or UNIQUE aggregate expression. For example, the following query fails with a syntax error:

```
SELECT order_num, COUNT(*) number, AVG (total_price) average  
  FROM items  
  GROUP BY order_num  
  HAVING COUNT(DISTINCT *) > 2;
```

No error is issued, however, if the DISTINCT keyword is omitted from the example above.

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Set operators in combined queries

The set operators UNION, UNION ALL, INTERSECT, and MINUS can manipulate the result sets of two queries that specify the same number of columns in the Projection clause, and that have compatible data types in the corresponding columns of both queries.

(The MINUS set operator has EXCEPT as its keyword synonym. Results that the MINUS and EXCEPT operators return from the same operands are always identical.)

These operators perform basic set operations of *union*, *intersection*, and *difference* on the result sets of two queries that are the left and right operands of the set operators:

- The UNION set operator combines the qualifying rows from two queries into a single result set that consists of the distinct rows that either or both of the queries returned. (If you also include the ALL keyword, the UNION ALL result set can include duplicate rows.)
- The INTERSECT set operator compares the result sets from two queries, but returns only the distinct rows that are in the result sets of both queries.
- The MINUS set operator compares the result sets from two queries, but returns only the distinct rows in the result set of the left query that are absent from the result set of the right query.

The set operators are useful in business analytic contexts. They can also be used in SELECT statements to check the integrity of your database after you have performed a DML operation like UPDATE, INSERT, DELETE, or MERGE. The set operators can similarly be used when you transfer data to a history table, for example, when you need to verify that the correct data is in the history table before you delete rows from the original table.

All of the set operators have the same precedence. In complex queries that include more than one set operator, the precedence of operators is from left to right. Use parentheses to group set operators and their operands, if you need to override the default left-to-right precedence of set operators.

Only the UNION set operator supports the ALL keyword. The ALL keyword is not valid with the INTERSECT, MINUS, or EXCEPT set operators, from which only distinct rows are returned.

When comparing rows to calculate a set intersection or difference, two NULL values are considered equal in INTERSECT and MINUS operations.

- [Restrictions on a Combined SELECT](#)
Several restrictions apply to queries that you can combine with the UNION, INTERSECT, MINUS, or EXCEPT set operators.
- [UNION Operator](#)
Place the UNION operator between two SELECT statements to combine the queries into a single query.
- [INTERSECT Operator](#)
When two queries are combined by this set operator, INTERSECT calculates the set intersection of the rows returned by the two queries that are its operands.
- [MINUS operator](#)
When two queries are combined by this set operator, the MINUS operator calculates the set difference between the rows returned by the SELECT statement on the left side and the rows returned by the SELECT statement on the right side.

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Restrictions on a Combined SELECT

Several restrictions apply to queries that you can combine with the UNION, INTERSECT, MINUS, or EXCEPT set operators.

- The number of items in the Projection clause of each query must be the same, and the corresponding items in each Projection clause must have compatible data types.
- The Projection clause of each query cannot specify BYTE or TEXT objects. (This restriction does not apply to UNION ALL operations.)
- If a combined query includes the ORDER BY clause of the SELECT statement, it must follow the last Projection clause, and you must specify each ordered item by its integer *select_number*, not by its SQL identifier. Sorting takes place after the set operation is complete.
- You can store the combined results of any set operator in a temporary table, but the INTO TEMP clause can appear only in the final SELECT statement.
- In Informix® ESQL/C, you cannot use an INTO clause in a compound query unless exactly one row is returned, and you are not using a cursor. In this case, the INTO clause must be in the first SELECT statement that the set operator combines.

A *UNION subquery* is a query that includes the UNION or UNION ALL operator within a subquery. The following additional restrictions affect UNION subqueries, but they do not apply to combined queries that include the INTERSECT, MINUS, or EXCEPT set operators:

- The CREATE VIEW statement cannot specify a UNION subquery to define the view.
- Only columns in the local database are valid in a UNION subquery. You cannot reference a remote table or view in a UNION subquery.

Unlike UNION, the INTERSECT, MINUS, and EXCEPT set operators are valid in the following contexts:

- In combined queries that reference columns of tables in other databases of the local Informix server instance, and in tables of other Informix server instances.
- In view definitions. (You cannot, however, specify WITH CHECK OPTION in a CREATE VIEW statement that also includes a set operator.)

The following restrictions, however, affect all combined queries, including UNION and UNION ALL subqueries and queries that include the INTERSECT, MINUS, or EXCEPT set operators:

- Combined queries cannot be triggering events. If a valid combined query specifies a column on which a Select trigger has been defined, the query succeeds, but the trigger (or the INSTEAD OF trigger on a view) is ignored.
- General expressions that include host variables are not valid on the left of the ALL, ANY, IN, NOT IN and SOME operators in a query that includes a UNION subquery or any other set operator. An expression that consists solely of a single host variable, however, is valid in this context.

For example, the following query is valid under the above restriction:

```
SELECT col1 FROM tab1 WHERE ? <= ALL
(SELECT col2 FROM tab2 UNION SELECT col3 FROM tab3);
```

In this example, the expression to the left of ALL is a single host variable (?), which is the only expression involving host variables that is supported before the ALL, ANY, IN, NOT IN, or SOME operators in a query that also includes a set operator.

In contrast, the following example shows an invalid query:

```
SELECT col1 FROM tab1 WHERE (? + 8) <= ALL
(SELECT col2 FROM tab2 UNION SELECT col3 FROM tab3);
```

This query fails because an operand of the <= relational operator to the left of the ALL operator is (? + 8). An arithmetic expression that includes a host variable is not valid syntax in a UNION subquery, nor in queries that are combined by any other set operator.

Expressions that do not contain host variables are not subject to this restriction. Thus, the following query (that includes the same UNION subquery) is valid:

```
SELECT col1 FROM tab1 WHERE (col1 + 8) <= ALL
(SELECT col2 FROM tab2 UNION SELECT col3 FROM tab3);
```

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UNION Operator

Place the UNION operator between two SELECT statements to combine the queries into a single query.

You can string several SELECT statements together using the UNION operator. Corresponding items do not need to have the same name. Omitting the ALL keyword excludes duplicate rows.

UNION ALL operator

If you use the UNION ALL operator, all the qualifying rows from both queries are returned, without excluding any duplicate rows. (If you combine two queries by using the UNION operator without the ALL keyword, any duplicate rows are removed from the combined set of qualifying rows. That is, if multiple rows contain identical values in the corresponding columns or expressions that the Projection clauses of both queries specify, only one row from each set of duplicates is retained in the result set.)

The next example uses UNION ALL to combine the results of two SELECT statements without removing duplicates. The query returns a list of all the calls that were received during the first quarter of 2007 and the first quarter of 2008.

```
SELECT customer_num, call_code FROM cust_calls
WHERE call_dtime BETWEEN
    DATETIME (2007-1-1) YEAR TO DAY
    AND DATETIME (2007-3-31) YEAR TO DAY
UNION ALL
SELECT customer_num, call_code FROM cust_calls
WHERE call_dtime BETWEEN
    DATETIME (2008-1-1) YEAR TO DAY
    AND DATETIME (2008-3-31) YEAR TO DAY;
```

If you want to remove duplicates from the result set, use UNION without the keyword ALL as the set operator between the queries. In the preceding example, if the combination 101 B were returned by both SELECT statements, the UNION operator would cause the combination to be listed only once. (If you want to remove duplicates within each SELECT statement, use the DISTINCT or UNIQUE keyword immediately before the Select list of the Projection clause, as described in [Controlling duplicate return values](#).)

The ALL keyword is valid for specifying set operations only with the UNION operator. The database server issues an error if ALL immediately follows the INTERSECT, MINUS, or EXCEPT set operators, which exclude duplicates.

For information on how the database server identifies duplicate NCHAR and NVARCHAR values in databases that have the NLCASE INSENSITIVE property, see the topic [NCHAR and NVARCHAR expressions in case-insensitive databases](#).

UNION in subqueries

You can use the UNION and UNION ALL operators in subqueries of SELECT statements within the WHERE clause, the FROM clause, and in collection subqueries. In this release of Informix®, however, subqueries that include UNION or UNION ALL are not supported in the following contexts:

- In the definition of a view
- In the event or in the Action clause of a trigger
- With the FOR UPDATE clause or with an Update cursor
- In a distributed query (accessing tables outside the local database)

For more information about collection subqueries, see [Collection Subquery](#). For more information about the FOR UPDATE clause, see [FOR UPDATE Clause](#).

In a combined subquery, the database server can resolve a column name only within the scope of its qualifying table reference. The following query, for example, returns an error:

```
SELECT * FROM t1 WHERE EXISTS
    (SELECT a FROM t2
    UNION
    SELECT b FROM t3 WHERE t3.c IN
        (SELECT t4.x FROM t4 WHERE t4.4 = t2.z));
```

Here **t2.z** in the innermost subquery cannot be resolved, because **z** occurs outside the scope of reference of the table reference **t2**. Only column references that belong to **t4**, **t3**, or **t1** can be resolved in the innermost subquery. The scope of a table reference extends downwards through subqueries, but not across the UNION operator to sibling SELECT statements.

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INTERSECT Operator

When two queries are combined by this set operator, INTERSECT calculates the set intersection of the rows returned by the two queries that are its operands.

The rows that INTERSECT returns are present in the results sets of both the left and the right SELECT statements. The INTERSECT results are always distinct or unique rows, because INTERSECT eliminates any duplicate rows.

Consider the following example, where the table **t1** has following rows:

```
create table t1 (col1 int);
insert into t1 values (1);
insert into t1 values (2);
insert into t1 values (2);
insert into t1 values (2);
insert into t1 values (3);
insert into t1 values (4);
insert into t1 values (4);
insert into t1 values (NULL);
```



```
'-----| OLAP window function |-----'
Substring
      (4)                (8)
|-----[--first, last --]-----|
```

Notes:

1. See [ORDER SIBLINGS BY Clause](#)
2. See [Expression](#)
3. See [Ordering by a CASE expression](#)
4. Informix extension
5. Not valid if SIBLINGS keyword is also specified
6. See [OLAP window expressions](#)
7. See [Ascending and Descending Orders](#)
8. See [Ordering by a Substring](#)

Element	Description	Restrictions	Syntax
<i>column</i>	Sort rows by value in this column	None	Identifier
<i>display_label</i>	Temporary name for a column or for a column expression	Must be unique among labels declared in the Projection clause	Identifier
<i>first, last</i>	First and last byte in column substring to sort the result set	Integers; for BYTE, TEXT, and character data types only	Literal Number
<i>select_number</i>	Ordinal position of a column in the select list of the Projection clause	See GROUP BY Clause .	Literal Number
<i>table</i>	Name, synonym, or alias of the table or view containing <i>column</i>	Must exist and must be specified in the FROM clause	Identifier

The ORDER BY clause implies that the query returns more than one row. In SPL, the database server issues an error if you specify the ORDER BY clause without a FOREACH loop to process the returned rows individually within the SPL routine.

The following query specifies a derived table in the FROM clause whose rows are ordered by the **col1** value, and declares **vtab** as the name of the derived table, and **vcol** as the name of its only column:

```
SELECT vcol FROM
  (SELECT FIRST 5 col1 FROM tab1 ORDER BY col1) vtab(vcol);
```

ORDER BY in NLSCASE INSENSITIVE databases

In databases created with the NLSCASE INSENSITIVE property, operations on columns and expressions of NCHAR or NVARCHAR data types make no distinction between upper case and lower case letters. For this reason, queries that include the ORDER BY clause might return rows in a sequence that disregard variants in letter case, if the column or expression are of NLS data types, and the data includes values that differ only in letter case.

If the data set includes letter case variants of the same string, these will be processed as duplicates, with case variants listed in their order of retrieval. For example, a set of NCHAR or NVARCHAR strings that were processed as duplicates might appear in this order:

```
gAMma
GAMma
GaMMA
gamma
GAMMA
```

For more information, see [Duplicate rows in NLSCASE INSENSITIVE databases](#) and [NCHAR and NVARCHAR expressions in case-insensitive databases](#).

- [Ordering by a Column or by an Expression](#)
- [Ordering by a Substring](#)
- [Ordering by a CASE expression](#)
- [Ascending and Descending Orders](#)

You can use the ASC and DESC keywords to specify ascending (smallest value first) or descending (largest value first) order.

- [Nested Ordering](#)
- [Using Select Numbers](#)
- [Ordering by Rowids](#)
- [ORDER BY Clause with DECLARE](#)
- [Placing Indexes on ORDER BY Columns](#)
- [ORDER SIBLINGS BY Clause](#)

The ORDER SIBLINGS BY clause is valid only in a hierarchical query. The optional SIBLINGS keyword specifies an order that first sorts the parent rows, and then sorts the child rows of each parent for every level within the hierarchy.

- [OLAP window functions in the ORDER BY clause of SELECT statements](#)

You can include OLAP window functions in the final ORDER BY clause of SELECT statements that do not include the CONNECT BY clause.

- [Ordering STANDARD or RAW result tables](#)

When the SELECT INTO Table clause defines a permanent table to store the result of a query, any non-trivial column expression in that clause must also declare an alias for the corresponding column in the newly-created result table. To specify that column as a sorting key for the result table, the ORDER BY clause must also reference the same alias, rather than specifying the non-trivial column expression.

Ordering by a Column or by an Expression

To order query results by an expression, you must also declare a display label for the expression in the Projection clause, as in the following example, which declares the display label **span** for the difference between two columns:

```
SELECT paid_date - ship_date span, customer_num FROM orders
ORDER BY span;
```

Informix® supports columns and expressions in the ORDER BY clause that do not appear in the select list of the Projection clause. You can omit a display label for the derived column in the select list and specify the derived column by means of a select number in the ORDER BY clause.

The select list of the Projection clause must include any column or expression that the ORDER BY clause specifies, however, if any of the following is true:

- The query includes the DISTINCT, UNIQUE, or UNION operator.
- The query includes the INTO TEMP *table* clause.
- The distributed query accesses a remote database whose server requires every column or expression in the ORDER BY clause to also appear in the select list of the Projection clause.
- An expression in the ORDER BY clause includes a display label for a column substring. (See the next section, [Ordering by a Substring](#).)

The next query selects one column from the **orders** table and sorts the results by the value of another column. By default, the rows are listed in ascending order.

```
SELECT ship_date FROM orders ORDER BY order_date;
```

You can order by an aggregate expression only if the query also has a GROUP BY clause. This query declares the display label **maxwgt** for an aggregate in the ORDER BY clause:

```
SELECT ship_charge, MAX(ship_weight) maxwgt
FROM orders GROUP BY ship_charge ORDER BY maxwgt;
```

If the current processing locale defines a localized collation, then NCHAR and NVARCHAR column values are sorted in that localized order.

In Informix, no *column* in the ORDER BY clause can be a collection type, but a query whose result set defines a collection-derived table can include the ORDER BY clause. For an example, see [Collection-Derived Table](#).

You might improve the performance of some non-PDQ queries that use the ORDER BY clause to sort a large set of rows if you increase the setting of the DS_NONPDQ_QUERY_MEM configuration parameter.

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Ordering by a Substring

You can order by a substring instead of by the entire length of a character, BYTE, or TEXT column, or of an expression returning a character string. The database server uses the substring to sort the result set. Define the substring by specifying integer subscripts (the *first* and *last* parameters), representing the starting and ending byte positions of the substring within the column value.

The following SELECT statement queries the **customer** table and specifies a column substring in the ORDER BY column. This instructs the database server to sort the query results by the portion of the **lname** column contained in the sixth through ninth bytes of the column value.

```
SELECT * from customer ORDER BY lname[6,9];
```

Assume that the value of **lname** in one row of the **customer** table is **Greenburg**. Because of the column substring in the ORDER BY clause, the database server determines the sort position of this row by using the value **burg**, rather than the complete column value **Greenburg**.

When ordering by an expression, you can specify substrings only for expressions that return a character data type. If you specify a column substring in the ORDER BY clause, the column must have one of the following data types: BYTE, CHAR, NCHAR, NVARCHAR, TEXT, or VARCHAR.

Informix® can also support LVARCHAR column substrings in the ORDER BY clause, if the column is in a database of the local database server.

For information on the GLS aspects of using column substrings in the ORDER BY clause, see the *IBM® Informix GLS User's Guide*.

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Ordering by a CASE expression

The ORDER BY clause can include CASE expressions to specify a sorting key.

In the following example, column **a_col** of table **tab_case** is of type INT. The query on table **tab_case** includes both column **a_col** and the aggregate expression **SUM(a_col)** in the Projection list, and groups the results by the value of **a_col**. The ORDER BY clause specifies two sorting keys:

- A CASE expression that immediately follows the ORDER BY keywords
- The **AVG(a_col)** aggregate expression:

```
CREATE TABLE tab_case(a_col INT, b_col VARCHAR(32));
SELECT a_col, SUM(a_col)
```

```
FROM tab_case
GROUP BY a_col
ORDER BY CASE
    WHEN a_col IS NULL
    THEN 1
    ELSE 0 END ASC,
    AVG(a_col);
```

Here the ASC keyword explicitly identifies the result of the CASE expression as an ascending sort key. By default, the **AVG(a_col)** sorting key also specifies an ascending order.

In the following similar example, based on a query on the same **tab_case** table, a second CASE expression returns either 1 or 0 as the sorting key value for the returned **AVG(a_col)** aggregate values.

```
SELECT a_col, SUM(a_col)
FROM tab_case GROUP BY a_col
ORDER BY CASE
    WHEN a_col IS NULL
    THEN 1
    ELSE 0 END ASC,
    AVG(a_col),
    CASE
    WHEN AVG(a_col) IS NULL
    THEN 1
    ELSE 0 END;
```

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Ascending and Descending Orders

You can use the ASC and DESC keywords to specify ascending (smallest value first) or descending (largest value first) order.

The default order is ascending. For DATE and DATETIME data types, *smallest* means earliest in time and *largest* means latest in time. For character data types in the default locale, the order is the ASCII collating sequence, as listed in [Collating Order for U.S. English Data](#).

For NCHAR or NVARCHAR data types, the localized collating order of the current session is used, if that is different from the code set order. For more information about collation, see [SET COLLATION statement](#).

If you specify the ORDER BY clause, NULL values by default are ordered as less than values that are not NULL. Using the ASC order, a NULL value comes before any non-NULL value; using DESC order, the NULL comes last.

Specifying the order of NULL values

The ORDER BY clause can include the NULLS FIRST keywords or the NULLS LAST keywords to show explicitly (or else to override) the default sort order of NULL values:

- The NULLS FIRST keywords instruct the database server to put NULL values first in the sorted query results. In an ascending sort, the ASC NULLS FIRST keywords request the default order. In a descending sort, DESC NULLS FIRST specifies that rows with a NULL value in the sort key column precede non-NULL rows in the sorted result set.
- The NULLS LAST keywords instruct the database server to put NULL values last in the sorted query results. In a descending sort, the DESC NULLS LAST keywords request the default order. In an ascending sort, ASC NULLS LAST specifies that rows with a NULL value in the sort key column follow non-NULL rows in the sorted result set.

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Nested Ordering

If you list more than one column in the ORDER BY clause, your query is ordered by a nested sort. The first level of sort is based on the first column; the second column determines the second level of sort. The following example of a nested sort selects all the rows in the **cust_calls** table and orders them by **call_code** and by **call_dtime** within **call_code**:

```
SELECT * FROM cust_calls ORDER BY call_code, call_dtime;
```

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Using Select Numbers

In place of column names, you can enter in the ORDER BY clause one or more integers that refer to the position of items listed in the select list of the Projection clause. You can also use a select number to sort by an expression.

The following example orders by the expression **paid_date - order_date** and **customer_num**, using select numbers in a nested sort:

```
SELECT order_num, customer_num, paid_date - order_date
FROM orders
ORDER BY 3, 2;
```

Select numbers are required in the ORDER BY clause when SELECT statements are joined by the UNION or UNION ALL keywords, or when compatible columns in the same position have different names.

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Ordering by Rowids

You can specify the ROWID keyword in the ORDER BY clause. This specifies the **rowid** column, a hidden column in nonfragmented tables and in fragmented tables that were created with the WITH ROWIDS clause. The **rowid** column contains a unique internal record number that is associated with a row in a table. (It is recommended, however, that you utilize primary keys as your access method, rather than exploiting the **rowid** column.)

The ORDER BY clause cannot specify the **rowid** column if the table from which you are selecting is a fragmented table that has no **rowid** column.

You do not need to include the ROWID keyword in the Projection clause when you specify ROWID in the ORDER BY clause.

For further information about **rowid** values and how to use the **rowid** column in column expressions, see [WITH ROWIDS Option](#) and [Using Rowids](#).

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ORDER BY Clause with DECLARE

In Informix® ESQ/C, you cannot use a DECLARE statement with a FOR UPDATE clause to associate a cursor with a SELECT statement that has an ORDER BY clause.

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Placing Indexes on ORDER BY Columns

When you include an ORDER BY clause in a SELECT statement, you can improve the performance of the query by creating an index on the column or columns that the ORDER BY clause specifies. The database server uses the index that you placed on the ORDER BY columns to sort the query results in the most efficient manner. For more information on how to create indexes that correspond to the columns of an ORDER BY clause, see [Using the ASC and DESC Sort-Order Options](#).

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ORDER SIBLINGS BY Clause

The ORDER SIBLINGS BY clause is valid only in a hierarchical query. The optional SIBLINGS keyword specifies an order that first sorts the parent rows, and then sorts the child rows of each parent for every level within the hierarchy.

Rows that have duplicate lists of values in the columns specified after the SIBLINGS BY keywords are arbitrarily ordered among the rows with the same list of values and the same parent. If a hierarchical query includes the ORDER BY clause without the SIBLINGS keyword, rows are ordered according to the sort specifications that follow the ORDER BY keywords. Neither the ORDER BY clause nor the ORDER SIBLINGS BY option to the ORDER BY clause is required in hierarchical queries.

The hierarchical query in the following example returns the subset of rows in the hierarchical data set whose root is **Goyal**, as listed in the topic [Hierarchical Clause](#). This query includes the ORDER SIBLINGS BY clause to sort by **name** the employees who report to the same manager:

```
SELECT empid, name, mgrid, LEVEL
FROM employee
  START WITH name = 'Goyal'
  CONNECT BY PRIOR empid = mgrid
 ORDER SIBLINGS BY name;
```

The rows returned by this query are sorted in the following order:

empid	name	mgrid	level
16	Goyal	17	1
12	Henry	16	2
7	O'Neil	12	3
9	Shoeman	12	3
8	Smith	12	3
14	Scott	16	2
11	Zander	16	2
6	Barnes	11	3
5	McKeough	11	3

9 row(s) retrieved.

Here the START WITH clause returned the **Goyal** row at the root of this hierarchy. Two subsequent CONNECT BY steps (marked as 2 and 3 in the **level** pseudocolumn) returned three sets of sibling rows:

- **Henry, Scott, and Zander** are siblings whose parent is **Goyal**;
- **O'Neil, Shoeman, and Smith** are siblings whose parent is **Henry**;
- **Barnes and McKeough** are siblings whose parent is **Zander**.

The next CONNECT BY step returned no rows, because the rows for which **level** = 3 are leaf nodes within this hierarchy. At this point in the execution of the query, the ORDER SIBLINGS BY clause was applied to the result set, sorting the rows in the order shown above.

Because the sort key, **name**, is a VARCHAR column, the returned rows within each set of siblings are in the ASCII order of their **employee.name** values. Only the sets of siblings that are leaf nodes in the hierarchy of returned rows appear consecutively in the sorted result set, because the managers are immediately followed by the employees who report to them, rather than by their siblings. An exception in this example is **Scott**, whose child nodes form an empty set.

The SIBLINGS keyword in the ORDER BY clause is an extension to the ISO standard syntax for the SQL language. The SELECT statement fails with an error if you include the SIBLINGS keyword in the ORDER BY clause of a query or subquery that does not include a valid CONNECT BY clause.

For more information about hierarchical queries and the CONNECT BY clause, see [Hierarchical Clause](#).

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OLAP window functions in the ORDER BY clause of SELECT statements

You can include OLAP window functions in the final ORDER BY clause of SELECT statements that do not include the CONNECT BY clause.

If an OLAP function clause is present in the ORDER BY clause, then the OLAP function is evaluated first, before the ORDER BY evaluation.

More generally, for simple SELECT statements that includes one or more OLAP window functions, the database server follows this sequence of processing:

- Apply any joins, filters, GROUP BY, or HAVING specifications to obtain the set of qualifying rows to return as the query result.
- Create window partitions of qualifying rows and apply the specified OLAP functions to each row in each partition (or to the entire query result set, if no partitions are defined).
- Apply the ORDER BY clause of the SELECT statement to the final query result.

For nested queries, each subquery follows the order above, but OLAP window partitions and their OLAP functions are applied to the result set of the innermost subquery in which the OLAP window is defined.

If the OLAP window includes a window ORDER clause, that clause, rather than the ORDER BY clause of the SELECT statement, defines the row numbers that the window ROW_NUMBER function assigns to the rows in partitions of the same OLAP window. The window ORDER clause does not, however, define the ordering of the query result set, which the ORDER BY clause of SELECT statement defines.

If the OLAP window does not include a window ORDER clause, the row numbers that the window ROW_NUMBER function assigns to the rows are in arbitrary order, as returned by the query or subquery, rather than according to any ORDER BY clause of the SELECT statement.

Related reference:

[OLAP window expressions](#)

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Ordering STANDARD or RAW result tables

When the SELECT INTO Table clause defines a permanent table to store the result of a query, any non-trivial column expression in that clause must also declare an alias for the corresponding column in the newly-created result table. To specify that column as a sorting key for the result table, the ORDER BY clause must also reference the same alias, rather than specifying the non-trivial column expression.

For example, in the following nested query, **tab56** is the identifier of a result table, and **tab56_col0** is an alias for the non-trivial column expression that a subquery in the Projection clause defines. The ORDER BY clause specifies the same subquery as a sorting key, rather than referencing that non-trivial column expression by its alias:

```
SELECT ( SELECT tab54.tab54_col17 tab56_col0
        FROM tab54
        WHERE (tab54.tab54_col17 = -1423023 )
      ) tab56_col0,
      " tab56_col11
FROM tab57
WHERE tab57.tab57_col11 == -6296233
ORDER BY (
  SELECT tab54.tab54_col17 tab56_col0
  FROM tab54
  WHERE (tab54.tab54_col17 = -1423023 )
) NULLS FIRST,2 NULLS FIRST
INTO tab56;
```

Specifying the non-trivial column expression in the ORDER BY clause is acceptable in a normal SELECT statement, but not in an ORDER BY clause that sorts a result table that the SELECT INTO Table clause created. In the example above, the database server returns SQL error -19828.

```
SELECT ( SELECT tab54.tab54_col17 tab56_col10
        FROM tab54
        WHERE (tab54.tab54_col17 = -1423023 )
        ) tab56_col10,
      "" tab56_col11
FROM tab57
WHERE tab57.tab57_col11 == -6296233
ORDER BY
      tab56_col10      -- Substituted alias for column expression in result table)
NULLS FIRST,2 NULLS FIRST
INTO tab56;
```

LIMIT Clause

The LIMIT clause can restrict the result set of the query to some maximum number of rows. If this clause specifies a value smaller than the number of qualifying rows, the query returns only a subset of the rows that satisfy the selection criteria.

The LIMIT clause is an extension to the ISO/ANSI standard for the SQL language. This syntax fragment is part of the [SELECT statement](#).

LIMIT clause

(1)

|-----LIMIT--+max-----+-----|
 '-max var-'

Notes:

- ## 1. Informix extension

Element	Description	Restrictions	Syntax
<i>max</i>	Integer (> 0) specifying maximum number of rows to return	If <i>max</i> > number of qualifying rows then all matching rows are returned	Literal Number
<i>max_var</i>	Host variable or local SPL variable storing the value of <i>max</i>	Same as <i>max</i> ; valid in prepared objects and in SPL routines	Language dependent

Usage

The LIMIT clause specifies that the result set includes no more than *max* rows (or exactly *max* rows, if *max* is less than the number of qualifying rows). Any additional rows that satisfy the query selection criteria are not returned.

The following example sets *max* with a literal integer to retrieve at most 10 rows from table *tab1*:

```
SELECT a, b FROM tab1 LIMIT 10;
```

You can also use a host variable, or the value of an SPL input parameter in a local variable, to assign the value of *max*.

If the LIMIT clause follows the ORDER BY clause, the returned rows are sorted according to the ORDER BY specifications. Because query results are generally not retrieved in any particular sequence, using ORDER BY to constrain the order of rows can be useful in queries whose LIMIT clause returns only a subset of the qualifying rows.

For example, the following query returns data about the ten highest-paid employees:

```
SELECT name, salary FROM emp
ORDER BY salary DESC LIMIT 10;
```

You can use the LIMIT clause in a query whose result set defines a collection-derived table (CDT) within the FROM clause of another SELECT statement. The following query specifies a CDT that has no more than ten rows:

```
SELECT *
FROM TABLE(MULTISET(SELECT * FROM employees
ORDER BY employee_id LIMIT 10 )) vt(x,y), tab2
WHERE tab2.id = vt.x;
```

The next example applies the LIMIT clause to the result of a UNION query:

```
SELECT a, b FROM tab1 LIMIT 10 UNION SELECT a, b FROM tab2;
```

Restrictions on the LIMIT clause

The LIMIT clause is not valid in any of the following contexts:

- In the definition of a view


```
EXEC SQL BEGIN DECLARE SECTION;
char fname[ 16];
char lname[ 16];
EXEC SQL END DECLARE SECTION;
. . .

EXEC SQL connect to 'stores_demo';
/* select statement being prepared contains a for update clause */
EXEC SQL prepare x from 'select fname, lname from customer for update';
EXEC SQL declare xc cursor for x;

for (;;)
{
EXEC SQL fetch xc into $fname, $lname;
if (strcmp(SQLSTATE, '00', 2) != 0) break;
printf("%d %s %s\n",cnum, fname, lname );
if (cnum == 999)          --update rows with 999 customer_num
EXEC SQL update customer set fname = 'rosey' where current of xc;
}

EXEC SQL close xc;
EXEC SQL disconnect current;
```

A SELECT . . . FOR UPDATE statement, like an Update cursor, allows you to perform updates that are not possible with the UPDATE statement alone, because both the decision to update and the values of the new data items can be based on the original contents of the row. The UPDATE statement cannot query the table that is being updated.

Note: A normal update inside the FETCH loop of a cursor cannot guarantee that the updated rows are not fetched again after the UPDATE. The WHERE CURRENT OF specification relates the UPDATE to the Update cursor, and guarantees that each row is updated no more than once, by internally keeping a list of the rows that have already been updated. These rows will not be fetched again by the Update cursor.

Restrictions

A SELECT statement that includes the FOR UPDATE clause must conform to the following restrictions:

- The statement can select data from only one table.
- The statement cannot include any aggregate functions.
- The statement cannot include any of the following clauses or keywords: DISTINCT, EXCEPT, FOR READ ONLY, GROUP BY, INTO TEMP, INTERSECT, INTO EXTERNAL, MINUS, ORDER BY, UNION, UNIQUE.
- DECLARE statements that associate a cursor with the statement cannot also include the FOR UPDATE keywords.
- The statement is valid only in ESQL/C routines, in IBM® Informix 4GL, and (within transactions) in the DB-Access utility. It cannot, for example, be issued within an SPL routine.

For information on how to declare an update cursor for a SELECT statement that does not include a FOR UPDATE clause, see [Using the FOR UPDATE Option](#).

Update cursors in SPL routines

You cannot include the FOR UPDATE keywords in the SELECT . . . INTO segment of the FOREACH statement of SPL. An SPL routine, however, can provide the functionality of a FOR UPDATE cursor

- by declaring a *cursor* name in the FOREACH statement,
- and then using the WHERE CURRENT OF *cursor* clause in UPDATE or DELETE statements that operate on the current row of that *cursor* within the same FOREACH loop.

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FOR READ ONLY Clause

Use the FOR READ ONLY keywords to specify that the Select cursor declared for the SELECT statement is a read-only cursor. A read-only cursor is a cursor that cannot modify data.

Normally, you do not need to include the FOR READ ONLY clause in a SELECT statement. SELECT is a read-only operation by definition, so the FOR READ ONLY clause is usually unnecessary. In certain circumstances, however, you must include the FOR READ ONLY keywords in a SELECT statement.

If you attempt to include both the FOR READ ONLY clause and the FOR UPDATE clause in the same SELECT statement, the SELECT statement fails. For information on declaring a read-only cursor for a SELECT statement that does not include a FOR READ ONLY clause, see [DECLARE statement](#).

If you have used the High-Performance Loader (HPL) in express mode to load data into the tables of an ANSI-compliant database, and you have not yet performed a level-0 backup of this data, the database is in read-only mode. When the database is in read-only mode, the database server rejects any attempts by a Select cursor to access the data unless the SELECT or the DECLARE includes a FOR READ ONLY clause. This restriction remains in effect until the user has performed a level-0 backup of the data.

In an ANSI-compliant database, Select cursors are update cursors by default. An update cursor is a cursor that can be used to modify data. These update cursors are incompatible with the read-only mode of the database. For example, this SELECT statement against the **customer_ansi** table fails:

```
EXEC SQL declare ansi_curs cursor for
select * from customer_ansi;
```

```
EXEC SQL declare ansi_read cursor for
      select * from customer_ansi for read only;
```

For more information on level-0 backups, see your *IBM Informix Backup and Restore Guide*. For more information on Select cursors, read-only cursors, and update cursors, see [DECLARE statement](#).

Related information:
[Backup levels that ontape supports](#)

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This syntax fragment is part of the [SELECT statement](#).

[illegible]

1. See [INTO TEMP clause](#)
2. See [INTO EXTERNAL clause](#)
3. See [INTO STANDARD and INTO RAW Clauses](#)
4. See [Storage options](#)
5. See [LOCK MODE Options](#)

```
SELECT customer_num, call_dtime + 5 UNITS DAY slowdate
FROM cust calls INTO TEMP pushdate;
```

```
SELECT col1::FLOAT fcol1, col2
FROM tab1 INTO STANDARD stab1;
```


This release of Informix continues to process the remaining statements of a multistatement prepared object after encountering the SQLNOTFOUND value of 100. You can maintain the legacy behavior, however, of not executing the remaining prepared statements by setting the **IFX_MULTIPREPSTMT** environment variable to 1.

Restrictions with INTO table clauses in ESQL/C

In Informix ESQL/C, do not use both the INTO *table* clause and the INTO *variable* clause in the same query. If you do, no results are returned to the program variables and the **SQLCODE** variable is set to a negative value. For more information about the INTO *variable* clause, see [INTO Clause](#).

- [INTO TEMP clause](#)
The INTO TEMP clause creates a temporary table to hold the query results.
- [INTO STANDARD and INTO RAW Clauses](#)
You can use the INTO STANDARD and INTO RAW clauses to create a new permanent table that stores the result set of the SELECT statement. This syntax provides a single mechanism to specify a query, to receive the qualifying records, and to insert those query results into a permanent database table.
- [INTO EXTERNAL clause](#)
The INTO EXTERNAL clause unloads query results into an external table, creating a default external table description that you can use when you later reload the files.

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INTO TEMP clause

The INTO TEMP clause creates a temporary table to hold the query results.

The default initial extent and next extent for a temporary table that the INTO TEMP clause creates are each eight pages. The temporary table must be accessible by the built-in RSAM access method of the database server; you cannot specify another access method.

If you use the same query results more than once, using a temporary table saves time. In addition, using an INTO TEMP clause often gives you clearer and more understandable SELECT statements.

Data values in a temporary table are static; they are not updated as changes are made to the tables that were used to build the temporary table. You can use the CREATE INDEX statement to create indexes on a temporary table.

A logged temporary table exists until one of the following events occurs:

- The application disconnects from the database.
- A DROP TABLE statement is issued on the temporary table.
- The database is closed.

A nonlogging temporary table exists until one of the following events occurs:

- The application disconnects from the database.
- A DROP TABLE statement is issued on the temporary table.

If your Informix® database does not have transaction logging, the temporary table behaves in the same way as a table created with the WITH NO LOG option.

If you specify more than one temporary dbspace in the **DBSPACETEMP** environment variable (or if this is not set, in the DBSPACETEMP configuration parameter), the INTO TEMP clause loads the rows of the results set of the query into each of these dbspaces in round-robin fashion. For more information about the storage location of temporary tables that queries with the INTO TEMP clause create, see [Where temporary tables are stored](#).

Because operations on nonlogging temporary tables are not logged, using the WITH NO LOG option reduces the overhead of transaction logging.

Because nonlogging temporary tables do not disappear when the database is closed, you can use a nonlogging temporary table to transfer data from one database to another while the application remains connected. The behavior of a temporary table that you create with the WITH NO LOG option of the INTO TEMP clause resembles that of a RAW table.

For more information about temporary tables, see [CREATE TEMP TABLE statement](#).

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INTO STANDARD and INTO RAW Clauses

You can use the INTO STANDARD and INTO RAW clauses to create a new permanent table that stores the result set of the SELECT statement. This syntax provides a single mechanism to specify a query, to receive the qualifying records, and to insert those query results into a permanent database table.

When using SELECT INTO to create a new permanent table, you can specify its type as STANDARD or RAW. The default type is STANDARD. You can optionally specify the storage location, extent size, and lock mode options for the new table.

The column names of the new permanent table are the names specified in the select list of the Projection clause. If an asterisk (*) appears as the select list of the Projection clause, the asterisk is expanded to all the column names the corresponding tables or views in the FROM clause of the SELECT statement. Any shadow columns are not expanded by the asterisk specification.

The following example creates a new raw table called **ptabl** to store the results of a join query:

When the Autofree feature is enabled for a cursor, and the cursor is subsequently closed, you do not need to explicitly use the FREE statement to release the memory that the database server allocated for the cursor. If you issue SET AUTOFREE but specify no option, the default is ENABLED.

The SET AUTOFREE statement that enables the Autofree feature must appear before the OPEN statement that opens a cursor. The SET AUTOFREE statement does not affect the memory allocated to a cursor that is already open. After a cursor is Autofree enabled, you cannot open that cursor a second time.

- [Globally Affecting Cursors with SET AUTOFREE](#)
- [Using the FOR Clause to Specify a Specific Cursor](#)
- [Associated and Detached Statements](#)
- [Closing Cursors Implicitly](#)

Related reference:

[CLOSE statement](#)
[DECLARE statement](#)
[FETCH statement](#)
[FREE statement](#)
[OPEN statement](#)
[PREPARE statement](#)

Related information:

[Automatically freeing a cursor](#)

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Globally Affecting Cursors with SET AUTOFREE

If you include no FOR *cursor_id* or FOR *cursor_id_var* clause, then the scope of SET AUTOFREE is all subsequently-declared cursors in the program (or more precisely, all cursors declared before a subsequent SET AUTOFREE statement with no FOR clause globally resets the Autofree feature). This example enables the Autofree feature for all subsequent cursors in the program:

```
EXEC SQL set autofree;
```

The next example disables the Autofree feature for all subsequent cursors:

```
EXEC SQL set autofree disabled;
```

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Using the FOR Clause to Specify a Specific Cursor

If you specify FOR *cursor_id* or FOR *cursor_id_var*, then SET AUTOFREE affects only the cursor that you specify after the FOR keyword.

This option allows you to override a global setting for all cursors. For example, if you issue a SET AUTOFREE ENABLED statement for all cursors in a program, you can issue a subsequent SET AUTOFREE DISABLED FOR statement to disable the Autofree feature for a specific cursor.

In the following example, the first statement enables the Autofree feature for all cursors, while the second statement disables the Autofree feature for the cursor named **x1**:

```
EXEC SQL set autofree enabled;  
EXEC SQL set autofree disabled for x1;
```

Here the **x1** cursor must have been declared but not yet opened.

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Associated and Detached Statements

When a cursor is automatically freed, its associated prepared statement (or associated statement) is also freed.

The term *associated statement* has a special meaning in the context of the Autofree feature. A cursor is associated with a prepared statement if it is the first cursor that you declare with the prepared statement, or if it is the first cursor that you declare with the statement after the statement is detached.

The term *detached statement* has a special meaning in the context of the Autofree feature. A prepared statement is detached if you do not declare a cursor with the statement, or if the cursor with which the statement is associated was freed.

If the Autofree feature is enabled for a cursor that has an associated prepared statement, and that cursor is closed, the database server frees the memory allocated to the prepared statement as well as the memory allocated for the cursor. Suppose that you enable the Autofree feature for the following cursor:

```
/*Cursor associated with a prepared statement */  
EXEC SQL prepare sel_stmt 'select * from customer';  
EXEC SQL declare sel_curs2 cursor for sel_stmt;
```

When the database server closes the **sel_curs2** cursor, it automatically performs the equivalent of the following FREE statements:

```
FREE sel_curs2;  
FREE sel_stmt;
```

Because memory for the **sel_stmt** statement is freed automatically, you cannot declare a new cursor on it unless you prepare the statement again.

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Closing Cursors Implicitly

A potential problem exists with cursors that have the Autofree feature enabled. In a database that is not ANSI-compliant, if you do not close a cursor explicitly and then open it again, the cursor is closed implicitly. This implicit closing of the cursor triggers the Autofree feature. The second time the cursor is opened, the database server generates an error message (*cursor not found*) because the cursor is already freed.

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SET COLLATION statement

Use the SET COLLATION statement to specify a new collating order for the session, superseding the collation implied by the DB_LOCALE environment variable setting. SET NO COLLATION restores the default collation.

Syntax

```
>>-SET--+--COLLATION--locale+-----><  
      '-NO COLLATION-----'
```

Element	Description	Restrictions	Syntax
<i>locale</i>	Name of a locale whose collating order is to be used in this session	Must be the name of a locale that the database server can access	Quoted String

Usage

The SET COLLATION statement is an extension to the ANSI/ISO standard for SQL. You can use this statement with Informix® ESQ/L/C.

As the *IBM® Informix GLS User's Guide* explains, the database server uses locale files to specify the character set, the collating order, and other conventions of some natural language to display and manipulate character strings and other data values. The collating order of the database locale is the sequential order in which the database server sorts character strings.

If you set no value for DB_LOCALE, the default locale, based on United States English, is **en_us.8859-1** for UNIX, or Code Page 1252 for Windows systems. Otherwise, the database server uses the DB_LOCALE setting as its locale. The SET COLLATION statement overrides the collating order of DB_LOCALE at runtime for all database servers previously accessed in the same session.

The new collating order remains in effect for the rest of the session, or until you issue another SET COLLATION statement. Other sessions are not affected, but database objects that you created with a non-default collation use whatever collating order was in effect at their time of their creation.

By default, the collating order is the code-set order, but some locales also support a locale-specific order. In most contexts, only NCHAR and NVARCHAR data values can be sorted according to a locale-specific collating order.

- [Specifying a Collating Order with SET COLLATION](#)
SET COLLATION replaces the current collating order for NCHAR and NVARCHAR values with that of the specified *locale* for all database servers previously accessed in the current session.
- [Restrictions on SET COLLATION](#)
Although SET COLLATION enables you to change the collating order of the database server dynamically within a session, you should be aware of several limitations on the scope of what the SET COLLATION statement can accomplish.
- [Collation Performed by Database Objects](#)

Related information:

[A GLS locale](#)

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Specifying a Collating Order with SET COLLATION

SET COLLATION replaces the current collating order for NCHAR and NVARCHAR values with that of the specified *locale* for all database servers previously accessed in the current session.

For example, this statement specifies the collating order for the **GB18030-2000** code set of the Chinese language:

```
EXEC SQL set collation "zh_cn.gb18030-2000";
```

If the next operation of a database server in this session sorted NCHAR or NVARCHAR values, the result would follow the Chinese collating order that the SET COLLATION statement specified.

Suppose that in the same session, the following SET NO COLLATION statement restores the **DB_LOCALE** setting for the collating order:

```
EXEC SQL set no collation;
```

After SET NO COLLATION executes, subsequent collation in the same session is based on the **DB_LOCALE** setting. Any database objects that you created using the Chinese collating order, however, such as check constraints, indexes, prepared objects, triggers, or UDRs, will continue to apply Chinese collation rules to NCHAR and NVARCHAR data types.

Collation in an NLSCASE INSENSITIVE database

Suppose that you use the following SET COLLATION statement to replace the current collating order with that of the **de_de.8859-1** locale for the German language:

```
SET COLLATION "de_de.8859-1";
```

By default, this locale supports case differences between uppercase and lowercase alphabetic characters. For example, two CHAR or VARCHAR strings of the same letters and in the same order, but with differences in case, such as 'Zug' and 'zUG', are treated in LIKE or MATCHES expressions or sorted in ORDER BY clauses as distinct data values.

In a database created with the **NLSCASE INSENSITIVE** keywords, however, collating operations on NCHAR and NVARCHAR data disregard case differences, so that the database server treats case variants among strings composed of same sequence letters as duplicates. The resulting collated list orders these case-insensitive duplicates in their order of retrieval, so a collated list with case variants of the string `alpha` might appear in any order, such as this order, which disregards variations in case:

```
alpha
Alpha
alpha
ALPHA
Alpha
```

For more information, see [Duplicate rows in NLSCASE INSENSITIVE databases](#) and [NCHAR and NVARCHAR expressions in case-insensitive databases](#).

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Restrictions on SET COLLATION

Although SET COLLATION enables you to change the collating order of the database server dynamically within a session, you should be aware of several limitations on the scope of what the SET COLLATION statement can accomplish.

- Only collation performed by the database server is affected. Client processes that sort data are not affected by SET COLLATION.
- Only the current session is affected. Other sessions are not affected directly by your SET COLLATION statements, but the database server will use their creation-time collating order to set any database objects that you create after SET COLLATION has run successfully.
- Changing the collating order does not change the code set. The database server always uses the code set specified by **DB_LOCALE**.
- Only NCHAR and NVARCHAR values are sorted in locale-specific order.

Processing characters from dissimilar code sets

Because SET COLLATION changes only the collating order, rather than the current locale or code set, you generally cannot use this statement to insert character data from different locales, such as French and Japanese, into the same database. You must instead use a locale that supports Unicode if the database needs to store characters from two or more languages that require inherently different code sets or code pages. For Informix® ESQL/C applications and for other client applications that use the IBM® Informix GLS library, databases with locales that support UTF-8 character encoding can store characters that correspond to code points from dissimilar character sets of more than one natural language, but only if all of the following conditions are satisfied:

- The GL_USEGLU environment variable was set to 1 when the database server instance was started.
- The DB_LOCALE environment variable was set to a valid Unicode locale when the database was created.
- The CLIENT_LOCALE environment variable is set to valid Unicode locale that the DB_LOCALE setting of the database server supports.

For IBM Informix to use the International Components for Unicode (ICU) 4.8.1 libraries to support versions of Unicode up to 6.0, the GL_USEGLU environment variable must be set to a value of 1 (one) in the server environment before the server is started. This setting initializes conversion routines that enable Unicode collation and SQL operations in databases that use **UTF-8** character encoding, including the Chinese **GB18030-2000** code set. This conversion applies only to databases that were created with **GL_USEGLU=1** already set.

Attention: The GL_USEGLU environment variable has no effect, however, on JDBC client applications, including those of the IBM Informix JSON compatibility wire protocol listener. To support JDBC applications correctly in Unicode locales, there is no requirement that GL_USEGLU be set to 1 in the client or in the server environments.

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Collation Performed by Database Objects

Although the database reverts to the **DB_LOCALE** collating order after the session ends (or after you execute SET NO COLLATION), objects that you create using a non-default collation persist in the database. You can create, for example, multiple indexes on the same set of columns, called *multilingual indexes*, using different collating orders that SET COLLATION specifies.

Only one clustered index, however, can exist on a given set of columns.

Only one unique constraint or primary key can exist on a given set of columns, but you can create multiple unique indexes on the same set of columns, if each index has a different collation order.

The query optimizer ignores indexes that apply any collation other than the current session collation to NCHAR or NVARCHAR columns when calculating the cost of a query.

The collating order of an attached index must be the same as that of its table, and this must be the default collating order specified by **DB_LOCALE**.

The ALTER INDEX statement cannot change the collation of an index. Any previous SET COLLATION statement is ignored when ALTER INDEX executes.

When you compare values from CHAR columns with NCHAR columns, Informix® casts the CHAR value to NCHAR, and then applies the current collation. Similarly, before comparing VARCHAR and NVARCHAR values, Informix first casts the VARCHAR values to NVARCHAR.

When synonyms are created for remote tables or views, the participating databases must have the same collating order. Existing synonyms, however, can be used in other databases that support SET COLLATION and the collating order of the synonym, regardless of the **DB_LOCALE** setting.

Check constraints, cursors, prepared objects, triggers, and SPL routines that sort NCHAR or NVARCHAR values use the collation that was in effect at the time of their creation, if this is different from the **DB_LOCALE** setting.

The effect on performance is sensitive to how many different collations are used when creating database objects that sort in a localized order.

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SET CONNECTION statement

Use the SET CONNECTION statement to reestablish a connection between an application and a database environment and to make the connection current. You can also use this statement with the DORMANT option to put the current connection in a dormant state. Use this statement with Informix® ESQL/C.

Syntax

```
>>-SET CONNECTION----->
>--+-'connection '-----+--+>
| | (1) | | (1) | |
| +-----connection_var-----+ '-----DORMANT-' |
| | (1) | | (2) | |
| +-----| Database Environment |-----+
| '-DEFAULT-----'
| | (1) |
| '-----CURRENT DORMANT-----'
```

Notes:

1. Informix extension
2. See [Database Environment](#)

Element	Description	Restrictions	Syntax
<i>connection</i>	Name of the initial connection that the CONNECT statement made	The database must already exist	Quoted String
<i>connection_var</i>	Host variable that contains the value of <i>connection</i>	Must be a character data type	Language specific

Usage

You can use SET CONNECTION to make a dormant connection the current connection or to make the current connection dormant.

SET CONNECTION is not valid as a prepared statement.

- [Making a dormant connection as the current connection](#)
If you use the SET CONNECTION statement without the DORMANT option, *connection* must represent a dormant connection. A *dormant connection* is a connection that is established but is not current.
- [Making a current connection as the dormant connection](#)
In the SET CONNECTION *connection* DORMANT statement, *connection* must represent the current connection. The SET CONNECTION statement with the DORMANT option makes the specified current connection a dormant connection.
- [Dormant Connections in a Single-Threaded Environment](#)
- [Dormant Connections in a Thread-Safe Environment](#)
- [Identifying the Connection](#)
- [DEFAULT Option](#)
- [CURRENT Keyword](#)

- [When a Transaction is Active](#)

Related reference:

[SET SESSION AUTHORIZATION statement](#)

[DISCONNECT statement](#)

[CONNECT statement](#)

[DATABASE statement](#)

Related information:

[Program a thread-safe ESQL/C application](#)

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Making a dormant connection as the current connection

If you use the SET CONNECTION statement without the DORMANT option, *connection* must represent a dormant connection. A *dormant connection* is a connection that is established but is not current.

The SET CONNECTION statement, with no DORMANT option, makes the specified dormant connection the current one. The connection that the application specifies must be dormant. The connection that is current when the statement executes becomes dormant.

The SET CONNECTION statement in the following example makes connection `con1` the current connection and makes `con2` a dormant connection:

```
CONNECT TO 'stores_demo' AS 'con1';  
...  
CONNECT TO 'demo' AS 'con2';  
...  
SET CONNECTION 'con1';
```

A dormant connection has a *connection context* associated with it. When an application makes a dormant connection current, it reestablishes that connection to a database environment and restores its connection context. (For more information on connection context, see the [CONNECT statement](#) on page [CONNECT statement](#).) Reestablishing a connection is comparable to establishing the initial connection, except that it typically avoids authenticating the permissions for the user again, and it avoids reallocating resources associated with the initial connection. For example, the application does not need to reprepare any statements that have previously been prepared in the connection, nor does it need to redeclare any cursors.

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Making a current connection as the dormant connection

In the SET CONNECTION *connection* DORMANT statement, *connection* must represent the current connection. The SET CONNECTION statement with the DORMANT option makes the specified current connection a dormant connection.

For example, the following SET CONNECTION statement makes connection `con1` dormant:

```
SET CONNECTION 'con1' DORMANT;
```

The SET CONNECTION statement with the DORMANT option generates an error if you specify a connection that is already dormant. For example, if connection `con1` is current and connection `con2` is dormant, the following SET CONNECTION statement returns an error message:

```
SET CONNECTION 'con2' DORMANT;
```

The following SET CONNECTION statement executes successfully:

```
SET CONNECTION 'con1' DORMANT;
```

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Dormant Connections in a Single-Threaded Environment

In a single-threaded Informix® ESQL/C application (one that does not use threads), the DORMANT option makes the current connection dormant. Using this option makes single-threaded Informix ESQL/C applications upwardly compatible with thread-safe Informix ESQL/C applications. A single-threaded environment, however, can have only one active connection while the program executes.

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Dormant Connections in a Thread-Safe Environment

In a thread-safe Informix® ESQL/C application, the DORMANT option makes an active connection dormant. Another thread can now use the connection by issuing the SET CONNECTION statement without the DORMANT option. A thread-safe environment can have many threads (concurrent pieces of work performing particular tasks) in one Informix ESQL/C application, and each thread can have one active connection.

An active connection is associated with a particular thread. Two threads cannot share the same active connection. Once a thread makes an active connection dormant, that connection is available to other threads. A dormant connection is still established but is not currently associated with any thread. For example, if the connection named `con1` is active in the thread named `thread_1`, the thread named `thread_2` cannot make connection `con1` its active connection until `thread_1` has made connection `con1` dormant.

The following code fragment from a thread-safe Informix ESQL/C program shows how a particular thread within a thread-safe application makes a connection active, performs work on a table through this connection, and then makes the connection dormant so that other threads can use the connection:

```
thread_2()
{ /* Make con2 an active connection */
  EXEC SQL connect to 'db2' as 'con2';
  /*Do insert on table t2 in db2*/
  EXEC SQL insert into table t2 values(10);
  /* make con2 available to other threads */
  EXEC SQL set connection 'con2' dormant;
}
```

If a connection to a database environment was initiated using the `CONNECT . . . WITH CONCURRENT TRANSACTION` statement, any thread that subsequently connects to that database environment can use an ongoing transaction. In addition, if an open cursor is associated with such a connection, the cursor remains open when the connection is made dormant.

Threads within a thread-safe Informix ESQL/C application can use the same cursor by making the associated connection current, even though only one thread can use the connection at any given time.

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Identifying the Connection

If the application did not specify a connection name in the initial `CONNECT` statement, you must use a database environment (such as a database name or a database pathname) as the connection name. For example, the following `SET CONNECTION` statement uses a database environment for the connection name because the `CONNECT` statement does not use a connection name. For information about quoted strings that specify a database environment, see [Database Environment](#).

```
CONNECT TO 'stores_demo';
...
CONNECT TO 'demo';
...
SET CONNECTION 'stores_demo';
```

If a connection to a database server was assigned a connection name, however, you must use the connection name to reconnect to the database server. An error is returned if you use a database environment rather than the connection name when a connection name exists.

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DEFAULT Option

The `DEFAULT` option specifies the default connection for a `SET CONNECTION` statement. The default connection is one of the following connections:

- An explicit default connection (a connection established with the `CONNECT TO DEFAULT` statement)
- An implicit default connection (any connection established with the `DATABASE` or `CREATE DATABASE` statements)

Use `SET CONNECTION` without a `DORMANT` option to reestablish the default connection, or with that option to make the default connection dormant.

For more information, see [The DEFAULT Connection Specification](#) and [The Implicit Connection with DATABASE Statements](#).

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CURRENT Keyword

Use the `CURRENT` keyword with the `DORMANT` option of the `SET CONNECTION` statement as a shorthand form of identifying the current connection. The `CURRENT` keyword replaces the current connection name. If the current connection is `con1`, the following two statements are equivalent:

```
SET CONNECTION 'con1' DORMANT;

SET CONNECTION CURRENT DORMANT;
```

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When a Transaction is Active

When you issue a SET CONNECTION statement with the DORMANT keyword, the SET CONNECTION statement explicitly puts the current connection in the dormant state. In both cases, the statement can fail if a connection that becomes dormant has an uncommitted transaction. If the connection that becomes dormant has an uncommitted transaction, the following conditions apply:

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Use the SET CONSTRAINTS statements to change how some or all of the existing constraints on a table are processed.

Only the CREATE TABLE, CREATE TEMP TABLE and ALTER TABLE ADD CONSTRAINT statements of SQL can create new constraints. The SET CONSTRAINTS statement supports the following syntax for modifying how the database server enforces (or ignores) one or more existing constraints on a single table:

Notes:

1. Informix® extension. Constraint must be on a table in the current database.
2. See [Filtering Modes](#)
3. Valid for FOREIGN KEY or CHECK constraints only

Element	Description	Restrictions	Syntax
<i>constraint</i>	Constraint whose mode is to be reset	Must exist, and must all be defined on the same table	Identifier
<i>owner</i>	Owner of <i>table</i>	Must own table	Owner name
<i>table</i>	Table whose constraint mode is to be reset for all constraints	Must exist in the database	Identifier

Constraint-mode keyword options of the SET CONSTRAINTS statements include these:

- The `SET CONSTRAINTS` keywords can begin the SET Transaction Mode statement, which is described in [SET Transaction Mode statement](#).

For information on using the SET CONSTRAINTS statement to enable or disable system-defined indexes that are implicitly created by PRIMARY KEY and FOREIGN KEY constraint definitions, see the topic [SET INDEXES statement](#).

The database server automatically drops the NOVALIDATE attribute when the SET CONSTRAINTS statement completes execution. The following statement enables the same foreign-key constraint and restores automatic validation of the constraint:

```
SET CONSTRAINTS u100_2 ENABLE;
```

When you use the `FILTERING WITHOUT ERROR` keywords to define a filtering mode, subsequent violations of that constraint, or uniqueness violations of that index, do not cause INSERT, DELETE, MERGE, or UPDATE operations to fail if some rows violate the constraint or the unique index. In this filtering mode, the DML statement succeeds, but the database server enforces the constraint or the unique index requirement by writing the noncompliant rows to the violations table.

The following statement instructs the database server to write any rows that violate the r104_11 constraint to the violations table, provided that a violations table is associated with the target table.

```
SET CONSTRAINTS r104_11 FILTERING WITHOUT ERROR;
```

For more information about filtering modes, see the topic [Filtering Modes](#).
The following statement disables all constraints defined on the orders table:

```
SET CONSTRAINTS FOR orders DISABLED;
```

Subsequent DML operations on that table ignore rows that violate constraints on the orders table, creating no entries in its violations or diagnostics tables, if those tables exist. If any unique indexes exist on the orders table, however, rows that violate uniqueness requirements are processed according to the current modes of the indexes, as listed in the `sysobjstate` system catalog table.

- [Enabling foreign-key constraints when an index exists on the referenced table](#)

By default, the database server automatically validates referential constraints when their mode is changed to ENABLED. You might be able to save time when the SET CONSTRAINTS statement enables a foreign-key constraint, if the referenced table already has a unique index or a primary-key constraint on the column (or on the set of columns) corresponding to the key of the foreign-key constraint.

Related concepts:

[CREATE TRIGGER statement](#)

Related reference:

[ALTER TABLE statement](#)

[CREATE TABLE statement](#)

[CREATE INDEX statement](#)

[START VIOLATIONS TABLE statement](#)

[STOP VIOLATIONS TABLE statement](#)

Related information:

[Object modes and violation detection](#)

[SYSOBJSTATE](#)

[SYSVIOLATIONS](#)

[System catalog tables](#)

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Enabling foreign-key constraints when an index exists on the referenced table

By default, the database server automatically validates referential constraints when their mode is changed to ENABLED. You might be able to save time when the SET CONSTRAINTS statement enables a foreign-key constraint, if the referenced table already has a unique index or a primary-key constraint on the column (or on the set of columns) corresponding to the key of the foreign-key constraint.

The database server makes a cost-based decision on how to validate the enabled foreign-key constraint. The index-key algorithm might be faster in many contexts, because it validates the constraint by scanning only the index values, rather than by scanning all the rows in the table.

The database server can consider using the index-key algorithm to validate the foreign-key constraint that it enables, but only if all of the following conditions are satisfied when the SET CONSTRAINTS ENABLED statement resets the constraint mode:

- The SET CONSTRAINTS statement is enabling only one foreign-key constraint.
If this is the case, the database server needs to check individual values for only the column on which the foreign-key constraint is being enabled. Validating two foreign-key constraints at the same time would require two indices to be used on the same scan, which is not supported.
- The same statement is not enabling a CHECK constraint.
If the SET CONSTRAINTS statement is enabling more than one constraint, validating CHECK constraints requires that every row be checked, rather than individual values. In that case, the index-key algorithm cannot be used for validating the foreign-key constraint.
- The foreign-key columns do not include user-defined data types (UDTs) or built-in opaque data types.
To make the fast index-key algorithm as efficient as possible, it eliminates all the inefficiencies of executing routines associated with user-defined or built-in opaque data types, such as the BOOLEAN and VARCHAR built-in opaque types.
- The new mode of the foreign-key constraint is not DISABLED.
If it is disabled, then no constraint-checking algorithm is needed, because no checking for referential integrity violations occurs.
- The table is not associated with an active violation table.
Violations tables require that at the time of checking, every row that does not satisfy the new constraint must be inserted into the violation table. Scanning every row for violations prevents the database server from using the faster index-key algorithm that skips duplicate rows.

Except in the case of one or more violating rows, the SET CONSTRAINTS statement can enable and validate a foreign-key constraint when some of these requirements are not satisfied, but the database server will not consider using the index-key algorithm to validate the foreign-key constraint. The additional validation costs for scanning the entire table are generally proportional to the size of the table. These costs can be substantial for very large tables.

When you enable a self-referencing foreign-key constraint, whose REFERENCING clause specifies the same table on which the constraint is defined, the database server can consider an index-key algorithm for validating referential-integrity, if all the conditions listed above are satisfied.

Related reference:

[Creating foreign-key constraints when an index exists on the referenced table](#)

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Modes for Triggers and Duplicate Indexes

You can specify ENABLED or DISABLED as the only object modes for triggers on tables, and for triggers on views, and for indexes that allow duplicate values.

You can specify the modes for triggers or duplicate indexes.

Modes for Triggers and Duplicate Indexes

```
.-ENABLED--.  
|---+---DISABLED-+-----|
```

If you specify no mode for an index or for a trigger when you create it or in a subsequent SET Database Object Mode statement, the object is enabled by default.

Example of changing the mode of an index

The following example of the SET INDEXES statement disables the unique **acc_num_ix** index, which was created in ENABLED mode by default:

```
CREATE TABLE accounts (  
  acc_num INTEGER DEFAULT 1,  
  acc_type CHAR(1) DEFAULT 'A',  
  acc_descr CHAR(20) DEFAULT 'New Account',  
  acc_bal MONEY(9,2)  
  acc_id CHAR(32) DEFAULT CURRENT_USER);  
  
CREATE DISTINCT INDEX acc_num_ix ON accounts (acc_num);  
  
SET INDEXES acc_num_ix DISABLED;
```

Here the SET INDEXES statement used the Object-list format to specify the index by name. Because no other index is defined on the **accounts** table, the following SET INDEXES statement that uses the Table format has the same effect:

```
SET INDEXES FOR accounts DISABLED;
```

Example of changing mode of a trigger

The following example enables a **backup_accts** trigger that was created in DISABLED mode:

```
SET TRIGGERS backup_accts ENABLED;
```

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Definitions of Database Object Modes

You can use database object modes to control the effects of INSERT, DELETE, and UPDATE statements. Your choice of mode affects the tables whose data you are manipulating, the behavior of the database objects defined on those tables, and the behavior of the data manipulation statements themselves.

- [Enabled Mode](#)
Database objects in the enabled mode behave as constraints, indexes, or triggers during DML operations on the table.
- [Disabled Mode](#)
When a database object is disabled, the database server ignores it during the execution of an INSERT, DELETE, MERGE, SELECT, or UPDATE statement. A disabled constraint is not enforced, a disabled index is not updated, and a disabled trigger is not executed when the trigger event takes place.
- [Filtering Modes](#)
A constraint or unique index in a filtering mode can insert into an associated violations table any rows that fail to comply with the constraint or index during DML operation. This mode also supports WITH ERROR and WITHOUT ERROR options for processing referential-integrity violations from INSERT, DELETE, MERGE, and UPDATE statements.

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Enabled Mode

Database objects in the enabled mode behave as constraints, indexes, or triggers during DML operations on the table.

If you specify no database object mode when constraints, indexes, or triggers are created, they are enabled by default. The data definition statements CREATE TABLE, ALTER TABLE, CREATE INDEX, and CREATE TRIGGER all create database objects in enabled mode, unless you explicitly specify a different mode.

Which nondefault object modes are available at creation-time depends on the type of object:

- When a trigger or a non-unique index is created, the only keyword alternative to the enabled mode is `DISABLED`.
- When a constraint or a unique index is created, alternatives to the default or explicit `ENABLED` keyword include `DISABLED`, `FILTERING WITH ERROR`, and `FILTERING WITHOUT ERROR`. (But if you only specify `FILTERING`, then `FILTERING WITHOUT ERROR` is the default error mode for `FILTERING` objects.)
- While the ALTER TABLE ADD CONSTRAINT statement is creating a foreign-key or check constraint, however, any of these three modes can instead be specified as additional alternatives to the enabled mode:
 - `ENABLED NOVALIDATE`
 - `FILTERING WITH ERROR NOVALIDATE`
 - `FILTERING WITHOUT ERROR NOVALIDATE`.

When the SET Database Object Mode statement changes the mode of an existing constraint, index, or trigger, however, there no default mode. If you specify no object mode, the SET Database Object Mode statement fails with error -201. If you want to reset the mode of a constraint, index, or trigger to enabled from some other mode, you must explicitly specify the `ENABLED` keyword.

When a database object is successfully enabled, the database server registers that object state in the **sysobjstate** table of the system catalog, and takes that database object into consideration when its table is the target of a subsequent INSERT, DELETE, MERGE, or UPDATE statement (or for Select triggers, a SELECT statement). Thus, an enabled constraint is enforced, an enabled index is updated, and an enabled trigger on a table is executed when the trigger event takes place.

For example, after you set foreign-key constraints and unique indexes to enabled mode, when an INSERT, DELETE, MERGE, or UPDATE operation attempts to violate the referential integrity of the table, the data manipulation operation fails, no rows in the table are changed, and the database server returns an error message.

ENABLED NOVALIDATE mode for foreign-key or check constraints

While the SET Database Object Mode statement is changing the mode of a foreign-key or check constraint to `ENABLED`, the database server validates the constraint by examining every row in the constrained table to verify the constraint conditions. This validation can require significant time and resources. You can instead bypass the search for violating rows during the SET Database Object mode operation by including the `NOVALIDATE` keyword to change the constraint mode to `ENABLED NOVALIDATE`. For large tables, specifying `ENABLED NOVALIDATE` can substantially reduce the time required to enable the constraint.

After the SET CONSTRAINTS option to the SET Database Object Mode statement successfully enables a foreign-key or check constraint, the constraint mode is registered as enabled (E) in the **sysobjstate** system catalog table. The `NOVALIDATE` keyword, that had prevented checking for referential-integrity or check condition violations while the SET CONSTRAINTS statement was running, is not encoded anywhere in the system catalog, and has no further effect on the object mode or the behavior of the constraint.

Until it is dropped or disabled, that constraint is enforced during subsequent DML operations on its table, in order to maintain the referential integrity of the database.

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Disabled Mode

When a database object is disabled, the database server ignores it during the execution of an INSERT, DELETE, MERGE, SELECT, or UPDATE statement. A disabled constraint is not enforced, a disabled index is not updated, and a disabled trigger is not executed when the trigger event takes place.

When you disable constraints and unique indexes, any data manipulation statement that violates the restriction of the constraint or unique index succeeds (that is, the target row is changed), and the database server does not return an error message.

You can use the disabled mode to add a new constraint or new unique index to an existing table, even if some rows in the table do not satisfy the new integrity specification. Disabling can also be efficient in LOAD operations.

For information on adding a constraint, see [Adding a Constraint That Existing Rows Violate](#) in the ALTER TABLE statement. For information on adding a unique index, see [Adding a Unique Index When Duplicate Values Exist in the Column](#) in the CREATE INDEX statement.

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Filtering Modes

A constraint or unique index in a filtering mode can insert into an associated violations table any rows that fail to comply with the constraint or index during DML operation. This mode also supports WITH ERROR and WITHOUT ERROR options for processing referential-integrity violations from INSERT, DELETE, MERGE, and UPDATE statements.

When a constraint or unique index is in `FILTERING WITH ERROR` mode, the database server returns a referential-integrity violation error message after the INSERT, DELETE, MERGE, or UPDATE statement results in one or more rows that are not in compliance with the unique index or with the constraint.

By default, the `FILTERING` keyword with no error option specifies the `FILTERING WITHOUT ERROR` object mode.

Effects of FILTERING mode in DML operations

When a constraint or unique index is in **FILTERING WITHOUT ERROR** mode, the **INSERT**, **DELETE**, **MERGE**, or **UPDATE** statement succeeds, but the database server enforces the constraint or the unique-index requirement by writing any failed rows to the violations table associated with the target table. Diagnostic information about the constraint violation or unique-index violation is written to the diagnostics table associated with the target table.

In data manipulation operations, filtering mode has the following specific effects on **INSERT**, **UPDATE**, and **DELETE** statements:

- A constraint violation during an **INSERT** statement causes the database server to make a copy of the nonconforming record and write it to the violations table. The database server does not write the nonconforming record to the target table. If the **INSERT** statement is not a singleton **INSERT**, the rest of the insert operation proceeds with the next record.
- A constraint violation or unique-index violation during an **UPDATE** statement causes the database server to make a copy of the existing record that was to be updated and write it to the violations table. The database server also makes a copy of the new record and writes it to the violations table, but the actual record is not updated in the target table. If the **UPDATE** statement is not a singleton update, the rest of the update operation proceeds with the next record.
- A constraint violation or unique-index violation during a **DELETE** statement causes the database server to make a copy of the record that was to be deleted and write it to the violations table. The database server does not delete the actual record in the target table. If the **DELETE** statement is not a singleton delete, the rest of the delete operation proceeds with the next record.
- In **MERGE** statements, the component **INSERT**, **DELETE**, or **UPDATE** operations are processed as respectively described above.

In all of these cases, the database server sends diagnostic information about each constraint violation or unique-index violation to the diagnostics table associated with the target table.

For information on the structure of the records that the database server writes to the violations and diagnostics tables, see [Structure of the violations table](#) and [Structure of the diagnostics table](#).

FILTERING NOVALIDATE modes

While the **SET Database Object Mode** statement is changing the mode of a foreign-key or check constraint to **FILTERING WITHOUT ERROR** or to **FILTERING WITH ERROR**, the database server validates the constraint by examining every row in the constrained table. For large tables, this validation can require significant time and resources.

You can instead bypass the search for violating rows during the **SET Database Object mode** operation by including the **NOVALIDATE** keyword to change the constraint mode to **FILTERING WITHOUT ERROR NOVALIDATE** or to **FILTERING WITH ERROR NOVALIDATE**, as in these examples for foreign-key constraints:

```
SET CONSTRAINTS (refcon_1, refcon_2) FILTERING WITH ERROR;  
SET CONSTRAINTS (refcon_3, refcon_4) FILTERING WITHOUT ERROR;
```

For constraints on large tables that need to be relocated, specifying **NOVALIDATE** for **ENABLED** or **FILTERING** modes can substantially reduce the time required to change the mode of the constraint to a filtering mode.

After the **SET Database Object Mode** statement successfully enables a constraint in a **NOVALIDATE** filtering mode, the constraint is registered in **FILTERING WITHOUT ERROR** mode (**F**) or in **FILTERING WITH ERROR** mode (**G**) in the **sysobjstate** system catalog table. Because the **NOVALIDATE** keyword has no encoding in the system catalog, it has no subsequent effect on the behavior of the database server. The database server enforces the foreign-key constraint during subsequent DML operations as the **SET CONSTRAINTS** statement specified, with or without integrity violation errors, to maintain the referential integrity of the database.

Important:

When the **ALTER TABLE ADD CONSTRAINT** statement defines an **ENABLED** referential constraint in **NOVALIDATE** mode on a table that contains data, the database server can achieve the same efficiencies of bypassing constraint validation that are described above for the **SET CONSTRAINTS** statement. For more information about the **NOVALIDATE** option in **ALTER TABLE** operations that define new referential constraints, see [Creating foreign-key constraints in NOVALIDATE modes](#).

- [Starting and Stopping the Violations and Diagnostics Tables](#)
- [Error Options for Filtering Mode](#)
- [Effect of Filtering Mode on the Database](#)

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Starting and Stopping the Violations and Diagnostics Tables

You must use the **START VIOLATIONS TABLE** statement to start the violations and diagnostics tables for the target table on which the database objects are defined, either before you set any database objects that are defined on the table to the filtering mode, or after you set database objects to filtering, but before any users issue **INSERT**, **DELETE**, or **UPDATE** statements.

If you want to stop the database server from filtering bad records to the violations table and sending diagnostic information about each bad record to the diagnostics table, you must issue a **STOP VIOLATIONS TABLE** statement.

For further information on these statements, see [START VIOLATIONS TABLE statement](#) and [STOP VIOLATIONS TABLE statement](#).

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Error Options for Filtering Mode

When you set the mode of a constraint or unique index to filtering, you can specify one of two error options. These error options control whether the database server displays an integrity-violation error message when it encounters bad records during execution of data manipulation statements:

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This statement is an extension to the ANSI/ISO standard for SQL.

```
SET DATASKIP OFF;
```

- [Circumstances When a Dbspace Cannot Be Skipped](#)

Related information:

[Skip inaccessible fragments](#)

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Circumstances When a Dbspace Cannot Be Skipped

The database server cannot skip a dbspace under certain conditions. The following list outlines those conditions:

- Referential constraint checking
When you want to delete a parent row, the child rows must also be available for deletion, and must exist in an available fragment.

When you want to insert a new child row, the parent row must be found in the available fragments.
- Updates
When you perform an update that moves a record from one fragment to another, both fragments must be available.
- Inserts
When you try to insert records in a expression-based fragmentation strategy and the dbspace is unavailable, an error is returned.

When you try to insert records in a round-robin fragment-based strategy, and a dbspace is down, the database server inserts the rows into any available dbspace.

When no dbspace is available, an error is returned.
- Indexing
When you perform updates that affect the index, such as when you insert or delete rows, or update an indexed column, the index must be available.

When you try to create an index, the dbspace you want to use must be available.
- Serial keys
The first fragment is used to store the current serial-key value internally. This is not visible to you except when the first fragment becomes unavailable and a new serial key value is required, which can happen during INSERT statements.

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SET DEBUG FILE statement

Use the SET DEBUG FILE statement to identify the file that is to receive the runtime trace output of an SPL routine.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-SET DEBUG FILE TO--+-'filename'---+--+-----+-----><
      +-filename_var+  '-WITH APPEND-'
      '-expression---'
```

Element	Description	Restrictions	Syntax
<i>expression</i>	Expression that returns a filename	Must be a valid filename	Expression
<i>filename</i>	Pathname of the file that contains the output of the TRACE statement	See Using the WITH APPEND Option	Quoted String .
<i>filename_var</i>	Host variable storing <i>filename</i> string	Must be a character type	Language specific

Usage

This statement specifies the file to which the database server writes the output from the TRACE statement in the SPL routine. Each time the TRACE statement is executed, the trace information is added to this output file.

- [Using the WITH APPEND Option](#)
- [Closing the Output File](#)
- [Redirecting Trace Output](#)
- [Location of the Output File](#)

Related reference:

[TRACE](#)

Related information:

[Create and use SPL routines](#)

Using the WITH APPEND Option

The output file that you specify in the SET DEBUG FILE statement can be a new file or existing file. If you specify an existing file, its current contents are deleted when you issue the SET DEBUG FILE TO statement. The first execution of a TRACE statement sends trace output to the beginning of the file.

If you include the WITH APPEND option, the current contents of the file are preserved when you issue the SET DEBUG FILE statement. The first execution of a TRACE statement adds the new trace output to the end of the file.

If you specify a new file in the SET DEBUG FILE TO statement, it makes no difference whether you include the WITH APPEND option. The first execution of a TRACE statement sends trace output to the beginning of the new file whether you include or omit the WITH APPEND option.

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Closing the Output File

To close the file that the SET DEBUG FILE TO statement opened, issue another SET DEBUG FILE TO statement with another filename. You can then read or edit the contents of the first file.

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Redirecting Trace Output

You can use the SET DEBUG FILE TO statement outside an SPL routine to direct the trace output of the SPL routine to a file. You can also use this statement within an SPL routine to redirect its own output.

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Location of the Output File

If you execute the SET DEBUG FILE statement with a simple filename on a local database, the output file is located in your current directory. If your current database is on a remote database server, the output file is located in your home directory on the remote database server. If you provide a full pathname for the debug file, the file is placed in the directory that you specify on the remote database server. If you do not have write permissions in the directory, you receive an error.

The following example sends the output of the SET DEBUG FILE TO statement to a file called **debug.out**:

```
SET DEBUG FILE TO 'debug' || '.out';
```

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SET DEFERRED_PREPARE statement

Use the SET DEFERRED_PREPARE statement to control whether a client process postpones sending a PREPARE statement to the database server until the OPEN or EXECUTE statement is sent.

Only Informix® supports this statement, which is an extension to the ANSI/ISO standard for SQL. You can use this statement only with Informix ESQL/C.

Syntax

```
                .-ENABLED-----.  
>>-SET DEFERRED_PREPARE--+-----+-----><  
                '-DISABLED-'
```

Usage

By default, the SET DEFERRED_PREPARE statement causes the application program to delay sending the PREPARE statement to the database server until the OPEN or EXECUTE statement is executed. In effect, the PREPARE statement is bundled with the other statement so that one round-trip of messages, instead of two, is sent between the client and the server. This Deferred-Prepare feature can affect the following series of Dynamic SQL statement:

- PREPARE, DECLARE, OPEN statement blocks that operate with the FETCH or PUT statements
- PREPARE followed by the EXECUTE or EXECUTE IMMEDIATE statement

You can specify ENABLED or DISABLED options for SET DEFERRED_PREPARE.

If you specify no option, the default is ENABLED. The following example enables the Deferred-Prepare feature by default:

```
EXEC SQL set deferred_prepare;
```

The ENABLED option enables the Deferred-Prepare feature within the application. The following example explicitly specifies the ENABLED option:

```
EXEC SQL set deferred_prepare enabled;
```

After an application issues SET DEFERRED_PREPARE ENABLED, the Deferred-Prepare feature is enabled for subsequent PREPARE statements in the application. The application then exhibits the following behavior:

- The sequence PREPARE, DECLARE, OPEN sends the PREPARE statement to the database server with the OPEN statement. If the prepared statement has syntax errors, the database server does not return error messages to the application until the application declares a cursor for the prepared statement and opens the cursor.
- The sequence PREPARE, EXECUTE sends the PREPARE statement to the database server with the EXECUTE statement. If a prepared statement contains syntax errors, the database server does not return error messages to the application until the application attempts to execute the prepared statement.

If Deferred-Prepare is enabled in a PREPARE, DECLARE, OPEN statement block that contains a DESCRIBE statement, the DESCRIBE statement must follow the OPEN statement rather than the PREPARE statement. If the DESCRIBE follows PREPARE, the DESCRIBE statement results in an error.

Use the DISABLED option to disable the Deferred-Prepare feature within the application. The following example specifies the DISABLED option:

```
EXEC SQL set deferred_prepare disabled;
```

If you specify the DISABLED option, the application sends each PREPARE statement to the database server when the PREPARE statement is executed.

- [Example of SET DEFERRED_PREPARE](#)
- [Using Deferred-Prepare with OPTOFC](#)

Related reference:

[DECLARE statement](#)
[DESCRIBE statement](#)
[EXECUTE statement](#)
[OPEN statement](#)
[PREPARE statement](#)
[FETCH statement](#)

Related information:

[Dynamic SQL](#)
[The SET DEFERRED_PREPARE statement](#)

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Example of SET DEFERRED_PREPARE

The following code fragment shows a SET DEFERRED_PREPARE statement with a PREPARE, EXECUTE statement block. In this case, the database server executes the PREPARE and EXECUTE statements all at once:

```
EXEC SQL BEGIN DECLARE SECTION;
  int a;
EXEC SQL END DECLARE SECTION;
EXEC SQL allocate descriptor 'desc';
EXEC SQL create database test;
EXEC SQL create table x (a int);

/* Enable Deferred-Prepare feature */
EXEC SQL set deferred_prepare enabled;
/* Prepare an INSERT statement */
EXEC SQL prepare ins_stmt from 'insert into x values(?)';
a = 2;
EXEC SQL EXECUTE ins_stmt using :a;
if (SQLCODE)
  printf("EXECUTE : SQLCODE is %d\n", SQLCODE);
```

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Using Deferred-Prepare with OPTOFC

You can use the Deferred-Prepare and Open-Fetch-Close Optimization (OPTOFC) features in combination. The OPTOFC feature delays sending the OPEN message to the database server until the FETCH message is sent. The following situations occur if you enable the Deferred-Prepare and OPTOFC features at the same time:

- If the text of a prepared statement contains syntax errors, the error messages are not returned to the application until the first FETCH statement is executed.
- A DESCRIBE statement cannot be executed until after the FETCH statement.
- You must issue an ALLOCATE DESCRIPTOR statement before a DESCRIBE or GET DESCRIPTOR statement can be executed.

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Use this statement with Informix® ESQL/C.

```
>>-SET DESCRIPTOR--+descriptor_var+----->
                        '-descriptor --'

>--+COUNT=--+total_items_var+-----+-->
|               '-total_items----'|
|                               |
|                               V -----(1) |
'-VALUE--+item_num_var+---| Item Descriptor |--+++'
          '-item num----'
```

1. See [Item Descriptor](#)

Element	Description	Restrictions	Syntax
<i>descriptor</i>	String that identifies the SDA to which values are assigned	System-descriptor area (SDA) must be previously allocated	Quoted String
<i>descriptor_var</i>	Host variable that stores <i>descriptor</i>	Same restrictions as <i>descriptor</i>	Language specific
<i>item_num</i>	Unsigned integer that specifies ordinal position of an item descriptor in the SDA	$0 < item_num \leq (\text{number of item descriptors specified when SDA was allocated})$	Literal Number
<i>item_num_var</i>	Host variable that stores <i>item_num</i>	Same restrictions as <i>item_num</i>	Language specific
<i>total_items</i>	Unsigned integer that specifies how many items the SDA describes	Same restrictions as <i>item_num</i>	Literal Number
<i>total_items_var</i>	Host variable that stores <i>total_items</i>	Same restrictions as <i>total_items</i>	Language specific

A system-descriptor area

Using the COUNT Clause

Use the COUNT clause to set the number of items that are to be used in the system-descriptor area. If you allocate a system-descriptor area with more items than you are using, you need to set the **COUNT** field to the number of items that you are actually using. The following example shows a fragment of the Informix® ESQL/C program:

```
EXEC SQL BEGIN DECLARE SECTION;
    int count;

EXEC SQL END DECLARE SECTION;

EXEC SQL allocate descriptor 'desc_100'; /*allocates for 100 items*/
    count = 2;
EXEC SQL set descriptor 'desc_100' count = :count;
```

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Using the VALUE Clause

Use the VALUE clause to assign values from host variables into fields of a system-descriptor area. You can assign values for items for which you are providing a description (such as parameters in a WHERE clause), or you can modify values for items after you use a DESCRIBE statement to fill the fields for an UPDATE or INSERT statement.

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Item Descriptor

Use the Item Descriptor portion of the SET DESCRIPTOR statement to set value for an individual field in a system-descriptor area.

Item Descriptor

```
|---+--TYPE-----+ = --+literal_int_var+-----+-----|
| +-LENGTH-----+   '-literal_int-----'           |
| +-PRECISION--+      |                               |
| +-SCALE-----+     |                               |
| +-NULLABLE--+       |                               |
| +-INDICATOR--+      |                               |
| +-ITYPE-----+     |                               |
| '-ILENGTH---'       |                               |
|                               | (1)                 |
| +-+DATA---+ = --+| Literal Number |-----+-----+
| '-IDATA-'      |                               | (2) |
|               +-| Literal DATETIME |-----+-----+
|               |                               | (3) |
|               +-| Literal INTERVAL |-----+-----+
|               |                               | (4) |
|               +-| Quoted String |-----+-----+
|               '-input_var-----'           |
|                               | (4)                 |
| +-+NAME-----+ = --+| Quoted String |-----+-----+
| +-EXTYPENAME-----+   '-input_var-----'           |
| '-EXTYPEOWNERNAME-'   |                               |
| +-+SOURCEID-----+ = --+literal_int_var+-----+
| +-SOURCEID-----+   '-literal_int-----'           |
| +-EXTYPEID-----+
| +-EXTYPELENGTH-----+
| '-EXTYPEOWNERLENGTH-'
```

Notes:

1. See [Literal Number](#)
2. See [Literal DATETIME](#)
3. See [Literal INTERVAL](#)
4. See [Quoted String](#)

Element	Description	Restrictions	Syntax
<i>input_var</i>	Host variable storing data for the specified item descriptor field	Must be appropriate for the specified field	Language-specific
<i>literal_int</i>	Integer value (> 0) assigned to the specified item descriptor field	Restrictions depend on the keyword to the left of = symbol	Literal Number

Element	Description	Restrictions	Syntax
<i>literal_int_var</i>	Variable having <i>literal_int</i> value	Same as for <i>literal_int</i>	Language-specific

For information on codes that are valid for the TYPE or ITYPE fields and their meanings, see [Setting the TYPE or ITYPE Field](#).

For the restrictions that apply to other field types, see the individual headings for field types under [Using the VALUE Clause](#).

- [Setting the TYPE or ITYPE Field](#)
- [Setting the DATA or IDATA Field](#)
- [Setting the LENGTH or ILENGTH Field](#)
- [Setting the INDICATOR Field](#)
- [Setting Opaque-Type Fields](#)
- [Setting Distinct-Type Fields](#)

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Setting the TYPE or ITYPE Field

Use these integer values to set the value of **TYPE** or **ITYPE** for each item.

SQL Data Type	Integer Value	X-Open Integer Value	SQL Data Type	Integer Value	X-Open Integer Value
CHAR	0	1	MONEY	8	–
SMALLINT	1	4	DATETIME	10	–
INTEGER	2	5	BYTE	11	–
FLOAT	3	6	TEXT	12	–
SMALLFLOAT	4	–	VARCHAR	13	–
DECIMAL	5	3	INTERVAL	14	–
SERIAL	6	–	NCHAR	15	–
DATE	7	–	NVARCHAR	16	–

The following table lists integer values that represent additional data types available with Informix®.

SQL Data Type	Integer Value	SQL Data Type	Integer Value
INT8	17	Fixed-length OPAQUE type	41
SERIAL8	18	LVARCHAR (client-side only)	43
SET	19	BOOLEAN	45
MULTISET	20	BIGINT	52
LIST	21	BIGSERIAL	53
ROW (unnamed)	22	IDSSECURITYLABEL	2061
COLLECTION	23	ROW (named)	4118
Variable-length OPAQUE type	40		

The same **TYPE** constants can also appear in the **syscolumns.coltype** column in the system catalog; see *IBM® Informix Guide to SQL: Reference*.

For code that is easier to maintain, use the predefined constants for these SQL data types instead of their actual integer values. These constants are defined in the **\$INFORMIX/incl/public/sqltypes.h** header file. You cannot, however, use the actual constant name in the SET DESCRIPTOR statement. Instead, assign the constant to an integer host variable and specify the host variable in the SET DESCRIPTOR statement file.

The following example shows how you can set the **TYPE** field in Informix ESQL/C:

```
main()
{
EXEC SQL BEGIN DECLARE SECTION;
  int itemno, type;
EXEC SQL END DECLARE SECTION;
...
EXEC SQL allocate descriptor 'desc1' with max 5;
...
type = SQLINT; itemno = 3;
EXEC SQL set descriptor 'desc1' value :itemno type = :type;
}
```

This information is identical for **ITYPE**. Use **ITYPE** when you create a dynamic program that does not comply with the X/Open standard.

- [Compiling Without the -xopen Option](#)
- [Setting the TYPE Field in X/Open Programs](#)
- [Using DECIMAL or MONEY Data Types](#)
- [Using DATETIME or INTERVAL Data Types](#)

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Compiling Without the -xopen Option

If you compile without the **-xopen** option, the normal Informix® SQL code is assigned for **TYPE**. You must be careful not to mix normal and X/Open modes, because errors can result. For example, if a data type is not defined under X/Open mode, but is defined under normal mode, executing a SET DESCRIPTOR statement can result in an error.

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Setting the TYPE Field in X/Open Programs

In X/Open mode, you must use the X/Open set of integer codes for the data type in the **TYPE** field.

If you use the **ILENGTH**, **IDATA**, or **ITYPE** fields in a SET DESCRIPTOR statement, a warning message appears. The warning indicates that these fields are not standard X/Open fields for a system-descriptor area.

For code that is easier to maintain, use the predefined constants for these X/Open SQL data types instead of their actual integer value. These constants are defined in the **\$INFORMIX/incl/public/sqlxtype.h** header file.

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Using DECIMAL or MONEY Data Types

If you set the **TYPE** field for a DECIMAL or MONEY data type, and you want to use a scale or precision other than the default values, set the **SCALE** and **PRECISION** fields. You do not need to set the **LENGTH** field for a DECIMAL or MONEY item; the **LENGTH** field is set accordingly from the **SCALE** and **PRECISION** fields.

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Using DATETIME or INTERVAL Data Types

If you set the **TYPE** field for a DATETIME or INTERVAL value, the **DATA** field can be a DATETIME or INTERVAL literal or a character string. If you use a character string, the **LENGTH** field must be the encoded qualifier value.

To determine the encoded qualifiers for a DATETIME or INTERVAL character string, use the datetime and interval macros in the **datetime.h** header file.

If you set **DATA** to a host variable of DATETIME or INTERVAL, you do not need to set **LENGTH** explicitly to the encoded qualifier integer.

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Setting the DATA or IDATA Field

When you set the **DATA** or **IDATA** field, use the appropriate type of data (character string for CHAR or VARCHAR, integer for INTEGER, and so on).

If any value other than **DATA** is set, the value of **DATA** is undefined. You cannot set the **DATA** or **IDATA** field for an item without setting **TYPE** for that item. If you set the **TYPE** field for an item to a character type, you must also set the **LENGTH** field. If you do not set the **LENGTH** field for a character item, you receive an error.

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Setting the LENGTH or ILENGTH Field

If your **DATA** or **IDATA** field contains a character string, you must specify a value for **LENGTH**. If you specify **LENGTH=0**, **LENGTH** is automatically set to the maximum length of the string. The **DATA** or **IDATA** field can contain a literal character string of up to 368-bytes, or a character string derived from a character variable of a CHAR or VARCHAR data type. This provides a method to determine dynamically the length of a string in the **DATA** or **IDATA** field.

If a DESCRIBE statement precedes a SET DESCRIPTOR statement, **LENGTH** is automatically set to the maximum length of the character field that is specified in your table.

This information is identical for **ILENGTH**. Use **ILENGTH** when you create a dynamic program that does not comply with the X/Open standard.

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Setting the INDICATOR Field

If you want to put a NULL value into the system-descriptor area, set the **INDICATOR** field to -1 and do not set the **DATA** field.

If you set the **INDICATOR** field to 0 to indicate that the data is not NULL, you must set the **DATA** field.

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Setting Opaque-Type Fields

The following item-descriptor fields provide information about a column that has an opaque type as its data type:

- The **EXTYPEID** field stores the extended identifier for the opaque type. This integer value must correspond to a value in the **extended_id** column of the **sysxdtypes** system catalog table.
- The **EXTYPENAME** field stores the name of the opaque type. This character value must correspond to a value in the **name** column of the row with the matching **extended_id** value in the **sysxdtypes** system catalog table.
- The **EXTYPELENGTH** field stores the length of the opaque-type name. This integer value is the length, in bytes, of the string in the **EXTYPENAME** field.
- The **EXTYPEOWNERNAME** field stores the name of the opaque-type owner. This character value must correspond to a value in the **owner** column of the row with the matching **extended_id** value in the **sysxdtypes** system catalog table.
- The **EXTYPEOWNERLENGTH** field stores the length of the value in the **EXTYPEOWNERNAME** field. This integer value is the length, in bytes, of the string in the **EXTYPEOWNERNAME** field.

For more information on the **sysxdtypes** system catalog table, see the *IBM® Informix® Guide to SQL: Reference*.

Related information:

[SYSXDTYPES](#)

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Setting Distinct-Type Fields

The following item-descriptor fields provide information about a column that has a distinct type as its data type:

- The **SOURCEID** field stores the extended identifier for the source data type.
Set this field if the source type of the distinct type is an opaque data type. This integer value must correspond to a value in the **source** column for the row of the **sysxdtypes** system catalog table whose **extended_id** value matches that of the distinct type you are setting.
- The **SOURCETYPE** field stores the data type constant for the source data type.
This value is the data type constant for the built-in data type that is the source type for the distinct type. The codes for the **SOURCETYPE** field are the same as those for the **TYPE** field (page [Setting the TYPE or ITYPE Field](#)). This integer value must correspond to the value in the **type** column for the row of the **sysxdtypes** system catalog table whose **extended_id** value matches that of the distinct type you are setting.

For more information on the **sysxdtypes** system catalog table, see the *IBM® Informix® Guide to SQL: Reference*.

Related information:

[SYSXDTYPES](#)

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Modifying Values Set by the DESCRIBE Statement

You can use a DESCRIBE statement to modify the contents of a system-descriptor area after it is set.

After you use DESCRIBE on a SELECT or an INSERT statement, you must check to determine whether the **TYPE** field is set to either 11 or 12 to indicate a TEXT or BYTE data type. If **TYPE** contains an 11 or a 12, you must use the SET DESCRIPTOR statement to reset **TYPE** to 116, which indicates FILE type.

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SET ENCRYPTION PASSWORD statement

Use the SET ENCRYPTION PASSWORD statement to define or reset a *session password* for the encryption and decryption of character, BLOB, or CLOB values.

Only Informix® supports this statement, which is an extension to the ANSI/ISO standard for SQL. You can use this statement with ESQL/C.

Syntax

```
>>-SET ENCRYPTION PASSWORD-- 'password'--+-----+--+<
'-WITH HINT-- 'hint'--'
```

Element	Description	Restrictions	Syntax
<i>hint</i>	String that GETHINT returns from an encrypted argument	(0 byte) ≤ <i>hint</i> ≤ (32 bytes). Do not include the <i>password</i> in the <i>hint</i> .	Expression
<i>password</i>	Password (or a multi-word phrase) for data encryption	(6 bytes) ≤ <i>password</i> ≤ (120 bytes). Do not specify your login password.	Expression

Usage

The SET ENCRYPTION PASSWORD statement declares a password to support data confidentiality through built-in functions that use the Triple-DES or AES algorithms for encryption and decryption. These functions enable the database to store sensitive data in an encrypted format that prevents anyone who cannot provide the secret password from viewing, copying, or modifying encrypted data.

The password is not stored as plain text in the database and is not accessible to the DBA. This security feature is independent of the Trusted Facility feature.

Important: By default, communication between client systems and Informix is in plain text. Unless the database is accessible only by a secure network, the DBA must enable the encryption communication support module (ENCCSM) to provide data encryption between the database server and any client system. Otherwise, an attacker might read the password and use it to access encrypted data.

If the network is not secure, all of the database servers in a distributed query need ENCCSM enabled, so that the password is not transmitted as plain text. For information about how to enable a communication support module (CSM), see your *IBM® Informix Administrator's Guide*.

Operations on encrypted data tend to be slower than corresponding operations on plain text data, but use of this feature has no effect on unencrypted data.

The SET ENCRYPTION PASSWORD statements can be prepared, and EXECUTE IMMEDIATE can process a prepared SET ENCRYPTION PASSWORD statement.

- [Storage Requirements for Encryption](#)
- [Specifying a Session Password and Hint](#)
- [Levels of Encryption](#)
- [Protecting Passwords](#)

Passwords and hints that you declare with SET ENCRYPTION PASSWORD are not stored as plain text in any table of the system catalog, which also maintains no record of which columns or tables contain encrypted data.

Related concepts:

[IFX_AUTO_REPREPARE session environment option](#)

Related information:

[INFORMIXCONSCMCFG environment variable](#)

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Storage Requirements for Encryption

Use the **ENCRYPT_AES** or **ENCRYPT_TDES** built-in functions to encrypt data. Encrypted values of character data types are stored in BASE64 format (also called Radix-64). For character data, this requires significantly more storage than the corresponding unencrypted data. Omitting the *hint* can reduce encryption overhead by more than 50 bytes for each encrypted value. It is the responsibility of the user to make sufficient storage space available for encrypted values.

The following table lists the data types that can be encrypted, and built-in functions that you can use to encrypt and decrypt values of those data types:

Original Data Type	Encrypted Data Type	BASE64 Format	Decryption Function
CHAR	CHAR	Yes	DECRYPT_CHAR
NCHAR	NCHAR	Yes	DECRYPT_CHAR
VARCHAR	VARCHAR	Yes	DECRYPT_CHAR
NVARCHAR	NVARCHAR	Yes	DECRYPT_CHAR
LVARCHAR	LVARCHAR	Yes	DECRYPT_CHAR
BLOB	BLOB	No	DECRYPT_BINARY
CLOB	BLOB	No	DECRYPT_CHAR

You cannot encrypt a column of the IDSSECURITYLABEL data type.

If the encrypted VARCHAR (or NVARCHAR) value is longer than the 255 byte maximum size for those data types, the encryption function returns a CHAR (or NCHAR) value of sufficient size to store the encrypted value.

DECRYPT_BINARY and **DECRYPT_CHAR** both return the same value from encrypted CHAR, NCHAR, VARCHAR, NVARCHAR, or LVARCHAR values. No built-in encryption or decryption functions support BYTE or TEXT data types, but you can use BLOB data types to encrypt very large strings.

Warning: If the declared size of a database column in which you intend to store encrypted data is smaller than the encrypted data length, truncation occurs when you insert the encrypted data into the column. The truncated data cannot subsequently be decrypted, because the data length indicated in the header of the encrypted string does not match what the column stores. To avoid truncation, make sure that any column storing encrypted strings has sufficient length. (See the cross-reference in the next paragraph for details of how to calculate encrypted string lengths.)

Besides the unencrypted data length, the storage required for encrypted data depends on the encoding format, on whether you specify a *hint*, and on the block size of the encryption function. For a formula to estimate the encrypted size, see "Calculating storage requirements for encrypted data" on page [Calculating storage requirements for encrypted data](#).

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Specifying a Session Password and Hint

The required *password* specification can be quoted strings or other character expression that evaluates to a string whose length is at least 6 bytes but no more than 128 bytes. The optional *hint* can specify a string no longer than 32 bytes.

The password or *hint* can be a single word or several words. The *hint* should be a word or phrase that helps you to remember the *password*, but does not include the *password*. You can subsequently execute the built-in **GETHINT** function (with an encrypted value as its argument) to return the plain text of *hint*.

The following ESQL/C program fragment defines a routine that includes the SET ENCRYPTION PASSWORD statement and executes DML statements:

```
process_ssn ( )
{
EXEC SQL BEGIN DECLARE SECTION;
char password[128];
char myhint[33];
char myid[16], myssn[16];
EXEC SQL END DECLARE SECTION;
...
EXEC SQL SET ENCRYPTION PASSWORD :password WITH HINT :myhint;
...
EXEC SQL INSERT INTO tab1 VALUES ('abcd', ENCRYPT_AES("111-22-3333"));
EXEC SQL SELECT Pid, DECRYPT(ssn, :password) INTO :myid, :myssn;
...
EXEC SQL SELECT GETHINT(ssn) INTO :myhint, WHERE id = :myid;
}
```

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Levels of Encryption

You can use SET ENCRYPTION PASSWORD with encryption and decryption functions to support these granularities of encryption in the database.

- **Column-Level Encryption:** All values in a given column of a database table are encrypted using the same password, the same encryption algorithm, and the same encryption mode. (In this case, you can save disk space by storing the *hint* outside the encrypted column, rather than repeating it in every row.)
- **Cell-Level Encryption:** Values of a given column in different rows of the same database table are encrypted using different passwords, or different encryption algorithms, or different encryption modes. This technique is sometimes necessary to protect personal data. (*Row-column level* encryption and *set-column level* encryption are both synonyms for cell-level encryption.)
Cell-level encryption can cause substantial maintenance costs. If you implement this level of encryption, your application is responsible for determining which rows contain encrypted data and for using the correct code to handle the data. The built-in decryption functions of Informix® fail with error -26005 if they are applied to unencrypted data. The simplest way to avoid this error is to use column-level encryption rather than cell-level encryption.

If you do not use encryption functions, people might enter unencrypted data into columns that are meant to contain encrypted data. To ensure that data entered into a field is always encrypted, use views and INSTEAD OF triggers.

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Protecting Passwords

Passwords and hints that you declare with SET ENCRYPTION PASSWORD are not stored as plain text in any table of the system catalog, which also maintains no record of which columns or tables contain encrypted data.

To prevent other users from accessing the plain text of encrypted data or of a password, however, you must avoid actions that might compromise the secrecy of a password:

- Do not create a functional index using a decryption function. (This would store plain-text data in the database, defeating the purpose of encryption.)
- On a network that is not secure, always work with encrypted data, or use session encryption, because the SQL communication between client and server sends passwords, hints, and the data to be encrypted as plain text.
- Do not store passwords in a trigger or in a UDR that exposes the password to the public.
- Do not set the session password prior to creating any view, trigger, procedure, or UDR. Set the session password only when you use the object. Otherwise, the password might be visible in the schema to other users, and queries executed by other users might return unencrypted data. The following example shows a procedure that includes an encrypted password:

```
-- reset session encryption password
set encryption password null;

-- create procedure without password
create procedure p1 ();
```

```

insert into tab2 select (decrypt_char (coll))
from tab1;
end procedure;

-- set session encryption password
set encryption password ("PASSWD2");

-- insert data
insert into tab1 values (encrypt_aes ('WXY'));

-- call procedure

```

Output from the SET EXPLAIN statement always displays the *password* and *hint* parameters as xxxxxx, rather than displaying actual *password* or *hint* values.

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SET ENVIRONMENT statement

Use the SET ENVIRONMENT statement to specify settings for session environment variables that can affect how queries are executed in the same routine, or other operations in the current user session. For some options, the session variable overrides default behavior that is set by a configuration parameter or by an environment variable of the client or of the database server.

This statement is an extension to the ISO/ANSI standard for the SQL language.

Syntax

```

>>--SET ENVIRONMENT----->

>--+--AUTOLOCATE -----+--'integer'-----+-->
| '-IFX_SESSION_LIMIT_LOCKS-' |
| '-QUERY_TIMEOUT-----' |
| +-+AUTO_READAHEAD-----+--'0'-----+-- |
| +-IFX_BATCHEDREAD_INDEX--+ +-'1'-----+ | (1) | |
| '-IFX_BATCHEDREAD_TABLE-' | (1) | '-----,'--'integer'-' |
| |-----'2'-' |
| +-+EXTDIRECTIVES-----+--OFF-----+-- |
| +-IFX_AUTO_REPREPARE--+ +-'0'-----+-- |
| +-NOVALIDATE-----+--ON-----+-- |
| '-USTLOW_SAMPLE-----' +-'1'-----+-- |
| | (2) |
| |-----DEFAULT-' |
| +-+AUTO_STAT_MODE-----+--OFF-----+-- |
| +-BOUND_IMPL_PDQ--+ +-ON-----+-- |
| '-IMPLICIT_PDQ---' | (3) |
| |-----'integer'-' |
| +-CLUSTER_TXN_SCOPE--+--'SESSION'--+-- |
| | +-SERVER--+-- |
| | +-CLUSTER--+-- |
| | +-DEFAULT---' |
| +-DEFAULTESCCHAR--+--'char'--+-- |
| | '-NONE'-' |
|
| +-DBINFO_DBSPACE_RETURN_NULL_FOR_INVALID_PARTNUM--+--'0'--+-- |
| |-----'1'-' |
| +-FORCE_DDL_EXEC--+--OFF-----+-- |
| | +-0'-----+-- |
| | +-ON-----+-- |
| | +-1'-----+-- |
| | '-integer'-' |
| |.-OFF----- |
| +-GRID_NODE_SKIP--+--ON--+-- |
| | '-ON-' |
| | +------+-- |
| | +-DEFAULT-' |
| +-HDR_TXN_SCOPE--+--ASYNC--+-- |
| | +-FULL_SYNC--+-- |
| | +-NEAR_SYNC--+-- |
| +-INFORMIXCONRETRY--+-- |
| '-INFORMIXCONTIME--' '-integer'-' |
| +-+OPTCOMPIND--+--DEFAULT--+-- |
| | '-STATCHANGE-' '-integer'-' |
| +-+RETAINUPDATELOCKS--+--ALL--+-- |
| | '-USELASTCOMMITTED--' +-NONE'-----+-- | |
| | +-DIRTY_READ'-----+-- |
| | +-COMMITTED_READ'-----+-- |
| | | (4) |
| | |-----CURSOR_STABILITY'-' |
| +-+SELECT_GRID-----+--grid'--+-- |
| | '-SELECT_GRID_ALL-' +-region--+-- | |
| | |-----DEFAULT---' |
| | (5) | (6) |
| +-+USE_DWA--+--USE_DWA options |-----+-- |
| | '-USE_SHARDING--+--ON--+-- |
| | |-----OFF-' |

```

```
| '-SHARDJOIN_FALLBACK--+-ON--+-+-----' - |
|                                     '-OFF-' |
```

Element	Description	Restrictions	Syntax
<i>char</i>	A single character to set as the default escape character in <code>LIKE</code> or <code>MATCHES</code> operands in the session	Must be a single-byte character	Quoted String
<i>grid</i>	Name of default existing grid for subsequent queries with no explicit <code>GRID</code> clause	Must exist, and be defined by the cdr define grid command	Quoted String
<i>integer</i>	See Options supporting ranges of integer values for the semantics and ranges of <i>integer</i> settings among session environment options	Must be valid for the specified session environment option	Quoted String
<i>region</i>	Default region within an existing grid for subsequent queries with no explicit <code>GRID</code> clause	Must exist, and be defined by the cdr define region command	Quoted String

Usage

The `SET ENVIRONMENT` statement can set session environment variables that affect queries or resource use during the current session. Many of its options can override the explicit or default value of an environment variable or of a configuration parameter.

For example, the following statement enables external directives during the current session:

```
SET ENVIRONMENT EXTDIRECTIVES "1";
```

This instructs the query optimizer to consider external optimizer directives in the **sysdirectives** system catalog table, if any are registered there, when choosing query execution plans. The database server complies, even if this conflicts with settings of the `EXT_DIRECTIVES` configuration parameter and `IFX_EXTDIRECTIVES` environment variable that disable external directives. If several mechanisms can define database server behavior that a session environment variable can also control, the `SET ENVIRONMENT` setting generally takes precedence over the following settings during the current session:

- conflicting system default values,
- conflicting explicit or default settings of configuration parameters,
- conflicting explicit or default settings of client or server environment variables.

The scope of session environment variables

As the term *session environment variable* implies, most options influence the server only during the same session that issues the `SET ENVIRONMENT` statement. When that session terminates, permanent database objects that it created or modified persist, but other sessions follow the system default behavior, unless they issue their own `SET ENVIRONMENT` statements. (But options set by a **sysdbopen** routine are restored in future sessions, if the same **sysdbopen** routine runs.)

For some options, however, a setting persists only while the routine that set it is running, rather than until the session ends. For example,

```
SET ENVIRONMENT OPTCOMPIND '2';
```

instructs the query optimizer to use cost as the basis for subsequent join plans during the session, rather than favoring nested-loop joins. The setting takes effect even if this behavior conflicts with the current 0 or 1 setting of the `OPTCOMPIND` configuration parameter, or of the environment variable with the same name. Concurrent sessions are not affected by `SET ENVIRONMENT OPTCOMPIND` statements in UDRs of another session. See also the [OPTCOMPIND session environment option](#).

SQL syntax in some DDL or DML statements can override a session environment variable setting for some database objects, as in this example, where **unseen** is a fragmented table:

```
SET ENVIRONMENT AUTO_STAT_MODE OFF;
UPDATE STATISTICS HIGH FOR TABLE unseen AUTO;
```

The `SET ENVIRONMENT` statement instructs the server to ignore `STATCHANGE` criteria for recalculating only stale distribution statistics, so that by default, statistics must be recalculated for all fragments. The `AUTO` keyword, however, instructs the server to disregard the `OFF` setting of `AUTO_STAT_MODE`. This has higher precedence than `SET ENVIRONMENT`, placing the `UPDATE STATISTICS` statement outside the scope of the session environment variable. Statistics for fragment of the **unseen** table will be recalculated selectively, without recalculating any fragments with `HIGH` mode statistics that are not stale. See also [AUTO_STAT_MODE session environment option](#) and [STATCHANGE session environment option](#).

Similarly, this `SET ENVIRONMENT` statement makes automatic location and implicit fragmentation the default storage option for tables created in the session:

```
SET ENVIRONMENT AUTOLOCATE "2";
SELECT sname FROM state WHERE LENGTH(sname) < 7
  INTO RAW reSuLt IN dbsp07; --IN clause blocks AUTOLOCATE
```

The `IN` clause prevents automatic location for the two fragments that the `AUTOLOCATE` setting of "2" implies. Rather than storing result table fragments in dbspaces automatically chosen by the database server, this query creates a nonfragmented **reSuLt** table in the **dbsp07** dbspace. This explicit Storage Options syntax excludes this `SELECT` example from the scope of the `AUTOLOCATE` setting, which can take effect only for new tables that are created during the session with syntax satisfying the automatic location requirements. For more information, see [AUTOLOCATE session environment option](#).

Effects of SET ENVIRONMENT options on concurrent sessions

For some session environment variables, however, `SET ENVIRONMENT` statements in one session can affect the server behavior in concurrent sessions. For example, suppose a nonadministrative user needs to limit how many ROW locks are available to a session by setting the `IFX_SESSION_LIMIT_LOCKS` option below the explicit or default `SESSION_LIMIT_LOCKS` configuration parameter value. A statement like this can accomplish that goal:

```
SET ENVIRONMENT IFX_SESSION_LIMIT_LOCKS "1700";
```

Until the session ends, users in other sessions who do not hold administrative privileges can hold no more than 1700 locks. The `IFX_SESSION_LIMIT_LOCKS` setting has no effect on administrators like user **informix** or DBSA users. See also [IFX_SESSION_LIMIT_LOCKS session environment option](#).

The FORCE_DDL_EXEC session environment option also can affect concurrent transactions, but in an asymmetrical way. The effects of enabling this option can force out transactions in concurrent sessions that hold locks on tables that the enabling session references in ALTER FRAGMENT ON TABLE statements. For more information, see [FORCE_DDL_EXEC session environment option](#).

Options supporting ranges of integer values

The following SET ENVIRONMENT session environment variables can be set to values with delimited *integer* settings. This table identifies those options, their ranges, and effects of their *integer* settings.

Table 1. Effects of session environment options that accept *integer* values

Environment option	Integer range	Effect
AUTOLOCATE	'1' ≤ 'integer' ≤ '32'	Enables automatic storage location of tables, and allocates that number of initial round-robin fragments. A setting of '0' disables this storage automation.
AUTO_READAHEAD	'4' ≤ 'integer' ≤ '4096'	For the optional second parameter, a value in the range '4'-'4096' specifies how many pages to include in automatic read-ahead requests. If omitted, the default is '128'.
BOUND_IMPL_PDQ and IMPLICIT_PDQ	'1' ≤ 'integer' ≤ '100'	To use explicit PDQPRIORITY environment variable settings as the upper bound (and optional lower bound) of memory granted to a query, set the BOUND_IMPL_PDQ option. The database server scales its PDQPRIORITY estimate by the specified IMPLICIT_PDQ value.
FORCE_DDL_EXEC	'2' ≤ 'integer'	Limits the number of seconds to allow the server to force out transactions that are open or hold a lock on the target table of an ALTER FRAGMENT ON TABLE statement, until the server obtains a lock and exclusive access on the table. If any of those transactions persist beyond the specified time limit, the server stops attempting to force out the transactions.
IFX_SESSION_LIMIT_LOCKS	'500' ≤ 'integer' ≤ SESSION_LIMIT_LOCKS	The maximum number of locks for users who are not administrators. This limit cannot exceed the SESSION_LIMIT_LOCKS configuration parameter value. If this parameter is not set, the default value of 2147483647 is the upper limit for 'integer'.
INFORMIXCONTIME	SESSION_LIMIT_LOCKS ≤ 'integer'	Limits for how many seconds the CONNECT statement attempts to establish a connection to a database server. A setting of '0' defaults to the INFORMIXCONTIME configuration parameter value.
INFORMIXCONRETRY	'1' ≤ 'integer'	Sets the maximum number of additional connection attempts by the CONNECT statement after the first connection failure. A connection attempt can end sooner than the specified value, if the INFORMIXCONTIME value is exceeded.
OPTCOMPIND	'0', '1', or '2'	Prioritizes available execution plans for join queries: <ul style="list-style-type: none"> • AUTO_READAHEAD favors nested-loop joins • '1' bases the decision on the isolation level • '2' favors the lowest cost.
QUERY_TIMEOUT	'0' ≤ 'integer' ≤ '10000'	Sets the maximum clock time, in seconds, that a query may run before it is internally interrupted. This timeout does not affect DML or DDL statements, or administration commands. A setting of '0' effectively disables the timeout.
STATCHANGE	'1' ≤ 'integer' ≤ '100'	Sets a percentage of rows that were modified since distribution statistics were calculated. The server uses this as a data-change threshold for UPDATE STATISTICS operations in automatic mode on tables or fragments.

In addition to the session environment variables that accept as their setting a cardinal number in the integer ranges listed here, the following session environment variables support as their setting the values '1' and '0', encoding these Boolean semantics:

- '1' Enables the database server behavior associated with the session environment variable
- '0' Disables the database server behavior associated with the session environment variable.

These are the SET ENVIRONMENT options that accept '1' or '0' as their setting:

- AUTO_READAHEAD,
- EXTDIRECTIVES,
- FORCE_DDL_EXEC,
- IFX_AUTO_REPREPARE,
- IFX_BATCHEDREAD_INDEX,
- IFX_BATCHEDREAD_TABLE,
- NOVALIDATE,
- USTLOW_SAMPLE.

The OFF, ON, and DEFAULT keyword options

The following keywords have similar effects for several session environment options:

- OFF disables the specified option
- ON enables the option

- **DEFAULT** sets the option to its default value.

The arguments that follow the option name depend on the syntax of the option. The option name and its **ON**, **OFF**, and **DEFAULT** keywords do not require quotation mark delimiters, and are not case-sensitive. All other arguments must be enclosed between single (') or double (") quotation marks. If a quoted string is a valid argument for a session environment option, the argument is not case-sensitive. The SET ENVIRONMENT statement syntax diagram is simplified, by showing only single (') quotation mark around syntax tokens for which double (") quotation marks are also valid as delimiters. As in all SQL operations, both delimiters of a string value (or of an empty string) must be identical.

If you specify an unsupported session environment option name, error **-19840** is returned. If you specify an unsupported *integer* or *digit* value as the setting for a valid environment option, an option-specific error is returned (for example, error **-19843**, *Invalid IFX_AUTO_REPREPARE value specified*).

- [AUTOLOCATE session environment option](#)
Use the AUTOLOCATE environment option of the SET ENVIRONMENT statement to enable or disable the automatic location of databases, indexes, and permanent tables.
- [AUTO_READAHEAD session environment option](#)
Use the AUTO_READAHEAD environment option to change the automatic read-ahead mode or the page-count, or to disable automatic read-ahead operations for the current session.
- [AUTO_STAT_MODE session environment option](#)
Use the AUTO_STAT_MODE environment option to enable or disable an automatic mode for UPDATE STATISTICS operations on column distribution statistics during the current session. In automatic mode, the user can define a minimum data change threshold as a property of the table. The database server refreshes statistics on the table, its indexes, and on table and index fragments selectively, only if the data has changed in a percentage of rows beyond that threshold since the distribution statistics were last calculated.
- [BOUND_IMPL_PDQ session environment option](#)
You can set the BOUND_IMPL_PDQ session environment option to limit PDQ resource allocation. If the IMPLICIT_PDQ session environment option is set to **ON** or to a positive integer value no greater than 100, you can use the BOUND_IMPL_PDQ environment option to specify that the allocated memory should be bounded by the current explicit **PDQPRIORITY** value or by a range.
- [CLUSTER_TXN_SCOPE session environment option](#)
When a client session in a high-availability cluster server issues a commit, the server blocks the current session until the committed transaction is applied in that session, or applied on a secondary server, or applied across the cluster, depending on the setting of the CLUSTER_TXN_SCOPE session environment option of the SET ENVIRONMENT statement.
- [DEFAULTESCCCHAR session environment option](#)
You can use the DEFAULTESCCCHAR session environment option of the SET ENVIRONMENT statement to override the current default escape character within character-string operands of LIKE or MATCHES expressions during the current session.
- [EXTDIRECTIVES session environment option](#)
You can use the EXTDIRECTIVES environment option of the SET ENVIRONMENT statement to enable or disable external optimizer directives during the current session.
- [FORCE_DDL_EXEC session environment option](#)
Use the FORCE_DDL_EXEC session environment option of the SET ENVIRONMENT statement to force out other transactions that have opened or have locks on the tables involved in an ALTER FRAGMENT ON TABLE operation.
- [GRID_NODE_SKIP session environment option](#)
Use the GRID_NODE_SKIP option of the SET ENVIRONMENT statement to define the behavior of the database server when a grid server within the grid or region that the query specifies is not available.
- [HDR_TXN_SCOPE session environment option](#)
Use the SET ENVIRONMENT HDR_TXN_SCOPE statement of SQL to control when a transaction commit is returned to a client application in a cluster environment.
- [IFX_AUTO_REPREPARE session environment option](#)
Use the IFX_AUTO_REPREPARE session environment option to temporarily change the system-wide setting of the AUTO_REPREPARE configuration parameter. The new setting is in effect for the remainder of the session or until you reset IFX_AUTO_REPREPARE for the session.
- [IFX_BATCHEDREAD_INDEX session environment option](#)
You can use the IFX_BATCHEDREAD_INDEX session environment option of the SET ENVIRONMENT statement of SQL to enable the query execution plans that execute light scans on the indexes of large tables, bypassing the buffer pool by using session memory to read directly from disk.
- [IFX_BATCHEDREAD_TABLE session environment option](#)
Use the IFX_BATCHEDREAD_TABLE environment option of the SET ENVIRONMENT statement to enable or disable light scans on compressed tables, tables with rows that are larger than a page, and tables with VARCHAR, LVARCHAR, and NVARCHAR data during the current session.
- [IFX_SESSION_LIMIT_LOCKS session environment option](#)
When IFX_SESSION_LIMIT_LOCKS is set in the session, its setting can specify a lower limit than the SESSION_LIMIT_LOCKS configuration parameter value for the maximum number of locks for users who are not administrators. This option, however, cannot restrict the number of locks in the session of a user who holds administrative privileges, such as user **informix** or a DBSA user, and cannot specify a limit for nonadministrative users below 500 locks.
- [IMPLICIT_PDQ session environment option](#)
Use the IMPLICIT_PDQ session environment option to allow the database server to determine the amount of memory allocated to a query, ignoring the explicit system default **PDQPRIORITY** environment variable setting.
- [INFORMIXCONRETRY session environment option](#)
Use the INFORMIXCONRETRY session environment option of the SET ENVIRONMENT statement to specify the maximum number of additional connection attempts that can be made to each database server during a single CONNECT statement in the current session, after the initial connection attempt fails. All these attempts must be made within the time limit that the INFORMIXCONTIME setting specifies.
- [INFORMIXCONTIME session environment option](#)
Use the INFORMIXCONTIME session environment option of the SET ENVIRONMENT statement to set an upper limit on the number of seconds while the current session attempts to establish a connection to another database server, before an error is returned.
- [NOVALIDATE session environment option](#)
Use the NOVALIDATE environment option to specify whether a foreign-key or check constraint that the ALTER TABLE ADD CONSTRAINT statement creates, or that has its constraint mode reset by the SET CONSTRAINTS statement, are in NOVALIDATE mode by default. The NOVALIDATE setting has no effect, however, on ADD CONSTRAINT or SET CONSTRAINT operations that specify DISABLED mode.
- [OPTCOMPIND session environment option](#)
Use the OPTCOMPIND session environment option of the SET ENVIRONMENT statement to specify methods for the query optimizer to choose in join queries and MERGE statements of the currently executing routine.
- [QUERY_TIMEOUT session environment option](#)
Use the QUERY_TIMEOUT environment option of the SET ENVIRONMENT statement to limit the amount of clock time a query may take before being

interrupted internally.

- [RETAINUPDATELOCKS session environment option](#)
The RETAINUPDATELOCKS environment option can improve concurrency in Dynamic SQL applications that include the SELECT ... FOR UPDATE statement. This option can modify the behavior of the current transaction isolation level at runtime if the session is using the Committed Read, Dirty Read, or Cursor Stability isolation levels to enable (or to disable) the RETAIN UPDATE LOCKS clause of the SET ISOLATION statement.
- [SELECT_GRID session environment option](#)
Use the SELECT_GRID option of the SET ENVIRONMENT statement to define a default GRID clause for grid queries. This clause specifies a default grid or region from which to return a result set equivalent to logical UNION of qualifying rows from participating grid servers.
- [SELECT_GRID_ALL session environment option](#)
Use the SELECT_GRID_ALL option of the SET ENVIRONMENT statement to define a default GRID clause for subsequent grid queries in the session. This clause specifies a default grid or region from which to return a result set equivalent to a logical UNION ALL of qualifying rows from participating grid servers.
- [STATCHANGE session environment option](#)
Use the STATCHANGE environment option to specify a positive integer as a global percentage-of-change threshold for UPDATE STATISTICS operations in automatic mode. The setting restricts automatic UPDATE STATISTICS operations to stale or missing distributions in which at least that percentage of rows have changed since statistics were updated.
- [USELASTCOMMITTED session environment option](#)
The USELASTCOMMITTED session environment option can improve concurrency in sessions that use the Committed Read, Dirty Read, Read Committed, or Read Uncommitted isolation levels by reducing the risk of locking conflicts when two or more sessions attempt to access the same row in a table whose locking granularity is row-level locking.
- [USE_SHARDING session environment option](#)
The USE_SHARDING session environment option controls the scope of sharded queries.
- [SHARDJOIN_FALLBACK session environment option](#)
Use SHARDJOIN_FALLBACK session environment option to create a local temporary table to pull the data from the shard participants.
- [USE_DWA session environment options](#)
Use the USE_DWA session environment options of the SET ENVIRONMENT statement to control various aspects of workload analysis, data mart creation, and query acceleration by setting the database client environment for Informix® Warehouse Accelerator sessions. Each of the USE_DWA options has an effect only with Informix Warehouse Accelerator.
- [USTLOW_SAMPLE environment option](#)
Use the USTLOW_SAMPLE session environment option to enable or disable sampling during the collection of index statistics for UPDATE STATISTICS LOW operations in the current session.

Related concepts:

[Performance considerations of UPDATE STATISTICS statements](#)

Related reference:

[SET OPTIMIZATION statement](#)

[SET ISOLATION statement](#)

[SET PQDPRIORITY statement](#)

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AUTOLOCATE session environment option

Use the AUTOLOCATE environment option of the SET ENVIRONMENT statement to enable or disable the automatic location of databases, indexes, and permanent tables.

Setting this session environment option to an integer value greater than '0' but less than '33' also enables round-robin fragmentation as the default distributed storage for new tables created during the current session, using the AUTOLOCATE setting as the initially allocated number of fragments.

The SET ENVIRONMENT AUTOLOCATE statement of SQL supports the following syntax:

```
AUTOLOCATE environment option

|--SET ENVIRONMENT AUTOLOCATE--+-'0'-----+-----|
                               '---integer--'-'
```

Element	Description	Restrictions	Syntax
<i>integer</i>	Nonnegative integer that defines how many round-robin fragments to allocate initially	Must be in the range $1 \leq integer \leq 32$	Quoted String

Usage

The AUTOLOCATE session environment option can have the following values:

'0' or "0"

Disables automatic location and implicit fragmentation during the current session.

'integer' or "integer" where $1 \leq integer \leq 32$

Enables automatic location and round-robin fragmentation. The *integer* value defines how many round-robin fragments to initially allocate to each permanent table created in the current session.

The current setting of the AUTOLOCATE option overrides the value of the AUTOLOCATE configuration parameter during the current session.

Effect of automatic location on the CREATE DATABASE statement

The setting of the AUTOLOCATE session environment option affects CREATE DATABASE statements that include no IN clause list of dbspaces.

Suppose that automatic location is disabled, because the AUTOLOCATE configuration parameter is set to 0. You can issue the following statement to enable automatic location and implicit fragmentation in the current session:

```
SET ENVIRONMENT AUTOLOCATE '2';
```

The new AUTOLOCATE session environment setting of '2' has the following effect during the session on how the database server processes subsequent CREATE DATABASE statements in which the IN clause is omitted, such as the following example:

```
CREATE DATABASE IF NOT EXISTS stores_new
WITH LOG NLSCASE SENSITIVE;
```

- The **stores_new** database will not be created in the **root** dbspace, if a noncritical dbspace is available.
- Dbspaces with the smallest page size will be favored over those with larger pages.
- Dbspaces with the most free space will be favored.
- Dbspaces with extendable chunks will be favored.

If the AUTOLOCATE configuration parameter has a valid setting greater than 0, the above criteria for automatically choosing a dbspace are already in effect.

The enabled AUTOLOCATE session environment setting has no effect, however, on the following CREATE DATABASE statement, because the dbspaces specified in the IN clause overrides automatic selection of dbspaces by the database server for the **stores_newer** database:

```
CREATE DATABASE IF NOT EXISTS stores_newer IN dbbsp04, dbbsp05
WITH LOG NLSCASE SENSITIVE;
```

Databases like **stores_newer** that are created without automatic location can store tables and indexes whose storage location and fragmentation are based on the AUTOLOCATE session environment setting. For example, any permanent table or index that is created in the **stores_newer** database during a session with the AUTOLOCATE session environment option enabled can use implicit round-robin fragmentation for fragments in the **dbbsp04** and **dbbsp05** dbspaces, if the table or index is created without the Storage Options clause.

Effect on CREATE TABLE statements

The same SET ENVIRONMENT AUTOLOCATE '2' example has the following effect during the session on CREATE TABLE statements that omit the FIRST EXTENT and Storage Options clauses:

- The database server implicitly uses round-robin distributed storage for each permanent table that is created without a Storage Options clause, allocating two fragments, as specified by the AUTOLOCATE session environment setting.
- The dbspaces that store those fragments will be chosen automatically, based on the same criteria identified above for the CREATE DATABASE statement.

Effect on CREATE INDEX statements

The same SET ENVIRONMENT AUTOLOCATE '2' example has the following effect during the session on CREATE INDEX statements when the Storage Options clause is omitted:

- The database creates a nonfragmented index by default in a dbspace chosen by the server, based on the above criteria. The same index will also store index-key information about rows in any additional table fragments that the database creates automatically, if the storage capacity limit or the maximum number of rows is exceeded for both of the initially allocated table fragments.
- You cannot apply the IN TABLE storage option of the CREATE INDEX statement to indexes on tables that are implicitly fragmented by the SET ENVIRONMENT AUTOLOCATE session environment option.

Effect on permanent result tables of SELECT statements

The SET ENVIRONMENT AUTOLOCATE '2' example also applies automatic storage and implicit fragmentation to SELECT statements that use the INTO STANDARD or INTO RAW keywords, with no Storage Options clause, to store the result of a query in a new permanent table, as in the following query:

```
SELECT coll::INT fcoll, col2
FROM tabl INTO STANDARD MyResultTab;
```

Because the AUTOLOCATE session environment setting is '2', the database server automatically allocates two fragments for the **MyResultTab** permanent table that the SELECT statement created.

The AUTOLOCATE setting has no effect, however, on result tables created with the INTO TEMP or INTO EXTERNAL keyword options, or on result tables created with a Storage Options clause.

Effect on other DML operations that insert rows

During the same session, the SET ENVIRONMENT AUTOLOCATE '2' example has the following effects on INSERT, LOAD, and MERGE statements that insert new rows into a table that was created with implicit fragmentation. When rows are inserted, the fragment with the fewest rows is favored until all fragments contain the same number of rows. But if the DML operation attempts to insert more rows than can fit in the existing fragments, or attempts to insert rows beyond the maximum number of rows that a fragment can contain, the database server takes the following actions:

- It creates a new round-robin fragment of the same page size as the original fragments, allocating this in a dbspace that has enough free pages. As in the case of CREATE DATABASE, if noncritical dbspaces are available, the database server does not choose critical dbspaces.
- After the new fragment is automatically attached to the table, the database server resumes inserting rows for the current INSERT, LOAD, or MERGE operation.

Any other *integer* setting for AUTOLOCATE within the range from "1" to "32" has the effects described above, but for *integer* initially allocated fragments. For example, the following statement instructs the database server to initially allocate 9 round-robin fragments to each new permanent table that uses automatic location and implicit fragmentation:

```
SET ENVIRONMENT AUTOLOCATE '9';
```

The next example enables automatic location and allocates a single initial fragment.

```
SET ENVIRONMENT AUTOLOCATE '1';
```

The fragment is initially empty, but if rows are inserted into the table, all are inserted into that fragment, because no other exists. Tables created in the session with implicit fragmentation can be referenced by the ALTER FRAGMENT statement, despite their superficial resemblance to nonfragmented tables. When no additional rows can be inserted into the original fragment, the database server automatically attaches a new round-robin fragment to the table.

See also the *IBM® Informix® Administrator's Reference* for information about how to run **admin()** and **task()** SQL administration API commands with one of the **autolocate database** arguments to manage the list of dbspaces that can store table fragments created with automatic location enabled by the AUTOLOCATE environment option or by the AUTOLOCATE configuration parameter.

Disabling automatic location and implicit fragmentation

To disable automatic location and default round-robin fragmentation for the current session, run the following statement:

```
SET ENVIRONMENT AUTOLOCATE '0';
```

This setting only affects databases, indexes, and permanent tables that are created by subsequent DDL operations in the current session. Other sessions follow the behavior that corresponds to the AUTOLOCATE configuration parameter setting, or to SET ENVIRONMENT AUTOLOCATE statements issued in those sessions. When automatic location is not in effect, the database server replaces the behavior described above with the following legacy behavior of Informix releases earlier than 12.10.xC3:

- Databases are created by default in the **root** dbspace, or in the dbspace that the IN clause of the CREATE DATABASE statement specifies.
- Tables are created without implicit fragmentation, and stored according to the default or explicit Storage Options clauses of the CREATE TABLE, ALTER TABLE, and ALTER FRAGMENT statements.
- New round-robin fragments are not created automatically when all existing fragments of the table are at their limit for storage size or for the number of rows in a fragment.

Related information:

[AUTOLOCATE configuration parameter](#)

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AUTO_READAHEAD session environment option

Use the AUTO_READAHEAD environment option to change the automatic read-ahead mode or the page-count, or to disable automatic read-ahead operations for the current session.

The AUTO_READAHEAD session environment option has this syntax:

AUTO_READAHEAD session environment option

```
--SET ENVIRONMENT AUTO_READAHEAD +- '0' -+-----+-----|
                                     +- '1' -+  '-, -- 'pages' -'
                                     +- '2' -'
```

Element	Description	Restrictions	Syntax
<i>pages</i>	Number of data pages to read ahead	Must be an integer in the range '4' ≤ 'page' ≤ '4096'	Quoted String

Usage

The SET ENVIROMENT AUTO_READAHEAD statement of SQL accepts up to two values as its automatic read-ahead setting:

- A required *mode* setting, encoded as a digit in the range $0 \leq mode \leq 2$
- An optional *pages* setting, encoded as an integer in the range $4 \leq page \leq 4096$.

Setting the mode to aggressive, standard, or disabled

You can change the automatic read-ahead mode for the current session by specifying one of the following values as the first AUTO_READAHEAD parameter:

'0' or "0"

Disable automatic read-ahead requests.

'1' or "1"

Enable automatic read-ahead requests in the standard mode. The server will automatically process read-ahead requests only when a query waits on I/O.

'2' or "2"

Enable automatic read-ahead requests in the aggressive mode. The server will automatically process read-ahead requests at the start of the query, and continuously through the duration of the query.

The value that you specify for the *mode* overrides the setting of the AUTO_READAHEAD configuration parameter for the session.

This is the descending order of precedence (highest to lowest) among methods for setting automatic read-ahead:

- The SET ENVIRONMENT AUTO_READAHEAD statement (for a session)
- The AUTO_READAHEAD configuration parameter value of 1 or 2.
- If AUTO_READAHEAD has no setting in the **onconfig** file, but the AUTO_TUNE configuration parameter is set to 1, the server performs automatic read-ahead on 128 data pages, equivalent to the default *pages* value in the standard mode.

Setting the number of pages to read ahead

Besides setting the automatic read-ahead mode, you can also optionally specify a *pages* value as the second AUTO_READAHEAD parameter:

'pages' or "pages"

Specifies the number of data pages (as an integer in the range $4 \leq \text{'pages'} \leq 4096$) read by the database server when it receives an automatic read-ahead request.

Use a comma (,) as the separator between the values of read-ahead *mode* and read-ahead *'pages'*.

The specified *"pages"* value overrides the explicit or default page-count setting of the AUTO_READAHEAD configuration parameter for the current session.

If the SET ENVIRONMENT AUTO_READAHEAD statement includes no second parameter, the page-count value defaults to the explicit AUTO_READAHEAD configuration parameter setting, or to 128 pages, if that configuration parameter is not set.

Examples of setting AUTO_READAHEAD

This statement disables automatic read-ahead operations during the current session:

```
SET ENVIRONMENT AUTO_READAHEAD '0';
```

After a session completes the work in which you wanted automatic read-ahead disabled, the following statement restores automatic read-ahead in standard mode for subsequent operations that scan tables:

```
SET ENVIRONMENT AUTO_READAHEAD '1';
```

If a larger AUTO_READAHEAD *page* setting seems more efficient, the next example maintains the standard mode, but instructs the server to increase the page count to 1024 for subsequent read-ahead requests:

```
SET ENVIRONMENT AUTO_READAHEAD '1','1924';
```

Generally, the standard mode (AUTO_READAHEAD = 1) is appropriate in typical production environments, even for cached environments, but the SET ENVIRONMENT AUTO_READAHEAD statement enables you to take action in contexts where the efficiency of specific scans might benefit from modifying the read-ahead behavior.

The following example enables automatic read-ahead in aggressive mode, but accepts the default number of read-ahead pages:

```
SET ENVIRONMENT AUTO_READAHEAD '2';
```

Use aggressive read-ahead operations only in situations in which you tested both settings and know that aggressive read-ahead operations are more effective. Do not use aggressive read-ahead operations if you are not sure that they are more effective.

For scans that might turn read-ahead operations off and on because the scan encounters pockets of cached data, aggressive mode read-ahead operations do not turn off read-ahead operations.

Related information:

[AUTO_READAHEAD configuration parameter](#)

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AUTO_STAT_MODE session environment option

Use the AUTO_STAT_MODE environment option to enable or disable an automatic mode for UPDATE STATISTICS operations on column distribution statistics during the current session. In automatic mode, the user can define a minimum data change threshold as a property of the table. The database server refreshes statistics on the table, its indexes, and on table and index fragments selectively, only if the data has changed in a percentage of rows beyond that threshold since the distribution statistics were last calculated.

The AUTO_STAT_MODE session environment option has this syntax:

AUTO_STAT_MODE environment option

```
|--SET ENVIRONMENT AUTO_STAT_MODE -+-ON-+-----|
                                     '-OFF-'
```

Usage

Distribution statistics are used by the query optimizer to identify efficient execution plans for DML operations. Because calculating statistics for a large table is a resource-intensive operation, however, recalculating distributions that have not substantially changed from their current values in the system catalog degrades the performance of the database server, compared to a more efficient allocation of system resources.

The value that the SET ENVIRONMENT AUTO_STAT_MODE statement specifies can enable or disable the automatic identification and recalculation of stale column distribution statistics:

ON

Automatic UPDATE STATISTICS mode is enabled, and only stale statistics are automatically recalculated.

OFF

Automatic mode is disabled and UPDATE STATISTICS operations recalculate both stale and current statistics.

Automatic mode has no effect on routine statistics, or on UPDATE STATISTICS statements that include the **FORCE** keyword.

When automatic UPDATE STATISTICS mode is enabled, the UPDATE STATISTICS statement selectively refreshes only the table, column, and index data distribution statistics that it identifies as stale or missing. The user can specify the minimum change threshold as a table attribute when the table is created or altered. The value of this attribute overrides the explicit or default setting of the STATCHANGE configuration parameter.

The SET ENVIRONMENT STATCHANGE statement similarly overrides the STATCHANGE configuration parameter setting for the current session. If no STATCHANGE threshold is explicitly set, the system default threshold (of at least 10 percent of the rows changed since statistics were last calculated) defines stale data distributions when the automatic UPDATE STATISTICS mode is enabled.

When automatic mode is disabled, the database server does not consider any user-defined or default threshold for stale statistics when the UPDATE STATISTICS statement recalculates distribution statistic. In nonautomatic mode (or when you include the **FORCE** keyword in the UPDATE STATISTICS statement), the database server drops and recalculates the statistics for all of the specified tables and indexes, without reference to any previously calculated data distributions.

The automatic mode for UPDATE STATISTICS requires all of the fragments of a table to maintain the distribution of a column at the same resolution. This implies that consecutive UPDATE STATISTICS operations with a resolution different from what was used for creating the current column distribution in the system catalog forces a refresh of all column distributions for all fragments. If no resolution is specified, the database server uses the one that is stored with the distribution, rather than the default resolution of 2.5.

Only permanent tables are affected by automatic mode. The AUTO_STAT_MODE setting has no effect on temporary tables.

The AUTO_STAT_MODE and STATCHANGE configuration parameters

The AUTO_STAT_MODE configuration parameter can specify a '1' or '0' global value for the automatic mode for UPDATE STATISTICS operations for all sessions of the database server, respectively encoding the enabled or disabled modes that this session environment option encodes as **ON** and **OFF**. You can use the SET ENVIRONMENT AUTO_STAT_MODE statement of SQL, however, to override the AUTO_STAT_MODE configuration parameter setting for the current session.

The STATCHANGE configuration parameter can specify a positive integer as a global percentage of the change threshold to define stale data distributions. When the automatic mode for UPDATE STATISTICS is enabled by the AUTO_STAT_MODE configuration parameter, this setting takes effect as the default change threshold for any table whose STATCHANGE table attribute is specified as **AUTO**, or that is **AUTO** by default. You can use the SET ENVIRONMENT STATCHANGE statement of SQL, however, to override the STATCHANGE configuration parameter setting for the current session.

Examples of SET ENVIRONMENT AUTO_STAT_MODE

The following statement enables automatic mode for the current session:

```
SET ENVIRONMENT AUTO_STAT_MODE ON;
```

This overrides the setting of the AUTO_STAT_MODE configuration parameter, if it is 0, for the remainder of the current session, or until you reset the AUTO_STAT_MODE session environment variable.

If you are satisfied the behavior of UPDATE STATISTICS operations on distribution statistics without automatic mode, you can disable automatic mode for the session, as in this example:

```
SET ENVIRONMENT AUTO_STAT_MODE OFF;
```

Statement-level granularity for setting automatic mode

For individual UPDATE STATISTICS FOR TABLE statements, appending the **AUTO** keyword can override the disabled AUTO_STAT_MODE status in contexts where automatic mode is appropriate, as in this example:

```
SET ENVIRONMENT AUTO_STAT_MODE OFF;  
UPDATE STATISTICS MEDIUM FOR SPECIFIC TABLE orders AUTO;
```

Here the distribution statistics for the **orders** table will be refreshed (or for its fragments, if it has distributed storage with fragment-level STATCHANGE behavior) only for system catalog statistics of the **orders** table that qualify as stale. The scope of the **AUTO** keyword is restricted to the statement that includes it, rather than persisting. In contrast, the AUTO_STAT_MODE session environment variable remains disabled until the mode is reset or until the session ends.

Conversely, when automatic mode is enabled, you can temporarily disable it by including the **FORCE** keyword in individual UPDATE STATISTICS statements, so that the STATCHANGE status is disregarded and all table or fragment distribution statistics are refreshed while the statement is running, as in the next example:

```
SET ENVIRONMENT AUTO_STAT_MODE ON;  
UPDATE STATISTICS MEDIUM FOR TABLE FORCE;
```

Because no table is specified, the scope of UPDATE STATISTICS in this example is every table in the database, but automatic mode remains in effect for any subsequent UPDATE STATISTICS operations that omit the **FORCE** keyword in the same session.

For more information about the **AUTO** keyword of UPDATE STATISTICS, and about its logical inverse, the **FORCE** keyword, see [Using the FORCE and AUTO keywords](#).

For more information about the AUTO_STAT_MODE and STATCHANGE configuration parameters, see your *IBM® Informix® Administrator's Reference*.

For more information about the STATCHANGE table attribute, see the topics [Statistics options of the ALTER TABLE statement](#), [Statistics options of the CREATE TABLE statement](#), and [Performance considerations of UPDATE STATISTICS statements](#).

Related information:

[AUTO_STAT_MODE configuration parameter](#)

BOUND_IMPL_PDQ session environment option

You can set the BOUND_IMPL_PDQ session environment option to limit PDQ resource allocation. If the IMPLICIT_PDQ session environment option is set to ON or to a positive integer value no greater than 100, you can use the BOUND_IMPL_PDQ environment option to specify that the allocated memory should be bounded by the current explicit **PDQPRIORITY** value or by a range.

The IMPLICIT_PDQ and the BOUND_IMPL_PDQ session environment options are available only on systems that support **PDQPRIORITY**. If IMPLICIT_PDQ is set to OFF, then the BOUND_IMPL_PDQ setting is ignored, and the server does not override the current **PDQPRIORITY** setting.

The BOUND_IMPL_PDQ session environment option has this syntax:

BOUND_IMPL_PDQ environment option

```
|--SET ENVIRONMENT BOUND_IMPL_PDQ +-OFF-----+-----|
                                     +-ON-----+
                                     '- integer -'
```

Element	Description	Restrictions	Syntax
<i>integer</i>	Nonnegative integer limiting the memory available to a query in the session as this percentage of the PDQPRIORITY value	Must be in the range $0 < integer < 101$	Quoted String

Usage

The BOUND_IMPL_PDQ environment option can be set to the following values, but its effects depend on the IMPLICIT_PDQ session environment option being enabled:

OFF

No upper bound on implicit **PDQPRIORITY** calculation.

ON

The server uses the explicitly specified **PDQPRIORITY** setting as the upper bound for calculating the implicit PDQPRIORITY.

'integer' or "integer"

The explicit **PDQPRIORITY** value is scaled by this percentage in the current session.

For example, you might execute the following statement to force the database server to use explicit **PDQPRIORITY** values as guidelines in allocating memory if the IMPLICIT_PDQ environment option is enabled for the current session:

```
SET ENVIRONMENT BOUND_IMPL_PDQ ON;
```

If you instead specify a positive integer in the range from 1 to 100, the explicit **PDQPRIORITY** value is scaled by that setting during the current session. The specified integer must be delimited by quotation marks, as in the following example, which specifies 75% of available PDQ memory as the upper bound:

```
SET ENVIRONMENT BOUND_IMPL_PDQ "75";
```

By default, BOUND_IMPL_PDQ is not enabled. When the BOUND_IMPL_PDQ session environment option is set to ON for the current session, you require the database server to use the explicit **PDQPRIORITY** setting as the upper bound for memory that can be allocated to a query. If you set both IMPLICIT_PDQ and BOUND_IMPL_PDQ, then the explicit **PDQPRIORITY** value determines the upper limit of memory that can be allocated to a query. If **PDQPRIORITY** is specified as a range, the database server grants memory within the range specified.

The following example disables BOUND_IMPL_PDQ in the current session, so that the server is not restricted in the proportion of the **PDQPRIORITY** setting that it can allocate to a query:

```
SET ENVIRONMENT BOUND_IMPL_PDQ OFF;
```

See also the *IBM® Informix® Performance Guide* discussion of parallel database query (PDQ).

CLUSTER_TXN_SCOPE session environment option

When a client session in a high-availability cluster server issues a commit, the server blocks the current session until the committed transaction is applied in that session, or applied on a secondary server, or applied across the cluster, depending on the setting of the CLUSTER_TXN_SCOPE session environment option of the SET ENVIRONMENT statement.

The CLUSTER_TXN_SCOPE session environment option has this syntax:

CLUSTER_TXN_SCOPE session environment option

```
|--SET ENVIRONMENT CLUSTER_TXN_SCOPE -'---+CLUSTER +---'-----|
```



```
--SERVER--+
--SESSION--+
'DEFAULT'
```

Usage

In a cluster environment, this statement can apply a different transaction scope that overrides the setting of the `CLUSTER_TXN_SCOPE` configuration parameter for the current user session. It can also restore the effects of that onconfig file setting, after a `SET ENVIRONMENT` statement in the same session overrode the configuration parameter setting.

To use this transaction coordination feature, specify one of the following options, delimited by single (') or double (") quotation marks, immediately after the `SET ENVIRONMENT CLUSTER_TXN_SCOPE` keywords. The syntax diagram is simplified by omitting the " delimiters.

'SESSION'

When a client session issues a commit, the database server blocks the session until the effects of the transaction commit are returned to that session. After control is returned to the session, other sessions at the same database server instance or on other database servers in the same cluster might be unaware of the transaction commit and of the effects of the transaction.

'SERVER'

The database server reads the most recently committed version of the data if it encounters an exclusive lock while attempting to read a row in the Dirty Read or Read Uncommitted isolation level. This is the default behavior, unless the `CLUSTER_TXN_SCOPE` configuration parameter has a nondefault setting for your database server instance.

'CLUSTER'

When a client session issues a commit, the database server blocks the session until the transaction is applied at all database servers in the high-availability cluster, excluding RS secondary servers that have the `DELAY_APPLY` or `STOP_APPLY` configuration parameters enabled. Other sessions at any database server in the high-availability cluster, excluding RS secondary servers that are using `DELAY_APPLY` or `DELAY_APPLY`, are aware of the transaction commit and the transaction's effects.

'DEFAULT'

The cluster transaction scope reverts to the `CLUSTER_TXN_SCOPE` configuration parameter setting in the onconfig file of the database server instance, if that parameter is set.

The `CLUSTER_TXN_SCOPE` setting affects sessions on read-only secondary servers and on updatable secondary servers. Transactions do not need to be applied on the RS secondary servers before client applications can receive commits.

Examples of setting CLUSTER_TXN_SCOPE

This statement sets the cluster as the scope of transaction coordination during the session:

```
SET ENVIRONMENT CLUSTER_TXN_SCOPE 'CLUSTER';
```

This setting minimizes the risk of transaction coordination failure, but it can increase the time required for the session to receive the transaction commit. For the session with this setting, after the primary server sends logical log buffers to the HDR secondary server, it returns control to the session, but the session does not receive a commit until the transaction is applied on all of the servers in the cluster.

The next example specifies the local database server as the scope of transaction coordination:

```
SET ENVIRONMENT CLUSTER_TXN_SCOPE 'SERVER';
```

The 'SERVER' setting can reduce the risk of transaction coordination failure when different sessions on the same server are concurrently processing data in the same tables.

This example allows processing to resume after a transaction commit is returned to the current session:

```
SET ENVIRONMENT CLUSTER_TXN_SCOPE 'SESSION';
```

This setting might be appropriate if the session is accessing database objects that are unlikely to be referenced by concurrent sessions of the same server, or of other servers in the same cluster.

The following statement makes the value for the current setting match the `CLUSTER_TXN_SCOPE` configuration parameter setting of the local server instance:

```
SET ENVIRONMENT CLUSTER_TXN_SCOPE "DEFAULT";
```

If the `CLUSTER_TXN_SCOPE` configuration parameter setting for the server is `CLUSTER` or `SERVER`, then "DEFAULT" might have been a more appropriate `CLUSTER_TXN_SCOPE` session environment setting than the previous "SESSION" example, if transactions in concurrent sessions produce unexpected results.

Related information:

[CLUSTER_TXN_SCOPE configuration parameter](#)

[DELAY_APPLY Configuration Parameter](#)

[STOP_APPLY configuration parameter](#)

[Cluster transaction coordination](#)

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DEFAULTESCCHAR session environment option

You can use the `DEFAULTESCCHAR` session environment option of the `SET ENVIRONMENT` statement to override the current default escape character within character-string operands of `LIKE` or `MATCHES` expressions during the current session.

`DEFAULTESCCHAR` environment option

```
--DEFAULTESCCHAR--+ 'char' +-----|
```


' - 'NONE' - '

Element	Description	Restrictions	Syntax
<i>char</i>	A single character to set as the default escape character in LIKE or MATCHES expressions that include no ESCAPE clause	Must be a single-byte character, and must be delimited between single (') or double (") quotation marks	Literal Number as Quoted String

Usage

The DEFAULTESCCHAR session environment option can be set to one of the following values:

'char' or "char"

A single-byte ASCII character, delimited by single (') or double (") quotation marks, that designates the default escape character for this session in LIKE or MATCHES expressions that include no ESCAPE clause.

'NONE' or "NONE"

A case-insensitive quoted string, indicating that in this session there is no default escape character for LIKE or MATCHES expressions that include no ESCAPE clause.

This is the descending order of precedence, from highest to lowest, among the methods for specifying an escape character for LIKE or MATCHES expressions:

- The character following the `ESCAPE` keyword of the LIKE or MATCHES expression
- The character following the `DEFAULTESCCHAR` keyword in the `SET ENVIRONMENT` statement (for the current session only)
- The character setting of the `DEFAULTESCCHAR` configuration parameter
- The system default backslash (\) character.

Setting a default escape character for the current session

An *escape character* instructs the SQL parser to interpret as a literal character (rather than as having special significance for the next character) any characters that can be wildcard characters. For example, default wildcards are

- % and _ for operands of the LIKE operator,
- or * and ^ for operands of the MATCHES operator.

In a LIKE or MATCHES expression, the escape character must immediately precede the character whose special significance is to be ignored.

For LIKE or MATCHES expressions in subsequent DML statements in the same session, the *escape character* value defined by the `SET ENVIRONMENT DEFAULTESCCHAR` statement overrides the setting of the `DEFAULTESCCHAR` configuration parameter. `SET ENVIRONMENT DEFAULTESCCHAR` statements in the current session, however, have no effect on how the database server evaluates LIKE or MATCHES expressions in other sessions, which can use the system default escape character in the onconfig file for LIKE or MATCHES expressions that include no ESCAPE clause, or can use a different setting of the `DEFAULTESCCHAR` option, if data records that those sessions process require a different escape character.

For example, in subsequent LIKE and MATCHES expressions in the same session that include no ESCAPE clause, the following statement makes '#' the default escape character:

```
SET ENVIRONMENT DEFAULTESCCHAR '#';
```

In the following WHERE clause with a LIKE expression, the previous `SET ENVIRONMENT` statement causes the SQL parser to interpret the three backslash (\) symbols as literal characters in the file path, rather than as escape characters:

```
SELECT pathname FROM OldFiles2014
WHERE pathname LIKE 'C:#\user#\argos#\collars';
```

Setting the DEFAULTESCCHAR to 'NONE'

To treat as a literal character the system default escape character (\), and the default escape character set by the `DEFAULTESCCHAR` configuration parameter, and any session default escape character previously set by `SET ENVIRONMENT DEFAULTESCCHAR` in the current session, you can specify 'NONE' as the setting of the `DEFAULTESCCHAR` option:

```
SET ENVIRONMENT DEFAULTESCCHAR 'NONE';
```

When the 'NONE' setting is in effect, the database server has the following behavior when evaluating LIKE or MATCHES expressions during the session:

- In character-string operands of LIKE or MATCHES expressions, any escape character that an SQL statement uses to mark a wildcard symbol as a literal character must be defined in the `ESCAPE` clause of the same LIKE or MATCHES expression.
- LIKE or MATCHES expressions that include no ESCAPE clause must prefix wildcard characters that are used as literals with the default escape characters of the LIKE or MATCHES operators, or with the backslash (\) character.
- In LIKE or MATCHES expressions, any other escape character that the `DEFAULTESCCHAR` configuration parameter defines in the `ONCONFIG` file is treated as a literal character, rather than as an escape character.

Only LIKE or MATCHES expressions that include no ESCAPE clause are affected by the `DEFAULTESCCHAR` session environment setting. For more information about escape characters in LIKE or MATCHES expressions, see the topics [ESCAPE with LIKE](#) and [ESCAPE with MATCHES](#).

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EXTDIRECTIVES session environment option

You can use the `EXTDIRECTIVES` environment option of the `SET ENVIRONMENT` statement to enable or disable external optimizer directives during the current session.

The `EXTDIRECTIVES` session environment option has this syntax:

```
EXTDIRECTIVES environment option

|----EXTDIRECTIVES----+--OFF----+-----|
                        +- '0' ----+
                        +-ON-----+
                        +- '1' ----+
                        '-DEFAULT--'
```

Usage

The setting that you specify for `EXTDIRECTIVES` session environment option can override the settings of both the **IFX_EXTDIRECTIVES** environment variable and of the `EXT_DIRECTIVES` configuration parameter in the `ONCONFIG` file for enabling or disabling external optimizer directives in the current session. Other user sessions are not affected.

To set the `EXTDIRECTIVES` session environment variable, specify one of these values:

'1' or ON

Enables external optimizer directives. During the current session, this setting overrides whatever values are set in the client-side **IFX_EXTDIRECTIVES** environment variable or in the `EXT_DIRECTIVES` configuration parameter.

'0' or OFF

Disables external optimizer directives. During the current session, this setting overrides whatever values are set in the client-side **IFX_EXTDIRECTIVES** environment variable or in the `EXT_DIRECTIVES` configuration parameter.

DEFAULT

Enables during the current session a default value that depends on the settings of the client-side **IFX_EXTDIRECTIVES** environment variable, if that is set, and on the `EXT_DIRECTIVES` configuration parameter, if that is set, as described immediately below in this topic.

The DEFAULT setting

If you or the **sysdbopen** routine used the `SET ENVIRONMENT EXTDIRECTIVES` statement earlier in the same session to enable or to disable external optimizer directives, the `SET ENVIRONMENT EXTDIRECTIVES DEFAULT` statement restores the external optimizer directives behavior of the database server to its default state.

After the **DEFAULT** setting takes effect for the session, whether the query execution optimizer is influenced by external directives depends on the settings of the `EXT_DIRECTIVES` configuration parameter and of the client-side **IFX_EXTDIRECTIVES** environment variable.

- When the `EXTDIRECTIVES` option of the `SET ENVIRONMENT` statement is set to **DEFAULT**, and `EXT_DIRECTIVES` and **IFX_EXTDIRECTIVES** are both enabled, then external optimizer directives are enabled during the current session.
- When `EXTDIRECTIVES` is set to **DEFAULT**, and `EXT_DIRECTIVES` and **IFX_EXTDIRECTIVES** are both disabled, then external optimizer directives are disabled during the current session.
- If `EXTDIRECTIVES` is set to **DEFAULT**, but `EXT_DIRECTIVES` and **IFX_EXTDIRECTIVES** have conflicting settings, so that one of them is set to enabled, but the other is set to disabled, then the database server behaves according to these rules:
 - if `EXT_DIRECTIVES` is set to 0 (or if it has no setting), then by default, external directives are disabled, even if **IFX_EXTDIRECTIVES** is enabled.
 - if `EXT_DIRECTIVES` is set to 1, external directives are disabled if **IFX_EXTDIRECTIVES** is set to disabled.
 - if `EXT_DIRECTIVES` is set to 1, external directives are enabled if **IFX_EXTDIRECTIVES** is set to enabled.
 - if `EXT_DIRECTIVES` is set to 2), then external directives are enabled, regardless of the **IFX_EXTDIRECTIVES** setting.

If no `SET ENVIRONMENT EXTDIRECTIVES` statement was previously issued in the current session, it is generally not necessary to run the `SET ENVIRONMENT EXTDIRECTIVES DEFAULT` statement. Unless the `EXT_DIRECTIVES` configuration parameter has been reset since the session began, the database server is already in its default state for processing external optimizer directives.

Examples of enabling or disabling external directives

The following statement enables external directives in subsequent queries executed in the current session:

```
SET ENVIRONMENT EXTDIRECTIVES "1";
```

The following statement has the same effect:

```
SET ENVIRONMENT EXTDIRECTIVES ON;
```

In both cases, the database server ignores the `EXT_DIRECTIVES` and **IFX_EXTDIRECTIVES** settings, but those settings might affect queries in other concurrent sessions,

Both of the following statements disable external directives in subsequent queries in the current session:

```
SET ENVIRONMENT EXTDIRECTIVES OFF;
```

```
SET ENVIRONMENT EXTDIRECTIVES "0";
```

The following statement allows processing of external directives in subsequent queries of the current session to be determined by the `EXT_DIRECTIVES` and **IFX_EXTDIRECTIVES** settings, as described earlier in this topic:

```
SET ENVIRONMENT EXTDIRECTIVES DEFAULT;
```

[SAVE EXTERNAL DIRECTIVES statement](#) for a table that identifies the `DEFAULT` behavior of the database server for external optimizer directives for all possible combinations of `EXT_DIRECTIVES` configuration parameter settings and `IFX_EXTDIRECTIVES` environment variable settings.

Related information about external optimizer directives

For information on how to define external optimizer directives and how to save them in the `sysdirectives` table of the system catalog, see the same [SAVE EXTERNAL DIRECTIVES statement](#) topic. For more information about the `EXT_DIRECTIVES` configuration parameter and the effects of its settings, see the IBM® Informix® Administrator's Reference.

For more information about the `IFX_EXTDIRECTIVES` environment variable, see the *IBM Informix Guide to SQL: Reference*, which also describes how the settings of the `EXT_DIRECTIVES` configuration parameter and of the `IFX_EXTDIRECTIVES` environment variable can jointly determine whether access to external directives is enabled or disabled for the query optimizer.

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FORCE_DDL_EXEC session environment option

Use the `FORCE_DDL_EXEC` session environment option of the `SET ENVIRONMENT` statement to force out other transactions that have opened or have locks on the tables involved in an `ALTER FRAGMENT ON TABLE` operation.

These are prerequisites for enabling the `FORCE_DDL_EXEC` session environment option:

- You must be user **informix** or have DBA privileges on the database.
- The database must be a logging database.

`FORCE_DDL_EXEC` session environment option has this syntax:

```
FORCE_DDL_EXEC session environment option
|--SET ENVIRONMENT FORCE_DDL_EXEC--+-+--OFF--+-+-----+-----+-----+
| '0' |
| +-+--ON--+-+-----+-----+
| '1' |
| '-seconds--' |
```

Element	Description	Restrictions	Syntax
<code>seconds</code>	Nonnegative integer, setting a limit in seconds on the time available for the server to force out transactions and obtain exclusive access to the table	Must be an integer greater than zero	Quoted String

Usage

The `FORCE_DDL_EXEC` option can have any of the following values:

ON or **'1'**

This enables the server to force out transactions that are open or have a lock on the table when an `ALTER FRAGMENT ON TABLE` statement is issued until the server gets a lock and exclusive access on the table.

'seconds'

Specifies a time interval, in units of seconds, to allow the server to force out transactions that are open or that hold a lock on the target table of an `ALTER FRAGMENT ON TABLE` statement, until the server obtains a lock and exclusive access on the table, or until the specified time limit occurs. If the server cannot force out transactions within the specified time interval, the server stops attempting to force out the transactions, and the `ALTER FRAGMENT` statement waits for the locks to be released when the concurrent transactions are committed or rolled back.

OFF or **'0'**

Prevent the database server from forcing out transactions that are open or have a lock on the table when an `ALTER FRAGMENT ON TABLE` statement is issued. (This is the default behavior, unless a previous `SET ENVIRONMENT FORCE_DDL_EXEC` statement in the same session has enabled forcing out transactions during `ALTER FRAGMENT ON TABLE` statements.)

You must delimit the `seconds`, `1`, or `0` setting by single (`'`) or double (`"`) quotation marks. The `ON` and `OFF` keywords are case insensitive.

Important: When you use the `FORCE_DDL_EXEC` environment option, also use the `SET LOCK MODE TO WAIT` statement to specify a period of time for the server to force out any transactions in order to get exclusive access and a lock. If you run `SET LOCK MODE TO WAIT` without specifying an amount of time, the `FORCE_DDL_EXEC` option will not impact the `ALTER FRAGMENT` operation. For more information, see the [SET LOCK MODE statement](#).

When you enable the `FORCE_DDL_EXEC` environment option, the server supports multiple sessions performing `ALTER FRAGMENT ON TABLE` operations. If two sessions perform `ALTER FRAGMENT ON TABLE` on the same table when the `FORCE_DDL_EXEC` option is enabled, the second session receives an error. If another `ALTER` operation is occurring on the table, the `ALTER FRAGMENT ON TABLE` operation with an enabled `FORCE_DDL_EXEC` environment option will get an error.

Enabling this feature in sessions that issue `ALTER FRAGMENT ON TABLE` statements can avoid waiting for locks to be released. Effects on applications in other sessions where DDL statements access the same tables, however, can include closing their Update cursors, and rolling back their uncommitted transactions.

After you complete an `ALTER FRAGMENT ON TABLE` operation with the `FORCE_DDL_EXEC` environment option enabled, you can run the following statement to disable `FORCE_DDL_EXEC` environment option:

```
SET ENVIRONMENT FORCE_DDL_EXEC '0';
```

The **onshowaudit** utility displays an ALTER FRAGMENT event code (ALFR), which identifies ALTER FRAGMENT events that ran while the FORCE_DDL_EXEC environment option was enabled.

When the FORCE_DDL_EXEC environment option is enabled, the server also closes the hold cursors during rollback by the session that performs the ALTER FRAGMENT ON TABLE operation.

Examples of setting FORCE_DDL_EXEC

Unlike most session environment options of the SET ENVIRONMENT statement, the effects of enabling the FORCE_DDL_EXEC option in a logged database can directly affect DDL operations on the same table in concurrent sessions,

- by requiring their transaction to commit within your SET LOCK MODE TO WAIT *interval* time limit,
- or by rolling back their transaction, if that provides you with exclusive access to the table within the *seconds* value of your SET ENVIRONMENT FORCE_DDL_EXEC statement, or when the FORCE_DDL_EXEC option is enabled with no time limit.

If the database server succeeds in rolling back a transaction in the other session, it issues the following error, regardless of the duration of the forced-out transaction:

```
-458 Long transaction aborted.
```

For example, the following SQL statements take these actions:

- Enable FORCE_DDL_EXEC for 240 seconds
- Wait up to 60 seconds for locks held by other sessions to be released
- Change the Rolling Window purge policy of the **window_orders** table
- Disable the FORCE_DDL_EXEC environment option.

```
SET ENVIRONMENT FORCE_DDL_EXEC '240';
SET LOCK MODE TO WAIT 60;
ALTER FRAGMENT ON TABLE window_orders MODIFY INTERVAL
LIMIT TO 10 MiB DETACH INTERVAL ONLY;
SET ENVIRONMENT FORCE_DDL_EXEC OFF;
```

But if the SET LOCK MODE statement above had specified no limit

```
SET ENVIRONMENT FORCE_DDL_EXEC '240';
SET LOCK MODE TO WAIT;
```

then the FORCE_DDL_EXEC setting would have no effect, because the database server would have waited until no concurrent transactions held locks on the **window_orders** table, which is the default behavior without FORCE_DDL_EXEC set.

The following statement enables the FORCE_DDL_EXEC environment option with no time limit during ALTER FRAGMENT operations:

```
SET ENVIRONMENT FORCE_DDL_EXEC '1';
```

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GRID_NODE_SKIP session environment option

Use the GRID_NODE_SKIP option of the SET ENVIRONMENT statement to define the behavior of the database server when a grid server within the grid or region that the query specifies is not available.

GRID_NODE_SKIP environment option

```
|--SET ENVIRONMENT GRID_NODE_SKIP--+-ON-----+-----|
                                     '+-OFF-----+'
                                     '-DEFAULT-'
```

Usage

The GRID_NODE_SKIP session environment option can be set to any of three values:

ON

If a grid server within the specified grid or region is not available when the grid query attempts to retrieve qualifying rows from that node, an error is returned to the server that issued the grid query. That server continues processing the query by attempting to connect to the next server in the grid or region, unless the server whose results were skipped was last among the participating grid servers. In that case, the results from the available nodes are combined, and the logical UNION or UNION ALL from the results of the available grid servers is calculated by the server that issued the grid query.

DEFAULT

This setting specifies the default behavior. If a grid server within the specified grid or region is not available when the grid query attempts to retrieve qualifying rows from a database of that node, an error is returned to the server that issued the grid query, and the query fails.

OFF

This has the same effect as the explicit DEFAULT setting, as described above.

When the SET ENVIRONMENT GRID_NODE_SKIP ON statement is in effect for the current session, a grid query can return results when multiple grid servers are unavailable. The identity of a skipped grid server can be returned by executing the **ifx_gridquery_skipped_nodes()** function. Another function, **ifx_gridquery_skipped_node_count()**, can be called to detect how many nodes of the grid or region were skipped. For more information about these functions, see the .

Because a grid query is a dynamic UNION or UNION ALL combined query, the decision to skip a grid server occurs at the start of statement preparation, not when the statement is executed. The reason for this is that if information from the remote data dictionary cannot be obtained, then the SELECT statement cannot be prepared. Therefore, the database server that issues the grid query makes the decision to skip or not skip any unavailable grid servers prior to statement execution, if the GRID_NODE_SKIP session environment option is set to ON.

The GRID_NODE_SKIP setting has no effect outside a grid context.

Examples of setting GRID_NODE_SKIP

From a session in a database of a grid server, the following statement prevents subsequent grid queries from failing with an error if any of the grid servers are unavailable when the grid or the region of the query:

```
SET ENVIRONMENT GRID_NODE_SKIP ON;
```

With the GRID_NODE_SKIP option enabled, the database server ignores any node which is not available when it executes a grid query, and returns qualifying rows from the participating grid servers.

The next example has the opposite effect, disabling the GRID_NODE_SKIP option:

```
SET ENVIRONMENT GRID_NODE_SKIP DEFAULT;
```

The following statement achieves the same effect as the DEFAULT setting, but with fewer keystrokes:

```
SET ENVIRONMENT GRID_NODE_SKIP OFF;
```

Related reference:

[GRID clause](#)

Related information:

[ifx_gridquery_skipped_nodes\(\) function](#)

[ifx_gridquery_skipped_node_count\(\) function](#)

[Grid queries](#)

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HDR_TXN_SCOPE session environment option

Use the SET ENVIRONMENT HDR_TXN_SCOPE statement of SQL to control when a transaction commit is returned to a client application in a cluster environment.

The HDR_TXN_SCOPE session environment option has this syntax:

HDR_TXN_SCOPE session environment option

```
|--SET ENVIRONMENT HDR_TXN_SCOPE -'---+--ASYNC-----+--'-----|
                                     +-NEAR_SYNC--+
                                     '-FULL_SYNC-'
```

Usage

In a cluster environment, this statement can perform the following actions:

- Override the current setting of the HDR_TXN_SCOPE configuration parameter for the current user session.
- Restore the effects of that onconfig file setting after a previous SET ENVIRONMENT HDR_TXN_SCOPE statement in the same session overrode the configuration parameter setting.

To use this transaction synchronization feature, set the DRINTERVAL configuration parameter to 0, and then run a SET ENVIRONMENT statement that specifies one of the following options, delimited by single (') or double (") quotation marks, immediately after the SET ENVIRONMENT HDR_TXN_SCOPE keywords. The syntax diagram is simplified by omitting the " delimiters.

'ASYNC'

Asynchronous mode, where transactions do not require acknowledgement of being received or completed on the HDR secondary server before they can complete. System performance is best when a replication pair uses asynchronous mode, but if there is a server failure, data can be lost.

'FULL_SYNC'

Fully synchronous mode, where transactions require acknowledgement of completion on the HDR secondary server before they can complete. Data integrity is highest when a replication pair uses fully synchronous mode, but system performance can be negatively affected if client applications use unbuffered logging and have many small transactions.

'NEAR_SYNC'

Nearly synchronous mode, where transactions require acknowledgement of being received on the HDR secondary server before they can complete. Nearly synchronous mode can have better performance than fully synchronous mode and better data integrity than asynchronous mode. If used with unbuffered logging, SYNC mode, which is turned on when DRINTERVAL is set to -1, is the same as nearly synchronous mode.

When the DRINTERVAL configuration parameter is set to 0, the value of the HDR_TXN_SCOPE parameter determines the synchronization mode for HDR replication.

Examples of setting HDR_TXN_SCOPE

To maintain safeguards against data loss, but avoid performance problems that are caused by client applications that perform many small transactions with unbuffered logging, you can enable nearly synchronous mode by running the following statement:

the PREPARE statement, and (for cursors associated with routines) the UPDATE STATISTICS FOR ROUTINE statement for any routines that reference the table whose schema has been modified.

If enabling the IFX_AUTO_REPREPARE session environment variable results in a runtime error, that error is passed back to the application.

Examples

The following statement enables automatic reparation after DDL operations on tables that prepared objects or SPL routines reference:

```
SET ENVIRONMENT IFX_AUTO_REPREPARE '1';
```

That setting overrides the setting of the AUTO_REPREPARE configuration parameter, if it is zero or 'None', for the remainder of the current session, or until you reset IFX_AUTO_REPREPARE.

The following statement, which uses an equivalent keyword, has the same effect for the current session:

```
SET ENVIRONMENT IFX_AUTO_REPREPARE on;
```

The following sequence of statements from different sessions will result in a -710 error, even though IFX_AUTO_REPREPARE is enabled for Session 1:

1. Session 1 prepares the following statement: `PREPARE s FROM "SELECT c1, c2 FROM t1"`
2. Session 2 drops column c2 from table t1: `ALTER TABLE t1 DROP (c2)`
3. Session 1 attempts to execute the following statement: `EXECUTE s INTO :v1, :v2`

As a result, the database server sends the -710 error to the client application because it cannot send a value for column c2, which no longer exists. For the statement to succeed, you must resubmit it without referencing column c2.

When you are satisfied with how your client application currently handles errors from schema changes, you can stop overriding the system-wide setting of the AUTO_REPREPARE configuration parameter. For example, you can use one of the following equivalent statements:

```
SET ENVIRONMENT IFX_AUTO_REPREPARE OFF;  
SET ENVIRONMENT IFX_AUTO_REPREPARE off;  
SET ENVIRONMENT IFX_AUTO_REPREPARE "0";  
SET ENVIRONMENT IFX_AUTO_REPREPARE '0';
```

Related reference:

[SET ENCRYPTION PASSWORD statement](#)

Related information:

[Avoiding index or prepared object exceptions by forced reoptimization](#)

[AUTO_REPREPARE configuration parameter](#)

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IFX_BATCHEDREAD_INDEX session environment option

You can use the IFX_BATCHEDREAD_INDEX session environment option of the SET ENVIRONMENT statement of SQL to enable the query execution plans that execute light scans on the indexes of large tables, bypassing the buffer pool by using session memory to read directly from disk.

IFX_BATCHEDREAD_INDEX session environment option

```
|--SET ENVIRONMENT IFX_BATCHEDREAD_INDEX--+-'1'-----|  
                                     '-!0!-'
```

Usage

When the IFX_BATCHEDREAD_INDEX configuration parameter not set, or is set to 0, enabling the IFX_BATCHEDREAD_INDEX session environment option can improve the performance of some DML operations on indexed tables.

To set this session environment variable, specify one of the following digits as a quoted string:

'1' or "1"

Enables the query optimizer to execute light scans for indexes during the session.

'0' or "0"

Prevents the query optimizer from executing light scans for indexes.

For example, to enable the optimizer use light scans for reading index keys, specify:

```
SET ENVIRONMENT IFX_BATCHEDREAD_INDEX '1';
```

The following statement disables the same query optimizer feature:

```
SET ENVIRONMENT IFX_BATCHEDREAD_INDEX '0';
```

In sessions where the IFX_BATCHEDREAD_INDEX configuration parameter and the IFX_BATCHEDREAD_INDEX session environment variable have different settings, the setting of the session environment variable takes precedence over the configuration parameter setting for the duration of the session, or until the IFX_BATCHEDREAD_INDEX session environment variable is reset.

The default value of the IFX_BATCHEDREAD_INDEX configuration parameter in the onconfig.std file is 1. That value can be reset to zero, however, disabling light scans of indexes, by either of the following onmode commands:

```
EXECUTE FUNCTION task("onmode","wf","IFX_BATCHEDREAD_INDEX=0");
EXECUTE FUNCTION task("onmode","wm","IFX_BATCHEDREAD_INDEX=0");
```

When IFX_BATCHEDREAD_INDEX has been disabled by those function calls, running the SET ENVIRONMENT statement

```
SET ENVIRONMENT IFX_BATCHEDREAD_INDEX "1";
```

restores support for light scans on indexes during the current session, if you expect that light scans on indexes will be more efficient for some DML operations in your application.

For more information about the advantages of light scans in queries of large tables, and restrictions on light scans, see [IFX_BATCHEDREAD_TABLE session environment option](#)

Related information:

[BATCHEDREAD_INDEX configuration parameter](#)

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IFX_BATCHEDREAD_TABLE session environment option

Use the IFX_BATCHEDREAD_TABLE environment option of the SET ENVIRONMENT statement to enable or disable light scans on compressed tables, tables with rows that are larger than a page, and tables with VARCHAR, LVARCHAR, and NVARCHAR data during the current session.

A light scan bypasses the buffer pool by utilizing session memory to read directly from disk. Query execution plans that uses light scans on large tables can improve performance, compared to plans using full-table scans.

IFX_BATCHEDREAD_TABLE environment option

```
--SET ENVIRONMENT IFX_BATCHEDREAD_TABLE--+-'1'+-----|
                                     '-0'-
```

Usage

When the BATCHEDREAD_TABLE configuration parameter is not enabled, enabling the IFX_BATCHEDREAD_TABLE session environment variable can improve the performance of some DML operations on indexed tables.

To set this session environment variable, specify one of the following digits as a quoted string:

'1' or "1"

Enable light scans during the session for query execution on compressed tables, on tables with rows larger than a page, and on tables with VARCHAR, LVARCHAR, and NVARCHAR columns

'0' or "0"

Prevent the query optimizer from using these light scans for the session.

For example, the following statement enables queries to perform light scans on compressed tables, on tables with rows larger than a page, and on tables with character data types of variable length:

```
SET ENVIRONMENT IFX_BATCHEDREAD_TABLE '1';
```

The following statement restores the default restriction on light scans of tables with those attributes:

```
SET ENVIRONMENT IFX_BATCHEDREAD_TABLE "0";
```

Light scans

Light scans can provide performance advantages over other query execution plans that use the buffer pool for sequential scans or for skip scans of large tables. The following requirements, however, restrict the contexts in which the query optimizer can consider execution paths that include a light scan:

- The optimizer must choose a sequential scan or a skip-scan of the table.
- The table must store at least a megabyte (MiB) of data.
- One of the following locking conditions must be satisfied:
 - The isolation level is not Cursor Stability, and you hold at least a shared lock on the entire table.
 - The isolation level is Dirty Read, or the database transaction logging mode is WITH NO LOG.

But even if all of the optimizer plan, table size, and locking requirements listed above are satisfied, the following additional table restrictions can prevent light scans on tables with any of the following attributes. The tables cannot be

- compressed tables,
- tables with rows that are larger than a page,
- tables of variable row length.

The variable row length restriction prohibits tables with VARCHAR, LVARCHAR, or NVARCHAR columns, or with ROW-type columns that include VARCHAR, LVARCHAR, or NVARCHAR fields, or with data types DISTINCT of these variable-length types.

Although these three table restrictions are in effect by default, they do not prevent light scans on qualifying large tables in databases where the BATCHEDREAD_TABLE configuration parameter is enabled, or in sessions where the BATCHEDREAD_TABLE session environment option is enabled.

In both examples, the double quotation-mark character (") could be substituted as the delimiters, but as in any SET ENVIRONMENT operation, an undelimited digit for the setting returns an error:


```
SET ENVIRONMENT IFX_BATCHEDREAD_TABLE 0; --Fails to disable light scans
--on qualifying large tables
```

In sessions where the IFX_BATCHEDREAD_TABLE configuration parameter and the IFX_BATCHEDREAD_TABLE session environment variable have different settings, the setting of the session environment variable takes precedence over the configuration parameter setting for the duration of the session, or until the IFX_BATCHEDREAD_TABLE session environment variable is reset.

Important:

The lists of table attributes identified above as preventing light scans are not exhaustive. Tables with any of the following attributes cannot be processed using light scans in query execution plans, regardless of the current setting of the IFX_BATCHEDREAD_TABLE configuration parameter or the IFX_BATCHEDREAD_TABLE session environment variable:

- tables with data stored in blobspaces,
- tables with data stored in smart blobspaces,
- tables of variable row length.

Related information:

[BATCHEDREAD_TABLE configuration parameter](#)

[Light scans](#)

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IFX_SESSION_LIMIT_LOCKS session environment option

When IFX_SESSION_LIMIT_LOCKS is set in the session, its setting can specify a lower limit than the SESSION_LIMIT_LOCKS configuration parameter value for the maximum number of locks for users who are not administrators. This option, however, cannot restrict the number of locks in the session of a user who holds administrative privileges, such as user **informix** or a DBSA user, and cannot specify a limit for nonadministrative users below 500 locks.

The SET ENVIRONMENT IFX_SESSION_LIMIT_LOCKS statement cannot reset the maximum number of locks in a session to a value higher than the current setting of the SESSION_LIMIT_LOCKS configuration parameter.

The SET ENVIRONMENT AUTOLOCATE statement of SQL supports the following syntax:

```
IFX_SESSION_LIMIT_LOCKS environment option
```

```
|--SET ENVIRONMENT IFX_SESSION_LIMIT_LOCKS----'--integer--'-----|
```

Element	Description	Restrictions	Syntax
<i>integer</i>	Nonnegative integer that defines how many locks in the internal lock table are available during the session for nonadministrative users	Must be in the range $500 \leq integer \leq$ SESSION_LIMIT_LOCKS value	Quoted String

Usage

For users who are not administrators of the database server instance, the IFX_SESSION_LIMIT_LOCKS session environment option can have an integer values greater than 499 but no greater than the current value of the SESSION_LIMIT_LOCKS configuration parameter.

'integer' or "integer"

This defines the maximum number of locks that a nonadministrative user can hold during the session. If the SESSION_LIMIT_LOCKS configuration parameter is not set, the upper limit is 2,147,483,647 locks.

If the IFX_SESSION_LIMIT_LOCKS session environment option and the SESSION_LIMIT_LOCKS configuration parameter are set to different values, the session environment option takes precedence over the configuration parameter for operations during the current sessions by users who are not administrator, but only until the current session ends. If neither of those values is set, the default limit for every user is 2,147,483,647 locks.

Lock limits set by users who are not administrators

If you are a regular user, you (or the **sysdbopen** routine that configures your session) can set the IFX_SESSION_LIMIT_LOCKS session environment option only to an unsigned integer value between the minimum (500) and the current value set by the SESSION_LIMIT_LOCKS configuration parameter.

For example, you might execute the following statement to restrict subsequent DDL and DML operations during the session to no more than 1056 locks:

```
SET ENVIRONMENT IFX_SESSION_LIMIT_LOCKS '1056';
```

If you attempt to specify an invalid value, the database server returns an error:

```
SET ENVIRONMENT IFX_SESSION_LIMIT_LOCKS '400'; --Below lower limit
```

```
-26041: Invalid values specified for the environment variable.
```

Issuing this exception is unlike the behavior of the SESSION_LIMIT_LOCKS configuration parameter, which replaces any nonnegative setting in the range from 0 to 499, or any negative value, with 500, the minimum value for nonadministrative users.

Important:

Because an insufficient locks can cause DML or DDL operations to fail, nonadministrative users should generally use caution when considering whether to use this session environment variable to restrict the number of locks available in contexts like these:

- If the session is using Repeatable Read isolation level for operations on large tables, because each row touched requires a lock.
- If the session of a non-DBSA user is running commands of the **cdr** utility of Enterprise Replication.

In data processing contexts that require very large numbers of locks, however, administrators might set `SESSION_LIMIT_LOCKS` (or might set `IFX_SESSION_LIMIT_LOCKS` in **sysdbopen** routines for specific users or for specific roles) to a value intended to reduce the risk of nonadministrative users in concurrent sessions depleting the lock resources of the database server, thereby interfering with massively lock-intensive operations.

Lock limits set by administrative users

If you are a user who holds administrative privileges, such as user **informix** or a DBSA user, the setting of `IFX_SESSION_LIMIT_LOCKS` has no effect. The only value that you can set is 2147483647, which is already the default limit for administrative users. If you attempt to set this option to any other specific value, the database server will either issue the -26041 invalid value error, or else error -26000, indicating that administrative users cannot set a limit on the locks in their own sessions:

```
SET ENVIRONMENT IFX_SESSION_LIMIT_LOCKS "2147456789";

-26000 Locks cannot be limited for a user who has administrative privileges.
```

In releases earlier than version 12.10.xC4, it was possible for administrators to restrict themselves, but this is no longer an option.

Lock limits for sessions in tenant databases

An administrator can use the SQL administration API to create a tenant database with the tenant create argument to the **admin()** or **task()** function. The function call can include a `session_limit_locks` parameter value to set a nondefault limit on the number of locks that nonadministrative users can hold in a session.

For example, this statement creates a tenant database called **companyC** with a `session_limit_locks` limit of 250000 locks for each nonadministrative user session.

```
EXECUTE FUNCTION task('tenant create','companyC',
  '{dbspace:"companyC_dbs1,companyC_dbs2,companyC_dbs3",
   sbpace:"companyC_sbs",
   vpclass:"tvp_C,num=4",
   dbspacetemp:"companyC_tdb",
   session_limit_locks:"250000",
   logmode:"UNBUFFERED",
   locale:"en_us.8859-1"}'
);
```

Administrators can also use the "tenant update" argument to the **admin()** or **task()** function to reset the number of locks and other attributes of a tenant database. For example, the following function uses a `session_limit_locks` value of 3000 to change that limit for the same **companyC** tenant database:

```
EXECUTE FUNCTION task('tenant update','companyC',
  '{session_limit_locks:"3000"}');
```

Multiple properties can be reset by a single "tenant update" function call, but this example resets only the `session_limit_locks` property of **companyC**. The changed limit takes effect for new sessions.

If the **companyC** database was assigned a session limit of 3000 by the previous SQL administration API "tenant update" example, the following statement fails:

```
SET ENVIRONMENT IFX_SESSION_LIMIT_LOCKS '5000';
```

The example fails because this session environment variable cannot be set above the limit defined in the current setting of the `session_limit_locks` property of the tenant database.

In tenant databases, a **sysdbopen** session configuration routine that includes the `SET ENVIRONMENT IFX_SESSION_LIMIT_LOCKS` statement can set a limit on locks that is lower than the `session_limit_locks` setting of the tenant database:

```
SET ENVIRONMENT IFX_SESSION_LIMIT_LOCKS '1600';
```

If the `session_limit_locks` property currently specifies a limit of 3000, that limit would be temporarily reduced to 1600. This lower limit on locks persists in the tenant database for all new sessions of nonadministrative users, until the session in which **sysdbopen** routine set the new lower limit terminates. The limit on locks then reverts to the current `session_limit_locks` setting.

In tenant databases, as in all databases, the `IFX_SESSION_LIMIT_LOCKS` setting has no effect on users who hold administrative privileges, such as user **informix** or DBSA users.

Related information:

[SESSION_LIMIT_LOCKS configuration parameter](#)

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IMPLICIT_PDQ session environment option

Use the `IMPLICIT_PDQ` session environment option to allow the database server to determine the amount of memory allocated to a query, ignoring the explicit system default **PDQPRIORITY** environment variable setting.

```
IMPLICIT_PDQ environment option

|--SET ENVIRONMENT IMPLICIT_PDQ--+-OFF-----+-----|
                                +-ON-----+
                                '---integer--'-'
```

Element	Description	Restrictions	Syntax
<i>integer</i>	Nonnegative integer limiting the memory available to a query in the session as this percentage of the PDQPRRIORITY value	Must be in the range $0 < integer < 101$	Quoted String

Usage

Only systems that support **PDQPRRIORITY** can reset the IMPLICIT_PDQ session environment variable, which can have the following values:

The IMPLICIT_PDQ environment option can be set to the following values:

OFF

Disable IMPLICIT_PDQ. The server calculates no implicit PDQPRRIORITY.

ON

The server automatically calculates an implicit PDQPRRIORITY to use for each query.

'integer' or "integer"

Use *integer*% of the server-calculated implicit PDQPRRIORITY value for each query, where *integer* is a nonnegative whole number in the range 1-100.

Unless BOUND_IMPL_PDQ is also set, the database server ignores the explicit setting of the **PDQPRRIORITY** environment variable when IMPLICIT_PDQ is set to ON or to "100".

The database server does not allocate more memory, however, than is available when **PDQPRRIORITY** is set to "100". The maximum amount of memory that the database server can allocate is limited by the physical memory available to your system, and by the settings of these parameters:

- The PDQPRRIORITY environment variable
- The most recent SET PDQPRRIORITY statement of SQL
- The MAX_PDQPRRIORITY configuration parameter
- The DS_TOTAL_MEMORY configuration parameter
- The BOUND_IMPL_PDQ session environment variable

When concurrent queries are running, the DS_MAX_QUERIES configuration parameter setting can also restrict the amount of PDQ memory available for a new query.

By default, IMPLICIT_PDQ is not enabled. When IMPLICIT_PDQ is set to OFF, whether explicitly or by default, the database server does not override the current **PDQPRRIORITY** setting when allocating resources to queries. For example, the following statement prevents the server from using implicit PDQPRRIORITY for subsequent queries in the session:

```
SET ENVIRONMENT IMPLICIT_PDQ OFF;
```

If you set IMPLICIT_PDQ to an integer value between 1 and 100, the database server scales its estimate by the specified percentage. If you set a low value, the amount of memory allocated to the query is reduced, which might increase the risk of query-operator overflow. The following statement restricts the memory available for subsequent queries in the session to 75% of the calculated implicit PDQPRRIORITY:

```
SET ENVIRONMENT IMPLICIT_PDQ '75';
```

To request the database server to determine memory allocations for queries and distribute memory among query operators according to their needs, enter the following statement:

```
SET ENVIRONMENT IMPLICIT_PDQ ON;
```

To require the database server to use explicit **PDQPRRIORITY** settings as the upper bound and optional lower bound of memory that it grants to a query, set the BOUND_IMPL_PDQ session environment option.

Star-join query execution plans require PDQ priority to be set. Setting the IMPLICIT_PDQ session environment option to enable implicit PDQ offers an alternative. If IMPLICIT_PDQ is set to ON for the session, then a star-join execution plan will be considered without explicit setting PDQPRRIORITY. The SET ENVIRONMENT IMPLICIT_PDQ ON statement can be issued by a **sysdbopen** routine, so that users automatically enable implicit PDQ when they open the database. In this case, the query optimizer automatically considered a star join without explicit PDQPRRIORITY setting by the user.

The IMPLICIT_PDQ functionality for a query requires at least LOW level distribution statistics on all tables in the query. If distribution statistics are missing for one or more tables in the query, the IMPLICIT_PDQ setting has no effect. This restriction also applies to star join queries, which are not supported in the case of missing statistics.

For information on creating a **sysdbopen** routine and on specifying the users whose sessions it will affect, see the topic [Using SYSDBOPEN and SYSDBCLOSE Procedures](#). For information about the **PDQPRRIORITY** environment variable, see the *IBM® Informix® Guide to SQL: Reference*. For information about the DS_TOTAL_MEMORY and MAX_PDQPRRIORITY configuration parameters, see the *IBM Informix Administrator's Reference*.

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INFORMIXCONRETRY session environment option

Use the INFORMIXCONRETRY session environment option of the SET ENVIRONMENT statement to specify the maximum number of additional connection attempts that can be made to each database server during a single CONNECT statement in the current session, after the initial connection attempt fails. All these attempts must be made within the time limit that the INFORMIXCONTIME setting specifies.

The INFORMIXCONRETRY session environment option has this syntax:

```
INFORMIXCONRETRY environment option
```

```

      .-'1'-----.
|--SET ENVIRONMENT INFORMIXCONRETRY--+-----+-----|
      '-integer'-

```

Element	Description	Restrictions	Syntax
<i>integer</i>	The maximum number of retry attempts during a CONNECT statement	Must be greater than zero. If you specify no value, the default behavior is a single retry.	Literal Number as Quoted String

Usage

Use the INFORMIXCONRETRY session environment option to specify the maximum number of additional connection attempts that each CONNECT statement can make for a server-to-server connection during the session, if the first attempt of fails to establish a connection to the target database server instance. You can specify a nonzero *integer* value for this limit on the maximum number of retries by the CONNECT statement:

integer > 0

If the first attempt by the CONNECT statement to establish a connection to a database server fails, this value sets an upper limit on the number of additional attempts.

If no connection with another database has been established after (*integer* + 1) attempts, or after the time limit that INFORMIXCONTIME specifies has been exceeded, the CONNECT statement returns an error.

For the current session only, the setting of the INFORMIXCONRETRY session environment option overrides any other value that is currently set for the INFORMIXCONRETRY client environment variable or for the INFORMIXCONRETRY configuration parameter.

Order of precedence for INFORMIXCONRETRY settings

This is the descending order of precedence (highest to lowest) among methods for setting the maximum number of retry attempts for CONNECT statements:

- The SET ENVIRONMENT INFORMIXCONRETRY statement (for a session)
- The **INFORMIXCONRETRY** client environment variable setting.
- If INFORMIXCONRETRY configuration parameter in the **onconfig** file.
- The system default value of 1 additional attempt to establish a new connection to a server.

Unless the setting of the INFORMIXCONRETRY session environment option, or of the INFORMIXCONRETRY configuration parameter, or of the **INFORMIXCONRETRY** environment variable is an integer greater than zero, the default behavior of the CONNECT statement after a failed initial connection attempt is to attempt a single connection retry.

Examples of setting INFORMIXCONRETRY

For example, the following statement resets the INFORMIXCONRETRY session environment option to the default value of 1, restricting the database server to no more than a single additional connection attempt if the first attempt fails:

```
SET ENVIRONMENT INFORMIXCONRETRY;
```

The next example specifies that, if the initial connection attempt fails, up to three additional connection attempts are made before the database server issues an error.

```
SET ENVIRONMENT INFORMIXCONRETRY '3';
```

You can also use double (") quotation marks to delimit the setting, which allows five retries (or up to a total of 6 connection attempts) in the following example:

```
SET ENVIRONMENT INFORMIXCONRETRY "5";
```

Important:

If the INFORMIXCONTIME session environment option or the INFORMIXCONTIME configuration parameter is set to a time interval, that value takes precedence over the INFORMIXCONRETRY setting. That is, the connection attempts can end after the limit in seconds from the INFORMIXCONTIME setting has elapsed, even if this limit is exceeded before the INFORMIXCONRETRY limit on attempts is reached.

Related information:

[INFORMIXCONRETRY environment variable](#)
[INFORMIXCONRETRY configuration parameter](#)

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INFORMIXCONTIME session environment option

Use the INFORMIXCONTIME session environment option of the SET ENVIRONMENT statement to set an upper limit on the number of seconds while the current session attempts to establish a connection to another database server, before an error is returned.

The INFORMIXCONTIME session environment option has this syntax:

```
INFORMIXCONTIME environment option
```

```

      .-'1'-----
|--SET ENVIRONMENT INFORMIXCONTIME--+-----+-----|
      '-integer'-

```

Element	Description	Restrictions	Syntax
<i>integer</i>	An unsigned integer value > 0 sets the maximum number of seconds to attempts to establish a connection to a database server	Must be delimited between single (') or double (") quotation marks. A setting of '0' defaults to the setting of the INFORMIXCONTIME configuration parameter.	Literal Number as Quoted String

Usage

Use the INFORMIXCONTIME session environment option of the SET ENVIRONMENT statement to limit the number of *seconds* to spend attempting to establish a connection to a database server in the current session, before the connection effort times out with an error.

`'integer' > 0`

This value sets an upper limit on the time spent attempting to establish a connection, including (if the initial attempt fails) at least one additional attempt.

After the time limit that INFORMIXCONTIME specifies has been exceeded, or if no connection with another database server has been established after (*integer_R* + 1) attempts, for *integer_R* the INFORMIXCONRETRY setting, the CONNECT statement or the implicit connection fails, and the database server returns an error. By setting the INFORMIXCONTIME and INFORMIXCONRETRY session environment variables to configure your sever-to-server connection capability in the current session, you can minimize connection errors. To estimate the optimal value for INFORMIXCONTIME, take into account the total distance between nodes, the hardware speed, the volume of traffic, and the concurrency level of the network.

Order of precedence for time limits on connections

This is the ascending order of precedence (lowest to highest) among the methods for setting an upper limit on the amount of time that a CONNECT statement can spend attempting to connect to a database server instance:

- System default value of 60 seconds, if none of the methods below are set.
- INFORMIXCONTIME configuration parameter
- INFORMIXCONTIME client environment variable
- SET ENVIRONMENT INFORMIXCONTIME statement of SQL.

The INFORMIXCONTIME session environment option can override the setting of the client **INFORMIXCONTIME** environment variable, or of the INFORMIXCONTIME configuration parameter, or of the system default value, if any of these has established a time limit different from the SET ENVIRONMENT INFORMIXCONTIME value.

Setting session environment options for connections

The value of the INFORMIXCONTIME session environment option is divided by the value of the INFORMIXCONRETRY session environment option to determine the maximum number of seconds between successive connection attempts, if the previous attempt of the same CONNECT statement failed to establish a connection.

For example, the following statements set INFORMIXCONTIME to 60 seconds and INFORMIXCONRETRY to one retry:

```

SET ENVIRONMENT INFORMIXCONTIME '60';
SET ENVIRONMENT INFORMIXCONRETRY '1';

```

In this example, the CONNECT statement attempts to establish a connection for 60 seconds. An initial attempt is made to connect to the database server at 0 seconds. If the INFORMIXCONTIME session environment option is set to the default value of '0', an additional attempt to connect is made within 60 seconds, if necessary, before connection failure error -908 is returned.

Similarly, you can configure these session environment options for multiple retries. With the same INFORMIXCONTIME setting, the following statement specifies three additional retries:

```

SET ENVIRONMENT INFORMIXCONRETRY '3';

```

If INFORMIXCONRETRY is set to '3', up to three additional attempts to connect to the database server are made (at 20, 40, and 60 seconds, if necessary), before an error is returned.

This 20-second interval is the result of dividing the INFORMIXCONTIME value by the INFORMIXCONRETRY value.

If you set the INFORMIXCONTIME session environment option to '0', as in this example,

```

SET ENVIRONMENT INFORMIXCONTIME '0';

```

the database server automatically uses the setting of the INFORMIXCONTIME configuration parameter. If the INFORMIXCONTIME parameter is not set, its default value of 60 seconds is used during subsequent CONNECT statements in the session.

Implicit connections with database statements

If the CONNECT statement does not begin your application, its first SQL statement must either be one of the following *database statements*, or else be a single-statement prepared object for one of the same statements:

- DATABASE
- CREATE DATABASE
- DROP DATABASE

If one of these statements, rather than the `CONNECT` statement, is the first SQL statement in an application, that database statement can establish a connection to a database server that is known as an *implicit* connection, because no `CONNECT` statement in the session has established an explicit connection. To establish the implicit connection, a database statement must specify one of the following, either as an SQL identifier or as the content of a variable:

- a database server and a database,
- or a database server only,
- or a database only.

If the database statement specifies only a database, the database server obtains a database server name from the **DBPATH** environment variable setting. For more information on establishing implicit connections in UNIX or Windows environments, see the topic [Specifying the Database Environment](#). If you issue the CONNECT statement after the application establishes an implicit connection with only a database name, the CONNECT statement must search **DBPATH** to identify the database server for that database. For this search, the INFORMIXCONRETRY session environment option specifies the number of additional connection attempts that can be made for each database server entry in **DBPATH**.

- All appropriate servers in the DBPATH setting are accessed at least once, even if the INFORMIXCONTIME value is exceeded. In this context, the CONNECT statement might take longer than the INFORMIXCONTIME time limit to return an error that indicates a connection failure, or indicating that the database was not found.
- The INFORMIXCONTIME value is divided among the number of database server entries that are specified in DBPATH. Thus, if DBPATH contains numerous servers, you can use the SET ENVIRONMENT INFORMIXCONTIME statement to increase the INFORMIXCONTIME value accordingly. For example, if DBPATH contains three entries, in order to spend at least 30 seconds attempting each connection, set INFORMIXCONTIME to '90'.

```
SET ENVIRONMENT INFORMIXCONTIME '90';
```

Related information:

[INFORMIXCONTIME environment variable](#)
[INFORMIXCONTIME configuration parameter](#)

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NOVALIDATE session environment option

Use the `NOVALIDATE` environment option to specify whether a foreign-key or check constraint that the `ALTER TABLE ADD CONSTRAINT` statement creates, or that has its constraint mode reset by the `SET CONSTRAINTS` statement, are in `NOVALIDATE` mode by default. The `NOVALIDATE` setting has no effect, however, on `ADD CONSTRAINT` or `SET CONSTRAINT` operations that specify `DISABLED` mode.

NOVALIDATE environment option

```
|--SET ENVIRONMENT NOVALIDATE--+--+ '1' +--+-----+
                                     | 'ON--' |
                                     +--+ '0' +--+
                                     'OFF-'
```

Usage

Enabling this session environment variable can prevent referential-integrity checking of the foreign-key constraint or checking the condition of the check constraint during these subsequent SQL statements:

- ALTER TABLE ADD CONSTRAINT
- SET CONSTRAINTS ENABLED
- SET CONSTRAINTS FILTERING

Bypassing validation during these data definition language (DDL) operations can improve the performance of the database server in contexts where there is no reason to expect integrity or check condition violations, or where validation of constraints can be postponed until after the tables are relocated to another database.

To set the NOVALIDATE session environment variable, specify one of these values:

'1' or ON

You do not need to explicitly include the `NOVALIDATE` keyword to bypass validation of the `ENABLED` or `FILTERING` constraint while either of those DDL statements is running.

'0' or OFF

This restores the default behavior of those DDL statements, so that the database server automatically checks the table for constraint violations during the ALTER TABLE or SET CONSTRAINTS operation that created or enabled the constraint.

Note: Whether or not the SET ENVIRONMENT NOVALIDATE session environment option is enabled, any NOVALIDATE attribute that the ALTER TABLE ADD CONSTRAINT statement or the SET CONSTRAINTS option of the SET Database Object Mode statement applied to the object mode of a constraint is automatically dropped after execution of that DDL statement completes. The mode of the constraint becomes whatever the SET CONSTRAINTS or ALTER TABLE statement registered in the **sysobjstate** system catalog table, which ignores the NOVALIDATE attribute.

While you are creating **ENABLED** or **FILTERING** constraints with the **ALTER TABLE ADD CONSTRAINT** statement, or changing the mode of a constraint to **ENABLED** or **FILTERING** with the **SET CONSTRAINTS** statement, the **NOVALIDATE** option prevents the database server from checking for constraint violations while the **ALTER TABLE** or **SET CONSTRAINTS** statement is running. That can save significant time in moving large tables.

For example, the following statement enables the NOVALIDATE session environment variable:

```
SET ENVIRONMENT NOVALIDATE '1';
```

It has these subsequent effects during the following DDL operations on foreign-key or check constraints in the database to which the current session is connected:

- SET CONSTRAINTS options of the SET Database Object Mode statements for constraints change the default or explicit constraint mode to include NOVALIDATE, unless DISABLED is specified as the constraint mode.
- Constraints that the ALTER TABLE ADD CONSTRAINT statement specifies with no explicit mode are created in ENABLED NOVALIDATE mode by default.
- Constraints that the ALTER TABLE ADD CONSTRAINT statement specifies in ENABLED or in FILTERING mode are also in NOVALIDATE mode by default.

The following example restores the default constraint mode behavior:

```
SET ENVIRONMENT NOVALIDATE OFF;
```

For subsequent SET CONSTRAINTS or ALTER TABLE ADD CONSTRAINT statements that omit the NOVALIDATE keyword from the object mode of a constraint, the database server validates the referential integrity or check conditions of the table by performing a full-table scan or an index scan. For tables with a million rows, for example, the cost of this validation is substantial.

Suspending constraint-checking during SET CONSTRAINTS or ALTER TABLE ADD CONSTRAINT statements by enabling the NOVALIDATE session environment option can be efficient for tables that have been populated by OLTP operations that enforced the same constraints. After moving those tables to another database or to a data warehouse with their constraints dropped or disabled, you can use the SET ENVIRONMENT NOVALIDATE ON statement to avoid the overhead of checking for violations while the constraints are being restored.

Examples of setting NOVALIDATE

Like all SQL keywords, the ON and OFF settings are case insensitive.

Double (") and single (') quotation marks are both valid as delimiters for the "1" and "0" settings, but both delimiters of a numeric setting must be the same.

For example, to make NOVALIDATE a default keyword in subsequent DDL operations setting the mode of constraints within the scope of this session environment option, use any of the following statements:

```
SET ENVIRONMENT NOVALIDATE '1';
SET ENVIRONMENT NOVALIDATE ON;
SET ENVIRONMENT NOVALIDATE "1";
SET ENVIRONMENT NOVALIDATE on;
```

Similarly, each of the following statements restores the default behavior that requires the explicit NOVALIDATE keyword in SQL operations that create or reset the mode of a constraint without checking:

```
SET ENVIRONMENT NOVALIDATE '0';
SET ENVIRONMENT NOVALIDATE OFF;
SET ENVIRONMENT NOVALIDATE "0";
SET ENVIRONMENT NOVALIDATE off;
```

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OPTCOMPIND session environment option

Use the OPTCOMPIND session environment option of the SET ENVIRONMENT statement to specify methods for the query optimizer to choose in join queries and MERGE statements of the currently executing routine.

The SET ENVIRONMENT OPTCOMPIND statement of SQL supports the following syntax:

```
OPTCOMPIND environment option

|--SET ENVIRONMENT OPTCOMPIND--+-'0'-----+-----+-----+-----+-----+
                                +- '1'-----+
                                +- '2'-----+
                                '-DEFAULT-'
```

Usage

The OPTCOMPIND environment option can improve the performance of databases that are used for both decision support and online transaction processing. Use this option to specify join methods for the query optimizer to use in queries of the same routine.

'0' or "0"

The query optimizer uses a nested-loop join where possible, rather than a sort-merge join or a hash join

'1' or "1"

If the transaction isolation level is Repeatable Read, the optimizer behaves as in setting '0', as described above; for any other isolation level, it behaves like setting '2', as described next.

'2' or "2"

The query optimizer does not necessarily prefer nested-loop joins, but bases its decision entirely on the estimated cost, regardless of the transaction isolation mode.

DEFAULT

This keyword restores the system default value, as described in the **OPTCOMPIND** topic of the *IBM® Informix® Guide to SQL: Reference*

Any numeric setting of the SET ENVIRONMENT OPTCOMPIND statement can override the default setting of the **OPTCOMPIND** environment variable while the routine that issues this statement is running in the current session.

That is, the scope of this session environment setting is local to the routine that issues the SET ENVIRONMENT OPTCOMPIND statement. That setting persists only until the routine exits, or until the same routine issues another SET ENVIRONMENT OPTCOMPIND statement, rather than persisting for the entire session. After

that routine terminates, the setting reverts to the system default value that the **OPTCOMPIND** environment variable specifies, or else the value set by another method in the order of precedence described below in this topic.

Important:

No other option to SET ENVIRONMENT has a scope that is local to the routine that sets the value. The settings of all the other SET ENVIRONMENT options persist until the session ends, or until another SQL statement in the same session resets their value.

The system default value of OPTCOMPIND

This is the descending order of precedence for the default OPTCOMPIND value, from highest to lowest, if conflicting values have been set by different methods:

- the **OPTCOMPIND** environment variable setting
- OPTCOMPIND configuration parameter setting, if **OPTCOMPIND** is not set
- 2, if neither of the above are set.

Examples of resetting OPTCOMPIND

The following statement replaces the default setting with a purely cost-based optimizer strategy:

```
SET ENVIRONMENT OPTCOMPIND '2';
```

The following statement has the same effect as the previous example, unless transaction isolation level is Repeatable Read:

```
SET ENVIRONMENT OPTCOMPIND '1';
```

If isolation level is Repeatable Read, the query optimizer chooses index scans. This is the recommended setting for Repeatable Read, because it reduces the risk of lock contention among connections when hash-join execution paths set temporary locks on all records of joined tables.

The next example makes the query optimizer prefer nested-loop joins over other possible join methods:

```
SET ENVIRONMENT OPTCOMPIND "0";
```

If a routine has set the OPTCOMPIND session environment option to a numeric value appropriate for the next join query, after that transaction completes, the same routine can issue the following statement to restore the system default value:

```
SET ENVIRONMENT OPTCOMPIND DEFAULT;
```

For more information about the different join methods that the optimizer can choose, and the performance implications of the OPTCOMPIND session environment setting, see your *IBM Informix Performance Guide*.

For more information about the OPTCOMPIND configuration parameter, see your *IBM Informix Administrator's Reference*.

For more information about the **OPTCOMPIND** environment variable, see your *IBM Informix Guide to SQL: Reference*.

Related information:

[OPTCOMPIND environment variable](#)

[Influencing the choice of a query plan](#)

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RETAINUPDATELOCKS session environment option

The RETAINUPDATELOCKS environment option can improve concurrency in Dynamic SQL applications that include the SELECT ... FOR UPDATE statement. This option can modify the behavior of the current transaction isolation level at runtime if the session is using the Committed Read, Dirty Read, or Cursor Stability isolation levels to enable (or to disable) the RETAIN UPDATE LOCKS clause of the SET ISOLATION statement.

The RETAINUPDATELOCKS session environment option supports the following syntax:

```
RETAINUPDATELOCKS session environment option

|--SET ENVIRONMENT RETAINUPDATELOCKS -'---+COMMITTED READ-----'--|
                                     +-CURSOR STABILITY-+
                                     +-DIRTY READ-----+
                                     +-ALL-----+
                                     '-NONE-----'
```

Usage

The RETAINUPDATELOCKS option accepts any one of five settings that can affect the current Informix® isolation level, as well as the isolation levels established by SET ISOLATION statements issued after the SET ENVIRONMENT statement. For every setting except 'NONE', the effect of the setting is to implicitly include the RETAIN UPDATE LOCKS keywords in SET ISOLATION specifications:

'COMMITTED READ'

The database server retains any update lock until the end of a transaction that uses the Committed Read isolation level.

'CURSOR STABILITY'

The database server retains any update lock until the end of a transaction that uses the Cursor Stability isolation level.

'DIRTY READ'

The database server retains any update lock until the end of a transaction that uses the Dirty Read isolation level.

'ALL'

The database server retains any update lock until the end of the transaction that uses the Committed Read, Dirty Read, or Cursor Stability isolation level.

'NONE'

the RETAINUPDATELOCKS feature is disabled until the session ends, or until another SET ISOLATION or SET ENVIRONMENT statement re-enables the retention of update locks. Under the NONE setting, if your application defines an update cursor, the database server releases its update locks at the next FETCH operation, or when the update cursor is closed. Update locks are not retained, even if the Committed Read, Dirty Read, or Cursor Stability isolation level had enforced RETAIN UPDATE LOCKS behavior before the SET ENVIRONMENT RETAINUPDATELOCKS 'NONE' statement executed.

When the RETAINUPDATELOCKS environment option is enabled for the current isolation level, the database server, by default, retains the update lock on a row until the end of the transaction. Any update locks are held until the transaction is committed or rolled back, whether or not the SET ISOLATION statement that defined the isolation level included the RETAIN UPDATE LOCKS keywords. When this option is set to ALL or to the name of the current Informix isolation level (if this level is Committed Read, Dirty Read, or Cursor Stability), this setting prevents concurrent users in other sessions from deleting or updating a row on which you have placed an update lock, but that you have not yet updated.

By specifying NONE as the RETAINUPDATELOCKS setting, you disable this feature and restore the default locking behavior. When NONE is the setting, unless the isolation level has been set by a SET ISOLATION statement that explicitly included the RETAIN UPDATE LOCKS keywords, the database server releases the update lock at the next FETCH operation, or when the cursor is closed.

The SET ENVIRONMENT RETAINUPDATELOCKS statement has no effect on update cursors if the Informix isolation level is REPEATABLE READ. Similarly out of scope are transactions whose isolation level has been set by the SET TRANSACTION statement, which defines ANSI/ISO-compliant isolation levels, rather than Informix isolation levels. (For more information about Informix and ISO isolation levels, see the topic [Comparing SET TRANSACTION with SET ISOLATION](#).)

Like other SET ENVIRONMENT options, these settings are not case-sensitive, but they require single (') or double (") quotation marks as delimiters. For example, the settings 'ALL' and 'all' and "aLl" and "aLl" have the same effect.

Examples of setting RETAINUPDATELOCKS

The SET ENVIRONMENT RETAINUPDATELOCKS statement takes effect (by resetting the session environment) when it is issued. It can be issued outside a transaction. If the isolation level of the current transaction matches the setting specified after the RETAINUPDATELOCKS keyword, the new setting can change the RETAIN UPDATE LOCKS behavior of the transaction that is running when the statement is issued.

For example, consider the following SET ENVIRONMENT and SET ISOLATION statements:

```
BEGIN WORK; --Begin first transaction
SET ENVIRONMENT RETAINUPDATELOCKS 'COMMITTED READ';
SET ISOLATION TO COMMITTED READ LAST COMMITTED;
SELECT ... FOR UPDATE ...
...
COMMIT WORK;
SET ENVIRONMENT RETAINUPDATELOCKS 'DIRTY READ';
BEGIN WORK; --Begin second transaction
SET ISOLATION TO COMMITTED READ LAST COMMITTED;
SELECT ... FOR UPDATE ...
...
COMMIT WORK;
```

In the first transaction above, the RETAINUPDATELOCKS setting in the SET ENVIRONMENT statement makes the retention of update locks the default behavior for the Committed Read isolation level. As a result, the database server interprets the first SET ISOLATION statement, which specifies Committed Read but has no RETAIN UPDATE LOCKS clause, as if it had included that clause:

```
SET ISOLATION TO
READ LAST COMMITTED RETAIN UPDATE LOCKS;
```

Because the SET ENVIRONMENT RETAINUPDATELOCKS statement in the second transaction specifies DIRTY READ as its setting, however, it has no effect on the second SET ISOLATION statement, which defines a Committed Read isolation level. Each of the settings that correspond to a specific Informix isolation level only affect update locks in transactions that use the same isolation level.

If your goal is to enable retention of update locks in the Dirty Read isolation level, this is a more appropriate example than the second transaction above:

```
SET ENVIRONMENT RETAINUPDATELOCKS 'DIRTY READ';
BEGIN WORK; --Begin third transaction
SET ISOLATION TO DIRTY READ;
SELECT ... FOR UPDATE ...
...
COMMIT WORK;
```

In the third transaction, the database server interprets the SET ISOLATION TO DIRTY READ statement, which matches the SET ENVIRONMENT isolation level of Dirty Read, but has no RETAIN UPDATE LOCKS clause, as if it had included that clause:

```
SET ISOLATION TO DIRTY READ RETAIN UPDATE LOCKS;
```

In cross-server SELECT ... FOR UPDATE distributed queries, but some participating servers do not support update lock retention, the entire transaction conforms to the isolation level of the session that issued the transaction. If that session has an enabled RETAINUPDATELOCKS option in effect, it is also in effect for the servers that support update lock retention, but other participating servers follow their default behavior for releasing update locks.

The SET ENVIRONMENT RETAINUPDATELOCKS statement fails with error -26199 if the database in which it is issued does not support transaction logging.

Setting RETAINUPDATELOCKS in the sysdbopen() procedure

For a user, for a role, or for the PUBLIC group, the built-in **sysdbopen()** routine can issue the SET ENVIRONMENT RETAINUPDATELOCKS statement when the session connects to a database in which **sysdbopen()** is defined, as in the following example.

```
CREATE PROCEDURE PUBLIC.SYSDBOPEN()
SET PDQPRIORITY 10;
SET ENVIRONMENT RETAINUPDATELOCKS 'ALL';
END PROCEDURE
```

After the example above takes effect, it prevents other sessions from modifying rows on which you have placed an update lock, so that you can update the rows later in the current transaction. Unless you issue another SQL statement within the same session to disable the retention of update locks, the effects of a SET ENVIRONMENT RETAINUPDATELOCKS statement that **sysdbopen()** issues persists until the end of the session.

This session-long persistence of the RETAINUPDATELOCKS value that **sysdbopen()** specifies, however, is a special case. Any other SPL routine can use the SET ENVIRONMENT statements to specify update lock retention for the Committed Read, Dirty Read, or Cursor Stability transaction isolation level, or for 'ALL', but their effect persists only while the routine is executing, and not after the routine exits.

Restoring the default update lock behavior

In releases of Informix earlier than version 11.50.xC6, the most recently executed SET ISOLATION statement specified the default for subsequent transactions. If the most recent SET ISOLATION statement included the RETAIN UPDATE LOCKS clause, it was necessary to execute the SET ISOLATION statement for the same isolation level (but without the RETAIN UPDATE LOCKS clause) to disable the retention of update locks.

In this release, however, if SET ENVIRONMENT RETAINUPDATELOCKS has enabled retention, you must explicitly run the SET ENVIRONMENT RETAINUPDATELOCKS 'NONE' statement to restore non-retention as the default behavior, as in the following example.

```
BEGIN WORK; --Begin first transaction
SET ISOLATION TO COMMITTED READ LAST COMMITTED;
SET ENVIRONMENT RETAINUPDATELOCKS 'COMMITTED READ';
SELECT ... FOR UPDATE ...
...
COMMIT WORK;
BEGIN WORK; --Begin second transaction
SET ENVIRONMENT RETAINUPDATELOCKS 'NONE';
SET ISOLATION TO COMMITTED READ LAST COMMITTED;
SELECT ... FOR UPDATE ...
...
```

In the first transaction above, the first SET ENVIRONMENT statement modifies the behavior of the Committed Read isolation level of the current transaction to retain update locks, even though the SET ISOLATION statement that established that isolation level preceded the SET ENVIRONMENT statement in the lexical order of statements within the transaction. The LAST COMMITTED specification for this isolation level is not affected by this SET ENVIRONMENT statement.

The SET ISOLATION statement in the second transaction is interpreted literally, however, because the default behavior was reset to NONE by the second SET ENVIRONMENT statement.

Update lock retention in High Availability Clusters

In a high availability cluster environment, the RETAINUPDATELOCKS option is valid only on a primary server. Applications that require the retention of update locks must be run on the primary server if they include the SET ENVIRONMENT RETAINUPDATELOCKS statement. When it is issued from a secondary server, the statement has no effect on locking behavior, and the server returns an error.

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SELECT_GRID session environment option

Use the SELECT_GRID option of the SET ENVIRONMENT statement to define a default GRID clause for grid queries. This clause specifies a default grid or region from which to return a result set equivalent to logical UNION of qualifying rows from participating grid servers.

```
SELECT_GRID environment option

|--SET ENVIRONMENT SELECT_GRID -+-'grid'-----|
+-'region'--+
'-DEFAULT--'
```

Element	Description	Restrictions	Syntax
<i>grid</i>	Name of a default grid for queries with no GRID clause	The <i>grid</i> must exist	Identifier
<i>region</i>	Name of a default region for queries with no GRID clause	The <i>region</i> must exist	Identifier

Usage

The SELECT_GRID session environment option can be set to any of three values:

'grid'

This specifies the default *grid* from which SELECT statements that include no GRID clause can return a result set that is the logical UNION of distinct qualifying rows from all of the participating *grid* servers in the specified *grid*. While the SELECT_GRID option of the SET ENVIRONMENT statement is set to the name of a grid, the database server that issued the SET ENVIRONMENT SELECT_GRID '*grid*' statement interprets all queries as UNION *grid* queries.

'region'

This specifies the default region from which SELECT statements that include no GRID clause can return a result set that is the logical UNION of distinct qualifying values from all of the participating grid servers in the specified region. While the SELECT_GRID option of the SET ENVIRONMENT statement is set to the name of a region, the database server that issued the SET ENVIRONMENT SELECT_GRID 'region' statement interprets all queries as UNION grid queries.

DEFAULT

This setting specifies the default behavior that requires an explicit GRID clause. While the SELECT_GRID option of the SET ENVIRONMENT statement is set to DEFAULT, the database server does not process every query that has no GRID clause as a grid query. That is, the DEFAULT setting specifies that there is no default GRID clause for SELECT statements. Use this option to disable the effects of a previous SET ENVIRONMENT SELECT_GRID or SET ENVIRONMENT SELECT_GRID_ALL statement in the same session that defined a default GRID clause for all queries that include no GRID clause.

Unlike the SELECT_GRID_ALL option, the SELECT_GRID setting enables subsequent queries that include no GRID clause to behave as grid queries that return distinct values.

The SELECT_GRID and the SELECT_GRID_ALL options of the SET ENVIRONMENT statement are mutually exclusive. After you issue the SET ENVIRONMENT SELECT_GRID or SET ENVIRONMENT SELECT_GRID_ALL statement, issuing a different option of either statement in the same session replaces whatever the previous SET ENVIRONMENT SELECT_GRID or SET ENVIRONMENT SELECT_GRID_ALL statement established as the server behavior for grid queries in the session.

Restrictions on SELECT_GRID

Do not call the `ifx_gridquery_skipped_nodes()` function while the SELECT_GRID session environment variable is set to 'grid' or to 'region'.

The SELECT_GRID session environment option should not be set to 'grid' or to 'region' outside a grid context.

Examples of setting SELECT_GRID

The following statement establishes a default grid called **inverness** for the current session, and instructs the database server to interpret all queries that include no GRID clause as UNION grid queries for that grid:

```
SET ENVIRONMENT SELECT_GRID "inverness";
```

If **cawdor** were the name of a region in the **inverness** grid, the next example would instruct the database server to interpret all queries that include no GRID clause as UNION grid queries for the **cawdor** region, rather than having the entire **inverness** grid as their scope:

```
SET ENVIRONMENT SELECT_GRID "cawdor";
```

The following example overrides the effect of any previous SET ENVIRONMENT SELECT_GRID statement that established a default grid or a default region, and an implicit UNION operator, as the scope of subsequent queries that include no GRID clause:

```
SET ENVIRONMENT SELECT_GRID DEFAULT;
```

The statement above restores the default behavior for processing queries in the session, so that the database interprets only SELECT statements that explicitly include the GRID clause as grid queries.

For more information about grid queries, see the [GRID clause](#) and the .

Related reference:

[SELECT_GRID_ALL session environment option](#)

[GRID clause](#)

Related information:

[ifx_grid_connect\(\) procedure](#)

[cdr remaster gridtable](#)

[ifx_grid_release\(\) function](#)

[ifx_grid_remove\(\) function](#)

[Examples of grid queries](#)

[Grid queries](#)

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SELECT_GRID_ALL session environment option

Use the SELECT_GRID_ALL option of the SET ENVIRONMENT statement to define a default GRID clause for subsequent grid queries in the session. This clause specifies a default grid or region from which to return a result set equivalent to a logical UNION ALL of qualifying rows from participating grid servers.

SELECT_GRID_ALL environment option

```
|--SET ENVIRONMENT SELECT_GRID_ALL --+ 'grid'-----|
                                     +- 'region'--+
                                     '-DEFAULT--'
```

Element	Description	Restrictions	Syntax
<i>grid</i>	Name of a default grid for queries with no GRID clause	The <i>grid</i> must exist	Identifier
<i>region</i>	Name of a default region for queries with no GRID clause	The <i>region</i> must exist	Identifier

Usage

The `SELECT_GRID_ALL` session environment option can be set to any of three values:

'grid'

This specifies the default grid from which `SELECT` statements that include no `GRID` clause can return a result set that is the logical `UNION ALL` of qualifying rows, including duplicates, from all of the participating grid servers in the specified *grid*. While the `SELECT_GRID` option of the `SET ENVIRONMENT` statement is set to the name of a grid, the database server that issued the `SET ENVIRONMENT SELECT_GRID_ALL 'grid'` statement interprets all queries as `UNION ALL` grid queries.

'region'

This specifies the default region from which `SELECT` statements that include no `GRID` clause can return a result set that is the logical `UNION ALL` of qualifying values, including duplicates, from all of the participating grid servers in the specified region. While the `SELECT_GRID` option of the `SET ENVIRONMENT` statement is set to the name of a region, the database server that issued the `SET ENVIRONMENT SELECT_GRID_ALL 'region'` statement interprets all queries as `UNION ALL` grid queries.

`DEFAULT`

This setting specifies the default behavior. While the `SELECT_GRID_ALL` option of the `SET ENVIRONMENT` statement is set to `DEFAULT`, the database server does not process every query that has no `GRID` clause as a grid query. Thus, the `DEFAULT` setting specifies that there is no default `GRID` clause for `SELECT` statements. Use this option to disable the effects of a previous `SET ENVIRONMENT SELECT_GRID` or `SET ENVIRONMENT SELECT_GRID_ALL` statement that defined a default `GRID` clause for all queries that include no `GRID` clause.

Unlike the `SELECT_GRID` option, the `SELECT_GRID_ALL` setting enables subsequent queries that include no `GRID` clause to behave as grid queries that return duplicate values.

The `SELECT_GRID_ALL` and the `SELECT_GRID` options of the `SET ENVIRONMENT` statement are mutually exclusive. After you issue the `SET ENVIRONMENT SELECT_GRID_ALL` or `SET ENVIRONMENT SELECT_GRID` statement, issuing a different option of either statement in the same session replaces whatever the previous `ENVIRONMENT SELECT_GRID_ALL` or `SET ENVIRONMENT SELECT_GRID` statement established as the server behavior for grid queries in the session.

Restrictions on `SELECT_GRID_ALL`

Do not call the `ifx_gridquery_skipped_nodes()` function while the `SELECT_GRID_ALL` session environment variable is set to *'grid'* or to *'region'*.

The `SELECT_GRID_ALL` session environment option should not be set to *'grid'* or to *'region'* outside a grid context.

Examples of setting `SELECT_GRID_ALL`

The following statement establishes a default grid called **escorial** for the current session, and instructs the database server to interpret all queries that include no `GRID` clause as `UNION ALL` grid queries for that grid:

```
SET ENVIRONMENT SELECT_GRID_ALL "escorial";
```

If **california** were the name of a region in the **escorial** grid, the next example would instruct the database server to interpret all queries that include no `GRID` clause as `UNION ALL` grid queries for the **california** region, rather than having the entire **escorial** grid as their scope:

```
SET ENVIRONMENT SELECT_GRID_ALL "california";
```

The following example overrides the effect of any previous `SET ENVIRONMENT SELECT_GRID_ALL` statement that established a default grid or a default region, and an implicit `UNION ALL` operator, as the scope of subsequent queries that include no `GRID` clause:

```
SET ENVIRONMENT SELECT_GRID_ALL DEFAULT;
```

The statement above restores the default behavior for processing queries in the session, so that the database interprets only `SELECT` statements that explicitly include the `GRID` clause as grid queries.

For more information about grid queries, see the [GRID clause](#) and the .

Related reference:

[SELECT_GRID session environment option](#)

[GRID clause](#)

Related information:

[ifx_grid_connect\(\) procedure](#)

[cdr remaster gridtable](#)

[ifx_grid_release\(\) function](#)

[ifx_grid_remove\(\) function](#)

[Examples of grid queries](#)

[Grid queries](#)

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STATCHANGE session environment option

Use the `STATCHANGE` environment option to specify a positive integer as a global percentage-of-change threshold for `UPDATE STATISTICS` operations in automatic mode. The setting restricts automatic `UPDATE STATISTICS` operations to stale or missing distributions in which at least that percentage of rows have changed since statistics were updated.

You can specify an integer percentage value in the range from 1 to 100 for the `STATCHANGE` session environment option, which has this syntax:

STATCHANGE environment option

```
|--SET ENVIRONMENT STATCHANGE--+-DEFAULT-----+-----|  
      '- 'integer' -'
```

Element	Description	Restrictions	Syntax
<i>integer</i>	An unsigned integer value in the range 1 - 100 as a percentage of rows changed in a table or fragment since the most recent recalculation	Must be delimited between single (') or double (") quotation marks. The DEFAULT keyword applies the current STATCHANGE configuration parameter value.	Literal Number as Quoted String

Usage

When automatic UPDATE STATISTICS operations are enabled, the database server can reset the value of the STATCHANGE session environment option as the threshold for recalculating distribution statistics in the current session when your SET ENVIRONMENT STATCHANGE statement specifies one of these values:

'integer' or *"integer"*

Sets a data-change threshold, as a percentage of rows modified since distribution statistics were calculated, for automatic UPDATE STATISTICS operations on tables or fragments. The *integer* value (where '1' ≤ '*integer*' ≤ '100') has no effect, however, except when the automatic statistics mode has been enabled by one of the mechanisms identified below at one of the following scopes:

- the UPDATE STATISTICS statement, if it includes the **AUTO** keyword
- the session, if the AUTO_STAT_MODE session option is **ON**
- the system default, if the AUTO_STAT_MODE configuration setting is 1
- for the table, if its STATCHANGE table attribute is **AUTO**.

If the UPDATE STATISTICS statement includes the **FORCE** keyword, however, these STATCHANGE settings and attributes are ignored, and table statistics are recalculated, even if the most recently calculated distribution statistics for the table in the system catalog have not been changed by subsequent DML operations.

DEFAULT

Applies the current setting of the AUTO_STAT_MODE configuration parameter to the current session. This automatic location and fragmentation during the current session.

- for all sessions, when the AUTO_STAT_MODE configuration parameter has enabled the automatic mode,
- or for only the current session, when the SET ENVIRONMENT AUTO_STAT_MODE statement of SQL has enabled the automatic mode.

Automatic UPDATE STATISTICS mode

In automatic mode, the database server selectively recalculates distribution statistics that already exist in the **sysdistrib** or **sysfragdist** system catalog tables only for stale distributions. The value that you set for STATCHANGE specifies criteria for determining whether the column distribution statistics of a table or a fragment qualify for an update.

When UPDATE STATISTICS is in automatic mode, but the STATCHANGE session environment option is not set, or is set to **DEFAULT**, the explicit or default setting of the STATCHANGE configuration parameter can specify a positive integer as a threshold to define stale data distributions. If the STATCHANGE configuration parameter is not set, the default value is 10. The database server compares this threshold to the actual percentage of rows that have been deleted, inserted, or modified by DML operations since the distribution statistics were most recently updated. Only if the actual percentage is equal to or greater than the threshold are distributions recalculated automatically.

You can use the SET ENVIRONMENT STATCHANGE statement, however, to specify an integer value that overrides the explicit or default STATCHANGE configuration parameter setting for the current session.

Examples of SET ENVIRONMENT STATCHANGE

The following statement sets a threshold of 50 percent for the database server to use in determining if distribution statistics qualify for an update:

```
SET ENVIRONMENT STATCHANGE '50';
```

With a STATCHANGE threshold of 50 for the session, when automatic UPDATE STATISTICS operations are enabled, the column distributions of a table or fragment are recalculated only if half of all the rows have been processed by DML operations since the current values in the **sysdistrib** or **sysfragdist** system catalog tables were calculated.

Whether the granularity of distributions to be calculated in automatic mode is the entire table or is some of its fragments depends on the current STATLEVEL setting for the table, as described in the topics [Statistics options of the CREATE TABLE statement](#) and [Statistics options of the ALTER TABLE statement](#).

The following statement sets the threshold for the server to use to determine if distribution statistics qualify for an update to the current setting of the STATCHANGE configuration parameter:

```
SET ENVIRONMENT STATCHANGE DEFAULT;
```

You might use the **DEFAULT** option to restore a STATCHANGE threshold that the SET ENVIRONMENT STATCHANGE statement had reset because the session required an unusual STATCHANGE value for automatic UPDATE STATISTICS operations on a specific table.

The next example includes successive SQL statements that can affect whether distribution statistics are recalculated for the **customer** table:

```
SET ENVIRONMENT AUTO_STAT_MODE ON;  
SET ENVIRONMENT STATCHANGE '25';  
UPDATE STATISTICS HIGH FOR customer FORCE;
```

In this example,

- The first statement enables automatic statistics mode for the session.
- The second statement sets the change threshold at 25% for the current session.
- The UPDATE STATISTICS statement ignores the STATCHANGE setting for the session, and ignores the percentage of modified rows in the **customer** table, because the **FORCE** keyword requires the database server to recalculate distribution statistics for all columns in that table.

See also the topic [AUTO_STAT_MODE session environment option](#).

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USELASTCOMMITTED session environment option

The USELASTCOMMITTED session environment option can improve concurrency in sessions that use the Committed Read, Dirty Read, Read Committed, or Read Uncommitted isolation levels by reducing the risk of locking conflicts when two or more sessions attempt to access the same row in a table whose locking granularity is row-level locking.

The SET ENVIRONMENT USELASTCOMMITTED statement of SQL supports the following syntax:

```
USELASTCOMMITTED session environment option

|--SET ENVIRONMENT USELASTCOMMITTED -'---COMMITTED READ---'|
                                     +-DIRTY READ-----+
                                     +-ALL-----+
                                     '-NONE-----'
```

Usage

The SET ENVIRONMENT USELASTCOMMITTED statement can specify whether queries and other operations that encounter exclusive locks that other sessions hold while changing data values should use the most recently committed version of the data, rather than wait for the lock to be released.

This statement can override the USELASTCOMMITTED configuration parameter setting for the duration of the current session. You can use the SET ISOLATION statement to override the USELASTCOMMITTED session environment setting.

The USELASTCOMMITTED session environment option can have any one of four values:

'COMMITTED READ'

The database server reads the most recently committed version of the data when it encounters an exclusive lock while attempting to read a row in the Committed Read or Read Committed isolation level.

'DIRTY READ'

The database server reads the most recently committed version of the data if it encounters an exclusive lock while attempting to read a row in the Dirty Read or Read Uncommitted isolation level.

'ALL'

The database server reads the most recently committed version of the data if it encounters an exclusive lock while attempting to read a row in the Committed Read, Dirty Read, Read Committed, or Read Uncommitted isolation level.

'NONE'

This value disables the USELASTCOMMITTED feature that can access the last committed version of data in a locked row. Under this setting, if your session encounters an exclusive lock when attempting to read a row in the Committed Read, Dirty Read, Read Committed, or Read Uncommitted isolation level, your transaction cannot read that row until the concurrent transaction that holds the exclusive lock is committed or rolled back.

Examples of SET ENVIRONMENT USELASTCOMMITTED

The following statements specify the Committed Read isolation mode and replace the explicit or default USELASTCOMMITTED configuration parameter setting with a setting that reads the most recently committed version of the data in rows on which concurrent readers hold an exclusive lock:

```
SET ISOLATION COMMITTED READ;
SET ENVIRONMENT USELASTCOMMITTED 'ALL';
```

By including the following statements within a **PUBLIC.sysdbopen** or **user.sysdbopen** procedure, specify at connection time the Committed Read isolation mode and replace the explicit or default USELASTCOMMITTED configuration parameter setting with a setting that reads the most recently committed version of the data in tables on which concurrent readers hold an exclusive lock:

```
SET ENVIRONMENT USELASTCOMMITTED 'COMMITTED READ';
```

Besides **sysdbopen()**, any SPL routine can use these statements to specify the Committed Read Last Committed transaction isolation level during a session. These statements enable SQL operations that read data to use the last committed version when an exclusive lock is encountered during an operation that reads a table. This can avoid deadlock situations or other locking errors when another session is attempting to modify the same row or table. It does not reduce the risk of locking conflicts with other sessions that are writing to tables, or with concurrent DDL transactions that hold implicit or explicit locks on a user table or on a system catalog table.

In cross-server distributed queries, if the isolation level of the session that issued the query has the LAST COMMITTED isolation level option in effect, but one or more of the participating databases does not support this LAST COMMITTED feature, then the entire transaction conforms to the Committed Read or Dirty Read isolation level of the session that issued the transaction, without the LAST COMMITTED option enabled.

The next example enables the database server reads the most recently committed version in transactions where the isolation level is Dirty Read or Read Uncommitted:

```
SET ENVIRONMENT USELASTCOMMITTED 'DIRTY READ';
```

The following example disables the explicit or default USELASTCOMMITTED configuration parameter setting, so that in the Committed Read, Dirty Read, Read Committed, or Read Uncommitted isolation, DML operations that encounter exclusive locks during the session must wait until the lock is released before reading the last committed version of the row:

```
SET ENVIRONMENT USELASTCOMMITTED 'NONE';
```

Restrictions on the USELASTCOMMITTED option

This session environment option is designed for operations on tables that use a locking granularity of ROW. For operations on tables with a locking granularity of TABLE, the USELASTCOMMITTED setting does not reduce the risk of locking conflicts when concurrent processes attempt to access the same tables.

For information about additional restrictions that can prevent a transaction from reading the most recently committed data from a table locked by another transaction while USELASTCOMMITTED is enabled, see [The LAST COMMITTED Option to Committed Read](#).

For more information about the USELASTCOMMITTED configuration parameter, see your *IBM® Informix® Administrator's Reference*.

Related information:

[USELASTCOMMITTED configuration parameter](#)

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USE_SHARDING session environment option

The USE_SHARDING session environment option controls the scope of sharded queries.

The SET ENVIRONMENT USE_SHARDING statement of SQL supports the following syntax:

```
USE_SHARDING session environment option

|--SET ENVIRONMENT USE_SHARDING --+ON--+-----|
                                     '-OFF-'
```

Usage

When you enable the USE_SHARDING environment option, sharded queries run on all shard servers in the cluster. When the USE_SHARDING environment option is disabled, sharded queries are limited to the local database. For consistent sharded insert, update, and delete operations, sharded transactions are applied with the two phase commit protocol instead of being eventually consistent. Data is moved to the appropriate shard server before the transaction is committed. Consistent shard insert, update and delete operations also require that you set the SHARD_ID configuration parameter on each shard server.

You can automatically run the SET ENVIRONMENT USE_SHARDING statement when the session connects to a database by defining the **sysdbopen()** routine, for example:

```
CREATE PROCEDURE PUBLIC.SYSDBOPEN()
SET ENVIRONMENT USE_SHARDING ON;
END PROCEDURE
```

Related concepts:

[Session Configuration Procedures](#)

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SHARDJOIN_FALLBACK session environment option

Use SHARDJOIN_FALLBACK session environment option to create a local temporary table to pull the data from the shard participants.

The SET ENVIRONMENT SHARDJOIN_FALLBACK statement of SQL supports the following syntax:

```
SHARDJOIN_FALLBACK session environment option

|--SET ENVIRONMENT SHARDJOIN_FALLBACK --+ON--+-----|
                                     '-OFF-'
```

Usage

When you enable the SHARDJOIN_FALLBACK, IDS execute the sharded table joins by creating temporary tables locally and pull the data from the respective participants. This solution is sub-optimal but the query can be executed to its completion with out raising an error. The intention of this support is only to have a migration comfort and not an optimal scaling solution. The application might have to change their sharding scheme to match with the join criteria to achieve an optimal performance. Any other cases that can not be done even by the fallback mechanism are rejected.

USE_DWA session environment options

Use the USE_DWA session environment options of the SET ENVIRONMENT statement to control various aspects of workload analysis, data mart creation, and query acceleration by setting the database client environment for Informix® Warehouse Accelerator sessions. Each of the USE_DWA options has an effect only with Informix Warehouse Accelerator.

The USE_DWA options of the SET ENVIRONMENT statement have this syntax:

```
>>--SET ENVIRONMENT--use_dwa----->
```

```

      .-off-.
>--'---+-----+-----+accelerate--+on--+-----+-----+><
      | '-session--session_id-'      | .-on--.      | | | |
      | |                             | +--fallback--+off--+-----+ |
      | |                             | | .-stop--.      | |
      | |                             | +--probe--+start--+-----+ |
      | |                             | | .-off-.      | |
      | |                             | +--debug--+on--+-----+ |
      | |                             | +--debug file--+--+-----+ |
      | |                             | | '-file_name-' | |
      | |                             | | .-on-----. | |
      | |                             | +--uniquecheck--+--+-----+ |
      | |                             | | '-off-'      | |
      | |                             | '-loadpdq---resources-----+ |
      | '-probe cleanup-----+-----+

```

Element	Description	Restrictions	Syntax
<i>file_name</i>	File path of the debug log file, overriding the default MSGPATH configuration setting.	This name is case-sensitive, and cannot include any special characters, such as the new line, blank space, or tab characters.	File path name
<i>session_id</i>	The unsigned integer identifier of a session	Must be the identifier of an existing session. Only user informix can issue the SET ENVIRONMENT USE_DWA SESSION <i>session_id</i> statement, which is not valid in sysdbopen() routines.	Literal Number
<i>resources</i>	The PDQPRIORITY setting for the database sessions that extract data from the database tables during a data mart load operation.	resources is a positive integer value between 0 and 100 (inclusive).	Literal Number

Usage

In SET ENVIRONMENT USE_DWA statements of SQL, the keywords SET ENVIRONMENT USE_DWA must be followed by a string argument that is delimited between single (') or double (") quotation marks. The keywords of the USE_DWA option are not case-sensitive. Within that string, the first syntax token must be one of the following keywords, or ordered set of keywords, in some cases followed by a session identifier or by a file path:

SESSION *session_id*

Only user **informix** can include the SESSION *session_id* option in SET ENVIRONMENT USE_DWA statements to specify USE_DWA environment variable settings for a different session, as identified by the *session_id* number.

This option can change the USE_DWA settings for a session originating from an application that opens the connection to the database and does not close the connection. Besides requiring user **informix**, the SESSION option has these additional restrictions:

- The SESSION *session_id* option is not valid in SET ENVIRONMENT USE_DWA statements that also include the PROBE CLEANUP option
- The SESSION *session_id* option is not valid in SET ENVIRONMENT USE_DWA statements within the **sysdbopen()** session configuration routine.

ACCELERATE ON

Enables query acceleration, so that subsequent queries that match one of the accelerated query tables (AQTs) are sent to the accelerator server for processing.

ACCELERATE OFF

Disables query acceleration, so that subsequent queries are not sent to the accelerator server, even if the queries meet the required AQT criteria.

DEBUG ON

Turns on debugging. This option has an effect during workload analysis and during query acceleration, when either the ACCELERATE ON or the PROBE START option of the SET ENVIRONMENT USE_DWA statement is already in effect for the current session. The default log file for query acceleration debugging is the online.log file, as specified by the MSGPATH configuration parameter.

DEBUG OFF

Turns off debugging.

DEBUG FILE

This option has an effect when either or both of the ACCELERATE ON or the PROBE START option of the SET ENVIRONMENT USE_DWA statement is already in effect.

DEBUG FILE *file_name*

Makes the specified file the log file for subsequent query acceleration debugging in the current session. This replaces the default online.log file, as specified by the MSGPATH configuration parameter, or replaces a nondefault log file from a previous SET ENVIRONMENT USE_DWA 'DEBUG FILE *file_name*' statement. This option has an effect when either the ACCELERATE ON or the PROBE START option of the SET ENVIRONMENT USE_DWA statement is already in effect, and the path and the *file_name* include no special characters.

FALLBACK ON

If Informix Warehouse Accelerator cannot accelerate subsequent queries, the queries are processed by the Informix database server. For example, the accelerator server is offline, or the queries do not match one of the accelerated query tables (AQTs). This option has an effect during query acceleration,

when the `ACCELERATE ON` option of the `SET ENVIRONMENT USE_DWA` statement is already in effect.

FALLBACK OFF

If Informix Warehouse Accelerator cannot accelerate subsequent queries, the queries are not processed by the Informix database server. This option has an effect when the `ACCELERATE ON` option of the `SET ENVIRONMENT USE_DWA` statement is already in effect.

PROBE START

Activates query probing. Query probing is gathering information about query workload. Query probing is used in workload analysis to create a data mart definition.

PROBE STOP

Deactivates query probing.

LOADPDQ resources

Controls the PDQPRIORITY setting for the database sessions that extract data from the database tables during a data mart load operation.

This setting is effective for full data mart load, partition load and refresh mart.

The PDQPRIORITY is used with the MAX_PDQPRIORITY configuration parameter to calculate the effective PDQ priority for the data extraction database sessions.

The default PDQPRIORITY for data extraction database sessions is 2.

PROBE CLEANUP

Removes from the database all probing data that any past and current query workload analysis produced in the database. The `SESSION` keyword option cannot be specified in the same `SET ENVIRONMENT USE_DWA` statement that includes the `PROBE CLEANUP` keywords.

UNIQUECHECK ON

Enables uniqueness checking for primary key columns and for unique constraint keys during the creation of a data mart. By default, uniqueness checking is enforced for data mart creation.

UNIQUECHECK OFF

Disables uniqueness checking This can be useful when creating a data mart that requires one-to-many references to a parent table in a database of a remote server instance, or one-to-many references to a parent table that the query specifies as a synonym for a view. In these contexts where the uniqueness of index key column values in the parent table cannot be validated, avoiding the uniqueness check can prevent failure-to-validate exceptions during data mart creation.

Important: For synonyms of tables in remote database server instances, and for views, information on the uniqueness of data values in key columns is not available while the data mart is being created. For these table objects, the `UNIQUECHECK OFF` setting enables you to create one-to-many references where the parent table is a synonym that references a remote table or a view. Because this check is skipped, the user is responsible for ensuring the uniqueness of data in the parent-key column(s) by other means. But if you create a one-to-many reference with nonunique data values in the key columns of the parent table, your accelerated queries will return incorrect results.

Examples of setting USE_DWA environment options

The following example turns on query acceleration for the current session.

```
SET ENVIRONMENT USE_DWA 'ACCELERATE ON';
```

As for all `USE_DWA` options, double (") quotation-mark delimiters are also valid, as in this statement that has the same effect of turning on query acceleration:

```
SET ENVIRONMENT USE_DWA "ACCELERATE ON";
```

The following example removes all the probing data that was previously collected for the current database.

```
SET ENVIRONMENT USE_DWA 'PROBE CLEANUP';
```

The following example turns on acceleration and turns off fallback. The queries are not processed by the Informix database server. Queries that cannot be accelerated by Informix Warehouse Accelerator will fail.

```
SET ENVIRONMENT USE_DWA 'ACCELERATE ON';  
SET ENVIRONMENT USE_DWA 'FALLBACK OFF';
```

The following example activates the debug option. By default, the debug information is appended to the `online.log` file.

```
SET ENVIRONMENT USE_DWA 'DEBUG ON';
```

The following example creates probing data for your queries, turns on debugging, and appends the debugging information to a file named `/tmp/my_debug_file`.

```
SET ENVIRONMENT USE_DWA 'PROBE START';  
SET ENVIRONMENT USE_DWA 'DEBUG ON';  
SET ENVIRONMENT USE_DWA 'DEBUG FILE /tmp/my_debug_file';
```

The following example turns on debugging. The debug output of query 1 is written to the file `/tmp/myDwaDebugFile`. The debug output of query 2 is written to the default `online.log` file.

```
SET ENVIRONMENT USE_DWA 'DEBUG ON';  
SET ENVIRONMENT USE_DWA 'DEBUG FILE /tmp/myDwaDebugFile';  
SELECT ... { query 1 }  
SET ENVIRONMENT USE_DWA 'DEBUG FILE';  
SELECT ... { query 2 }
```

The following example turns on query acceleration for user session 64.

```
SET ENVIRONMENT USE_DWA 'SESSION 64 ACCELERATE ON';
```

This `SESSION` example of `USE_DWA` would not be valid in a `sysdbopen()` session configuration routine. The DBSA or user **informix** can issue the `onstat -g ses` command to display the `session_id` identifying numbers of all the currently running user sessions.

The following example deactivates query probing for session 32, and removes from the current database all probing data that past and current query workload analysis produced.

```
SET ENVIRONMENT USE_DWA "SESSION 32 PROBE";  
SET ENVIRONMENT USE_DWA "PROBE CLEANUP";
```

The following example turns off validating the uniqueness of data values in key columns during data mart creation within session 64.

```
SET ENVIRONMENT USE_DWA 'SESSION 64 UNIQUECHECK OFF';
```

For more information about Informix Warehouse Accelerator support for workload analysis, data marts, accelerated query tables, and installing and configuring the accelerator server, see the *IBM® Informix Warehouse Accelerator Administration Guide*.

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USTLOW_SAMPLE environment option

Use the USTLOW_SAMPLE session environment option to enable or disable sampling during the collection of index statistics for UPDATE STATISTICS LOW operations in the current session.

By default, when the UPDATE STATISTICS statement gathers distribution statistics for a table on which one or more indexes are defined, the database server reads all index leaf pages in sequence to calculate index statistics, such as the number of leaf pages, the number of unique lead index-key values, and cluster information.

For an index with more than 100 KiB leaf pages, estimating these index statistics from sampling can increase the speed of the UPDATE STATISTIC LOW operation.

To set the USTLOW_SAMPLE session environment variable, specify:

- '0' or OFF to disable sampling
- '1' or ON to enable sampling

The value that you specify overrides the setting of the USTLOW_SAMPLE configuration parameter for the session.

For example, to enable sampling for index statistics in the current session, use either of the following statements:

```
SET ENVIRONMENT USTLOW_SAMPLE '1';
```

```
SET ENVIRONMENT USTLOW_SAMPLE ON;
```

You cannot control how much data is in the sample.

Related concepts:

[Using the LOW mode option](#)

[Performance considerations of UPDATE STATISTICS statements](#)

Related reference:

[UPDATE STATISTICS statement](#)

Related information:

[USTLOW_SAMPLE configuration parameter](#)

[Data sampling during update statistics operations](#)

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SET EXPLAIN statement

Use the SET EXPLAIN statement to enable or disable the recording measurements of queries in the current session, including the plan of the query optimizer, an estimate of the number of rows returned, and the relative cost of the query.

Syntax

```
>>-SET EXPLAIN--+-+--OFF-----+-----+-----><
| '-ON-----+-' |
| '-AVOID_EXECUTE-' |
'-FILE TO--+-expression-----+-'
      +-|--file_name--'+-
      '-file_name_var---'
```

Element	Description	Restrictions	Syntax
<i>expression</i>	Expression that returns a file name specification	Must return a string satisfying the restrictions on the file name	Expression
<i>file_name</i>	The explain output file name. If the file's absolute path is not included, the explain output file will be created in the default explain output file location	Must conform to operating-system rules. If the file already exists, explain output will be appended to it.	Quoted String
<i>file_name_var</i>	Host variable that stores a file name	Must be a character data type	Language specific

Usage

Output from a SET EXPLAIN ON statement is directed to the appropriate file until you issue a SET EXPLAIN OFF statement or until the program ends. If you do not enter a SET EXPLAIN statement, then the default behavior is OFF, and the database server does not generate measurements for queries.

The SET EXPLAIN statement executes during the database server optimization phase, which occurs when you initiate a query. For queries that are associated with a cursor, if the query is prepared and does not have host variables, optimization occurs when you prepare it. Otherwise, optimization occurs when you open the cursor.

The SET EXPLAIN statement provides various measurements of the work involved in performing a query.

Option

Effect

ON

Generates measurements for each subsequent query and writes the results to an output file in the current directory. If the file already exists, new output is appended to the existing file.

AVOID_EXECUTE

Prevents a SELECT, INSERT, MERGE, UPDATE, or DELETE statement from executing. The database server prints the query plan to an output file

OFF

Terminates activity of the SET EXPLAIN statement, so that measurements for subsequent queries are no longer generated or written to the output file

FILE TO

Generates measurements for each subsequent query and allows you to specify the location for the explain output file.

The following example writes the query plan in the explain output file for subsequent queries in the current session:

```
SET EXPLAIN ON;
```

The following example suspends writing query plans to a file in the current session:

```
SET EXPLAIN OFF;
```

- [Using the AVOID_EXECUTE Option](#)
The AVOID_EXECUTE keyword prevents DML statements from executing. Instead, the database server prints the query plan to an output file.
- [Using the FILE TO option](#)
- [Default name and location of the explain output file on UNIX](#)
- [Default name and location of the output file on Windows](#)
- [SET EXPLAIN output](#)
View the SET EXPLAIN output file to analyze information on an executed query, including the directives set for the query, an estimate of the cost of the query, an estimate of the number of returned rows, the order in which the server accessed tables, index keys, join methods, and query statistics.

Related concepts:

[Performance considerations of UPDATE STATISTICS statements](#)

[Default name and location of the explain output file on UNIX](#)

[Default name and location of the output file on Windows](#)

Related reference:

[SET OPTIMIZATION statement](#)

[SET EXPLAIN output](#)

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Using the AVOID_EXECUTE Option

The AVOID_EXECUTE keyword prevents DML statements from executing. Instead, the database server prints the query plan to an output file.

The SET EXPLAIN ON AVOID_EXECUTE statement activates the Avoid Execute option for a session, or until the next SET EXPLAIN OFF (or ON) without AVOID_EXECUTE. If you activate AVOID_EXECUTE for a query that contains a remote table, the query does not execute at either the local or remote site.

The following example stores the output in the specified file.

```
SET EXPLAIN ON AVOID_EXECUTE;  
SET EXPLAIN FILE TO '/tmp/explain.out';
```

When AVOID_EXECUTE is set, the database server sends a warning message. If you are using DB-Access, it displays a text message

```
Warning! avoid_execute has been set
```

for any select, delete, update or insert query operations. From ESQL, the **sqlwarn.sqlwarn7** character is set to 'W'.

Use the SET EXPLAIN ON or the SET EXPLAIN OFF statement to turn off the AVOID_EXECUTE option. The SET EXPLAIN ON statement turns off the AVOID_EXECUTE option but continues to generate a query plan and writes the results to an output file.

If you issue the SET EXPLAIN ON AVOID_EXECUTE statement in an SPL routine, the SPL routine and any DDL statements still execute, but the DML statements inside the SPL routine do not execute. The database server prints the query plan of the SPL routine to an output file. To turn off this option, you must execute the SET EXPLAIN ON or the SET EXPLAIN OFF statement outside the SPL routine. If you execute the SET EXPLAIN ON AVOID_EXECUTE statement before you execute an SPL routine, the DML statements inside the SPL routine do not execute, and the database server does not print a query plan of the SPL routine to an output file.

Nonvariant functions in a query are still evaluated when AVOID_EXECUTE is in effect, because the database server calculates these functions before optimization.

For example, the **func()** function is evaluated, even though the following SELECT statement is not executed:

```
SELECT * FROM orders WHERE func(10) > 5;
```

For other performance implications of the AVOID_EXECUTE option, see your *IBM® Informix Performance Guide*.

If you execute the SET EXPLAIN ON AVOID_EXECUTE statement before you open a cursor in the Informix® ESQL/C program, each FETCH operation returns the message that the row was not found. If you execute SET EXPLAIN ON AVOID_EXECUTE after the Informix ESQL/C program opens a cursor, however, this statement

has no effect on the cursor, which continues to return rows.

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Using the FILE TO option

When you execute a SET EXPLAIN FILE TO statement, explain output is turned on. The SET EXPLAIN FILE TO statement can change the default file name for the explain output until the end of the session or until another SET EXPLAIN statement is issued.

The filename can be any valid combination of path and file name. If no path component is specified, the file is placed in the default explain output location. The permissions for the file are owned by the current user.

The output file that you specify in the SET EXPLAIN statement can be a new file or an existing file. If the FILE TO clause specifies an existing file, the new output is appended to that file.

Related concepts:

[Default name and location of the explain output file on UNIX](#)

[Default name and location of the output file on Windows](#)

Related reference:

[SET EXPLAIN output](#)

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Default name and location of the explain output file on UNIX

When you issue the SET EXPLAIN ON statement, the plan that the optimizer chooses for each subsequent query is written to the explain output file.

If the explain output file does not exist when you issue SET EXPLAIN ON, the database server creates the file. If the explain output file already exists when you issue the SET EXPLAIN ON statement, subsequent output is appended to the file.

Default name of the explain output file

Explain output files generated by a SET EXPLAIN statement and explain files generated by **onmode -Y** have different default names. Explain output filenames for mapped users are different than the explain output filenames for OS users, as well. The following table shows the default names:

Table 1. Default explain output file names.

User and generation type	File name
Regular user and SET EXPLAIN	sqexplain.out
Mapped user and SET EXPLAIN	username_sqexplain.out
Regular user and onmode -Y	sqexplain.out.session_id
Mapped user and onmode -Y	username_sqexplain.out.session_id

Default location of the explain output file

If the client application and the database server are on the same computer, the output file is stored in your current directory. If you are using a version 5.x or earlier client application and the output file does not appear in the current directory, check your home directory for the file. When the current database is on another computer, the output file is stored in your home directory on the remote host.

For a mapped user without a home directory, the explain output file is stored in \$INFORMIXDIR/users/server_svrnum/uid_uid.

For a mapped user with a home directory, remote clients' explain output files are stored in the user's home directory, and local clients' explain output files are stored in the user's current working directory.

Related concepts:

[Using the FILE TO option](#)

Related reference:

[SET EXPLAIN statement](#)

Related information:

[Mapped users \(UNIX, Linux\)](#)

[Location and file names for mapped users' generated files \(UNIX, Linux\)](#)

[onmode -Y: Dynamically change SET EXPLAIN](#)

[onmode and Y arguments: Change query plan measurements for a session \(SQL administration API\)](#)

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Default name and location of the output file on Windows

On Windows, SET EXPLAIN ON writes the plan that the optimizer chooses for each subsequent query to a file in %INFORMIXDIR%\sqexpln.

For explain output files generated by the SET EXPLAIN statement, the default file name is *user_name.out*, where *user_name* is the user login.

For explain output files generated by **onmode -Y**, the default file name is *sqexplain.out.session_id*.

Related concepts:

[Using the FILE TO option](#)

Related reference:

[SET EXPLAIN statement](#)

Related information:

[onmode -Y: Dynamically change SET EXPLAIN](#)

[onmode and Y arguments: Change query plan measurements for a session \(SQL administration API\)](#)

[Location and file names for mapped users' generated files \(UNIX, Linux\)](#)

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SET EXPLAIN output

View the SET EXPLAIN output file to analyze information on an executed query, including the directives set for the query, an estimate of the cost of the query, an estimate of the number of returned rows, the order in which the server accessed tables, index keys, join methods, and query statistics.

The following table lists terms that can appear in the output file and their significance.

Table 1. Output file terms

Term	Significance
Query	Displays the executed query and indicates whether SET OPTIMIZATION was set to HIGH or LOW. If you SET OPTIMIZATION to LOW, the output displays the following uppercase string as the first line: <code>QUERY: {LOW}</code> If you SET OPTIMIZATION to HIGH, the output of SET EXPLAIN displays the following uppercase string as the first line: <code>QUERY:</code>
Directives followed	Lists the directives set for the query If the syntax for a directive is incorrect, the query is processed without the directive. In that case, the output shows <code>DIRECTIVES NOT FOLLOWED</code> in addition to <code>DIRECTIVES FOLLOWED</code> . For more information on the directives specified after this term, see the Optimizer Directives or SET OPTIMIZATION statement . If a DELETE or UPDATE statement specifies an uncorrelated subquery in the WHERE clause, the set of qualifying rows returned by the subquery is materialized as a temporary table, and the output of SET EXPLAIN displays within parentheses the following message: <code>(Temp Table For Subquery)</code>
Estimated cost	An estimate of the amount of work for the query The optimizer uses an estimate to compare the cost of one path with another. The estimate is a number the optimizer assigns to the selected access method. This number does not translate directly into time and cannot be used to compare different queries. It can be used, however, to compare changes made for the same query. When data distributions are used, a query with a higher estimate generally takes longer to run than one with a smaller estimate. In the case of a query and a subquery, two estimated cost figures are returned; the query figure also includes the subquery cost. The subquery cost is shown so that you can see the cost that is associated with only the subquery.
Estimated number of rows returned	An estimate of the number of rows to be returned This number is based on information in the system catalog tables.
Numbered list	The order in which tables are accessed, followed by the access method used (index path or sequential scan) When a query involves table inheritance, all the tables are listed under the supertable in the order in which they were accessed.
Index name	The name of the index For example, <code>idx1</code> is the name of the following index: <code>Index Name: informix.idx1</code> FOT in the index name identifies the index as a forest of trees index: For example, the following index is a forest of trees index: <code>Index Name: informix.fot_idx (FOT)</code>
Index keys	The columns used as filters or indexes; the column name used for the index path or filter is indicated. The notation <i>(Key Only)</i> indicates that all the desired columns are part of the index key, so a key-only read of the index could be substituted for a read of the actual table. In databases that have the NLSCASE INSENSITIVE property, all index scan methods (except key-only scans) allow the query execution plan to map all case-sensitive values to a single value for NCHAR and NVARCHAR columns. For more on NLSCASE INSENSITIVE databases, see Duplicate rows in NLSCASE INSENSITIVE databases . The <i>Lower Index Filter</i> shows the key value where the index read begins; and the <i>Upper Index Filter</i> is shown for the key value where the index read stops. The <i>Index Key Filters</i> show filters that will be applied on retrieved index key values. If the query uses an index self-join path, the <i>Index Self Join Keys</i> shows the leading index key columns used as self-join keys, and the <i>Lower bound</i> and <i>Upper bound</i> show the boundaries of the leading index key columns.
Join method	When the query involves a join between two tables, the join method that the optimizer used (Nested Loop or Dynamic Hash) is shown at the bottom of the output for that query. When the query involves a dynamic join of two tables, if the output contains the words <i>Build Outer</i> , the hash table is built on the first table listed (called the build table). If the words <i>Build Outer</i> do not appear, the hash table is built on the second table listed.

Term	Significance
Query statistics	When the EXPLAIN_STAT configuration parameter is set to 1, this section shows the number of rows returned, the number of rows estimated in the query plan, the time required, calls to iterator functions, and the estimated cost of scan and join operations on table objects.
Time	When the output displays the elapsed time for a query execution plan or for a component of that plan, the value is formatted as <i>minutes:seconds.fraction</i> to display the minutes, seconds, and fractional part of a second.

If the query uses a collating order other than the default for the **DB_LOCALE** setting, then the **DB_LOCALE** setting and the name of the other locale that is the basis for the collation in the query (as specified by the SET COLLATION statement) are both included in the output file. Similarly, if an index is not used because of its collation, the output file indicates this.

- [Complete-Connection Level Settings and Output Examples](#)
The SET EXPLAIN statement supports *complete-connection level* settings.
- [External Table Operations in SET EXPLAIN Output](#)
The Query Statistics section of SET EXPLAIN output provides information on operations that are loading data from or unloading data to an external table.

Related concepts:

[Default name and location of the explain output file on UNIX](#)

[Default name and location of the output file on Windows](#)

[Using the FILE TO option](#)

Related reference:

[SET EXPLAIN statement](#)

Related information:

[Mapped users \(UNIX, Linux\)](#)

[Location and file names for mapped users' generated files \(UNIX, Linux\)](#)

[onmode -Y: Dynamically change SET EXPLAIN](#)

[onmode and Y arguments: Change query plan measurements for a session \(SQL administration API\)](#)

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Complete-Connection Level Settings and Output Examples

The SET EXPLAIN statement supports *complete-connection level* settings.

The SET EXPLAIN statement supports *complete-connection level* settings. This means that values in the local session environment at the time of connection are propagated to all new or resumed transactions of the following types:

- transactions within the local database
- distributed transactions across databases of the same server instance
- distributed transactions across databases of two or more database server instances
- global transactions with XA-compliant data sources that are registered in the local database

If you change the SET EXPLAIN setting within a transaction, the new value is propagated back to the local environment and also to all subsequent new or resumed transactions.

Examples of SET EXPLAIN Output

The following SQL statements cause the database server to write the query plans of the UPDATE statement (and of its subquery) to the default explain output file:

```
DATABASE stores_demo;
SET EXPLAIN ON;
UPDATE orders SET ship_charge = ship_charge + 2.00
  WHERE customer_num IN
    (SELECT orders.customer_num FROM orders
     WHERE orders.ship_weight < 50);
CLOSE DATABASE;
```

The following information is displayed in the resulting output:

```
QUERY:
-----
update orders set ship_charge = ship_charge + 2.00
where customer_num in
(select orders.customer_num from orders where
  orders.ship_weight < 50)

Estimated Cost: 4
Estimated # of Rows Returned: 8

1) informix.orders: INDEX PATH

(1) Index Keys: customer_num (Serial, fragments: ALL)
Lower Index Filter: informix.orders.customer_num = ANY

Subquery:
-----
Estimated Cost: 2
Estimated # of Rows Returned: 8
(Temp Table For Subquery)
```

```
1) informix.orders: SEQUENTIAL SCAN
```

```
Filters: informix.orders.ship_weight < 50.00
```

The next example is based on the following SQL statements, which include a DELETE operation:

```
DATABASE stores_demo;  
SET EXPLAIN ON;  
DELETE FROM catalog WHERE stock_num IN  
(SELECT stock.stock_num FROM stock, catalog WHERE  
stock.stock_num = catalog.stock_num  
AND stock.unit_price < 50);  
CLOSE DATABASE;
```

Below is the resulting output:

QUERY:

```
-----  
DELETE FROM catalog WHERE stock_num IN  
(SELECT stock.stock_num from stock, catalog  
WHERE stock.stock_num = catalog.stock_num  
AND stock.unit_price < 50);
```

Estimated Cost: 19

Estimated # of Rows Returned: 37

```
1) ajay.catalog: INDEX PATH
```

```
(1) Index Keys: stock_num manu_code (Serial, fragments: ALL)  
Lower Index Filter: ajay.catalog.stock_num = ANY
```

Subquery:

```
-----  
Estimated Cost: 12  
Estimated # of Rows Returned: 44  
(Temp Table For Subquery)
```

```
1) ajay.stock: SEQUENTIAL SCAN
```

```
Filters: ajay.stock.unit_price < $50.00
```

```
2) ajay.catalog: INDEX PATH
```

```
(1) Index Keys: stock_num manu_code  
(Key-Only) (Serial, fragments: ALL)  
Lower Index Filter:  
ajay.stock.stock_num = ajay.catalog.stock_num
```

NESTED LOOP JOIN

Related concepts:

[Default name and location of the explain output file on UNIX](#)

[Default name and location of the output file on Windows](#)

Related reference:

[UPDATE STATISTICS statement](#)

[Explain-Mode Directives](#)

Related information:

[Report that shows the query plan chosen by the optimizer](#)

[The explain output file](#)

[Query statistics section provides performance debugging information](#)

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External Table Operations in SET EXPLAIN Output

The Query Statistics section of SET EXPLAIN output provides information on operations that are loading data from or unloading data to an external table.

The following codes in the Query Statistics section of the SET EXPLAIN output file provides information on external tables:

- `x1cnv` identifies an operation that is loading data from an external table and inserting the data into a base table. Here `x` = external table, `1` = loading, and `cnv` = converter
- `xucnv` identifies an operation that is reading data from the base table and writing to the file that the external table is pointing to. Here `x` = external table, `u` = unloading, and `cnv` = converter

Examples

The following example shows a query in which an operating is loading data from an external table and inserting the data into a base table:

```
QUERY: (OPTIMIZATION TIMESTAMP: 11-11-2009 12:55:20)  
-----  
insert into items select * from ext_items
```

Estimated Cost: 5
Estimated # of Rows Returned: 68

1) informix.ext_items: SEQUENTIAL SCAN

Query statistics:

Table map :

Internal name	Table name
t1	items

type	it_count	time
xlread	1	00:00.00

type	it_count	time
xlcnv	67	00:00.00

type	table	rows_ins	time
insert	t1	67	00:00.00

The following example shows a query in which an operating is loading data from an external table and inserting the data into a base table:

QUERY: (OPTIMIZATION TIMESTAMP: 11-11-2009 12:47:55)

```
select * from orders into external ord_ext
using (datafiles ('disk:/tmp/ord'))
```

Estimated Cost: 2
Estimated # of Rows Returned: 23

1) informix.orders: SEQUENTIAL SCAN

Query statistics:

Table map :

Internal name	Table name
t1	orders

type	table	rows_prod	est_rows	rows_scan	time	est_cost
scan	t1	23	23	23	00:00.00	3

type	it_count	time
xucnv	23	00:00.00

type	it_count	time
xuwrite	23	00:00.00

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SET INDEXES statement

Use the SET INDEXES statement to enable or disable a user-defined index, or to change the filtering mode of a unique index.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
      .- ,----- .
      V          |
>>-SET INDEXES-+-index-+-+----->
      '-FOR--table-'

>-+-+--ENABLED-+-+-----+-----><
| '-DISABLED-'
| (1)          .-WITHOUT ERROR-. (2) |
| '-----FILTERING-+-WITH ERROR-----'
```

Notes:

1. Unique indexes only

2. See [Filtering Modes](#)

Element	Description	Restrictions	Syntax
<i>index</i>	Index to be enabled, disabled, or changed in its filtering mode	Must exist	Identifier
<i>table</i>	Table whose indexes are all to be enabled, disabled, or changed in their filtering mode	Must exist	Identifier

Usage

You can use this statement to enable or disable a specific index or a list of indexes. You can also use the *table* option to enable or disable all of the user-defined indexes on a table without specifying their individual identifiers. For example, the next two examples respectively disable and enable all of the indexes on the **cust_calls** table:

```
SET INDEXES FOR cust_calls DISABLED;  
SET INDEXES FOR cust_calls ENABLED;
```

This simple syntax can be convenient in operations where you intend to LOAD or TRUNCATE all the data in a table, or to consolidate the free space in a table.

Explicitly-defined and implicitly-defined indexes

The SET INDEXES statement operates on indexes that the CREATE INDEX statement created explicitly. It is not useful, however, with system-defined indexes that PRIMARY KEY or FOREIGN KEY constraint definitions create implicitly. The SET INDEXES statement cannot specify system-generated names that begin with the blank (ASCII 32) character, even if your database has the **DELIMIDENT** environment variable set to support double quotation marks as delimiters for database object identifiers.

To enable or disable implicitly-defined indexes, use instead the SET CONSTRAINTS statement, whose FOR *table* option can reference system-generated constraints implicitly, as in the following examples:

```
SET CONSTRAINTS FOR cust_calls DISABLED;  
SET CONSTRAINTS FOR cust_calls ENABLED;
```

To disable all the explicitly-defined and implicitly-defined indexes of a table, use the FOR *table* options of both the SET INDEXES and SET CONSTRAINTS statements, as in the following examples:

```
SET INDEXES FOR cust_calls DISABLED;  
SET CONSTRAINTS FOR cust_calls DISABLED;
```

You can similarly enable all the explicitly-defined and implicitly-defined indexes of a table, without referencing the system-generated names of the implicitly-defined indexes, by substituting **ENABLED** for **DISABLED** in the examples above.

The SET INDEXES statement is a special case of the SET Database Object Mode statement. The SET Database Object Mode statement can also enable or disable a trigger or constraint, or can change the filtering mode of constraints and unique indexes.

For the complete syntax and semantics of the SET INDEXES statement, see [SET Database Object Mode statement](#).

Do not confuse the SET INDEXES statement with the SET INDEX statement, which was supported in releases earlier than Version 9.40. The Informix® database server ignores the SET INDEX statement in current releases.

Restrictions on Secondary Servers

In cluster environments, the SET INDEXES statement is not supported on updatable secondary servers. (More generally, session-level index, trigger, and constraint modes that the SET Database Object Mode statement specifies are not redirected for UPDATE operations on table objects in databases of secondary servers.)

Related reference:

[SET CONSTRAINTS statement](#)

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SET ISOLATION statement

Use the SET ISOLATION statement to define the degree of concurrency among processes that attempt to access the same rows simultaneously.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-SET ISOLATION----->  
    '-TO-'  
  
>--+REPEATABLE READ-----+>  
    '-+-COMMITTED READ-+-+-----+-'  
    |           '-LAST COMMITTED-' | '-RETAIN UPDATE LOCKS-'  
    +--CURSOR STABILITY-----+  
    '-DIRTY READ-----'  
    '-WITH WARNING-'
```

Usage

The SET ISOLATION statement is the Informix® extension to the ANSI SQL-92 standard. The SET ISOLATION statement can change the enduring isolation level for the session. If you want to set isolation levels through an ANSI-compliant statement, use the SET TRANSACTION statement instead. For a comparison of these two statements, see [SET TRANSACTION statement](#).

The TO keyword is optional, and has no effect.

SET ISOLATION provides the same functionality as the ISO/ANSI-compliant SET TRANSACTION statement for isolation levels of DIRTY READ (called UNCOMMITTED in SET TRANSACTION), COMMITTED READ, and REPEATABLE READ (called SERIALIZABLE in SET TRANSACTION).

The database *isolation_level* affects read concurrency when rows are retrieved from the database. The isolation level specifies the phenomena that can occur during execution of concurrent SQL transactions. The following phenomena are possible:

- **Dirty Read.** SQL transaction T1 modifies a row. SQL transaction T2 then reads that row before T1 performs a COMMIT. If T1 then performs a ROLLBACK, T2 will have read a row that was never committed, and therefore can be considered never to have existed.
- **Non-Repeatable Read.** SQL transaction T1 reads a row. SQL transaction T2 then modifies or deletes that row and performs a COMMIT. If T1 then attempts to reread that row, T1 might receive the modified value or discover that the row has been deleted.
- **Phantom Row.** SQL transaction T1 reads the set of rows N that satisfy some search condition. SQL transaction T2 then executes SQL statements that generate one or more new rows that satisfy the search condition used by SQL transaction T1. If T1 then repeats the original read with the same search condition, T1 receives a different set of rows.

The database server uses shared locks to support different levels of isolation among processes attempting to access data.

The update or delete process always acquires an exclusive lock on the row that is being modified. The level of isolation does not interfere with rows that you are updating or deleting. If another process attempts to update or delete rows that you are reading with an isolation level of Repeatable Read, that process is denied access to those rows.

In Informix ESQL/C, cursors that are open when SET ISOLATION executes might or might not use the new isolation level when rows are retrieved. Any isolation level that was set from the time the cursor was opened until the application fetches a row might be in effect. The database server might have read rows into internal buffers and internal temporary tables using the isolation level that was in effect at that time. To ensure consistency and reproducible results, close any open cursors before you execute the SET ISOLATION statement.

You can issue the SET ISOLATION statement from a client computer only after a database is opened.

- [Complete-Connection Level Settings](#)
- [Informix Isolation Levels](#)
- [Effects of Isolation Levels](#)
- [Isolation Levels for Secondary Data Replication Servers](#)

Related reference:

[LOCK TABLE statement](#)
[SET LOCK MODE statement](#)
[SET TRANSACTION statement](#)
[CREATE DATABASE statement](#)
[SET ENVIRONMENT statement](#)

Related information:

[Set the isolation level](#)

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Complete-Connection Level Settings

The SET ISOLATION statement supports *complete-connection level* settings. This means that values in the local session environment at the time of connection are propagated to all new or resumed transactions. These can include the following types of transactions:

- transactions within the local database,
- distributed transactions across databases of the same server instance,
- distributed transactions across databases of two or more database server instances,
- global transactions with XA-compliant data sources that are registered in the local database.

If you change the isolation level within a transaction, the new value is propagated back to the local environment and also to all subsequent new or resumed transactions.

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Informix® Isolation Levels

The following definitions explain the critical characteristics of each isolation level, from the lowest level of isolation to the highest.

- [Using the Dirty Read Isolation Level](#)
- [Using the Committed Read Isolation Level](#)

Use the Committed Read option to guarantee that every retrieved row is committed in the table at the time that the row is retrieved. This option does not place a lock on the fetched row. Committed Read is the default level of isolation in a database with logging that is not ANSI compliant.

- [Using the Cursor Stability Isolation Level](#)
- [Using the Repeatable Read Isolation Level](#)
- [Default Isolation Levels](#)
- [Using the RETAIN UPDATE LOCKS Option](#)

Use the RETAIN UPDATE LOCKS option to affect the behavior of the database server when it handles a SELECT ... FOR UPDATE statement.

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Using the Dirty Read Isolation Level

Use the Dirty Read option to copy rows from the database whether or not there are locks on them. The program that fetches a row places no locks and it respects none. Dirty Read is the only isolation level available to databases that do not implement transaction logging.

This isolation level is most appropriate for static tables that are used for queries of tables where data is not being modified, because it provides no isolation. With Dirty Read, the program might return an uncommitted row that was inserted or modified within a transaction that has subsequently rolled back, or a *phantom row* that was not visible when you first read the query set, but that materializes in the query set before a subsequent read within the same transaction. (Only the Repeatable Read isolation level prevents access to phantom rows. Only Dirty Read provides access to uncommitted rows from concurrent transactions that might subsequently be rolled back.)

The optional WITH WARNING keywords instruct the database server to issue a warning when DML operations that use the Dirty Read isolation level might return an uncommitted row or a phantom row. The transaction in the following example uses this isolation level:

```
BEGIN WORK;  
SET ISOLATION TO DIRTY READ WITH WARNING;  
...  
COMMIT WORK;
```

The Dirty Read isolation level is sensitive to the current setting of the USELASTCOMMITTED configuration parameter and of the **USELASTCOMMITTED** session environment variable. For information about the behavior of the Dirty Read isolation level when either of these are set to DIRTY READ or to ALL, see [The LAST COMMITTED Option to Committed Read](#).

When you use High Availability Data Replication, the database server effectively uses Dirty Read isolation on the HDR Secondary Server, regardless of the specified SET ISOLATION or SET TRANSACTION isolation level, unless the UPDATABLE_SECONDARY configuration parameter is enabled. For more information about this topic, see [Isolation Levels for Secondary Data Replication Servers](#).

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Using the Committed Read Isolation Level

Use the Committed Read option to guarantee that every retrieved row is committed in the table at the time that the row is retrieved. This option does not place a lock on the fetched row. Committed Read is the default level of isolation in a database with logging that is not ANSI compliant.

Committed Read is appropriate when each row is processed as an independent unit, without reference to other rows in the same table or in other tables.

- [The LAST COMMITTED Option to Committed Read](#)
Use the LAST COMMITTED keyword option of the Committed Read isolation level to reduce the risk of exclusive row-level locks held by other sessions either causing applications to fail with locking errors, or preventing applications from reading a locked row until after a concurrent transaction is committed or rolled back.

Related reference:

[SET LOCK MODE statement](#)

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The LAST COMMITTED Option to Committed Read

Use the LAST COMMITTED keyword option of the Committed Read isolation level to reduce the risk of exclusive row-level locks held by other sessions either causing applications to fail with locking errors, or preventing applications from reading a locked row until after a concurrent transaction is committed or rolled back.

In contexts where an application attempts to read a row on which another session holds an exclusive lock, these keywords instruct the database server to return the most recently committed version of the row, rather than wait for the lock to be released.

This feature takes effect implicitly in all user sessions that use the Committed Read isolation level of the SET ISOLATION statement, or that use the Read Committed isolation level of the ANSI/ISO-compliant SET TRANSACTION statement, under any of the following circumstances:

- if the USELASTCOMMITTED configuration parameter is set to 'COMMITTED READ' or to 'ALL'
- if the SET ENVIRONMENT statement sets the USELASTCOMMITTED session environment variable to 'COMMITTED READ' or to 'ALL'.

This feature also takes effect implicitly in all user sessions that use the Dirty Read isolation level of the SET ISOLATION statement, or that use the Read Uncommitted isolation level of the ANSI/ISO-compliant SET TRANSACTION statement, under any of the following circumstances:

- if the USELASTCOMMITTED configuration parameter is set to 'DIRTY READ' or to 'ALL'

- if the SET ENVIRONMENT statement sets the USELASTCOMMITTED session environment variable to 'DIRTY READ' or to 'ALL'.

Enabling this feature cannot eliminate the possibility of locking conflicts, but they reduce the number of scenarios in which other sessions reading the same row can cause an error. The LAST COMMITTED keywords are only effective with concurrent read operations. They cannot prevent locking conflicts or errors that can occur when concurrent sessions attempt to write to the same row.

This feature has no effect on Committed Read or Dirty Read behavior in contexts where no "last committed" version of the table is available, including these:

- The database does not support transaction logging
- The table was created with the LOCK MODE PAGE keywords, or has been altered to have a locking mode of PAGE
- The IFX_DEF_TABLE_LOCKMODE environment variable is set to 'PAGE'
- The DEF_TABLE_LOCKMODE configuration parameter is set to 'PAGE'
- The LOCK TABLE statement has explicitly set an exclusive lock on the table
- An uncommitted DDL statement has implicitly set an exclusive lock on the table
- The table is a system catalog table on which an uncommitted DDL statement has implicitly set an exclusive lock
- The table has columns of complex data types or of user-defined data types
- The table is a RAW table
- A DataBlade module is accessing the table
- The table was created using the Virtual Table Interface.

User-defined access methods are not required to support the LAST COMMITTED feature.

The scope of LAST COMMITTED semantics is neither statement-based nor transaction-based. This isolation level has the same instant-in-time scope that the Committed Read isolation level has without the LAST COMMITTED option. For example, when a query is executed twice within a single transaction with LAST COMMITTED in effect, different results might be returned by the same query, if other DML transactions that were operating on the same data are committed in the interval between the two submissions of the query. This instantaneous nature of the semantics of Committed Read and of Committed Read Last Committed exactly implements the ANSI/ISO Read Committed isolation level.

The LAST COMMITTED feature does not support reading through table-level locks. If the access plan for a query that uses the LAST COMMITTED feature encounters a table-level lock in a table or index that it needs to access, the query will return the following error codes:

SQL error code:

252: Cannot get system information for table.

ISAM error code:

113: ISAM error: the file is locked.

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Using the Cursor Stability Isolation Level

Use the Cursor Stability option to place a shared lock on the fetched row, which is released when you fetch another row or close the cursor. Another process can also place a shared lock on the same row, but no process can acquire an exclusive lock to modify data in the row. Such row stability is important when the program updates another table based on the data it reads from the row.

If you set the isolation level to Cursor Stability, but you are not using a transaction, the Cursor Stability acts like the Committed Read isolation level.

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Using the Repeatable Read Isolation Level

Use the Repeatable Read option to place a shared lock on every row that is selected during the transaction. Another process can also place a shared lock on a selected row, but no other process can modify any selected row during your transaction, nor insert a row that meets the search criteria of your query during your transaction. If you repeat the query during the transaction, you reread the same information. The shared locks are released only when the transaction commits or rolls back. Repeatable Read is the default isolation level in an ANSI-compliant database.

Repeatable Read isolation places the largest number of locks and holds them the longest. Therefore, it is the level that reduces concurrency the most.

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Default Isolation Levels

The default isolation level for a particular database is established when you create the database according to database type. The following list describes the default isolation level for each database type.

Isolation Level

Database Type

Dirty Read

Default level in a database without logging

Committed Read

Default level in a logged database that is not ANSI compliant

Repeatable Read

Default level in an ANSI-compliant database

The default level remains in effect until you issue a SET ISOLATION statement. After a SET ISOLATION statement executes, the new isolation level remains in effect until one of the following events occurs:

- You enter another SET ISOLATION statement.
- You open another database that has a default isolation level different from the level that your last SET ISOLATION statement specified.
- The program ends.

For a Informix® database that is not ANSI-compliant, unless you explicitly set the USELASTCOMMITTED configuration parameter, the LAST COMMITTED feature is not in effect for the default isolation levels. The SET ENVIRONMENT statement or the SET ISOLATION statement can override this default and enable LAST COMMITTED for the current session.

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Using the RETAIN UPDATE LOCKS Option

Use the RETAIN UPDATE LOCKS option to affect the behavior of the database server when it handles a SELECT ... FOR UPDATE statement.

In a database with the isolation level set to Dirty Read, Committed Read, or Cursor Stability, the database server places an update lock on a fetched row of a SELECT ... FOR UPDATE statement. When you turn on the RETAIN UPDATE LOCKS option, the database server retains the update lock until the end of the transaction rather than releasing it at the next subsequent FETCH or when the cursor is closed. This option prevents other users from placing an exclusive lock on the updated row before the current user reaches the end of the transaction.

You can use this option to achieve the same locking effects but avoid the overhead of dummy updates or the repeatable read isolation level.

You can turn this option on or off at any time during the current session.

You can turn the option off by resetting the isolation level without using the RETAIN UPDATE LOCKS keywords, as in the following example.

```
BEGIN WORK;
SET ISOLATION TO
  COMMITTED READ LAST COMMITTED RETAIN UPDATE LOCKS;
...
COMMIT WORK;
BEGIN WORK;
SET ISOLATION TO COMMITTED READ LAST COMMITTED ;
...
COMMIT WORK;
```

Controlling Update Locks through the Session Environment

Another way to disable RETAIN UPDATE LOCKS behavior is to execute this SQL statement:

```
SET ENVIRONMENT RETAINUPDATELOCKS 'NONE' ;
```

This disables the RETAIN UPDATE LOCKS clause for the current transaction, and for any subsequent transactions of the same session, by resetting the RETAINUPDATELOCKS session environment variable.

The SET ENVIRONMENT RETAINUPDATELOCKS statement can also make the retention of update locks the default behavior for either the Committed Read, Cursor Stability, or Dirty Read isolation levels, or for all of these isolation levels, regardless of whether the SET ISOLATION statement includes the RETAIN UPDATE LOCKS clause.

For more information on update locks, see [RETAINUPDATELOCKS session environment option](#) and [Locking Considerations](#).

- [Turning the Option OFF During a Transaction](#)

If you set the RETAIN UPDATE LOCKS option to OFF after a transaction has begun, but before the transaction has been committed or rolled back, several update locks might still exist.

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Turning the Option OFF During a Transaction

If you set the RETAIN UPDATE LOCKS option to OFF after a transaction has begun, but before the transaction has been committed or rolled back, several update locks might still exist.

Switching OFF the feature does not directly release any update lock. When you turn this option off, the database server reverts to normal behavior for the three isolation levels. That is, a FETCH statement releases the update lock placed on a row by the immediately preceding FETCH statement, and a closed cursor releases the update lock on the current row.

Update locks placed by earlier FETCH statements are not released unless multiple update cursors are present within the same transaction. In this case, a subsequent FETCH could also release older update locks of other cursors.

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Effects of Isolation Levels

You cannot set the transaction isolation level in a database that does not have logging. Every retrieval in such a database occurs as a Dirty Read.

The data retrieved from a BYTE or TEXT column can vary, depending on the transaction isolation level. Under Dirty Read or Committed Read levels of isolation, a process can read a BYTE or TEXT column that is either deleted (if the delete is not yet committed) or in the process of being deleted. Under these isolation levels, deleted data is readable under certain conditions. For information about these conditions, see the *IBM® Informix® Administrator's Guide*.

When you use DB-Access, as you use higher levels of isolation, lock conflicts occur more frequently. For example, if you use Cursor Stability, more lock conflicts occur than if you use Committed Read.

Using a scroll cursor in an ESQL/C transaction, you can force consistency between your temporary table and the database table either by setting the level to Repeatable Read or by locking the entire table during the transaction.

If you use a scroll cursor WITH HOLD in a transaction, you cannot force consistency between your temporary table and the database table. A table-level lock or locks that are set by Repeatable Read are released when the transaction is completed, but the scroll cursor with hold remains open beyond the end of the transaction. You can modify released rows as soon as the transaction ends, but retrieved data in the temporary table might be inconsistent with the actual data. Attention: Do not use nonlogging tables within a transaction. If you need to use a nonlogging table within a transaction, either set the isolation level to Repeatable Read or else lock the table in Exclusive mode to prevent concurrency problems.

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Isolation Levels for Secondary Data Replication Servers

If the UPDATABLE_SECONDARY configuration parameter is disabled (by being unset or by being set to zero), a secondary data replication server is read-only. In this case, only the Dirty Read or Read Uncommitted transaction isolation levels are available on High-Availability Data Replication (HDR) and Remote Standalone Secondary (RSS) servers.

If the UPDATABLE_SECONDARY parameter is enabled (by being set to a valid number of connections greater than zero), a secondary data replication server can support the Read Committed, Committed Read, or Committed Read Last Committed transaction isolation level, with or without the USELASTCOMMITTED session environment variable of the SET ENVIRONMENT statement. Only the DELETE, INSERT, UPDATE, and MERGE statements of SQL (and the **dbexport** utility, if the STOP_APPLY, USELASTCOMMITTED, and UPDATABLE_SECONDARY configuration parameters are set) can support write operations on an updatable secondary server.

Shared Disk Secondary (SDS) servers, however, can support the Read Committed, Committed Read, Committed Read Last Committed isolation levels, regardless of their UPDATABLE_SECONDARY setting. For more information about the UPDATABLE_SECONDARY configuration parameter, see the *IBM® Informix® Administrator's Reference*.

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SET LOCK MODE statement

Use the SET LOCK MODE statement to define how the database server handles a process that tries to access a locked row or table.

This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-SET LOCK MODE TO--+-NOT WAIT-----+-----><
                        '-WAIT--++-----+-'
                        '-seconds-'
```

Element	Description	Restrictions	Syntax
seconds	Maximum number of seconds that a process waits for a lock to be released before issuing an error	Valid only if shorter than system default	Literal Number

Usage

This statement can direct the response of the database server in the following ways when a process tries to access a locked row or table.

Lock Mode

Effect

NOT WAIT

Database server ends the operation immediately and returns an error code. This condition is the default.

WAIT

Database server suspends the process until the lock releases.

WAIT seconds

Database server suspends the process until the lock releases or until the waiting period ends. If the lock remains after the waiting period, the operation ends and an error code is returned.

For a description of the two distinct meanings of the term *lock mode* in this document, see Locking Granularity in the related concepts section.

To avoid waiting in operations that attempt to read rows on which concurrent sessions hold exclusive row-level locks, you can also use the LAST COMMITTED feature, either by setting it explicitly in the SET ISOLATION COMMITTED READ statement, or by setting the USELASTCOMMITTED configuration parameter or the USELASTCOMMITTED session environment option.

Examples

In the following example, the user specifies that if the process requests a locked row, the operation should end immediately and an error code should be returned:

```
SET LOCK MODE TO NOT WAIT;
```

In the following example, the user specifies that the process should be suspended until the lock is released:

```
SET LOCK MODE TO WAIT;
```

The next example sets an upper limit of 17 seconds on the length of any wait:

```
SET LOCK MODE TO WAIT 17;
```

- [WAIT Clause](#)

Related concepts:

[Locking Granularity](#)

[Using the Committed Read Isolation Level](#)

Related reference:

[LOCK TABLE statement](#)

[SET ISOLATION statement](#)

[SET TRANSACTION statement](#)

[UNLOCK TABLE statement](#)

Related information:

[Set the lock mode](#)

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WAIT Clause

The WAIT clause causes the database server to suspend the process until the lock is released or until a specified number of seconds have passed without the lock being released.

The database server protects against the possibility of a deadlock when you request the WAIT option. Before the database server suspends a process, it checks whether suspending the process could create a deadlock. If the database server discovers that a deadlock could occur, it ends the operation (overruling your instruction to wait) and returns an error code. In the case of either a suspected or actual deadlock, the database server returns an error.

Cautiously use the unlimited waiting period that was created when you specify the WAIT option without *seconds*. If you do not specify an upper limit, and the process that placed the lock somehow fails to release it, suspended processes could wait indefinitely. Because a true deadlock situation does not exist, the database server does not take corrective action.

In a network environment, the DBA uses the ONCONFIG parameter DEADLOCK_TIMEOUT to establish a default value for *seconds*. If you use a SET LOCK MODE statement to set an upper limit, your value applies only when your waiting period is shorter than the system default.

- [Complete-Connection Level Settings](#)

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Complete-Connection Level Settings

The SET LOCK MODE statement supports *complete-connection level* settings. This means that values in the local session environment at the time of connection are propagated to all new or resumed transactions. These can include the following types of transactions:

- transactions within the local database,
- distributed transactions across databases of the same server instance,
- distributed transactions across databases of two or more database server instances,
- global transactions with XA-compliant data sources that are registered in the local database.

If you change the lock mode setting within a transaction, the new value is propagated back to the local environment and also to all subsequent new or resumed transactions.

In releases of Informix® earlier than 9.40.UC8, the SET LOCK MODE statement did not support complete-connection level settings. The process waited for the specified number of seconds only if you acquired locks within the current database server and a remote database server within the same transaction.

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SET LOG statement

Use the SET LOG statement to change your database logging mode from buffered transaction logging to unbuffered transaction logging or vice versa.

This statement is an extension to the ANSI/ISO standard for SQL. Unlike most extensions, the SET LOG statement is not valid in an ANSI-compliant database.

Syntax

```
>>-SET--+-----+--LOG-----><
      '-BUFFERED-'
```

Usage

You activate transaction logging when you create a database or add logging to an existing database. These transaction logs can be buffered or unbuffered.

Buffered logging is a type of logging that holds transactions in a memory buffer until the buffer is full, regardless of when the transaction is committed or rolled back. The database server provides this option to speed up operations by reducing the number of disk writes.

Attention: You gain a marginal increase in efficiency with buffered logging, but you incur some risk. In the event of a system failure, the database server cannot recover any completed transactions in the memory buffer that were not written to disk.

The SET LOG statement in the following example changes the transaction logging mode to buffered logging:

```
SET BUFFERED LOG;
```

Unbuffered logging is a type of logging that does not hold transactions in a memory buffer. As soon as a transaction ends, the database server writes the transaction to disk. If a system failure occurs when you are using unbuffered logging, you recover all completed transactions, but not those still in the buffer. The default condition for transaction logs is unbuffered logging.

The SET LOG statement in the following example changes the transaction logging mode to unbuffered logging:

```
SET LOG;
```

The SET LOG statement redefines the mode for the current session only. The default mode, which the database administrator sets with the **ondblog** utility, remains unchanged.

The buffering option does not affect retrievals from external tables. For distributed queries, a database with logging can retrieve only from databases with logging, but it makes no difference whether the databases use buffered or unbuffered logging.

An ANSI-compliant database cannot use buffered logging.

You cannot change the logging mode of ANSI-compliant databases. If you created a database with the WITH LOG MODE ANSI keywords, you cannot later use the SET LOG statement to change the logging mode to buffered or unbuffered transaction logging.

Related reference:

[CREATE DATABASE statement](#)

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SET OPTIMIZATION statement

Use the SET OPTIMIZATION statement to specify how much time the query execution optimizer spends developing a query plan or specifying optimization goals. The SET OPTIMIZATION statement is an extension to the ANSI/ISO standard for SQL.

When you use **DB-Access** with Informix®, the ENVIRONMENT options to the SET OPTIMIZATION statement can define a general optimization environment for all statements in the current session.

Syntax

```
>>-SET OPTIMIZATION--+--HIGH--+-----+-----><
      | '-LOW--' |
      +---+FIRST_ROWS+-----+
      | '-ALL_ROWS--' |
      | (1) | (2) |
      '-----| ENVIRONMENT Options |-----'
```

Notes:

1. DB-Access only
2. See [ENVIRONMENT Options](#)

Usage

You can execute a SET OPTIMIZATION statement at any time. The specified optimization level carries across databases on the current database server. The option that you specify remains in effect until you issue another SET OPTIMIZATION statement or until the program ends. The default database server optimization level for the amount of time that the query optimizer spends determining the query plan is HIGH.

On Informix, the default optimization goal is ALL_ROWS. Although you can set only one option at a time, you can issue two SET OPTIMIZATION statements: one that specifies the time the optimizer spends to determine the query plan and one that specifies the optimization goal of the query.

Similarly, you can issue multiple SET OPTIMIZATION statements that include the ENVIRONMENT Options clause to specify a session environment for optimizing queries. In data warehousing applications, an appropriate optimizer environment can improve the performance of join queries of tables in a star schema. Optimizer environment settings persist until another SET OPTIMIZATION ENVIRONMENT statement overrides them, or until the session ends. For more information, see the [ENVIRONMENT Options](#) topic.

Examples

The following example shows optimization across a network. The **central** database (on the **midstate** database server) is to have LOW optimization; the **western** database (on the **rockies** database server) is to have HIGH optimization.

```
CONNECT TO 'central@midstate';
SET OPTIMIZATION LOW;
SELECT * FROM customer;
CLOSE DATABASE;
CONNECT TO 'western@rockies';
SET OPTIMIZATION HIGH;
SELECT * FROM customer;
CLOSE DATABASE;
CONNECT TO 'wyoming@rockies';
SELECT * FROM customer;
```

Here the **wyoming** database is to have HIGH optimization because it resides on the same database server as the **western** database. The code does not need to re-specify the optimization level for the **wyoming** database because the **wyoming** database resides on the **rockies** database server like the **western** database.

The following example directs the Informix optimizer to use the most time to determine a query plan, and to then return the first rows of the result as soon as possible:

```
SET OPTIMIZATION LOW;
SET OPTIMIZATION FIRST_ROWS;
SELECT lname, fname, bonus
FROM sales_emp, sales
WHERE sales.empid = sales_emp.empid AND bonus > 5,000
ORDER BY bonus DESC;
```

- [HIGH and LOW Options](#)
- [FIRST_ROWS and ALL_ROWS Options](#)
- [Optimizing SPL Routines](#)
- [ENVIRONMENT Options](#)

Use the ENVIRONMENT Options clause of the SET OPTIMIZATION statement to define attributes of the optimization environment in the current session. These attributes persist until the session ends, or until another SET OPTIMIZATION ENVIRONMENT statement resets an optimization directive.

Related concepts:

[Performance considerations of UPDATE STATISTICS statements](#)

Related reference:

[SET EXPLAIN statement](#)

[SET ENVIRONMENT statement](#)

[UPDATE STATISTICS statement](#)

[Optimizer Directives](#)

[SET STATEMENT CACHE statement](#)

Related information:

[Queries and the query optimizer](#)

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HIGH and LOW Options

The HIGH and LOW options determine how much time the query optimizer spends to determine the query plan:

- **HIGH**
This option directs the optimizer to use a sophisticated cost-based algorithm that examines all reasonable query-plan choices and selects the best overall alternative.

For large joins, this algorithm can incur more overhead than you desire. In extreme cases, you can run out of memory.

- **LOW**
This option directs the optimizer to use a less sophisticated but faster to design optimization algorithm, based on the lowest-cost path at each stage. This algorithm eliminates unlikely join strategies during the early stages of optimization and reduces the time and resources spent during optimization.

When you specify the LOW level of optimization, the database server might not select the optimal strategy because that strategy was eliminated from consideration during the early stages of the algorithm.

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FIRST_ROWS and ALL_ROWS Options

The `FIRST_ROWS` and `ALL_ROWS` keyword options identify two different query optimization goals:

- **FIRST_ROWS**
This option directs the optimizer to choose the query plan that returns the first qualifying record as soon as possible, ignoring plans that would sort records or create a hash table.
- **ALL_ROWS**
This option directs the optimizer to choose the query plan that returns all the qualifying records as quickly as possible.

Inline optimizer directives

Rather than choosing either of these `SET OPTIMIZATION` statement options, you might instead specify an optimization-goal directive for an individual query as a comment immediately following the `SELECT` keyword that begins the query or subquery. For more information about the syntax and options for inline optimizer directives for queries in `DELETE`, `SELECT`, or `UPDATE` statements, see [Optimizer Directives](#).

External optimizer directives

Besides the query optimizer directives that the `SET OPTIMIZATION` statement can specify for queries in the current session, or the inline optimizer directives that can follow the `SELECT` keyword, the database server also supports a third format for influencing the choice of execution path by the query optimizer.

The DBA or user **informix** can execute the `SAVE EXTERNAL DIRECTIVES` statement to register *external optimizer directives*, also called *external directives*, in the **sysdirectives** table of the system catalog. If support for external directives has been enabled, the Informix® database server applies these directives automatically to queries that match a specified `SELECT` statement. The `ACTIVE`, `INACTIVE`, or `TEST ONLY` keyword options of `SAVE EXTERNAL DIRECTIVES` statements respectively enable, disable, or restrict the scope of an external directive.

Setting the `EXT_DIRECTIVES` configuration parameter in the `ONCONFIG` file to 1 or 2, and setting the **IFX_EXTDIRECTIVES** client-side environment variable to 1 enables support for external directives.

Independent of the `EXT_DIRECTIVES` configuration setting or the **IFX_EXTDIRECTIVES** client-side settings, the `SET ENVIRONMENT EXTDIRECTIVES` setting of '1', `on`, or `ON` for the session environment enables external optimizer directives in the current user session, if any active external directives are registered in the **sysdirectives** table.

The `SET EXPLAIN` output file displays whether external directives are in effect for a query.

For more information about external optimizer directives, see [Enabling or disabling external directives for a session](#).

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Optimizing SPL Routines

For SPL routines that remain unchanged or change only slightly, you might want to set the `SET OPTIMIZATION` statement to `HIGH` when you create the SPL routine. This step stores the best query plans for the SPL routine. Then execute a `SET OPTIMIZATION LOW` statement before you execute the SPL routine. The SPL routine then uses the optimal query plans and runs at the more cost-effective rate.

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ENVIRONMENT Options

Use the `ENVIRONMENT Options` clause of the `SET OPTIMIZATION` statement to define attributes of the optimization environment in the current session. These attributes persist until the session ends, or until another `SET OPTIMIZATION ENVIRONMENT` statement resets an optimization directive.

For some data warehousing applications, session environment settings that you specify in this clause can improve the performance of queries that join fact tables with dimension tables, in databases where the primary key of each dimension table corresponds to a foreign key of the fact table.

The **DB-Access** utility of Informix® supports the `ENVIRONMENT Options` clause of the `SET OPTIMIZATION` statement.

Syntax

```
>>-ENVIRONMENT--+-STAR_JOIN--'--+-ENABLED--+-'-----+-----><
|               +-DISABLED-+
|               '-FORCED---'
|               .-./-----
|               V
|+-FACT-----+-'-----table-+-'-----
|+-AVOID_FACT-+ '-+-DEFAULT-+-----
|'-NON_DIM----' '-'-----'
```

Element	Description	Restrictions	Syntax
<i>table</i>	Table, view, or synonym	Must exist in the database	Identifier

Usage

This syntax diagram is simplified, and does not show the double (") quotation mark option for delimiters enclosing the list of one or more *table* objects, or enclosing the **DISABLED**, **ENABLED**, or **FORCED** keyword that you specify as the optimization environment setting.

Important: Do not use quotation marks to delimit the **STAR_JOIN**, **FACT**, **AVOID_FACT**, **NON_DIM**, or **DEFAULT** keywords. In the **ENVIRONMENT** Options clause, the **DEFAULT** keyword and the empty string (' ' or "") are equivalent.

The following table lists each **ENVIRONMENT** option, and describes their effect on whether the query optimizer considers star-join execution plans.

Keywords	Effect	Optimizer Action
STAR_JOIN	The 'ENABLED' setting turns on (and 'DISABLED' turns off) star-join support for the current session. The 'FORCED' setting favors a star-join execution path, when possible, for all queries	For 'ENABLED', the optimizer considers the possibility of a star-join execution plan. For 'FORCED', a star-join plan will be chosen, if available. For 'DISABLED', star-join is not considered.
FACT	Identifies tables that correspond to fact tables in a star schema. If an AVOID_FACT table is also specified in the same session as FACT , then FACT takes precedence. DEFAULT or an empty string turns off the FACT directive for the session.	Only tables in the FACT list are considered as fact tables in star-join optimization. Multiple tables can be listed as FACT .
AVOID_FACT	Do not use the table (or any table in the list of tables) as a fact table in star-join optimization. DEFAULT or an empty string turns off the AVOID_FACT directive for the session.	Tables in the AVOID_FACT list are not considered as fact tables in star-join optimization. Multiple tables can be listed as AVOID_FACT .
NON_DIM	Identifies tables that do not correspond to dimension tables in a star schema. DEFAULT or an empty string turns off the NON_DIM directive for the session.	Tables in the NON_DIM list are not considered as dimension tables in star-join optimization. Multiple tables can be listed as NON_DIM .

Unless you explicitly set the **FACT**, **AVOID_FACT**, or **NON_DIM** optimizer directive to **DEFAULT**, a valid **SET OPTIMIZATION ENVIRONMENT** statement must include exactly one quoted string that defines an optimization environment setting. When the setting for the directive that follows the **ENVIRONMENT** keyword is not **DEFAULT**, a pair of single (') or double (") quotation mark symbols must delimit the last specification:

- Either the 'ENABLED', 'DISABLED', or 'FORCED' keyword that follows the **STAR_JOIN** directive,
- or the comma-separated list of one or more *table* identifiers that specifies the setting of an optimizer environment attribute.
- If the setting is the empty string or the **DEFAULT** keyword, the **FACT**, **AVOID_FACT**, or **NON_DIM** optimizer directive that follows the **ENVIRONMENT** keyword does not affect the query optimizer during subsequent queries in the same session. You can use this option to disable a previously specified **FACT**, **AVOID_FACT**, or **NON_DIM** optimizer directive.

The following restrictions apply to blank spaces within the **SET OPTIMIZATION ENVIRONMENT** statement:

- If a comma-separated list of more than one *table* identifier follows the **FACT**, **AVOID_FACT**, or **NON_DIM** keywords, do not include blank spaces between any of the items in the list.
- Similarly, do not include blank characters between the two single (') or two double (") delimiters of the empty string that is a synonym for the **DEFAULT** keyword.

For example, the following statements override any previous directives to prevent the query optimizer from considering any specific tables as fact tables or as dimension tables:

```
SET OPTIMIZATION ENVIRONMENT AVOID_FACT "";
SET OPTIMIZATION ENVIRONMENT NON_DIM '';
```

By associating the **AVOID_FACT**, or **NON_DIM** keywords with an empty set of tables, the statements in the examples above allow any table to be considered as a fact table or as a dimension table in a star-join execution path.

Configuring optimization at connection time

The DBA can use an **sysdbopen()** routine to define an optimization environment that takes effect when the user connects to the database. For example, to specify an optimizer environment that always favors a star-join execution plan, the **sysdbopen()** routine should include these SQL statements:

```
SET OPTIMIZATION ENVIRONMENT STAR_JOIN 'FORCED';
SET OPTIMIZATION ENVIRONMENT FACT 'table1, table2, ... tableN';
```

In the **SET OPTIMIZATION ENVIRONMENT FACT** statement, the tables listed after the **FACT** keyword should all be fact tables.

Additional methods for enabling join directives

The **SET OPTIMIZATION ENVIRONMENT** statement is one of several ways to specify **FACT** optimizer directives:

- Directives within the **SELECT** statement, embedded comment-like. The scope is the SQL statement.
- The **SET OPTIMIZATION ENVIRONMENT FACT** statement. The scope is the session.
- The **SAVE EXTERNAL DIRECTIVES** statement. The scope is the database. This can define **FACT** directives and save them in the **sysdirectives** system catalog table.

Three mechanisms exist for enabling the query optimizer to consider external directives in the **sysdirectives** system catalog table, including any **FACT** directives. This is the (approximately) ascending order of precedence:

- The EXT_DIRECTIVES configuration parameter. If this is set to 2, external directives are enabled for the database server, unless the IFX_EXTDIRECTIVES environment variable on the client system is set to 0.
- The IFX_EXTDIRECTIVES environment variable. If this is set to 1 on the client system, external optimizer directives are enabled for the database server, unless the EXT_DIRECTIVES configuration parameter is set to 0.
- The SET ENVIRONMENT statement. To enable the query optimizer to consider the external optimizer directives in **sysdirectives** when it chooses an execution path for queries during the current session, the DBA can issue any of these statements:

```
SET ENVIRONMENT EXTDIRECTIVES on;
SET ENVIRONMENT EXTDIRECTIVES ON;
SET ENVIRONMENT EXTDIRECTIVES '1';
SET ENVIRONMENT EXTDIRECTIVES "1";
```

To prevent the query optimizer from considering external optimizer directives in **sysdirectives**, the DBA can issue any of these statements:

```
SET ENVIRONMENT EXTDIRECTIVES off;
SET ENVIRONMENT EXTDIRECTIVES OFF;
SET ENVIRONMENT EXTDIRECTIVES '0';
SET ENVIRONMENT EXTDIRECTIVES "0";
```

These statements override (for the current session only) any conflicting settings of the EXT_DIRECTIVES configuration parameter or of the IFX_EXTDIRECTIVES environment variable.

For information about the SET ENVIRONMENT EXTDIRECTIVES statement, see [EXTDIRECTIVES session environment option](#).

For a table showing the effects of various combinations of EXT_DIRECTIVES settings and IFX_EXTDIRECTIVES settings on enabling or disabling external optimizer directives, see [Enabling or disabling external directives for a session](#).

For information about query optimizer directives that can favor or avoid star-join execution plans, see [Star-Join Directives](#).

For information about how to use the built-in **sysdbopen()** routine to define the session environment at the time of connection for a specified user, for the PUBLIC group, or for a role, see [Session Configuration Procedures](#).

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SET PDQPRIORITY statement

The SET PDQPRIORITY statement enables an application to set the query priority level dynamically within a routine. The SET PDQPRIORITY statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>SET PDQPRIORITY--+-DEFAULT---+-----><
      +-LOW-----+
      +-OFF-----+
      +-HIGH-----+
      '-resources-'
```

Element	Description	Restrictions	Syntax
<i>resources</i>	Integer that specifies the query priority level and the percent of resources to process the query	Can range from -1 to 100. See also Allocating Database Server Resources .	Literal Number

Usage

The SET PDQPRIORITY statement overrides the **PDQPRIORITY** environment variable (but has lower precedence than the MAX_PDQPRIORITY configuration parameter). The scope of SET PDQPRIORITY is local to the routine, and does not affect other routines within the same session. When a routine that issues this statement terminates, the setting reverts to the system default value.

Set PDQ priority to a value less than the quotient of 100 divided by the maximum number of prepared statements. For example, if two prepared statements are active, you should set the PDQ priority to less than 50.

For example, assume that the DBA sets the MAX_PDQPRIORITY parameter to 50. Then a user enters the following SET PDQPRIORITY statement to set the query priority level to 80 percent of resources:

```
SET PDQPRIORITY 80;
```

When it processes the query, the database server uses the MAX_PDQPRIORITY value to factor the query priority level set by the user. The database server silently processes the query with a priority level of 40. This priority level represents 50 percent of the 80 percent of resources that the user specifies.

The following keywords are supported by the SET PDQPRIORITY statement.

Keyword

Effect

DEFAULT

Uses the setting of the **PDQPRIORITY** environment variable

LOW

Data values are fetched from fragmented tables in parallel. (In Informix®, when you specify LOW, the database server uses no other forms of parallelism.)

OFF

PDQ is turned off (Informix only). The database server uses no parallelism. OFF is the default if you use neither the PDQPRIORITY environment variable nor the SET PDQPRIORITY statement.

HIGH

The database server determines an appropriate PDQPRIORITY value, based on factors that include the number of available processors, the fragmentation of the tables being queried, the complexity of the query, and others. reserves the right to change the performance behavior of queries when HIGH is specified in future releases.

The following SET PDQPRIORITY statements have the same effects:

```
SET PDQPRIORITY DEFAULT;
```

```
SET PDQPRIORITY -1;
```

Both replace any prior SET PDQPRIORITY level with the setting of the **PDQPRIORITY** environment variable. See also, however, the following description of the order of precedence among methods for allocating query priority resources.

Precedence of methods for allocating PDQ priority

For memory available in operations that are affected by **PDQPRIORITY**, the maximum amount of memory that the database server can allocate is limited by the physical memory available to your system, and by the settings (in ascending order of lowest precedence to highest precedence) of the following environment variables, SQL statements, configuration parameters, and session environment variables:

- The **PDQPRIORITY** environment variable
- The most recent SET PDQPRIORITY statement of SQL
- The MAX_PDQPRIORITY configuration parameter
- The DS_TOTAL_MEMORY configuration parameter
- The BOUND_IMPL_PDQ session environment variable, if the IMPLICIT_PDQ session environment variable is enabled in the current session by the SET ENVIRONMENT statement of SQL.

The scope of the SET ENVIRONMENT BOUND_IMPL_PDQ and SET ENVIRONMENT IMPLICIT_PDQ statements is the current session.

When concurrent queries are running, the DS_MAX_QUERIES configuration parameter setting can also restrict the amount of PDQ memory available for a new query.

- [Allocating Database Server Resources](#)

Related reference:

[SET ENVIRONMENT statement](#)

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Allocating Database Server Resources

You can specify an integer in the range from -1 to 100 to indicate a query priority level as the percent of database server resources to process the query. Resources include the amount of memory and the number of processors. The higher the number you specify, the more resources the database server uses.

Use of more resources usually indicates better performance for a given query. Using excessive resources, however, can cause contention for resources and remove resources from other queries, so that degraded performance results. With the *resources* option, the following values are numeric equivalents of the keywords that indicate query priority level.

Value

Equivalent Keyword-Priority Level

-1

DEFAULT

0

OFF

1

LOW

For Informix®, the following statements are equivalent. The first statement uses the keyword LOW to establish a low query-priority level. The second uses a value of 1 in the *resources* parameter to establish a low query-priority level.

```
SET PDQPRIORITY LOW;
```

```
SET PDQPRIORITY 1;
```

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SET ROLE statement

Use the SET ROLE statement to enable the privileges of a user-defined role. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-SET ROLE--+--role-----><
| '-role-' |
| +-NULL-----+
| +-NONE-----+
| +-DEFAULT-'
```

Element	Description	Restrictions	Syntax
<i>role</i>	Name of a role to be enabled	Must already exist in the database and must already have been granted to the user, but cannot be a built-in role. If enclosed between quotation marks, <i>role</i> is case sensitive.	Owner name ;

Usage

Any user who is granted a role can enable the role by using the SET ROLE statement. You can only enable one role at a time. If you execute the SET ROLE statement after a role is already set, the new role replaces the old role as the current role.

The SET ROLE statement returns an error if the user does not currently hold the role, or if the role is a built-in role. (The access privileges held by a built-in role, such as the EXTEND role or the DBSECADM role, are always in effect, and do not require activation by the SET ROLE statement if the user holds that role.)

Users can be granted a default role for the database instance when the DBA issues the GRANT DEFAULT ROLE statement. If no default role exists for the user in the current database, role NULL or NONE is assigned by default. In this context, NULL and NONE are synonyms. Roles NULL and NONE can have no privileges. To set your role to NULL or NONE disables your current role.

When you use SET ROLE to enable a role, you gain the privileges of the role, in addition to the privileges of PUBLIC and your own privileges. If a role is granted to another role that has been assigned to you, you gain the privileges of both roles, in addition to any privileges of PUBLIC and your own privileges.

After SET ROLE executes successfully, the specified role remains effective until the current database is closed or the user executes another SET ROLE statement. Only the user, however, not the role, retains ownership of any database objects, such as tables, that were created during the session.

A role is in scope only within the current database. You cannot use privileges that you acquire from a role to access data in another database. For example, if you have privileges from a role in the database named **acctg**, and you execute a distributed query over the databases named **acctg** and **inventory**, your query cannot access the data in the **inventory** database unless you were also granted appropriate privileges in the **inventory** database. As a security precaution, discretionary access privileges that the user holds only from a role cannot provide access to tables outside the current database through a view or through the action of a trigger.

If your database supports explicit transactions, you must issue the SET ROLE statement outside a transaction. If your database is ANSI-compliant, SET ROLE must be the first statement of a new transaction. If the SET ROLE statement is executed while a transaction is active, an error occurs. For more information about SQL statements that initiate an implicit transaction, see [SET SESSION AUTHORIZATION and Transactions](#).

If the SET ROLE statement is executed as a part of a trigger or SPL routine, and the owner of the trigger or SPL routine was granted the role with the WITH GRANT OPTION, the role is enabled even if you are not granted the role. For example, this code fragment sets a role and then relinquishes it after a query:

```
EXEC SQL set role engineer;
EXEC SQL select frame, lname, project
        INTO :efname, :elname, :eproject FROM projects
        WHERE project_num > 100 AND lname = 'Larkin';
printf ("%s is working on %s\n", efname, eproject);
EXEC SQL set role NULL;
```

- [Setting the Default Role](#)

Related reference:

[CREATE ROLE statement](#)
[DROP ROLE statement](#)
[GRANT statement](#)
[REVOKE statement](#)

Related information:

[Access-management strategies](#)

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Setting the Default Role

The DBA or the owner of the database can issue the GRANT DEFAULT ROLE statement to assign an existing role as the *default role* to a specified list of users or to PUBLIC. Unlike a non-default role, the default role does not require the SET ROLE statement to enable it. When a user is assigned to the default role, an implicit connection to the database is granted to the user.

Each of the three statements in next example respectively performs one of the following operations on a role:

- Declares a role called **Engineer**
- Assigns Select privileges on the **locomotives** table to the **Engineer** role
- Defines **Engineer** as the default role for the user **jgould**.

```
EXEC SQL CREATE ROLE 'Engineer';
EXEC SQL GRANT SELECT ON locomotives TO 'Engineer';
EXEC SQL GRANT DEFAULT ROLE 'Engineer' TO jgould;
```

If **jgould** subsequently uses the SET ROLE statement to enable some other role, then by executing the following statement, **jgould** replaces that role with **Engineer** as the current role:

SET ROLE DEFAULT;

If you have no default role, SET ROLE DEFAULT makes NONE your current role, leaving only the privileges that have been granted explicitly to your *username* or to PUBLIC. After GRANT DEFAULT ROLE changes your default role to a new default role, executing SET ROLE DEFAULT restores your most recently granted default role, even if this role was not your default role when you connected to the database.

If one default role is granted to PUBLIC, but a different role is granted as the default role to an individual user, the individually-granted default role takes precedence if that user issues SET ROLE DEFAULT or connects to the database.

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SET SESSION AUTHORIZATION statement

The SET SESSION AUTHORIZATION statement lets you change the user name under which database operations are performed in the current session.

Syntax

```
.-'user_identifier'-.
>>-SET SESSION AUTHORIZATION TO +-user_ID_variable--+-----+><
                                     '-USING--+-password-----+-'
                                     '-auth_variable-'
```

Element	Description	Restrictions	Syntax
<i>auth_variable</i>	Host variable that holds the valid password for the login name specified in <i>user_identifier</i> or <i>user_ID_variable</i> .	Variable must be a fixed-length character data type. Its value has the same restrictions as <i>password</i> .	Must conform to language-specific rules for variable names.
<i>password</i>	Quoted string that is the password of the specified user.	Must be the password of that user, and no more than 32 bytes	Quoted String
<i>user_identifier</i>	Quoted string that is a valid login name for the application. The quotation mark delimiters preserve the lettercase.	Authorization identifier of no more than 32 bytes	Quoted String
<i>user_ID_variable</i>	The name of an ESQL/C host variable that holds the value of a user identifier.	Variable must be a fixed-length character data type. Its value has the same restrictions as <i>user_identifier</i> .	Must conform to language-specific rules for variable names.

Usage

This statement allows you to assume the identity of another user, including the discretionary access control (DAC) and label-based access control (LBAC) credentials. You can also use this statement in an API that supports Informix® trusted contexts to switch the user ID on a trusted connection.

Both the DBA and SETSESSIONAUTH access privilege are required to execute this statement. Unless when you start the session you already hold the SETSESSIONAUTH privilege for PUBLIC (or for the user whose name you specify in the SET SESSION AUTHORIZATION statement), and you also hold the DBA privilege, this statement fails with an error.

If the database server has been converted from a legacy version that did not support label-based access control, users who held the DBA privilege are automatically granted the SETSESSIONAUTH access privilege for PUBLIC in the migration process. If the database server has been initialized as a version that supports LBAC security policies, users who hold the **DBSECADM** role can grant the SETSESSIONAUTH privilege to other users. Because the security credentials of each user determine what data rows can be accessed in protected tables, the **DBSECADM** should exercise care in granting the SETSESSIONAUTH privilege and in specifying its scope.

The new identity remains in effect in the current database until you execute SET SESSION AUTHORIZATION again, or until you close the current database. When you use this statement, the specified *user* must have the Connect privilege on the current database. In addition, the DBA cannot set the new authorization identifier to the PUBLIC group, nor to any existing role in the current database.

Setting a session to another user causes a change in a user name in the current active database server. The specified *user*, as far as this database server process is concerned, is completely dispossessed of any privileges while accessing the database server through some administrative utility. Additionally, the new session *user* is not able to initiate any administrative operation (execute a utility, for example) by virtue of the acquired identity.

After the SET SESSION AUTHORIZATION statement successfully executes, any role enabled by a previous user is relinquished. You must use the SET ROLE statement if you wish to assume a role that has been granted to the specified *user*. The database server does not enable the default role of *user* automatically.

After SET SESSION AUTHORIZATION successfully executes, the database server puts any owner-privileged UDRs that the DBA created while using the new authorization identifier in RESTRICTED mode, which can affect access privileges during operations of the UDR on objects in remote databases. For more information on RESTRICTED mode, see the **sysprocedures** system catalog table in the *IBM® Informix Guide to SQL: Reference*.

When you assume the identity of another user by executing the SET SESSION AUTHORIZATION statement, you can perform operations in the current database only. You cannot perform an operation on a database object outside the current database, such as a remote table. In addition, you cannot execute a DROP DATABASE or RENAME DATABASE statement, even if the database is owned by the real user or by the effective user.

You can use this statement either to obtain access to the data directly or to grant the database-level or table-level privileges needed for the database operation to proceed. The following example shows how to use the SET SESSION AUTHORIZATION statement to obtain table-level privileges:

```
SET SESSION AUTHORIZATION TO 'cath1';
GRANT ALL ON customer TO 'mary';
SET SESSION AUTHORIZATION TO 'mary';
UPDATE customer SET fname = 'Carl' WHERE lname = 'Pauli';
```

If you enclose *user* in quotation marks, the name is case sensitive and is stored exactly as you typed it. In an ANSI-compliant database, if you do not use quotation marks as delimiters, the authorization identifier is stored in uppercase letters, unless the **ANSIOWNER** environment variable is set to prevent the conversion of lowercase letters to uppercase.

The following Open Database Connectivity (ODBC) API example enables user ID switching on a trusted connection with an authentication requirement:

```
SQLExecDirect(hstmt, "SET SESSION AUTHORIZATION TO 'zurbie' USING 'pass01'", SQL_NTS);
```

In the function call above,

- 'zurbie' specifies the authorization identifier for subsequent operations in this session
- pass01 must be the current password of user **zurbie**.

Note:

Except in a non-hostile environment, 'pass01' is not a recommended example of a login password, because in some locales it might be easy to guess.

- [SET SESSION AUTHORIZATION and Transactions](#)

Related reference:

[CONNECT statement](#)

[DATABASE statement](#)

[GRANT statement](#)

[REVOKE statement](#)

[SET CONNECTION statement](#)

[CREATE VIEW statement](#)

Related information:

[SYSPROCEDURES](#)

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SET SESSION AUTHORIZATION and Transactions

If your database is not ANSI compliant, you must issue the SET SESSION AUTHORIZATION statement outside a transaction. If you issue the statement within a transaction, you receive an error message.

In an ANSI-compliant database, you can execute the SET SESSION AUTHORIZATION statement only if you have not executed a statement that initiates an implicit transaction (for example, CREATE TABLE or SELECT). Statements that do not initiate an implicit transaction are statements that do not acquire locks or log data (for example, SET EXPLAIN and SET ISOLATION). You can execute the SET SESSION AUTHORIZATION statement immediately after a DATABASE statement or a COMMIT WORK statement.

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SET STATEMENT CACHE statement

Use the SET STATEMENT CACHE statement to turn on caching or turn off caching for the current session. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-SET STATEMENT CACHE--+-ON--+-----><
                        '-OFF-'
```

Usage

You can use the SET STATEMENT CACHE statement to turn caching in the SQL statement cache ON or OFF for the current session. The statement cache stores in a buffer identical statements that are repeatedly run in a session. Only data manipulation language (DML) statements (DELETE, INSERT, UPDATE, or SELECT) can be stored in the statement cache.

This mechanism allows qualifying statements to bypass the optimization stage, and avoid recompiling, which can reduce memory consumption and can improve query processing time.

Examples

The following example turns on statement caching for the current session:

```
SET STATEMENT CACHE ON;
```


The following turns off statement caching for the current session:

```
SET STATEMENT CACHE OFF;
```

- [Precedence and Default Behavior](#)
- [Turning the Cache ON](#)
- [Turning the Cache OFF](#)
- [SQL statement cache qualifying criteria](#)

A statement that can be cached in the SQL statement cache (and consequently, one that can match a statement that already appears in the SQL statement cache) must meet specified conditions.

Related reference:

[SAVE EXTERNAL DIRECTIVES statement](#)

[SET OPTIMIZATION statement](#)

[Optimizer Directives](#)

Related information:

[STMT_CACHE environment variable](#)

[STMT_CACHE configuration parameter](#)

[STMT_CACHE_NUMPOOL configuration parameter](#)

[STMT_CACHE_HITS configuration parameter](#)

[The onmode utility](#)

[Optimize queries with the SQL statement cache](#)

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Precedence and Default Behavior

SET STATEMENT CACHE takes precedence over the **STMT_CACHE** environment variable and the STMT_CACHE configuration parameter. You must enable the SQL statement cache, however, either by setting the STMT_CACHE configuration parameter or by using the **onmode** utility, before the SET STATEMENT CACHE statement can execute successfully.

When you issue a SET STATEMENT CACHE ON statement, the SQL statement cache remains in effect until you issue a SET STATEMENT CACHE OFF statement or until the program ends. If you do not use SET STATEMENT CACHE, the default behavior depends on the setting of the **STMT_CACHE** environment variable or the STMT_CACHE configuration parameter.

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Turning the Cache ON

Use the ON option to enable the SQL statement cache. When the SQL statement cache is enabled, each statement that you execute passes through the SQL statement cache to determine if a matching cache entry is present. If so, the database server uses the cached entry to execute the statement.

If the statement has no matching entry, the database server tests to see if it qualifies for entry into the cache. For the conditions a statement must meet to enter into the cache, see [SQL statement cache qualifying criteria](#).

- [Restrictions on Matching Entries in the SQL Statement Cache](#)

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Restrictions on Matching Entries in the SQL Statement Cache

When the database server considers whether or not a statement is identical to a statement in the SQL statement cache, the following items must match:

- Lettercase
- Comments
- White space
- Optimization settings
 - SET OPTIMIZATION statement options
 - Optimizer directives
 - The SET ENVIRONMENT OPTCOMPIND statement options or settings of the **OPTCOMPIND** environment variable, or of the OPTCOMPIND configuration parameter in the ONCONFIG file. (If conflicting settings exist for the same query, this is the descending order of precedence.)
- Parallelism settings
 - SET PDQPRIORITY statement options or settings of the **PDQPRIORITY** environment variable
- Query text strings
- Literals

If an SQL statement is semantically equivalent to a statement in the SQL statement cache but has different literals, the statement is not considered identical and qualifies for entry into the cache. For example, the following SELECT statements are not identical:

```
SELECT col1, col2 FROM tab1 WHERE col1=3;
```

```
SELECT col1, col2 FROM tab1 WHERE col1=5;
```

In this example, both statements are entered into the SQL statement cache.

Host-variable names, however, are insignificant. For example, the following select statements are considered identical:

```
SELECT * FROM tab1 WHERE x = :x AND y = :y;
```

```
SELECT * FROM tab1 WHERE x = :p AND y = :q;
```

In the previous example, although the host names are different, the statements qualify, because the case, query text strings, and white space match. Performance does not improve, however, because each statement has already been parsed and optimized by the PREPARE statement.

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Turning the Cache OFF

The OFF option disables the SQL statement cache. When you turn caching OFF for your session, no SQL statement cache code is executed for that session.

The SQL statement cache is designed to save memory in environments where identical queries are executed repeatedly and schema changes are infrequent. If this is not the case, you might want to turn the SQL statement cache off to avoid the overhead of caching. For example, if you have little cache cohesion, that is, when relatively few matches but many new entries into the cache exist, the cache management overhead is high. In this case, turn the SQL statement cache off.

If you know that you are executing many statements that do not qualify for the SQL statement cache, you might want to disable it and avoid the overhead of testing to see if each DML statement qualifies for insertion into the cache.

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SQL statement cache qualifying criteria

A statement that can be cached in the SQL statement cache (and consequently, one that can match a statement that already appears in the SQL statement cache) must meet specified conditions.

To qualify for caching, the statement must meet all of the following conditions:

- It must be a SELECT, INSERT, UPDATE, or DELETE statement.
- It must contain only non-opaque built-in data types (excluding BLOB, BOOLEAN, BYTE, CLOB, LVARCHAR, and TEXT).
- It must contain only built-in operators.
- It cannot contain user-defined routines.
- It cannot contain temporary or remote tables.
- It cannot contain subqueries in the Projection list.
- It cannot be part of a multistatement PREPARE.
- It cannot have user-privilege restrictions on target columns.
- In an ANSI-compliant database, it must contain fully qualified object names.
- It cannot require re-optimization.

- [Requiring Re-Execution Before Cache Insertion](#)
- [Enabling or Disabling Insertions After Size Exceeds Configured Limit](#)
- [Prepared Statements and the Statement Cache](#)

Prepared statements are inherently cached for a single session. That is, if a prepared statement is executed many times (or if a single cursor is opened many times), the same prepared query plan is used repeatedly by that session.

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Requiring Re-Execution Before Cache Insertion

A qualified SQL statement is fully inserted into the SQL statement cache only after the database server counts a configurable number of references (which are sometimes called "hits") to that statement. For the default value of zero, a qualified DML statement does not need to be re-executed before it is cached.

Using the STMT_CACHE_HITS configuration parameter, however, the database administrator (DBA) can specify that qualified DML statements must be executed a minimum number of times before they are inserted into the statement cache. By setting this to a value of one (or to a larger value), the DBA excludes one-time-only *ad hoc* queries from full insertion into the SQL statement cache, thereby lowering cache-management overhead.

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Enabling or Disabling Insertions After Size Exceeds Configured Limit

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Comparing SET TRANSACTION with SET ISOLATION

The SET TRANSACTION statement complies with ANSI SQL-92. This statement is similar to the Informix® SET ISOLATION statement; however, the SET ISOLATION statement is not ANSI compliant and does not provide access modes. In fact, the isolation levels that you can set with the SET TRANSACTION statement are almost parallel to the isolation levels that you can set with the SET ISOLATION statement, as the following table shows.

SET TRANSACTION Isolation Level	SET ISOLATION Isolation Level
Read Uncommitted	Dirty Read
Read Committed	Committed Read
[<i>Not supported</i>]	Cursor Stability
(ANSI) Repeatable Read	(Informix) Repeatable Read
Serializable	(Informix) Repeatable Read

Another difference between SET TRANSACTION and SET ISOLATION is the behavior of the isolation levels within transactions. You can issue SET TRANSACTION only once for a transaction. Any cursors that are opened during that transaction are guaranteed that isolation level (or access mode, if you are defining an access mode). With SET ISOLATION, after a transaction is started, you can change the isolation level more than once within the transaction.

The following examples illustrate this difference in the behavior of the SET ISOLATION and SET TRANSACTION statements:

```
EXEC SQL BEGIN WORK;
EXEC SQL SET ISOLATION TO DIRTY READ;
EXEC SQL SELECT ... ;
EXEC SQL SET ISOLATION TO REPEATABLE READ;
EXEC SQL INSERT ... ;
EXEC SQL COMMIT WORK; -- Executes without error
```

Compare the previous example to these SET TRANSACTION statements:

```
EXEC SQL BEGIN WORK;
EXEC SQL SET TRANSACTION ISOLATION LEVEL SERIALIZABLE;
EXEC SQL SELECT ... ;
EXEC SQL SET TRANSACTION ISOLATION LEVEL READ COMMITTED;
-- Produces error 876: Cannot issue SET TRANSACTION
-- in an active transaction.
```

An additional difference between SET ISOLATION and SET TRANSACTION is the duration of isolation levels. Because SET ISOLATION supports complete-connection level settings, the isolation level specified by SET ISOLATION remains in effect until another SET ISOLATION statement is issued. The isolation level set by SET TRANSACTION only remains in effect until the transaction terminates. Then the isolation level is reset to the default for the database type.

Informix® Isolation Levels

The following definitions explain the critical characteristics of each isolation level, from the lowest level of isolation to the highest.

- [Using the Read Uncommitted Option](#)
- [Using the Read Committed Option](#)
- [Using the Repeatable Read and Serializable Options](#)

Using the Read Uncommitted Option

Use the Read Uncommitted option to copy rows from the database whether or not locks are present on them. The program that fetches a row places no locks and it respects none. Read Uncommitted is the only isolation level available to databases that do not have transactions.

This isolation level is most appropriate in queries of static tables whose data is not being modified, because it provides no isolation. With Read Uncommitted, the program might return an uncommitted row that was inserted or modified within a transaction that was subsequently rolled back.

The Uncommitted Read isolation level of SET TRANSACTION does not directly support the LAST COMMITTED feature of the Committed Read isolation level of the SET ISOLATION statement. The LAST COMMITTED feature can reduce the risk of locking conflicts when an application attempts to read a row on which another session holds an exclusive lock while modifying data. When this feature is enabled, the database server returns the most recently committed version of the data, rather than wait for the lock to be released.

This feature takes effect implicitly, however, in all user sessions that use the Read Uncommitted isolation level of the SET TRANSACTION statement, under either of the following circumstances:

- if the USELASTCOMMITTED configuration parameter is set to 'DIRTY READ' or to 'ALL'
- if the SET ENVIRONMENT statement set the USELASTCOMMITTED session environment option to 'DIRTY READ' or to 'ALL'.

Using the Read Committed Option

Use the Read Committed option to guarantee that every retrieved row is committed in the table at the time that the row is retrieved. This option does not place a lock on the fetched row. Read Committed is the default level of isolation in a database with logging that is not ANSI compliant.

Read Committed is appropriate when each row of data is processed as an independent unit, without reference to other rows in the same or other tables.

The Read Committed isolation level of SET TRANSACTION does not directly support the LAST COMMITTED feature of the Committed Read isolation level of the SET ISOLATION statement, which can reduce the risk of locking conflicts when an application attempts to read data in a row on which another session holds an exclusive row-level lock. When this feature is enabled, the database server returns the most recently committed version of the data, rather than wait for the lock to be released

This feature takes effect implicitly, however, in all user sessions that use the Read Committed isolation level of the SET TRANSACTION statement, under either of the following circumstances:

- if the USELASTCOMMITTED configuration parameter is set to 'COMMITTED READ' or to 'ALL'
- if the SET ENVIRONMENT statement set the USELASTCOMMITTED session environment variable to 'COMMITTED READ' or to 'ALL'.

See the section [The LAST COMMITTED Option to Committed Read](#) for more information about the LAST COMMITTED feature and its restrictions.

Using the Repeatable Read and Serializable Options

The Informix® implementation of Repeatable Read and of Serializable are equivalent. The Serializable (or Repeatable Read) option places a shared lock on every row that is selected during the transaction.

Another process can also place a shared lock on a selected row, but no other process can modify any selected row during your transaction or insert a row that meets the search criteria of your query during your transaction.

A *phantom row* is a row that was not visible when you first read the query set, but that materializes in a subsequent read of the query set in the same transaction. Only this isolation level prevents access to a phantom row.

If you repeat the query during the transaction, you reread the same data. The shared locks are released only when the transaction is committed or rolled back. Serializable is the default isolation level in an ANSI-compliant database. Serializable isolation places the largest number of locks and holds them the longest. Therefore, it is the level that reduces concurrency the most.

Default Isolation Levels

The default isolation level is established when you create the database.

Informix® Name	ANSI Name	When This Is the Default Level of Isolation
Dirty Read	Read Uncommitted	Database without transaction logging
Committed Read	Read Committed	Databases with logging that are not ANSI-compliant
Repeatable Read	Serializable	ANSI-compliant databases

For Informix databases that are not ANSI-compliant, unless you explicitly set the USELASTCOMMITTED configuration parameter, the LAST COMMITTED feature is not in effect for the default isolation levels. The SET ENVIRONMENT statement or the SET ISOLATION statement can override this default and enable LAST COMMITTED for the current session.

The default isolation level remains in effect until you issue a SET TRANSACTION statement within a transaction. After a COMMIT WORK statement completes the transaction or a ROLLBACK WORK statement cancels the entire transaction, the isolation level is reset to the default.

When you use High Availability Data Replication, the database server effectively uses Dirty Read isolation on the HDR Secondary Server, regardless of the specified **SET ISOLATION** or **SET TRANSACTION** isolation level, unless the UPDATABLE_SECONDARY configuration parameter is enabled. For more information about this topic, see [Isolation Levels for Secondary Data Replication Servers](#).

Access Modes

Access modes affect read and write concurrency for rows within transactions. Use access modes to control data modification. SET TRANSACTION can specify that a transaction is read-only or read-write. By default, transactions are read-write. When you specify a read-only transaction, certain limitations apply. Read-only transactions cannot perform the following actions:

- Insert, delete, or update rows of a table.
- Create, alter, or drop any database object such as schemas, tables, temporary tables, indexes, or SPL routines.
- Grant or revoke access privileges.
- Update statistics.
- Rename columns or tables.

You can execute SPL routines in a read-only transaction as long as the SPL routine does not try to perform any restricted statement.

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Effects of Isolation Levels

You cannot set the transaction isolation level in a database that does not have logging. Every retrieval in an unlogged database occurs as a Read Uncommitted.

The data that is obtained during retrieval of BYTE or TEXT data can vary, depending on the transaction isolation levels. Under Read Uncommitted or Read Committed isolation levels, a process is permitted to read a BYTE or TEXT column that is either deleted (if the delete is not yet committed) or in the process of being deleted. Under these isolation levels, an application can read a deleted BYTE or TEXT column when certain conditions exist. For information about these conditions, see the *IBM® Informix Administrator's Guide*.

In Informix® ESQ/C, if you use a scroll cursor in a transaction, you can force consistency between your temporary table and the database table either by setting the isolation level to Serializable or by locking the entire table. A scroll cursor with hold, however, cannot guarantee the same consistency between the two tables. Table-level locks set by Serializable are released when the transaction is completed, but the scroll cursor with hold remains open beyond the end of the transaction. You can modify released rows as soon as the transaction ends, so the retrieved data in the temporary table might be inconsistent with the actual data. Warning: Do not use nonlogging tables within a transaction. If you need to use a nonlogging table within a transaction, either set the isolation level to Repeatable Read or lock the table in exclusive mode to prevent concurrency problems.

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SET Transaction Mode statement

Use the SET Transaction Mode statement to specify whether constraints are checked at the statement level or at the transaction level during the current transaction.

Syntax

```

      .-|-----|
      V          |
>>-SET CONSTRAINTS-----constraint-+-+--IMMEDIATE-+-----><
      '-ALL-----'      '-DEFERRED--'
```

Element	Description	Restrictions	Syntax
<i>constraint</i>	Constraint whose transaction mode is to be changed	All constraints must exist in the same database, which must support logging	Identifier

Usage

To enable or disable constraints, or to change their filtering mode, see [SET Database Object Mode statement](#).

This statement is valid only in a database with transaction logging, and its effect is limited to the transaction in which it is executed.

Use the IMMEDIATE keyword to set the transaction mode of constraints to statement-level checking. IMMEDIATE is the default transaction mode of constraints when they are created.

Use the DEFERRED keyword to set the transaction mode to transaction-level checking. You cannot change the transaction mode of a constraint to DEFERRED unless the constraint is currently enabled.

- [Statement-Level Checking](#)
- [Transaction-Level Checking](#)
- [Duration of Transaction Modes](#)
- [Specifying All Constraints or a List of Constraints](#)
- [Specifying Remote Constraints](#)
- [Examples of Setting the Transaction Mode for Constraints](#)

Related reference:

[CREATE TABLE statement](#)

[ALTER TABLE statement](#)

Statement-Level Checking

When you set the transaction mode to IMMEDIATE, statement-level checking is turned on, and all specified constraints are checked at the end of each INSERT, UPDATE, or DELETE statement. If a constraint violation occurs, the statement is not executed.

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Transaction-Level Checking

When you set the transaction mode of constraints to DEFERRED, statement-level checking is turned off, and all (or the specified) constraints are not checked until the transaction is committed. If a constraint violation occurs while the transaction is being committed, the transaction is rolled back.

Tip: If you defer checking a primary-key constraint, checking the not-NULL constraint for that column or set of columns is also deferred.

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Duration of Transaction Modes

The duration of the transaction mode that the SET Transaction Mode statement specifies is the transaction in which the SET Transaction Mode statement is executed. You cannot execute this statement outside a transaction. Once a COMMIT WORK or ROLLBACK WORK statement is successfully completed, the transaction mode of all constraints reverts to IMMEDIATE.

To switch from transaction-level checking to statement-level checking, you can use the SET Transaction Mode statement to set the transaction mode to IMMEDIATE, or you can use a COMMIT WORK or ROLLBACK WORK statement to terminate your transaction.

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Specifying All Constraints or a List of Constraints

You can specify all constraints in the database in the SET Transaction Mode statement, or you can specify a single constraint, or list of constraints.

If you specify the ALL keyword, the SET Transaction Mode statement sets the transaction mode for all constraints in the database. If any statement in the transaction requires that any constraint on any table in the database be checked, the database server performs the checks at the statement level or the transaction level, depending on the setting that you specify in the SET Transaction Mode statement.

If you specify a single constraint name or a list of constraints, the SET Transaction Mode statement sets the transaction mode for the specified constraints only. If any statement in the transaction requires checking of a constraint that you did not specify in the SET Transaction Mode statement, that constraint is checked at the statement level regardless of the setting that you specified in the SET Transaction Mode statement for other constraints.

When you specify a list of constraints, the constraints do not need to be defined on the same table, but they must exist in the same database.

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Specifying Remote Constraints

You can set the transaction mode of local constraints or remote constraints. That is, the constraints that are specified in the SET Transaction Mode statement can be constraints that are defined on local tables or constraints that are defined on remote tables.

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Examples of Setting the Transaction Mode for Constraints

The following example shows how to defer checking constraints within a transaction until the transaction is complete. The SET Transaction Mode statement in the example specifies that any constraints on any tables in the database are not checked until the COMMIT WORK statement is encountered.

```
BEGIN WORK;  
SET CONSTRAINTS ALL DEFERRED;  
...  
COMMIT WORK;
```

The following example specifies that a list of constraints is not checked until the transaction is complete:

```
BEGIN WORK;  
SET CONSTRAINTS update_const, insert_const DEFERRED;  
...  
COMMIT WORK;
```

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SET TRIGGERS statement

Use the SET TRIGGERS statement to enable or disable all or some of the triggers on a table, or all or some of the INSTEAD OF triggers on a view.

Syntax

```
.-,-,-----.  
v          |  
>>-SET TRIGGERS--+-trigger-+-----+----->  
    '-FOR--+-+-----+---+table+-'  
        '- 'owner' --.-' '-view--'  
  
.-ENABLED-----.  
>--+-+-----+-----+-----><  
    '-DISABLED--'
```

Element	Description	Restrictions	Syntax
<i>owner</i>	The owner of <i>table</i> or <i>view</i>	Must own the table or view	Owner name
<i>table</i>	Table whose triggers are all to be enabled or disabled	Must exist	Identifier
<i>trigger</i>	Trigger to be enabled or disabled	Must exist	Identifier
<i>view</i>	View whose INSTEAD OF triggers are all to be enabled or disabled	Must exist	Identifier

Usage

The SET TRIGGERS statement is a special case of the SET Database Object Mode statement. The SET Database Object Mode statement can also enable or disable an index or a constraint, or change the filtering mode of a unique index or of a constraint.

For the complete syntax and semantics of the SET TRIGGERS statement, see [SET Database Object Mode statement](#).

Restrictions on secondary servers

In cluster environments, the SET TRIGGERS statement is not supported on updatable secondary servers. (More generally, session-level index, trigger, and constraint modes that the SET Database Object Mode statement specifies are not redirected for UPDATE operations on table objects in databases of secondary servers.)

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SET USER PASSWORD statement (UNIX, Linux)

Use the SET USER PASSWORD statement to change your password for database server access if you are an internally authenticated user. This statement is an extension to the ANSI/ISO standard for the SQL language.

Syntax

```
>>-SET USER PASSWORD OLD--old_password--NEW--new_password-----><
```

Element	Description	Restrictions	Syntax
<i>new_password</i>	New password for internal authentication of the user.	Length must be between 6 and 32 bytes.	Quoted String
<i>old_password</i>	Existing password for internal authentication of the user.	Length must be between 6 and 32 bytes.	Quoted String

Usage

A DBSA cannot use this statement to change the password of another user. To change the passwords of other users, a DBSA can use the ALTER USER statement. Execution of the SET USER PASSWORD statement can be audited with the PWUR audit code.

Example

The following statement changes the password from **joebar** to **joefoo**:

```
SET USER PASSWORD OLD 'joebar' NEW 'joefoo';
```

Related reference:

[CREATE USER statement \(UNIX, Linux\)](#)

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START VIOLATIONS TABLE statement

Use the START VIOLATIONS TABLE statement to create a violations table and a diagnostics table for a specified target table. The START VIOLATIONS TABLE statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-START VIOLATIONS TABLE FOR--+-+-----+---table----->
                                '- 'owner' --,-'
>--+-----+-----+-----+----->
  '-USING--violations--,-diagnostics-'
>--+-----+-----+-----+-----><
  '-MAX ROWS--num_rows-'
```

Element	Description	Restrictions	Syntax
<i>diagnostics</i>	Declares the name of a diagnostics table to be associated with the target <i>table</i> . Default name is table_dia .	Must be unique among names of tables, views, sequences, and synonyms	Identifier
<i>num_rows</i>	Maximum number of rows that the database server can insert into <i>violations</i> when a single statement is executed on <i>table</i>	Must be an integer in range from 1 to the maximum value of the INTEGER data type	Literal Number
<i>owner</i>	The owner of <i>table</i>	Must own the table	Owner name
<i>table</i>	Target table for which <i>violations</i> and <i>diagnostics</i> tables are to be created	If USING clause is omitted, no more than 124 bytes	Identifier
<i>violations</i>	Violations table to be associated with <i>table</i> . Default name is table_vio .	Same restrictions as <i>diagnostics</i>	Identifier

Usage

The database server associates the *violations* table and the *diagnostics* table) with the target table that you specify after the FOR keyword by recording the relationship among the three tables in the **sysviolations** system catalog table.

A target table must satisfy these requirements:

- It cannot be a table in a database that is not the current database.
- It cannot be an object that the CREATE EXTERNAL TABLE statement defined.
- It cannot already be associated with a violations or diagnostics table.
- It cannot be a system catalog table.

The START VIOLATIONS TABLE statement creates the special violations table that holds nonconforming rows that fail to satisfy constraints and unique indexes during insert, update, and delete operations on target tables. This statement also creates the special diagnostics table that contains information about the integrity violations that each row causes in the violations table.

- [Relationship to the SET Database Object Mode statement](#)
- [Effect on concurrent transactions](#)
- [Stopping the Violations and Diagnostics Tables](#)
- [USING Clause](#)
- [Using the MAX ROWS clause](#)
- [Specifying the maximum number of rows in the diagnostics table](#)
- [Privileges required for starting violations or diagnostics tables](#)
- [Structure of the violations table](#)

When you issue START VIOLATIONS TABLE for a target table, the violations table that the statement creates has a predefined structure. This structure consists of the columns of the target table and three additional columns.

- [Examples of START VIOLATIONS TABLE Statements](#)
- [Relationships Among the Target, Violations, and Diagnostics Tables](#)

- [Initial Privileges on the Violations Table](#)
- [Example of Privileges on the Violations Table](#)
- [Using the Violations Table](#)
- [Example of a Violations Table](#)
- [Structure of the diagnostics table](#)

When you issue a START VIOLATIONS TABLE statement for a target table, the diagnostics table that the statement creates has a predefined structure. This structure is independent of the structure of the target table.

- [Initial privileges on the diagnostics table](#)
- [Using the Diagnostics Table](#)

The following issues concern the structure and use of the diagnostics table.

Related reference:

[Modes for constraints and unique indexes](#)
[STOP VIOLATIONS TABLE statement](#)
[CREATE INDEX statement](#)
[CREATE TABLE statement](#)
[SET Database Object Mode statement](#)

Related information:

[Object modes and violation detection](#)

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Relationship to the SET Database Object Mode statement

The START VIOLATIONS TABLE statement is closely related to the SET Database Object Mode statement. If you use SET Database Object Mode to set the constraints or unique indexes defined on a table to the FILTERING mode, without also using START VIOLATIONS TABLE, any rows that violate a constraint or unique-index requirement in data manipulation operations are not filtered out to a violations table. Instead you receive an error message that indicates that you must start a violations table for the target table.

Similarly, if you use the SET Database Object Mode statement to set a disabled constraint or disabled unique index to the ENABLED or FILTERING mode, but you do not use START VIOLATIONS TABLE for the table on which the database objects are defined, any rows that do not satisfy the constraint or unique-index requirement are not filtered out to a violations table.

In these cases, to identify the rows that do not satisfy the constraint or unique-index requirement, issue the START VIOLATIONS TABLE statement to start the violations and diagnostics tables. Do this before you use the SET Database Object Mode statement to set the database objects to the ENABLED or FILTERING database object mode.

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Effect on concurrent transactions

If the database has transaction logging, you must issue START VIOLATIONS TABLE in isolation. That is, no other transaction can be in progress on a target table when you issue START VIOLATIONS TABLE on that table within a transaction. Any transactions that start on the target table after the first transaction has issued the START VIOLATIONS TABLE statement will behave the same way as the first transaction with respect to the violations and diagnostics tables. That is, any constraint and unique-index violations by these subsequent transactions will be recorded in the violations and diagnostics tables.

For example, if transaction A operates on table **tab1** and issues a START VIOLATIONS TABLE statement on table **tab1**, the database server starts a violations table named **tab1_vio** and filters any constraint or unique-index violations on table **tab1** by transaction A to table **tab1_vio**. If transactions B and C start on table **tab1** after transaction A has issued the START VIOLATIONS TABLE statement, the database server also filters any constraint and unique-index violations by transactions B and C to table **tab1_vio**.

The result is that all three transactions do not receive error messages about constraint and unique-index violations, even though transactions B and C do not expect this behavior. For example, if transaction B issues an INSERT or UPDATE statement that violates a check constraint on table **tab1**, the database server does not issue a constraint violation error to transaction B. Instead, the database server filters the nonconforming row (also called a "bad row") to the violations table without notifying transaction B that a data-integrity violation occurred.

You can prevent this situation from arising in Informix® by specifying WITH ERRORS when you specify the FILTERING mode in a SET Database Object Mode, CREATE TABLE, ALTER TABLE, or CREATE INDEX statement. When multiple transactions operate on a table and the WITH ERRORS option is in effect, any transaction that violates a constraint or unique-index requirement on a target table receives a data-integrity error message.

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Stopping the Violations and Diagnostics Tables

After you use START VIOLATIONS TABLE to create an association between a target table and the violations and diagnostics tables, the only way to drop the association between the target table and the violations and diagnostics tables is to issue a STOP VIOLATIONS TABLE statement for the target table. For more information, see [STOP VIOLATIONS TABLE statement](#).

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USING Clause

You can use the USING clause to declare explicit names for the violations table and for the diagnostics table.

If you omit the USING clause, the database server assigns names to the violation table and the diagnostics table. The system-assigned name of the violations table consists of the name of the target table followed by the string `_vio`. The name that the database server assigns to the diagnostics table consists of the name of the target table followed by the string `_dia`.

If you omit the USING clause, the maximum length of the name of the target table is 124 bytes.

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Using the MAX ROWS clause

The MAX ROWS clause specifies the maximum number of rows that the database server can insert into the diagnostics table when a single statement is executed on the target table. If you omit the MAX ROWS clause, no upper limit is imposed on the number of rows that can be inserted into the diagnostics table when a single statement is executed on the target table.

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Specifying the maximum number of rows in the diagnostics table

The following statement starts violations and diagnostics tables for the target table named **orders**. The MAX ROWS clause specifies the maximum number of rows that can be inserted into the diagnostics table when a single statement, such as an INSERT statement, is executed on the target table.

```
START VIOLATIONS TABLE FOR orders MAX ROWS 50000;
```

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Privileges required for starting violations or diagnostics tables

To start a violations or a diagnostics table for a target table, you must meet one of the following requirements:

- You must have the DBA privilege on the database.
- You must be the owner of the target table and also have the Resource privilege on the database.
- You must have the Alter privilege on the target table and also have the Resource privilege on the database.

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Structure of the violations table

When you issue START VIOLATIONS TABLE for a target table, the violations table that the statement creates has a predefined structure. This structure consists of the columns of the target table and three additional columns.

The following table shows the schema of the violations table.

Column Name	Data Type	Column Description
Same columns (in the same order) that appear in the target table	Same types as corresponding columns in the target table.	The violations table has the same schema as the target table, so that rows violating constraints or a unique-index during insert, update, and delete operations can be filtered to the violations table.
informix_tupleid	SERIAL	Unique serial code for the nonconforming row
informix_optype	CHAR(1)	The type of operation that caused this bad row. This column can have the following values: <ul style="list-style-type: none">• I = Insert• D = Delete• O = Update (with original values in this row)• N = Update (with new values in this row)• S = SET Database Object Mode
informix_reowner	CHAR(32)	User who issued the statement that created this nonconforming row

If the target table of the START VIOLATIONS TABLE statement is protected by a security policy, the database server protects the violations table with same security policy. In this case, the schema of the violations table includes an IDSSECURITYLABEL column whose name and position among other columns corresponds to the

IDSSECURITYLABEL column of the target table. When the violations table is created, any SECURED WITH *label* specifications that protect columns in the target table also protect the corresponding violations table columns.

Serial columns in the target table are converted to integer data types in the violations table.

Users can examine these nonconforming rows in the violations table, analyze the related rows that contain diagnostic information in the diagnostics table, and take corrective actions.

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Examples of START VIOLATIONS TABLE Statements

The following examples show different ways to execute the START VIOLATIONS TABLE statement.

- [Violations and Diagnostics Tables with Default Names](#)
- [Violations and Diagnostics Tables with Explicit Names](#)

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Violations and Diagnostics Tables with Default Names

The following statement starts violations and diagnostics tables for the target table named **cust_subset**. The violations table is named **cust_subset_vio** by default, and the diagnostics table is named **cust_subset_dia** by default.

```
START VIOLATIONS TABLE FOR cust_subset;
```

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Violations and Diagnostics Tables with Explicit Names

The following statement starts a violations and diagnostics table for the target table named **items**. The USING clause assigns explicit names to the violations and diagnostics tables. The violations table is to be named **exceptions**, and the diagnostics table is to be named **reasons**.

```
START VIOLATIONS TABLE FOR items USING exceptions, reasons;
```

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Relationships Among the Target, Violations, and Diagnostics Tables

Users can take advantage of the relationships among the target, violations, and diagnostics tables to obtain diagnostic information about rows that cause data-integrity violations during INSERT, DELETE, and UPDATE statements. Each row of the violations table has at least one corresponding row in the diagnostics table.

- One row in the violations table is a copy of any row in the target table for which a data-integrity violation was detected. A row in the diagnostics table contains information about the nature of the data-integrity violation caused by the nonconforming row in the violations table.
- One row in the violations table has a unique serial identifier in the **informix_tupleid** column. A row in the diagnostics table has the same serial identifier in its **informix_tupleid** column.

A given row in the violations table can have more than one corresponding row in the diagnostics table. The multiple rows in the diagnostics table all have the same serial identifier in their **informix_tupleid** column so that they are all linked to the same row in the violations table. Multiple rows can exist in the diagnostics table for the same row in the violations table because a nonconforming row in the violations table can cause more than one data-integrity violation.

For example, the same nonconforming row can violate a unique index for one column, a not-NULL constraint for another column, and a check constraint for a third column. In this case, the diagnostics table contains three rows for the single nonconforming row in the violations table. Each of these diagnostic rows identifies a different data-integrity violation that the nonconforming row in the violations table caused.

By joining the violations and diagnostics tables, the DBA or target-table owner can obtain diagnostic information about any or all nonconforming rows in the violations table. SELECT statements can perform these joins interactively, or you can write a program to perform them within transactions.

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Initial Privileges on the Violations Table

When you issue the START VIOLATIONS TABLE statement to create the violations table, the database server uses the set of privileges granted on the target table as a basis for granting privileges on the violations table. The database server follows different rules, however, when it grants each type of privilege.

The following table summarizes the circumstances under which the database server grants each type of privilege on the violations table.

Privilege

Condition for Granting the Privilege

Alter

Alter privilege is not granted on the violations table. (Users cannot alter violations tables.)

Index

User has Index privilege on the violations table if the user has the Index privilege on the target table.

Insert

User has the Insert privilege on the violations table if the user has the Insert, Delete, or Update privilege on any column of the target table.

Delete

User has the Delete privilege on the violations table if the user has the Insert, Delete, or Update privilege on any column of the target table.

Select

User has the Select privilege on the **informix_tupleid**, **informix_optype**, and **informix_recowner** columns of the violations table if the user has the Select privilege on any column of the target table.

User has the Select privilege on any other column of the violations table if the user has the Select privilege on the same column in the target table.

Update

User has the Update privilege on the **informix_tupleid**, **informix_optype**, and **informix_recowner** columns of the violations table if the user has the Update privilege on any column of the target table.

(Even with the Update privilege on the **informix_tupleid** column, however, the user cannot update this SERIAL column.)

User has the Update privilege on any other violations table column if the user has the Update privilege on the same column in the target table.

References

The References privilege is not granted on the violations table. (Users cannot add referential constraints to violations tables.)

The following rules apply to ownership of the violations table and privileges on the violations table:

- When the violations table is created, the owner of the target table becomes the owner of the violations table.
- The owner of the violations table automatically receives all table-level privileges on the violations table, including the Alter and References privileges. The database server, however, prevents the owner of the violations table from altering the violations table or adding a referential constraint to the violations table.
- You can use the GRANT and REVOKE statements to modify the initial set of privileges on the violations table.
- When you issue an INSERT, DELETE, or UPDATE statement on a target table that has a filtering-mode unique index or constraint defined on it, you must have the Insert privilege on the violations and diagnostics tables.

If you do not have the Insert privilege on the violations and diagnostics tables, the database server executes the INSERT, DELETE, or UPDATE statement on the target table provided that you have the necessary privileges on the target table. The database server does not return an error concerning the lack of Insert privilege on the violations and diagnostics tables unless an integrity violation is detected during execution of the INSERT, DELETE, or UPDATE statement.

Similarly, when you issue a SET Database Object Mode statement to set a disabled constraint or disabled unique index to the enabled or filtering mode, and a violations table and diagnostics table exist for the target table, you must have the Insert privilege on the violations and diagnostics tables.

If you do not have the Insert privilege on the violations and diagnostics tables, the database server executes the SET Database Object Mode statement if you have the necessary privileges on the target table. The database server does not return an error concerning the lack of Insert privilege on the violations and diagnostics tables, unless an integrity violation is detected during the execution of the SET Database Object Mode statement.

- The grantor of the initial set of privileges on the violations table is the same as the grantor of the privileges on the target table.
For example, if user **henry** was granted the Insert privilege on the target table by both user **jill** and user **albert**, then the Insert privilege on the violations table is granted to **henry** both by **jill** and by **albert**.
- After the violations table is started, revoking a privilege on the target table from a user does not automatically revoke the same privilege on the violations table from that user. Instead, you must explicitly revoke the privilege on the violations table from the user.
- If you have fragment-level privileges on the target table, you have the corresponding fragment-level privileges on the violations table.

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Example of Privileges on the Violations Table

The following example illustrates how the initial set of privileges on a violations table is derived from the current set of privileges on the target table. Assume that a table named **cust_subset** consists of the following columns: **ssn** (customer Social Security number), **fname** (customer first name), **lname** (customer last name), and **city** (city in which the customer lives).

The following set of privileges exists on the **cust_subset** table:

- User **barbara** has the Insert and Index privileges on the table. She also has the Select privilege on the **ssn** and **lname** columns.
- User **carrie** has the Update privilege on the **city** column. She also has the Select privilege on the **ssn** column.
- User **danny** has the Alter privilege on the table.

Now user **alvin** starts a violations table named **cust_subset_viols** and a diagnostics table named **cust_subset_diags** for the **cust_subset** table:

```
START VIOLATIONS TABLE FOR cust_subset
USING cust_subset_viols, cust_subset_diags;
```

The database server grants the following set of initial privileges on the **cust_subset_viols** violations table:

- User **alvin** is the owner of the violations table, so he has all table-level privileges on the table.

- User **barbara** has the Insert, Delete, and Index privileges on the table.
User **barbara** has the Select privilege on five columns of the violations table: the **ssn**, the **lname**, the **informix_tupleid**, the **informix_optype**, and the **informix_reowner** columns.
- User **carrie** has Insert and Delete privileges on the violations table.
User **carrie** has the Update privilege on four columns of the violations table: the **city**, the **informix_tupleid**, the **informix_optype**, and the **informix_reowner** columns. She cannot, however, update the **informix_tupleid** column (because this is a SERIAL column).

User **carrie** has the Select privilege on four columns of the violations table: the **ssn** column, the **informix_tupleid** column, the **informix_optype** column, and the **informix_reowner** column.
- User **danny** has no privileges on the violations table.

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Using the Violations Table

The following rules concern the structure and use of the violations table:

- Every pair of update rows in the violations table has the same value in the **informix_tupleid** column to indicate that both rows refer to the same row in the target table.
- If the target table has columns named **informix_tupleid**, **informix_optype**, or **informix_reowner**, the database server attempts to generate alternative names for these columns in the violations table by appending a digit to the end of the column name (for example, **informix_tupleid1**). If this fails, an error is returned, and no violations table is started for the target table.
- When a table functions as a violations table, it cannot have triggers or constraints defined on it.
- When a table functions as a violations table, users can create indexes on it, even though the existence of an index affects performance. Unique indexes on the violations table cannot be set to FILTERING database object mode.
- If a target table has a violations and diagnostics table associated with it, dropping the target table in cascade mode (the default mode) causes the violations and diagnostics tables to be dropped also. If the target table is dropped in the restricted mode, the DROP TABLE operation fails (because the violations and diagnostics tables exist).
- After a violations table is started for a target table, ALTER TABLE cannot add, modify, or drop columns of the violations, diagnostics, or target tables. Before you can alter any of these tables, you must issue a STOP VIOLATIONS TABLE statement for the target table.
- The database server does not clear out the contents of the violations table before or after it uses the violations table during an INSERT, UPDATE, DELETE, or SET Database Object Mode operation.
- If a target table has a filtering-mode constraint or unique index defined on it and a violations table associated with it, users cannot insert into the target table by selecting from the violations table. Before you insert rows into the target table by selecting from the violations table, you must take one of the following steps:
 - You can set the constraint or unique index to DISABLED mode.
 - You can issue STOP VIOLATIONS TABLE for the target table.

If it is inconvenient to take either of these steps, but you intend to copy records from the violations table into the target table, a third option is to select from the violations table into a temporary table and then insert the contents of the temporary table into the target table.

- If the target table that is specified in the START VIOLATIONS TABLE statement is fragmented, the violations table has the same fragmentation strategy as the target table. Each fragment of the violations table is stored in the same dbspace partition as the corresponding fragment of the target table.
- Once a violations table is started for a target table, you cannot use the ALTER FRAGMENT statement to alter the fragmentation strategy of the target table or the violations table.
- If the target table specified in the START VIOLATIONS TABLE statement is not fragmented, the database server places the violations table in the same dbspace as the target table.
- If the target table has BYTE or TEXT columns, BYTE or TEXT data values in the violations table are created in the same blob space that stores the BYTE or TEXT data in the target table.

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Example of a Violations Table

To start a violations and diagnostics table for the target table named **customer** in the demonstration database, enter the following statement:

```
START VIOLATIONS TABLE FOR customer;
```

Because you include no USING clause, the violations table is named **customer_vio** by default. The **customer_vio** table includes these five columns:

Column One	Column Two	Column Three	Column Four	Column Five
customer_num fname lname	company address1 address2	city state	zipcode phone	informix_tupleid informix_optype informix_reowner

The **customer_vio** table has the same table definition as the **customer** table except that the **customer_vio** table has three additional columns that contain information about the operation that caused the nonconforming row.

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Structure of the diagnostics table

When you issue a START VIOLATIONS TABLE statement for a target table, the diagnostics table that the statement creates has a predefined structure. This structure is independent of the structure of the target table.

The following table shows the schema of the diagnostics table.

Column Name	Data Type	Description
informix_tupleid	INTEGER	Implicitly refers to informix_tupleid column values in the violations table This relationship, however, is not declared as a foreign-key to primary-key relationship.
objtype	CHAR(1)	Identifies the type of violation This column can have the following values: <ul style="list-style-type: none">• C = Constraint violation• I = Unique-index violation
objowner	CHAR(32)	Identifies the owner of the constraint or index for which an integrity violation was detected
objname	VARCHAR(128, 0)	Contains the name of the constraint or index for which an integrity violation was detected

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Initial privileges on the diagnostics table

When the START VIOLATIONS TABLE statement creates the diagnostics table, the set of access privileges granted on the target table are a basis for granting privileges on the diagnostics table. The database server follows different rules, however, when it grants each type of privilege.

The following table explains the circumstances under which the database server grants each privilege on the diagnostics table.

Privilege

Condition for Granting the Privilege

Insert

User has the Insert privilege on the diagnostics table if the user has the Insert, Delete, or Update privilege on any column of the target table.

Delete

User has the Delete privilege on the diagnostics table if the user has the Insert, Delete, or Update privilege on any column of the target table.

Select

User has the Select privilege on the diagnostics table if the user has the Select privilege on any column in the target table.

Update

User has the Update privilege on the diagnostics table if the user has the Update privilege on any column in the target table.

Index

User has the Index privilege on the diagnostics table if the user has the Index privilege on the target table.

Alter

Alter privilege is not granted on the diagnostics table.
(Users cannot alter the schema of diagnostics tables.)

References

References privilege is not granted on the diagnostics table.
(Users cannot define referential constraints on diagnostics tables.)

The following rules concern access privileges on the diagnostics table:

- When the diagnostics table is created, the owner of the target table becomes the owner of the diagnostics table.
 - The owner of the diagnostics table automatically receives all table-level privileges on the diagnostics table, including the Alter and References privileges. The database server, however, prevents the owner of the diagnostics table from altering the diagnostics table or adding a referential constraint to the diagnostics table.
 - You can use the GRANT and REVOKE statements to modify the initial set of privileges on the diagnostics table.
 - For INSERT, DELETE, or UPDATE operations on a target table that has a filtering-mode unique index or constraint defined on it, you must have the Insert privilege on the violations and diagnostics tables.
If you do not have the Insert privilege on the violations and diagnostics tables, the database server executes the INSERT, DELETE, or UPDATE statement on the target table, provided you have the necessary privileges on the target table. The database server does not return an error concerning the lack of Insert privilege on the violations and diagnostics tables unless an integrity violation is detected during execution of the INSERT, DELETE, or UPDATE statement.
- Similarly, when you issue a SET Database Object Mode statement to set a disabled constraint or disabled unique index to the enabled or filtering mode, and a violations table and diagnostics table exist for the target table, you must have the Insert privilege on the violations and diagnostics tables.
- If you do not have the Insert privilege on the violations and diagnostics tables, the database server executes the SET Database Object Mode statement, provided you have the necessary privileges on the target table. The database server does not return an error concerning the lack of Insert privilege on the violations and diagnostics tables unless an integrity violation is detected during the execution of the SET Database Object Mode statement.
- The grantor of the initial set of privileges on the diagnostics table is the same as the grantor of the privileges on the target table. For example, if the user **jenny** was granted the Insert privilege on the target table by both the user **wayne** and the user **laurie**, both user **wayne** and user **laurie** grant the Insert privilege on the diagnostics table to user **jenny**.
 - Once a diagnostics table is started for a target table, revoking a privilege on the target table from a user does not automatically revoke the same privilege on the diagnostics table from that user. Instead you must explicitly revoke the privilege on the diagnostics table from the user.
 - If you have fragment-level privileges on the target table, you have the corresponding table-level privileges on the diagnostics table.

The next example illustrates how the initial set of privileges on a diagnostics table is derived from the current privileges on the target table. Assume that you have a table called **cust_subset** that holds **customer** data. This table consists of the following columns: **ssn** (social security number), **fname** (first name), **lname** (last name), and **city** (city in which the customer lives). The following set of access privileges exists on the **cust_subset** table:

- User **alvin** is the owner of the table.
- User **barbara** has the Insert and Index privileges on the table. She also has the Select privilege on the **ssn** and **lname** columns.
- User **danny** has the Alter privilege on the table.
- User **carrie** has the Update privilege on the **city** column. She also has the Select privilege on the **ssn** column.

Now user **alvin** starts a violations table named **cust_subset_viol**s and a diagnostics table named **cust_subset_diags** for the **cust_subset** table:

```
START VIOLATIONS TABLE FOR cust_subset
  USING cust_subset_viol, cust_subset_diags;
```

The database server grants the following set of initial privileges on the **cust_subset_diags** diagnostics table:

- User **alvin** is the owner of the diagnostics table, so he has all table-level privileges on the table.
- User **barbara** has the Insert, Delete, Select, and Index privileges on the diagnostics table.
- User **carrie** has the Insert, Delete, Select, and Update privileges on the diagnostics table.
- User **danny** has no privileges on the diagnostics table.

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Using the Diagnostics Table

The following issues concern the structure and use of the diagnostics table.

- The MAX ROWS clause of the START VIOLATIONS TABLE statement sets a limit on the number of rows that can be inserted into the diagnostics table when you execute a single statement, such as an INSERT or SET Database Object Mode statement, on the target table.
- The MAX ROWS clause limits the number of rows only for operations in which the table functions as a diagnostics table.
- When a table functions as a diagnostics table, it cannot have triggers or constraints defined on it.
- When a table functions as a diagnostics table, users can create indexes on the table, but the existence of an index affects performance. You cannot set unique indexes on a diagnostics table to FILTERING database object mode.
- If a target table has a violations and diagnostics table associated with it, dropping the target table in cascade mode (the default mode) causes the violations and diagnostics tables to be dropped also.
- If the target table is dropped in restricted mode, the DROP TABLE operation fails (because the violations and diagnostics tables exist).
- Once a violations table is started for a target table, you cannot use the ALTER TABLE statement to add, modify, or drop columns in the target table, violations table, or diagnostics table. Before you can alter any of these tables, you must issue a STOP VIOLATIONS TABLE statement for the target table.
- The database server does not clear out the contents of the diagnostics table before or after it uses the diagnostics table during an Insert, Update, Delete, Merge, SET CONSTRAINTS, or SET INDEXES operation.
- If the target table that is specified in the START VIOLATIONS TABLE statement is fragmented, the diagnostics table is fragmented with a round-robin strategy over the same dbspaces in which the target table is fragmented.

To start a violations and diagnostics table for the target table named **stock** in the demonstration database, enter the following statement:

```
START VIOLATIONS TABLE FOR stock;
```

Because your START VIOLATIONS TABLE statement does not include a USING clause, the diagnostics table is named **stock_dia** by default. The **stock_dia** table includes the following two columns:

Column One	Column Two
informix_tupleid objtype	objowner objname

This list of columns shows an important difference between the diagnostics table and violations table for a target table. Whereas the violations table has a matching column for every column in the target table, the columns of the diagnostics table do not match any columns in the target table. The diagnostics table created by any START VIOLATIONS TABLE statement always has the same columns, with the same column names and data types.

For information on the relationship between the diagnostics table and the violations table, see [Relationships Among the Target, Violations, and Diagnostics Tables](#).

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STOP VIOLATIONS TABLE statement

Use the STOP VIOLATIONS TABLE statement to drop the association between a target table, its violations table, and its diagnostics table. This statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-STOP VIOLATIONS TABLE FOR--+-----+--table-----><
                                '- 'owner' --.-'
```


Element	Description	Restrictions	Syntax
<i>owner</i>	The owner of <i>table</i>	Must own the table	Owner name
<i>table</i>	Name of a target table whose association with the violations and diagnostics table is to be dropped. No default value exists.	Must be a local table that has an associated violations table and a diagnostics table	Identifier

Usage

The STOP VIOLATIONS TABLE statement drops the association between the target table, the violations table, and the diagnostics table. After you issue this statement, the former violations and diagnostics tables continue to exist, but they no longer function as violations and diagnostics tables for the target table. They now have the status of regular database tables instead of violations and diagnostics tables for the target table. You must issue the DROP TABLE statement to drop these two tables explicitly.

When DML operations (INSERT, DELETE, or UPDATE) cause data-integrity violations for rows of the target table, the nonconforming rows are no longer filtered to the former violations table, and diagnostic information about the data-integrity violations is not placed in the former diagnostics table.

- [Example of Stopping the Violations and Diagnostics Tables](#)
- [Example of Dropping the Violations and Diagnostics Tables](#)
- [Privileges Required for Stopping a Violations Table](#)

Related reference:

[Modes for constraints and unique indexes](#)
[SET Database Object Mode statement](#)
[START VIOLATIONS TABLE statement](#)

Related information:

[Object modes and violation detection](#)

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Example of Stopping the Violations and Diagnostics Tables

Assume that a target table named **cust_subset** has an associated violations table named **cust_subset_vio** and an associated diagnostics table named **cust_subset_dia**. To drop the association between the target table and the violations and diagnostics tables, enter the following statement:

```
STOP VIOLATIONS TABLE FOR cust_subset;
```

This deletes the row in the **sysviolations** system catalog table that had registered the former association. Subsequent DML operations on the target **cust_subset** table will no longer cause the database server to insert information about nonconforming rows into its former violations table or diagnostics table.

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Example of Dropping the Violations and Diagnostics Tables

After you execute the STOP VIOLATIONS TABLE statement in the preceding example, the **cust_subset_vio** and the **cust_subset_dia** tables continue to exist, but they are no longer associated with the **cust_subset** table. Instead they now have the status of regular database tables. To drop these two tables, enter the following statements:

```
DROP TABLE cust_subset_vio;  
DROP TABLE cust_subset_dia;
```

If you had previously issued the DROP TABLE statement without the RESTRICT keyword to successfully drop the **cust_subset** table, then the statements above would not be necessary, because dropping the target table in cascade mode implicitly drops any associated violations table and diagnostics table.

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Privileges Required for Stopping a Violations Table

To stop a violations or a diagnostics table for a given target table, you must meet one of the following requirements:

- You must have the DBA privilege on the database.
- You must be the owner of the target table and have the Resource privilege on the database.
- You must have the Alter privilege on the target table and the Resource privilege on the database.

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TRUNCATE statement

The **TABLE** keyword has no effect on this statement, but it can be included to make your code more legible for human readers. Both of the following statements have the same effect, deleting all rows and any related index data from the **customer** table:

```
TRUNCATE TABLE customer;
```

```
TRUNCATE customer;
```

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The Table Specification

You must specify the name or synonym of a table in the local database to which you are currently connected. If the **USETABLENAME** environment variable is set, you must use the name of the table, rather than a synonym. The table can be of type **STANDARD**, **RAW**, or **TEMP**, but you cannot specify the name or synonym of a view, or an object that the **CREATE EXTERNAL TABLE** statement defined. (Categories of tables that are not valid with **TRUNCATE** are listed in the section [Restrictions on the TRUNCATE statement](#).)

In a database that is ANSI-compliant, you must specify the *owner* qualifier if you are not the owner of the *table* or *synonym*.

After the **TRUNCATE** statement begins execution, Informix® attempts to place an exclusive lock on the specified table, to prevent other sessions from locking the table until the **TRUNCATE** statement is committed or rolled back. Exclusive locks are also applied to any dependent tables of the truncated table within a table hierarchy.

While concurrent sessions that use the Dirty Read isolation level are reading the table, however, the **TRUNCATE** statement fails with an RSAM -106 error. To reduce this risk, you can set the **IFX_DIRTY_WAIT** environment variable to specify that the **TRUNCATE** operation wait for a specified number of seconds for Dirty Read transactions to commit or rollback.

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The STORAGE specification

The optional **DROP STORAGE** or **REUSE STORAGE** keywords specify what action the database server takes with the storage extents of the table when the **TRUNCATE** operation begins. If you omit this specification, the **DROP STORAGE** option is the default.

Using the default or explicit **DROP STORAGE** option, a successful **TRUNCATE** statement releases all but the first extent among the extents currently allocated to the table and to its indexes. You can display the current list of extents with the `oncheck -pT table` command. If your table has only one extent, no space will be freed.

For the following table, for example, four default eight-page extents were merged into what is now the first extent. There is also a second, larger extent:

Extents					
Logical Page	Physical Page	Size	Physical	Pages	
0	1:104455	32		32	
32	1:104495	4576		4576	

After the **TRUNCATE** statement runs, output from the same `oncheck` command displays this:

Extents					
Logical Page	Physical Page	Size	Physical	Pages	
0	1:104455	32		32	

Alternatively, if you intend to keep the same storage space allocated to the same table for subsequently loaded data, specify the **REUSE STORAGE** keywords to prevent the space from being deallocated. The **REUSE STORAGE** option of **TRUNCATE** can make storage management more efficient in applications where the same table is periodically emptied and reloaded with new rows.

The following example truncates the **state** table and frees all of its extents except the first extent:

```
TRUNCATE TABLE state DROP STORAGE;
```

The following example truncates the same table but removes only the actual data. All extents stay the same.

```
TRUNCATE TABLE state REUSE STORAGE;
```

Whether you specify **DROP STORAGE** or **REUSE STORAGE**, any out-of-row data values are released for all rows of the table when the **TRUNCATE** transaction is committed. Storage occupied by any BLOB or CLOB values that become unreferenced in the **TRUNCATE** transaction is also released.

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The AM_TRUNCATE Purpose Function

Informix® provides built-in **am_truncate** purpose functions for its primary access methods that support **TRUNCATE** operations on columns of permanent and temporary tables. It also provides a built-in **am_truncate** purpose function for its secondary access method for **TRUNCATE** operations on B-tree indexes.

For the **TRUNCATE** statement to work correctly in a virtual table interface (VTI) table requires a valid **am_truncate** purpose function in the primary access method for the data type of the VTI table. To register a new primary access method in the database, use the **CREATE PRIMARY ACCESS_METHOD** statement of SQL:

```
CREATE PRIMARY ACCESS METHOD vti (
  AM_GETNEXT = vti_getnext
  AM_TRUNCATE = vti_truncate
  ...);
```

You can also use the ALTER ACCESS_METHOD statement to add a valid **am_truncate** purpose function to an existing access method that has no **am_truncate** purpose function:

```
ALTER ACCESS_METHOD abc (ADD AM_TRUNCATE = abc_truncate);
```

In these examples, the **vti_truncate** and **abc_truncate** functions must be routines that support the functionality of the AM_TRUNCATE purpose option keyword, and that were previously registered in the database by the CREATE FUNCTION or CREATE ROUTINE FROM statement.

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Performance Advantages of TRUNCATE

The TRUNCATE statement is not equivalent to DROP TABLE. After TRUNCATE successfully executes, the specified *table* and all its columns and indexes are still registered in the database, but with no rows of data. In information management applications that require replacing all of the records in a table after some time interval, TRUNCATE requires fewer updates to the system catalog than the equivalent DROP TABLE, CREATE TABLE, and any additional DDL statements to redefine any synonyms, views, constraints, triggers, privileges, fragmentation schemes, and other attributes and associated database objects of the table.

In contexts where no existing rows of a table are needed, the TRUNCATE statement is typically far more efficient than using the DELETE statement with no WHERE clause to empty the table, because TRUNCATE requires fewer resources and less logging overhead than DELETE:

- DELETE FROM *table* deletes each row as a separately logged operation. If indexes exist on the table, each index must be updated when a row is deleted, and this update is also logged for each row. If an enabled Delete trigger is defined on the table, its triggered actions must also be executed and logged.
- TRUNCATE *table* performs the removal of all rows and of the B-tree structures of every index on the table as a single operation, and writes a single entry in the logical log when the transaction that includes TRUNCATE is committed or rolled back. The triggered action of any enabled trigger is ignored.

These performance advantages of TRUNCATE over DELETE are reduced when the table has one or more columns with the following attributes:

- Any simple large object data types stored in blobspaces
- Any BLOB, CLOB, complex, or user-defined types stored in sbspaces
- Any opaque types for which a **destroy** support function is defined.

Each of these features require the database server to read each row of the table, substantially reducing the speed of TRUNCATE.

If a table includes one or more UDTs for which you have registered an **am_truncate()** purpose function, then the performance difference between TRUNCATE and DELETE would reflect the relative costs of invoking the **am_truncate** interface once for TRUNCATE versus invoking the **destroy()** support function for each row.

As listed in the next section, certain conditions cause TRUNCATE to fail with an error. Some of these conditions have no effect on DELETE operations, so in those cases you can remove all rows more efficiently with a DELETE statement, as in the following operation on the **customer** table:

```
DELETE customer;
```

The FROM keyword that immediately follows DELETE can be omitted, as in this example, only if the **DELIMIDENT** environment variable is set.

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Restrictions on the TRUNCATE statement

The TRUNCATE statement fails if any of the following conditions exist:

- The user does not hold the Delete access privilege on the table.
- The table has an enabled Delete trigger, but the user lacks the Alter privilege.
- The specified table or synonym does not exist in the local database.
- The table was defined by the CREATE EXTERNAL TABLE statement.
- The specified synonym does not reference a table in the local database.
- The statement specifies a synonym for a local table, but the **USETABLENAME** environment variable is set.
- The statement specifies the name of a view or a synonym for a view.
- The table is a system catalog table or a system-monitoring interface (SMI) table.
- An R-tree index is defined on the table.
- The table is a virtual table (or has a virtual-index interface) for which no valid **am_truncate** access method exists in the database.
- An Enterprise Replication replicate that is not a master replicate is defined on the table. (For more information about replicates, see the .)
- A shared or exclusive lock on the table already exists.
- One or more cursors are open on the table.
- A concurrent session with Dirty Read isolation level is reading the table.
- Another table, with at least one row, has an enabled foreign-key constraint on the specified table. (An enabled foreign key constraint of another table that has no rows, however, has no effect on a TRUNCATE operation.)

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UNLOAD statement

Use the UNLOAD statement to write the rows retrieved by a SELECT statement to an operating-system file. The UNLOAD statement is an extension to the ANSI/ISO standard for SQL.

Syntax

Only DB-Access supports the UNLOAD statement.

```
>>-UNLOAD TO-- 'filename'--+-+-----+----->
                               '-DELIMITER-- 'delimiter'-'
                               (1)
>--+| SELECT Statement |-----+-----><
  '-variable-----'
```

Notes:

1. See [SELECT statement](#)

Element	Description	Restrictions	Syntax
<i>delimiter</i>	Quoted string to specify the field delimiter character in <i>filename</i> file	See DELIMITER Clause	Quoted String
<i>filename</i>	Operating-system file to receive the rows. Default <i>pathname</i> is the current directory.	See UNLOAD TO File .	Quoted String
<i>variable</i>	Host variable that contains the text of a valid SELECT statement	Must have been declared as a character data type	Language- specific

Usage

Important: Use the UNLOAD statement only with DB-Access.

The UNLOAD statement copies to a file the rows retrieved by a query. You must have the Select privilege on all columns specified in the SELECT statement. For information on database-level and table-level privileges, see [GRANT statement](#).

You can specify a literal SELECT statement or a character variable that contains the text of a SELECT statement. (See [SELECT statement](#).)

The following example unloads rows whose value of `customer.customer_num` is greater than or equal to 138, and writes them to a file named `cust_file`:

```
UNLOAD TO 'cust_file' DELIMITER '!'
SELECT * FROM customer WHERE customer_num >= 138;
```

The resulting output file, `cust_file`, contains two rows of data values:

```
138!Jeffery!Padgett!Wheel Thrills!3450 El Camino!Suite 10!Palo Alto!CA!94306!!
139!Linda!Lane!Palo Alto Bicycles!2344 University!!Palo Alto!CA!94301!
(415) 323-5400
```

- [UNLOAD TO File](#)
The UNLOAD TO file, as specified by the *filename* parameter, receives the retrieved rows.
- [DELIMITER Clause](#)
Use the DELIMITER clause of the UNLOAD statement to specify the delimiter that separates the data contained in each column in a row in the output file.

Related reference:

[LOAD statement](#)

[OUTPUT statement](#)

[SELECT statement](#)

Related information:

[Environment variables](#)

[Unload data from a database](#)

[Data migration utilities](#)

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UNLOAD TO File

The UNLOAD TO file, as specified by the *filename* parameter, receives the retrieved rows.

You can use an UNLOAD TO file as input to a LOAD statement.

UNLOAD TO data formats in the default U.S. English locale

In the default locale, data values have these formats in the UNLOAD TO file.

Data Type	Output Format
BOOLEAN	BOOLEAN values appear as either t for TRUE or f for FALSE.

Data Type	Output Format
Character	If a character field contains the delimiter, IBM® Informix® products automatically escape it with a backslash (\) to prevent interpretation as a special character. In the UNLOAD TO file, a literal backslash character is represented as two consecutive backslash characters (\ \). If you use the LOAD statement of DB-Access to insert the rows into a table, the backslash escape characters are automatically stripped from that table.
Collections	A collection is unloaded with its values between braces ({ }) and a delimiter between each element. For more information, see Unloading Complex Types .
DATE	DATE values are represented as <i>mm/dd/yyyy</i> (or the default format for the database locale), where <i>mm</i> is the month (January = 1, and so on), <i>dd</i> is the day, and <i>yyyy</i> is the year. If you have set the GL_DATE or DBDATE environment variable, the UNLOAD statement uses the specified date format for DATE values.
DATETIME, INTERVAL	Literal DATETIME and INTERVAL values appear as digits and delimiters, without keyword qualifiers, in the default format <i>yyyy-mm-dd hh:mi:ss.fff</i> . Time units outside the declared precision are omitted. If the GL_DATETIME or DBTIME environment variable is set, DATETIME values appear in the specified format.
DECIMAL, MONEY	Values are unloaded with no leading currency symbol. In the default locale, comma (,) is the <i>thousands</i> separator and period (.) is the decimal separator. If DBMONEY is set, UNLOAD uses its specified separators and currency format for MONEY values.
NULL	NULL appears as two delimiters with no characters between them.
Number	Values appear as literals, with no leading blanks. For BIGINT, INTEGER, INT8, and SMALLINT data types, zero appears as 0. For MONEY, FLOAT, SMALLFLOAT, and DECIMAL data types, zero appears as 0 . 0.
ROW types (named and unnamed)	A ROW type is unloaded with its values enclosed between parentheses and a field delimiter separating each element. For more information, see Unloading Complex Types .
Simple large objects (TEXT, BYTE)	TEXT and BYTE columns are unloaded directly into the UNLOAD TO file. BYTE values appear in ASCII hexadecimal form, with no added white space or newline characters. For more information, see Unloading Simple Large Objects .
Smart large objects (CLOB, BLOB)	CLOB and BLOB columns are unloaded into a separate operating-system file (for each column) on the client computer. The CLOB or BLOB field in the UNLOAD TO file contains the name of this file. For more information, see Unloading Smart Large Objects .
User-defined data types (opaque types)	Opaque types must have an export() support function defined. They need special processing to copy data from the internal format of the opaque data type to the UNLOAD TO file format. An exportbinary() support function might also be required for data in binary format. The data in the UNLOAD TO file would correspond to the format that the export() or exportbinary() support function returns.

UNLOAD TO data formats in nondefault locales

In nondefault locales, DATE, DATETIME, MONEY, and numeric column values have formats that the locale supports for these data types. For more information, see the *IBM Informix GLS User's Guide*. For more information on **DBDATE**, **DBMONEY**, and **DBTIME** environment variables, refer to the *IBM Informix Guide to SQL: Reference*.

In databases that use a nondefault locale, if the **GL_DATETIME** environment variable has a nondefault setting, the **USE_DTEENV** environment variable must be set to 1 before the UNLOAD statement can correctly unload localized DATETIME values from the database table, or from view, or from a table object defined by the EXTERNAL TABLE statement. For more information on the **GL_DATETIME**, **GL_DATE**, and **USE_DTEENV** environment variables, refer to the *IBM Informix GLS User's Guide*.

- [Unloading Character Columns](#)
- [Unloading Simple Large Objects](#)
- [Unloading Smart Large Objects](#)
- [Unloading Complex Types](#)

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Unloading Character Columns

In unloading files that contain VARCHAR or NVARCHAR columns, trailing blanks are retained in VARCHAR, LVARCHAR, or NVARCHAR fields. Trailing blanks are discarded when CHAR or NCHAR columns are unloaded.

For CHAR, VARCHAR, NCHAR, and NVARCHAR columns, an empty string (a data string of zero length, containing no characters) appears in the UNLOAD TO file as the four bytes “ | \ | ” (delimiter, backslash, blank space, delimiter).

Some earlier releases of Informix® database servers used “ | | ” (consecutive delimiters) to represent the empty string in LOAD and UNLOAD operations. In this release, however, “ | | ” only represents NULL values in CHAR, VARCHAR, LVARCHAR, NCHAR, and NVARCHAR columns.

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Unloading Simple Large Objects

The database server writes BYTE and TEXT values directly into the UNLOAD TO file. BYTE values are written in hexadecimal dump format with no added blank spaces or new line characters. The logical length of an UNLOAD TO file containing BYTE data can therefore be long and difficult to print or edit.

If you are unloading files that contain simple-large-object data types, do not use characters that can appear in BYTE or TEXT values as delimiters in the UNLOAD TO file. See also the section [DELIMITER Clause](#).

The database server handles any required code-set conversions for TEXT data. For more information, see the *IBM® Informix® GLS User's Guide*.

If you are unloading files that contain simple-large-object data types, objects smaller than 10 kilobytes are stored temporarily in memory. You can adjust the 10-kilobyte setting to a larger setting with the **DBBLOBBUF** environment variable. BYTE or TEXT values larger than the default or the **DBBLOBBUF** setting are stored in a temporary file. For additional information about **DBBLOBBUF**, see the *IBM Informix Guide to SQL: Reference*.

Related information:

[DBBLOBBUF environment variable](#)

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Unloading Smart Large Objects

The database server unloads smart large objects (from BLOB or CLOB columns) into a separate operating-system file for each column, in the same directory on the client computer as the UNLOAD TO file. All the smart blobs in the same column are stored in a single file. The filename has one of these formats:

- For a BLOB value: blob#####
- For a CLOB value: clob#####

In the preceding formats, the pound (#) symbols represent the digits of the unique hexadecimal smart-large-object identifier of the first smart large object in the file. The maximum number of digits for a smart-large-object identifier is 17. Most smart large objects, however, would have an identifier with fewer digits.

When the database server unloads the first smart large object, it creates the appropriate BLOB or CLOB client file with the hexadecimal identifier of the smart large object. If additional smart-large-object values are present in the same column, the database server writes their values to the same file, and lists in the UNLOAD TO file (*.unl) the sbspace, chunk, and page numbers, and smart large object identifier, for each BLOB or CLOB value in the file.

The following example shows an UNLOAD TO file entry for two smart large object values from the same column:

```
Object # 1
Space Chunk Page = [5,6,3] Object ID = 1192071051
```

```
Object #2
Space Chunk Page = [5,6,4] Object ID = 1192071050
```

```
both rows unloaded
```

In an UNLOAD TO file, a BLOB or CLOB column value appears in this format:

start_off,length,client_path

Here *start_off* is the starting offset (in hexadecimal format) of the smart-large-object value within the client file, *length* is the length (in hexadecimal) of the BLOB or CLOB value, and *client_path* is the pathname for the client file. No blank spaces can appear between these values. If a CLOB value is 512 bytes long and is at offset 256 in the `/usr/apps/clob9ce7.318` file, for example, then the CLOB value appears as follows in the UNLOAD TO file:

```
|100,200,/usr/apps/clob9ce7.318|
```

If a BLOB or CLOB column value occupies an entire client file, the CLOB or BLOB column value appears as follows in the UNLOAD TO file:

client_path

For example, if a CLOB value occupies the entire file `/usr/apps/clob9ce7.318`, the CLOB value appears as follows in the UNLOAD TO file:

```
|/usr/apps/clob9ce7.318|
```

For locales that support multibyte code sets, be sure that the declared size (in bytes) of any column that receives character data is large enough to store the entire data string. For some locales, this can require up to 4 times the number of logical characters in the longest data string.

The database server handles any required code-set conversions for CLOB data. For more information, see the *IBM® Informix® GLS User's Guide*.

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Unloading Complex Types

In an UNLOAD TO file, values of complex data types appear as follows:

- Collections are introduced with the appropriate constructor (MULTISET, LIST, SET), with their comma-separated elements enclosed in braces ({}):

```
constructor{val1 , val2 , ... }
```

For example, to unload the SET values {1, 3, 4} from a column of the SET (INTEGER NOT NULL) data type, the corresponding field of the UNLOAD TO file appears as follows:

```
|SET{1 , 3 , 4}|
```

- ROW types (named and unnamed) are introduced by the ROW constructor and have their fields enclosed between parentheses and comma-separated:

```
ROW(val1 , val2 , ... )
```

For example, to unload the ROW values (1, 'abc'), the corresponding field of the UNLOAD TO file appears as follows:

```
|ROW(1 , abc) |
```

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DELIMITER Clause

Use the DELIMITER clause of the UNLOAD statement to specify the delimiter that separates the data contained in each column in a row in the output file.

If you omit this clause, then DB-Access checks the setting of the **DBDELIMITER** environment variable. If **DBDELIMITER** has not been set, the default delimiter is the pipe (|) symbol. You can specify the tab character TAB (CTRL-I) or a blank space (ASCII 32) as the delimiter symbol.

The following characters are not valid in any locale as delimiter symbols:

- Newline character (CTRL-J)
- Hexadecimal digits (0 to 9, a to f, A to F)
- Backslash (\)

The backslash (\) is not a valid field separator or record delimiter because it is the default escape character, indicating that the next character is a literal character in the data, rather than a special character. However, if you change the default escape character by setting the DEFAULTESCCHAR configuration parameter or the DEFAULTESCCHAR session environment option, you can use a backslash as a field separator.

The following UNLOAD statement specifies the semicolon (;) as the delimiter:

```
UNLOAD TO 'cust.out' DELIMITER ';'
SELECT fname, lname, company, city FROM customer;
```

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UNLOCK TABLE statement

Use the UNLOCK TABLE statement in a database that does not support transaction logging to unlock a table that you previously locked with the LOCK TABLE statement. The UNLOCK TABLE statement is an extension to the ANSI/ISO standard for SQL.

Syntax

```
>>-UNLOCK TABLE--+-table-----><
                    '-synonym-'
```

Element	Description	Restrictions	Syntax
<i>synonym</i>	Synonym for a table to unlock	The synonym and the table to which it points must exist	Database Object Name
<i>table</i>	Table to unlock	Must be in a database without transaction logging, and must be a table that you previously locked	Database Object Name

Usage

Restriction: The UNLOCK TABLE statement is not valid within a transaction.

You can lock a table if you own the table or if you have the Select privilege on the table, either from a direct grant to your user ID or from a grant to PUBLIC. You can only unlock a table that you locked. You cannot unlock a table that another process locked. Only one lock can apply to a table at a time.

You must specify the name or synonym of the table that you are unlocking. Do not specify the name of a view, or a synonym for a view.

To change the lock mode of a table in a database that was created without transaction logging, use the UNLOCK TABLE statement to unlock the table, then issue a new LOCK TABLE statement. The following example shows how to change the lock mode of a table in a database that was created without transaction logging:

```
LOCK TABLE items IN EXCLUSIVE MODE;
...
UNLOCK TABLE items;
...
LOCK TABLE items IN SHARE MODE;
```

The UNLOCK TABLE statement fails if it is issued within a transaction. Table locks set within a transaction are released automatically when the transaction completes.

If you are using an ANSI-compliant database, do not issue an UNLOCK TABLE statement. The UNLOCK TABLE statement fails if it is issued within a transaction, and a transaction is always in effect in an ANSI-compliant database.

Related reference:

[LOCK TABLE statement](#)

UPDATE statement

Use the UPDATE statement to change the values in one or more columns of one or more existing rows in a table or view.

Syntax

```
>>UPDATE----->
```

```
(3)
```

```
>--+---+-----+---| Target |--| SET Clause |-----| WHERE Options |----+-->  
| | (1) | (2) | |
| |-----| Optimizer Directives |-----'|  
| | (4) | (3) |  
| '-| Collection-Derived Table |-----| SET Clause |-----+-----+'  
| | (5) | (6) |  
| '-----WHERE CURRENT OF cursor-----'
```

Target

```
|---+---table---+---+-----+---+-----+---|  
| +-view-----+ '+-----alias-' |  
| '-synonym-' '-AS-' |  
| (1) |  
| '-----ONLY--(-+-table -+--)---' |  
| '-synonym-' |
```

WHERE Options

```
|---+---+-----+---+-----+---|  
| | (7) | |  
| |-WHERE--condition-----' |  
| (5) | (6) |  
| '-----WHERE CURRENT OF cursor id-----'
```

Notes:

1. Informix® extension
2. See [Optimizer Directives](#)
3. See [SET Clause](#)
4. See [Collection-Derived Table](#)
5. ESQ/C and SPL only
6. See [Using the WHERE CURRENT OF Clause \(ESQ/C, SPL\)](#)
7. See [WHERE Clause of UPDATE](#)

Element	Description	Restrictions	Syntax
<i>alias</i>	Temporary name that you declare here for a local or remote table	The AS keyword must precede <i>alias</i> if SET is the identifier of <i>alias</i>	Identifier
<i>condition</i>	Logical criteria that updated rows must satisfy	Cannot be a UDR nor a correlated subquery	Condition
<i>cursor</i>	Name of a cursor whose current row is to be updated	Cannot be a host variable. You cannot update a row that includes aggregates	Identifier
<i>synonym, table, view</i>	Synonym, table, or view that contains rows to be updated	The <i>synonym</i> and the table or view to which it points must exist	Database Object Name

Usage

Use the UPDATE statement to update any of the following types of database objects or program objects:

- A row in a table: a single row, a group of rows, or all rows in a table
- An element in a column of a collection data type
- In a column of a named or unnamed ROW data type, a field or all fields.

With Informix, you can also use this statement to change the values in one or more elements in Informix ESQL/C or SPL collection variables or ROW variables.

For information on how to update elements of a collection variable, see [Collection-Derived Table](#). Sections that follow in this description of the UPDATE statement describe how to update a row in a table.

You must either own the table or have the Update privilege for the table; see [GRANT statement](#). To update data in a view, you must have the Update privilege, and the view must meet the requirements that are explained in [Updating Rows Through a View](#).

The target of the UPDATE statement cannot be a table object that the CREATE EXTERNAL TABLE statement defined.

The cursor (as defined in the SELECT ... FOR UPDATE portion of a DECLARE statement) can contain only column names. If you omit the WHERE clause, all rows of the target table are updated.

If you are using effective checking and the checking mode is set to IMMEDIATE, all enabled constraints are checked at the end of each UPDATE statement. If the checking mode is set to DEFERRED, all enabled constraints are *not* checked until the transaction is committed.

In DB-Access, if you omit the WHERE clause and are in interactive mode, DB-Access does not run the UPDATE statement until you confirm that you want to change all rows. If the statement is in a command file, however, and you are running at the command line, the statement executes immediately.

Example

The following example creates and updates view.

```
CREATE VIEW cust_view AS SELECT * FROM customer;
UPDATE cust_view SET customer_num=10001 WHERE customer_num=101;
```

- [Using the ONLY Keyword](#)
- [Updating Rows Through a View](#)
- [Updating Rows in a Database Without Transactions](#)
- [Updating Rows in a Database with Transactions](#)
- [Locking Considerations](#)

When a row is selected with the intent to update, the update process acquires an update lock. Update locks permit other processes to read, or *share*, a row that is about to be updated, but they do not allow those processes to update or delete it.

- [Declaring an alias for the target table](#)
You can declare an alias for the target table. The alias can reference the fully-qualified database object name of a local or remote table, view, or synonym.
- [SET Clause](#)
Use the SET clause to identify the columns to be updated and assign values to each column.
- [Updating Values in Opaque-Type Columns](#)
- [Data Types in Distributed UPDATE Operations](#)
Distributed UPDATE operations across tables in databases of different server instances can return only a subset of the data types that distributed UPDATE operations can return from tables that are all in databases of the same Informix instance.
- [WHERE Clause of UPDATE](#)
- [Updating a Row Variable \(ESQL/C\)](#)

Related reference:

[DROP SEQUENCE statement](#)
[ALTER SEQUENCE statement](#)
[DECLARE statement](#)
[INSERT statement](#)
[OPEN statement](#)
[SELECT statement](#)
[FOREACH](#)
[Literal Row](#)
[DELETE statement](#)
[RENAME SEQUENCE statement](#)
[Collection-Derived Table](#)
[MERGE statement](#)

Related information:

[Update rows](#)
[Data manipulation statements](#)
[Complex data types](#)

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Using the ONLY Keyword

If you use the UPDATE statement to update rows of a supertable, rows from its subtables can also be updated. To update rows from the supertable only, use the ONLY keyword prior to the table name, as this example shows:

```
UPDATE ONLY(am_studies_super)
  WHERE advisor = "johnson"
  SET advisor = "camarillo";
```

Note: If you use the UPDATE statement on a supertable without the ONLY keyword and without a WHERE clause, all rows of the supertable and its subtables are updated. You cannot use the ONLY keyword if you plan to use the WHERE CURRENT OF clause to update the current row of the active set of a cursor.

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Updating Rows Through a View

You can update data through a *single-table* view if you have the Update privilege on the view (see [GRANT statement](#)). For a view to be updatable, the query that defines the view must not contain any of the following items:

- Columns in the projection list that are aggregate values
- Columns in the projection list that use the UNIQUE or DISTINCT keyword
- A GROUP BY clause
- A UNION operator

In addition, if a view is built on a table that has a derived value for a column, that column cannot be updated through the view. Other columns in the view, however, can be updated. In an updatable view, you can update the values in the underlying table by inserting values into the view.

```
CREATE VIEW cust_view AS SELECT * FROM customer;  
UPDATE cust_view SET customer_num=10001 WHERE customer_cum=101;
```

The following statements define a view that includes all the rows in the **customer** table and changes the **customer_num** value to 10001 in any row where the value of that column is 101:

```
CREATE VIEW cust_view AS SELECT * FROM customer;  
UPDATE cust_view SET customer_num=10001 WHERE customer_num=101;
```

You can use data-integrity constraints to prevent users from updating values in the underlying table when the update values do not fit the SELECT statement that defined the view. For more information, see [WITH CHECK OPTION Keywords](#).

Because duplicate rows can occur in a view even if its base table has unique rows, be careful when you update a table through a view. For example, if a view is defined on the **items** table and contains only the **order_num** and **total_price** columns, and if two items from the same order have the same total price, the view contains duplicate rows. In this case, if you update one of the two duplicate **total_price** values, you have no way to know which item price is updated.

Important: If you are using a view with a check option, you cannot update rows in a remote table.

An alternative to directly modifying data values in a view with the UPDATE statement is to create an INSTEAD OF trigger on the view. For more information, see [INSTEAD OF Triggers on Views](#).

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Updating Rows in a Database Without Transactions

If you are updating rows in a database without transactions, you must take explicit action to restore updated rows. For example, if the UPDATE statement fails after updating some rows, the successfully updated rows remain in the table. You cannot automatically recover from a failed update.

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Updating Rows in a Database with Transactions

If you are updating rows in a database with transactions, and you are using transactions, you can undo the update using the ROLLBACK WORK statement. If you do not execute a BEGIN WORK statement before the update, and the update fails, the database server automatically rolls back any database modifications that were made to the table since the beginning of the update operation.

The CREATE TEMP TABLE statement can include the WITH NO LOG option to create temporary tables that do not support transaction logging. These tables are not logged and are not recoverable.

Do not use RAW tables within a transaction. Tables that you create with the CREATE RAW TABLE statement are not logged. Thus, RAW tables are not recoverable, even if the database uses logging. RAW tables are intended for the initial loading and validation of data. After you have loaded the data, use the ALTER TABLE statement to change the table to type STANDARD, and perform a level-0 backup before you use the table in a transaction. For more information about RAW tables, refer to the *IBM® Informix® Administrator's Guide*.

In an ANSI-compliant database, transactions are implicit, and all database modifications take place within a transaction. In this case, if an UPDATE statement fails, you can use ROLLBACK WORK to undo the update.

If you are within an explicit transaction, and the update fails, the database server automatically undoes the effects of the update.

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Locking Considerations

When a row is selected with the intent to update, the update process acquires an update lock. Update locks permit other processes to read, or *share*, a row that is about to be updated, but they do not allow those processes to update or delete it.

Just before the update occurs, the update process *promotes* the shared lock to an exclusive lock. An exclusive lock prevents other processes from reading or modifying the contents of the row until the lock is released.

An update process can acquire an update lock on a row or on a page that has a shared lock from another process, but you cannot promote the update lock from shared to exclusive (and the update cannot occur) until the other process releases its lock.

If the number of rows that a single update affects is large, you can exceed the limits placed on the maximum number of simultaneous locks. If this occurs, you can reduce the number of transactions per UPDATE statement, or you can lock the page or the entire table before you execute the statement.

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Declaring an alias for the target table

You can declare an alias for the target table. The alias can reference the fully-qualified database object name of a local or remote table, view, or synonym.

The alias is a temporary name that is not registered in the system catalog of the database, and that persists only while the UPDATE statement is running.

If the name that you declare as the alias is also a keyword of the UPDATE statement, you must use the AS keyword to clarify the syntax:

```
UPDATE stock AS set
SET unit_price = unit_price * 0.94;
```

The following UPDATE statement references the qualified name of a table in the target clause and in two subqueries:

```
UPDATE nmosdb@wnmserver1:test
SET name=(SELECT name FROM test
WHERE test.id = nmosdb@wnmserver1:test.id)
WHERE EXISTS(
SELECT 1 FROM test WHERE test.id = nmosdb@wnmserver1:test.id
);
```

The next UPDATE statement is logically equivalent to the previous example, but declares **r_t** an alias for the qualified table name:

```
UPDATE nmosdb@wnmserver1:test r_t
SET name=(SELECT name FROM test
WHERE test.id = r_t.id)
WHERE EXISTS(
SELECT 1 FROM test WHERE test.id = r_t.id
);
```

Declaring the table alias simplifies the notation of the second example above.

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SET Clause

Use the SET clause to identify the columns to be updated and assign values to each column.

The SET clause supports the following syntax formats:

- A single-column format, which pairs each column with a single expression
- A multiple-column format, which associates a list of multiple columns with the values returned by one or more expressions

SET Clause

```

                                     (1)
|--SET--+--| Single-Column Format |-----+-----|
      | (2)                                (3) |
      '-----| Multiple-Column Format |-----'
```

Notes:

1. See [Single-Column Format](#)
2. Informix® extension
3. See [Multiple-Column Format](#)

The following UPDATE statement uses the single-column format of the SET clause to change the value of the **customer.city** column of any existing row whose value in the **customer.customer_num** column is 103.

```
UPDATE customer
SET city = 'Alviso'
WHERE customer_num = 103;
```

If no row has 103 as its **customer_num** column value, this example has no effect on the **customer** table.

- [Single-Column Format](#)
- [Using a Subquery to Update a Single Column](#)
- [Updating a Column to NULL](#)
- [Updating the Same Column Twice](#)
- [Multiple-Column Format](#)
- [Using a Subquery to Update Multiple Column Values](#)
- [Updating ROW-Type Columns](#)
- [Updating Collection Columns](#)

Single-Column Format

Use the single-column format to pair one column with a single expression.

Single-Column Format

```

      .- ,-----
      v |
|----column-- = +-expression-----+-----|
              +-(--singleton_select--)++
              +-NULL-----+
              '-collection_var-----'
```

Element	Description	Restrictions	Syntax
<i>column</i>	Column to be updated	Cannot be a serial data type	Identifier
<i>collection_var</i>	Host or program variable	Must be declared as a collection data type	Language specific
<i>expression</i>	Returns a value for <i>column</i>	Cannot contain aggregate functions	Expression
<i>singleton_select</i>	Subquery that returns exactly one row	Returned subquery values must have a 1-to-1 correspondence with <i>column</i> list	SELECT statement

You can use this syntax to update a column that has a ROW data type.

You can include any number of "single *column* = single *expression*" terms. The *expression* can be an SQL subquery (enclosed between parentheses) that returns a single row, provided that the corresponding *column* is of a data type that can store the value (or the set of values) from the row that the subquery returns.

To specify values of a ROW-type column in a SET clause, see [Updating ROW-Type Columns](#). The following examples illustrate the single-column format of the SET clause.

```
UPDATE customer
SET address1 = '1111 Alder Court', city = 'Palo Alto',
    zipcode = '94301' WHERE customer_num = 103;
```

```
UPDATE stock
SET unit_price = unit_price * 1.07;
```

Using a Subquery to Update a Single Column

You can update the column specified in the SET clause with the value that a subquery returns.

```
UPDATE orders
SET ship_charge =
    (SELECT SUM(total_price) * .07 FROM items
     WHERE orders.order_num = items.order_num)
WHERE orders.order_num = 1001;
```

If you are updating a supertable in a table hierarchy, the SET clause cannot include a subquery that references a subtable. If you are updating a subtable in a table hierarchy, a subquery in the SET clause can reference the supertable if it references only the supertable. That is, the subquery must use the SELECT ... FROM ONLY (*supertable*) syntax.

Updating a Column to NULL

Use the NULL keyword to modify a column value when you use the UPDATE statement. For example, for a customer whose previous address required two address lines but now requires only one, you would use the following entry:

```
UPDATE customer
SET address1 = '123 New Street',
    address2 = null,
    city = 'Palo Alto',
    zipcode = '94303'
WHERE customer_num = 134;
```

Updating the Same Column Twice

You can specify the same column more than once in the SET clause. If you do so, the column is set to the last value that you specified for the column. In the next example, the **fname** column appears twice in the SET clause. For the row where the customer number is 101, the user sets **fname** first to *gary* and then to *harry*. After the UPDATE statement executes, the value of **fname** is *harry*.

```
UPDATE customer
SET fname = "gary", fname = "harry"
WHERE customer num = 101;
```

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Multiple-Column Format

Use the multiple-column format of the SET clause to list multiple columns and set them equal to corresponding expressions.

Multiple-Column Format

```
.-,-----.  
V           |  
|--+-(---column+--)++- =----->  
'|_*-----'  
  
.-,-----.  
V           |  
>--(+--+expression-----++-)-----|  
      | .-,-----.  
      | V           |  
      '|+---(--singleton_select--)+++'  
        '--NULL-----'
```

Element	Description	Restrictions	Syntax
<i>column</i>	Name of a column to be updated	Cannot have a serial or ROW type. The number of <i>column</i> names must equal the number of values returned to the right of the = sign.	Identifier
<i>expression</i>	Expression that returns a value for a <i>column</i>	Cannot include aggregate functions	Expression
<i>singleton_ select</i>	Subquery that returns exactly one row	Values that the subquery returns must correspond to columns in the <i>column</i> list	SELECT statement
<i>SPL function</i>	SPL routine that returns one or more values	Returned values must have a 1-to-1 correspondence to columns in the <i>column</i> list	Identifier

The multiple-column format of the SET clause offers the following options for listing a set of columns that you intend to update:

- Explicitly list each column, placing commas between columns and enclosing the set of columns between parentheses.
- Implicitly list all columns in the table by using an asterisk (*).

You must list each expression explicitly, placing comma (,) separators between expressions and enclosing the set of expressions between parentheses. The number of columns must equal the number of values returned by the expression list, unless the expression list includes an SQL subquery.

The following examples show the multiple-column format of the SET clause:

```
UPDATE customer
SET (fname, lname) = ('John', 'Doe') WHERE customer num = 101;
```

```
UPDATE manufact
SET * = ('HNT', 'Hunter') WHERE manu code = 'ANZ';
```

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Using a Subquery to Update Multiple Column Values

The expression list can include one or more subqueries. Each must return a single row containing one or more values. The number of columns that the SET clause explicitly or implicitly specifies must equal the number of values returned by the expression (or expression list) that follows the equal (=) sign in the multiple-column SET clause.

The subquery must be enclosed between parentheses. These parentheses are nested within the parentheses that immediately follow the equal (=) sign. If the expression list includes multiple subqueries, each subquery must be enclosed between parentheses, with a comma (,) separating successive subqueries:

```
UPDATE ... SET ... = ((subqueryA), (subqueryB), ... (subqueryN))
```

The following examples show the use of subqueries in the SET clause:

```

UPDATE items
  SET (stock_num, manu_code, quantity) =
    ( (SELECT stock_num, manu_code FROM stock
      WHERE description = 'baseball'), 2)
  WHERE item_num = 1 AND order_num = 1001;

UPDATE table1
  SET (col1, col2, col3) =
    ((SELECT MIN (ship_charge), MAX (ship_charge) FROM orders), '07/01/2007')
  WHERE col4 = 1001;

```

If you are updating a supertable in a table hierarchy, the SET clause cannot include a subquery that references one of its subtables. If you are updating a subtable in a table hierarchy, a subquery in the SET clause can reference the supertable if it references only the supertable. That is, the subquery must use the SELECT... FROM ONLY (*supertable*) syntax.

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Updating ROW-Type Columns

Use the SET clause to update a named or unnamed ROW-type column. For example, suppose you define the following named ROW type and a table that contains columns of both named and unnamed ROW types:

```

CREATE ROW TYPE address_t
(
  street CHAR(20), city CHAR(15), state CHAR(2)
);
CREATE TABLE empinfo
(
  emp_id INT
  name ROW ( fname CHAR(20), lname CHAR(20)),
  address address_t
);

```

To update an unnamed ROW type, specify the ROW constructor before the parenthesized list of field values.

The following statement updates the **name** column (an unnamed ROW type) of the **empinfo** table:

```
UPDATE empinfo SET name = ROW('John','Williams') WHERE emp_id =455;
```

To update a named ROW type, specify the ROW constructor before the list (in parentheses) of field values, and use the cast (::) operator to cast the ROW value as a named ROW type. The following statement updates the **address** column (a named ROW type) of the **empinfo** table:

```

UPDATE empinfo
  SET address = ROW('103 Baker St', 'Tracy', 'CA')::address_t
  WHERE emp_id = 3568;

```

For more information on the syntax for ROW constructors, see [Constructor Expressions](#). See also [Literal Row](#).

The ROW-column SET clause can only support literal values for fields. To use an ESQL/C variable to specify a field value, you must select the ROW data into a **row** variable, use host variables for the individual field values, then update the ROW column with the **row** variable. For more information, see [Updating a Row Variable \(ESQL/C\)](#).

You can use Informix® ESQL/C host variables to insert *non-literal* values as:

- An entire row type into a column
Use a **row** variable as a variable name in the SET clause to update all fields in a ROW column at one time.
- Individual fields of a ROW type
To insert non-literal values into a ROW-type column, you can first update the elements in a **row** variable and then specify the **collection** variable in the SET clause of an UPDATE statement.

When you use a **row** variable in the SET clause, the **row** variable must contain values for each field value. For information on how to insert values into a **row** variable, see [Updating a Row Variable \(ESQL/C\)](#).

You can use the UPDATE statement to modify only some of the fields in a row:

- Specify the field names with field projection for all fields whose values remain unchanged.
For example, the following UPDATE statement changes only the **street** and **city** fields of the **address** column of the **empinfo** table:

```

UPDATE empinfo
  SET address = ROW('23 Elm St', 'Sacramento', address.state)
  WHERE emp_id = 433;

```

The **address.state** field remains unchanged.

- Select the row into an ESQL/C **row** variable and update the desired fields.
For more information, see [Updating a Row Variable \(ESQL/C\)](#).

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Updating Collection Columns

You can use the SET clause to update values in a collection column. For more information, see [Collection Constructors](#).

A collection variable can update a collection-type column. With a collection variable, you can insert one or more individual elements of a collection. For more information, see [Collection-Derived Table](#).

For example, suppose you define the **tab1** table as follows:

```
CREATE TABLE tab1
(
  int1 INTEGER,
  list1 LIST(ROW(a INTEGER, b CHAR(5)) NOT NULL),
  dec1 DECIMAL(5,2)
);
```

The following UPDATE statement updates a row in **tab1**:

```
UPDATE tab1
SET list1 = LIST(ROW(2, 'zyxwv'),
  ROW(POW(2,6), '=64'),
  ROW(ROUND(ROOT(146)), '=12')),
WHERE int1 = 10;
```

Collection column **list1** in this example has three elements. Each element is an unnamed ROW type with an INTEGER field and a CHAR(5) field. The first element includes two literal values: an integer (2) and a quoted string ('zyxwv').

The second and third elements also use a quoted string to indicate the value for the second field. They each designate the value for the first field with an expression, however, rather than with a literal value.

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Updating Values in Opaque-Type Columns

Some opaque data types require special processing when they are updated. For example, if an opaque data type contains spatial or multirepresentational data, it might provide a choice of how to store the data: inside the internal structure or, for large objects, in a smart large object.

This processing is accomplished by calling a user-defined support function called **assign()**. When you execute UPDATE on a table whose rows contain one of these opaque types, the database server automatically invokes the **assign()** function for the type. This function can make the decision of how to store the data. For more information about the **assign()** support function, see *IBM® Informix® User-Defined Routines and Data Types Developer's Guide*.

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Data Types in Distributed UPDATE Operations

Distributed UPDATE operations across tables in databases of different server instances can return only a subset of the data types that distributed UPDATE operations can return from tables that are all in databases of the same Informix® instance.

The UPDATE statement (or any other SQL data-manipulation language statement) that accesses a database of another Informix instance can reference only the following data types:

- Built-in data types that are not opaque or complex
- BOOLEAN
- BSON
- JSON
- LVARCHAR
- DISTINCT of built-in types that are not opaque
- DISTINCT of BOOLEAN
- DISTINCT of BSON
- DISTINCT of JSON
- DISTINCT of LVARCHAR
- DISTINCT of the DISTINCT types in this list.

Cross-server distributed UPDATE operations can support these DISTINCT types only if the DISTINCT types are cast explicitly to built-in types, and all of the DISTINCT types, their data type hierarchies, and their casts are defined exactly the same way in each participating database. For additional information about the data types that Informix supports in cross-server DML operations, see [Data Types in Cross-Server Transactions](#).

Cross-database distributed UPDATE operations that access other databases of the local Informix instance, however, can access the cross-server data types in the preceding list, and also the following data types:

- Most of the *built-in opaque data types*, as listed in [Data Types in Cross-Database Transactions](#)
- DISTINCT of the built-in types that are referenced in the preceding line
- DISTINCT of any of the data types that are listed in either of the two preceding lines
- Opaque user-defined data types (UDTs) that are explicitly cast to built-in data types.

Cross-database UPDATE operations can support these DISTINCT types and opaque UDTs only if all the opaque UDTs and DISTINCT types are cast explicitly to built-in types, and all of the opaque UDTs, DISTINCT types, data type hierarchies, and casts are defined exactly the same way in each of the participating databases.

Distributed UPDATE transactions cannot access the database of another Informix instance unless both servers define TCP/IP or IPCSTR connections in their DBSERVERNAME or DBSERVERALIASES configuration parameters and in the **sqlhosts** file or SQLHOSTS registry subkey. The requirement, that both participating servers support the same type of connection (either TCP/IP or else IPCSTR), applies to any communication between Informix instances, even if both reside on the same computer.

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WHERE Clause of UPDATE

The WHERE clause lets you specify search criteria to limit the rows to be updated. If you omit the WHERE clause, every row in the table is updated. For more information, see the [WHERE clause of SELECT](#).

- [SQLSTATE Values When Updating an ANSI-Compliant Database](#)
- [SQLSTATE Values When Updating a Non-ANSI Database](#)
- [Subqueries in the WHERE Clause of UPDATE](#)
- [Using the WHERE CURRENT OF Clause \(ESQL/C, SPL\)](#)

Use the WHERE CURRENT OF clause to update the current row of a cursor that was declared FOR UPDATE, or to update the current element of a Collection cursor.

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SQLSTATE Values When Updating an ANSI-Compliant Database

If you update a table in an ANSI-compliant database with an UPDATE statement that contains the WHERE clause and no rows are found, the database server issues a warning.

You can detect this warning condition in either of the following ways:

- The GET DIAGNOSTICS statement sets the **RETURNED_SQLSTATE** field to the value 02000. In an SQL API application, the **SQLSTATE** variable contains this same value.
- In an SQL API application, the **sqlca.sqlcode** and **SQLCODE** variables contain the value 100.

The database server also sets **SQLSTATE** and **SQLCODE** to these values if the UPDATE ... WHERE statement is part of a multistatement PREPARE and the database server returns no rows.

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SQLSTATE Values When Updating a Non-ANSI Database

In a database that is not ANSI compliant, the database server does not return a warning when it finds no matching rows for the WHERE clause of an UPDATE statement. The **SQLSTATE** code is 00000 and the **SQLCODE** code is zero (0). If the UPDATE ... WHERE statement is part of a multistatement PREPARE, however, and no rows are returned, the database server issues a warning, and sets **SQLSTATE** to 02000 and sets **SQLCODE** to 100.

Client-server communication protocols of Informix®, such as SQLI and DRDA, support **SQLSTATE** code values. For a list of these codes, and for information about how to get the message text, see [Using the SQLSTATE Error Status Code](#).

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Subqueries in the WHERE Clause of UPDATE

The FROM clause of a subquery in the WHERE clause of the UPDATE statement can specify as a data source the same table or view that the Table Options clause of the UPDATE statement specifies. UPDATE operations with subqueries that reference the same table object are supported only if all of the following conditions are true:

- The subquery either returns a single row, or else has no correlated column references.
- The subquery is in the UPDATE statement WHERE clause, using Condition with Subquery syntax.
- No SPL routine in the subquery can reference the same table that UPDATE is modifying.

Unless all of these conditions are satisfied, UPDATE statements that include subqueries that reference the same table or view that the UPDATE statement modifies return error -360.

The following example updates the **stock** table by reducing the **unit_price** value by 5% for a subset of prices. The WHERE clause specifies which prices to reduce by applying the IN operator to the rows returned by a subquery that selects only the rows of the **stock** table where the **unit_price** value is greater than 50:

```
UPDATE stock SET unit_price = unit_price * 0.95
WHERE unit_price IN
(SELECT unit_price FROM stock WHERE unit_price > 50);
```

This subquery includes only uncorrelated column references, because its only referenced column is in a table specified in its FROM clause. The requirements listed above are in effect, because the data source of the subquery is the same **stock** table that the Table Options clause of the outer UPDATE statement specifies.

The previous example produces the same results as issuing two separate DML statements:

- The SELECT statement, to return a temporary table, **tmp1**, that contains the same rows from the **stock** table that the subquery returned.
- The UPDATE statement, to issue a subquery of the temporary table as a predicate in its WHERE clause to modify every row of the **stock** table where the **unit_price** matches a value in the temporary table:

```
SELECT unit_price FROM stock WHERE unit_price > 50 INTO TEMP tmp1;
UPDATE stock SET unit_price = unit_price * 0.95
WHERE unit_price IN ( SELECT * FROM tmp1 );
```

Here is an example of a more complex UPDATE statement that includes multiple uncorrelated subqueries in its WHERE clause:

```
UPDATE t1 SET a = a + 10
WHERE a > ALL (SELECT a FROM t1 WHERE a > 1) AND
a > ANY (SELECT a FROM t1 WHERE a > 10) AND
EXISTS (SELECT a FROM t1 WHERE a > 5);;
```

If an enabled Select trigger is defined on a table that is the data source of a subquery in the WHERE clause of an UPDATE statement that modifies the same table, executing that subquery within the UPDATE statement does not activate the Select trigger. Consider the following program fragment:

```
CREATE TRIGGER selt11 SELECT ON t1 BEFORE
(UPDATE d1
SET (c1, c2, c3, c4, c5) =
(c1 + 1, c2 + 1, c3 + 1, c4 + 1, c5 + 1));

UPDATE t2 SET c1 = c1 + 1
WHERE c1 IN
(SELECT t1.c1 FROM t1 WHERE t1.c1 > 10 );
```

In the example above, trigger **selt11** is not activated as part of the UPDATE operation on table **t2**.

A subquery in the WHERE clause of the UPDATE statement can include the UNION or the UNION ALL operator, as in the following example.

```
UPDATE t1 SET a = a + 10 WHERE a IN (SELECT a FROM t1 WHERE a > 1
UNION SELECT a FROM t1, t2 WHERE a < b);
```

If the table that the outer UPDATE statement modifies a typed table within a table hierarchy, Informix® supports all of the following operations that use valid subqueries in the WHERE clause of UPDATE:

- UPDATE on target parent table with subquery (SELECT from parent table)
- UPDATE on target parent table with subquery (SELECT from child table)
- UPDATE on target child table with subquery (SELECT from parent table)
- UPDATE on target child table with subquery (SELECT from child table).

The following program fragment illustrates UPDATE operations with subqueries on typed tables:

```
CREATE ROW TYPE r1 (c1 INT, c2 INT);
CREATE ROW TYPE r2 UNDER r1;
CREATE TABLE t1 OF TYPE r1; -- parent table
CREATE TABLE t2 OF TYPE r2 UNDER t1; -- child table

UPDATE t1 SET c1 = c1 + 1 WHERE c1 IN
( SELECT t1.c1 FROM t1 WHERE t1.c1 > 10 );

UPDATE t1 SET c1 = c1 + 1 WHERE c1 IN
( SELECT t2.c1 FROM t2 WHERE t2.c1 > 10 );

UPDATE t2 SET c1 = c1 + 1 WHERE c1 IN
( SELECT t2.c1 FROM t2 WHERE t2.c1 > 10 );

UPDATE t2 SET c1 = c1 + 1 WHERE c1 IN
( SELECT t1.c1 FROM t1 WHERE t1.c1 > 10 );
```

See the [Condition with Subquery](#) topic for more information about how to use subqueries that return multiple rows as predicates in the WHERE clause of the UPDATE statement.

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Using the WHERE CURRENT OF Clause (ESQL/C, SPL)

Use the WHERE CURRENT OF clause to update the current row of a cursor that was declared FOR UPDATE, or to update the current element of a Collection cursor.

Here the *cursor* name cannot be specified as a host variable.

The current row is the most recently fetched row. Because the UPDATE statement does not advance the cursor to the next row, the current row position within the active set of the cursor is not changed by this operation.

For table hierarchies of Informix®, you cannot use this clause if you are selecting from only one table in a table hierarchy. That is, you cannot use this option if you use the ONLY keyword.

In ESQL/C routines, to include the WHERE CURRENT OF keywords, you must have previously used the DECLARE statement to define the *cursor* with the FOR UPDATE option. If the DECLARE statement that created the cursor specified one or more columns in the FOR UPDATE clause, you are restricted to updating only those columns in a subsequent UPDATE ... WHERE CURRENT OF statement. The advantage to specifying columns in the FOR UPDATE clause of a DECLARE statement is speed. The database server can usually perform updates more quickly if columns are specified in the DECLARE statement.

In SPL routines, you can specify a cursor after the WHERE CURRENT OF keywords in an UPDATE statement only if you declared the *cursor_id* in the FOREACH statement of SPL. You cannot use the DECLARE statement in an SPL routine to declare the name of a dynamic cursor and to associate that cursor with the statement identifier of a prepared object that the PREPARE statement has declared in the same SPL routine.

Note: An Update cursor can perform updates that are not possible with the UPDATE statement.

The following Informix ESQL/C example illustrates the CURRENT OF form of the WHERE clause. In this example, updates are performed on a range of customers who receive 10-percent discounts (assume that a new column, **discount**, is added to the **customer** table). The UPDATE statement is prepared outside the WHILE loop to ensure that parsing is done only once.

```
char answer [1] = 'y';
EXEC SQL BEGIN DECLARE SECTION;
    char fname[32],lname[32];
    int low,high;
EXEC SQL END DECLARE SECTION;
main()
{
    EXEC SQL connect to 'stores_demo';
    EXEC SQL prepare sel_stmt from
        'select fname, lname from customer
         where cust_num between ? and ? for update';

    EXEC SQL declare x cursor for sel_stmt;
    printf("\nEnter lower limit customer number: ");
    scanf("%d", &low);
    printf("\nEnter upper limit customer number: ");
    scanf("%d", &high);
    EXEC SQL open x using :low, :high;
    EXEC SQL prepare u from
        'update customer set discount = 0.1 where current of x';
    while (1)
    {
        EXEC SQL fetch x into :fname, :lname;
        if ( SQLCODE == SQLNOTFOUND) break;
    }
    printf("\nUpdate %.10s %.10s (y/n)?", fname, lname);
    if (answer = getch() == 'y')
        EXEC SQL execute u;
    EXEC SQL close x;
}
```

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Updating a Row Variable (ESQL/C)

The UPDATE statement with the Collection-Derived Table segment allows you to update fields in a **row** variable. The Collection-Derived Table segment identifies the **row** variable in which to update the fields. For more information, see [Collection-Derived Table](#).

To update fields

1. Create a **row** variable in your Informix® ESQL/C program.
2. Optionally, select a ROW-type column into the **row** variable with the SELECT statement (without the Collection-Derived Table segment).
3. Update fields of the **row** variable with the UPDATE statement and the Collection-Derived Table segment.
4. After the **row** variable contains the correct fields, you then use the UPDATE or INSERT statement on a table or view name to save the **row** variable in the ROW column (named or unnamed).

The UPDATE statement and the Collection-Derived Table segment allow you to update a field or a group of fields in the **row** variable. Specify the new field values in the SET clause. For example, the following UPDATE changes the **x** and **y** fields in the **myrect** Informix ESQL/C **row** variable:

```
EXEC SQL BEGIN DECLARE SECTION;
    row (x int, y int, length float, width float) myrect;
EXEC SQL END DECLARE SECTION;
. . .
EXEC SQL select into :myrect from rectangles where area = 64;
EXEC SQL update table(:myrect) set x=3, y=4;
```

Suppose that after the SELECT statement, the **myrect2** variable has the values x=0, y=0, length=8, and width=8. After the UPDATE statement, the **myrect2** variable has field values of x=3, y=4, length=8, and width=8. You cannot use a **row** variable in the Collection-Derived Table segment of an INSERT statement.

You can, however, use the UPDATE statement and the Collection-Derived Table segment to insert new field values into a **row** host variable, if you specify a value for every field in the row.

For example, the following code fragment inserts new field values into the **row** variable **myrect** and then inserts this **row** variable into the database:

```
EXEC SQL update table(:myrect)
    set x=3, y=4, length=12, width=6;
EXEC SQL insert into rectangles
    values (72, :myrect);
```


The Table and Column Scope clause and the Routine Statistics clause can be empty. If you specify no mode, no table, no routine, and no Resolution clause, the default scope of the UPDATE STATISTICS statement is all the permanent tables in the current database, as in the following example.

```
UPDATE STATISTICS; -- calculates LOW column distribution statistics for
                  -- all permanent user-defined and system catalog tables
                  -- that the AUTO_STAT_MODE and STATCHANGE settings allow
```

For more examples of UPDATE STATISTICS statements that specify no identifiers of tables or of SPL routines, see the topic [The scope of UPDATE STATISTICS statements](#). See also the references to AUTO_STAT_MODE and STATCHANGE topics in [Performance considerations of UPDATE STATISTICS statements](#).

The UPDATE STATISTICS statement is not supported on secondary servers within a high-availability cluster.

Restriction: You cannot update the statistics for a table or update the query plan of a UDR in any database except the current database. That is, the database server ignores remote database objects when executing the UPDATE STATISTICS statement.

Important: The statistics that the database server collects might require an sbpace for storage. You can create an sbpace by running the **onspaces -c -S** command. You must also set the SYSSBSPACENAME configuration parameter to the sbpace name. If the SYSSBSPACENAME configuration parameter is not set, the database server might not be able to store the column distribution statistics, so that the UPDATE STATISTICS statement fails with error -9814, "Invalid default sbpace name".

- [The scope of UPDATE STATISTICS statements](#)
The scope of UPDATE STATISTICS can be restricted by whatever identifiers of tables or columns follow the **FOR TABLE** keywords, or by whatever identifiers of SPL routines follow the **FOR FUNCTION**, **FOR PROCEDURE**, or **FOR ROUTINE** keywords.
- [Updating Statistics for Tables](#)
Although a change to the database might make information in the **systables**, **syscolumns**, **sysindices**, **sysfragments**, **sysdistrib**, and **sysfragdist** system catalog tables obsolete, the database server does not automatically update those tables after most SQL statements.
- [Updating Statistics for Columns of User-Defined Types](#)
To calculate statistics for a column of a user-defined data type (UDT), you must use either the UPDATE STATISTICS MEDIUM FOR TABLE or the UPDATE STATISTICS HIGH FOR TABLE statement.
- [Using the FORCE and AUTO keywords](#)
In sessions or in databases where the automatic UPDATE STATISTICS mode is enabled, you can optionally use either the **FORCE** keyword or the **AUTO** keyword to control the scope of the UPDATE STATISTICS statement when it updates the current distribution statistics of tables and columns in the system catalog. These keywords affect only table and fragment statistics, and are not valid in operations on SPL routine statistics.
- [Using the LOW mode option](#)
Use the LOW option of the UPDATE STATISTICS statement to generate and update some of the relevant statistical data regarding table, row, and page-count statistics in the **systables** system catalog table. If you do not specify any mode, the LOW mode is the default.
- [Using the MEDIUM mode option](#)
Use the MEDIUM mode option to update the same statistics that you can perform with the LOW mode option, and also generate statistics about the distribution of data values for each specified column.
- [Using the HIGH mode option](#)
Use the HIGH mode option to update the same statistics that you can calculate with the MEDIUM mode option. The difference between UPDATE STATISTICS HIGH and UPDATE STATISTICS MEDIUM is the number of rows sampled.
- [Resolution Clause](#)
Use the Resolution clause in MEDIUM or HIGH mode to adjust the size of the distribution bins, and to avoid calculating data on indexes.
- [Routine Statistics](#)
Before executing a new SPL routine for the first time, the database server optimizes the DML statements in the SPL routine. Immediately before you invoke that SPL routine, however, you can reduce the risk of error if you use the Routine Statistics syntax of UPDATE STATISTICS to update its query execution plans, some of which might reference tables whose schemas have been modified by DDL operations of concurrent sessions.
- [Updating statistics when you upgrade the database server](#)
When you upgrade a database to use with a newer database server, you can use the UPDATE STATISTICS statement to convert the indexes to the form that the newer database server uses.
- [Performance considerations of UPDATE STATISTICS statements](#)
The more specific you make the list of objects that the UPDATE STATISTICS statement examines, the faster it completes execution. Limiting the number of column distributions speeds the update. Similarly, precision affects the speed of the update. If all other keywords are the same, LOW works fastest, but HIGH examines the most data.

Related concepts:

[Overloading the Name of a Function](#)

[USTLOW_SAMPLE environment option](#)

[Complete-Connection Level Settings and Output Examples](#)

Related reference:

[SET OPTIMIZATION statement](#)

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The scope of UPDATE STATISTICS statements

The scope of UPDATE STATISTICS can be restricted by whatever identifiers of tables or columns follow the **FOR TABLE** keywords, or by whatever identifiers of SPL routines follow the **FOR FUNCTION**, **FOR PROCEDURE**, or **FOR ROUTINE** keywords.

Scope of UPDATE STATISTICS for tables

The specifications that follow the STATISTICS keyword determine the scope of UPDATE STATISTICS statements.

- If the UPDATE STATISTICS statement includes no **FOR** keyword, then the scope cannot be explicitly restricted to a single table or to a single SPL routine. In the case of no syntax tokens following the **STATISTICS** keyword, the default scope is to update statistics in **LOW** mode for every permanent table in the current database, including its system catalog tables, and to update the statistics in the **systables**, **syscolumns**, and **sysindices** system catalog tables.

Both of the following examples produce the same result:

```
UPDATE STATISTICS;  
UPDATE STATISTICS LOW;
```

For database tables with distributed storage, the CREATE TABLE or ALTER TABLE statement that defined the Statistics Options properties of the table determines the table-level or fragment-level granularity of these distribution statistics.

If you include only the MEDIUM or HIGH keyword, the scope is the same, although the resources required for the operation are greater.

- If you include only the FOR TABLE keywords without also specifying the name or synonym of a table, the database server recalculates distributions on all of the tables in the current database, and on all of the temporary tables in your session. UPDATE STATISTICS has no effect, however, on objects defined by the CREATE EXTERNAL TABLE statement.
- If you specify a table after the FOR TABLE keywords without also specifying a list of columns, the database server recalculates the statistical distributions on all of the columns of the specified table.
- If you specify a table after the FOR TABLE keywords and a list of columns, the database server recalculates the statistical distributions of only the specified columns.

In summary, for UPDATE STATISTICS statements that include no database object names, the database server updates distribution statistics on the following table objects by default:

- If you specify no scope or mode,

```
UPDATE STATISTICS;
```

distribution statistics are calculated in LOW mode for all permanent tables in the database.

- If you specify the scope as FOR TABLE, but with no list of tables,

```
UPDATE STATISTICS MEDIUM FOR TABLE;
```

distribution statistics are calculated in the specified mode for all permanent tables in the database and for all temporary tables in the session. In the example above, MEDIUM specifies a more costly statistics mode than the default LOW mode, but has no effect on which table objects are in scope.

The scope of UPDATE STATISTICS for SPL routines

For UPDATE STATISTICS statements that include the FOR FUNCTION, FOR PROCEDURE, or FOR ROUTINE keywords, the scope depends on whether you also include the name of a routine and an argument list.

- If you specify the scope as FOR PROCEDURE, or FOR ROUTINE, or FOR FUNCTION, but with no list of SPL routines, as in these examples,

```
UPDATE STATISTICS FOR FUNCTION;  
UPDATE STATISTICS FOR PROCEDURE;  
UPDATE STATISTICS FOR ROUTINE;
```

the database server takes these actions:

- reoptimizes the execution plans for the DML statements in every SPL routine in the database,
- and updates the **sysprocplan** system catalog table with the reoptimized execution plan.

It does not, however, refresh any table distribution statistics.

The scope for overloaded SPL routines

An UPDATE STATISTICS statement that specifies the identifier of an overloaded SPL routine identifier, where more than one routine have the same name, but different parameters, can reoptimize more than one SPL routine.

- If you specify the scope with the name of an SPL routine, but with no list of parameters,

```
UPDATE STATISTICS FOR FUNCTION someSPLroutine;  
UPDATE STATISTICS FOR PROCEDURE someSPLroutine;  
UPDATE STATISTICS FOR ROUTINE someSPLroutine;
```

the execution plans are reoptimized for the DML statements in any SPL routine with the specified identifier in the database. If the routine name is overloaded, because more than one SPL routine is registered in the database with that name, every SPL routine with that name is reoptimized.

- If you specify the scope with the name of an overloaded SPL routine and a parameter list,

```
UPDATE STATISTICS FOR FUNCTION someSPLroutine(INT, CHAR(140));  
UPDATE STATISTICS FOR PROCEDURE someSPLroutine(INT, CHAR(140));  
UPDATE STATISTICS FOR ROUTINE someSPLroutine(INT, CHAR(140));
```

the execution plans are reoptimized for the DML statements in any SPL routine with the specified identifier and the same argument types in the database.

If the name of an SPL routine is not overloaded, however, you can omit the parameter list and use the SPECIFIC keyword to restrict the scope of the UPDATE STATISTICS statement to the specified SPL routine:

```
UPDATE STATISTICS FOR SPECIFIC FUNCTION someSPLroutine;  
UPDATE STATISTICS FOR SPECIFIC PROCEDURE someSPLroutine;  
UPDATE STATISTICS FOR SPECIFIC ROUTINE someSPLroutine;
```

No other routine will be reoptimized, if the specified name is unique among SPL routine names in the database.

Restricting the scope for tables with automatic mode

When the automatic mode of UPDATE STATISTICS is enabled for the database or for only the current session, the default scope of UPDATE STATISTICS can be further reduced to tables and table fragments with stale distribution statistics. Only these are refreshed, if the percentage of rows that subsequent DML operations

have changed exceeds a user-defined STATCHANGE threshold. This restriction can apply to the database, to the session, or to individual tables, if you set their thresholds in the Statistics Options clause of CREATE TABLE or ALTER TABLE statements.

For example, if the AUTO_STAT_MODE setting is ON for the session, and one or more tables that the **Perform_work** function processed have a high STATCHANGE threshold, you might decide to override the selective refreshing of table statistics by including the **FORCE** keyword:

```
UPDATE STATISTICS FOR SPECIFIC FUNCTION Perform_work FORCE;
```

This overrides the restriction to tables with stale statistics, so that the execution plan for **Perform_work** will be based on the current data values, whether or not the column distribution statistics in the system catalog satisfy the STATCHANGE criteria for stale data.

For more information about automating the selective recalculation of distribution statistics, see the [STATCHANGE session environment option](#) and [AUTO_STAT_MODE session environment option](#) topics. For information about the performance advantages of restricting the scope of UPDATE STATISTICS statements, see [Performance considerations of UPDATE STATISTICS statements](#).

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Updating Statistics for Tables

Although a change to the database might make information in the **systables**, **syscolumns**, **sysindices**, **sysfragments**, **sysdistrib**, and **sysfragdist** system catalog tables obsolete, the database server does not automatically update those tables after most SQL statements.

Issue an appropriate UPDATE STATISTICS statement in the following situations to ensure that the column distribution information in the system catalog tables reflects the current state of the database:

- You perform extensive modifications to a table.
- An application changes the distribution of column values.
The UPDATE STATISTICS statement refreshes the data distribution statistics that the database server uses to optimize queries on the modified objects.
- You upgrade a database for use with a newer database server.
The UPDATE STATISTICS statement converts the old indexes to conform to the newer database server index format and implicitly drops the old indexes.

You can convert the indexes table by table or for the entire database at one time. Follow the conversion guidelines in the *IBM® Informix® Migration Guide*.

If your application makes many modifications to the data in a particular table, update the system catalog for that table routinely with UPDATE STATISTICS to improve query efficiency. The term *many modifications* is relative to the resolution of the distributions. If the data modifications have little effect on the distribution of column values, you do not need to execute UPDATE STATISTICS.

Distribution Statistics in NLSCASE INSENSITIVE databases

In a database created with the NLSCASE INSENSITIVE property, database server operations on columns and expressions of NCHAR or NVARCHAR data types make no distinction between upper case and lower case letters. In data sets that include strings of the same sequence of letters but with case variants, generating the data distributions of NCHAR and NVARCHAR columns requires fewer bins than in a case-sensitive database containing the same records. The database server identifies all the case-variant values as only a single distinct value, and uses this result when it generates the column, index, or fragment-level statistics.

For more information about NLSCASE INSENSITIVE databases, see [Duplicate rows in NLSCASE INSENSITIVE databases](#), [Specifying NLSCASE case sensitivity](#), and [NCHAR and NVARCHAR expressions in case-insensitive databases](#).

- [Automated Table Statistics Maintenance](#)
 - [Using the FOR TABLE ONLY Keywords](#)
 - [Updating Statistics for Columns](#)
- The Table and Column Scope specification can also include the names of one or more columns for which you want statistical distributions calculated.
- [Examining Index Pages](#)

Related information:

[Automatic statistics updating](#)

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Automated Table Statistics Maintenance

To simplify the complex and repetitive task of the DBA in maintaining current table statistics from which the query plan optimizer can design efficient query plans, Informix® provides a table statistics maintenance system, called Auto Update Statistics (AUS). This can automate the identification of tables whose statistics are stale, and can automate the construction and execution of the corresponding UPDATE STATISTICS statements to recalculate their column distributions. The AUS system is provided with built-in criteria for when table statistics should be updated, but the DBA can modify these criteria to reflect current requirements and workloads.

For more information, see the description of the Auto Update Statistics maintenance system in the *IBM® Informix Performance Guide*. See also the description of the Scheduler, which the DBA can use to specify the policies, resources, and frequency with which the AUS system recalculates table statistics, in the *IBM Informix Administrator's Guide*.

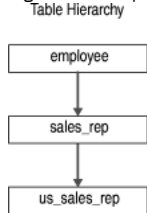
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Using the FOR TABLE ONLY Keywords

Use the FOR TABLE ONLY keywords to collect data for a single table within a hierarchy of typed tables. If you do not include the ONLY keyword immediately after FOR TABLE when the specified *table* has subtables, Informix® creates distributions for that table and also for every subtable under it in the hierarchy.

For example, suppose your database has the typed table hierarchy that appears in [Figure 1](#), which shows a supertable named **employee** that has a subtable named **sales_rep**. The **sales_rep** table, in turn, has a subtable named **us_sales_rep**.

Figure 1. Example of Typed Table Hierarchy



When the following statement executes, the database server generates statistics on both the **sales_rep** and **us_sales_rep** tables:

```
UPDATE STATISTICS FOR TABLE sales_rep;
```

In contrast, the following example generates statistical data for each column in table **sales_rep** but does not act on tables **employee** or **us_sales_rep**:

```
UPDATE STATISTICS FOR TABLE ONLY (sales_rep);
```

If you specify FOR TABLE ONLY, as in this example, the identifier of the table (or *owner.table*) must be enclosed between parentheses.

Because neither of the previous examples specified the level at which to update the statistical data, the database server uses the LOW mode by default.

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Updating Statistics for Columns

The Table and Column Scope specification can also include the names of one or more columns for which you want statistical distributions calculated.

In the following example, this statement calculates the distributions for three columns of the **orders** table:

```
UPDATE STATISTICS FOR TABLE orders (order_num, customer_num, ship_date);
```

If you include no *column* name in the FOR TABLE clause, then distributions are calculated for all columns of the specified *table*, using the LOW, MEDIUM, or HIGH mode and the number of bins implied by the specified or default Resolution clause *percentage* (for MEDIUM or HIGH mode) that you request.

See also [Updating Statistics for Columns of User-Defined Types](#) for UPDATE STATISTICS restrictions on columns that store UDTs.

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Examining Index Pages

In Informix®, when you execute the UPDATE STATISTICS statement in any mode, the database server reads through index pages to:

- Compute statistics for the query optimizer
- Locate pages that have the delete flag marked as 1

If pages are found with the delete flag marked as 1, the corresponding keys are removed from the B-tree cleaner list.

This operation is particularly useful if a system failure causes the B-tree cleaner list (which exists in shared memory) to be lost. To remove the B-tree items that have been marked as deleted but are not yet removed from the B-tree, run the UPDATE STATISTICS statement. For information on the B-tree cleaner list, see your *IBM® Informix Administrator's Guide*.

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Updating Statistics for Columns of User-Defined Types

To calculate statistics for a column of a user-defined data type (UDT), you must use either the UPDATE STATISTICS MEDIUM FOR TABLE or the UPDATE STATISTICS HIGH FOR TABLE statement.

Without the MEDIUM or HIGH keyword, the UPDATE STATISTICS FOR TABLE statement ignores UDT columns.

Restrictions on UDT statistics

The UPDATE STATISTICS statement does not collect values for the **colmin** and **colmax** columns of the **syscolumns** system catalog table for columns that hold user-defined data types.

To drop distribution statistics for columns that store values of user-defined data types, you must execute UPDATE STATISTICS in LOW mode and include the **DROP DISTRIBUTIONS** keywords.

When you run the UPDATE STATISTICS LOW FOR TABLE DROP DISTRIBUTIONS statement, the database server deletes the row in the **sysdistrib** system catalog table that corresponds to the **tableid** and **colno** values for the column. In addition, the database server removes any large objects that might have been created to store distribution statistics for the specified opaque column.

- [Requirements for Statistics on Opaque Columns](#)

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Requirements for Statistics on Opaque Columns

UPDATE STATISTICS can collect statistics for columns of user-defined opaque data types only if support routines for **statcollect()**, **statprint()**, and the selectivity functions are defined for the UDTs. You must also hold Usage privilege on these routines.

In some cases, UPDATE STATISTICS also requires an sbspace as specified by the SYSSBSPACENAME configuration parameter. For information about how to provide statistical data for a column whose data type is a UDT, refer to the *IBM® Informix® DataBlade API Programmer's Guide*. For information about SYSSBSPACENAME, refer to your *IBM Informix Administrator's Reference*.

Related information:

[SYSSBSPACENAME configuration parameter](#)

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Using the FORCE and AUTO keywords

In sessions or in databases where the automatic UPDATE STATISTICS mode is enabled, you can optionally use either the **FORCE** keyword or the **AUTO** keyword to control the scope of the UPDATE STATISTICS statement when it updates the current distribution statistics of tables and columns in the system catalog. These keywords affect only table and fragment statistics, and are not valid in operations on SPL routine statistics.

If you omit both the **FORCE** keyword and the **AUTO** keyword, the effect of the UPDATE STATISTICS statement on table and fragment distribution statistics is determined by the explicit or default setting of the **AUTO_STAT_MODE** configuration parameter, unless the **AUTO_STAT_MODE** session environment variable is set to override that configuration parameter for the current session.

Specifying either of the **FORCE** or **AUTO** keywords affects only the current UPDATE STATISTICS operation. The database server issues an exception if you attempt to include both the **FORCE** and the **AUTO** keywords in the same UPDATE STATISTICS statement.

The FORCE keyword

The **FORCE** keyword refreshes the statistics for all tables and columns within the specified scope. If automatic mode for the UPDATE STATISTICS statement is enabled, the **FORCE** keyword overrides automatic mode, so that values of the **STATCHANGE** attributes of tables and fragments within the scope of the **FOR TABLE** specification are ignored, as if the **AUTO_STAT_MODE** setting were **OFF** for the current UPDATE STATISTICS **FORCE** operation.

The two examples that follow apply the **FORCE** keyword, respectively, to the default table scope of UPDATE STATISTICS, and to a nonfragmented individual table called **tableN**.

```
UPDATE STATISTICS FORCE;  
UPDATE STATISTICS MEDIUM FOR TABLE tableN FORCE;
```

The first statement instructs the database server to take the following actions:

- Recalculate the distribution statistics in **LOW** mode for every permanent table and table fragment in the database, ignoring whether statistics for each table are stale according to their **STATCHANGE** thresholds.
- Store the new distributions in the system catalog tables.

The second statement instructs the database server to take the following actions:

- Recalculate the column distribution statistics in **MEDIUM** mode for table **tableN**.
- Update all the system catalog tables that store distribution statistics for that table.

Including the **FORCE** keyword emulates the previous UPDATE STATISTICS behavior of Informix® database servers before version 11.70.

The AUTO keyword

The **AUTO** keyword causes the database server to run the UPDATE STATISTICS statement in automatic mode, but only for tables and fragments whose statistics are missing or stale. The distribution statistics are not refreshed for any tables or fragments whose **STATCHANGE** value is below the specified threshold.

The following statements specify the **AUTO** keyword.

```
UPDATE STATISTICS AUTO;  
UPDATE STATISTICS MEDIUM FOR TABLE tableN AUTO;
```

The first statement instructs the database server to take the following actions:

- Examine every permanent table in the database, and recalculate only the missing or stale data distribution statistics for tables and fragments in which the percentage of new, deleted, or changed rows since the table distributions were last calculated exceeds the STATCHANGE threshold for that table. This might be an empty set, if no tables or table fragments exceed their STATCHANGE thresholds.
- If any tables or fragments qualified to be recalculated, store their new statistics in the appropriate system catalog tables.

The second statement instructs the database server to take the following actions: .

- If the current distribution statistics for **tableN** do not exceed the STATCHANGE threshold for that table, take no action.
- If the percentage of new, deleted, or changed rows indicate that the current distributions are stale, recalculate the column distribution statistics for table **tableN** in MEDIUM mode, and update all the system catalog tables that store distribution statistics for that table.

When sufficiently accurate statistics are already available to the query optimizer for some tables or table fragments, the AUTO option avoids unnecessary recalculations. In that case, an UPDATE STATISTICS AUTO operation requires less time, without detriment to query performance, than a corresponding UPDATE STATISTICS FORCE operation.

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Using the LOW mode option

Use the LOW option of the UPDATE STATISTICS statement to generate and update some of the relevant statistical data regarding table, row, and page-count statistics in the **sysdistrib** system catalog table. If you do not specify any mode, the LOW mode is the default.

In Informix®, the LOW mode also generates and updates some index and column statistics for specified columns in the **syscolumns** and the **sysindexes** system catalog tables.

The LOW mode generates the least amount of information about the column. If you want the UPDATE STATISTICS statement to do minimal work, specify a column that is not part of an index. The **colmax** and **colmin** values in **syscolumns** are not updated unless there is an index on the column.

The following example updates statistics on the **customer_num** column of the **customer** table:

```
UPDATE STATISTICS LOW FOR TABLE customer (customer_num);
```

Because the LOW mode option does not update data in the **sysdistrib** system catalog table, all distributions associated with the **customer** table remain intact, even those that already exist on the **customer_num** column.

You can set the USTLOW_SAMPLE configuration parameter or the USTLOW_SAMPLE option of the SET ENVIRONMENT statement to enable sampling during the gathering of index statistics for UPDATE STATISTICS operations in LOW mode, as in the following example:

```
SET ENVIRONMENT USTLOW_SAMPLE ON;  
UPDATE STATISTICS LOW FOR TABLE items (quantity,total_price);
```

If the USTLOW_SAMPLE configuration parameter value is zero, the default behavior for all sessions of the server instance is for LOW mode sampling to be disabled. In this example, however, the UPDATE STATISTICS LOW statement uses sampling, because the ON setting in the preceding SET ENVIRONMENT USTLOW_SAMPLE statement overrides the USTLOW_SAMPLE setting for subsequent LOW mode statistical operations in the same session. For more information, see [USTLOW_SAMPLE environment option](#).

- [Using the DROP DISTRIBUTIONS Option](#)
- [Using the DROP DISTRIBUTIONS ONLY Option](#)

Related concepts:

[USTLOW_SAMPLE environment option](#)

[Performance considerations of UPDATE STATISTICS statements](#)

Related information:

[USTLOW_SAMPLE configuration parameter](#)

[Data sampling during update statistics operations](#)

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Using the DROP DISTRIBUTIONS Option

Use the DROP DISTRIBUTIONS option to force the removal of distribution information from the **sysdistrib** system catalog table.

When you specify the DROP DISTRIBUTIONS option, the database server removes the existing distribution data for the column or columns that you specify. If you do not specify any columns, the database server removes all the distribution data for that table.

You must have the DBA privilege or be owner of the table to use this option.

The following example shows how to remove distributions for the **customer_num** column in the **customer** table:

```
UPDATE STATISTICS LOW  
FOR TABLE customer (customer_num) DROP DISTRIBUTIONS;
```

As the example shows, you drop the distribution data at the same time you update the statistical data that the LOW mode option generates.

Using the DROP DISTRIBUTIONS ONLY Option

Use the DROP DISTRIBUTIONS ONLY option to remove distribution information from the **sysdistrib** table and update the **systables.version** column in the system catalog for those tables whose distributions were dropped, without gathering any LOW mode table and index statistics.

If you specify both the DROP DISTRIBUTIONS ONLY option and the FOR TABLE clause, Informix® removes the existing distribution data for the set of columns of the *table* that the FOR TABLE clause specifies (or for all columns, if you provide no *column* specification), but does not gather any LOW mode table and index statistics.

You must have the DBA privilege or be owner of the table to use this option.

The following example removes distributions for the **customer_num** column in the **customer** table:

```
UPDATE STATISTICS LOW
FOR TABLE customer (customer_num) DROP DISTRIBUTIONS ONLY;
```

This drops the **customer.customer_num** distribution data without updating the statistical information that the LOW mode option generates when the ONLY keyword does not follow the DROP DISTRIBUTIONS keywords. This example deletes from the system catalog any row describing **customer.customer_num** from the **sysdistrib** table, and updates the **version** number for **customer** in the **systables** table. None of the other LOW mode updates are performed on **systables**, so the **nrow** and **npused** column values are unchanged by this example, and the **syscolumns**, **sysfragments** and **sysindexes** tables of the system catalog are not updated. The LOW keyword has no effect in this example, but the DROP DISTRIBUTIONS ONLY option is not available in MEDIUM or HIGH mode.

Because it specifies no FOR TABLE clause, the next example drops all rows from the **sysdistrib** table and updates the **systables.version** column in the system catalog for all tables in the database.

```
UPDATE STATISTICS DROP DISTRIBUTIONS ONLY;
```

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Using the MEDIUM mode option

Use the MEDIUM mode option to update the same statistics that you can perform with the LOW mode option, and also generate statistics about the distribution of data values for each specified column.

After UPDATE STATISTICS MEDIUM has been run on a table, the query optimizer typically chooses a more efficient execution plan, compared to the same SELECT statement when only LOW mode column distribution statistics are available for the table. column

The database server places distribution information in the **sysdistrib** system catalog table, and in other system catalog tables for fragmented tables that use distributed storage.

If you use the MEDIUM mode option, the database server scans tables at least once and takes longer to execute on a given table than the LOW mode option.

When you use the MEDIUM mode option, the data distributions are obtained by sampling a percentage of data rows, using a statistical confidence level that you specify, or else a default confidence level of 95 percent. You can also specify an explicit minimum sampling size in the Resolution clause. Because the MEDIUM sample size is usually much smaller than the actual number of rows, this mode executes more quickly than the HIGH mode.

In distributions obtained by sampling, the results can vary, because different samples of rows can have different sampling errors. If the results vary significantly, you can use the Resolution clause to increase the sampling size, or to lower the *percent*, or to increase the *confidence* level to obtain more consistent results.

If the Resolution clause specifies no *percent* of sampled rows per bin, the default average percentage of the sample in each bin is 2.5, which divides the range into approximately 40 intervals. If you do not specify a value for *confidence* level, the default level is 0.95. This value can be roughly interpreted to mean that 95 times out of 100, the difference between the MEDIUM estimate and the exact value from HIGH distributions is not statistically significant.

Distributions are not calculated, however, for LVARCHAR, BYTE, or TEXT columns.

You must have the DBA privilege or be the owner of the table to create MEDIUM mode distributions. For more information on the MEDIUM and HIGH mode options, see the [Resolution Clause](#).

Related concepts:

[Performance considerations of UPDATE STATISTICS statements](#)

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Using the HIGH mode option

Use the HIGH mode option to update the same statistics that you can calculate with the MEDIUM mode option. The difference between UPDATE STATISTICS HIGH and UPDATE STATISTICS MEDIUM is the number of rows sampled.

UPDATE STATISTICS HIGH scans the entire table, while UPDATE STATISTICS MEDIUM samples only a subset of rows, based on the confidence and resolution used by the UPDATE STATISTICS statement.

For indexed tables that already have MEDIUM mode distribution statistics available for every column, the query optimizer typically chooses more efficient execution plans after you run UPDATE STATISTICS HIGH on every column that is part of an index key.

The database server places distribution information in the **sysdistrib** system catalog table, and in other system catalog tables for fragmented tables that use distributed storage.

If you do not specify a Resolution clause, the default percentage of data distributed to every bin is 0.5, a value that partitions the range of values for each column into approximately 200 intervals.

The constructed distribution is exact. Because more information is gathered, this mode executes more slowly than LOW or MEDIUM modes. If you use the HIGH mode option of UPDATE STATISTICS, the database server can take considerable time to gather the information across the database, particularly a database with large tables. The HIGH mode might scan each table several times for each column. To minimize processing time, specify a table name and column names within that table, rather than accept the default scope of all tables.

Distributions are not calculated, however, for LVARCHAR, BYTE, or TEXT columns.

You must have the DBA privilege or be the owner of the table to create HIGH mode distributions. For more information on the MEDIUM and HIGH mode options, see the topic [Resolution Clause](#).

Related concepts:

[Performance considerations of UPDATE STATISTICS statements](#)

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Resolution Clause

Use the Resolution clause in MEDIUM or HIGH mode to adjust the size of the distribution bins, and to avoid calculating data on indexes.

In MEDIUM mode only, you can also use the Resolution clause to specify a lower limit to the sampling size and to adjust the confidence level.

Resolution Clause

```
|---+| Resolution Clause for MEDIUM Mode |-----+
'-| Resolution Clause for HIGH Mode |---'
```

Resolution Clause for MEDIUM Mode

```
|-----+-----+-----+-----+-----+-----+-----+-----+-----+
'-SAMPLING SIZE -min-'

>---+-----+-----+-----+-----+-----+-----+-----+-----+
'-RESOLUTION--percent--+-' '-DISTRIBUTIONS ONLY-'
'-confidence-'
```

Resolution Clause for HIGH Mode

```
|-----+-----+-----+-----+-----+-----+-----+-----+
'-RESOLUTION--percent-' '-DISTRIBUTIONS ONLY-'
```

Element	Description	Restrictions	Syntax
<i>confidence</i>	Estimated likelihood that sampling in MEDIUM mode produces results equivalent to the exact HIGH mode. Default level is 0.95.	Must be within the range from 0.80 (minimum) to 0.99 (maximum)	Literal Number
<i>percent</i>	Average percentage of the sample in each distribution bin. Default is 2.5 for MEDIUM and 0.5 for HIGH.	Minimum value is 1/nrows, for nrows the number of rows in the table	Literal Number
<i>min</i>	The minimum integer number of randomly selected rows on which to generate the data distributions	Must be greater than zero but cannot exceed nrows	Literal Number

A *distribution* is a mapping of the data in a column into a set of column values, ordered by magnitude or by collation. The range of these sample values is partitioned into disjunct intervals, called *bins*, each containing an approximately equal portion of the sample of column values. For example, if one bin holds 2 percent of the data, approximately 50 such intervals hold the entire sample.

Some statistical texts call these bins *equivalence categories*. Each contains a disjunct subset of the range of the data values that are sampled from the column.

If you include the RESOLUTION keyword, it must be followed by a literal number, specifying the *percent* of values in each bin. In MEDIUM mode, it can be followed by either one or two literal numbers, with the optional second number specifying the *confidence* level, as in this example:

```
UPDATE STATISTICS MEDIUM FOR TABLE orders
RESOLUTION 4 0.90 DISTRIBUTIONS ONLY;
```

This specifies 4% of the data per bin, implying approximately 25 bins, and a confidence level of 90%, and no examination of index data. If the 0.90 value were omitted, then the default level of confidence would have been in effect. If the RESOLUTION keyword and both numeric values were omitted, then default values for *percent* (2.5%) and for *confidence* (0.95) would be used.

The query optimizer estimates the selectivity of a WHERE clause by examining, for each column included in the WHERE clause, the proportional occurrence of the data values contained in the column.

You cannot create distributions for BYTE or TEXT columns. If you include a BYTE or TEXT column in an UPDATE STATISTICS statement that specifies MEDIUM or HIGH distributions, no distributions are created for those columns. Distributions are constructed for other columns in the list, however, and the statement does not return an error.

Columns of the VARCHAR data type do not use overflow bins, even when multiple bins are being used for duplicate values.

You can use the first two parameters of the **DBUPSPACE** environment variable to constrain the disk space and memory resources that the UPDATE STATISTICS statement can use to sort data when it constructs column distributions. These settings affect performance, because they determine how many times the database server scans the specified table to construct each distribution. (A third **DBUPSPACE** parameter can control whether UPDATE STATISTICS sorts with indexes when calculating column distributions, and whether the **explain** output file stores the plan by which the column distributions are calculated.)

- [Specifying the SAMPLING SIZE](#)
- [Using the DISTRIBUTIONS ONLY Option to Suppress Index Information](#)
- [Using DBUPSPACE Settings to Suppress Index Information](#)
- [Output for UPDATE STATISTICS from the SET EXPLAIN Statement](#)

Related concepts:

[Default name and location of the explain output file on UNIX](#)

[Default name and location of the output file on Windows](#)

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Specifying the SAMPLING SIZE

In MEDIUM mode, you can optionally use the SAMPLING SIZE keywords to specify the minimum number of rows to sample for calculating column distribution statistics. If the Resolution clause omits the RESOLUTION keyword and specifies no *confidence* level and no *percent* value, then the number of rows that Informix® samples will be the larger of the following two values:

- The *min* value that you specify immediately after the SAMPLING SIZE keywords
- The sampling size that is required for the default *percent* of rows in each bin (2.5%) and for the minimum *confidence* level (0.80).

If a sampling size is specified in a Resolution clause that includes explicit values for both the average *percent* of sampled rows per bin and for the *confidence* level, then the number of sampled rows will be the larger of these two values:

- The *min* value that you specify immediately after the SAMPLING SIZE keywords
- The sampling size that is required for the specified *percent* of rows and for the specified *confidence* level.

If a sampling size is specified in a Resolution clause that includes an average *percentage* value but sets no *confidence* level, then the minimum *confidence* value of 0.80 is used to calculate the actual sampling size for Informix to use if the specified *size* is smaller.

For example, the following statement calculates statistics for two columns of the **customer** table, without updating index information. At least 200 rows will be sampled, but the actual size of the sample might be larger than 200 if more rows are required to provide the default 0.80 confidence level for a sample distribution that uses approximately 50 equivalence categories, with an average percentage of 2% of the sampled values in each bin.

```
UPDATE STATISTICS MEDIUM FOR TABLE customer (city, state)
  SAMPLING SIZE 200 RESOLUTION 2 DISTRIBUTIONS ONLY;
```

Whether or not you include an explicit SAMPLING SIZE specification in the Resolution clause, Informix records in the system catalog the actual sampling size (as a percentage of the total number of rows in the table) at the time of MEDIUM mode UPDATE STATISTICS creation.

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Using the DISTRIBUTIONS ONLY Option to Suppress Index Information

In Informix®, when you specify the DISTRIBUTIONS ONLY option, you do not update index information. This option does not affect existing index information.

Use this option to avoid the examination of index information that can consume considerable processing time.

This option does not affect the recalculation of information on tables, such as the number of pages used, the number of rows, and fragment information. UPDATE STATISTICS needs this information to construct accurate column distributions and requires little time and system resources to collect it.

Do not confuse this DISTRIBUTIONS ONLY option with the DROP DISTRIBUTIONS ONLY option of LOW mode, whose syntax and semantics are not supported in MEDIUM or HIGH mode. For information on how to suppress the collection of column distributions, see [Using the DROP DISTRIBUTIONS ONLY Option](#).

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Using DBUPSPACE Settings to Suppress Index Information

You can also prevent indexes from being used by UPDATE STATISTICS operations in sorting rows by setting the third parameter of the **DBUPSPACE** environment variable to a value of 1. Refer to Chapter 3 of the *IBM® Informix® Guide to SQL: Reference* for information about the **DBSPACETEMP** and **DBUPSPACE** environment variables, which can restrict the system resources that are available for UPDATE STATISTICS operations. (The database server uses the storage locations that **DBSPACETEMP** specifies only when you use the HIGH option of UPDATE STATISTICS.)

Related information:

[Environment variables in Informix products](#)

Keyword**Which Execution Plans are Reoptimized****FUNCTION**

The plan for any SPL function with the specified name (and with parameter types that match *routine parameter list*, if parameters are supplied). If you specify the **FUNCTION** keyword, the **UPDATE STATISTICS** statement fails with an error unless the specified routine returns a value or values, with or without the **WITH RESUME** option.

PROCEDURE

The plan for any SPL procedure with the specified name (and parameter types that match *routine parameter list*, if supplied)

ROUTINE

The plan for SPL functions and procedures with the specified name (and parameter types that match *routine parameter list*, if supplied)

SPECIFIC

The plan for the SPL routine called *specific name*. If you include the **SPECIFIC** keyword, the immediately following keyword must be either **FUNCTION**, **PROCEDURE**, or **ROUTINE**.

The parentheses symbols are optional if you omit the **SPECIFIC** keyword and include no argument list.

If you specify no routine name immediately after the **FOR FUNCTION**, **FOR PROCEDURE**, or **FOR ROUTINE** keywords, the execution plans are reoptimized for all SPL routines in the current database.

The database server keeps a list of tables that the SPL routine references explicitly. Whenever an explicitly referenced table is modified, the database server reoptimizes the procedure the next time the procedure is executed.

The **sysprocplan** system catalog table stores execution plans for SPL routines. Two actions can update the **sysprocplan** system catalog table:

- Execution of an SPL routine that uses a modified table
- The **UPDATE STATISTICS FOR ROUTINE**, **FUNCTION**, or **PROCEDURE** statement.

If you change a table that an SPL routine references, you can run **UPDATE STATISTICS** to reoptimize the procedures that reference the table, rather than waiting until the next time an SPL routine that uses the table executes. If a table that an SPL routine references is dropped, however, running **UPDATE STATISTICS** cannot prevent the SPL routine from failing with an error.

Examples of updating statistics for a specific routine

The following **UPDATE STATISTICS FOR SPECIFIC** statement instructs the database server to update statistics for an existing function named **Perform_work** that returns one or more values:

```
UPDATE STATISTICS FOR SPECIFIC FUNCTION Perform_work;
```

For the same **Perform_work** function, the effect of the following example is identical to that of the previous example:

```
UPDATE STATISTICS FOR SPECIFIC ROUTINE Perform_work;
```

Similarly, use the keywords **SPECIFIC PROCEDURE** or **SPECIFIC ROUTINE** to update statistics for **SPECIFIC** procedures that return no value.

Do not include parentheses or a parameter list after the name of the **SPECIFIC** routine. Because of the parentheses that follow the name of the **Perform_work** function, the following statement fails with an error:

```
UPDATE STATISTICS FOR SPECIFIC ROUTINE Perform_work();
```

The database server also issues an error if parentheses enclose arguments to the **SPECIFIC** routine, function, or procedure.

- [Altered tables that are referenced indirectly in SPL routines](#)
After DDL operations that change the schema of a table that an SPL routine references indirectly, but not as the target of a DML operation, you might need to perform **UPDATE STATISTICS** operations on the modified table and on the SPL routine to avoid exceptions when the SPL routine is invoked.

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Altered tables that are referenced indirectly in SPL routines

After DDL operations that change the schema of a table that an SPL routine references indirectly, but not as the target of a DML operation, you might need to perform **UPDATE STATISTICS** operations on the modified table and on the SPL routine to avoid exceptions when the SPL routine is invoked.

If the SPL routine depends on a table that is referenced only indirectly, the database server cannot detect the need to reoptimize the procedure after that table is modified. For example, a table can be referenced indirectly if the SPL routine activates a trigger. After schema modifications of a table that is referenced by the trigger but not referenced directly by the SPL routine, the database server does not know that it should reoptimize execution plan of the SPL routine before running it. When the procedure is run after the table has been changed, error -710 can occur.

Each SPL routine is optimized the first time that it is run, not when it is created. This behavior means that an SPL routine might succeed the first time it is run, but might fail later under virtually identical circumstances, if the schema of an indirectly referenced table has been changed. The failure of an SPL routine can also be intermittent, because failure during one execution forces an internal warning to reoptimize the procedure before the next execution.

You can use either of two methods to recover from this error:

- Issue **UPDATE STATISTICS FOR PROCEDURE** to force reoptimization of the routine.
- Rerun the routine.

To prevent this error, you can force reoptimization of the SPL routine. To force reoptimization, execute the following statement:

```
UPDATE STATISTICS FOR PROCEDURE routine;
```


You can add this statement to your program in either of the following ways:

- Issue UPDATE STATISTICS after each statement that changes the mode of an object.
- Issue UPDATE STATISTICS FOR PROCEDURE before each invocation of the SPL routine.

For efficiency, you can put the UPDATE STATISTICS statement with the action that occurs less frequently in the program (change of object mode or execution of the procedure). In most cases, the action that occurs less frequently in the program is the change of object mode.

When you follow this method of recovering from this error, you must execute UPDATE STATISTICS FOR PROCEDURE for each SPL procedure that indirectly references the altered tables, unless the procedure also references the tables explicitly.

You can also recover from error -710 after an indirectly referenced table is altered simply by re-executing the SPL routine. The first time that the stored procedure fails, the database server marks the procedure as in need of reoptimization. The next time that you run the procedure, the database server reoptimizes the procedure before running it. Running the SPL routine twice, however, might be neither practical nor safe. A safer choice is to use the UPDATE STATISTICS FOR PROCEDURE statement to force reoptimization of the procedure.

When

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Updating statistics when you upgrade the database server

When you upgrade a database to use with a newer database server, you can use the UPDATE STATISTICS statement to convert the indexes to the form that the newer database server uses.

You can choose to convert the indexes one table at a time or for the entire database at one time. Follow the conversion guidelines that are outlined in the *IBM® Informix® Migration Guide*.

Migration to a newer database server is the only context in which the UPDATE STATISTICS statement causes table indexes to be implicitly dropped and re-created.

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Performance considerations of UPDATE STATISTICS statements

The more specific you make the list of objects that the UPDATE STATISTICS statement examines, the faster it completes execution. Limiting the number of column distributions speeds the update. Similarly, precision affects the speed of the update. If all other keywords are the same, LOW works fastest, but HIGH examines the most data.

For version 11.70 and later of the Informix® database server, the AUTO_STAT_MODE setting can improve the efficiency of UPDATE STATISTICS operations that refresh data distribution statistics. This enables the database server to selectively recalculate only the table or fragment distributions that have become stale as a result of DML operations since the statistics were last calculated, as determined by a change threshold that an explicit or default STATCHANGE table attribute defines. For information about how to set STATCHANGE and how to enable the automatic mode of UPDATE STATISTICS for refreshing only stale distribution statistics, see these topics:

- [Using the FORCE and AUTO keywords](#)
- [AUTO_STAT_MODE session environment option](#)
- [STATCHANGE session environment option](#)
- [Statistics options of the CREATE TABLE statement](#)
- [Statistics options of the ALTER TABLE statement](#)

The [USTLOW_SAMPLE environment option](#) enables sampling during the gathering of index statistics for UPDATE STATISTICS operations in LOW mode. For an index with more than 100 K leaf pages, the gathering of statistics using sampling can increase the speed of the UPDATE STATISTICS operation.

Examples of UPDATE STATISTICS statements

```
UPDATE STATISTICS MEDIUM;
UPDATE STATISTICS MEDIUM RESOLUTION 10;
UPDATE STATISTICS MEDIUM RESOLUTION 10 .95;
{ RESOLUTION 10, CONFIDENCE .95}
UPDATE STATISTICS MEDIUM RESOLUTION 10 DISTRIBUTIONS ONLY;
UPDATE STATISTICS MEDIUM RESOLUTION 10 .95 DISTRIBUTIONS ONLY;
```

```
UPDATE STATISTICS HIGH;
UPDATE STATISTICS HIGH RESOLUTION 10;
UPDATE STATISTICS HIGH RESOLUTION 10 DISTRIBUTIONS ONLY;
```

Resolution must be greater than 0.005 and less than or equal to 10.0. Confidence must be in the range [0.80, 0.99] (inclusive). Examples that follow are based on the **company_proc** procedure and **square_w_default** function, as defined below:

```
CREATE PROCEDURE company_proc ( no_of_items INT,
                               itm_quantity SMALLINT, sale_amount MONEY,
                               customer VARCHAR(50), sales_person VARCHAR(30) )
SPECIFIC spec_cmpy

DEFINE salesperson_proc VARCHAR(60);

-- Update the company table
```



```

INSERT INTO company_tbl VALUES (no_of_items, itm_quantity,
                                sale_amount, customer, sales_person);

-- Generate the procedure name for the variable salesperson_proc
LET salesperson_proc = sales_person || "." || "tbl" ||
                        month(current) || "_" || year(current) || "_proc" ;

-- Execute the SPL procedure that the salesperson_proc
-- variable specifies
EXECUTE PROCEDURE salesperson_proc (no_of_items,
                                    itm_quantity, sale_amount, customer);
END PROCEDURE;

CREATE FUNCTION square_w_default
    (i INT DEFAULT 0) {Specifies default value of i}
RETURNING INT {Specifies return of INT value}
SPECIFIC spec_square
    DEFINE j INT; {Defines routine variable j}
    LET j = i * i; {Finds square of i and assigns it to j}
    RETURN j; {Returns value of j to calling module}
END FUNCTION;

```

The UPDATE STATISTICS examples that follow reference the **company_proc** procedure and **square_w_default** function:

```

UPDATE STATISTICS FOR PROCEDURE;
UPDATE STATISTICS FOR PROCEDURE company_proc1;
UPDATE STATISTICS FOR PROCEDURE
    company_proc1(INT,SMALLINT,MONEY,VARCHAR(50), VARCHAR(30));
UPDATE STATISTICS FOR SPECIFIC PROCEDURE spec_cmpy;

UPDATE STATISTICS FOR FUNCTION;
UPDATE STATISTICS FOR FUNCTION square_w_default;
UPDATE STATISTICS FOR FUNCTION square_w_default(INT);
UPDATE STATISTICS FOR SPECIFIC FUNCTION spec_square;

```

For a discussion of the performance implications of UPDATE STATISTICS, see your *IBM® Informix Performance Guide*.

For a discussion of how to use the **dbschema** utility to view distributions created with UPDATE STATISTICS, see the *IBM Informix Migration Guide*.

Related concepts:

[Using the LOW mode option](#)
[USTLOW_SAMPLE environment option](#)
[Using the HIGH mode option](#)
[Using the MEDIUM mode option](#)

Related reference:

[SET ENVIRONMENT statement](#)
[SET EXPLAIN statement](#)
[SET OPTIMIZATION statement](#)

Related information:

[Data sampling during update statistics operations](#)
[Update statistics when they are not generated automatically](#)

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WHENEVER statement

Use the WHENEVER statement to trap exceptions that occur during the execution of SQL statements. The WHENEVER statement is equivalent to placing an exception-checking routine after every SQL statement.

Syntax

```

>>-WHENEVER--+-SQLERROR-----+----->
      +NOT FOUND-----+
      | (1)             |
      +-----SQLWARNING--+
      | (1)             |
      +-----ERROR-----+

>--+-CONTINUE-----+-----<
+-+GOTO--+-+--+label-----+
| '-GO TO-' | (1) | |
|           |-----label-| |
+-CALL--routine-----+
|'-STOP-----+

```

Notes:

1. Informix® extension

Element	Description	Restrictions	Syntax
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Element	Description	Restrictions	Syntax
<i>label</i>	Statement label to which program control transfers when an exception occurs	Must exist in the same source-code module.	Language-specific
<i>routine</i>	Name of a user-defined routine (UDR) to be invoked when an exception occurs	No arguments; UDR must exist at compile time.	Identifier

Usage

Important: Use this statement only with Informix ESQL/C.

The following table summarizes the types of exceptions that you can check with the WHENEVER statement.

Type of exception	WHENEVER Keyword	For More Information
Errors	SQLERROR or ERROR	SQLERROR Keyword
Warnings	SQLWARNING Keyword	
Not Found or End of Data	NOT FOUND Keywords	

Programs that do not use the WHENEVER statement do not automatically abort when an exception occurs. Such programs must explicitly check for exceptions and take whatever corrective action their logic specifies. If you do not check for exceptions, the program simply continues running. If errors occur, however, the program might not perform its intended purpose.

The first keyword that follows WHENEVER specifies some type of exceptional condition; the last part of the statement specifies some action to take when the exception is encountered (or no action, if CONTINUE is specified). The following table summarizes possible actions that WHENEVER can specify.

Type of action	WHENEVER keyword	For more information
Continue program execution	CONTINUE Keyword	
Stop program execution	STOP Keyword	
Transfer control to a specified label	GOTO GO TO	GOTO Keyword
Transfer control to a UDR	CALL Clause	

- [The Scope of WHENEVER](#)
- [SQLERROR Keyword](#)
- [ERROR Keyword](#)
- [SQLWARNING Keyword](#)
- [NOT FOUND Keywords](#)
- [CONTINUE Keyword](#)
- [STOP Keyword](#)
- [GOTO Keyword](#)
- [CALL Clause](#)

Related reference:

[BEGIN WORK statement](#)

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The Scope of WHENEVER

WHENEVER is a preprocessor directive, rather than an executable statement. The Informix® ESQL/C preprocessor, not the database server, handles the interpretation of the WHENEVER statement. When the preprocessor encounters a WHENEVER statement in the Informix ESQL/C source file, it inserts appropriate code into the preprocessed code after each SQL statement, based on the exception and the action that WHENEVER specifies. The scope of the WHENEVER statement begins where the statement appears in the source module and remains in effect until the preprocessor encounters one or the other of the following things while sequentially processing the source module:

- The next WHENEVER statement with the same condition (SQLERROR, SQLWARNING, or NOT FOUND) in the same source module
- The end of the source module

The following Informix ESQL/C example program has three WHENEVER statements, two of which are WHENEVER SQLERROR statements. Line 4 uses STOP with SQLERROR to override the default CONTINUE action for errors.

Line 8 specifies the CONTINUE keyword to return the handling of errors to the default behavior. For all SQL statements between lines 4 and 8, the preprocessor inserts code that checks for errors and halts program execution if an error occurs. Therefore, any errors that the INSERT statement on line 6 generates cause the program to stop.

After line 8, the preprocessor does not insert code to check for errors after SQL statements. Therefore, any errors that the INSERT statement (line 10), the SELECT statement (line 11), and DISCONNECT statement (line 12) generate are ignored. The SELECT statement, however, does not stop program execution if it does not locate any rows; the WHENEVER statement on line 7 tells the program to continue if such an exception occurs:

```

1  main()
2  {
3  EXEC SQL connect to 'test';
4  EXEC SQL WHENEVER SQLERROR STOP;
5  printf("\n\nGoing to try first insert\n\n");

```

```

6 EXEC SQL insert into test_color values ('green');
7 EXEC SQL WHENEVER NOT FOUND CONTINUE;
8 EXEC SQL WHENEVER SQLERROR CONTINUE;
9 printf("\n\nGoing to try second insert\n\n");
10 EXEC SQL insert into test_color values ('blue');
11 EXEC SQL select paint_type from paint where color='red';
12 EXEC SQL disconnect all;
13 printf("\n\nProgram over\n\n");
14 }

```

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SQLERROR Keyword

If you use the SQLERROR keyword, any SQL statement that encounters an error is handled as the WHENEVER SQLERROR statement directs. If an error occurs, the **sqlcode** variable (**sqlca.sqlcode**, **SQLCODE**) is set to a value less than zero (0) and the SQLSTATE variable is set to a class code with a value greater than 02.

The next example terminates program execution if an SQL error is detected:

```
WHENEVER SQLERROR STOP
```

If you do not include any WHENEVER SQLERROR statements in a program, the default action for WHENEVER SQLERROR is CONTINUE.

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ERROR Keyword

Within the WHENEVER statement (and only in this context), the keyword ERROR is a synonym for the SQLERROR keyword.

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SQLWARNING Keyword

If you use the SQLWARNING keyword, any SQL statement that generates a warning is handled as the WHENEVER SQLWARNING statement directs. If a warning occurs, the first field (**sqlca.sqlwarn.sqlwarn0**) of the warning structure in SQLCA is set to W, and the SQLSTATE variable is set to a class code of 01.

Besides the first field of the warning structure, a warning also sets an additional field to W. The field that is set indicates what type of warning occurred.

The next statement causes execution to stop if a warning condition exists:

```
WHENEVER SQLWARNING STOP
```

If you do not use any WHENEVER SQLWARNING statements in a program, the default action for WHENEVER SQLWARNING is CONTINUE.

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NOT FOUND Keywords

If you use the NOT FOUND keywords, exception handling for SELECT and FETCH statements (including implicit SELECT and FETCH statements in FOREACH and UNLOAD statements) is treated differently from other SQL statements. The NOT FOUND keyword checks for the following cases:

- The **End of Data** condition: a FETCH statement that attempts to get a row beyond the first or last row in the active set
- The **Not Found** condition: a SELECT statement that returns no rows

In each case, the **sqlcode** variable is set to 100, and the SQLSTATE variable has a class code of 02. For the name of the **sqlcode** variable in each IBM® Informix® product, see the table in [SQLERROR Keyword](#).

The following statement calls the **no_rows()** function each time the NOT FOUND condition exists:

```
WHENEVER NOT FOUND CALL no_rows
```

If you do not use any WHENEVER NOT FOUND statements in a program, the default action for WHENEVER NOT FOUND is CONTINUE.

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CONTINUE Keyword

Use the CONTINUE keyword to instruct the program to ignore the exception and to continue execution at the next statement after the SQL statement. The default action for all exceptions is CONTINUE. You can use this keyword to turn off a previously specified action for an exceptional condition.

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STOP Keyword

Use the STOP keyword to instruct the program to stop execution when the specified exception occurs. The following statement halts execution of an ESQL/C program each time that an SQL statement generates a warning:

```
EXEC SQL WHENEVER SQLWARNING STOP;
```

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GOTO Keyword

Use the GOTO clause to transfer control to the statement that the label identifies when a specified exception occurs. The GOTO and GO TO keywords are ANSI-compliant syntax for this feature of embedded SQL languages like ESQL/C. The following Informix® ESQL/C code fragment shows a WHENEVER statement that transfers control to the label **missing** each time that the NOT FOUND condition occurs:

```
query_data()  
...  
EXEC SQL WHENEVER NOT FOUND GO TO missing;  
  
...  
EXEC SQL fetch lname into :lname;  
...  
missing:  
    printf("No Customers Found\n");
```

Within the scope of the WHENEVER GOTO statement, you must define the labeled statement in *each* routine that contains SQL statements. If your program contains more than one user-defined function, you might need to include the labeled statement and its code in *each* function.

If the preprocessor encounters an SQL statement within the scope of a WHENEVER ... GOTO statement, but within a routine that does not have the specified label, the preprocessor tries to insert the code associated with the labeled statement, but generates an error when it cannot find the label.

To correct this error, either put a labeled statement with the same label name in each UDR, or issue another WHENEVER statement to reset the error condition, or use the CALL clause to call a separate function.

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CALL Clause

Use the CALL clause to transfer program control to the specified UDR when the specified type of exception occurs. Do not include parentheses after the UDR name. The following WHENEVER statement causes the program to call the **error_recovery()** function if the program detects an error:

```
EXEC SQL WHENEVER SQLERROR CALL error_recovery;
```

When the UDR returns, execution resumes at the next statement after the line that is causing the error. If you want to halt execution when an error occurs, include statements that terminate the program as part of the specified UDR.

Observe the following restrictions on the specified routine:

- The UDR cannot accept arguments nor can it return values. If it needs external information, use global variables or the WHENEVER ... GOTO option to transfer program control to a label that calls the UDR.
- You cannot specify the name of an SPL routine in the CALL clause. To call an SPL routine, use the CALL clause to invoke a UDR that contains the EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement.
- Make sure that all functions within the scope of WHENEVER ... CALL statements can find a declaration of the specified function.

Related Statements

Related statements: [EXECUTE FUNCTION statement](#), [EXECUTE PROCEDURE statement](#), and [FETCH statement](#)

For discussions on exception handling and error checking, see the *IBM® Informix® ESQL/C Programmer's Manual*.

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WITH statement (Common Table Expressions)

A common table expression (CTE) is a named temporary result set that exists within the scope of a single statement and that can be referred to later within that statement, possibly multiple times. The following discussion describes how to write statements that use CTEs.

Syntax

```
|--WITH -----> (1)

      .,-----+
      v         |
(1)----- cte_name -----+--AS (Subset of SELECT statement)--+--> (2)
      |         |         |
      |         v         |
      |-----column-----|
      |-----|
(2)----- SELECT/UPDATE/INSERT/DELETE statement
```

Element	Description	Restrictions	Syntax
column	Name that you declare here for a column in CTE. Default is a column name from Projection list of SELECT		Identifier
cte_name	Name that you declare here for the table expression, and it can be used as a virtual table in the following SELECT/UPDATE/INSERT/DELETE statement	Must be unique among view, table, sequence, and synonym names in the database.	Identifier

Usage

WITH statement can be run directly like SELECT/UPDATE/INSERT/DELETE statements, and it can be used with

- CREATE VIEW
- CREATE TRIGGER
- CREATE PROCEDURE/FUNCTION

Recursive CTE

A recursive CTE starts with either one non-recursive sub-query or several non-recursive sub-queries joined by UNION or UNION ALL and ends with exactly one recursive sub-query joined by UNION ALL. A recursive sub-query references the CTE being defined.

```
WITH recursive_cte AS (
    <initial subquery>
    UNION ALL
    <recursive subquery>
) SELECT ...
```

Example 1: Recursive query computing the factorial of numbers from 0 to 9

```
WITH temp (n, fact) AS (
    SELECT 0, 1 -- Initial Subquery
    UNION ALL
    SELECT n+1, (n+1)*fact FROM temp -- Recursive Subquery
    WHERE n < 9)
SELECT * FROM temp;

Other example of computing Fibonacci Numbers
WITH fib(p, n) as (
    select 0, 1 -- initial subquery
    UNION ALL -- 'UNION ALL'
    select n, (p+n) from fib -- recursive subquery
    where n < 100 -- terminate condition
)
select p as fn from fib;

    fn
    0
    1
    1
    2
    ...
    34
    55
    89
```

Example 2: Recursive CTE optional Cycle clause

```
CYCLE <column list> SET <cycle pseudo column>
    TO <value1> DEFAULT <value2>

create table cycle (id int, pid int);
insert into cycle values (1,2);
insert into cycle values (2,1);

WITH cte AS (
    select id, pid from cycle where id = 1 UNION ALL
```

```

select t.id, t.pid
      from cycle t, cte where t.pid = cte.id)
cycle id set iscycle to "yes" default "no"
SELECT id, pid, iscycle from cte ;

```

id	pid	iscycle
1	2	no
2	1	yes

Example 3: Recursive CTE Loops

```

with cte(n) as
(
  select 1
  UNION ALL
  select n+1 from cte
)
select first 2 n from cte;      -- 2 rows return

without the 'FIRST 2' the query will loop till integer limit error.

```

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SPL statements

These topics describe Stored Procedure Language (SPL) statements, which you use to write SPL routines. You can store these routines in the database as user-defined routines (UDRs).

SPL routines (formerly referred to as *stored procedures*) are effective tools for controlling SQL activity. This chapter contains descriptions of the SPL statements. The description of each statement includes the following information:

- A brief introduction that explains the effect of the statement
- A syntax diagram that shows how to enter the statement correctly
- A syntax table that explains each input parameter in the syntax diagram
- Rules of usage, including examples that illustrate these rules

If a statement is composed of multiple clauses, the statement description provides information about each clause.

For an overview of the SPL language and task-oriented information about creating and using SPL routines, see the *IBM Informix Guide to SQL: Tutorial*.

For an overview with detailed examples of how to create and use prepared objects and Dynamic SQL in SPL routines, see this IBM® developerWorks® article: [Dynamic SQL support in Informix® Dynamic Server Stored Procedure Language](#).

Informix can create an SPL function with the CREATE PROCEDURE or CREATE PROCEDURE FROM statement, but requires the CREATE FUNCTION or CREATE FUNCTION FROM statement for external functions. It is recommended, however, that you use the CREATE FUNCTION or CREATE FUNCTION FROM statement to create new user-defined functions.

- [Debugging SPL routines](#)
You can use a Routine Debugger client application to identify and analyze logical errors in an SPL routine.
- [<<Label >> statement](#)
Use the <<label>> statement of SPL to declare a statement label or a loop label.
- [CALL](#)
- [CASE](#)
Use the CASE statement when program execution needs to take exactly one among multiple branches, depending on the value of an SPL variable or of a simple expression. The CASE statement is a logical alternative to the IF statement.
- [CONTINUE](#)
- [DEFINE](#)
- [EXIT](#)
- [FOR](#)
- [FOREACH](#)
Use the FOREACH statement to declare a direct cursor that can select and manipulate more than one row from a the result set of a query, or more than one element from a collection.
- [GOTO](#)
- [IF](#)
- [LET](#)
- [LOOP](#)
- [ON EXCEPTION](#)
- [RAISE EXCEPTION](#)
- [RETURN](#)
- [SYSTEM](#)
- [TRACE](#)
- [WHILE](#)
Use the WHILE statement to establish a loop with variable end conditions.

Related concepts:

[Overloading the Name of a Function](#)

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Debugging SPL routines

You can use a Routine Debugger client application to identify and analyze logical errors in an SPL routine.

You can include the TRACE statement in your SPL routine to generate tracing output while the SPL routine runs. For information about how to produce and examine TRACE statement output, see the description of [TRACE](#).

Current® restrictions for debugging SPL routines

The following software products currently support client environments that can be used for debugging Informix® SPL routines:

- Optim™ Development Studio (ODS)
- IBM® Database Add-Ins for Visual Studio (IDAIVS)

Refer to the data type support document for information on which Informix data types are read-only and which are updateable.

The following restrictions apply to both the Optim Development Studio (ODS) and IBM Database Add-Ins for Visual Studio (IDAIVS) debugging environments:

Unlogged databases

Informix nontransactional databases do not support SPL debugging. You cannot use either the ODS or the IDAIVS debugging environments with the Informix database whose CREATE DATABASE statement omits the WITH LOG keywords.

Secondary server instances

Secondary servers within a cluster environment do not support 'Step into' trigger procedure operation for Insert, Delete, or Update triggers.

Data strings delimited by double (") quotation marks

The current interpretation by the ODS or IDAIVS debugging client of quotation-mark delimiters might conflict with the expected behavior of some SPL routines.

- Currently, in ODS debugging sessions the **DELIMIDENT** environment variable is set to 'y' by default in the IBM Data Server Driver for JDBC and SQLJ connection string. The default value of **DELIMIDENT** is 'n' for JDBC connection.
- Currently in IDAIVS debugging sessions, the **DELIMIDENT** environment variable is set to 'y' by default in the Informix .NET Provider connection string.

The setting of the **DELIMIDENT** environment variable affects how the database server interprets quoted strings:

- 'y' specifies that strings enclosed by double quotation (") marks are delimited SQL identifiers. Client applications must use single quotation (') marks to delimit character strings, and must use double quote (") symbols only around delimited SQL identifiers, which can support a larger character set than is valid in undelimited identifiers. In locales that support lettercase sensitivity, letters within delimited strings or within delimited identifiers are case-sensitive. This is the default value for .NET.
- 'n' specifies that client applications can use double (") or single (') quotation marks to delimit character strings, but not to delimit SQL identifiers. If the database server encounters a string that is delimited by double or single quotation marks in a context where an SQL identifier is required, it issues an error. An owner name that qualifies an SQL identifier can be delimited by single quotation (') marks. You must use a pair of the same quotation mark symbols to delimit a character string.
- If no value for **DELIMIDENT** is specified on the client system, the default setting is used. As indicated above, for ODS this default is 'n' (from the IBM Data Server Driver for JDBC and SQLJ connection string. For IDAIVS, this default is 'y' (from the Informix .NET Provider connection string).

Restrictions that only affect ODS debugging sessions

By default, 'AUTOCOMMIT' transaction mode is set to 'TRUE' by the IBM Data Server Driver for JDBC and SQLJ. This is enabled in ODS debugging session for all logging databases, including databases that were created WITH LOG MODE ANSI, and also databases that are not ANSI-compliant.

Currently, the Informix server performs an implicit commit operation after every SQL statement completes in an Optim Development Studio debugging session. If there is an explicit transaction started inside the Informix SPL procedure, the database server ignores SQL ERROR -535 and continues the debugging session.

Restrictions that only affect IDAIVS debugging sessions

Currently, SPL function debugging is not supported by IBM Database Add-Ins for Visual Studio. You can only use the IDAIVS debugging environment with Informix SPL procedures that do not return any value to the calling context.

- [Starting an SPL debugging session with Optim Development Studio](#)
To use Optim Development Studio (ODS) to debug an SPL routine, you must establish a connection between the Informix database server and the ODS client.
- [Debugging SPL procedures with IBM Database Add-Ins for Visual Studio](#)
You can use IBM Database Add-Ins for Visual Studio to debug Informix SPL procedures.

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Starting an SPL debugging session with Optim Development Studio

To use Optim™ Development Studio (ODS) to debug an SPL routine, you must establish a connection between the Informix® database server and the ODS client.

You can examine the runtime behavior of an SPL routine in a client debugging environment and control the flow of a debugging session, using the standard debugger interface of Optim Development Studio (ODS). The steps that follow are also valid for Optim Data Studio.

Note: SPL Routine Debugger support for the Informix database server is available in ODS 2.2.1.0 and later versions. Earlier ODS versions (like 2.2.0) support the Informix database server, but do not provide Informix SPL support nor SPL Routine Debugger support.

To begin an SPL Routine debugging session in ODS, follow these steps:

Informix server instance: start-up and configuration

To configure the Informix database server instance so that SPL routine debugging is enabled, follow these steps:

1. Install the Informix database server product.
2. Configure and bring up the Informix server with entries in the **onconfig** and **sqlhosts** files to support the DRDA communications protocol:

- **onconfig:**

```
DBSERVERNAME    ids_spldb
```

- **sqlhosts:**

```
ids_spldb      drsotcp    ids_server_machine_name  port_number
```

Note: SPL Routine Debugger support for Informix connects the database server to the client via the IBM Data Server Driver for JDBC and SQLJ, and requires a connection that uses the Informix DRDA protocol.

3. You must provide an sbspace where the database server can store XML messages that ODS sends to the server. The setting of the SBSPACENAME configuration parameter specifies the name of the system default sbspace. You can create a default sbspace on the database server by using the onspaces utility with the `-Df "LOGGING=ON"` option. This sbspace is a requirement for debugging SPL on ODS.
4. If this is a fresh server instance, create a new database using the CREATE DATABASE statement. You will later use this database to create a Database connection in ODS to deploy and debug your SPL routines.

Routine debugger session manager start-up (optional)

In most cases, you can use the built-in session manager that ODS provides to debug your Informix SPL routines. In some situations, however, (for example, if your server machine is behind a firewall), you might need to start a session manager on a TCP/IP port that has outbound access either on the server machine or on a different machine.

To start the session manager manually, follow these steps:

1. To start the session manager manually, use the following command to export the **CLASSPATH** environment variable setting:

```
export CLASSPATH=${INFORMIXDIR}/bin/db2dbgm.jar:$CLASSPATH
```

2. Using Java™ 1.5.0 or above and ensuring it is in the PATH environment variable run the following command, specifying your *port number* that the session manager will use and a *pathname* for the session manager log file:

```
java com.ibm.db2.psm.dmgr.Daemon -port port_num -log sess_mgr_log_path
```

Steps in ODS to deploy and debug SPL routines

To configure ODS to deploy and debug Informix SPL routines, , follow these steps:

1. If you are not using the built-in session manager and have started a stand-alone session manager, use menu commands to configure that option in ODS (**Window > Preferences > Run/Debug > Routine Debugger > IBM® DB2® screen**) by choosing the "Use an already running Session manager" radio button, and providing the port number and the machine name.
2. To configure ODS for debugging Informix SPL routines, you need to create a Database connection in the **Data Source Explorer** perspective in ODS. Refer to the Optim Development Studio documentation for details on how to create a Database connection.
3. Right Click on the **Database Connection > New Connection** dialog box, choose Informix, and create a new database connection by choosing the appropriate version of the IBM Data Server Driver for JDBC and SQLJ for Informix from the Driver list.
4. In the **Edit Driver Definitions** dialog box, open the **Jar List** tab and verify that it includes **db2jcc4.jar**. If it does not, replace **db2jcc.jar** with **db2jcc4.jar** in the **Driver files:** list.
5. Refer to the Optim Development Studio documentation for details on how to **Create**, **Deploy**, and **Debug** SPL routines.

Now you are ready to create, deploy and debug Informix SPL routines in Optim Development Studio.

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Debugging SPL procedures with IBM Database Add-Ins for Visual Studio

You can use IBM® Database Add-Ins for Visual Studio to debug Informix® SPL procedures.

You can debug SPL procedures as they run on the Informix server. You can step through your code, set line or variable breakpoints, view variable values, change variable values, view call stack information for nested procedures, and switch between different procedures on the call stack. By stepping through your code while running the procedure in debug mode and viewing the results, you can discover problems with your procedure and make the necessary changes.

To begin an SPL Routine debugging session in IBM Database Add-Ins for Visual Studio (IDAIVS), follow these steps:

Starting up and configuring the Informix database server instance

To configure the Informix database server instance so that SPL routine debugging is enabled, follow these steps:

1. Install the Informix database server product.
2. Configure and bring up the Informix database server with entries in the **onconfig** and **sqlhosts** files to support the DRDA communications protocol:

- **onconfig:**

```
DBSERVERNAME ids_spldb
```

- **sqlhosts:**

```
ids_spldb drsotcp ids_server_machine_name port_number
```

Note: SPL Routine Debugger support for Informix connects the server to the client via the Informix .NET Provider, and requires a connection with the Informix DRDA protocol.

3. You must provide an sbspace where the database server can store XML messages that IBM Database Add-Ins for Visual Studio sends to the server. The setting of the SBSPACENAME configuration parameter specifies the name of the system default sbspace. You can create a default sbspace on the database server by using the **onspaces** utility with the `-DF "LOGGING=ON"` option. This sbspace is a requirement for debugging SPL on IBM Database Add-Ins for Visual Studio.
4. If this is a fresh server instance, create a new database using the CREATE DATABASE statement. You will later use this database to create a Database connection in IBM Database Add-Ins for Visual Studio to deploy and debug your SPL routines.

Starting up the routine debugger session manager

To start the session manager, follow these steps:

1. To start the session manager manually, use the following command to export the **CLASSPATH** environment variable setting:

```
export CLASSPATH=${INFORMIXDIR}/bin/db2dbgm.jar:$CLASSPATH
```

2. Using Java™ 1.5.0 or above and ensuring it is in the **PATH** environment variable, run the following command, specifying your *port number* that the session manager will use and a *pathname* for the session manager log file:

```
java com.ibm.db2.psmg.mgr.Daemon -port port_num -log sess_mgr_log_path
```

Note: The session manager must start on a machine on which the Informix instance is running. This is a requirement for IBM Database Add-Ins for Visual Studio to connect to the session manager.

Establishing the Informix database server connection

The Add Connection dialog can be accessed from the action (right-click) pop-up menu on the "Data Connections" node in the Server Explorer by selecting the "Add Connection..." menu item to create a new connection. The **Data source** field should display "IBM DB2, Informix and U2 Servers (IBM DB2, Informix, and U2 Data Provider.)"

1. In the field immediately below the instruction "**1. Select or enter server name:**" enter the name of the Informix server instance.
2. In the field immediately below the instruction "**2. Enter information to log on to the server:**" enter your user id as the **User ID:** field, and in the **Password:** field enter the password for the **informix** account on the server.
3. In the field immediately below the instruction "**3. Select or enter a database name:**" enter the name of the database where the SPL procedure that you intend to debug is stored.
4. Click the **Test Connection** button to test the connection with the Informix server instance.
5. If the **Test connection succeeded** dialog appears, you can click the **OK** button. You can dismiss the Add Connection dialog, because you have created a connection between the Informix server and Visual Studio.

Setting up the session manager

Before you can start a debugging session, you need to specify the SPL routine to debug, and a database server connection and port number for the session manager.

1. From the "Data Connections" node in the Server Explorer, click on a database of the Informix server to which you are connected.
2. Expand the Procedures heading to display the names of all of the stored procedures in the database.
3. Click on the name of the SPL routine that you would like to debug.
4. From the Tools tab, select the "Options . . ." menu near the bottom of the Tools list.
5. From the Options dialog, expand the IBM Database Tools item and click on the **General** item to display a list of categories.
6. Use the slider control at the right of the **General** options list to display the **Session Manager Connection** and **Session Manager Port** number.
7. Click **OK** to accept these values for the session manager configuration.

Refer to the IBM Database Add-Ins for Visual Studio documentation for details on how to use the debugging capability of Visual Studio with SPL routines.

Debugging Informix SPL procedures

These are the steps for debugging an SPL procedure using the IBM Database Add-Ins for Visual Studio:

1. Enable debugging for the procedure:
 - a. In the Server Explorer under your data connection, right-click the procedure that you want to debug, and then click **Open Definition** on the shortcut menu.
 - b. In the Procedure view of the IBM Procedure Designer, select **ALLOW** in the **Debug mode** list.
 - c. Save the procedure, but leave the Designer open.

2. Set line breakpoints in the IBM Procedure Designer.
 - a. If the procedure is not open in the Designer, in the Server Explorer under the data connection, right-click the procedure and then click **Open Definition** on the shortcut menu.
 - b. In the **SQL Body** section of the Procedure view in the Designer, set line breakpoints. In
 - c. To set properties for a breakpoint, right-click the breakpoint in the left margin, select **Location, Filter, or When Hit** on the shortcut menu, and then specify the necessary information in the window that opens.
3. Start running the procedure in debug mode.
 - If the procedure is open in the IBM Procedure Designer, click **Step Into** on the IBM Procedure Designer toolbar.
 - If the procedure is not open in the Designer, right-click the procedure in the Server Explorer, and then click **Step Into** on the shortcut menu.
4. Run each procedure in debug mode, and use either of the following methods:
 - Set variable breakpoints. In the SQL body, right-click a variable name, click **Breakpoints** on the shortcut menu, and then select **Insert Variable Breakpoints**.
 - Modify variable breakpoint values.
5. Continue debugging the Informix SPL procedure until the procedure returns the expected results.

Debugging Informix SPL procedures in CLR applications

While you develop Windows or ASP.NET applications in C# and Visual Basic, you can debug the Common Language Runtime (CLR) applications with IBM Database Add-Ins for Visual Studio. If the applications access Informix database server instances, you can debug the SPL procedures that are called from the applications while you debug the applications.

The IBM Unified Debugger, which is the feature that you use to debug SPL procedures in C# and Visual Basic applications, is available for Informix, starting with version 11.70.

The IBM Unified Debugger debugs SPL procedures through the IBM Procedure Designer. If a procedure definition is open in the Designer when you start debugging an application, as the debugger steps into the procedure, that instance of the Designer is activated. If the procedure definition is not open in the Designer, as the debugger steps into the procedure, the debugger opens the procedure definition in a new instance of the Designer.

Prerequisite: To debug SPL procedures in a CLR application, enable IBM SQL debugging in the project that contains the application.

To debug SPL procedures in a CLR application, follow these steps:

1. For each SPL procedure in the application:
 - a. Enable debugging for the procedure:
 - i. In the Server Explorer under your data connection, right-click the procedure that you want to debug, and then click **Open Definition** on the shortcut menu.
 - ii. In the Procedure view of the IBM Procedure Designer, select **ALLOW** in the **Debug mode** list.
 - iii. Save the procedure, and optionally leave the Designer open to set line breakpoints.
 - b. Optional: Set line breakpoints in the IBM Procedure Designer.
 - i. In the **SQL Body** section of the Procedure view in the Designer, set line breakpoints.
 - ii. To set properties for a breakpoint, right-click the breakpoint in the left margin, select **Location, Filter, or When Hit** on the shortcut menu, and then specify the necessary information in the window that opens.
 - iii. Leave the Designer open.
2. Start debugging the application.

In the Solution Explorer, right-click the application, select **Debug** on the shortcut menu, and then select **Start new instance**.

Debugging starts and the Debugger Task Status window opens.

The call stack for each procedure that is being debugged is merged with the call stack for the thread that calls the procedure. You can see where the procedure is called from the C# or Visual Basic code.

3. Run each procedure in debug mode as it is called.
 - If you closed the IBM Procedure Designer in step **1a.iii**, in the new instance of the Designer, set line breakpoints and breakpoint properties for the procedure in the **SQL Body** section.
 - Set variable breakpoints. In the SQL body, right-click a variable name, click **Breakpoints** on the shortcut menu, and then select **Insert Variable Breakpoints**.
 - Modify variable breakpoint values.
4. To cancel a long-running task, click **Cancel** in the Debugger Task Status window.

If you closed the window while you were debugging your application, from the **Tools** menu, select Show IBM Debugger Task Status to reopen the window.
5. Continue debugging the application until all the Informix SPL procedures return the expected results.

Enabling SQL debugging in CLR applications

If you want to debug Informix SPL procedures in your C# and Visual Basic Common Language Runtime (CLR) application, you first must enable SQL debugging for the database project. You need to do this process only once for a given project. Enabling SQL debugging for a project sets a project property that persists from session to session in Visual Studio.

When you enable SQL debugging in an application, the IBM Unified Debugger must close and then reopen the database project that contains the application. After the project reopens, you must specify the data connection and, optionally, the port on which to run the debugger session manager. You must also change the settings of some standard Visual Studio project debug properties.

The add-ins, which is 32-bit application, does not support a 64-bit debugging process for console applications. On a 64-bit operating system, the default debug platform is **Any CPU**, which is a 64-bit debugging process. You must specify a 32-bit debug platform in the project properties.

Prerequisite: To enable SQL debugging in an application, the database project that contains the application must be open in the Solution Explorer.

To enable SQL debugging in an application, follow these steps:

1. In the Solution Explorer, right-click the database project node, and then select **Enable IBM SQL Debugging** on the shortcut menu.
A message is displayed that the project must be closed and reopened.
2. Click **Yes** in the message window to confirm the closing and reopening of the project.
All unsaved changes are saved, the project closes, and then reopens in the Solution Explorer.
3. In the Solution Explorer, right-click the database project node, and then select **Properties** on the shortcut menu.
The Project Designer opens.
4. In the left box of the Designer, click IBM Unified Debugger.
The IBM Unified Debugger page is displayed.
5. Perform one of the following sets of actions:
 - If you have one of the following connections to use for the debugger session manager:
 - Informix Version 12.10 or earlier
 - IBM DB2® for Linux, UNIX, and Windows, Version 9.1, or later
 - IBM DB2 for z/OS® Version 9.1 or Version 10
 - IBM DB2 for i V5R4 or V6R1
 - Select **Use an existing connection for session manager**.
 - In the list, select the data connection on which to run the debugger session manager.
 - If you are running the debugger session manager manually:
 - Select **Use a new host name for session manager**.
 - Specify a host name for the debugger session manager.
6. If you are debugging a console application on a 64-bit operating system, in the **Platform** list, select **x86**.
7. Optional: In the **Session manager port** field, type the port on which to run the debugger session manager.
8. In the left box of the Project Designer, click **Debug**.
The Debug page of the Project Designer is displayed.
9. Change the following properties on the Debug page:
 - Under **Start Options**, clear the **Use remote machine** check box.
 - Under **Enable Debuggers**, clear all three of the following check boxes:
 - **Enable unmanaged code debugging**
 - **Enable SQL Server debugging**
 - **Enable the Visual Studio hosting process**
10. Close the Project Designer.

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<< Label >> statement

Use the <<label>> statement of SPL to declare a statement label or a loop label.

- A *statement label* is an SQL identifier, delimited by double angle-brackets, immediately preceding a statement within a statement block to which the GOTO statement of SPL can transfer control of program execution.
- A *loop label* is an SQL identifier, delimited by double angle-brackets, immediately preceding a loop statement of SPL. The same label, without double angle-bracket delimiters, can follow the END LOOP keywords, or END FOR keywords, or END WHILE keywords that terminate the labeled loop. The EXIT *label* statement can pass control of program execution to whatever statement immediately follows the unlimited loop label.

Note that *label* is not a keyword of the <<label>> statement, but is a placeholder for some specific user-defined identifier of the statement label or loop label that the <<label>> statement declares.

Syntax

```
>>-<<label>>-----><
```

Element	Description	Restrictions	Syntax
<i>label</i>	Name that you declare here for a statement label or for a loop label	Must be unique among the identifiers of statement labels and of loop labels within the SPL routine	Identifier

Usage

You can use the <<Label>> statement in two ways:

- To declare a *statement label* before an executable statement to which the GOTO statement of SPL can transfer control of execution. The SPL statement that immediately follows the statement label declaration is called a *labeled statement*.
- To declare a *loop label* immediately before a LOOP, FOR, or WHILE statement of SPL. The LOOP, FOR, or WHILE statement that immediately follows the loop label declaration is called a *labeled loop*.

The EXIT *label* or EXIT *label* WHEN (*condition*) statement can exit from the labeled loop, passing control of execution to the statement immediately following an END LOOP *label* statement. The *label* specified in the EXIT statement can match the label identifier of the labeled loop of the EXIT statement, or if loops are nested, this *label* can match the label of an outer labeled loop. In either case, the EXIT *label* statement passes control to a statement that follows an END LOOP *label*

statement that specifies the same loop label. This EXIT *label* behavior differs from that of the GOTO *label* statement, which passes control to the statement that follows the declaration of the specified statement label.

The following restrictions apply to labels in SPL routines:

- The name of a statement label must be within the scope of reference of the GOTO statement.
- The GOTO option of the WHENEVER statement of SQL cannot reference an SPL statement label, because the WHENEVER statement is valid only in ESQL/C applications.
- The GOTO statement of SPL cannot reference a loop label.
- The GOTO statement cannot reference a statement label within an ON EXCEPTION statement block.
- A statement label cannot be declared within an ON EXCEPTION statement block.
- The label name must be unique among statement labels and loop labels within the SPL routine.
- [Examples of Labels](#)

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Examples of Labels

The following example illustrates a statement label called **increment_x** within an SPL routine:

```
DEFINE x INT;
LET x = 0;
BEGIN
    <<increment_x>>
    BEGIN
        LET x = x + 1;
    END;
    IF x < 10 THEN
        GOTO increment_x;
    END IF;
END;
END PROCEDURE;
```

The following program fragment shows an example of a labeled FOR loop:

```
<<lb_for>>
FOR i IN 1..5
    i := i + 1;
END FOR lb_for;
```

The following program fragment illustrates a labeled loop from which an EXIT *label* statement can exit:

```
<<outer>>
LOOP
...
LOOP
...
EXIT outer WHEN ... -- exit from both loops
END LOOP;
...
END LOOP outer;
```

Related Statements

[EXIT, FOR, GOTO, LOOP, WHILE](#)

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CALL

Use the CALL statement to execute a user-defined routine (UDR) from within an SPL routine.

Syntax

```
>>-CALL----->

>--+procedure--(-+-----+--)-+<
|               | .-,-----+ |
|               | V (1) | |
|               | '---| Argument |-----+-'
|               |
|               | .-,-----+ |
|               | V (1) | |
|               | '---| Argument |-----+-'
|               |
+function--(-+-----+--)-RETURNING----data_var++
|               | .-,-----+ |
|               | V (1) | |
|               | '---| Argument |-----+-'
|               |
```



```
CALL no_args (10,20);
CALL yes_args (5) RETURNING i, j, k;
END PROCEDURE;
```

The first routine call (**no_args**) expects no returned values. The second routine call is to a function (**yes_args**), which expects three returned values. The **not_much()** procedure declares three integer variables (**i**, **j**, and **k**) to receive the returned values from **yes_args**.

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CASE

Use the CASE statement when program execution needs to take exactly one among multiple branches, depending on the value of an SPL variable or of a simple expression. The CASE statement is a logical alternative to the IF statement.

Syntax

```
>>-CASE--value_expr----->
>--+| ELSE Clause |-----+-->
| .-----+-->
| V-----+-->
| '---WHEN---+constant_expr---THEN---| Statement Block |-----+-->
| '---NULL-----'-----+-->
| '---| ELSE Clause |-----+-->
>--END CASE-----><
ELSE Clause
(1)
|--ELSE--| Statement Block |-----|
```

Notes:

1. See [Statement Block](#)

Element	Description	Restrictions	Syntax
<i>constant_expr</i>	Expression that specifies a literal value	Can be a literal number, quoted string, literal datetime, or literal interval. The data type must be compatible with the data type of <i>value_expr</i> .	Constant Expressions
<i>value_expr</i>	Expression that returns a value	An SPL variable or any other type of expression that returns a value or NULL. The data type cannot be a large object (BLOB, BYTE, CLOB, TEXT), a collection, nor a user-defined OPAQUE or DISTINCT type. Among built-in OPAQUE types, only BOOLEAN and LVARCHAR are valid.	Expression

Usage

You can use the CASE statement to create a set of conditional branches within an SPL routine. The WHEN and the ELSE clauses are optional, but you must include at least one of them.

- If you include no WHEN clause and no ELSE clause, the CASE statement fails with a syntax error.
- If you include no ELSE clause, but no WHEN clause specifies a *constant_expr* that matches the *value_expr*, the CASE statement fails with runtime error -26062 when the routine is executed.

Do not confuse the CASE statement with CASE expressions of SQL. (CASE expressions support the same keywords as the CASE statement, but use different syntax and semantics to evaluate *conditions* that you specify. CASE expressions return a single value or NULL, as described in [CASE Expressions](#).)

How the database server executes a CASE statement

The database server executes the CASE statement by taking the following sequence of actions:

- The database server evaluates the *value_expr* expression.
- If the resulting value matches a literal value specified as the *constant_expr* specification of a WHEN clause, the database server executes the statement block that immediately follows the THEN keyword in that WHEN clause.
- If the value to which the *value_expr* parameter evaluates matches the *constant_expr* specification in more than one WHEN clause, the database server executes the statement block that immediately follows the THEN keyword in the first matching WHEN clause of the CASE statement. (In this case, the lexical order of the WHEN clauses can determine the result of the CASE statement.) If the database server executes a GOTO statement in the statement block that follows the THEN keyword, the database server transfers program control to the specified statement label. Otherwise, the database server executes the next SPL or SQL statement that follows the END CASE keywords that mark the end of the current CASE statement in the SPL routine.
- If the value to which the *value_expr* parameter evaluates does not match the literal value specified in the *constant_expr* specification of any WHEN clause, and if the CASE statement includes an ELSE clause, the database server executes the statement block that immediately follows the ELSE keyword. If the database server executes a GOTO statement in the statement block that follows the ELSE keyword, the database server transfers program control to the specified statement label. Otherwise, the database server executes the next SPL or SQL statement that follows the END CASE keywords that mark the end of the current CASE statement in the SPL routine.

- If the value to which the *value_expr* parameter evaluates does not match the literal value specified in the *constant_expr* specification of any WHEN clause, and if the CASE statement does not include an ELSE clause, the database server issues an exception, and the CASE statement fails with error -26062. Whether the SPL routine terminates or continues to execute depends on its exception-handling logic.

This implementation of the CASE statement closely resembles that of IBM® Informix® Parallel Server, except that IBM Informix Parallel Server issues no error when no ELSE clause is specified and no WHEN clause matches the *value_expr* parameter. In this case, program execution continues at the SPL or SQL statement that immediately follows the CASE statement.

The statement block that follows the THEN or ELSE keywords can include any SQL statement or SPL statement that is valid in a statement block of an SPL routine. For more information, see [Statement Block](#).

Evaluating the value expression in a CASE statement

The database server calculates the value of the *value_expr* parameter only once, at the start of execution of the CASE statement. If the expression specified in that parameter contains one or more SPL variables, and the value of any of these variables subsequently changes in one of the statement blocks within the CASE statement, the database server does not recalculate the value of the *value_expr* parameter. For this reason, any change in the value of variables specified in the *value_expr* parameter has no effect on the branch taken by the CASE statement.

Examples of CASE statements

In the following example, the CASE statement initializes one of a set of SPL variables (named **j**, **k**, **l**, and **m**) to the value of an SPL variable named **x**, depending on the value of another SPL variable named **i**:

```
CASE i
  WHEN 1 THEN LET j = x;
  WHEN 2 THEN LET k = x;
  WHEN 3 THEN LET l = x;
  WHEN 4 THEN LET m = x;
  ELSE
    RAISE EXCEPTION 100; --invalid value
END CASE;
```

Here each WHEN clause specifies a literal integer as its constant expression, under the assumption that the value expression has a numeric data type. (If these literal values had been delimited by quotation marks, the database server would treat them as character values.)

The following example includes a test for NULL in a WHEN clause, where the value expression and constant expression data types are CHAR(1):

```
CREATE PROCEDURE case_proc( )
RETURNING CHAR(1);
DEFINE grade CHAR(1);
LET grade = 'D';
CASE grade
  WHEN 'A' THEN LET grade = 'a';
  WHEN 'B' THEN LET grade = 'b';
  WHEN 'C' THEN LET grade = 'c';
  WHEN NULL THEN LET grade = 'z';
  ELSE LET grade = 'd';
END CASE;
RETURN grade;
END PROCEDURE;
```

Related statement

[IF](#)

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CONTINUE

Use the CONTINUE statement to start the next iteration of the innermost FOR, LOOP, WHILE, or FOREACH loop.

Syntax

```
>>-CONTINUE--+-----+--;-----><
      +-FOR-----+
      +-FOREACH--+
      +-LOOP-----+
      '-WHILE---'
```

Usage

When control of execution passes to a CONTINUE statement, the SPL routine skips the rest of the statements in the innermost loop of the specified type. Execution continues at the top of the loop with the next iteration.

```
CREATE FUNCTION loop_skip()
RETURNING INT;
DEFINE i INT;
...
FOR i IN (3 TO 15 STEP 2)
    INSERT INTO testtable values(i, null, null);
    IF i = 11
        CONTINUE FOR;
    END IF;
    RETURN i WITH RESUME;
END FOR;

END FUNCTION;
```

In the LOOP, FOR LOOP, and WHILE LOOP statements, whether labeled or unlabeled, a keyword indicating the type of loop is optional after the CONTINUE keyword but Informix® issues an error if you specify a keyword that does not correspond to the type of loop.

FOR, FOREACH, LOOP, WHILE

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Use the **DEFINE** statement to declare local variables that an SPL routine uses, or to declare global variables that can be shared by several SPL routines.

```
>>-DEFINE----->

      .-,-----.
      V          |                                     (1)
>--+GLOBAL---SPL_var+--+data_type--DEFAULT--| Default Value |--++-+-->
|               +-'REFERENCES--+BYTE--+DEFAULT NULL-----'|
|               |-TEXT-'|
|       .-,-----.
|       V          |
|'---SPL_var+--+data_type-----+-----+'
|           +-REFERENCES--+BYTE+-----+
|           |             '-TEXT-'|
|           +-LIKE--+view----+-column-----+
|           |         +-synonym+|
|           |         '-table---'|
|           +---PROCEDURE-----+-----+
|           '+--+BLOB+-----+-----+'
|           |   '-CLOB-'|
|                                   (2)|
|'+--+ Subset of Complex Data Types |--++-+'
|   +-distinct_type-----+-----+
|   '-opaque_type-----+'

>--;-----<
```

1. See [Default Value](#)
2. See [Subset of Complex Data Types](#)

Element	Description	Restrictions	Syntax
<i>column</i>	Column name	Must already exist in the <i>table</i> or <i>view</i>	Identifier
<i>data_type</i>	Type of <i>SPL_var</i>	See Declaring Global Variables	Data Type
<i>distinct_type</i>	A distinct type	Must already be defined in the database	Data Type
<i>opaque_type</i>	An opaque type	Must already be defined in the database	Data Type
<i>SPL_var</i>	New SPL variable	Must be unique within statement block	Identifier
<i>synonym, table, view</i>	Name of a table, view, or synonym	Synonym and the table or view to which it points must exist when DEFINE is issued	Identifier

1. See [Default Value](#)

Element	Description	Restrictions	Syntax
<i>data_type</i>	Type of <i>SPL_var</i>	See Declaring Global Variables .	Data Type
<i>SPL_var</i>	New SPL variable	Must be unique within statement block	Identifier

The GLOBAL keyword indicates that the variables that follow have a scope of reference that includes all SPL routines that run in a given DB-Access or SQL administration API session. The data types of these variables must match the data types of variables in the *global environment*. The global environment is the memory that is used by all the SPL routines that run in a given DB-Access or SQL administration API session. The values of global variables are stored in memory.

SPL routines that are running in the current session share global variables. Because the database server does not save global variables in the database, the global variables do not remain when the current session closes.

The first declaration of a global variable establishes the variable in the global environment; subsequent global declarations simply bind the variable to the global environment and establish the value of the variable at that point.

The following example shows two SPL procedures, **proc1** and **proc2**; each has defined the global variable **gl_out**:

- SPL procedure **proc1**

```
CREATE PROCEDURE proc1()
...
  DEFINE GLOBAL gl_out INT DEFAULT 13;
...
  LET gl_out = gl_out + 1;
END PROCEDURE;
```

- SPL procedure **proc2**

```
CREATE PROCEDURE proc2()
...
  DEFINE GLOBAL gl_out INT DEFAULT 23;
  DEFINE tmp INT;
...
  LET tmp = gl_out
END PROCEDURE;
```

If **proc1** is called first, **gl_out** is set to 13 and then incremented to 14. If **proc2** is then called, it sees that **gl_out** is already defined, so the default value of 23 is not applied. Then, **proc2** assigns the existing value of 14 to **tmp**. If **proc2** had been called first, **gl_out** would have been set to 23, and 23 would have been assigned to **tmp**. Later calls to **proc1** would not apply the default of 13.

Databases of different database server instances do not share global variables, but all the databases of the same database server instance can share global SPL variables in a single session. The database server and any application development tools, however, do not share global variables.

- [Default Value](#)
- [CURRENT](#)
- [SYSDATE](#)
- [USER](#)
- [TODAY](#)
- [BYTE and TEXT](#)
- [SITENAME or DBSERVERNAME](#)

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Default Value

Global variables can have literal, NULL, or system constant default values.

Default Value

```
(1)
|---+| Literal Number |-----+-----|
|                                     |
|                                     | (2) |
|+| Quoted String |-----+-----+
|                                     |
|                                     | (3) |
|+| Literal Interval |-----+-----+
|                                     |
|                                     | (4) |
|+| Literal Datetime |-----+-----+
|+| -CURRENT-+-----+-----+-----+
| | '-SYSDATE-' |                                     | (5) | |
| | '-| DATETIME Field Qualifier |-----' |
|+| -CURRENT USER-+-----+-----+
|+| -DBSERVERNAME-+
|+| -SITENAME-----+
|+| -TODAY-----+
|+| -USER-----+
|+| -NULL-----'
```

Notes:

1. See [Literal Number](#)
2. See [Quoted String](#)
3. See [Literal INTERVAL](#)
4. See [Literal DATETIME](#)
5. See [DATETIME Field Qualifier](#)

If you specify a default value, the global variable is initialized with the specified value.

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CURRENT

CURRENT is a valid default only for a DATETIME variable. If the YEAR TO FRACTION(3) is its declared precision, no qualifier is needed. Otherwise, you must specify the same DATETIME qualifier when **CURRENT** is the default, as in the following example of a DATETIME variable:

```
DEFINE GLOBAL d_var DATETIME YEAR TO MONTH
DEFAULT CURRENT YEAR TO MONTH;
```

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SYSDATE

SYSDATE is a valid default only for a DATETIME variable. If the YEAR TO FRACTION(5) is the declared precision of the variable, no qualifier is needed. Otherwise, you must specify the same DATETIME qualifier when **SYSDATE** is the default, as in the following example of a DATETIME variable:

```
DEFINE GLOBAL dt_var DATETIME YEAR TO DAY
DEFAULT SYSDATE YEAR TO DAY;
```

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USER

If you use the value that **USER**, or its synonym **CURRENT_USER**, returns as the default, the variable must be defined as a CHAR, VARCHAR, NCHAR, or NVARCHAR data type. It is recommended that the length of the variable be at least 32 bytes. You risk getting an error message during INSERT and ALTER TABLE operations if the length of the variable is too small to store the default value.

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TODAY

If you use **TODAY** as the default, the variable must be a DATE value. (See [Constant Expressions](#) for descriptions of **TODAY** and of the other system constants that can appear in the Default Value clause.)

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BYTE and TEXT

The only default value valid for a BYTE or TEXT variable is NULL. The following example defines a TEXT global variable that is called **l_blob**:

```
CREATE PROCEDURE use_text()
  DEFINE i INT;
  DEFINE GLOBAL l_blob REFERENCES TEXT DEFAULT NULL;
  ...
END PROCEDURE
```

Here the REFERENCES keyword is required, because the DEFINE statement cannot declare a BYTE or TEXT data type directly; the **l_blob** variable is a pointer to a TEXT value that is stored in the global environment.

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SITENAME or DBSERVERNAME

If you use the SITENAME or DBSERVERNAME keyword as the default, the variable must be a CHAR, VARCHAR, NCHAR, NVARCHAR, or LVARCHAR data type. Its default value is the name of the database server at runtime. It is recommended that the size of the variable be at least 128 bytes long. You risk getting an error message during INSERT and ALTER TABLE operations if the length of the variable is too small to store the default value.

The following example uses the SITENAME keyword to specify a default value. This example also initializes a global BYTE variable to NULL:

```
CREATE PROCEDURE gl_def()
  DEFINE GLOBAL gl_site CHAR(200) DEFAULT SITENAME;
  DEFINE GLOBAL gl_byte REFERENCES BYTE DEFAULT NULL;
  ...
END PROCEDURE
```

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Declaring Local Variables

A *local variable* has as its scope of reference the routine in which it is declared. If you omit the GLOBAL keyword, any variables declared in the DEFINE statement are local variables, and are not visible in other SPL routines.

For this reason, different SPL routines that declare local variables of the same name can run without conflict in the same DB-Access or SQL administration API session.

If a local variable and a global variable have the same name, the global variable is not visible within the SPL routine where the local variable is declared. (In all other SPL routines, only the global variable is in scope.)

The following DEFINE statement syntax is for declaring local variables:

```
.-.,-----.
V      |
>>-DEFINE---SPL_var-+----->
>--+data_type-----+---;-----><
+-REFERENCES---+BYTE+-----+
|               '-TEXT-'      |
+-LIKE---+view-----+column-----+
|         +-synonym-+      |
|         '-table---'      |
+---PROCEDURE-----+
'-++-BLOB-+-----+
| '-CLOB-'      |
|               (1) |
+-| Subset of Complex Data Types |----+
+-distinct_type-----+
'-opaque_type-----'
```

Notes:

1. See [Subset of Complex Data Types](#)

Element	Description	Restrictions	Syntax
<i>column</i>	Column name	Must already exist in the <i>table</i> or <i>view</i>	Identifier ;
<i>data_type</i>	Type of <i>SPL_var</i>	Cannot be BIGSERIAL, BYTE, SERIAL, SERIAL8, or TEXT	Data Type
<i>distinct_type</i>	A distinct type	Must already be defined in the database	Identifier
<i>opaque_type</i>	An opaque type	Must already be defined in the database	Identifier
<i>SPL_var</i>	New SPL variable	Must be unique within statement block	Identifier ;
<i>synonym, table, view</i>	Name of a table, view, or synonym	Synonym and the table or view to which it points must already exist when the statement is issued	Database Object Name

Local variables do not support default values. The following example shows some typical definitions of local variables:

```
CREATE PROCEDURE def_ex()
  DEFINE i INT;
  DEFINE word CHAR(15);
  DEFINE b_day DATE;
  DEFINE c_name LIKE customer.fname;
  DEFINE b_text REFERENCES TEXT;
END PROCEDURE
```

- [Subset of Complex Data Types](#)
To store one or more data values in a complex data type, the DEFINE statement can declare a local SPL variable as a collection of type SET, MULTISSET, or LIST, with elements of a specified type, or as a generic COLLECTION. The DEFINE statement can also declare a local SPL variable as a named or an unnamed ROW type with an ordered set of fields, or as a generic ROW type.
- [Declaring Collection Variables](#)
- [Declaring ROW Variables](#)
- [Declaring Opaque-Type Variables](#)
- [Declaring Variables LIKE Columns](#)

If you use the LIKE clause, the database server assigns the variable the same data type as a specified column in a table, synonym, or view.

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```
|--+COLLECTION-----|
|--SET--+---(--+_data_type-----+NOT NULL)+
|+_MULTISET++      '+_SET-----(--+_data_type--NOT NULL)--'+
|'_LIST-----'        +_MULTISET+
|                      '_LIST----'|
+'-row-----+'
|'-ROW--+-----+'
|         |       .-,-----|.   |
|         |       v          |    |
|         |'-(-----field-data type+--)-'
```

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A variable declared as type SET, MULTiset, or LIST is a *typed collection variable*. It can hold a collection of its specified data type only.

You must use the NOT NULL keywords when you define the elements of a typed collection variable, as in the following examples:

```
DEFINE a SET ( INT NOT NULL );

DEFINE b MULTiset ( ROW ( b1 INT,
                        b2 CHAR(50)
                      ) NOT NULL );

DEFINE c LIST( SET( INTEGER NOT NULL ) NOT NULL );
```

With variable **c**, both the INTEGER values in the SET and the SET values in the LIST are defined as NOT NULL.

You can define collection variables with nested complex types to hold matching nested complex type data. Any type or depth of nesting is allowed. You can nest ROW types within collection types, collection types within ROW types, collection types within collection types, ROW types within collection and ROW types, and so on.

If you declare a variable as COLLECTION type, the variable acquires varying data type declarations if it is reassigned within the same statement block, as in the following example:

```
DEFINE a COLLECTION;
LET a = setB;
...
LET a = listC;
```

In this example, **varA** is a generic collection variable that changes its data type to the data type of the currently assigned collection. The first LET statement makes **varA** a SET variable. The second LET statement makes **varA** a LIST variable.

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Declaring ROW Variables

ROW variables hold data from named or unnamed ROW types. You can define a generic ROW variable, a named ROW variable, or an unnamed ROW variable.

A generic ROW variable, defined with the ROW keyword, can hold data from any ROW type. A named ROW variable holds data from the named ROW type that you specified in the declaration of the variable.

The following statements show examples of generic ROW variables and named ROW variables:

```
DEFINE d ROW;           -- generic ROW variable

DEFINE rectv rectangle_t; -- named ROW variable
```

A named ROW variable holds named ROW types of the same type in the declaration of the variable.

To define a variable that will hold data stored in an unnamed ROW type, use the ROW keyword followed by the fields of the ROW type, as in:

```
DEFINE area ROW ( x int, y char(10) );
```

Unnamed ROW types are type-checked only by structural equivalence. Two unnamed ROW types are considered equivalent if they have the same number of fields, and if the fields have the same type definitions. Therefore, you could fetch either of the following ROW types into the variable **area** defined above:

```
ROW ( a int, b char(10) )
ROW ( area int, name char(10) )
```

ROW variables can have fields, just as ROW types have fields. To assign a value to a field of a ROW variable, use the qualifier notation *variableName.fieldName*, followed by an expression, as in the following example:

```
CREATE ROW TYPE rectangle_t (start point_t, length real, width real);

DEFINE r rectangle_t;
-- Define a variable of a named ROW type
LET r.length = 45.5;
-- Assign a value to a field of the variable
```

When you assign a value to a ROW variable, you can use any valid expression.

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Declaring Opaque-Type Variables

Opaque-type variables hold data retrieved from opaque data types, which you create with the CREATE OPAQUE TYPE statement. An opaque-type variable can only hold data of the same opaque type on which it is defined. The following example defines a variable of the opaque type **point**, which holds the **x** and **y** coordinates of a two-dimensional point:

```
DEFINE b point;
```

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Declaring Variables LIKE Columns

If you use the LIKE clause, the database server assigns the variable the same data type as a specified column in a table, synonym, or view.

The data types of variables that are defined as database columns are resolved at runtime; therefore, *column* and *table* do not need to exist at compile time.

You can use the LIKE keyword to declare that a variable is like a serial column. This declares:

- An INTEGER variable if the column is of the SERIAL data type
- An INT8 variable if the column is of the SERIAL8 data type
- A BIGINT variable if the column is of the BIGSERIAL data type

For example, if the column **serialcol** in the **mytab** table has the SERIAL data type, you can create the following SPL function:

```
CREATE FUNCTION func1()  
DEFINE local_var LIKE mytab.serialcol;  
RETURN;  
END FUNCTION;
```

The variable **local_var** is treated as an INTEGER variable.

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Defining Variables with Logical Character Semantics

When the SQL_LOGICAL_CHAR configuration parameter has specified for the current session) is set to 'ON' or to a value greater than 1, Informix® interprets size declarations as logical characters, rather than as bytes, in declarations of SPL variables of the following data types:

- CHAR or CHARACTER
- CHARACTER VARYING or VARCHAR
- LVARCHAR
- NCHAR
- NVARCHAR
- DISTINCT types whose base types are built-in character data types
- DISTINCT types whose base types are the previously listed data types
- ROW data type fields of any of the previously listed data types.
- Elements of these data types in LIST, MULTISSET, or SET collection data types.

Enabling logical character semantics for the database locale guarantees that sufficient storage is available for the data type to store the specified number of logical characters. The resulting size in bytes of the SPL variable is the product of the declared size of the data type multiplied by the SQL_LOGICAL_CHAR value, if this is 2, 3, or 4, or (if SQL_LOGICAL_CHAR is set to 'ON') by the number of bytes of storage that the largest logical character in the code set of the database locale requires.

If a client session connects to a database in which the SQL_LOGICAL_CHAR configuration parameter was enabled at the time of database creation, that setting takes effect at connection time.

DEFINE statements that use the LIKE keyword in datatype declarations create SPL variables whose data types match the schema of the column that the LIKE specification references. The SQL_LOGICAL_CHAR setting, if any is defined, has no effect on the size in memory of variables that DEFINE declares with the LIKE keyword.

For more information about the effect of the SQL_LOGICAL_CHAR setting in locales that use a multibyte code set, such as **UTF-8**, where a single logical character can require more than one byte of storage, see the description of the SQL_LOGICAL_CHAR configuration parameter in your *IBM® Informix Administrator's Reference*. For additional information about multibyte locales and logical characters, see the *IBM Informix GLS User's Guide*.

Related information:

[SQL_LOGICAL_CHAR configuration parameter](#)

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Declaring Variables as the PROCEDURE Type

The PROCEDURE keyword indicates that in the current scope, the variable is a call to a UDR.

The DEFINE statement does not support a FUNCTION keyword. Use the PROCEDURE keyword, whether you are calling a user-defined procedure or a user-defined function.

Declaring a variable as PROCEDURE type indicates that in the current statement scope, the variable is not a call to a built-in function. For example, the following statement defines **length** as an SPL routine, not as the built-in LENGTH function:

```
DEFINE length PROCEDURE;  
...  
LET x = length (a,b,c)
```

If you create an SPL routine with the same name as an aggregate function (SUM, MAX, MIN, AVG, COUNT) or with the name **extend**, you must qualify the routine name with the owner name.

Declaring Variables for BYTE and TEXT Data

EXIT

Syntax

Usage

EXIT From FOREACH Statements


```
END IF;  
END FOREACH;
```

- [EXIT From FOR, LOOP, and WHILE Loops](#)

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EXIT From FOR, LOOP, and WHILE Loops

If the EXIT statement is issued outside the FOREACH statement, it returns an error unless it is issued from the FOR, FOR LOOP, LOOP, WHILE LOOP, or WHILE statement as its innermost enclosing statement. In FOR or WHILE statements that do not include the LOOP keyword, the corresponding FOR or WHILE keyword is required after the EXIT keyword. Execution resumes at the first executable statement that follows the innermost loop from which the EXIT statement was issued.

The EXIT statement requires no other keyword when it is issued from the FOR LOOP, LOOP, or WHILE LOOP statement, with or without a loop label, but if you include the FOR, LOOP, or WHILE keyword after the EXIT keyword, that keyword must correspond to the type of loop from which the EXIT statement is issued.

If the EXIT keyword is followed by the identifier of a loop label, and no *condition* is specified, execution resumes at the first executable statement that follows the FOR, FOR LOOP, LOOP, WHILE LOOP, or WHILE statement whose label is specified. This enables the EXIT statement to exit from nested loops, if an outer loop is labeled.

If a WHEN *condition* follows the EXIT or EXIT *label* specification, EXIT has no effect unless the *condition* is true. If the condition is true, execution resumes after the labeled loop, or after the innermost loop, if no *label* is specified.

If the database server cannot find the specified loop or loop label, the EXIT statement fails. If EXIT is issued outside any FOR, FOREACH, LOOP, or WHILE statement, it generates errors.

The following example uses an EXIT FOR statement. In the FOR loop, when *j* becomes 6, the IF condition *i* = 5 in the WHILE loop is true. The FOR loop stops executing, and the SPL procedure continues at the next statement outside the FOR loop (in this case, the END PROCEDURE statement). In this example, the procedure ends when *j* equals 6:

```
CREATE PROCEDURE ex_cont_ex()  
  DEFINE i,s,j, INT;  
  FOR j = 1 TO 20  
    IF j > 10 THEN  
      CONTINUE FOR;  
    END IF  
    LET i,s = j,0;  
    WHILE i > 0  
      LET i = i -1;  
      IF i = 5 THEN  
        EXIT FOR;  
      END IF  
    END WHILE  
  END FOR  
END PROCEDURE;
```

The following program fragment shows two conditional EXIT statements in a labeled WHILE LOOP statement that is nested within another labeled LOOP statement:

```
<<outer>>  
LOOP  
  LET x = x+1;  
  <<inner>>  
  WHILE ( i >10 ) LOOP  
    LET x = x+1;  
    EXIT inner WHEN x = 2;  
    EXIT outer WHEN x > 3;  
  END LOOP inner;  
  LET x = x+1;  
END LOOP outer;
```

When the *x=2* condition is true, the EXIT *inner* statement transfers control to the LET statement that follows the loop whose label is **inner**. When the *x>3* condition is true, the EXIT *outer* statement terminates execution of the **outer** loop.

Related Statements

[<<Label>> statement](#), [FOR](#), [FOREACH](#), [LOOP](#), [WHILE](#)

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FOR

Use the FOR statement to initiate a controlled (definite) loop when you want to guarantee termination of the loop. The FOR statement uses expressions or range operators to specify a finite number of iterations for a loop.

Syntax

The next example shows two equivalent FOR statements. Each uses the TO keyword to define a range. The first uses the IN keyword, and the second uses an equal sign (=). Each statement causes the loop to execute five times:

```
FOR index_var IN (12 TO 21 STEP 2)
  -- statement block
END FOR;

FOR index_var = 12 TO 21 STEP 2
  -- statement block
END FOR;
```

If you omit the STEP option, the database server gives *increment_expr* the value of -1 if *right_expression* is less than *left_expression*, or +1 if *right_expression* is more than *left_expression*. If *increment_expr* is specified, it must be negative if *right_expression* is less than *left_expression*, or positive if *right_expression* is more than *left_expression*.

The two statements in the following example are equivalent. In the first statement, the STEP increment is explicit. In the second statement, the STEP increment is implicitly 1:

```
FOR index IN (12 TO 21 STEP 1)
  -- statement block
END FOR;

FOR index = 12 TO 21
  -- statement block
END FOR;
```

The database server initializes the value of *loop_var* to the value of *left_expression*. In subsequent iterations, the server adds *increment_expr* to the value of *loop_var* and checks *increment_expr* to determine whether the value of *loop_var* is still between *left_expression* and *right_expression*. If so, the next iteration occurs. Otherwise, an exit from the loop takes place. Or, if you specify another range, the variable takes on the value of the first element in the next range.

- [Specifying Two or More Ranges in a Single FOR Statement](#)

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Specifying Two or More Ranges in a Single FOR Statement

The following example shows a statement that traverses a loop forward and backward and uses different increment values for each direction:

```
FOR index_var IN (15 to 21 STEP 2, 21 to 15 STEP -3)
  -- statement body
END FOR;
```

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Using an Expression List as the Range

The database server initializes the value of *loop_var* to the value of the first expression specified. In subsequent iterations, *loop_var* takes on the value of the next expression. When the database server has evaluated the last expression in the list and used it, the loop stops.

The expressions in the IN list do not need to be numeric values, as long as you do not use range operators in the IN list. The following example uses a character expression list:

```
FOR c IN ('hello', (SELECT name FROM t), 'world', v1, v2)
  INSERT INTO t VALUES (c);
END FOR;
```

The following FOR statement shows the use of a numeric expression list:

```
FOR index IN (15,16,17,18,19,20,21)
  -- statement block
END FOR;
```

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Mixing Range and Expression Lists in the Same FOR Statement

If *loop_var* is an INT or SMALLINT value, you can mix ranges and expression lists in the same FOR statement. The following example shows a mixture that uses an integer variable. Values in the expression list include the value that is returned from a SELECT statement, a sum of an integer variable and a constant, the values that are returned from an SPL function named **p_get_int**, and integer constants:

```
CREATE PROCEDURE for_ex ()
  DEFINE i, j INT;
  LET j = 10;
  FOR i IN (1 TO 20, (SELECT c1 FROM tab WHERE id = 1),
    j+20 to j-20, p_get_int(99),98,90 to 80 step -2)
    INSERT INTO tab VALUES (i);
```

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To create a labeled FOR loop, declare a loop label before the initial FOR keyword, and repeat the label after the END FOR keywords, as in this example:

Here the `EXIT for lab` statement has the same effect that the `EXIT` or `EXIT FOR` keywords would have, terminating both the `FOR` loop and the routine. In this example, the statement that includes the `EXIT for lab` statement has the same effect that `EXIT for lab WHEN i = 5` would have.

You can use similar syntax to create an unlabeled loop that omits the `<<label>>` specification that immediately precedes the initial FOR keyword. In this case, you must also omit the undelimited loop label identifier that follows the END LOOP keywords. See the LOOP statement for a description and examples of these forms of labeled and unlabeled loop statements that enable you to combine FOR statement syntax, with a finite number of loop iterations, with the "loop forever" syntax of the LOOP statement.

<< Label >> statement, CONTINUE, EXIT, LOOP, FOREACH, WHILE

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Use the FOREACH statement to declare a direct cursor that can select and manipulate more than one row from a the result set of a query, or more than one element from a collection.

Direct sequential cursors that the FOREACH statement of SPL can create are distinct from the dynamic cursors that the DECLARE statement of SQL can create in SPL routines. (For the syntax and usage of dynamic cursors in SPL routines, see [Declaring a Dynamic Cursor in an SPL Routine.](#))

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```

>-- (-+-----+--)------+-----|
| .,-----+-----+-----|
| V          (3) | |
|'---| Argument |-----+--'|

```

Notes:

1. See [Using a SELECT ... INTO Statement](#)
2. See [Statement Block](#)
3. See [Arguments](#)

Element	Description	Restrictions	Syntax
<i>cursor</i>	Identifier that you declare here as the name of this direct cursor	Must be unique among names of cursors, prepared statements, and SPL variables in the routine	Identifier
<i>data_var</i>	SPL variable in the calling routine that receives the returned values	Data type of <i>data_var</i> must be appropriate for returned value	Identifier
<i>function, procedure</i>	SPL function or procedure to execute	Function or procedure must exist	Database Object Name
<i>SPL_var</i>	SPL variable that contains the name of a routine to execute	Must be of type CHAR, VARCHAR, NCHAR, or NVARCHAR	Identifier

Usage

To execute a FOREACH statement, the database server takes these actions:

1. It declares and implicitly opens a direct sequential cursor.
2. It obtains the first row from the query contained within the FOREACH loop, or else the first set of values from the called routine.
3. It assigns to each variable in the variable list the value of the corresponding value from the active set that the SELECT statement or the called routine creates.
4. It executes the statement block.
5. It fetches the next row from the SELECT statement or called routine on each iteration, and it repeats steps 3 and 4.
6. It terminates the loop when it finds no more rows that satisfy the SELECT statement or called routine. It closes the direct sequential cursor when the loop terminates.

Because the statement block can contain additional FOREACH statements, cursors can be nested. No limit exists on the number of nested cursors.

An SPL routine that returns more than one row, collection element, or set of values is called a *cursor function*. An SPL routine that returns only one row or value is called a *noncursor function*.

This SPL procedure illustrates FOREACH statements with a SELECT ... INTO clause, with an explicitly named cursor, and with a procedure call:

```

CREATE PROCEDURE foreach_ex()
  DEFINE i, j INT;
  FOREACH SELECT c1 INTO i FROM tab ORDER BY 1
    INSERT INTO tab2 VALUES (i);
  END FOREACH
  FOREACH cur1 FOR SELECT c2, c3 INTO i, j FROM tab
    IF j > 100 THEN
      DELETE FROM tab WHERE CURRENT OF cur1;
      CONTINUE FOREACH;
    END IF
    UPDATE tab SET c2 = c2 + 10 WHERE CURRENT OF cur1;
  END FOREACH
  FOREACH EXECUTE PROCEDURE bar(10,20) INTO i
    INSERT INTO tab2 VALUES (i);
  END FOREACH
END PROCEDURE; -- foreach_ex

```

A Select cursor is closed when any of the following situations occur:

- The cursor returns no further rows.
- The cursor is a Select cursor without a HOLD specification, and a transaction completes using the COMMIT or ROLLBACK statement.
- An EXIT statement executes, which transfers control out of the FOREACH statement.
- An exception occurs that is not trapped inside the body of the FOREACH statement. (See [ON EXCEPTION](#).)
- A cursor in the calling routine that is executing this cursor routine (within a FOREACH loop) closes for any reason.

Note:

The FOREACH statement cannot define a SCROLL cursor. Each FOREACH cursor is a sequential cursor, which can fetch only the next row in sequence from the active set. A cursor that FOREACH defines can read through the active set only once each time it is opened.

- [Using a SELECT ... INTO Statement](#)
- [Using the ORDER BY Clause of the SELECT Statement](#)
- [Using Hold Cursors](#)
- [Updating or Deleting Rows Identified by Cursor Name](#)
- [Using Collection Variables](#)
- [Using Select Cursors with FOREACH](#)
- [Calling a UDR in the FOREACH Loop](#)

Related reference:

[UPDATE statement](#)
[EXECUTE FUNCTION statement](#)
[EXECUTE PROCEDURE statement](#)
[INSERT statement](#)
[Collection-Derived Table](#)
[DECLARE statement](#)

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Using a SELECT ... INTO Statement

As indicated in the diagram for [FOREACH](#), not all clauses and options of the SELECT statement are available for you to use in a FOREACH statement. The SELECT statement in the FOREACH statement must include the INTO clause. It can also include UNION and ORDER BY clauses, but it cannot use the INTO TEMP clause. For a complete description of SELECT syntax and usage, see [SELECT statement](#). The data type and count of each variable in the variable list must match each value that the SELECT ... INTO statement returns.

The database server issues an error if you include a semicolon (;) within the FOREACH statement to terminate the SELECT ... INTO specification. The following program fragment, for example, fails with a syntax error:

```
CREATE DBA PROCEDURE IF NOT EXISTS shapes()  
  
  DEFINE vertexes SET( point NOT NULL );  
  DEFINE pnt point;  
  
  SELECT definition INTO vertexes FROM polygons  
    WHERE id = 207;  
  
  FOREACH cursor1 FOR  
    SELECT * INTO pnt FROM TABLE(vertexes); -- Semicolon not valid  
    . . .  
  END FOREACH  
  . . .  
END PROCEDURE;
```

In the example above, you can avoid this error by deleting the semicolon that immediately follows the TABLE(vertexes) specification.

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Using the ORDER BY Clause of the SELECT Statement

The ORDER BY clause of the SELECT statement implies that the query returns more than one row. Unless you use the DECLARE statement of SQL to define a Select cursor or a Function cursor, the database server issues an error if you specify the ORDER BY clause outside the context of a FOREACH loop to process the returned rows individually within an SPL routine.

For the syntax and usage of the DECLARE statement in SPL routines, see [Declaring a Dynamic Cursor in an SPL Routine](#).

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Using Hold Cursors

The WITH HOLD keywords specify that the cursor should remain open when a transaction closes (by being committed or by being rolled back).

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Updating or Deleting Rows Identified by Cursor Name

Specify a *cursor* name in the FOREACH statement if you intend to use the WHERE CURRENT OF *cursor* clause in UPDATE or DELETE statements that operate on the current row of *cursor* within the FOREACH loop. Although you cannot include the FOR UPDATE keywords in the SELECT ... INTO segment of the FOREACH statement, the cursor behaves like a FOR UPDATE cursor.

For a discussion of locking, see the section on [Locking with an Update Cursor](#). For a discussion of isolation levels, see the description of [SET ISOLATION statement](#).

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Using Collection Variables

The FOREACH statement allows you to declare a cursor for an SPL collection variable. Such a cursor is called a *Collection cursor*. Use a collection variable to access the elements of a collection (SET, MULTISSET, LIST) column. Use a cursor when you want to access one or more elements in a collection variable.

The following excerpt from an SPL routine shows how to fill a collection variable and then how to use a cursor to access individual elements:

```
DEFINE a SMALLINT;
DEFINE b SET(SMALLINT NOT NULL);
SELECT numbers INTO b FROM table1 WHERE id = 207;
FOREACH cursor1 FOR
    SELECT * INTO a FROM TABLE(b);
...
END FOREACH;
```

In this example, the SELECT statement selects one element at a time from the collection variable **b** into the element variable **a**. The projection list is an asterisk, because the collection variable **b** contains a collection of built-in types. The variable **b** is used with the TABLE keyword as a Collection-Derived Table. For more information, see [Collection-Derived Table](#).

The next example also shows how to fill a collection variable and then how to use a cursor to access individual elements. This example, however, uses a list of ROW-type fields in its projection list:

```
DEFINE employees employee_t;
DEFINE n VARCHAR(30);
DEFINE s INTEGER;

SELECT emp_list into employees FROM dept_table
WHERE dept_no = 1057;
FOREACH cursor1 FOR
    SELECT name,salary
        INTO n,s FROM TABLE( employees ) AS e;
...
END FOREACH;
```

Here the collection variable **employees** contains a collection of ROW types. Each ROW type contains the fields **name** and **salary**. The collection query selects one name and salary combination at a time, placing **name** into **n** and **salary** into **s**. The AS keyword declares **e** as an alias for the collection-derived table **employees**. The alias exists as long as the SELECT statement executes.

- [Restrictions on collection cursors](#)
- [Modifying Elements in a Collection Variable](#)

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Restrictions on collection cursors

When you use a Collection cursor to fetch individual elements from a collection variable, the FOREACH statement has the following restrictions:

- It cannot contain the WITH HOLD keywords.
- It must contain a restricted SELECT statement in the FOREACH loop.

In addition, the SELECT statement that you associate with the Collection cursor has the following restrictions:

- Its general structure is SELECT... INTO ... FROM TABLE. The statement selects one element at a time from a collection variable specified after the TABLE keyword into another variable called an *element variable*.
- It cannot contain an expression in the Projection list.
- It cannot include the following clauses or options: WHERE, GROUP BY, ORDER BY, HAVING, INTO TEMP, and WITH REOPTIMIZATION.
- The data type of the element variable must be the same as the element type of the collection.
- The data type of the element variable can be any opaque, distinct, or collection data type, or any built-in data type except BIGSERIAL, BLOB, BYTE, CLOB, SERIAL, SERIAL8, or TEXT.
- If the collection contains opaque, distinct, built-in, or collection types, the projection list must be an asterisk (*) symbol.
- If the collection contains ROW types, the projection list can be a list of one or more field names.

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Modifying Elements in a Collection Variable

To update an element of a collection within an SPL routine, you must first declare a cursor with the FOREACH statement.

Then, within the FOREACH loop, select elements one at a time from the collection variable, using the collection variable as a collection-derived table in a SELECT query.

When the cursor is positioned on the element to be updated, you can use the WHERE CURRENT OF clause, as follows:

- The UPDATE statement with the WHERE CURRENT OF clause updates the value in the current element of the collection variable.
- The DELETE statement with the WHERE CURRENT OF clause deletes the current element from the collection variable.

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Using Select Cursors with FOREACH

When using the FOREACH statement, if the result set from a query is to be modified, do not use this result set as an exit criterion for the FOREACH loop. For example, if the FOREACH statement declares a Select cursor that is expected to return 30 rows, but DELETE, INSERT, or UPDATE operations within the FOREACH loop modify the result set of the query, this might cause unexpected behavior. To ensure that a FOREACH loop works as intended, make sure that any Select cursor in the FOREACH statement completes its execution before you begin modifying its result set.

One way to avoid unexpected results from a FOREACH loop that performs DML operations on the rows returned by a query is to use an ORDER BY clause in the SELECT statement to materialize the result set.

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Calling a UDR in the FOREACH Loop

In general, use these guidelines for calling another UDR from an SPL routine:

- To call a user-defined procedure, use EXECUTE PROCEDURE *procedure name*.
- To call a user-defined function, use EXECUTE FUNCTION *function name* (or EXECUTE PROCEDURE *function name* if the user-defined function was created with the CREATE PROCEDURE statement).

If you use EXECUTE PROCEDURE, the database server looks first for a user-defined procedure of the name you specify. If it finds the procedure, the database server executes it. If it does not find the procedure, it looks for a user-defined function of the same name to execute. If the database server finds neither a function nor a procedure, it issues an error message. If you use EXECUTE FUNCTION, the database server looks for a user-defined function of the name you specify. If it does not find a function of that name, the database server issues an error message.

An SPL function can return zero (0) or more values or rows.

The data type and count of each variable in the variable list must match each value that the function returns.

Related Statements

[CONTINUE](#), [EXIT](#), [FOR](#), [LOOP](#), [WHILE](#)

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GOTO

Use the GOTO statement to transfer control of program execution to the statement that has a specified statement label.

Syntax

```
>>-GOTO--label--;-<
```

Element	Description	Restrictions	Syntax
<i>label</i>	Name of the loop label for this loop	Must be unique among labels in this SPL routine	Identifier

Usage

The GOTO statement branches to a statement label unconditionally. The statement label must be unique within its scope and must precede an executable statement. When successfully executed, the GOTO statement transfers control to the labeled statement or statement block.

In the following program fragment, the **jump_back** function transfers control to a LET statement that has the statement label **back** if the value of variable **j** is greater than 100.

```
CREATE FUNCTION jump_back()  
  RETURNING INT;  
  DEFINE i,j INT;  
  ...  
  <<back>>  
  LET j = j + i  
  FOR i IN (1 TO 52 STEP 5)  
    IF i < 11 THEN  
      LET j = j + 3  
      CONTINUE FOR;  
    END IF;  
    IF j > 100 THEN  
      GOTO back  
    END IF;  
  RETURN j WITH RESUME;
```



```
END FOR;  
END FUNCTION;
```

The GOTO statement is not valid in an ON EXCEPTION statement block.

The identifier of the statement label that the GOTO statement references must exist in the database, must be unique among statement labels and loop labels the SPL routine, and must be within a scope that the GOTO statement can reach.

Related Statements

<< Label >> statement

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IF

Use the IF statement to create a logical branch within an SPL routine.

Syntax

[illegible]

Notes:

1. See [Condition](#)
2. See [IF Statement List](#)

Usage

The database server processes the IF statement by the following steps:

1. If the condition that follows the IF keyword is true, any statements that follow the first THEN keyword of the IF statement execute, and the IF statement terminates.
2. If the result of the initial IF condition is false, but an ELIF clause exists, the database server evaluates the condition that follows the ELIF keyword.
3. If the result of the ELIF condition is true, any statements that follow the THEN keyword of the ELIF clause execute, and the IF statement terminates.
4. If the result of the condition in the first ELIF clause is also false, but one or more additional ELIF clauses exist, the database server evaluates the condition in the next ELIF clause, and proceeds as in the previous step if it is true. If it is false, the database server evaluates the condition in successive ELIF clauses, until it finds a condition that is true, in which case it executes the statement list that follows the THEN keyword of that ELIF clause, and the IF statement terminates.
5. If no condition in the IF statement is true, but the ELSE clause exists, statements that follow the ELSE keyword execute, and the IF statement terminates.
6. If none of the conditions in the IF statement are true, and no ELSE clause exists, the IF statement terminates without executing any statement list.

- [ELIF Clause](#)
- [ELSE Clause](#)
- [Conditions in an IF Statement](#)
- [Subset of SPL Statements Allowed in the IF Statement List](#)
- [SQL Statements Not Valid in an IF Statement](#)

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ELIF Clause

Use the ELIF clause to specify one or more additional conditions to evaluate. If the IF condition is false, the ELIF condition is evaluated. If the ELIF condition is true, the statements that follow the THEN keyword in the ELIF clause execute.

If no statement follows the THEN keyword of the ELIF clause when the ELIF condition is true, program control passes from the IF statement to the next statement.

ELSE Clause

The ELSE clause executes if no true previous condition exists in the IF clause or any of the ELIF clauses.

In the following example, the SPL function uses an IF statement with both an ELIF clause and an ELSE clause. The IF statement compares two strings.

The function displays 1 to indicate that the first string comes before the second string alphabetically, or -1 if the first string comes after the second string alphabetically. If the strings are the same, a zero (0) is returned.

```
CREATE FUNCTION str_compare (str1 CHAR(20), str2 CHAR(20))
RETURNING INT;
DEFINE result INT;
  IF str1 > str2 THEN LET result =1;
    ELIF str2 > str1 THEN LET result = -1;
    ELSE LET result = 0;
  END IF
RETURN result;
END FUNCTION -- str_compare
```

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Conditions in an IF Statement

Just as in the WHILE statement, if any expression in the *condition* evaluates to NULL, then the condition cannot be true, unless you are explicitly testing for NULL using the IS NULL operator. The following rules summarize NULL values in conditions:

1. If the expression **x** evaluates to NULL, then **x** is not true by definition. Furthermore, NOT (**x**) is also not true .
2. IS NULL is the only operator that can return true for **x**. That is, **x** IS NULL is true, and **x** IS NOT NULL is not true.

If an expression in the condition has an UNKNOWN value from an uninitialized SPL variable, the statement terminates and raises an exception.

You can specify a trigger-type Boolean operator (DELETING, INSERTING, SELECTING, or UPDATING) as a condition in an IF statement only within a trigger routine.

IF Statement List

IF Statement List

```
(1)
|---+BEGIN---| Statement Block |-----END+-----|
|          |          |          |
+-+ Subset of SPL Statements |-----+
|          |          |          |
'-+ Subset of SQL Statements |-----;-'
```

Notes:

1. See [Statement Block](#)
2. See [Subset of SPL Statements Allowed in the IF Statement List](#)
3. See [SQL Statements Not Valid in an IF Statement](#)

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Subset of SPL Statements Allowed in the IF Statement List

You can use any of the following SPL statements in the IF statement list:

- <<Label >>
- CALL
- CASE
- CONTINUE
- EXIT
- FOR
- FOREACH
- GOTO
- IF
- LET
- LOOP
- RAISE EXCEPTION
- RETURN

- SYSTEM
- TRACE
- WHILE

The “Subset of SPL Statements” syntax diagram for the [IF Statement List](#) refers to the SPL statements that are listed above.

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SQL Statements Not Valid in an IF Statement

The “Subset of SQL Statements” element in the syntax diagram for the [IF Statement List](#) refers to all SQL statements, except for the following SQL statements, which are not valid in the IF statement list.

- ALLOCATE DESCRIPTOR
- CLOSE DATABASE
- CONNECT
- CREATE DATABASE
- CREATE PROCEDURE
- DATABASE
- DEALLOCATE DESCRIPTOR
- DESCRIBE
- DISCONNECT
- DROP DATABASE
- EXECUTE
- FLUSH
- GET DESCRIPTOR
- GET DIAGNOSTICS
- INFO
- LOAD
- OUTPUT
- PUT
- RENAME DATABASE
- SET AUTOFREE
- SET CONNECTION
- SET DESCRIPTOR
- UNLOAD
- WHENEVER

You can use a SELECT statement only if you use the INTO TEMP clause to store the result set of the SELECT statement in a temporary table.

Related Statements

[WHILE](#)

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LET

Use the LET statement to assign values to variables or to call a user-defined SPL routine and assign the returned value or values to SPL variables.

Syntax

```

      .-.-.-.-.-.
      V      |
>>-LET---SPL_var-+----->

      .-.-.-.-.-.
      V      |
>---+function--(-+-----+)-+---;-----><
      |          |          |          |
      |          | V      (1) | |
      |          |'---| Argument |---+-'
      |          |          |          |
      |          | V      (2) |
      |          | Expression |-----+
      |          |          |          |
      |          | V      (3) |
      |          |'---| SELECT Statement |---+---'

```

Notes:

1. See [Arguments](#)

2. See [Expression](#)
3. See [SELECT statement](#)

Element	Description	Restrictions	Syntax
<i>function</i>	SPL function to be invoked	Must exist in the database	Identifier
<i>SPL_var</i>	SPL variable to receive a value that the <i>function</i> , expression, or query returns	Must be defined and in scope within the statement block	Identifier :

Usage

The LET statement can assign a value returned by an expression, function, or query to an SPL variable. At runtime, the value to be assigned is calculated first. The resulting value is cast to the data type of *SPL_var*, if possible, and the assignment occurs. If conversion is not possible, an error occurs, and the value of the variable remains undefined. (A LET operation that assigns a single value to a single SPL variable is called a *simple assignment*.)

A *compound assignment* assigns multiple expressions to multiple SPL variables. The data types of expressions in the expression list do not need to match the data types of the corresponding variables in the variable list, because the database server automatically converts the data types. (For a detailed discussion of casting, see the *IBM® Informix Guide to SQL: Reference*.)

In multiple-assignment operations, the number of variables to the left of the equal (=) sign must match the number of values returned by the functions, expressions, and queries listed on the right of the equal (=) sign. The following example shows several LET statements that assign values to SPL variables:

```
LET a = c + d ;
LET a,b = c,d ;
LET expire_dt = end_dt + 7 UNITS DAY;
LET name = 'Brunhilda';
LET sname = DBSERVERNAME;
LET this_day = TODAY;
```

You cannot use multiple values to the right of the equal (=) sign to operate on other values. For example, the following statement is not valid:

```
LET a,b = (c,d) + (10,15); -- INVALID EXPRESSION
```

- [Using a SELECT Statement in a LET Statement](#)
- [Calling a Function in a LET Statement](#)

Related reference:

[EXECUTE PROCEDURE statement](#)

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Using a SELECT Statement in a LET Statement

The examples in this section use a SELECT statement in a LET statement. You can use a SELECT statement to assign values to one or more variables on the left side of the equals (=) operator, as the following example shows:

```
LET a,b = (SELECT c1,c2 FROM t WHERE id = 1);
LET a,b,c = (SELECT c1,c2 FROM t WHERE id = 1), 15;
```

You cannot use a SELECT statement to make multiple values operate on other values. The following example is invalid:

```
LET a,b = (SELECT c1,c2 FROM t) + (10,15); -- INVALID CODE
```

Because a LET statement is equivalent to a SELECT ... INTO statement, the two statements in the following example have the same results: a=c and b=d:

```
CREATE PROCEDURE proof()
  DEFINE a, b, c, d INT;
  LET a,b = (SELECT c1,c2 FROM t WHERE id = 1);
  SELECT c1, c2 INTO c, d FROM t WHERE id = 1
END PROCEDURE
```

If the SELECT statement returns more than one row, you must enclose the SELECT statement in a FOREACH loop.

For a description of SELECT syntax and usage, see [SELECT statement](#).

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Calling a Function in a LET Statement

You can call a user-defined function in a LET statement and assign the returned values to an SPL variable that receives the values that the function returns.

An SPL function can return multiple values (that is, values from multiple columns in the same row) into a list of variable names. In other words, the function can have multiple values in its RETURN statement and the LET statement can have multiple variables to receive the returned values.

When you call the function, you must specify all the necessary arguments to the function unless the arguments of the function have default values. If you specify the name of one of the parameters in the called function with syntax such as **name = 'smith'**, you must name all of the parameters.

The following two examples show valid LET statements:

The following LET statement is not valid because it tries to add the output of two functions and then assign the sum to two variables, **a** and **b**.

You can easily split this LET statement into two valid LET statements:

A function called in a LET statement can have an argument of COLLECTION, SET, MULTiset, or LIST. You can assign the value that the function returns to a variable, for example:

In the first statement, the SPL function **function1** accepts **collection1** (that is, any collection data type) as an argument and returns its value to the variable **d**. In the second statement, the SPL function **function2** accepts **set1** as an argument and returns a value to the variable **a**.

LOOP

Syntax

Notes:

1. See [Condition](#)
2. See [Statement Block](#)
3. Valid only if `<<label>>` precedes the first keyword

Element	Description	Restrictions	Syntax
<i>expression</i>	Value to compare with <i>loop_var</i>	Must match <i>loop_var</i> data type	Expression
<i>increment_expr</i>	Positive or negative value by which <i>loop_var</i> is incremented	Must return an integer. Cannot return 0.	Expression
<i>label</i>	Name of the loop label for this loop	Must be unique among labels in this SPL routine	Identifier
<i>left_expression</i>	Starting expression of a range	Value must match SMALLINT or INT data type of <i>loop_var</i>	Expression
<i>loop_var</i>	Variable that determines how many times the loop executes	Must be defined and in scope within this statement block	Identifier
<i>right_expression</i>	Ending expression in the range	Same as for <i>left_expression</i>	Expression

Usage

The LOOP statement is an iterative statement that resembles the FOR and WHILE statements. Like FOR and WHILE, the LOOP statement can have an optional loop label. It can include the CONTINUE statement to specify another iteration, and the EXIT statement to terminate execution of the loop.

Besides resembling FOR and WHILE in its functionality, the LOOP statement can use the syntax of FOR or WHILE that precedes the statement block. Sections that follow describe several forms of the LOOP statement, including these:

- Simple LOOP statements that iterate a statement loop indefinitely
- FOR LOOP statements, that use FOR statement syntax specify a finite number of iterations
- WHILE LOOP statements, that iterate while a specified condition is true
- Labeled versions of each of these LOOP statements, which can terminate deeply nested loops.

- [Simple LOOP Statements](#)
- [FOR LOOP Statements](#)
- [WHILE LOOP Statements](#)
- [Labeled LOOP Statements](#)

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Simple LOOP Statements

The following program fragment illustrates a simple form of the LOOP statement.

```
LOOP
LET i = i + 1;
IF i = 5 THEN EXIT;
ELSE
CONTINUE;
END IF
END LOOP;
```

In this example the IF statement limits the number of iterations. Here the CONTINUE and EXIT statements omit the optional LOOP keyword, but the END LOOP statement is required at the end of the statement loop. A similar FOR or WHILE keyword would have required the FOR or WHILE keywords, respectively, in the CONTINUE and EXIT statements.

The next example uses a conditional EXIT statement to terminate the loop:

```
LOOP
LET i = i + 1;
EXIT WHEN i = 4;
END LOOP;
```

No keyword identifying the type of loop statement is required after the EXIT statement, as would be the case for an EXIT statement in a FOR, WHILE, or FOREACH statement. When the `i = 4` condition becomes true, program control passes from the LOOP statement to whatever statement follows the END LOOP keywords.

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FOR LOOP Statements

The FOR LOOP statement uses FOR statement syntax to specify a variable and a range of values that the variable can take. The loop iterates until the specified limit to these values is reached, or until control is transferred outside the loop, as by the unconditional EXIT statement in the following example:

```
FOR i IN (1 TO 5) LOOP
IF i = 5 THEN EXIT;
ELSE
CONTINUE;
END LOOP;
```

In the FOR LOOP statement, the FOR keyword can follow the EXIT or CONTINUE keyword, but the FOR keyword is not required, as it is in an ordinary FOR statement.

The following example replaces the IF statement with a functionally equivalent conditional EXIT statement:

```
FOR i IN (1 TO 5) LOOP
EXIT WHEN i = 5;
END LOOP;
```

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WHILE LOOP Statements

To create a WHILE LOOP statement, loop, you can immediately follow a WHILE *condition* specification with a LOOP statement. The resulting loop terminates after the *condition* becomes false, or when some other statement transfers program control from the loop. In the following WHILE LOOP statement, the condition specifies that the loop terminates after the loop variable `i` has been incremented to the value of 6:

```

WHILE (i < 6) LOOP
  LET i = i + 1;
  IF i = 5 THEN EXIT;
  ELSE
    CONTINUE;
  END IF
END LOOP;

```

As in the FOR LOOP statement, the EXIT and CONTINUE keywords do not need to specify the type of loop statement, but the example would not be affected if EXIT WHILE and CONTINUE WHILE replaced the EXIT and CONTINUE keywords. The END LOOP keywords are required, however, because Informix® treats the WHILE LOOP (and FOR LOOP) statements as LOOP statements, despite their initial FOR and WHILE specifications.

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Labeled LOOP Statements

All forms of the LOOP statement, including the FOR LOOP, WHILE LOOP, and simple LOOP statements can have statement labels. You can create a labeled LOOP statement in the following steps:

1. Write a valid LOOP, FOR LOOP, or WHILE LOOP statement.
2. Create a statement label by enclosing an SQL identifier (that is not already the name of a label in the same SPL routine) between angle brackets (<<loop_label>>) immediately before the first line of the LOOP, FOR LOOP, or WHILE LOOP statement.
3. Enter the same SQL identifier, but without angle bracket delimiters, immediately after the END LOOP keywords that terminate the statement, which is now a labeled loop statement.

One advantage of labeled LOOP statements is that they can be referenced in EXIT statements. When the EXIT *label* statement executes, program control passes from the EXIT statement to the statement that follows the specified loop label.

In the following example, a labeled WHILE LOOP loop, whose loop label identifier is **endo**, is part of the statement block of a labeled LOOP statement whose loop label identifier is **voort**. If the conditional EXIT statement EXIT endo WHEN x = 7: detects that its condition is true, program control passes to the LET x = x + 1 statement that follows the END LOOP endo statement. If the conditional EXIT statement EXIT voort WHEN x > 9: detects that its condition is true, program control passes to the LET x = x + 1 statement that follows the END LOOP voort statement, and the value of x is not incremented by the LET statement,

```

<<voort>>
LOOP
  LET x = x+1;
  <<endo>>
  WHILE ( i < 10 ) LOOP
    LET x = x+1;
    EXIT endo WHEN x = 7;
    EXIT voort WHEN x > 9;
    END LOOP endo;
    LET x = x+1;
  END LOOP voort;

```

uses FOR statement syntax to specify a variable and a range of values that the variable can take. The loop iterates until the specified limit to these values is reached, or until control is transferred outside the loop, as by the unconditional EXIT statement in the following example:

```

FOR i IN (1 TO 5) LOOP
  IF i = 5 THEN EXIT;
  ELSE
    CONTINUE;
  END LOOP;

```

In the FOR LOOP statement, the FOR keyword can follow the EXIT or CONTINUE keyword, but the FOR keyword is not required, as it is in an ordinary FOR statement.

The following example replaces the IF statement with a functionally equivalent conditional EXIT statement:

```

FOR i IN (1 TO 5) LOOP
  EXIT WHEN i = 5;
  END LOOP;

```

Related Statements

[<< Label >> statement, FOR, WHILE](#)

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ON EXCEPTION

Use the ON EXCEPTION statement to specify actions to be taken for any error, or for a list of one or more specified errors, during execution of a statement block.

Syntax

```

>>-ON EXCEPTION--+-+-----+----->
                  |         .-+-----+-----+

```

```

      |          V          |          |
      '-IN--(---error_number---)-'
>-----+----->
      '-SET--SQL_error_var-----+-'
              +---ISAM_error_var--+
              '-,--error_data_var-'

      (1)
>--| Statement Block |-----END EXCEPTION----->
                                   '-WITH RESUME-'

>-----+----->
      '-;-'
```

Notes:

1. See [Statement Block](#)

Element	Description	Restrictions	Syntax
<i>error_data_var</i>	SPL variable to receive a string returned by an SQL error or by a user-defined exception	Must be a character type to receive the error information. Must be valid in current statement block.	Identifier
<i>error_number</i>	SQL error number or a number defined by a RAISE EXCEPTION statement that is to be trapped	Must be of integer type. Must be valid in current statement block.	Literal Number
<i>ISAM_error_var</i>	SPL variable that receives the ISAM error number of the exception raised	Same as for <i>error_number</i>	Identifier
<i>SQL_error_var</i>	SPL variable that receives the SQL error number of the exception raised	Same as for <i>ISAM_error_var</i>	Identifier

Usage

The ON EXCEPTION statement, together with the RAISE EXCEPTION statement, provides an error-trapping and error-recovery mechanism for SPL routines. ON EXCEPTION can specify the errors that you want to trap as the SPL routine executes, and specifies the action to take if the error occurs within the statement block. The ON EXCEPTION statement can list one or more specific error numbers in the IN clause, or it can trap all errors (or any error) if the IN clause is omitted.

A statement block can include more than one ON EXCEPTION statement. The exceptions that are trapped can be either system-defined or user-defined.

The scope of the ON EXCEPTION statement is the statement block that contains it, and any statement blocks that are nested within that statement block, unless one of the nested statement blocks provides an ON EXCEPTION statement that overrides the outer one.

When an exception is trapped, the error status is cleared.

If you specify a variable to receive an ISAM error, but no accompanying ISAM error exists, a zero (0) is assigned to the variable. If you specify a variable to receive the error text, but none exists, the variable stores an empty string.

No ON EXCEPTION Support in Triggered Actions

The ON EXCEPTION statement has no effect when it is issued from an SPL routine in the following calling contexts:

- in a trigger routine,
- in the Action clause or the Correlated Action clause of a trigger on a table,
- in the Action clause of an INSTEAD OF trigger on a view.

When a UDR includes ON EXCEPTION in any of these contexts, the database server ignores the ON EXCEPTION statement.

- [Placement of the ON EXCEPTION statement](#)
The ON EXCEPTION statement is a declarative statement, not an executable statement. For this reason, ON EXCEPTION must follow immediately after any DEFINE statements, and must precede any executable statement within the same SPL statement block.
- [Using the IN Clause to Trap Specific Exceptions](#)
- [Receiving Error Information in the SET Clause](#)
- [Forcing Continuation of the Routine](#)

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Placement of the ON EXCEPTION statement

The ON EXCEPTION statement is a declarative statement, not an executable statement. For this reason, ON EXCEPTION must follow immediately after any DEFINE statements, and must precede any executable statement within the same SPL statement block.

Because the body of the SPL routine is a statement block, the ON EXCEPTION statement often appears at the top of the routine, and applies to all of the code in the routine.

The following example positions an ON EXCEPTION statement so that a FOREACH statement can continue processing rows after an error occurs. Procedure **X()** reads customer numbers from table **A** and inserts them into table **B**. Because the INSERT statement is in scope of the ON EXCEPTION statement, any error during

an INSERT operation causes control of execution to move to the next row of the FOREACH cursor, without terminating the FOREACH loop.

```
CREATE PROCEDURE X()  
  
    DEFINE v_cust_num CHAR(20);  
  
    FOREACH cs_insert FOR SELECT cust_num INTO v_cust_num FROM A  
    BEGIN  
        ON EXCEPTION  
        END EXCEPTION WITH RESUME;  
        INSERT INTO B(cust_num) VALUES(v_cust_num);  
    END  
END FOREACH  
  
END PROCEDURE
```

In the next example, function `add_salesperson()` inserts a set of values into a table. If the table does not exist, it is created, and the values are inserted. The function also returns the total number of rows in the table after the insert occurs:

```
CREATE FUNCTION add_salesperson(last CHAR(15), first CHAR(15))  
    RETURNING INT;  
    DEFINE x INT;  
    ON EXCEPTION IN (-206) -- If no table was found, create one  
        CREATE TABLE emp_list  
        (lname CHAR(15), fname CHAR(15), tele CHAR(12));  
        INSERT INTO emp_list VALUES -- and insert values  
        (last, first, '800-555-1234');  
    END EXCEPTION WITH RESUME;  
    INSERT INTO emp_list VALUES (last, first, '800-555-1234');  
    SELECT count(*) INTO x FROM emp_list;  
    RETURN x;  
END FUNCTION;
```

When an error occurs, the database server searches for the last ON EXCEPTION statement that traps the error code. If the database server finds no pertinent ON EXCEPTION statement, the error code is passed back to the calling context (the SPL routine, application, or interactive user), and execution terminates.

In the previous example, the minus sign (-) is required in the IN clause that specifies error -206; most error codes are negative integers.

The next example uses two ON EXCEPTION statements with the same error number so that error code 691 can be trapped in two levels of nesting. All of the DELETE statements except the one that is marked { 6 } are within the scope of the first ON EXCEPTION statement. The DELETE statements that are marked { 1 } and { 2 } are within the scope of the inner ON EXCEPTION statement:

```
CREATE PROCEDURE delete_cust (cnum INT)  
    ON EXCEPTION IN (-691) -- children exist  
    BEGIN -- Begin-end so no other DELETES get caught in here.  
        ON EXCEPTION IN (-691)  
            DELETE FROM another_child WHERE num = cnum; { 1 }  
            DELETE FROM orders WHERE customer_num = cnum; { 2 }  
        END EXCEPTION -- for error -691  
        DELETE FROM orders WHERE customer_num = cnum; { 3 }  
    END  
    DELETE FROM cust_calls WHERE customer_num = cnum; { 4 }  
    DELETE FROM customer WHERE customer_num = cnum; { 5 }  
    END EXCEPTION  
    DELETE FROM customer WHERE customer_num = cnum; { 6 }  
END PROCEDURE
```

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Using the IN Clause to Trap Specific Exceptions

An error is trapped if the SQL error code or the ISAM error code matches an exception code in the list of error numbers. The search through the list of errors begins from the left and stops with the first match. You can use a combination of an ON EXCEPTION statement without an IN clause and one or more ON EXCEPTION statements with an IN clause. When an error occurs, the database server searches for the last declaration of the ON EXCEPTION statement that traps the particular error code.

```
CREATE PROCEDURE ex_test()  
    DEFINE error_num INT;  
    ...  
    ON EXCEPTION SET error_num  
    -- action C  
END EXCEPTION  
    ON EXCEPTION IN (-300)  
    -- action B  
END EXCEPTION  
    ON EXCEPTION IN (-210, -211, -212) SET error_num  
    -- action A  
END EXCEPTION
```

A summary of the sequence of statements in the previous example would be:

1. Test for an error.
2. If error -210, -211, or -212 occurs, take action A.
3. If error -300 occurs, take action B.
4. If any other error occurs, take action C.

Receiving Error Information in the SET Clause

If you use the SET clause, when an exception occurs, the SQL error code and (optionally) the ISAM error code are inserted into the variables that are specified in the SET clause. If you provide an *error_data_var*, any error text that the database server returns is put into the *error_data_var*. Error text includes information such as the offending table or column name.

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Forcing Continuation of the Routine

The first example in [Placement of the ON EXCEPTION statement](#) includes the WITH RESUME keyword to specify that if the ON EXCEPTION statement traps an error, execution of the FOREACH loop resumes on the next row of the **cs_insert** cursor, the row immediately following the row on which the error was raised. If an error is issued on the last row of the active set, the procedure exits. After procedure **X** completes execution, table **B** contains a copy of every customer number in table **A** on which no error was issued during the INSERT operation.

The second example in [Placement of the ON EXCEPTION statement](#) uses the WITH RESUME keyword to indicate that after the statement block in the ON EXCEPTION statement executes, execution is to continue at the **SELECT COUNT(*) FROM emp_list** statement, which is the line following the line that raised the error. For this function, the result is that the count of salespeople names occurs even if the error occurred.

- [Continuing Execution After an Exception Occurs](#)

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Continuing Execution After an Exception Occurs

If you omit the WITH RESUME keywords, the next statement that executes after an exception occurs depends on the placement of the ON EXCEPTION statement, as the following scenarios describe:

- If the ON EXCEPTION statement is inside a statement block with a BEGIN and an END keyword, execution resumes with the first statement (if any) after that BEGIN ... END block. That is, it resumes after the scope of the ON EXCEPTION statement.
- If the ON EXCEPTION statement is inside a loop (FOR, WHILE, FOREACH), the rest of the loop is skipped, and execution resumes with the next iteration of the loop.
- If no statement or block, but only the SPL routine, contains the ON EXCEPTION statement, the routine executes a RETURN statement with no arguments, returning a successful status and no values.

To prevent an infinite loop, if an error occurs during execution of the statement block, then the search for another ON EXCEPTION statement to trap the error does not include the current ON EXCEPTION statement.

Related Statements

[RAISE EXCEPTION](#)

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RAISE EXCEPTION

Use the RAISE EXCEPTION statement to simulate the generation of an error.

Syntax

```
>>-RAISE EXCEPTION--SQL_error_var----->
>-+-----+--;----->
  '-,--ISAM_error--+-----+-'
      '-,--error_text-'
```

Element	Description	Restrictions	Syntax
<i>error_text</i>	SPL variable or expression that contains error message text for error -746	Must be a character data type and be valid in the statement block	Identifier ; Expression

In Informix®, for backward compatibility, you can use the RETURN statement inside a CREATE PROCEDURE statement to create an SPL function. By only using RETURN in CREATE FUNCTION statements, however, you can maintain the convention of using CREATE FUNCTION to define routines that return a value, and CREATE PROCEDURE for other routines.

All RETURN statements in the SPL function must be consistent with the RETURNING clause of the CREATE FUNCTION (or CREATE PROCEDURE) statement that defines the function. Any RETURN list of expressions must match in cardinality (and be of data types compatible with) the ordered list of data types in the RETURNING clause of the function definition.

Alternatively, however, the RETURN statement can specify no expressions, even if the RETURNING clause lists one or more data types. In this case, a RETURN statement that specifies no expression is equivalent to returning the expected number of NULL values to the calling context. A RETURN statement without any expressions exits only if the SPL function is declared as not returning any values. Otherwise it returns NULL values.

The following SPL function has two valid RETURN statements:

```
CREATE FUNCTION two_returns (stockno INT) RETURNING CHAR (15);
  DEFINE des CHAR(15);
  ON EXCEPTION (-272)      -- if user does not have select privilege
    RETURN;                -- return no values.
  END EXCEPTION;
  SELECT DISTINCT descript INTO des FROM stock
    WHERE stock_num = stockno;
  RETURN des;
END FUNCTION;
```

A program that calls the function in the previous example should test whether no values are returned and act accordingly.

- [WITH RESUME Keyword](#)

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WITH RESUME Keyword

If you use the WITH RESUME keywords, then after the RETURN statement completes execution, the next invocation of the SPL function (upon the next FETCH or FOREACH statement) starts from the statement that follows the RETURN statement. Any function that executes a RETURN WITH RESUME statement must be invoked within a FOREACH loop, or else in the FROM clause of a SELECT statement. If an SPL routine executes a RETURN WITH RESUME statement, a FETCH statement in the Informix® ESQ/C application can call the SPL routine.

The following example shows a cursor function that another UDR can call. After the RETURN WITH RESUME statement returns each value to the calling UDR or program, the next line of **series** executes the next time **series** is called. If the variable **backwards** equals zero (0), no value is returned to the calling UDR or program, and execution of **series** stops:

```
CREATE FUNCTION series (limit INT, backwards INT) RETURNING INT;
  DEFINE i INT;
  FOR i IN (1 TO limit)
    RETURN i WITH RESUME;
  END FOR;
  IF backwards = 0 THEN
    RETURN;
  END IF;
  FOR i IN (limit TO 1 STEP -1)
    RETURN i WITH RESUME;
  END FOR;
END FUNCTION; -- series
```

- [Returning Values from Another Database](#)

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Returning Values from Another Database

If an SPL function uses the Return clause to return values from another database of the local Informix® instance, the following data types are supported as the returned data type:

- Built-in data types that are not opaque
- Most of the *built-in opaque data types*, as listed in [Data Types in Cross-Database Transactions](#)
- DISTINCT of the built-in types that are referenced in the two lines above
- DISTINCT of any DISTINCT data type in this list
- Any opaque user-defined type (UDT) that is cast explicitly to one of the built-in data types in this list.

The definitions of the UDF and of the type hierarchies, casts, DISTINCT types, and UDTs must be exactly the same in each of the participating databases. The same data-type restrictions apply to a value that an external function returns from another database of the local Informix instance. For more information about data types that are supported in distributed operations across two or more databases of the same database server, see [Data Types in Cross-Database Transactions](#).

UDRs can return only the following data types from tables in databases of other database servers:

- Any non-opaque built-in data type
- BOOLEAN

- LVARCHAR
- DISTINCT of non-opaque built-in types
- DISTINCT of BOOLEAN
- DISTINCT of LVARCHAR
- DISTINCT of any DISTINCT type that appears in this list.

UDRs can return these DISTINCT types from databases of other Informix instances only if the DISTINCT types are cast explicitly to built-in types. The definitions of the DISTINCT data types, their type hierarchies, and their casts must be exactly the same in all databases that participate in the distributed operations. For queries or other DML operations in cross-server UDRs that use the data types in the preceding list as parameters or as returned data types, the UDR must be defined in each participating database, and the participating Informix instances must support the data type as a returned value in cross-server operations.

For additional information about the data types that Informix can access in distributed operations, see [Data Types in Distributed Queries](#).

- [External Functions and Iterator Functions](#)

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External Functions and Iterator Functions

In an SPL program, you can use a C or Java™ language external function as an expression in a RETURN statement, provided that the external function is not an iterator function. An *iterator function* is an external function that returns one or more rows of data (and therefore requires a cursor to execute).

SPL iterator functions must include the RETURN WITH RESUME statement. For information about using an iterator function with a virtual table interface in the FROM clause of a query, see [Iterator Functions](#).

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SYSTEM

Use the SYSTEM statement to issue an operating-system command from within an SPL routine.

Syntax

```
>>-SYSTEM--+-expression-+---;-----><
      '-SPL_var-----'
```

Element	Description	Restrictions	Syntax
<i>expression</i>	Evaluates to a user-executable operating-system command	You cannot specify that the command run in the background	Operating-system dependent
<i>SPL_var</i>	SPL variable containing a command	Must be of a character data type	Identifier :

Usage

If the specified *expression* is not a character expression, it is converted to a character expression and passed to the operating system for execution.

The command that SYSTEM specifies cannot run in the background. The database server waits for the operating system to complete execution of the command before it continues to the next statement in the SPL routine. The SPL routine cannot use any returned values from the command.

If the operating-system command fails (that is, returns a nonzero status for the command), an exception is raised that contains the returned operating-system status as the ISAM error code and an appropriate SQL error code.

A rollback does not terminate a system call, so a suspended transaction can wait indefinitely for the call to return. For instructions on recovery from a deadlock during a long transaction rollback, see the *IBM® Informix Administrator's Guide*.

The dynamic log feature of Informix® automatically adds log files until the long transaction completes or rolls back successfully.

In DBA- and owner-privileged SPL routines that contain SYSTEM statements, the command runs with the access privileges of the user who executes the routine.

- [Executing the SYSTEM statement on UNIX](#)
In SPL procedures for UNIX platforms, a specification that evaluates to a valid UNIX operating system command must immediately follow the SYSTEM keyword.
- [Executing the SYSTEM statement on Windows](#)
On Windows systems, any SYSTEM statements in an SPL routine are executed only if the current user who is executing the SPL routine has logged on with a password.
- [Setting Environment Variables in SYSTEM Commands](#)

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Executing the SYSTEM statement on UNIX

In SPL procedures for UNIX platforms, a specification that evaluates to a valid UNIX operating system command must immediately follow the SYSTEM keyword.

Both of the program fragments that follow use the SYSTEM statement of SPL to send a message to the system administrator.

- In the first example, the **sensitive_update** routine defines an SPL variable called **mailcall** to store a character string that specifies the name of the **mail** utility, and the user ID of the message recipient, and the message text.
- In the second example, the **sensitive_update2** routine similarly invokes the **mail** utility with a SYSTEM statement. The expression constructs a valid command line by concatenating three quoted strings and the SPL variables **user1** and **user2** to send to the system administrator a file called **violations_file**.

Sending email using the SYSTEM statement

The SYSTEM statement in the following example of an SPL routine causes the UNIX operating system to send a mail message to the system administrator whose user ID is **headhoncho**:

```
CREATE PROCEDURE sensitive_update()
...
  LET mailcall = 'mail headhoncho < alert';
  -- code to execute if user tries to execute a specified
  -- command, then sends email to system administrator
  SYSTEM mailcall;
...
END PROCEDURE; -- sensitive_update
```

You can use a double-pipe symbol (| |) to concatenate expressions within a SYSTEM statement, as the following example shows:

```
CREATE PROCEDURE sensitive_update2()
  DEFINE user1 char(15);
  DEFINE user2 char(15);
  LET user1 = 'joe';
  LET user2 = 'mary';
  ...
  -- code to execute if user tries to execute a specified
  -- command, then sends email to system administrator
  SYSTEM 'mail -s violation' || user1 || ' ' || user2
    || '< violation_file';
  ...
END PROCEDURE; --sensitive_update2
```

In both examples above, blank spaces separate elements of the command line, so the expression that follows the SYSTEM keyword evaluates to a character string that conforms to the syntax requirements of the operating system **mail** utility.

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Executing the SYSTEM statement on Windows

On Windows systems, any SYSTEM statements in an SPL routine are executed only if the current user who is executing the SPL routine has logged on with a password.

The database server must have the password and login name of the user in order to execute a command on behalf of that user.

The first SYSTEM statement in the following example of an SPL routine causes Windows to send an error message to a temporary file and to put the message in a system log that is sorted alphabetically. The second SYSTEM statement causes the operating system to delete the temporary file:

```
CREATE PROCEDURE test_proc()
...
  SYSTEM 'type errormess101 > %tmp%tmpfile.txt |
    sort >> %SystemRoot%systemlog.txt';
  SYSTEM 'del %tmp%tmpfile.txt';
  ...
END PROCEDURE; --test_proc
```

The expressions that follow the SYSTEM statements in this example contain variables **%tmp%** and **%SystemRoot%** that are defined by Windows.

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Setting Environment Variables in SYSTEM Commands

When the operating-system command that SYSTEM specifies is executed, no guarantee exists that any environment variables that the user application sets are passed to the operating system. If you set an environment variable in a SYSTEM command, the setting is only valid during that SYSTEM command.

To avoid this potential problem, the following method is recommended to ensure that any environment variables that the user application requires are carried forward to the operating system.

To Change Environment Settings for an Operating System Command

1. Create a shell script (on UNIX systems) or a batch file (on Windows platforms) that sets up the desired environment and then executes the operating system command.
2. Use the SYSTEM command to execute the shell script or batch file.

This solution has an additional advantage: if you subsequently need to change the environment, you can modify the shell script or the batch file without needing to recompile the SPL routine.

For information about operating system commands that set environment variables, see the *IBM® Informix® Guide to SQL: Reference*.

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TRACE

Use the TRACE statement to control the generation of debugging output.

Syntax

```
>>-TRACE--+ON-----+--;-----><
      +-OFF-----+
      +-PROCEDURE-----+
      |               (1) |
      '-| Expression |-----'
```

Notes:

1. See [Expression](#)

Usage

The TRACE statement generates output that is sent to the file that the SET DEBUG FILE TO statement specifies. Tracing writes to the debug file the current values of the following program objects:

- SPL variables
- Routine arguments
- Return values
- SQL error codes
- ISAM error codes

The output of each executed TRACE statement appears on a separate line.

If you use the TRACE statement before you specify a DEBUG file to contain the output, an error is generated.

Any routine that the SPL routine calls inherits the trace state. That is, a called routine (on the same database server) assumes the same trace state (ON, OFF, or PROCEDURE) as the calling routine. The called routine can set its own trace state, but that state is not passed back to the calling routine.

A routine that is executed on a remote database server does not inherit the trace state.

- [TRACE ON](#)
- [TRACE OFF](#)
- [TRACE PROCEDURE](#)
- [Displaying Expressions](#)
- [Example Showing Different Forms of TRACE](#)
- [Looking at the Traced Output](#)

Related reference:

[SET DEBUG FILE statement](#)

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TRACE ON

If you specify the keyword ON, all statements are traced. The values of variables (in expressions or otherwise) are printed before they are used. To turn tracing ON implies tracing both routine calls and statements in the body of the routine.

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TRACE OFF

If you specify the keyword OFF, all tracing is turned off.

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TRACE PROCEDURE

If you specify the keyword PROCEDURE, only the routine calls and return values, but not the body of the routine, are traced.

The TRACE statement supports no ROUTINE or FUNCTION keywords. Use the TRACE PROCEDURE keywords when the SPL routine that you trace is a function.

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Displaying Expressions

You can use the TRACE statement with a quoted string or an expression to display values or comments in the output file. If the expression is not a literal expression, the expression is evaluated before it is written to the output file.

You can use the TRACE statement with an expression even if you used a TRACE OFF statement earlier in a routine. You must first, however, use the SET DEBUG statement to establish a trace output file.

The next example uses a TRACE statement with an expression after using a TRACE OFF statement. The example uses UNIX file naming conventions:

```
CREATE PROCEDURE tracing ()
  DEFINE i INT;
BEGIN
  ON EXCEPTION IN (1)
  END EXCEPTION; -- do nothing
  SET DEBUG FILE TO '/tmp/foo.trace';
  TRACE OFF;
  TRACE 'Forloop starts';
  FOR i IN (1 TO 1000)
    BEGIN
      TRACE 'FOREACH starts';
      FOREACH SELECT...INTO a FROM t
        IF <some condition> THEN
          RAISE EXCEPTION 1 -- emergency exit
        END IF
      END FOREACH -- return some value
    END
  END FOR -- do something
END;
END PROCEDURE
```

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Example Showing Different Forms of TRACE

The following example shows several different forms of the TRACE statement. The example uses Windows file naming conventions:

```
CREATE PROCEDURE testproc()
  DEFINE i INT;
  SET DEBUG FILE TO 'C:\tmp\test.trace';
  TRACE OFF;
  TRACE 'Entering foo';
  TRACE PROCEDURE;
  LET i = test2();

  TRACE ON;
  LET i = i + 1;

  TRACE OFF;
  TRACE 'i+1 = ' || i+1;
  TRACE 'Exiting testproc';

  SET DEBUG FILE TO 'C:\tmp\test2.trace';

END PROCEDURE
```

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Looking at the Traced Output

To create a labeled WHILE loop, you can declare a loop label before the initial WHILE keyword, and repeat the label after the END WHILE keywords, as in the two WHILE loops of the following example:

```
CREATE PROCEDURE ex_cont_ex()
  DEFINE i,s,j, INT;
  <<while_jlab>>
  WHILE j < 20
    IF j > 10 THEN
      CONTINUE WHILE;
    END IF
    LET i,s = j,0;
    <<while_slab>>
    WHILE i > 0
      LET i = i -1;
      IF i = 5 THEN
        EXIT while_jlab;
      END IF
    END WHILE while_slab
  END WHILE while_jlab
END PROCEDURE;
```

Here the `EXIT while_jlab` statement has the same effect that the `EXIT` or `EXIT FOR` keywords would have, terminating both the outer WHILE loop and the routine. In this example, the statement that includes the `EXIT while_jlab` statement has the same effect that `EXIT while_jlab WHEN i = 5` would have.

You can also label a LOOP statement that begins with a loop `<<label>>` specification that immediately precedes the initial WHILE keyword and *condition*. In this type of loop, the `CONTINUE LOOP`, `EXIT LOOP`, and `END LOOP` keywords replace the `CONTINUE WHILE`, `EXIT WHILE`, and `END WHILE` keywords. Both the `LOOP` and `WHILE` keywords are optional after the `CONTINUE` and `EXIT` keywords, but the `END LOOP` keywords are required in SPL loop statements that include the `LOOP` keyword.

You can use similar syntax to create an unlabeled loop that omits the `<<label>>` declaration that immediately precedes the WHILE *condition* specification. In this case, you must also omit the undelimited loop label identifier that follows the `END LOOP` keywords. See the `LOOP` statement for a description and examples of these forms of labeled and unlabeled loop statements that enable you to combine WHILE statement syntax, with its condition-based number of loop iterations, with the "loop forever" syntax of the `LOOP` statement.

Related Statements

[<<Label>> statement](#), [CONTINUE](#), [EXIT](#), [LOOP](#)

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Data types and expressions

These topics describe the data types and expressions that Informix® supports.

These fundamental syntax segments can appear in data definition language (DDL) and data manipulation language (DML) statements, and in other types of SQL statements. Some SPL statements can also specify data types or expressions. You can use these features of a relational or object-relational database in various contexts, such as to define the schema of a table, to specify the signature and arguments of a routine, or to represent or calculate specific data values.

- [Scope of Segment Descriptions](#)
- [Use of Segment Descriptions](#)
- [Data type and expression segments](#)
Data type and expression segments can appear in SQL statements.
- [Collection Subquery](#)
- [Condition](#)
- [Data Type](#)
The Data Type segment specifies the data type of a column, of a component of a collection, of a field within a ROW type, of a routine parameter, or of a value returned by an expression or by a cast function. Use this segment whenever you see a reference to a data type in a syntax diagram.
- [DATETIME Field Qualifier](#)
Use a DATETIME Field Qualifier to specify the largest and smallest unit of time in a DATETIME column or value. Use this segment whenever you see a reference to a DATETIME Field Qualifier in a syntax diagram.
- [Expression](#)
- [OLAP window expressions](#)
You can include On-Line Analytical Processing (OLAP) expressions in a SELECT statement to operate on subsets of the rows in the result set of a query or subquery. You can use OLAP window expressions to examine subsets of the qualifying rows for patterns, trends, or exceptions in the data.
- [INTERVAL Field Qualifier](#)
- [Literal Collection](#)
- [Literal DATETIME](#)
The Literal DATETIME segment specifies a DATETIME value
- [Literal INTERVAL](#)
The Literal INTERVAL segment specifies a literal INTERVAL value. Use this whenever you see a reference to a literal INTERVAL in a syntax diagram.
- [Literal Number](#)
- [Literal Row](#)
The Literal Row segment specifies the syntax for literal values of named and unnamed ROW data types.
- [Quoted String](#)
- [Relational Operator](#)

Related reference:

[CREATE CAST statement](#)

Scope of Segment Descriptions

The description of each segment includes the following information:

- A brief introduction that explains the effect of the segment
- A syntax diagram that shows how to enter the segment correctly
- A table that explains the terms in the syntax diagram for which you must substitute names, values, or other specific information
- Rules of usage, typically including examples that illustrate these rules

If a segment consists of multiple parts, the segment description provides similar information about each part. Some descriptions conclude with references to related information in this document and in other documents.

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Use of Segment Descriptions

The syntax diagram within each segment description is not a stand-alone diagram. Rather, it is a subdiagram of the syntax of the SQL statements (in [SQL statements](#)) or of SPL statements (in [SPL statements](#)) that can include the segment.

SQL or SPL syntax descriptions can refer to segment descriptions in two ways:

- A *subdiagram reference* in a syntax diagram can list a segment name and the page in this document where the segment description begins.
- The **Syntax** column of the table that immediately follows a syntax diagram can list a segment name and the page where the segment description begins.

If the syntax diagram for a statement includes a reference to a segment, turn to that segment description to see the complete syntax for the segment.

For example, if you want to write a CREATE VIEW statement that includes a *database* and *database server* qualifiers of the *view* name, first look up the syntax diagram for the [CREATE VIEW statement](#). The table beneath that diagram refers to the Database Object Name segment for the syntax of *view*. Then use the Database Object Name segment syntax to enter a valid CREATE VIEW statement that also specifies the *database* and *database server* name for the view. In the following example, the CREATE VIEW statement defines a view called **name_only** in the **sales** database on the **boston** database server:

```
CREATE VIEW sales@boston:name_only AS
SELECT customer_num, fname, lname FROM customer;
```

Besides the Data Types and Expressions syntax segments that this chapter documents, [Other syntax segments](#) provides additional syntax segments that are referenced in the syntax diagrams of this document.

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Data type and expression segments

Data type and expression segments can appear in SQL statements.

Data type and expression segments can include the following items:

- Data Type
- DATETIME Field Qualifier
- INTERVAL Field Qualifier
- Expression
- Aggregate Expression
- AVG, COUNT, MAX, MIN, SUM, RANGE, STDEV, VARIANCE, and User-Defined Aggregates
- Arithmetic Expressions
- Binary (+, -, *, /) Operators, Operator Functions, and Unary (+, -) Operators
- Cast Expressions
- CAST function and Cast (::) Operator
- Collection Subquery
- Column Expressions
- Column Name, ROWID, and Substring ([...]) Operator
- CONCAT Function and Concatenation (||) Operator
- Condition Segment and Conditional Expressions
- Comparison Condition: AND, OR, NOT, BETWEEN, IS NULL, LIKE, MATCHES, and Relational Operators
- Condition with Subquery: IN, EXISTS, ALL, ANY, and SOME Operators
- Boolean UDF
- CASE Expressions
- NVL Function
- DECODE Function
- Constant Expressions: CURRENT, SYSDATE, TODAY, DBSERVERNAME, SITENAME, UNITS, CURRENT_USER, and USER
- Literal Value

- Literal Collection
- Literal DATETIME
- Literal INTERVAL
- Literal Number
- Literal Row
- Quoted String
- Constructor Expressions
- Collection Constructor
- ROW Constructor Function Expressions
- Algebraic Functions: ABS, MOD, POW, power ROOT, ROUND, SQRT, and TRUNC Functions
- CARDINALITY Function
- DBINFO Function
- Encryption and Decryption Functions: DECRYPT_BINARY, DECRYPT_CHAR, ENCRYPT_AES, ENCRYPT_TDES, and GETHINT Functions
- Exponential and Logarithmic Functions: EXP, LOGN, and LOG10 Functions
- HEX Function
- Hierarchical Query Operators and Functions: CONNECT_BY_ROOT, PRIOR, and SQL_CONNECT_BY_PATH
- IFX_ALLOW_NEWLINE Function
- Length Functions: CHARACTER_LENGTH, CHAR_LENGTH, LENGTH, and OCTET_LENGTH Functions
- Sequence Operators: CURRVAL, NEXTVAL
- Smart Large Object Functions: FILETOBLOB, FILETOCLOB, LOCOPY, and LOTOFIL Functions
- String-Manipulation Functions: LPAD, RPAD, TRIM, REPLACE, SUBSTR, SUBSTRING, INITCAP, LOWER, and UPPER Functions
- Time Functions: DATE, DAY, EXTEND, MDY, MONTH, TO_CHAR, TO_DATE, WEEKDAY, and YEAR Functions
- Trigger-Type Boolean Operators: DELETING, INSERTING, SELECTING, and UPDATING
- Trigonometric Functions: ACOS, ASIN, ATAN, ATAN2, COS, SIN, and TAN Functions
- User-Defined Functions
- Statement-Local Variable Expressions

You can also use host variables or SPL variables as expressions. For an alphabetic list of expressions with page references, see [List of Expressions](#).

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Collection Subquery

You can use a Collection Subquery to create a MULTISET collection from the results of a subquery. This syntax is an extension to the ANSI/ISO standard for SQL.

Syntax

Collection Subquery

```
(1)
|-----MULTISET--(--+-subquery-----+--)------|
|               '-SELECT ITEM--singleton_select-'   |
```

Notes:

1. Informix® extension

Element	Description	Restrictions	Syntax
<i>singleton_select</i>	Subquery returning exactly one row	Subquery cannot repeat the SELECT keyword, nor include the ORDER BY clause	SELECT statement
<i>subquery</i>	Embedded query	Cannot contain the ORDER BY clause	SELECT statement

Usage

The MULTISET and SELECT ITEM keywords have the following significance:

- MULTISET specifies a collection of elements that can contain duplicate values, but that has no specific order of elements.
- SELECT ITEM supports only one expression in the projection list. You cannot repeat the SELECT keyword in the singleton subquery.

You can use a collection subquery in the following contexts:

- The Projection clause and WHERE clause of the SELECT statement
- The VALUES clause of the INSERT statement
- The SET clause of the UPDATE statement
- Wherever you can use a collection expression (that is, any expression that evaluates to a single collection)
- As an argument passed to a user-defined routine

The following restrictions apply to a collection subquery:

- The Projection clause cannot contain duplicate column (field) names.
- It cannot contain aliases for table names. (But it can use aliases for column (field) names, as in some of the examples that follow.)
- It is read-only.

- It cannot be opened twice.
- It cannot contain NULL values.
- It cannot contain syntax that attempts to seek within the subquery.

A collection subquery returns a multiset of unnamed ROW data types. The fields of this ROW type are elements in the projection list of the subquery. Examples that follow access the tables and the ROW types that these statements define:

```
CREATE ROW TYPE rt1 (a INT);
CREATE ROW TYPE rt2 (x int, y rt1);
CREATE TABLE tab1 (col1 rt1, col2 rt2);
CREATE TABLE tab2 OF TYPE rt1;
CREATE TABLE tab3 (a ROW(x INT));
```

The following examples of collection subqueries return the MULTISET collections that are listed to the right of the subquery.

Collection Subquery	Resulting Collections
MULTISET (SELECT * FROM tab1)...	MULTISET(ROW(col1 rt1, col2 rt2))
MULTISET (SELECT col2.y FROM tab1)...	MULTISET(ROW(y rt1))
MULTISET (SELECT * FROM tab2)...	MULTISET(ROW(a int))
MULTISET(SELECT p FROM tab2 p)...	MULTISET(ROW(p rt1))
MULTISET (SELECT * FROM tab3)...	MULTISET(ROW(a ROW(x int)))

The following is another collection subquery:

```
SELECT f(MULTISET(SELECT * FROM tab1 WHERE tab1.x = t.y))
FROM t WHERE t.name = 'john doe';
```

The following collection subquery includes the UNION operator:

```
SELECT f(MULTISET(SELECT id FROM tab1
UNION
SELECT id FROM tab2 WHERE tab2.id2 = tab3.id3)) FROM tab3;
```

- [Table expressions in the FROM clause](#)
Informix supports ANSI/ISO standard syntax for table expressions in the FROM clause of SELECT queries and subqueries as a substitute for the Informix-extension collection subquery syntax. The keywords TABLE and MULTISET are required in version 10.00 and in earlier releases. These extensions to the ANSI/ISO standard for SQL are supported but are no longer required for collection subqueries in the FROM clause of SELECT statements.

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Table expressions in the FROM clause

Informix® supports ANSI/ISO standard syntax for table expressions in the FROM clause of SELECT queries and subqueries as a substitute for the Informix-extension collection subquery syntax. The keywords TABLE and MULTISET are required in version 10.00 and in earlier releases. These extensions to the ANSI/ISO standard for SQL are supported but are no longer required for collection subqueries in the FROM clause of SELECT statements.

The following two queries return the same result set, but only the second query complies with the ANSI/ISO standard:

```
SELECT * FROM TABLE(MULTISET(SELECT col1 FROM tab1 WHERE col1 = 100))
AS vtab(c1),
(SELECT col1 FROM tab1 WHERE col1 = 10) AS vtab1(vc1) ORDER BY c1;

SELECT * FROM (SELECT col1 FROM tab1 WHERE col1 = 100) AS vtab(c1),
(SELECT col1 FROM tab1 WHERE col1 = 10) AS vtab1(vc1)
ORDER BY c1;
```

The same SELECT statement can combine instances of both the Informix-extension and ANSI/ISO syntax for collection subqueries:

```
SELECT * FROM (select col1 FROM tab1 WHERE col1 = 100) AS vtab(c1),
TABLE(MULTISET(SELECT col1 FROM tab1 WHERE col1 = 10)) AS vtab1(vc1)
ORDER BY c1;
```

The collection subquery must be delimited by parentheses in both formats, but the outer set of parentheses () that immediately follows the TABLE keyword and encloses the MULTISET collection subquery specification is an extension to the ANSI/ISO syntax. This ANSI/ISO syntax is valid only in the FROM clause of the SELECT statement. You cannot omit these keywords and parentheses from a collection subquery specification in any other context.

Important:

Collection subqueries in the FROM clause cannot include correlated table references, and cannot include the LATERAL keyword.

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Condition

Use a condition to test whether data meets certain qualifications. Use this segment wherever you see a reference to a condition in a syntax diagram.

```

      .-Logical_Operator------.
      v                               (1) |
|---+---+---+---+ Comparison Conditions |---+---+---+
      '-NOT-' |
              +-| Condition with Subquery |---+
              | | (2) |
              +-| User-Defined Function |---+
              | | (3) |
              '-|

```

1. See [Comparison Conditions \(Boolean Expressions\)](#).
2. See [Condition with Subquery](#).
3. See [User-Defined Functions](#)

Element	Description	Restrictions	Syntax
<i>Logical_Operator</i>	Combines two conditions	Valid options are OR (= <i>logical union</i>) or AND (= <i>logical intersection</i>)	Conditions with AND or OR

- Comparison conditions (also called filters or Boolean expressions)
- Conditions with a subquery
- User-defined functions (Informix® only)

aggregate function can appear in a condition in the WHERE clause of a DELETE, SELECT, or UPDATE statement unless both of the following are TRUE:

- Aggregate is on a correlated column originating from a parent query.
- The WHERE clause appears in a subquery within a HAVING clause.

- In the HAVING clause of a SELECT statement
- In the definition of a check constraint

- In the definition of a check constraint
- In the ON clause of a SELECT statement
- In the WHERE clause of a DELETE, SELECT, or UPDATE statement

- In the definition of a check constraint
- In the ON clause of a SELECT statement
- In the WHERE clause of a DELETE, SELECT, or UPDATE statement
- In the WHEN clause of CREATE TRIGGER
- In the IF, CASE, or WHILE statements of SPL

- [Comparison Conditions \(Boolean Expressions\)](#)
Comparison conditions are often called *Boolean expressions* because they return a TRUE or FALSE result.
- [Column Name](#)
- [Quotation Marks in Conditions](#)
- [Relational-Operator Condition](#)
A relational operator compares two expressions quantitatively.
- [BETWEEN Condition](#)
Use the BETWEEN condition to test whether the value of a numeric, character, or time expression is within a specified range.
- [IN Condition](#)
- [IS NULL and IS NOT NULL Conditions](#)
- [Trigger-Type Boolean Operator](#)
- [LIKE and MATCHES Condition](#)
A LIKE or MATCHES condition tests for matching character strings.
- [Stand-Alone Condition](#)
- [Condition with Subquery](#)
- [NOT Operator](#)
- [Conditions with AND or OR](#)

Create a comparison condition
Subqueries in WHERE clauses

Comparison conditions are often called *Boolean expressions* because they return a `TRUE` or `FALSE` result.

Six kinds of Boolean operators can specify a comparison condition:

- Their syntax is summarized in this diagram and explained in the sections that follow.

(1)		(2)		(1)	
Expression	Relational Operator	Expression	AND	Expression	
Expression	BETWEEN	Expression		Expression	
	'NOT'				
(3)	(4)				
IN Condition					
column	IS	column	NULL		
'expression'	'NOT'				
(5)	(6)				
Trigger-Type Operator					
string	LIKE	string	ESCAPE	'char'	
'column'	'NOT'	(3)		'column'	
	MATCHES	'column'			

1. See [Expression](#)
2. See [Relational Operator](#)
3. Informix® extension
4. See [IN Condition](#)
5. SPL trigger routines only
6. See [Trigger-Type Boolean Operator](#)

Element	Description	Restrictions	Syntax
<i>char</i>	An ASCII character to be the escape character in the quoted string. Single (') and double (") quotation marks are not valid as <i>char</i> .	See ESCAPE with LIKE and ESCAPE with MATCHES	Quoted String
<i>column</i>	Name of a column (or a field of a ROW-type column) whose data value is compared to NULL, to <i>string</i> , or to another <i>column</i>	Can be qualified by the identifier, synonym, or alias of a table or view	See Column Name
<i>expression</i>	An SQL expression that returns a single value	Must return a single value	Expression
<i>string</i>	A string delimited by single (') or double (") quotation marks	Both delimiters must be identical	See Quoted String

The following sections describe the different types of comparison conditions:

- Relational-Operator Condition
- BETWEEN Condition
- IN Condition
- IS NULL and IS NOT NULL Conditions
- LIKE and MATCHES Condition.

For a discussion of comparison conditions in the context of the SELECT statement, see [Using a Condition in the WHERE Clause](#).

Warning: A literal DATE or DATETIME value in a comparison condition should specify 4 digits for the year. When you specify a 4-digit year, the **DBCENTURY** environment variable has no effect on the result. When you specify a 2-digit year, **DBCENTURY** can affect how the database server interprets the comparison condition, which might not work as you intended. For more information about **DBCENTURY**, see the *IBM® Informix Guide to SQL: Reference*.

Related information:

DBCENTURY environment variable

Column Name

Notes:

- | Element | Description | Restrictions | Syntax |
|-----------------------------|--|--|----------------------------|
| <i>alias</i> | Temporary alternative name for table or view | Must be defined in the FROM clause of the SELECT statement | Identifier |
| <i>column</i> | Name of a column | Must exist in the specified table | Identifier |
| <i>field</i> | A field to compare in a ROW type column | Must be a component of <i>row-column name</i> or <i>field name</i> (for nested rows) | Identifier |
| <i>row_column</i> | A column of type ROW | Must be an existing named ROW type or unnamed ROW type | Identifier |
| <i>synonym, table, view</i> | Name of a synonym, table, or view | The <i>synonym</i> and the table or view to which it points must exist in the database | Identifier |

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Part VIII: SQL programming **739**

Conditions testing for NULL values

If any expression within the *condition* evaluates to NULL, the *condition* cannot be true, unless you are explicitly testing for NULL by using the IS NULL operator. For example, if the **paid_date** column has a NULL value, then neither of the following queries can retrieve that row:

```
SELECT customer_num, order_date FROM orders
WHERE paid_date = '';
```

```
SELECT customer_num, order_date FROM orders
WHERE NOT (paid_date != '');
```

You must use the IS NULL operator to test for a NULL value, as the next example shows.

```
SELECT customer_num, order_date FROM orders
WHERE paid_date IS NULL;
```

The IS NULL operator and its logical inverse, the IS NOT NULL operator, are described in [IS NULL and IS NOT NULL Conditions](#).

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BETWEEN Condition

Use the BETWEEN condition to test whether the value of a numeric, character, or time expression is within a specified range.

BETWEEN Condition

```
|--| Expression |-----+-----+--BETWEEN--| Expression |-----AND--| Expression |-----|
                        (1)                                (1)                                (1)
                        'NOT-'
```

Notes:

1. See [Expression](#)

Usage

NULL values cannot satisfy the condition. Neither of the expressions that define the range can evaluate to NULL.

The three expressions in a BETWEEN condition must satisfy these restrictions:

- All three expressions must evaluate to mutually compatible numeric, time, or character data types.
- The value of the expression that immediately follows the BETWEEN keyword must be less than the value of the expression that follows the AND keyword.

Numeric and time expressions in BETWEEN conditions

For number expressions, *less than* means to the left on the real line.

For DATE and DATETIME expressions, *less than* means earlier in time.

For INTERVAL expressions, *less than* means a shorter span of time.

Character expressions in BETWEEN conditions

For CHAR, VARCHAR, and LVARCHAR expressions, *less than* means *before* in code-set order.

For NCHAR and NVARCHAR expressions, *less than* means *before* in the localized collation order, if one exists; otherwise, *less than* means *before* in code-set order.

Locale-based collation order, if one is defined for the locale, is used for NCHAR and NVARCHAR expressions. So for NCHAR and NVARCHAR expressions, *less than* means *before* in the locale-based collation order. For more information on locale-based collation order and the NCHAR and NVARCHAR data types, see the *IBM® Informix® GLS User's Guide*.

For information on how relational operator expressions with NCHAR and NVARCHAR operands in databases that have the NLCASE INSENSITIVE property differ from their behavior in databases that are case sensitive, see the topic [NCHAR and NVARCHAR expressions in case-insensitive databases](#).

The NOT keyword in BETWEEN conditions

For a BETWEEN condition to be TRUE depends on whether you include the NOT keyword.

- If you omit the NOT keyword, the BETWEEN condition is TRUE only if the value of the expression on the left of the BETWEEN keyword is in the inclusive range of the values of the two expressions on the right of the BETWEEN keyword.
- If the NOT keyword immediately precedes the BETWEEN keyword, the BETWEEN condition is TRUE only if the value of the expression on the left of the BETWEEN keyword is not in the inclusive range of the values of the two expressions on the right of the BETWEEN keyword.

Otherwise, the BETWEEN condition is FALSE.

Examples of BETWEEN conditions

The following examples illustrate BETWEEN conditions:

```
order_date BETWEEN '6/1/97' and '9/7/97'
```

```
zipcode NOT BETWEEN '94100' and '94199'
```

```
EXTEND(call_dtime, DAY TO DAY) BETWEEN
      (CURRENT - INTERVAL(7) DAY TO DAY) AND CURRENT
```

```
lead_time BETWEEN INTERVAL (1) DAY TO DAY
AND INTERVAL (4) DAY TO DAY
```

unit_price BETWEEN loprice AND hiprice

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IN Condition

The IN condition is satisfied when the expression to the left of the keyword IN is included in the list of items.

IN Condition

```
(1)
|--| Expression |-----+---IN----->
      '-NOT-'

      .-,------.
      V              (2)                |
>--+-(---+--| Literal Number |-----+---)-+-+|
      |               (3)
      +--| Literal DATETIME |-----+
      |               (4)
      +--| Quoted String |-----+
      |               (5)
      +--| Literal INTERVAL |-----+
      +--USER-----+
      +--CURRENT_USER-----+
      +--TODAY-----+
      +--CURRENT-----+
      |               (6)
      |   '-| DATETIME Field Qualifier |-----'
      +--SITENAME-----+
      +--DBSERVERNAME-----+
      |               (6)
      |   '-| Literal Row |-----'
      +--+collection_col-----+
      |   .-,------.
      |   V              (7)
      +-(---+--| Literal Collection |-----+---)+
      |               (7)
      |   '-| Literal Collection |-----'
```

Notes:

1. See [Expression](#)
2. See [Literal Number](#)
3. See [Literal DATETIME](#)
4. See [Quoted String](#)
5. See [Literal INTERVAL](#)
6. See [DATETIME Field Qualifier](#)
7. See [Literal Row](#)

Element	Description	Restrictions	Syntax
<i>collection_col</i>	Name of a collection column that is used in an IN condition	The column must exist in the specified table	Identifier

If you specify the NOT operator, the IN condition is **TRUE** when the expression is not in the list of items. NULL values do not satisfy the IN condition.

The following examples show some IN conditions:

```
WHERE state IN ('CA', 'WA', 'OR')
WHERE manu_code IN ('HRO', 'HSK')
WHERE user_id NOT IN (USER)
WHERE order_date NOT IN (TODAY)
```

In Informix® ESQL/C, the built-in TODAY function is evaluated at execution time. The built-in CURRENT function is evaluated when a cursor opens or when the query executes, if it is a singleton SELECT statement.

The built-in USER function is case sensitive: for example, it interprets **minnie** and **Minnie** as different values.

- [Using the IN operator with collection data types](#)
You can use the IN operator to determine if an element is contained in a collection.

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Using the IN operator with collection data types

You can use the IN operator to determine if an element is contained in a collection.

The collection can be a simple or nested collection. (In a *nested* collection type, the element type of the collection is also a collection type.) When you use IN to search for an element of a collection, the expression to the left or right of the IN keyword cannot contain a BYTE or TEXT data type.

Suppose you create the following table that contains two collection columns:

```
CREATE TABLE tab_coll
(
  set_num SET(INT NOT NULL),
  list_name LIST(SET(CHAR(10) NOT NULL) NOT NULL)
);
```

The following statement fragments show how you might use the IN operator for search conditions on the collection columns of the **tab_coll** table:

```
WHERE 5 IN set_num
WHERE 5.0::INT IN set_num
WHERE "5" NOT IN set_num
WHERE set_num IN ("SET{1,2,3}", "SET{7,8,9}")
WHERE "SET{'john', 'sally', 'bill'}" IN list_name
WHERE list_name IN ("LIST{"SET{'bill', 'usha'}",
  "SET{'ann', 'moshi'}",
  "LIST{"SET{'bob', 'ramesh'}",
  "SET{'bomani', 'ann'}"}")
```

In general, when you use the IN operator on a collection data type, the database server checks whether the value on the left of the IN operator is an element in the set of values on the right of the IN operator.

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IS NULL and IS NOT NULL Conditions

The IS NULL condition is satisfied if the term that immediately precedes the IS keyword specifies one of the following undefined values:

- The name of a *column* that contains a null value.
- An *expression* that evaluates to null.

Conversely, if you use the IS NOT NULL operator, the condition is satisfied when the *column* contains a value that is not null, or when the *expression* that immediately precedes the IS NOT NULL keywords does not evaluate to null.

Suppose that you wish to perform an arithmetic computation on a column that can contain NULL values. You can create a table, insert values into the table, and then perform a query that uses a generic CASE expression that converts null values to 0 for the purpose of arithmetic calculations:

```
CREATE TABLE employee (emp_id INT, savings_in_401k INT, total_salary INT);

INSERT INTO employee VALUES(1, 5000, 40000);
INSERT INTO employee VALUES(2, 0, 40000);
INSERT INTO employee VALUES(3, NULL, 100000);

SELECT emp_id, savings_in_401k AS employer_match FROM employee WHERE
  CASE WHEN(savings_in_401k IS NULL) THEN 0
  ELSE savings_in_401k END * 0.06 > 0;
```

This example shows that by using IS NULL in the CASE expression, you can provide a value for the entries that otherwise are not computable because null is not a valid numeric value.

The IS NULL condition is satisfied if the column contains a null value or if the expression cannot be evaluated because it contains one or more null values. If you use the IS NOT NULL operator, the condition is satisfied when the operand is column value that is not null, or an expression that does not evaluate to null.

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Trigger-Type Boolean Operator

The trigger-type Boolean operators of Informix® can test at runtime whether the currently executing triggered action was triggered by the specified type of DML event. These operators take no operands.

Trigger-Type Boolean Operator

```

--+-+-----+-----+-----+-----+-----+-----+-----+-----+-----+
+-DELETING--+
+-INSERTING--+
+-SELECTING--+
'-UPDATING--'

```

These operators return TRUE ('t') if the triggering event of the currently executing trigger is the DML operation corresponding to the name of the operator, and they return FALSE ('f') otherwise. These operators are valid in IF statements, in CASE expressions, and in other contexts within an SPL trigger routines where a Boolean condition is valid.

For example, in the following statement fragment, the LET statement in the first THEN clause is executed only if the currently executing trigger was activated by an INSERT event, and the LET statement in the second THEN clause is executed only if the trigger was activated by a DELETE event:

```
IF (INSERTING = 't') THEN
    LET square = NEW.X * NEW.X
ELSEIF (DELETING = 't') THEN
    LET square = 0
```

The **SELECTING**, **DELETING**, **INSERTING**, and **UPDATING** operators are valid only in trigger UDRs that are invoked in the **FOR EACH ROW** triggered action of a trigger on a table, or (for the **DELETING**, **INSERTING**, and **UPDATING** operators) of an **INSTEAD OF** trigger on a view. An error is issued if you attempt to use a trigger-type Boolean operator in any other context.

If a trigger routine is invoked by a Delete, Insert, or Update trigger that the MERGE statement has activated,

- DELETING returns TRUE while MERGE is deleting a row from the target table
- INSERTING returns TRUE while MERGE is inserting a row into the target table.
- UPDATING returns TRUE while MERGE is updating a row of the target table.

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LIKE and MATCHES Condition

A LIKE or MATCHES condition tests for matching character strings.

The condition is **TRUE**, or satisfied, when either of the following tests is **TRUE**:

- The value of the column on the left matches the pattern that the quoted string specifies. You can use wildcard characters in the string. NULL values do not satisfy the condition.
- The value of the column on the left matches the pattern that the column on the right specifies. The value of the column on the right serves as the matching pattern in the condition.

If the quoted string includes literal characters that match any of the wildcard characters that the LIKE or MATCHES operator recognizes, the ESCAPE clause can define an ASCII character that you can include in the quoted string. When the column value on the left is compared to the quoted string, the next character that immediately follows this *escape character* is interpreted as a literal character, rather than as a wildcard, and the escape character is ignored. The LIKE and MATCHES operators recognize different wildcard characters. For more information about LIKE and MATCHES escape characters, see [ESCAPE with LIKE](#) and [ESCAPE with MATCHES](#) topics.

You can use the single quotation mark (`'`) only with the quoted string to match a literal single quotation mark; you cannot use the ESCAPE clause. You can use the single quotation mark character as the escape character in matching any other pattern if you write it as this: `''`.

Important: Columns that you specify in LIKE or MATCHES conditions should be simple character data types, like CHAR, NVARCHAR, NCHAR, or VARCHAR. You cannot, for example, specify a complex data type, such as a ROW-type column, in a LIKE or MATCHES condition. (A ROW-type column is a column that is declared as a named or unnamed ROW type.) Similarly, the database server cannot evaluate a condition that uses LIKE or MATCHES with a simple or smart large object column, such as a CLOB column; a query that includes this condition fails with error -640.

- [NOT Operator](#)
- [LIKE Operator](#)
LIKE is the ANSI/ISO standard operator for comparing a column value to another column value, or to a quoted string.
- [MATCHES Operator](#)
The MATCHES operator is the Informix® extension for comparing a column value to another column value, or to a quoted string.
- [ESCAPE with LIKE](#)
The ESCAPE clause can specify an escape character that is different from the default escape character. The default escape character is set by the DEFAULTESCCHAR configuration parameter or the DEFAULTESCCHAR session environment option.
- [ESCAPE with MATCHES](#)
The ESCAPE clause can specify an escape character that is different from the default escape character. The default escape character is set by the DEFAULTESCCHAR configuration parameter or the DEFAULTESCCHAR session environment option.

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NOT Operator

The NOT operator makes the search condition successful when the column on the left has a value that is not NULL and that does not match the pattern that the quoted string specifies.

For example, the following conditions exclude all rows that begin with the characters `Baxter` in the **lname** column:

```
WHERE lname NOT LIKE 'Baxter%'
WHERE lname NOT MATCHES 'Baxter*'
```

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LIKE Operator

LIKE is the ANSI/ISO standard operator for comparing a column value to another column value, or to a quoted string.

The LIKE operator supports these wildcard characters in the quoted string.

Wildcard

Effect

- % Matches zero or more characters
- _ Matches any single character

Besides % and _, LIKE supports a third wildcard character when both the DEFAULTESCCHAR configuration parameter and the DEFAULTESCCHAR session environment variable are not set:

Wildcard

Effect

- \ Removes the special significance of the next character (to match a literal % or _ or \ by specifying \% or \% or \\)

Using the backslash (\) symbol as the default escape character(when DEFAULTESCCHAR is not set) is the Informix® extension to the ANSI/ISO-standard for SQL. You can specify backslash (\) symbol or some other ASCII character as the default escape character by setting the DEFAULTESCCHAR value to that character. For more information, see [DEFAULTESCCHAR session environment option](#).

In an ANSI-compliant database, you can only use the LIKE escape character to escape a percent sign (%), an underscore (_), or the escape character itself.

The following condition tests the **description** column for the string `tennis`, alone or in a longer string, such as `tennis ball` or `table tennis paddle`:

```
WHERE description LIKE '%tennis%' ESCAPE '\'
```

The next example tests **description** for rows containing an underscore character. Here the backslash (\) escape character is necessary because underscore (_) is a wildcard character.

```
WHERE description LIKE '%\_%' ESCAPE '\'
```

The LIKE operator has an associated operator function called **like()**. You can define a **like()** function to handle your own user-defined data types. See also *IBM® Informix User-Defined Routines and Data Types Developer's Guide*.

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MATCHES Operator

The MATCHES operator is the Informix® extension for comparing a column value to another column value, or to a quoted string.

The MATCHES operator supports these wildcard characters in the quoted string.

Wildcard

Effect

- * Matches any string of zero or more characters
- ? Matches any single character
- [...] Matches any of the enclosed characters, including ranges, as in [a-z]. Characters within the brackets cannot be escaped.
- ^ As first character within the brackets, matches any character that is not listed. Thus, [^abc] matches any character except a, b, or c.
- \ Removes the special significance of the next character (to match a literal \ or any other wildcard by specifying \\ or * or \? and so forth)

The following condition tests for the string `tennis`, alone or within a longer string, such as `tennis ball` or `table tennis paddle`:

```
WHERE description MATCHES '*tennis*'
```

The following condition is **TRUE** for the names `Frank` and `frank`:

```
WHERE fname MATCHES '[Ff]rank'
```

The following condition is **TRUE** for any name that begins with either `F` or `f`:

```
WHERE fname MATCHES '[Ff]*'
```

The next condition is **TRUE** for any name that ends with the letters a, b, c, or d:

```
WHERE fname MATCHES '*[a-d]'
```

MATCHES has an associated **matches()** operator function. You can define a **matches()** function for your own user-defined data types. For more information, see *IBM® Informix User-Defined Routines and Data Types Developer's Guide*.

If **DB_LOCALE** or **SET COLLATION** specifies a nondefault locale supporting a localized collation, and you specify a range for the **MATCHES** operator using bracket ([...]) symbols, the database server uses the localized collating order, instead of code-set order, to interpret the range and to compare values that have **CHAR**, **CHARACTER VARYING**, **LVARCHAR**, **NCHAR**, **NVARCHAR**, and **VARCHAR** data types.

This behavior is an exception to the usual rule that only **NCHAR** and **NVARCHAR** data types can be compared in a localized collating order. For more information on the GLS aspects of conditions that include the **MATCHES** or **LIKE** operators, see the *IBM Informix GLS User's Guide*.

In a **NLSCASE INSENSITIVE** database, comparison operations on **NCHAR** and **NVARCHAR** data disregard lettercase differences, so that the database server treats case variants among strings composed of same sequence letters as duplicates. All pairs of the following strings return **TRUE** as operands of the **MATCHES** operator:

```
'beta' 'Beta' 'BETA' 'bETa' 'betA' 'BeTA'
```

For more information, see [Duplicate rows in NLSCASE INSENSITIVE databases](#) and [NCHAR and NVARCHAR expressions in case-insensitive databases](#).

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ESCAPE with LIKE

The **ESCAPE** clause can specify an escape character that is different from the default escape character. The default escape character is set by the **DEFAULTESCCHAR** configuration parameter or the **DEFAULTESCCHAR** session environment option.

For example, if you specify **z** in the **ESCAPE** clause, then a quoted string operand that included **z_** is interpreted as including a literal underscore (**_**) character, rather than **_** as a wildcard. Similarly, **z%** is interpreted as a literal percent (**%**) sign, rather than **%** as a wildcard. Finally, the characters **zz** in a string would be interpreted as single literal **z**. The following statement retrieves rows from the **customer** table in which the **company** column includes a literal underscore character:

```
SELECT * FROM customer WHERE company LIKE '%z_%' ESCAPE 'z';
```

You can also use a host variable that contains a single character. The next statement uses a host variable to specify an escape character:

```
EXEC SQL BEGIN DECLARE SECTION;
  char escp='z';
  char fname[20];
EXEC SQL END DECLARE SECTION;
EXEC SQL select fname from customer
  into :fname where company like '%z_%' escape :escp;
```

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ESCAPE with MATCHES

The **ESCAPE** clause can specify an escape character that is different from the default escape character. The default escape character is set by the **DEFAULTESCCHAR** configuration parameter or the **DEFAULTESCCHAR** session environment option.

Use this as you would the default escape character, the backslash, to include a question mark (**?**), an asterisk (*****), a caret (**^**), or a left (**[**) or right (**]**) bracket as a literal character within the quoted string, to prevent them from being interpreted as special characters. If you choose to use **z** as the escape character, the characters **z?** in a string stand for a literal question mark (**?**). Similarly, the characters **z*** stand for a literal asterisk (*****). Finally, the characters **zz** in the string stand for the single character **z**.

The following example retrieves rows from the **customer** table in which the value of the **company** column includes the question mark (**?**):

```
SELECT * FROM customer WHERE company MATCHES '*z?*' ESCAPE 'z';
```

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Stand-Alone Condition

A stand-alone condition can be any expression that is not explicitly listed in the syntax for the comparison condition. Such an expression is valid as a condition only if it returns a **BOOLEAN** value. For example, the following example returns a value of the **BOOLEAN** data type:

```
funcname(x)
```

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Condition with Subquery

Include a SELECT statement within a condition specifies a condition with subquery. You can use a subquery in a SELECT, INSERT, DELETE, or UPDATE statement to perform tasks like the following:

- Compare an expression to the result of the query.
- Determine if an expression is included in the results of the query.
- Ask whether the query selects any rows.

Condition with Subquery

```

              (1)
|---+| EXISTS Subquery |-----+-----|
|   |                 |           |
| +--+ IN Subquery |-----+-----+
|   |                 |           |
| -+ ALL, ANY, SOME Subquery |-----'
              (2)
              (3)
```

Notes:

1. See [EXISTS Subquery condition](#)
2. See [IN Subquery](#)
3. See [ALL, ANY, and SOME Subqueries](#)

The subquery can depend on the current row that the outer SELECT statement is evaluating; in this case, the subquery is called a *correlated subquery*. (For a discussion of correlated subqueries and their impact on performance, see the *IBM® Informix® Guide to SQL: Tutorial*.)

The following sections describe subquery conditions and their syntax.

- For a discussion of types of subquery conditions in the context of the SELECT statement, see [Using a Condition in the WHERE Clause](#).
- For a discussion of types of subquery conditions in the context of the INSERT statement, see [Subset of SELECT Statement](#).
- For a discussion of types of subquery conditions in the context of the DELETE statement, see [Subqueries in the WHERE Clause of DELETE](#).
- For a discussion of types of subquery conditions in the context of the UPDATE statement, see [Subqueries in the WHERE Clause of UPDATE](#).

A subquery can return a single value, no value, or a set of values, depending on its context. If a subquery returns a value, it must select only a single column. If the subquery simply checks whether a row (or rows) exists, it can select any number of rows and columns.

A subquery cannot reference BYTE or TEXT columns, nor can it contain an ORDER BY clause. A subquery that specifies a table expression in the FROM clause, however, can include the ORDER BY clause.

A subquery and its outer DML statement operate on the same table object if the FROM clause of the subquery specifies the same table or view that the outer statement references in one of these clauses:

- in the FROM clause of the DELETE or SELECT statement
- in the INTO clause of the INSERT statement
- in the Table Options or Collection Derived Table specification of the UPDATE statement.

Subqueries that return more than one row and that operate on the same table or view as the enclosing DML statement are valid only in the WHERE clause of the DELETE or UPDATE statement. Even in this context, such subqueries return error -360 unless all of the following conditions are satisfied:

- The subquery does not reference any column name in its FROM list that is in a table not specified in the projection list
- The subquery is specified using the Condition with Subquery syntax.
- Any SPL routines within the subquery cannot reference the table that is being modified.

The following program fragment includes examples of conditions with subqueries in UPDATE and DELETE statements:

```
CREATE TABLE t1 ( a INT, a1 INT)
CREATE TABLE t2 ( b INT, b1 INT) ;
...
UPDATE t1 SET a = a + 10 WHERE EXISTS
  (SELECT a FROM t1 WHERE a > 1);
UPDATE t1 SET a = a + 10 WHERE a IN
  (SELECT a FROM t1, t2 WHERE a > b
   AND a IN
    (SELECT a FROM t1 WHERE a > 50 ) );
DELETE FROM t1 WHERE EXISTS
  (SELECT a FROM t1);
```

For more information about subqueries in the DELETE statement, see [Subqueries in the WHERE Clause of DELETE](#).

For more information about subqueries in the UPDATE statement, see [Subqueries in the WHERE Clause of UPDATE](#).

- [IN Subquery](#)
- [EXISTS Subquery condition](#)
- [ALL, ANY, and SOME Subqueries](#)

IN Subquery

An IN subquery condition is **TRUE** if the value of the expression matches one or more of the values from the subquery. (The subquery must return only one row, but it can return more than one column.) The keyword **IN** is equivalent to the **=ANY** specification. The keywords **NOT IN** are equivalent to the **!=ALL** specification. See the [ALL, ANY, and SOME Subqueries](#).

IN Subquery

```
(1)
|--| Expression |-----+---IN--(--subquery--)-----|
                        '-NOT-'
```

Notes:

1. See [Expression](#)

Element	Description	Restrictions	Syntax
<i>subquery</i>	Embedded query	Cannot contain the FIRST nor the ORDER BY clause	SELECT statement

The following example of an IN subquery finds the order numbers for orders that do not include baseball gloves (**stock_num** = 1):

```
WHERE order_num NOT IN
      (SELECT order_num FROM items WHERE stock_num = 1)
```

Because the IN subquery tests for the presence of rows, duplicate rows in the subquery results do not affect the results of the main query. Therefore, the **UNIQUE** or **DISTINCT** keyword in the subquery has no effect on the query results, although not testing duplicates can improve query performance.

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EXISTS Subquery condition

An EXISTS subquery condition evaluates to **TRUE** if the subquery returns a row. With an EXISTS subquery, one or more columns can be returned. The subquery always contains a reference to a column of the table in the main query. If you use an aggregate function in an EXISTS subquery that includes no HAVING clause, at least one row is always returned.

EXISTS Subquery

```
--+---EXISTS--(--subquery--)-----|
      '-NOT-'
```

Element	Description	Restrictions	Syntax
<i>subquery</i>	Embedded query	Cannot contain the FIRST nor the ORDER BY clause	SELECT statement

The following example of a SELECT statement with an EXISTS subquery returns the stock number and manufacturer code for every item that has never been ordered (and is therefore not listed in the **items** table). You can appropriately use an EXISTS subquery in this SELECT statement because you use the subquery to test both **stock_num** and **manu_code** in **items**.

```
SELECT stock_num, manu_code FROM stock
WHERE NOT EXISTS (SELECT stock_num, manu_code FROM items
                  WHERE stock.stock_num = items.stock_num AND
                        stock.manu_code = items.manu_code);
```

The preceding example works equally well if you use **SELECT *** in the subquery in place of the column names, because the existence of the entire row is tested; specific column values are not tested.

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ALL, ANY, and SOME Subqueries

Use the **ALL**, **ANY**, and **SOME** keywords to specify what makes the condition **TRUE** or **FALSE**. A search condition that is **TRUE** when the **ANY** keyword is used might not be **TRUE** when the **ALL** keyword is used, and vice versa.

ALL, ANY, SOME Subquery

```
(1)                                (2)
|--| Expression |-----| Relational Operator |-----+----->
                                           +-ALL--+
                                           +-ANY--+
                                           '-SOME-'
```


>--(--subquery--)-----|

Notes:

1. See [Expression](#)
2. See [Relational Operator](#)

Element	Description	Restrictions	Syntax
<i>subquery</i>	Embedded query	Cannot contain the FIRST or the ORDER BY clause	SELECT statement

- [Using the ALL Keyword](#)
- [Using the ANY or SOME Keywords](#)
- [Omitting the ANY, ALL, or SOME Keywords](#)

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Using the ALL Keyword

The ALL keyword specifies that the search condition is **TRUE** if the comparison is **TRUE** for every value that the subquery returns. If the subquery returns no value, the condition is **TRUE**.

In the following example, the first condition tests whether each **total_price** is greater than the total price of every item in order number 1023. The second condition uses the **MAX** aggregate function to produce the same results.

```
total_price > ALL (SELECT total_price FROM items
                   WHERE order_num = 1023)
```

```
total_price > (SELECT MAX(total_price) FROM items
               WHERE order_num = 1023)
```

Using the NOT keyword with an ALL subquery tests whether an expression is not **TRUE** for at least one element that the subquery returns. For example, the following condition is **TRUE** when the expression **total_price** is not greater than all the selected values. That is, it is **TRUE** when **total_price** is not greater than the highest total price in order number 1023.

```
NOT total_price > ALL (SELECT total_price FROM items
                      WHERE order_num = 1023)
```

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Using the ANY or SOME Keywords

The ANY keyword denotes that the search condition is **TRUE** if the comparison is **TRUE** for at least one of the values that is returned. If the subquery returns no value, the search condition is **FALSE**. The SOME keyword is a synonym for ANY.

The following conditions are **TRUE** when the total price is greater than the total price of at least one of the items in order number 1023. The first condition uses the ANY keyword; the second uses the MIN aggregate function:

```
total_price > ANY (SELECT total_price FROM items
                  WHERE order_num = 1023)
```

```
total_price > (SELECT MIN(total_price) FROM items
               WHERE order_num = 1023)
```

Using the NOT keyword with an ANY subquery tests whether an expression is not **TRUE** for all elements that the subquery returns. For example, the following condition is **TRUE** when the expression **total_price** is not greater than any selected value. That is, it is **TRUE** when **total_price** is greater than none of the total prices in order number 1023.

```
NOT total_price > ANY (SELECT total_price FROM items
                      WHERE order_num = 1023)
```

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Omitting the ANY, ALL, or SOME Keywords

You can omit the keywords ANY, ALL, or SOME in a subquery if you know that the subquery will return exactly one value. If you omit the ANY, ALL, or SOME keywords, and the subquery returns more than one value, you receive an error. The subquery in the following example returns only one row because it uses an aggregate function:

```
SELECT order_num FROM items
       WHERE stock_num = 9 AND quantity =
             (SELECT MAX(quantity) FROM items WHERE stock_num = 9);
```

NOT Operator

If you preface a condition with the keyword NOT, the test is **TRUE** only if the condition that NOT qualifies is **FALSE**. If the condition that NOT qualifies has a **NULL** or an **UNKNOWN** value, the NOT operator has no effect.

The following truth table shows the effect of NOT with 3-valued Boolean operands. Here T represents a **TRUE** condition, F represents a **FALSE** condition, and a question mark (?) represents an **UNKNOWN** condition. (An **UNKNOWN** value can occur when an operand is **NULL**).

NOT	
T	F
?	?
F	T

The left column shows the value of the operand of the NOT operator, and the right column shows the returned value after NOT is applied to the operand.

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Conditions with AND or OR

You can combine simple conditions with the logical operators AND or OR to form complex conditions.

The following SELECT statements contain examples of complex conditions in their WHERE clauses:

```
SELECT customer_num, order_date FROM orders
  WHERE paid_date > '1/1/97' OR paid_date IS NULL;
SELECT order_num, total_price FROM items
  WHERE total_price > 200.00 AND manu_code LIKE 'H
SELECT lname, customer_num FROM customer
  WHERE zipcode BETWEEN '93500' AND '95700'
  OR state NOT IN ('CA', 'WA', 'OR');
```

The following truth tables show the effect of the AND and OR operators. The letter T represents a **TRUE** condition, F represents a **FALSE** condition, and the question mark (?) represents an **UNKNOWN** value. An **UNKNOWN** value can occur when part of an expression that uses a logical operator is **NULL**.

OR	T	?	F
T	T	T	T
?	T	?	?
F	T	?	F

AND	T	?	F
T	T	?	F
?	?	?	F
F	F	F	F

The marginal values at the left represent the first operand, and values in the top row represent the second operand. Values within each 3x3 matrix show the returned value after the operator is applied to operands of those values.

If the Boolean expression evaluates to **UNKNOWN**, the condition is not satisfied.

Consider the following example within a WHERE clause:

```
WHERE ship_charge/ship_weight < 5
  AND order_num = 1023
```

The row where **order_num** = 1023 is a row where **ship_weight** is **NULL**. Because **ship_weight** is **NULL**, **ship_charge/ship_weight** is also **NULL**; therefore, the truth value of **ship_charge/ship_weight** < 5 is **UNKNOWN**. Because **order_num** = 1023 is **TRUE**, the AND table states that the truth value of the entire condition is **UNKNOWN**. Consequently, that row is not chosen. If the condition used an OR in place of the AND, the condition would be **TRUE**.

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Data Type

The Data Type segment specifies the data type of a column, of a component of a collection, of a field within a ROW type, of a routine parameter, or of a value returned by an expression or by a cast function. Use this segment whenever you see a reference to a data type in a syntax diagram.

Syntax

Data Type

```
(1)
|---+| Built-In Data Type |-----+-----|
| (2) | (3) |
'-----+| User-Defined Data Type |-----+|
| (4) |
```

Notes:

1. See [Built-In Data Types](#)
2. Informix® extension
3. See [User-Defined Data Type](#)
4. See [Complex Data Type](#)

Usage

Sections that follow summarize these data types. For more information, see the chapter about data types in the *IBM® Informix Guide to SQL: Reference*.

- [Built-In Data Types](#)
- [User-Defined Data Type](#)
- [Complex Data Type](#)

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Built-In Data Types

Built-in data types are data types that are defined by the database server.

Built-In Data Type

(1)	
|---+--BOOLEAN-----+-----|	
|	(2)
+--| BSON and JSON data types |-----+ |	
|	(3)
+--| Character Data Type |-----+ |	
|	(4)
+--| Numeric Data Type |-----+ |	
|	(5)
+-----| Large-Object Data Type |-----+ |	(6)
|	(7)
+--| Time Data Type |-----+ |	
|	(8)
'-IDSSECURITYLABEL-----'	

Notes:

1. See [BOOLEAN and other built-in opaque data types](#)
2. See [BSON and JSON built-in opaque data types](#)
3. See [Character Data Types](#)
4. See [Numeric Data Types](#)
5. Informix® extension
6. See [Large-Object Data Types](#)
7. See [Time Data Types](#)
8. See [IDSSECURITYLABEL Data Type](#)

These data types are built into the database server in the sense that the information and support functions required to interpret and transfer these data types is part of the database server software, which supports *character*, *numeric*, *large-object*, and *time* categories of built-in data types.

- [BOOLEAN and other built-in opaque data types](#)
Informix also supports the BOOLEAN data type, which is a *built-in opaque data type* that can store *true*, *false*, or NULL values. The symbol *t* represents a literal BOOLEAN *true* value, and *f* represents a literal BOOLEAN *false* value.
- [BSON and JSON built-in opaque data types](#)
The BSON and JSON data types are built-in opaque types of Informix that can be accessed and manipulated in local and distributed queries and in other DML operations. These are SQL data types that directly support relational database operations on data in BSON or JSON document store format. However, if you plan to query JSON and BSON data through the wire listener, you must create your database objects, such as collections and indexes, through the wire listener. You can use SQL statements to query JSON and BSON data whether you created your database objects through the wire listener or with SQL statements.
- [Character Data Types](#)
- [IDSSECURITYLABEL Data Type](#)
In a table that is protected by a label-based security policy, the IDSSECURITYLABEL data type of Informix stores a security label.
- [Numeric Data Types](#)
- [Exact Numeric Data Types](#)
- [Approximate Numeric Data Types](#)
- [Large-Object Data Types](#)
- [Time Data Types](#)
The time data types store calendar dates, points in time, and intervals of time.

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BOOLEAN and other built-in opaque data types

Informix® also supports the BOOLEAN data type, which is a *built-in opaque data type* that can store `true`, `false`, or NULL values. The symbol `t` represents a literal BOOLEAN `true` value, and `f` represents a literal BOOLEAN `false` value.

BOOLEAN, BSON, JSON, and LVARCHAR are the only built-in opaque data types that can be returned by cross-server distributed queries or by other cross-server distributed DML operations. Column values of other built-in opaque data types cannot be retrieved by a distributed query (nor modified by INSERT, DELETE, MERGE, or UPDATE operations on a remote database) unless all of the tables that the DML operation accesses are in databases of the local Informix instance.

Similarly, in UDRs that perform distributed operations on databases of other Informix instances, BOOLEAN, BSON, JSON, and LVARCHAR are the only built-in opaque types that are valid as a parameter or as the returned data type of the UDR, which must be defined in all participating databases.

Besides the BOOLEAN type, other built-in opaque data types of Informix include BLOB, , BSON, JSON, CLOB, LVARCHAR, IFX_LO_SPEC, IFX_LO_STAT, INDEXKEYARRAY, POINTER, RTNPARAMTYPES, SELFUNCARGS, STAT, CLIENTBINVAL, and XID data types. These built-in opaque types are supported in the local database and in distributed operations across databases of the same server instance. The first five of these types are discussed in subsequent sections of this chapter.

Informix also supports the built-in opaque data types LOLIST, IMPEXP, IMPEXPBIN, and SENDRECV. These types cannot, however, be accessed in a remote database by DML operations, nor returned from a remote database by a UDR, because these data types do not have the required support functions. For more information about the data types that Informix supports in distributed transactions, see [Data Types in Distributed Queries](#).

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BSON and JSON built-in opaque data types

The BSON and JSON data types are built-in opaque types of Informix® that can be accessed and manipulated in local and distributed queries and in other DML operations. These are SQL data types that directly support relational database operations on data in BSON or JSON document store format. However, if you plan to query JSON and BSON data through the wire listener, you must create your database objects, such as collections and indexes, through the wire listener. You can use SQL statements to query JSON and BSON data whether you created your database objects through the wire listener or with SQL statements.

JSON and BSON documents contain one or more fields, which are similar to columns, and values for fields. A JSON or BSON column can contain multiple documents, each similar to a row in a relational database. The data values in JSON and BSON documents can be numbers, strings, or Boolean values. Documents can be nested within documents.

The database server validates JSON or BSON documents that you insert into the database. The JSON data type contains plain text. The BSON data type is a binary format of the JSON data type. You can create a table column of either the JSON or the BSON data type, however, the BSON data type is better suited for storing structured data in an Informix database. The database server can operate on data in BSON columns, but can only insert and display data in JSON columns.

JSON and BSON documents up to 4 KB are stored in-row. Documents that are greater than 4 KB in size are stored in the sbpace that is associated with the table, or the default sbpace if the table does not have a designated sbpace. The maximum size of a JSON or BSON document is 32 KB. The maximum size of a JSON or BSON column is limited only by the operating system.

- [JSON data type](#)
- [BSON data type](#)
- [Supported SQL operations for BSON and JSON data types](#)
- [Restrictions on BSON and JSON data types](#)
- [Examples](#)

JSON data type

The JSON data type is a plain text format for entering and displaying structured data. JSON is named after the JavaScript Object Notation (JSON), a data-interchange format that is based on the object-literal notation of JavaScript.

A JSON document has the format:

```
JSON document
      .- ,-----
      v |
>>--{---field---+---+---value---+---+---}-----><
      | '-"- '      '-"- ' |
      +-| JSON document |---+
      '-| JSON array |-----'

JSON array
      .- ,-----
      v |
|--[---+---+---+---value---+---+---]-----|
      | '-"- '      '-"- ' |
      +-| JSON document |---+
      '-| JSON array |-----'
```

Element	Description
---------	-------------

Element	Description
<i>field</i>	A string of Unicode characters that represents a field name.
<i>value</i>	A string of Unicode characters that represents a data value.

JSON documents require the following notation:

- Braces ({ and }) surround each JSON document. JSON documents can be nested.
- A comma (,) separates field-value pairs.
- Double quotation marks (") delimit character values. Quotation marks are not necessary around numeric values.
- Brackets ([and]) surround arrays of values. Arrays can contain nested documents or arrays.

The following JSON document has a nested document and an array:

```
{ "person" : {
  "givenname" : "Jim",
  "surname" : "Flynn",
  "age" : 29,
  "cars" : [ "dodge", "olds" ]
}}
```

BSON data type

The BSON data type is the binary representation of a JSON data type format for serializing JSON documents.

When you insert JSON documents through the wire listener with MongoDB API commands, a BSON column that is named **data** is created in the specified collection. The MongoDB API command also automatically adds an ObjectId field-value pair. When you insert JSON and BSON documents through SQL statements or utilities, the documents do not contain ObjectIds unless you explicitly include them.

To create a BSON column in a table with an SQL statement, use the standard CREATE TABLE statement and specify a BSON column. The only valid default value for a BSON column is NULL.

The BSON data type differs from standard SQL data types in that you must cast the data or use built-in BSON processing functions:

- To insert data that is in plain text with an SQL statement into a BSON column, you must cast the data to JSON. If you do not provide the cast to JSON, the database server treats the document as a string.
- To view BSON data in a readable format when you select data from a BSON column with an SQL statement, you must either cast the column to JSON or use a BSON value function in a function expression. BSON value functions convert field values in BSON columns to standard SQL data types. You can use dot notation to select data from specific fields within the BSON column and a JSON cast to return the results in a readable format.
- To update BSON data with an SQL statement, use the BSON_GET or the BSON_UPDATE function.
- When you include a JSON document as an expression in an SQL statement that operates on a BSON column, you must cast the document to JSON and then to BSON.
- To create an index on a BSON field, use the BSON_GET function and the USING BSON keywords as the index-key specification in the CREATE INDEX statement.

For more information, see [BSON processing functions](#).

Supported SQL operations for BSON and JSON data types

The following table lists supported DDL operations on BSON and JSON data types.

Table 1. DDL operations on BSON and JSON data type

Operation	Supported for BSON data type	Supported for JSON data type
Create a table or a temporary table with one or more columns of the data type or a distinct type of the data type	Yes	Yes
Alter a table to add a column of the data type	Yes	Yes
Drop a column of the data type	Yes	Yes
Create a B-tree index on a column of the data type	No	No
Create an index or a functional index on a field	Yes	No
Create a basic text search index on a column of the data type	Yes	Yes
Truncate tables with columns of the data type	Yes	Yes
Fragment a table based on field values	Yes	Yes
Create a view based on columns of the data type and field values	Yes	No
Compress data in a column of the data type	Yes	Yes
Create a cast on the data type	Yes	Yes
Create triggers on fields	Yes	No
Include a column of the data type in a TimeSeries row data type	Yes	No

The following table lists supported DML operations on BSON and JSON data types.

Table 2. DML operations on BSON and JSON data

Operation	Supported for BSON data type	Supported for JSON data type
Cast data	Yes	Yes
Use a cursor to read data	Yes	Yes
Select contents of column of the data type	Yes	Yes
Select field values with dot notation or with BSON processing functions	Yes	No
Update data	Yes	No
Insert data	Yes	Yes
Find the size of a field value	Yes	No
Update statistics on a table with columns of the data type	Yes	Yes
Merge tables based on field values	Yes	No
Join tables based on field values	Yes	No
Load and unload data with the LOAD and UNLOAD statements, external tables, the onload and onunload utilities, or the dbschema , dbexport , and dbimport utilities	Yes	Yes
Replicate data to Remote stand-alone secondary servers	Yes	No
Shard data among Enterprise Replication servers	Yes	No

Restrictions on BSON and JSON data types

The following operations are not supported for BSON or JSON data types:

- Encryption of BSON or JSON columns
- Table-level restore of tables that have BSON or JSON columns
- Capture data through the Change Data Capture API

Examples

The examples use the following document:

```
{ "person" : {  
  "givenname" : "Jim",  
  "surname" : "Flynn",  
  "age" : 29,  
  "cars" : [ "dodge", "olds" ]  
}
```

Example: Create a table with a BSON column

The following statements create a table with a BSON column and insert a document:

```
CREATE DATABASE testdb WITH LOG;  
CREATE TABLE IF NOT EXISTS bson_table(bson_col BSON);  
  
INSERT INTO bson_table VALUES (  
  '{person:{givenname:"Jim",surname:"Flynn",age:29,cars:["dodge","olds"]}}'::JSON);
```

The document is explicitly cast to JSON and then implicitly cast to BSON.

Example: Select the whole BSON column

The following statement returns the contents of the BSON column:

```
SELECT bson_col::JSON FROM bson_table;  
  
(expression)  
{ "person": { "givenname": "Jim", "surname": "Flynn", "age": 29, "cars": [ "dodge", "olds" ] } }
```

If the column is not cast to JSON format, the returned data is in an unreadable binary format.

Example: Select a field-value pair with dot notation

The following statement returns the value of the **surname** field:

```
SELECT bson_col.person.surname::JSON FROM bson_table;
```

```
(expression)
{surname:"Flynn"}
```

The dot notation uses the same format as *table_name.column_name*, but specifies a field within the column. The cast to JSON is necessary, and the returned value is a JSON document with the specified field-value pair.

Example: Select a field value with a BSON value function

The following statement returns the value of the **surname** field:

```
SELECT BSON_VALUE_LVARCHAR(bson_col, "person.surname") FROM bson_table;
```

```
(expression)
Flynn
```

The BSON_VALUE_LVARCHAR function converts the value of the **surname** field to an LVARCHAR data type. A cast to JSON is not needed, and the returned value is only the value of the specified field.

Example: Create an index on a BSON field

The following statement creates an index on the **surname** field in the BSON column:

```
CREATE INDEX idx2 ON bson_table(
  BSON_GET(bson_col, "person.surname")) USING BSON;
```

The BSON_GET function specifies that the **surname** field is indexed. The USING BSON keywords are necessary to specify that the index is created on a BSON column.

Related concepts:

[BSON processing functions](#)

[Index-key specification](#)

Related reference:

[Column Expressions](#)

[Indexing a BSON field](#)

Related information:

[Manipulate BSON data with SQL statements](#)

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Character Data Types

The character data types enable the database server to store text strings.

Character Data Type

```

      .- (-- 1 -) ---.
|---+-CHAR-----+--- (--size--) +-----+-----|
| +-CHARACTER---+ |
| | (1) | |
| '-----NCHAR-' |
| (1) | |
|-----NVARC-----+ (max--+-----+---) +---+
| +-VARCHAR-----+ '---reserve-' |
| '-CHARACTER VARYING-' |
| | |
| | .- (--2048--) - |
| '-LVARCHAR---+ (-max--) +-----+-----|

```

Notes:

1. Localized Collation

Element	Description	Restrictions	Syntax
<i>max</i>	Maximum size in bytes. For VARCHAR and NVARCHAR, this is required. LVARCHAR default is 2048	VARCHAR and NVARCHAR: Integer; $1 \leq max \leq 255$ (or $1 \leq max \leq 254$, if indexed) LVARCHAR: $1 \leq max \leq 32,739$	Literal Number
<i>reserve</i>	Bytes reserved. Default is 0.	Integer; $0 \leq reserve \leq max$	Literal Number
<i>size</i>	Size in bytes. Default is 1.	Integer; $1 \leq size \leq 32,767$	Literal Number

The database server issues an error if the data type declaration includes empty parentheses, such as LVARCHAR(). To declare a CHAR or LVARCHAR data type of the default length, simply omit any (*size*) or (*max*) specification. The CREATE TABLE statement of Informix® accepts VARCHAR and NVARCHAR column declarations that have no (*max*) nor (*max, reserve*) specifications, using (1, 0) as the (*max, reserve*) default values for the column.

The following table summarizes the built-in character data types.

Data Type	Description
-----------	-------------

Data Type	Description
CHAR	Stores single-byte or multibyte text strings of fixed length (up to 32,767 bytes); supports code-set order in collation of text data. Default size is 1 byte.
CHARACTER	Synonym for CHAR
CHARACTER VARYING	ANSI-compliant synonym for VARCHAR
LVARCHAR	Stores single-byte or multibyte text strings of varying length (up to 32,739 bytes). The size of other columns in the same table can further reduce this upper limit. Default size is 2,048 bytes.
NCHAR	Stores single-byte or multibyte text strings of fixed length (up to 32,767 bytes); supports localized collation of text data.
NVARCHAR	Stores single-byte or multibyte text strings of varying length (up to 255 bytes); supports localized collation of text data.
VARCHAR	Stores single-byte or multibyte text strings of varying length (up to 255 bytes); supports code-set order collation of text data.

- [Single-byte and multi-byte characters and locales](#)
- [Fixed- and Varying-Length Character Data Types](#)
- [LVARCHAR Data Type](#)
- [NCHAR and NVARCHAR data types](#)

The character data types NCHAR and NVARCHAR can support a localized order of collation in some database locales. In databases created with the NLSCASE INSENSITIVE property, NCHAR and NVARCHAR columns (and string values that are cast to these data types) can support case-insensitive queries.

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Single-byte and multi-byte characters and locales

All built-in character data types can support single- and multibyte characters in the code set that the **DB_LOCALE** setting specifies. Locales for most European and Middle Eastern languages support only single-byte code sets, but the **UTF-8** code set for the Unicode locale, and code sets for some East Asian locales, such as the Chinese **GB18030-2000** locale, support multibyte logical characters.

When the SQL_LOGICAL_CHAR configuration parameter is enabled, you can instruct the database server to interpret explicit or default size parameters in declarations of built-in character data types as specifying the number of logical characters that can be stored, rather than the number of bytes. These logical character semantics are also applied to DISTINCT types whose base types are built-in character types, and to fields of built-in character types in declarations of named or unnamed ROW data types. This feature does not, however, support user-defined data types (UDTs) that store character strings. For more information about this feature, see the *IBM® Informix® Administrator's Reference* description of the SQL_LOGICAL_CHAR configuration parameter.

The TEXT and CLOB data types also support single-byte or multibyte character data, but most built-in functions for manipulating character strings do not support TEXT nor CLOB data. For more information, see [Large-Object Data Types](#).

Related information:

[SQL_LOGICAL_CHAR configuration parameter](#)

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Fixed- and Varying-Length Character Data Types

The database server supports storage of fixed-length and varying-length character data. A *fixed-length* column requires the defined number of bytes regardless of the actual size of the data. The CHAR data type is of fixed-length. For example, a CHAR(25) column requires 25 bytes of storage for all values, so the string "This is a text string" uses 25 bytes of storage.

A *varying-length* column size can be the number of bytes occupied by its data. NVARCHAR, VARCHAR, and the LVARCHAR data types are varying-length character data types. For example, a VARCHAR(25) column reserves up to 25 bytes of storage for the column value, but the character string "This is a text string" uses only 21 bytes of the reserved 25 bytes. The VARCHAR data type can store up to 255 bytes of data. For information about the **IFX_PAD_VARCHAR** environment variable, whose setting controls how the database server sends and receives VARCHAR and NVARCHAR data values, see *IBM® Informix® Guide to SQL: Reference*.

Because of the maximum row size limit of 32,767 bytes, a single table cannot be created with more than approximately 195 varying-length or ROW type columns.

Accessing large tables that have varying-length columns

For tables with more than a million rows, queries that use full-table scan or skip-scan access methods are more efficient if they perform light scans, rather than bufferpool scans. Light scans are not supported, however, on tables that include NVARCHAR, VARCHAR, or LVARCHAR data types columns, or columns of DISTINCT data types whose base types are a *varying-length* column, unless the BATCHEDREAD_TABLE configuration parameter (or the BATCHEDREAD_TABLE session environment option) is set to 1.

Restriction:

This dependency of light scans on BATCHEDREAD_TABLE being enabled also applies to tables whose schema or storage attributes include any of the following:

- table compression
- columns of any variable-length data type
- rows that occupy more than a single page of storage.

For more information about when the query optimizer can choose execution paths that perform light scans to access large tables, see your *IBM Informix Performance Guide*.

Related information:

[IFX_PAD_VARCHAR environment variable](#)

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LVARCHAR Data Type

The LVARCHAR type of Informix® can store up to 32,739 bytes of text, but if you specify no *size* in an LVARCHAR data type declaration, the default length is 2,048 bytes. LVARCHAR is a built-in opaque data type. Unlike most of the built-in opaque types, LVARCHAR column values can be accessed in a database of a non-local Informix instance in a distributed query or other DML operations, and LVARCHAR can be the data type of a parameter or of a returned value of a UDR that accesses data outside the local database.

Informix uses the LVARCHAR data type in cross-server I/O operations on opaque data types. In this context, the maximum size of the LVARCHAR data value is limited only by the operating system.

Light scans during query execution are not supported on tables that include LVARCHAR columns, unless the BATCHEDREAD_TABLE configuration parameter (or the BATCHEDREAD_TABLE session environment option) is set to 1.

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NCHAR and NVARCHAR data types

The character data types NCHAR and NVARCHAR can support a localized order of collation in some database locales. In databases created with the NLSCASE INSENSITIVE property, NCHAR and NVARCHAR columns (and string values that are cast to these data types) can support case-insensitive queries.

The character data types CHAR, LVARCHAR, and VARCHAR support *code-set order* collation of data. This is the order in which the characters are defined within in the code set of the database locale that the **DB_LOCALE** environment variable specifies. The default (U.S. English) locale is an example of a locale that uses the code-set order of collation for sorting CHAR, LVARCHAR, and VARCHAR string values.

For information on how the settings (or default values) of the **DB_LOCALE**, **CLIENT_LOCALE**, and **SERVER_LOCALE** environment variables determine which locale is used for collation, see the *IBM® Informix® GLS User's Guide*.

Some locales, however, specify an order of collation that is not identical to the code-set order. To support any locale-specific order of collation, you can use the NCHAR and NVARCHAR data types. The NCHAR data type is a fixed-length character data type that supports localized collation. The NVARCHAR data type is a varying-length character data type that can store up to 255 bytes of text data and supports localized collation. In locales where the code set defines no localized order of collation, such as the default locale, there is no difference between the CHAR and NCHAR data types, nor between the VARCHAR and NVARCHAR data types, except in case-insensitive databases.

In databases created with the NLSCASE INSENSITIVE property, values of these data types are stored exactly as they are loaded into the database, but in data processing operations, including comparison and collation of NVARCHAR and NCHAR strings, the database server ignores letter case, ordering the data values without respect to or preference for case. For example, the NCHAR or NVARCHAR string "PH" might precede or follow "pH" or "ph" in the collated list, in which these three strings are considered duplicates, depending on the order in which these values are retrieved. For more information about NCHAR or NVARCHAR data processing in case-insensitive databases, see [Specifying NLSCASE case sensitivity](#), [Duplicate rows in NLSCASE INSENSITIVE databases](#), and [NCHAR and NVARCHAR expressions in case-insensitive databases](#).

For NCHAR or NVARCHAR values, the SET COLLATION statement of SQL can override the localized collation order of the current session by specifying another locale. Indexes on NCHAR or NVARCHAR columns sort values according to the localized collation order that was in effect when the index was created, if that is different from the current collation order. For more information about how the SET COLLATION statement can affect the sorting behavior of indexes, constraints, cursors, prepared objects, and SPL routines, see [Collation Performed by Database Objects](#).

If you specify no parameters in CREATE TABLE or ALTER TABLE statements that declare VARCHAR or NVARCHAR columns, then the new columns default to a *max* size of 1 byte and a *reserve* size of zero.

- [NCHAR and NVARCHAR expressions in case-insensitive databases](#)

In databases created with the NLSCASE INSENSITIVE property, the database server makes no distinction between uppercase and lowercase variants of the same letter in NCHAR and NVARCHAR expressions, regardless of whether a localized collation order is defined for the locale.

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NCHAR and NVARCHAR expressions in case-insensitive databases

In databases created with the NLSCASE INSENSITIVE property, the database server makes no distinction between uppercase and lowercase variants of the same letter in NCHAR and NVARCHAR expressions, regardless of whether a localized collation order is defined for the locale.

This disregard for letter case can change the values that case-insensitive operations on NCHAR or NVARCHAR expressions return, compared to the same operations on the same expressions in a case-sensitive database, if letter case variants are the only differences among the operands of relational operators, or among the arguments to string functions.

Suppose, for example, that for a record in a table of a database in the default locale, the NCHAR column **lname** stores the value McDavid.

In a case-sensitive database, the Boolean expression `lname > "MCDAVID"` evaluates as true, because the database server uses the codeset order of the default locale to compare the two operands. Although both strings begin with uppercase M, the next character in the column value is lowercase c, the ASCII 99 code point, but the next character in the quoted string is uppercase C, the ASCII 67 code point. Because 99 is greater than 67, the column value is greater than the quoted string in a case-sensitive database.

In a case-insensitive database, however, the same expression `lname > "MCDAVID"` evaluates as false, because the database server ignores letter case variants when it compares the two operands. Both strings have the same letters in the same sequence, so by these criteria, the column value is identical to the quoted string.

Because a database that has the `NLSCASE INSENSITIVE` property disregards letter case in comparisons that include an `NCHAR` or `NVARCHAR` operand, operations on `NCHAR` or `NVARCHAR` character strings in case-insensitive databases can produce results that differ from those of a case-sensitive database. Contexts in which a case-sensitive database and a case-insensitive database might use the same SQL operations to return different results from the same data set include these:

- sorting and collation
- foreign key and primary key dependencies
- enforcing unique constraints
- clustered indexes
- access-method optimizer directives
- queries with `WHERE` predicates
- queries with `UNIQUE` or `DISTINCT` in the projection clauses
- queries with `ORDER BY` clauses
- queries with `GROUP BY` clauses
- cascading `DELETE` operations
- table or index storage distribution `BY EXPRESSION`
- table or index storage distribution `BY LIST`
- data distributions from `UPDATE STATISTICS` operations.

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IDSSECURITYLABEL Data Type

In a table that is protected by a label-based security policy, the `IDSSECURITYLABEL` data type of Informix® stores a security label.

Only a user who holds the `DBSECADM` role can create, alter, or drop a column of this data type. This is a built-in `DISTINCT OF VARCHAR(128)` data type, but it is not classified as a character data type because its use is restricted to label-based access control. A table that has a security policy can have no more than one `IDSSECURITYLABEL` column, and a table that is associated with no security policy can have none.

The `DBSECADM` can use the `GRANT` statement to associate a specific security label with a user, and the `REVOKE` statement can cancel a security label that a user holds. For a given security policy, a user can have no more than one label that supports both read and write access, or no more than one label for write access and no more than one label for read access. For data protected by a security policy, but for which the user has been granted discretionary access privileges, the database server determines whether a specific user can access the data by comparing the security label of the data with the security label of the user, while also taking into consideration any exemptions to the security policy rules that the user holds.

For information on how to specify an `IDSSECURITYLABEL` value, see [Security Label Support Functions](#).

For a discussion of security policies, security components, security labels, and other concepts of label-based access control (LBAC), see the IBM® Informix Security Guide.

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Numeric Data Types

Numeric data types enable the database server to store numbers such as integers and real numbers in a column.

Numeric Data Type

```

      (1)
|---+---| Exact Numeric Data Type |-----+-----|
|      |                          |              |
|      |                          |      (2)      |
|---+---| Approximate Numeric Data Type |-----+-----|
```

Notes:

1. See [Exact Numeric Data Types](#)
2. See [Approximate Numeric Data Types](#)

The values of numbers are stored either as *exact numeric* data types or as *approximate numeric* data types.

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Exact Numeric Data Types

Exact Numeric Data Type

Notes:

1. Informix® extension

The *precision* of a data type is the number of digits that the data type stores. The *scale* is the number of digits to the right of the decimal separator.

The following table summarizes the exact numeric data types available.

- DECIMAL(p,s) Data Types
- Serial Data Types

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The *p* parameter specifies the *precision* (the total number of digits) and the second parameter, (*s*), specifies the *scale* (the number of digits in the fractional part). If you provide only one parameter, an ANSI-compliant database interprets it as the precision of a fixed-point number and the default scale is 0. If you specify no parameters, and the database is ANSI-compliant, then by default the precision is 16 and the scale is 0.

If the database is not ANSI-compliant, and you specify fewer than 2 parameters, you declare a floating-point DECIMAL, which is not an exact number data type. (See instead the section [Approximate Numeric Data Types](#).)

DECIMAL(*p*, *s*) values are stored internally with the first byte representing a sign bit and a 7-bit exponent in excess-65 format. The other bytes express the mantissa as base-100 digits. This implies that DECIMAL(32, *s*) data types store only *s*-1 decimal digits to the right of the decimal point, if *s* is an odd number.

Serial Data Types

You can declare columns of SERIAL, BIGSERIAL, or SERIAL8 data types. If user-defined routines require whole-number values for variables, arguments, or returned data types, specify INT, BIGINT, or INT8 as the data types, rather than SERIAL, BIGSERIAL, or SERIAL8. These data types are integer data types that differ primarily in their names, their range, and their storage requirements. Columns of serial data types cannot store values less than 1. A table can have no more than one SERIAL column and no more than one BIGSERIAL or SERIAL8 column. Because the serial values are assigned by the database server, you cannot use the UPDATE statement to change an existing serial value in the database.

To insert an explicit value into a SERIAL, BIGSERIAL, or SERIAL8 column, specify any integer greater than zero. For details of an alternative way to generate integer values, see [CREATE SEQUENCE statement](#).

A SERIAL, BIGSERIAL, or SERIAL8 column is unique only if you set a unique index on the column. (The index can also be in the form of a primary key or a unique constraint.) With a unique index, values in serial data type columns are guaranteed to be unique, but successive values are not necessarily contiguous.

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Approximate Numeric Data Types

An *approximate numeric* data type represents numeric values approximately.

Approximate Numeric Data Type

```
(1)
.----- (16) -----
|---+-DECIMAL+---+- (--precision--) +-----+-----|
| +-DEC-----+ |
| '-NUMERIC-' |
| +-FLOAT-----+ +-----+-----+
| '-DOUBLE PRECISION-' '- (float_precision)-' |
| (1) |
| '+-----SMALLFLOAT+-----+-----+
| '-REAL-----' |
```

Notes:

1. Informix® extension

Element	Description	Restrictions	Syntax
<i>float_precision</i>	The <i>float_precision</i> is ignored, but is ANSI/ISO compliant.	Must be a positive integer. Specified value has no effect.	Literal Number
<i>precision</i>	Significant digits. Default is 16.	An integer; $1 \leq \text{precision} \leq 32$	Literal Number

Use approximate numeric data types for very large and very small numbers that can tolerate some degree of rounding during arithmetic operations.

The following table summarizes the built-in approximate numeric data types.

Data Type	Description
DEC(<i>p</i>)	Synonym for DECIMAL(<i>p</i>)
DECIMAL(<i>p</i>)	Stores floating-point decimal values in the approximate range from 1.0E-130 to 9.99E+126 The <i>p</i> parameter specifies the precision. If no precision is specified, the default is 16. This floating-point data type is available as an approximate numeric type only in a database that is not ANSI-compliant. In an ANSI-compliant database, DECIMAL(<i>p</i>) is implemented as a fixed-point DECIMAL; see Exact Numeric Data Types .
DOUBLE PRECISION	ANSI-compliant synonym for FLOAT. The <i>float_precision</i> term is not valid when you use this synonym in data type declarations.
FLOAT	Stores double-precision floating-point numbers with up to 16 significant digits. The <i>float_precision</i> parameter is accepted in data-type declarations for compliance with the ANSI/ISO standard for SQL, but this parameter has no effect on the actual precision of values that the database server stores.
NUMERIC(<i>p</i>)	ANSI-compliant synonym for DECIMAL(<i>p</i>) In an ANSI-compliant database, this is implemented as an exact numeric type, with the specified precision and a scale of zero, rather than an approximate numeric (floating-point) data type.
REAL	ANSI-compliant synonym for SMALLFLOAT
SMALLFLOAT	Stores single-precision floating-point numbers with approximately 8 significant digits

The built-in number data types of Informix database servers support real numbers. They cannot directly store imaginary or complex numbers.

In Informix, you must create a user-defined data type for applications that support values that can have an imaginary part.

No more than nine arguments to an external UDR can be DECIMAL data types of SQL that the UDR declares as BigDecimal data types of the Java™ language.

Large-Object Data Types

Large-object data types can store extremely large column values, such as images and documents, independently of the column.

Large-Object Data Type

```
|---+---TEXT---+---+-----+---+-----|
| '-BYTE-' '-IN---TABLE-----+' |
|           '-blobspace-'         |
| '-+---BLOB---+-----+-----+' |
| '-CLOB-'                        |
```

Element	Description	Restrictions	Syntax
<i>blobspace</i>	Name of an existing blobspace	Must exist	Identifier

The large object data types can be classified in two categories:

- Simple large objects: TEXT and BYTE
- Smart large objects: CLOB and BLOB
- [Simple-large-object data types](#)
A simple large object data type stores text or binary data in blobspaces.
- [Storing BYTE and TEXT Data](#)
- [Smart-large-object data types](#)
A smart large object data type stores text or binary data in sbspaces.

Related reference:

[Storage options](#)

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Simple-large-object data types

A simple large object data type stores text or binary data in blobspaces.

These are the simple-large-object data types:

TEXT

Stores text data of up to 2^{31} bytes

BYTE

Stores any digitized data of up to 2^{31} bytes

Do not supply a BYTE value where TEXT is expected. No built-in cast supports BYTE to TEXT data type conversion.

Because of the maximum row size limit of 32,767 bytes, you cannot create a table with more than approximately 195 BYTE or TEXT columns. (This restriction also applies to all varying-length data types and ROW data types.)

For more information about the simple large object data types, see the *IBM® Informix® Guide to SQL: Reference*.

For information on how to create blobspaces, see your *IBM Informix Administrator's Guide*.

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Storing BYTE and TEXT Data

A simple-large-object data type can store text or binary data in blobspaces or in tables. The database server can access a BYTE or TEXT value in one piece. When you specify a BYTE or TEXT data type, you can specify the location in which it is stored. You can store data with the table or in a separate blobspace.

If you are creating a named ROW data type that has a BYTE or TEXT field, you cannot use the IN clause to specify a separate storage space.

The following example shows how blobspaces and dbspaces are specified. The user creates the **resume** table. The data values are stored in the **employ** dbspace. The data in the **vita** column is stored with the table, but the data associated with the **photo** column is stored in a blobspace named **photo_space**.

```
CREATE TABLE resume
(
  fname      CHAR(15),
  lname      CHAR(15),
  phone      CHAR(18),
  recd_date  DATETIME YEAR TO HOUR,
  contact_date DATETIME YEAR TO HOUR,
```

```

comments      VARCHAR(250, 100),
vita          TEXT IN TABLE,
photo        BYTE IN photo_space
)
IN employ;

```

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Smart-large-object data types

A smart large object data type stores text or binary data in sbspaces.

The database server can provide random access to a smart large object value. That is, it can access any portion of the smart large object value. These data types are recoverable. The following list summarizes the smart large object data types that IBM® Informix® supports.

BLOB

Stores binary data of up to 4 terabytes (4×2^{40} bytes)

CLOB

Stores text data of up to 4 terabytes (4×2^{40} bytes)

A smart large object is stored in a single sbspac. The SBSPACENAME configuration parameter specifies the system default sbspac in which smart large objects are created, unless you specify another storage area. For information about how the CREATE TABLE statement can specify nondefault storage locations and nondefault storage characteristics for BLOB or CLOB columns, see the description of the [PUT Clause](#).

Both of these are built-in opaque data types. Like most opaque types, they cannot be accessed in a database of a non-local database server by a distributed query or by other DML operations, nor can they be returned from a database of another database server by a UDR. For information on accessing BLOB or CLOB values in other databases of the local server, however, see [BOOLEAN and other built-in opaque data types](#).

Smart large object data types are not parallelizable. The PDQ feature of Dynamic Serve has no effect on operations that load or unload BLOB or CLOB values, or that process them in queries or in other DML operations.

For more information about the smart large object data types, see the *IBM Informix Guide to SQL: Reference*.

For information about how to create sbspaces, see your *IBM Informix Administrator's Guide*.

For information about the built-in functions that you can use to import, export, and copy smart large objects, see [Smart-Large-Object Functions](#) and the *IBM Informix Guide to SQL: Tutorial*.

Related information:

[Blobspaces](#)

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Time Data Types

The time data types store calendar dates, points in time, and intervals of time.

Time Data Types

```

|---+DATE-----+-----|
|                                     (1) |
|+-----+-----+-----+
|+INTERVAL--| INTERVAL Field Qualifier |-----+
| (2) |                                     (3) |
|'-----DATETIME--| DATETIME Field Qualifier |-----'

```

Notes:

1. See [INTERVAL Field Qualifier](#)
2. Informix® extension
3. See [DATETIME Field Qualifier](#)

The following table summarizes the built-in time data types.

Data Type

Description

DATE

Stores a date value as a Julian date in the range from January 1 of the year 1 up to December 31, 9999.

DATETIME

Stores a point-in-time date (*year, month, day*) and time-of-day (*hour, minute, second, and fraction of second*), in the range of years 1 to 9999. Also supports contiguous subsets of these time units.

INTERVAL

Stores spans of time, in *years* and/or *months*, or in smaller time units (*days, hours, minutes, seconds, and/or fractions of second*), with up to 9 digits of precision in the largest time unit, if this is not FRACTION. Also supports contiguous subsets of these time units.

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- For DISTINCT data types in distributed operations, the data type hierarchy must have one of the following forms, which cannot vary across the participating databases:

```
>>-DISTINCT OF-----+----->
      | .-----+-----|
      | V         | |
      | '---distinct_type---DISTINCT OF---'
>--+-BOOLEAN-----+-----<
+--BSON-----+
+--JSON-----+
|      .-(--2048-)-. |
+--LVARCHAR---+-(--max---)+-+
'built-in non-opaque type'
```

Element	Description	Restrictions	Syntax
<i>built-in _ non-opaque_type</i>	Atomic built-in data type that is not opaque	Type cannot be complex, serial, BYTE, or TEXT	Data Type
<i>distinct_type</i>	DISTINCT type whose base type is another DISTINCT type	Root of this hierarchy must be a BSON, BOOLEAN, JSON, LVARCHAR, or an atomic <i>built-in non-opaque</i> data type	Data Type

Important:

The diagram above shows the generalized logical hierarchy of the base types for any DISTINCT data type. Using the DISTINCT OF keywords recursively, however, as in the diagram above, is not valid SQL syntax. The CREATE DISTINCT type statement must specify exactly one base type for the new DISTINCT type. To create a hierarchy of DISTINCT data types, you must issue a separate CREATE DISTINCT TYPE statement for every DISTINCT type in the hierarchy. For the SQL syntax to define a new DISTINCT data type, see the topic [CREATE DISTINCT TYPE statement](#).

A user-defined routine can return to the local database a DISTINCT data type from another database of the same Informix instance only if all of the conditions listed above are true, and the UDR is defined in all of the participating databases.

The IDSSecurityLabel data type, which stores the security label in rows of protected tables, is a built-in DISTINCT type that satisfies this requirement, because its base type is the built-in VARCHAR(128) data type.

In queries that access a protected table in an Informix database, the security label stored in the IDSSecurityLabel column prevents protected rows from being returned by the query, unless the user issuing the query holds sufficient LBAC credentials for the security policy of which that label is a component.

The same rules that apply to DISTINCT data types in distributed operations across databases of the same Informix instance also apply to DISTINCT data types in cross-server distributed operations on databases of different Informix instances.

For additional information about the data types that Informix supports in distributed operations, see [Data Types in Distributed Queries](#).

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An opaque data type is a user-defined data type that can be used in the same way as a built-in data type. To create an opaque type, you must use the CREATE OPAQUE TYPE statement. Because an opaque type is encapsulated, you create support functions to access the individual components of an opaque type. The internal storage details of the type are hidden or opaque.

For more information about how to create an opaque data type and its support functions, see *IBM® Informix® User-Defined Routines and Data Types Developer's Guide*.

Because of the maximum row size limit of 32,767 bytes, when you create a new table, no more than approximately 195 columns can be varying-length opaque or distinct user-defined data types. (The same restriction applies to BYTE, TEXT, VARCHAR, LVARCHAR, NVARCHAR, and ROW type columns. See [ROW Data Types](#) for additional information about ROW data types.)

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Complex Data Type

Complex data types are ROW types or COLLECTION types that you create from built-in types, opaque types, distinct types, or other complex types.

Complex Data Type

```
(1)
|---+| Row Data Types |-----+-----|
|
| (2) |
|'-| Collection Data Types |-----'
```

Notes:

1. See [CREATE ROW TYPE statement](#)
2. See [Collection Data Types](#)

A single complex data type can include multiple components. When you create a complex type, you define the components of the complex type. Unlike an opaque type, however, a complex type is not encapsulated. You can use SQL to access the individual components of a complex data type. The individual components of a complex data type are called *elements*.

Informix® supports the following categories of complex data types:

- ROW data types: Named ROW types and unnamed ROW types
- COLLECTION data types: SET, MULTISSET, and LIST

The elements of a COLLECTION data type must all be of the same data type. You can use the keyword `COLLECTION` in SPL data type declarations to specify an untyped collection variable. NULL values are not supported in elements of COLLECTION data types.

The elements of a ROW data type can be of different data types, but the pattern of data types from the first to the last element cannot vary for a given ROW data type. NULL values are supported in elements of ROW data types, unless you specify otherwise in the data type declaration or in a constraint.

- [ROW Data Types](#)
A ROW data type is a complex data type that can store multiple data values within its ordered set of one or more fields. Informix supports two categories of ROW data types: *named ROW types* that the CREATE ROW TYPE statement registers in the system catalog, and *unnamed ROW types* that ROW constructor expressions define.
- [Collection Data Types](#)

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ROW Data Types

A ROW data type is a complex data type that can store multiple data values within its ordered set of one or more fields. Informix supports two categories of ROW data types: *named ROW types* that the CREATE ROW TYPE statement registers in the system catalog, and *unnamed ROW types* that ROW constructor expressions define.

You can use this syntax when you assign a ROW data type to a column or to an SPL variable.

Named and unnamed ROW data types

```
|---+| Named ROW data type |-----+-----|
|'-| Unnamed ROW data type |-----'
```

Named ROW data type

```
|---+-----+---row_type-----+-----|
|'-owner--.-'
```

Unnamed ROW data type

```
|---ROW---+-----+-----+-----|
|
| .,-----|
| v |
|'- (----field--data_type+---) -'
```

Element	Description	Restrictions	Syntax
<i>data_type</i>	Data type of <i>field</i>	Any built-in type except BYTE or TEXT, or a UDT that has a support function for bit-hashing	Data Type
<i>field</i>	Name of a field within <i>row_type</i>	Must be unique among field names of the same ROW type	Identifier
<i>owner</i>	Authorization identifier of the owner of this ROW type	In an ANSI-compliant database, the combination <i>owner.row_type</i> must be unique among data types in the database	Owner name

Element	Description	Restrictions	Syntax
<i>row_type</i>	Named ROW type that CREATE ROW TYPE statement defined	ROW type must exist in the database	Identifier ; Data Type

Named ROW types

You can assign a named ROW type to a table, to a column, or to an SPL variable. A named ROW type must already exist in the database before you can use it in any of the following contexts:

- to create a typed table
- to define a column
- to define an SPL variable of a named ROW type.

A field in a named ROW type can be another existing named ROW type, as in this example:

```
CREATE ROW TYPE row_t ( w INT, y INT);
CREATE ROW TYPE rowspace_t ( u INT, v row_t, z DATE);
```

Each row of the named ROW type `rowspace_t` can stores three INT values and one DATE value, but two of those INT values are in the field of ROW type `row_t`. To specify a named ROW data type in an ANSI-compliant database, you must qualify the *row_type* with its *owner* name, if you are not the owner of *row_type*.

A named ROW type can be the child of a supertype within a data type hierarchy, from which it inherits the field data types of its parent ROW type, or it can have no parent supertype. For the DDL syntax to create a new named ROW data type, see [CREATE ROW TYPE statement](#).

Unnamed ROW types

An unnamed ROW data type is identified by its structure, which specifies fields that you create with its ROW constructor. For the syntax of unnamed ROW constructors, see [Constructor Expressions](#).

You can define a column or an SPL variable as an unnamed ROW data type.

If you omit the field list of the ROW constructor when the DEFINE statement of SPL declares an SPL variable as an unnamed ROW data type, the new variable has a generic ROW data type, to which the SPL routine can assign the field values of any ROW data type. For the syntax to declare SPL variables as ROW data types, see [Subset of Complex Data Types](#).

Restrictions on ROW types

Columns in database tables cannot be generic ROW types.

An SPL variable declared as a generic ROW data type cannot return the result of an SQL routine. Before you can use a ROW type variable in an SPL routine, you must initialize the row variable with a LET statement or with a SELECT INTO statement.

Fields in a ROW data type cannot include TEXT or BYTE data types. Fields in ROW types also cannot be user-defined types (UDTs) that are not bit-hashable using the built-in hashing function of the database server.

Because of the maximum row size limit of 32,767 bytes, a single table cannot be created with more than approximately 195 ROW type columns.

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Collection Data Types

This diagram shows the syntax to define a column or an SPL variable as a collection data type. (A table can include no more than 97 columns of collection data types.) For the syntax to specify values of collection elements, see [Collection Constructors](#).

Collection Data Type

```
|--+-COLLECTION-----+--|
'--+-SET-----+--' (---data_type-----+--NOT NULL)-'
+-MULTISET+-' (---data_type-- NOT NULL--)-'
'-LIST-----'
```

Element	Description	Restrictions	Syntax
<i>data_type</i>	Data type of each of the elements of the collection	Can be any data type except BIGSERIAL, BYTE, SERIAL, or SERIAL8, or TEXT	Data Type

A SET is an unordered collection of elements, each of which has a unique value. Define a column as a SET data type when you want to store collections whose elements contain no duplicate values and have no associated order.

A MULTISET is an unordered collection of elements that can have duplicate values. You can define a column as a MULTISET collection type when you want to store collections whose elements might not be unique and have no specific order associated with them.

A LIST is an ordered collection of elements that can include duplicate elements. A LIST differs from a MULTISET in that each element in a LIST collection has an ordinal position in the collection. You can define a column as a LIST collection type when you want to store collections whose elements might not be unique but have a specific order associated with them.

The keyword `COLLECTION` can be used in SPL data type declarations to specify an untyped collection variable.

If you attempt to insert a collection that includes one or more duplicate values into a `SET` column, Informix® issues no error, but the duplicate values are ignored, and only the unique values are inserted.

- [Duplicate Elements in DML Operations on SET Columns](#)
- [Defining the Element Type](#)

The element type can be any data type except `TEXT`, `BYTE`, `SERIAL`, `SERIAL8`, or `BIGSERIAL`. You can nest collection types, using elements of a collection type.

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Duplicate Elements in DML Operations on SET Columns

The `SET` data type does not allow duplicate element values in the same collection. If you attempt to insert duplicate elements into a `SET` data type, or to update a `SET` column or variable to a value that includes duplicate elements, the database server issues no error or warning when the `INSERT` or `UPDATE` statement executes, but only one of the duplicate elements is stored in the `SET` column or variable.

For example, suppose you create table `t3` with column `a` of the `SET` data type, and then you insert four rows, some of which include elements that have identical values:

```
> CREATE TABLE t3(a SET(INT NOT NULL));

Table created.

> INSERT INTO t3 VALUES( SET{10, 20, 30} );

1 row(s) inserted.

> INSERT INTO t3 VALUES( SET{10, 20, 10} );

1 row(s) inserted.

> INSERT INTO t3 VALUES( SET{10, 10, 10} );

1 row(s) inserted.

> INSERT INTO t3 VALUES( SET{10,10,10} );

1 row(s) inserted.
```

When you look at the data values that were inserted into column `t3.a`, the four inserted rows include no duplicate element values:

```
> SELECT * FROM t3;

a SET{10      ,20      ,30      }
a SET{10      ,20      }
a SET{10      }
a SET{10      }
```

4 row(s) retrieved.

In this example, Informix® silently discarded all but one instance of the duplicated elements from what the `VALUES` clause of the `INSERT` statement specified for each `SET` value.

Similar behavior occurs if the `SET` clause of the `UPDATE` statement includes duplicate elements within the same `SET` value. Declare collection columns of the `MULTISET` data type, rather than of the `SET` data type, if you want the database to store unordered sets that can include duplicate elements within the same collection

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Defining the Element Type

The element type can be any data type except `TEXT`, `BYTE`, `SERIAL`, `SERIAL8`, or `BIGSERIAL`. You can nest collection types, using elements of a collection type.

Every element must be of the same type. For example, if the element type of a collection data type is `INTEGER`, every element must be of type `INTEGER`.

An exception to this restriction occurs if the database server determines that some elements of a collection of character strings are `VARCHAR` data types (whose length is limited to 255 or fewer bytes) but other elements are longer than 255 bytes. In this case, the collection constructor can assign a `CHAR(n)` data type to all elements, for `n` the length in bytes of the longest element. If this is undesirable, you can cast the collection to `LVARCHAR`, to prevent padding extra length in elements of the collection, as in this example:

```
LIST {'first character string longer than 255 bytes . . . ',
     'second character string longer than 255 bytes . . . ',
     'another character string'} ::LIST (LVARCHAR NOT NULL)
```

See [Collection Constructors](#) for additional information.

If the element type of a collection is an unnamed ROW type, the unnamed ROW type cannot contain fields that hold unnamed ROW types. That is, a collection cannot contain nested unnamed ROW data types.

The elements of a collection cannot be NULL. When you define a column as a collection data type, you must use the NOT NULL keywords to specify that the elements of the collection cannot be NULL.

Privileges on a collection data type are those of the database column. You cannot specify privileges on individual elements of a collection.

Related information:

[Select data types](#)

[Data types](#)

[Character data types](#)

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DATETIME Field Qualifier

Use a DATETIME Field Qualifier to specify the largest and smallest unit of time in a DATETIME column or value. Use this segment whenever you see a reference to a DATETIME Field Qualifier in a syntax diagram.

Syntax

DATETIME Field Qualifier

```
| --+-YEAR--+-TO YEAR-----+-----+-----+
|      +-TO MONTH-----+      |
|      +-TO DAY-----+      |
|      +-TO HOUR-----+      |
|      +-TO MINUTE-----+     |
|      +-TO SECOND-----+     |
|      '-TO FRACTION--+-+-----+
|                      '-(--scale--)-'
+-MONTH--+-TO MONTH-----+-----+
|      +-TO DAY-----+      |
|      +-TO HOUR-----+     |
|      +-TO MINUTE-----+    |
|      +-TO SECOND-----+    |
|      '-TO FRACTION--+-+-----+
|                      '-(--scale--)-'
+-DAY--+-TO DAY-----+-----+
|      +-TO HOUR-----+      |
|      +-TO MINUTE-----+     |
|      +-TO SECOND-----+     |
|      '-TO FRACTION--+-+-----+
|                      '-(--scale--)-'
+-HOUR--+-TO HOUR-----+-----+
|      +-TO MINUTE-----+     |
|      +-TO SECOND-----+     |
|      '-TO FRACTION--+-+-----+
|                      '-(--scale--)-'
+-MINUTE--+-TO MINUTE-----+-----+
|      +-TO SECOND-----+     |
|      '-TO FRACTION--+-+-----+
|                      '-(--scale--)-'
+-SECOND--+-TO SECOND-----+-----+
|      '-TO FRACTION--+-+-----+
|                      '-(--scale--)-'
'-FRACTION--TO FRACTION--+-+-----+
|                      '-(--scale--)-'
```

Element	Description	Restrictions	Syntax
<i>scale</i>	Fraction of a second. Default is 3.	Integer ($1 \leq scale \leq 5$)	Literal Number

Usage

This segment specifies the precision and scale of a DATETIME data type.

Specify, as the first keyword, the largest time unit that the DATETIME column will store. After the keyword TO, specify the smallest unit as the last keyword. These can be the same keyword. If they are different, the qualifier implies that any intermediate time units between the first and last are also recorded by the DATETIME data type.

The keywords can specify the following time units for the DATETIME column.

Unit of Time

Description

YEAR

Specifies a year, in the range from A.D. 1 to 9999

MONTH

Specifies a month, in the range from 1 (January) to 12 (December)

DAY
Specifies a day, in the range from 1 to 28, 29, 30, or 31 (depending on the specific month)

HOURL
Specifies an hour, in the range from 0 (midnight) to 23

MINUTE
Specifies a minute, in the range from 0 to 59

SECOND
Specifies a second, in the range from 0 to 59

FRACTION
Specifies a fraction of a second, with up to five decimal places
The default scale is three digits (thousandth of a second).

Unlike INTERVAL qualifiers, DATETIME qualifiers cannot specify nondefault precision (except for FRACTION, when FRACTION is the smallest unit in the qualifier). Some examples of DATETIME qualifiers follow:

YEAR TO MINUTE	MONTH TO MONTH
DAY TO FRACTION(4)	MONTH TO DAY

On some platforms, the system clock cannot support precision greater than FRACTION(3).

An error results if the first keyword represents a smaller time unit than the last, or if you use the plural form of a keyword (such as MINUTES).

Operations on DATETIME values that do not include YEAR in their qualifier use values from the system clock-calendar to supply any additional precision. If the first term in the qualifier is DAY, and the current month has fewer than 31 days, unexpected results can occur.

Related information:

[DATETIME data type](#)

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Expression

Data values in SQL statements must be represented as expressions. An *expression* is a specification, which can include operators, operands, and parentheses, that the database server can evaluate to one or more values, or to a reference to some database object.

Expressions can refer to values already in a table of the database, or to values derived from such data, but some expressions (such as TODAY, USER, or literal values) can return values that are independent of the database. You can use expressions to specify values in data-manipulation statements, to define fragmentation strategies, and in other contexts. Use the Expression segment whenever you see a reference to an expression in a syntax diagram.

In most contexts, however, you are restricted to expressions whose returned value is of some specific data type, or of a data type that can be converted by the database server to some required data type.

IBM® Informix® database servers support the following categories of expressions:

SQL Expressions

```

.-Binary Operators-----
V                               (1)
|-----+-----+-----+-----+-----+-----+-----+-----+
+- - + | Cast Expressions |-----+-----+-----+-----+
'- + ' | Column Expressions |-----+-----+-----+-----+
      | (2)
      |-----+-----+-----+-----+
      +-| Conditional Expressions |-----+-----+-----+
      | (3)
      |-----+-----+-----+-----+
      +-| Constant Expressions |-----+-----+-----+
      | (4)
      |-----+-----+-----+-----+
      +-| Constructor Expressions |-----+-----+-----+
      | (5)
      |-----+-----+-----+-----+
      +-| Function Expressions |-----+-----+-----+
      | (6)
      |-----+-----+-----+-----+
      +-| Statement-Local Variable Expressions |-----+
      | (7)
      |-----+-----+-----+-----+
      +-| Aggregate Expressions |-----+-----+-----+
      | (8)
      |-----+-----+-----+-----+
      +-NULL-----+-----+-----+-----+
      +-variable-----+-----+-----+-----+
      | (9)
      |-----+-----+-----+-----+
      +-SPL_variable-----+-----+-----+-----+
      |-----+-----+-----+-----+
      '-(-| Expression |-)-----+-----+-----+-----+

```

Binary Operators

```

|-----+-----+-----+-----+-----+-----+-----+-----+
+- - +-
+- * +-
+- / +-
'- || '

```

Notes:

1. See [CAST Expressions](#)

2. See [Column Expressions](#)
3. See [Conditional Expressions](#)
4. See [Constant Expressions](#)
5. See [Constructor Expressions](#)
6. See [Function Expressions](#)
7. See [Statement-Local Variable Expressions](#)
8. See [Aggregate Expressions](#)
9. Stored Procedure Language only

Element	Description	Restrictions	Syntax
<i>SPL_variable</i>	In an SPL routine, a variable that contains some expression type that the syntax diagram shows	Must conform to the rules for expressions of that type	Identifier
<i>variable</i>	Host or program variable that contains some expression type that the syntax diagram shows	Must conform to the rules for expressions of that type	Language-specific rules for names

Usage

The following table lists the types of SQL expressions and describes what each type returns.

Table 1. SQL expressions

Expression Type	Description
Aggregate functions	Returns values from built-in or from user-defined aggregates
Arithmetic operators	Supports arithmetic operations on one (unary operators) or two (binary operators) numeric operands
Concatenation operator	Concatenates two string values
Cast operators	Explicit casts from one data type to another
Column expressions	Column values
Conditional expressions	Returns values that depend on conditional tests
Constant expressions	Literal values in data manipulation (DML) statements
Constructor expressions	Dynamically creates values for complex data types
Function expressions	Returns values from built-in or user-defined functions
Statement-Local Variable expressions	References a statement-local variable (SLV) in the same SQL statement where it was declared

You can also use host variables or SPL variables as expressions.

- [List of Expressions](#)
Each category of SQL expression includes many individual expressions.
- [Arithmetic Operators](#)
- [Bitwise Logical Functions](#)
- [Concatenation Operator](#)
- [CAST Expressions](#)
Use the `CAST (... AS ...)` keywords or the double-colon (`::`) cast operator to convert the data type of the value of an *expression* to some other *target data type*.
- [Column Expressions](#)
A *column expression* specifies a data value in a column in the database, or a substring of the value, or a field within a ROW-type column, or a field in a BSON column.
- [Conditional Expressions](#)
- [Constant Expressions](#)
Certain expressions that return a fixed value are called *constant expressions*. These include variant function operators that read the system clock, but that are valid in contexts where literal constants are also valid.
- [Constructor Expressions](#)
- [NULL Keyword](#)
- [Function Expressions](#)
- [Statement-Local Variable Expressions](#)
- [Aggregate Expressions](#)

Related reference:

[Projection Clause](#)

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List of Expressions

Each category of SQL expression includes many individual expressions.

The following table lists all the SQL expressions (and some operators) in alphabetical order. The columns in this table have the following meanings:

- **Name** gives the name of each expression.
- **Description** gives a short description of each expression.
- **Syntax** lists the page that shows the syntax of the expression.

- **Usage** shows the page that describes the usage of the expression.

Name	Description	Syntax	Usage
ABS function	Returns absolute value of a numeric argument	Algebraic Functions	ABS Function
ACOS function	Returns the arc cosine of a numeric argument	Trigonometric Functions	ACOS Function
ACOSH function	Returns the hyperbolic tangent of the specified numeric input	Trigonometric Functions	ACOSH Function
ADD_MONTHS function	Adds a specified number of months	Time Functions	ADD_MONTHS Function
Addition (+) operator	Returns the sum of two numeric operands	Expression	Arithmetic Operators
ASCII function	Returns the ASCII codepoint of the first character in its string argument	String-Manipulation Functions	ASCII Function
ASIN function	Returns the arc sine of a numeric argument	Trigonometric Functions	ASIN Function
ASINH function	Returns the arc hyperbolic sine of the specified numeric input	Trigonometric Functions	ASINH Function
ATAN function	Returns the arc tangent of numeric argument	Trigonometric Functions	ATAN Function
ATAN2 function	Calculates the angular component of polar coordinate arguments	Trigonometric Functions	ATAN2 Function
ATANH function	Returns the hyperbolic tangent of the specified numeric input	Trigonometric Functions	ATANH Function
AVG function	Returns the mean of a set of numeric values	Aggregate Expressions	AVG Function
BITAND	Returns the bitwise AND of two arguments	Bitwise Logical Functions	BITAND Function
BITANDNOT	Returns the bitwise ANDNOT of two arguments	Bitwise Logical Functions	BITANDNOT Function
BITNOT	Returns the bitwise NOT of two arguments	Bitwise Logical Functions	BITNOT Function
BITOR	Returns the bitwise OR of two arguments	Bitwise Logical Functions	BITOR Function
BITXOR	Returns the bitwise XOR of two arguments	Bitwise Logical Functions	BITXOR Function
CARDINALITY function	Returns the number of elements in a collection data type (SET, MULTISSET, or LIST)	CARDINALITY Function	CARDINALITY Function
CASE expression	Returns a value that depends on which of several conditional tests evaluates to true	CASE Expressions	CASE Expressions
CAST expression	Converts an expression to a specified data type	CAST Expressions	CAST Expressions
Cast (::) operator	See "Double-colon (::) cast operator"	CAST Expressions	CAST Expressions
CEIL function	Returns the smallest integer that is greater than or equal to its single argument	Algebraic Functions	CEIL Function
CHARACTER_LENGTH function	See CHAR_LENGTH function. (In multibyte locales, this replaces the LENGTH function.)	Length functions	CHAR_LENGTH Function
CHAR_LENGTH function	Returns count of logical characters in a string argument	Length functions	CHAR_LENGTH Function
CHARINDEX function	Returns the location of a substring within a string	CHARINDEX function	CHARINDEX function
CHR	Returns a code point in the range 0 through 255 from the default code set	String-Manipulation Functions	CHR Function
COALESCE function	Returns the first non-NULL value from a series of expressions	COALESCE Function	COALESCE Function
Column expression	Column value from a table	Column Expressions	Column Expressions
CONCAT operator function	Concatenates the results of two expressions	String-Manipulation Functions	CONCAT Function
Concatenation ( || ) operator	Concatenates the results of two expressions	Expression	Concatenation Operator
Constant expression	Expression with a literal, fixed, or variant value	Constant Expressions	Constant Expressions
COS function	Returns the cosine of a radian expression	Trigonometric Functions	COS Function

Name	Description	Syntax	Usage
COSH function	Returns the hyperbolic cosine of the argument, where the argument is an angle expressed in radians	Trigonometric Functions	COSH function
COUNT (as a set of functions)	Functions that return frequency counts Each form of the COUNT function is listed below.	Aggregate Expressions	Overview of COUNT Functions
COUNT (ALL <i>column</i>) function	See COUNT (<i>column</i>) function.	Aggregate Expressions	COUNT column Function
COUNT (<i>column</i>) function	Returns the number of non-NULL values in a specified column	Aggregate Expressions	COUNT column Function
COUNT DISTINCT function	Returns the number of unique non-NULL values in a specified column	Aggregate Expressions	COUNT DISTINCT and COUNT UNIQUE functions
COUNT UNIQUE function	See COUNT DISTINCT function.	Aggregate Expressions	COUNT DISTINCT and COUNT UNIQUE functions
COUNT (*) function	Returns the cardinality of the set of rows that satisfy a query	Aggregate Expressions	COUNT(*) function
CUME_DIST function	Returns percentile rankings for each row in an OLAP partition	OLAP ranking function expressions	CUME_DIST function
CURRENT operator	Returns the current time as a DATETIME value that consists of the date and the time of day	Constant Expressions	CURRENT Operator
CURRENT_ROLE operator	Returns the currently enabled role of the user	Constant Expressions	CURRENT_ROLE Operator
CURRENT_USER operator	Returns the authorization identifier of the user. Synonym for USER operator.	Constant Expressions	USER or CURRENT_USER Operator
<i>sequence</i> .CURRVAL	Returns the current value of specified <i>sequence</i>	Constant Expressions	Using CURRVAL
DATE function	Converts a nondatetime argument to a DATE value	Time Functions	DATE Function
DAY function	Returns the day of the month as an integer	Time Functions	DAY Function
DBINFO (<i>option</i>)	Functions for retrieving database and session information. Each <i>option</i> is listed below.	DBINFO Function	DBINFO Options
DBINFO ('bigserial')	Returns most recently inserted BIGSERIAL value	DBINFO Function	Using the 'serial8' and 'bigserial' options
DBINFO ('cdrsession')	Shows whether a DML operation is part of a replicated transaction	DBINFO Function	Using the 'cdrsession' option
DBINFO ('dbhostname')	Returns the host name of the database server to which a client application is connected	DBINFO Function	Using the 'dbhostname' Option
DBINFO ('dbname')	Returns the identifier of the database to which a client application is connected	DBINFO Function	Using the 'dbname' Option
DBINFO ('dbspace', <i>tblspace_number</i>)	Returns the name of a dbspace corresponding to a tblspace number	DBINFO Function	Using the ('dbspace', tblspace_num) Option
DBINFO ('get_tz')	Returns the time zone of the current session	DBINFO Function	Using the 'get_tz' Option
DBINFO ('serial8')	Returns most recently inserted SERIAL8 value	DBINFO Function	Using the 'serial8' and 'bigserial' options
DBINFO ('sessionid')	Returns the session ID of the current session	DBINFO Function	Using the 'sessionid' Option
DBINFO ('sqlca.sqlerrd1')	Returns the last serial value inserted in a table	DBINFO Function	Using the 'sqlca.sqlerrd1' Option
DBINFO ('sqlca.sqlerrd2')	Returns the number of rows processed by DML statements, and by EXECUTE PROCEDURE and EXECUTE FUNCTION statements	DBINFO Function	Using the 'sqlca.sqlerrd2' Option
DBINFO ('utc_current')	Returns the current Coordinated Universal Time (UTC) value.	DBINFO Function	Using the 'utc_current' Option
DBINFO ('utc_to_datetime', <i>expression</i>)	Returns the DATETIME value of an integer or column <i>expression</i> that specifies a UTC value.	DBINFO Function	Using the 'utc_to_datetime' Option

Name	Description	Syntax	Usage
DBINFO ('version', <i>parameter</i>)	Returns all or part, as specified by the <i>parameter</i> , of the exact version of the database server to which the client application is connected.	DBINFO Function	Using the 'version' Option
DBSERVERNAME function	Returns the name of the database server	Constant Expressions	DBSERVERNAME and SITENAME Operators
DECODE function	Evaluates one or more expression pairs and compares the <i>when</i> expression in each pair with a specified value expression	DECODE Function	DECODE Function
DECRYPT_BINARY function	Returns a plain-text BLOB data value after processing an encrypted BLOB argument	Encryption and decryption functions	DECRYPT_BINARY Function
DECRYPT_CHAR function	Returns a plain-text string or CLOB after processing an encrypted argument	Encryption and decryption functions	DECRYPT_CHAR Function
DEFAULT_ROLE operator	Returns the default role of the current user	Constant Expressions	DEFAULT_ROLE Operator
DEGREES function	Converts units of radians to degrees	Trigonometric Functions	DEGREES function
DELETING Boolean operator	Returns 't' if triggering event is a DELETE	Trigger-Type Boolean Operator	Trigger-Type Boolean Operator
DENSERANK function	Synonym for the DENSE_RANK function	OLAP ranking function expressions	DENSE_RANK function
DENSE_RANK function	Ranks each row in an OLAP partition, with no gaps in ranks	OLAP ranking function expressions	DENSE_RANK function
Division (/) operator	Returns the quotient of two numeric operands	Expression	Arithmetic Operators
Double-colon (::) cast operator	Converts the value of an expression to a specified data type	CAST Expressions	CAST Expressions
Double-pipe ( || ) concatenation operator	Returns a string that joins one string operand to another string operand	Expression	Concatenation Operator
ENCRYPT_AES function	Returns an encrypted string or BLOB after processing a plain-text string, BLOB, or CLOB	Encryption and decryption functions	ENCRYPT_AES Function
ENCRYPT_TDES function	Returns an encrypted string or BLOB after processing a plain-text string, BLOB, or CLOB	Encryption and decryption functions	ENCRYPT_TDES Function
EXP function	Returns the exponent of a numeric expression	Exponential and Logarithmic Functions	EXP Function
EXTEND function	Resets precision of DATETIME or DATE value	Time Functions	EXTEND Function
FILETOBLOB function	Creates a BLOB value from data stored in a specified operating-system file	Smart-Large-Object Functions	FILETOBLOB and FILETOCLOB Functions
FILETOCLOB function	Creates a CLOB value from data stored in a specified operating-system file	Smart-Large-Object Functions	FILETOBLOB and FILETOCLOB Functions
FIRST_VALUE function	Returns the value of a specified expression for the first row in each OLAP window partition	OLAP aggregation function expressions	LAST_VALUE function
FLOOR function	Returns the largest integer that is smaller than or equal to its single argument	Algebraic Functions	FLOOR Function
FORMAT_UNITS function	Returns a character string that specifies a number and abbreviated units of memory or of storage	FORMAT_UNITS Function	FORMAT_UNITS Function
GETHINT function	Returns a plain-text hint string after processing an encrypted data-string argument	Encryption and decryption functions	GETHINT Function
GREATEST function	Returns the maximum value in a set of values	Algebraic Functions	GREATEST function
HEX function	Returns the hexadecimal encoding of a base-10 integer argument	HEX Function	HEX Function
Host variable	See Variable.	Expression	Expression
IFX_ALLOW_NEWLINE function	Sets a newline session mode that allows or disallows newline characters in quoted strings	IFX_ALLOW_NEWLINE Function	IFX_ALLOW_NEWLINE Function
INITCAP function	Converts a string argument to a string in which only the initial letter of each word is uppercase	Case-Conversion Functions	INITCAP Function

Name	Description	Syntax	Usage
INSERTING Boolean operator	Returns 't' if triggering event is an INSERT	Trigger-Type Boolean Operator	Trigger-Type Boolean Operator
INSTR function	Returns position of Nth occurrence of a substring within a string	INSTR function	INSTR function
LAG function	Returns an expression value for the row at a specified offset before the current row in an OLAP partition	OLAP ranking function expressions	LAG and LEAD functions
LAST_DAY function	Returns the date of the last day of the month that its argument specifies	Time Functions	LAST_DAY Function
LAST_VALUE function	Returns the value of a specified expression for the last row in an OLAP window partition	OLAP aggregation function expressions	LAST_VALUE function
LEAD function	Returns an expression value for the row at a specified offset after the current row in an OLAP partition	OLAP ranking function expressions	LAG and LEAD functions
LEAST function	Returns the minimum value in a set of values	Algebraic Functions	LEAST function
LEFT function	Returns the leftmost N characters of a string	LEFT function	LEFT function
LEN function	Synonym for the LENGTH function	Length functions	LENGTH Function
LENGTH function	Returns the number of bytes in a character column, not including trailing blank spaces	Length functions	LENGTH Function
LIST collection constructor	Constructor for ordered collections that can contain duplicate values	Collection Constructors	Collection Constructors
Literal BOOLEAN	Literal representation of a BOOLEAN value	Constant Expressions	Constant Expressions
Literal collection	Represents elements in a collection data type	Constant Expressions	Literal Collection
Literal DATETIME	Represents a DATETIME value	Constant Expressions	Literal DATETIME
Literal INTERVAL	Represents an INTERVAL value	Constant Expressions	Literal INTERVAL
Literal number	Represents a numeric value	Constant Expressions	Literal Number
Literal opaque type	Represents an opaque data type	Constant Expressions	Constant Expressions
Literal row	Represents the elements in a ROW data type	Constant Expressions	Literal Row
LN	Returns the natural logarithm of a numeric argument	Exponential and Logarithmic Functions	LN function
LOCOPY function	Creates a copy of a smart large object	Smart-Large-Object Functions	LOCOPY Function
LOG10 function	Returns the base-10 logarithm of a numeric argument	Exponential and Logarithmic Functions	LOG10 Function
LOGN function	Returns the natural logarithm of a numeric argument	Exponential and Logarithmic Functions	LOGN Function
LOTOFILE function	Copies a BLOB or CLOB object to a file	Smart-Large-Object Functions	LOTOFILE Function
LOWER function	Converts uppercase letters to lowercase	Case-Conversion Functions	LOWER Function
LPAD function	Returns a string that is left-padded by a specified number of pad characters	String-Manipulation Functions	LPAD Function
LTRIM function	Removes specified leading pad characters from a string.	String-Manipulation Functions	LTRIM Function
MAX function	Returns the largest in a specified set of values	Aggregate Expressions	MAX Function
MDY function	Returns a DATE value from integer arguments	Time Functions	MDY Function
MIN function	Returns the smallest in a specified set of values	Aggregate Expressions	MIN Function
MOD function	Returns the modulus (the integer-division remainder value) from two numeric arguments	Algebraic Functions	MOD Function
MONTH function	Returns the month value from a DATE or DATETIME argument	Time Functions	MONTH Function
MONTHS_ BETWEEN function	Returns the difference in months between two time arguments	Time Functions	MONTHS_ BETWEEN Function

Name	Description	Syntax	Usage
Multiplication (*) operator	Returns the product of two numeric operands	Expression	Arithmetic Operators
MULTISET collection constructor	Constructor for a non-ordered collection of elements that can contain duplicate value	Collection Constructors	Collection Constructors
NEXT_DAY function	Returns the earliest calendar date that satisfies both of two conditions	Time Functions	NEXT_DAY Function
<i>sequence</i> .NEXTVAL	Increments value of the specified <i>sequence</i>	Constant Expressions	Using NEXTVAL
NTILE function	Classifies the rows in an OLAP partition into N ranked categories, called <i>tiles</i> , of similar cardinalities	OLAP ranking function expressions	NTILE function
NULL keyword	Unknown, missing, or logically undefined value	NULL Keyword	NULL Keyword
NULLIF function	Returns NULL if both arguments are equal	NULLIF Function	NULLIF Function
NVL function	Returns the value of a not-NULL argument, or a specified value if the argument is NULL	NVL Function	NVL Function
NVL2 function	Returns the second argument when the first argument is not NULL	NVL2 Function	NVL2 Function
OCTET_LENGTH function	Returns the number of bytes in a character column, including any trailing blank spaces	Length functions	OCTET_LENGTH Function
PERCENT_RANK function	Returns a ranking value for each row in an OLAP window partition, normalized to a range from 0 to 1	OLAP ranking function expressions	PERCENT_RANK function
POW function	Raises a base value to a specified power	Algebraic Functions	POW Function
Power [®] function	Synonym for POW function	Algebraic Functions	POW Function
Procedure-call expression	See user-defined function.	User-Defined Functions	User-Defined Functions
Program variable	See variable.	Expression	Expression
QUARTER function	Returns the calendar quarter of a DATE or DATETIME value	Time Functions	QUARTER Function
Quoted string	Literal character string	Constant Expressions	Quoted String
RADIANS function	Converts units of degrees to radians	Trigonometric Functions	RADIANS function
RANGE function	Returns the range of a specified set of values	Aggregate Expressions	RANGE Function
RANK	Returns an ordinal number to rank each row in an OLAP window	OLAP ranking function expressions	RANK function
RATIO_TO_REPORT function	Synonym for the RATIO_TO_REPORT function	OLAP aggregation function expressions	RATIO_TO_REPORT function
RATIO_TO_REPORT function	Returns the fractional ratio of each row value to the sum for all rows in the same OLAP window partition	OLAP aggregation function expressions	RATIO_TO_REPORT function
REPLACE function	Replaces specified characters in a source string	String-Manipulation Functions	REPLACE Function
REVERSE	Reverses the order of characters in a source string	String-Manipulation Functions	REVERSE function
RIGHT function	Returns the N rightmost characters from a source string	RIGHT function	RIGHT function
ROOT function	Returns a real, positive, Nth root value of a numeric argument	Algebraic Functions	ROOT Function
ROUND function	Returns the rounded value of an argument	Algebraic Functions	ROUND Function
ROW constructor	Constructor for a named ROW data type	Constructor Expressions	ROW constructors
ROWNUMBER function	Synonym for the ROW_NUMBER function	OLAP numbering function expression	OLAP numbering function expression
ROW_NUMBER function	Returns sequential integers for each row in an OLAP window partition	OLAP numbering function expression	OLAP numbering function expression
RPAD function	Returns a string right-padded by a specified number of pad characters	String-Manipulation Functions	RPAD Function
RTRIM function	Removes trailing blank pad characters from a string	String-Manipulation Functions	RTRIM Function
SECLABEL_BY_COMP function	Returns the security label whose components are the arguments	Security Label Support Functions	SECLABEL_BY_COMP Function

Name	Description	Syntax	Usage
SECLABEL_BY_NAME function	Returns the security label whose identifier is the argument	Security Label Support Functions	SECLABEL_BY_NAME Function
SECLABEL_TO_CHAR function	Returns the security label whose string format is the argument	Security Label Support Functions	SECLABEL_TO_CHAR Function
SELECTING Boolean operator	Returns 't' if triggering event is a SELECT	Trigger-Type Boolean Operator	Trigger-Type Boolean Operator
SET collection constructor	Constructor for an unordered collection of unique elements	Collection Constructors	Collection Constructors
SIGN function	Returns an indicator of the sign of the numeric argument	SIGN function	SIGN function
SIN function	Returns the sine of a radians argument	Trigonometric Functions	SIN Function
SINH function	Returns the hyperbolic sine of a radians argument	Trigonometric Functions	SINH function
SITENAME function	See DBSERVERNAME function.	Constant Expressions	DBSERVERNAME and SITENAME Operators
SLV expression	A statement-local variable (SLV) whose scope is the SQL statement that declares it	Statement-Local Variable Declaration	Statement-Local Variable Expressions
SPACE function	Returns a string of N blank characters	String-Manipulation Functions	SPACE function
SPL routine expression	See "User-defined functions"	User-Defined Functions	User-Defined Functions
SPL variable	SPL variable that stores an expression	Expression	Expression
SQLCODE function	Returns sqlca.sqlcode value to an SPL UDR	SQLCODE Function (SPL)	SQLCODE Function (SPL)
SQRT function	Returns the square root of a numeric argument	Algebraic Functions	SQRT Function
STDEV function	Returns the standard deviation of a data set	Aggregate Expressions	STDEV Function
SUBSTR function	Returns a substring of a source string	SUBSTR function	SUBSTR function
SUBSTRB function	Returns a substring of a source string	SUBSTRB function	SUBSTRB function
SUBSTRING function	Returns a substring of a source string	SUBSTRING function	SUBSTRING function
SUBSTRING_INDEX function	Returns a substring that includes the Nth occurrence of a delimiter	SUBSTRING_INDEX function	SUBSTRING_INDEX function
Substring ([x, y]) operator	Returns a substring from a string operand	Column Expressions	Using the Substring Operator
Subtraction (-) operator	Returns the difference between two numbers	Expression	Arithmetic Operators
SUM function	Returns the sum of a specified set of values	Aggregate Expressions	SUM Function
SYSDATE operator	Returns the current DATETIME value from the system clock.	Constant Expressions	SYSDATE Operator
TAN function	Returns the tangent of a radians expression	Trigonometric Functions	TAN Function
TANH function	Returns the hyperbolic tangent of a radians argument	Trigonometric Functions	TANH Function
TO_CHAR function	Converts a time or number to a character string	Time Functions	TO_CHAR Function
TO_DATE function	Converts a character string to a DATETIME value	Time Functions	TO_DATE Function
TO_NUMBER function	Converts a number or a character string to a DECIMAL value	TO_NUMBER Function	TO_NUMBER Function
TODAY operator	Returns the current system date	Constant Expressions	TODAY Operator
TRIM function	Drops blank pad characters from a character string argument	String-Manipulation Functions	TRIM Function
TRUNC function	Returns a truncated numeric or time value	Algebraic Functions	TRUNC Function
Unary minus (-) sign	Specifies a negative (< 0) numeric value	Expression	Arithmetic Operators
Unary plus (+) sign	Specifies a positive (> 0) numeric value .	Expression	Arithmetic Operators
UNITS operator	Convert an integer to an INTERVAL value	Constant Expressions	UNITS Operator
UPDATING Boolean operator	Returns 't' if triggering event is an UPDATE	Trigger-Type Boolean Operator	Trigger-Type Boolean Operator
UPPER function	Converts lowercase letters to uppercase	Case-Conversion Functions	UPPER Function

Name	Description	Syntax	Usage
User-defined aggregate	Aggregate that a user defines (as opposed to a built-in aggregate)	User-Defined Aggregates	User-Defined Aggregates
User-defined function	Function that a user writes (as opposed to a built-in function)	User-Defined Functions	User-Defined Functions
USER operator	Returns the authorization identifier of the current user	Constant Expressions	USER or CURRENT_USER Operator
Variable	Host or program variable that stores a value	Expression	Expression
VARIANCE function	Returns the variance for a set of numeric values	Aggregate Expressions	VARIANCE Function
WEEKDAY function	Returns an integer code for the day of the week	Time Functions	WEEKDAY Function
Window aggregate functions	Return aggregate results from OLAP window partitions	OLAP window expressions	OLAP window aggregate functions
YEAR function	Returns a 4-digit integer representing a year	Time Functions	YEAR Function
* symbol	See "Multiplication (*) operator"	Expression	Arithmetic Operators
+ symbol	See "Addition" and "Unary plus (+) sign"	Expression	Arithmetic Operators
- symbol	See "Subtraction" and "Unary minus (-) sign"	Expression	Arithmetic Operators
/ symbol	See "Division operator"	Expression	Arithmetic Operators
:: symbols	See "Double-colon (::) cast operator"	CAST Expressions	CAST Expressions
|| symbol	See "Double-pipe ( || ) concatenation operator"	Expression	Concatenation Operator
[first, last] symbols	See "Substring operator"	Column Expressions	Using the Substring Operator

Sections that follow describe the syntax and usage of each expression that appears in the preceding table.

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Arithmetic Operators

Binary arithmetic operators can combine expressions that return numbers.

Arithmetic Operation	Arithmetic Operator	Operator Function		Arithmetic Operation	Arithmetic Operator	Operator Function
Addition	+	plus()		Multiplication	*	times()
Subtraction	-	minus()		Division	/	divide()

The following examples use binary arithmetic operators:

```
quantity * total_price
price * 2
COUNT(*) + 2
```

If you combine a DATETIME value with one or more INTERVAL values, all the fields of the INTERVAL value must be present in the DATETIME value; no implicit EXTEND function is performed. In addition, you cannot use YEAR to MONTH intervals with DAY to SECOND intervals. For additional information about binary arithmetic operators, see the *IBM® Informix® Guide to SQL: Reference*.

The binary arithmetic operators have associated operator functions, as the preceding table shows. Connecting two expressions with a binary operator is equivalent to invoking the associated operator function on the expressions. For example, the following two statements both select the product of the **total_price** column and 2. In the first statement, the * operator implicitly invokes the **times()** function.

```
SELECT (total_price * 2) FROM items
WHERE order_num = 1001;
SELECT times(total_price, 2) FROM items
WHERE order_num = 1001;
```

You cannot use arithmetic operators to combine expressions that use aggregate functions with column expressions.

The database server provides the operator functions associated with the relational operators for all built-in data types. You can define new versions of these operator functions to handle your own user-defined data types.

For more information, see *IBM Informix User-Defined Routines and Data Types Developer's Guide*.

The database server also supports the following unary arithmetic operators.

Sign of Number	Unary Arithmetic Operator	Operator Function
Positive	+	positive()
Negative	-	negate()

The unary arithmetic operators have the associated operator functions that the preceding table shows. You can define new versions of these functions to handle your own user-defined data types. For more information on this topic, see *IBM Informix User-Defined Routines and Data Types Developer's Guide*.

If any value that participates in an arithmetic expression is NULL, the value of the entire expression is NULL, as the following example shows:

```
SELECT order_num, ship_charge/ship_weight FROM orders
WHERE order_num = 1023;
```

If either **ship_charge** or **ship_weight** is NULL, the value returned for the expression **ship_charge/ship_weight** is also NULL. If the NULL expression **ship_charge/ship_weight** is used in a condition, its truth value cannot be TRUE, and the condition is not satisfied (unless the NULL expression is an operand of the **IS NULL** operator).

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Bitwise Logical Functions

Use the bitwise logical functions to perform named bit operations.

Bitwise Logical Functions

```
(1)
|-----+---BITAND----- (--int8_expr--,--int8_expr--) +-----|
| +-BITOR-----+ |
| +-BITXOR-----+ |
| '-BITANDNOT-' |
| '-BITNOT--(--int8_expr--)-----' |
```

Notes:

1. Informix® extension

Element	Description	Restrictions	Syntax
<i>int8_expr</i>	Number expression that can be converted to an INT8 value	For BITNOT the maximum size is reduced by 1	Expression

The arguments to these functions can be any numeric data type that can be converted to the INT8 data type.

Except for **BITNOT**, which takes a single argument, these bitwise logical functions take two arguments that can be converted to an INT8 value.

If both arguments have the same integer types, the data type of the returned value is the same type as the arguments. If the two arguments are of different integer types, the returned value is the integer type with the greater precision. For example, if the first argument is of type INT, and the second argument is of type INT8, the returned value is of type INT8.

If the arguments are any other numeric type, such as DECIMAL, SMALLFLOAT, FLOAT, or MONEY, or some combination of those types, the returned data type is DECIMAL(32).

If using host variables, and the data types of the arguments are not known at prepare time, the data type INTEGER is assumed for both arguments, and the returned value is INTEGER. If, after prepare, at execution time, a different data type value is supplied for the host variable, Informix issues a -9750 error. To prevent such an occurrence, you can specify the host variable data type by using a cast, as in the following ESQL/C program fragment:

```
sprintf(query1, "\n
  bitand( ?::int8, ?::int8) from mytab");
EXEC SQL prepare selectq from :query;
EXEC SQL declare select_cursor cursor for selectq;
EXEC SQL open select_cursor
  using :hostvar_int8_input1, :hostvar_int8_input2;
EXEC SQL fetch select_cursor into :var_int8_output;
```

- [BITAND Function](#)
- [BITOR Function](#)
- [BITXOR Function](#)
- [BITANDNOT Function](#)
- [BITNOT Function](#)

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BITAND Function

The **BITAND** function takes two arguments. The arguments can be any number type value that can be converted to an INT8 value.

Fractional values are truncated before the bit operation. The result is the AND for the two arguments.

If both arguments have the same integer types, the data type of the returned value is the same type as the arguments. If the arguments are of different integer types (for example, INT and INT8), the data type with the greater precision is returned. If the arguments are any other numeric type, such as DECIMAL, SMALLFLOAT, FLOAT, or MONEY, or some combination of those types, the returned data type is DECIMAL(32).

The following example illustrates a query that calls the **BITAND** function:

```
select task_id, task_status,  
decode(bitand(task_status,1), 1, 'Y', 'N') as task_a,  
decode(bitand(task_status,2), 2, 'Y', 'N') as task_b,  
decode(bitand(task_status,4), 4, 'Y', 'N') as task_c  
from tasks;
```

The following table shows the output of this SELECT statement.

task_id	task_status	task_a	task_b	task_c
100	1	Y	N	N
101	1	Y	N	N
102	2	N	Y	N
103	4	N	N	Y
104	6	N	Y	Y
105	3	Y	Y	N
106	5	Y	N	Y
107	7	Y	Y	Y

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BITOR Function

The **BITOR** function takes two arguments. The arguments can be any number type value that can be converted to an INT8 value.

Fractional values are truncated before the bit operation. The result is the bitwise OR of its two arguments.

If both arguments have the same integer types, the data type of the returned value is the same type as the arguments. If the arguments are of different integer types (for example, INT and INT8), the returned type is the type with the greater precision. If the arguments are any other numeric type, such as DECIMAL, SMALLFLOAT, FLOAT, or MONEY, or some combination of those types, the returned data type is DECIMAL(32).

The following example illustrates a query that calls the **BITOR** function:

```
SELECT BITOR(8, 20) AS bitor FROM systables WHERE tabid = 1;
```

The following table shows the output of this SELECT statement.

bitor
28

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BITXOR Function

The **BITXOR** function takes two arguments. The arguments can be any number type value that can be converted to an INT8 value.

Fractional values are truncated before the bit operation. The result is the bitwise XOR of its two arguments.

If both arguments have the same integer types, the data type of the returned value is the same type as the arguments. If the arguments are of different integer types (for example, INT and INT8), the returned type is the type with the greater precision. If the arguments are any other numeric type, such as DECIMAL, SMALLFLOAT, FLOAT, or MONEY, or some combination of those types, the returned data type is DECIMAL(32).

The following example illustrates a query that calls the **BITXOR** function:

```
SELECT BITXOR(41, 33) AS bitxor FROM systables WHERE tabid = 1;
```

The following table shows the output of this SELECT statement.

bitxor
8

This query calls the **BITXOR** function with negative arguments:

```
SELECT BITXOR(-20, -41) AS bitxor FROM systables WHERE tabid = 1;
```

The following table shows the output of this SELECT statement.

bitxor
59

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BITANDNOT Function

The **BITANDNOT** function takes two arguments. The arguments can be any number type value that can be converted to an INT8 value.

Fractional values are truncated before the bit operation. The result is the same as `BITAND(arg1, BITNOT(arg2))` for the two arguments.

If both arguments have the same integer types, the data type of the returned value is the same type as the arguments. If the arguments are of different integer types (for example, `INT` and `INT8`), the returned type is the type with the greater precision. If the arguments are any other numeric type, such as `DECIMAL`, `SMALLFLOAT`, `FLOAT`, or `MONEY`, or some combination of those types, the returned data type is `DECIMAL(32)`.

The query in the following example calls the **BITANDNOT** function:

```
SELECT BITANDNOT(20,-20) AS bitandnot FROM systables WHERE tabid = 1;
```

The following table shows the output of this `SELECT` statement.

bitandnot
16

The following query calls the equivalent **BITAND** and **BITNOT** functions for the arguments in the previous example:

```
select bitand(20, bitnot(-20)) as bitandnot from systables
where tabid = 1;
```

The following table shows the output of this `SELECT` statement.

bitandnot
16

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BITNOT Function

The **BITNOT** function can take any number type value that is one less than the maximum `INT8` value.

Fractional values are truncated before the bit operation. The result is the bitwise NOT of its argument.

The returned data type is the same type as the argument if the argument is `SMALLINT`, `INT`, `BIGINT`, or `INT8`. Otherwise the returned data type is `DECIMAL(32)`.

The following query calls the **BITNOT** function:

```
SELECT BITNOT(8) AS bitnot FROM systables WHERE tabid = 1;
```

The following table shows the output of this `SELECT` statement.

bitnot
-9

The next query calls the **BITNOT** function with a negative argument:

```
SELECT BITNOT(-20) AS bitnot FROM systables WHERE tabid = 1;
```

The following table shows the output of this `SELECT` statement.

bitnot
19

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Concatenation Operator

The concatenation operator is a binary operator, whose syntax is shown in the general diagram for an SQL [Expression](#). You can use the concatenation operator (`||`) to concatenate two expressions that evaluate to character data types or to numeric data types. These examples show some possible concatenated expression combinations.

- The first example concatenates the **zipcode** column to the first three letters of the **lname** column.
- The second example concatenates the suffix **.dbg** to the contents of a host variable called **file_variable**.
- The third example concatenates the value that the **TODAY** operator returns to the string **Date**.

```
lname[1,3] || zipcode
:file_variable || '.dbg'
'Date: ' || TODAY
```

You cannot use the concatenation operator in the following embedded-language statements:

- `ALLOCATE COLLECTION`
- `ALLOCATE DESCRIPTOR`
- `ALLOCATE ROW`
- `CREATE FUNCTION FROM`
- `CREATE PROCEDURE FROM`
- `CREATE ROUTINE FROM`
- `DEALLOCATE COLLECTION`

- DEALLOCATE DESCRIPTOR
- DEALLOCATE ROW DESCRIBE
- DESCRIBE INPUT
- EXECUTE
- FLUSH
- GET DESCRIPTOR
- GET DIAGNOSTICS
- PUT
- SET AUTOFREE
- SET CONNECTION
- SET DESCRIPTOR
- WHENEVER

Except as noted for the DECLARE and PREPARE statement, routines written in external languages, such as the Informix® ESQL/C language, cannot use the concatenation operator in the following dynamic SQL statements:

- CLOSE
- DECLARE
- EXECUTE IMMEDIATE
- FETCH
- FREE
- OPEN
- PREPARE

Although input parameters of the DECLARE statement, such as a *cursor_id* specification, cannot be expressions that include the concatenation operator, Informix ESQL/C routines can use this operator in a SELECT, INSERT, EXECUTE FUNCTION, or EXECUTE PROCEDURE statement within the DECLARE statement.

Informix ESQL/C routines can use the concatenation operator in the text of the SQL statement or statements that you pass to the PREPARE statement.

In SPL routines, you can include the concatenation operator in an expression that specifies the text of the SQL statement that you pass to the EXECUTE IMMEDIATE statement or to the PREPARE statement, even if the calling context of the SPL routine is Informix ESQL/C routines.

You cannot use the concatenation operator directly with user-defined data types, with complex or large-object data types, nor with operands that are not built-in character or number data types. You must explicitly cast UDTs or other unsupported data types to a built-in character or numeric data type before you can pass the result to the concatenation operator.

The data type of the result of a concatenation operation depends of the data types of the operands and on the length of the resulting string, using the return type promotion rules that the section [Return Types from the CONCAT Function](#) describes.

The concatenation operator (||) has an associated operator function called **CONCAT**. The **CONCAT** function cannot be overloaded.

When you define a text-based UDT, you can define a **CONCAT** function to concatenate objects of that user-defined data type. For more information, see *IBM® Informix User-Defined Routines and Data Types Developer's Guide*.

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CAST Expressions

Use the CAST (... AS ...) keywords or the double-colon (::) cast operator to convert the data type of the value of an *expression* to some other *target data type*.

If an SQL statement includes the cast operator or the CAST (... AS ...) keywords, the database server examines the **syscasts** system catalog table for an existing cast corresponding to the data types of the *expression* value and the target data types that the Cast Expression specifies. If no built-in cast, explicit cast, or implicit cast registered in the system catalog can perform the specified conversion, the SQL statement returns an error.

Cast Expressions

```
|---+--CAST--(--expression--+-----+--AS--target_type--+--)|
|                                     | .-----+-----+ | | | |
|                                     | | v | | |
|                                     | '---:--target_type--+-' |
|                                     | | | | |
|                                     | .-----+-----+ |
|                                     | | v | | |
|---+--expression---:--target_type--+-----+-----+---
```

Element	Description	Restrictions	Syntax
<i>expression</i>	Expression whose data type will be replaced by a <i>target_type</i>	Must evaluate to an atomic, or JSON document, or large object, or ROW data type	Expression
<i>target_type</i>	Data type replacing the type returned by <i>expression</i> (or by an intermediate cast)	See Rules for the Target Data Type	Data Type

Usage

A non-recursive cast expression converts a data value from its current data type directly to a specified target data type.

To execute an SQL statement that includes the cast operator or the `CAST (... AS ...)` keywords, the database server searches the **syscasts** system catalog table for an existing cast corresponding to

- the data type of the *expression* value in the **syscasts.argument_type** column,
- and the *target data type* that the Cast Expression specifies in the **syscasts.result_type** column.

If no built-in cast, explicit cast, or implicit cast registered in the **syscasts** table matches these criteria for performing the specified conversion, the database server returns an error.

In this case, you might consider whether a recursive CAST expression is required, using intermediate data types. You might also consider whether you can use the [CREATE CAST statement](#) to define and register in the system catalog an appropriate new explicit or implicit cast for data-type conversion to the target type.

For examples of explicit cast expressions for target types of non-opaque, user-defined, and large object data types, see [Examples of Cast Expressions](#).

Recursive CAST expressions

As the syntax diagram indicates, however, the `::target_type` syntax can be used recursively, so that the value of the original source expression is cast to one or more successive intermediate data types before it is cast to the last target type.

For example, the following expression casts a DATETIME (YEAR TO DAY) value to MONEY(16,2), using DATE, INTEGER, and DECIMAL as intermediate data types:

```
CAST (CURRENT::DATE::INTEGER::DECIMAL AS MONEY(16,2))
```

The next CAST expression, without the `CASE` or `AS` keywords, is logically equivalent:

```
CURRENT::DATE::INTEGER::DECIMAL::MONEY(16,2)
```

Tip: Use caution before interpreting this syntax example, which was designed to illustrate multiple casts within a single CAST expression, as validation of "Time is money" economic theories.

- [Rules for the Target Data Type](#)
- [Examples of Cast Expressions](#)
- [The Keyword NULL in Cast Expressions](#)

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Rules for the Target Data Type

The following rules restrict the *target data type* in cast expressions:

- The target data type must be either a built-in type, a user-defined type, or a named row type in the database.
- The target data type cannot be an unnamed row or a collection type.
- The target data type can be a BLOB data type under the following conditions:
 - The source expression (the expression to be cast to another data type) is a BYTE data type.
 - The source expression is a user-defined type and the user has defined a cast from the user-defined type to the BLOB type.
- The target data type can be a CLOB type under these conditions:
 - The source expression is a TEXT data type.
 - The source expression is a user-defined type and the user has defined a cast from the user-defined type to the CLOB type.
- You cannot cast a BLOB data type to a BYTE data type.
- You cannot cast a CLOB data type to a TEXT data type.
- An explicit or implicit cast must exist that can convert the data type of the source expression to the target data type.

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Examples of Cast Expressions

The following examples show two different ways to convert the sum of *x* and *y* to a user-defined data type, **user_type**. The two methods produce identical results. Both require the existence of an explicit or implicit cast from the type returned by `(x + y)` to the user-defined type:

```
CAST ((x + y) AS user_type)
(x + y)::user_type
```

The following examples show two different ways of finding the integer equivalent of the expression **expr**. Both require the existence of an implicit or explicit cast from the data type of **expr** to the INTEGER data type:

```
CAST (expr AS INTEGER)
expr::INTEGER
```

In the following example, the user casts a BYTE column to the BLOB type and copies the BLOB data to an operating-system file:

```
SELECT LOTOFILE(mybytecol::blob, 'fname', 'client')
FROM mytab
WHERE pkey = 12345;
```

In the following example, the user casts a TEXT column to a CLOB value and then updates a CLOB column in the same table to have the CLOB value derived from the TEXT column:

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Cast expressions can appear in the projection list, including expressions of the form `NULL::datatype`, where *datatype* is any data type known to the database:

The keyword NULL has a global scope of reference within expressions. In SQL, the keyword NULL is the only syntactic mechanism for accessing a NULL value. Any attempt to redefine or restrict the global scope of the keyword NULL (for example, declaring an SPL variable called **null**) disables any cast expression that involves a NULL value. Make sure that the keyword NULL receives its global scope in all expression contexts.

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A *column expression* specifies a data value in a column in the database, or a substring of the value, or a field within a ROW-type column, or a field in a BSON column.

```
|+--+table.+--+column.+--+--+--+|
|+view.+--+| | (1) | | |
|+synonym.+--+| | '-----[-- first--,--last--]-' | |
|'-alias.'+--+| (1) | | |
|+-----ROWID-----+--+--+|
|'-row_column'+-----+--+--+|
| | +.*+-----+--+--+| | |
| | | .+-----+--+--+|
| | V (2) | | |
| | '+----- row_field_name+--+--+|
|+row_col_expr+--+--+--+|
| | +.*+-----+--+--+| | |
| | | .+-----+--+--+|
| | V (2) | | |
| | '+----- row_field_name+--+--+|
|'-BSON_col_expr+--+--+--+|
| | +.*+-----+--+--+| | |
| | | .+-----+--+--+|
| | V (3) | | |
| | '+-----++BSON_field_name+--+--+|
| | '-BSON_array_position-'
```

1. Informix® extension
2. Use path no more than three times
3. Use path no more than 32 times

782 Part VIII: SQL programming

Element	Description	Restrictions	Syntax
<i>row_column</i>	Name of a ROW-type column	Must be a named ROW data type or an unnamed ROW data type	Identifier
<i>row_field_name</i>	Name of a ROW field in the ROW column or ROW-column expression	Must be a member of the row that <i>row_column name</i> or <i>row_col_expr</i> or <i>row_field name</i> (for nested rows) specifies	Identifier
<i>synonym, table, view</i>	Table, view, or synonym (for the table or view) that contains <i>column</i>	Synonym and the table or view to which it points must exist	Database Object Name

You qualify a column name with a table name or alias to distinguish between columns that have the same name but are in different tables. You use dot notation to select a field from a ROW or a BSON column.

The following examples illustrate some formats of column expressions:

- Unqualified column name: `company`
- Column name that is qualified by table name: `items.price`
- Substring of a character-type column: `catalog_advert [1,15]`
- Multilevel BSON field identifier: `bson_col.person.cars.1`

In syntax contexts that support a default value for a column, you can omit the default column expression.

Example: Qualify columns with table names

The following statement, two column expressions qualify the column name, **customer_num**, with the table names **customer** and **orders**:

```
SELECT * FROM customer, orders
WHERE customer.customer_num = orders.customer_num;
```

Example: Qualify columns with table aliases

The following statement includes column expressions that qualify column name, **customer_num**, with the table aliases **c** and **o**:

```
SELECT * FROM customer c, orders o
WHERE c.customer_num = o.customer_num;
```

Example: Select a field from a ROW column

The following statements creates a table with a ROW column that is named **rect** and that has four fields:

```
CREATE TABLE rectangles
(
    area float,
    rect ROW(x int, y int, length float, width float)
);
```

The following statement uses dot notation to access the **length** field of the **rect** column:

```
SELECT rect.length FROM rectangles
WHERE area = 64;
```

Example: Select a multilevel field from a BSON column

The following statements create and populate a BSON column that is named **bson_col**:

```
CREATE DATABASE testdb WITH LOG;
CREATE TABLE IF NOT EXISTS bson_table(bson_col BSON);

INSERT INTO bson_table VALUES (
    '{person: {givenname: "Jim", surname: "Flynn", age: 29, cars: ["dodge", "olds"]}}'
    ::JSON::BSON);
```

Nested in the **person** field is an array that is named **cars**, which has two values. The values in arrays do not have field names. You specify array values with numbers that represent the position in the array, starting with 0 for the first value.

The following statement selects the second value in the **cars** array that is nested in the **person** field:

```
SELECT bson_col.person.cars.1::JSON FROM bson_table;
```

```
(expression)
{cars:"olds"}
```

- [Using Dot Notation](#)
- [Using the Substring Operator](#)
- [Using Rowids](#)
- [Using Smart Large Objects](#)

Related concepts:

Using Dot Notation

Dot notation (sometimes called the *membership operator*) qualifies an SQL identifier with another SQL identifier of which it is a component. You separate the identifiers with the period (.) symbol.

Column projections qualify a column name with the following SQL identifiers:

- Table name: *table_name.column_name*
- View name: *view_name.column_name*
- Synonym name: *syn_name.column_name*

Field projections directly access fields in a ROW or a BSON column: *column_name.field_name*. BSON documents can have a hierarchical structure. You can specify multiple fields and positions in arrays, each separated by a period. A field name or array position must be preceded by all its ancestor field names.

- [Selecting All Fields of a ROW Column with Asterisk Notation](#)
- [Selecting Nested Fields](#)
- [Rules of Precedence](#)
- [Using Dot Notation with Row-Type Expressions](#)

Selecting All Fields of a ROW Column with Asterisk Notation

If you want to select all fields of a column that has a ROW type, you can specify the column name without using dot notation. For example, you can select all fields of the **rect** column as follows:

```
SELECT rect FROM rectangles
WHERE area = 64;
```

You can also use asterisk (*) notation to project all the fields of a column that has a ROW data type. For example, if you want to use asterisk notation to select all fields of the **rect** column, you can enter the following statement:

```
SELECT rect.* FROM rectangles
WHERE area = 64;
```

Asterisk notation is easier than specifying each field of the **rect** column individually:

```
SELECT rect.x, rect.y, rect.length, rect.width
FROM rectangles
WHERE area = 64;
```

Asterisk notation for ROW fields is valid in the projection list of a SELECT statement. It can specify all fields of a ROW-type column or the data that a ROW-column expression returns.

Asterisk notation is not necessary with ROW-type columns, because you can specify the column name alone to project all of its fields. Asterisk notation is quite helpful, however, with ROW-type expressions such as subqueries and user-defined functions that return ROW-type values. For more information, see [Using Dot Notation with Row-Type Expressions](#).

You can use asterisk notation with columns and expressions of ROW data types in the projection list of a SELECT statement only. You cannot use asterisk notation with columns and expressions of ROW type in any other clause of a SELECT statement.

Selecting Nested Fields

When the ROW type that defines a column itself contains other ROW types, the column contains nested fields. Use dot notation to access these nested fields within a column.

For example, assume that the **address** column of the **employee** table contains the fields: **street**, **city**, **state**, and **zip**. In addition, the **zip** field contains the nested fields: **z_code** and **z_suffix**. A query on the **zip** field returns values for the **z_code** and **z_suffix** fields. You can specify, however, that a query returns only specific nested fields. The following example shows how to use dot notation to construct a SELECT statement that returns rows for the **z_code** field of the **address** column only:

```
SELECT address.zip.z_code
FROM employee;
```

Rules of Precedence

The database server uses the following precedence rules to interpret dot notation:

1. schema *name_a* . table *name_b* . column *name_c* . field *name_d*
2. table *name_a* . column *name_b* . field *name_c* . field *name_d*
3. column *name_a* . field *name_b* . field *name_c* . field *name_d*

When the meaning of an identifier is ambiguous, the database server uses precedence rules to determine which database object the identifier specifies. Consider the following two tables:

```
CREATE TABLE b (c ROW(d INTEGER, e CHAR(2)));
CREATE TABLE c (d INTEGER);
```

In the following SELECT statement, the expression **c.d** references column **d** of table **c** (rather than field **d** of column **c** in table **b**) because a table identifier has a higher precedence than a column identifier:

```
SELECT *
FROM b,c
WHERE c.d = 10;
```

For more information about precedence rules and how to use dot notation with ROW columns, see the *IBM® Informix® Guide to SQL: Tutorial*.

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Using Dot Notation with Row-Type Expressions

Besides specifying a column of a ROW data type, you can also use dot notation with any expression that evaluates to a ROW type. In an INSERT statement, for example, you can use dot notation in a subquery that returns a single row of values. Assume that you created a ROW type named **row_t**:

```
CREATE ROW TYPE row_t (part_id INT, amt INT);
```

Also assume that you created a typed table named **tab1** that is based on the **row_t** ROW type:

```
CREATE TABLE tab1 OF TYPE row_t;
```

Assume also that you inserted the following values into table **tab1**:

```
INSERT INTO tab1 VALUES (ROW(1,7));
INSERT INTO tab1 VALUES (ROW(2,10));
```

Finally, assume that you created another table named **tab2**:

```
CREATE TABLE tab2 (colx INT);
```

Now you can use dot notation to insert the value from only the **part_id** column of table **tab1** into the **tab2** table:

```
INSERT INTO tab2
VALUES ((SELECT t FROM tab1 t
WHERE part_id = 1).part_id);
```

The asterisk form of dot notation is not necessary when you want to select all fields of a ROW-type column because you can specify the column name alone to select all of its fields. The asterisk form of dot notation can be quite helpful, however, when you use a subquery, as in the preceding example, or when you call a user-defined function to return ROW-type values.

Suppose that a user-defined function named **new_row** returns ROW-type values, and you want to call this function to insert the ROW-type values into a table. Asterisk notation makes it easy to specify that all the ROW-type values that the **new_row()** function returns are to be inserted into the table:

```
INSERT INTO mytab2 SELECT new_row (mycol).* FROM mytab1;
```

References to the fields of a ROW-type column or a ROW-type expression are not allowed in fragment expressions. A fragment expression is an expression that defines a table fragment or an index fragment in SQL statements like CREATE TABLE, CREATE INDEX, and ALTER FRAGMENT.

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Using the Substring Operator

You can use the substring operator on CHAR, VARCHAR, NCHAR, NVARCHAR, BYTE, and TEXT columns to define a *column substring* as the portion of the column that is specified by the expression.

After the identifier of a character column, when a pair of bracket ([]) symbols enclose a comma-separated pair of unsigned integers in which the *first* integer is greater than zero but not greater than the *last* integer, Informix® interprets the brackets as the substring operator. The expression returns the *first* through *last* characters of the data value in the column, where *first* and *last* define a substring. For example, in the expression `cat_advert [6,15]`, the returned value is the 6th through 15th characters of column **cat_advert**.

In the default locale, if the data value occupies at least 15 bytes, this expression evaluates to a substring that includes ten bytes of the column value, but in a multibyte locale this expression returns a string of ten consecutive logical characters whose storage length might exceed 10 bytes, beginning with the sixth logical character. For more information on the GLS aspects of column substrings, see the *IBM® Informix GLS User's Guide*.

In the following example, if a value in the **lname** column of the **customer** table is *Greenburg*, the following expression evaluates to *burg*:

```
lname[6,9]
```

A conditional expression can include a column expression that uses the substring operator ([*first*, *last*]), as in the following example:

```
SELECT lname FROM customer WHERE phone[5,7] = '356';
```

Here the quotation marks are required, to prevent the database server from applying a numeric filter to the digits in the criterion value.

See also the section [String-Manipulation Functions](#), which describes two built-in SQL functions, **SUBSTR()** and **SUBSTRING()** that can specify a substring expression within an SQL statement.

Note: The database server can use substrings defined by the substring operator as index filters in queries. This is not the case, however, for substrings defined by **SUBSTR()** or **SUBSTRING()**, nor for other built-in string manipulation functions.

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Using Rowids

In Informix®, you can use the **rowid** column that is associated with a table row as a property of the row. The **rowid** column is essentially a hidden column in nonfragmented tables and in fragmented tables that were created with the WITH ROWIDS clause. The **rowid** column is unique for each row, but it is not necessarily sequential. It is recommended, however, that you use primary keys as an access method rather than exploiting the **rowid** column.

The following examples use the ROWID keyword in a SELECT statement:

```
SELECT *, ROWID FROM customer;
```

```
SELECT fname, ROWID FROM customer ORDER BY ROWID;
```

```
SELECT HEX(rowid) FROM customer WHERE customer_num = 106;
```

The last example shows how to get the page number (the first six digits after 0x) and the slot number (the last two digits) of the location of your row.

You cannot use the ROWID keyword in the select list of the Projection clause of a query that contains an aggregate function.

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Using Smart Large Objects

The SELECT, UPDATE, and INSERT statements do not manipulate the values of smart large objects directly. Instead, they use a *handle value*, which is a type of pointer, to access the BLOB or CLOB value, as follows:

- The SELECT statement returns a handle value to the BLOB or CLOB value that the projection list specifies. SELECT does not return the actual data for the BLOB or CLOB column that the projection list specifies. Instead, it returns a handle value to the column data.
- The INSERT and UPDATE statements do not send the actual data for the BLOB or CLOB column to the database server. Instead, they accept a handle value to this data as the value to be inserted or updated.

To access the data of a smart-large-object column, you must use one of the following application programming interfaces (APIs):

- From within IBM® Informix® ESQL/C programs, use the Informix ESQL/C library functions that access smart large objects. For more information, see the *IBM Informix ESQL/C Programmer's Manual*.
- From within a C program such as a DataBlade module, use the Client and Server API. For more information, see your *IBM Informix DataBlade Developers Kit User's Guide*.

You cannot use the name of a smart-large-object column in expressions that involve arithmetic operators. For example, operations such as addition or subtraction on the smart-large-object handle value have no meaning.

When you select a smart-large-object column, you can assign the handle value to any number of columns: all columns with the same handle value share the CLOB or BLOB value. This storage arrangement reduces the amount of disk space that the CLOB or BLOB value, but when several columns share the same smart-large-object value, the following conditions result:

- The chance of lock contention on a CLOB or BLOB column increases. If two columns share the same smart-large-object value, the data might be locked by either column that needs to access it.
- The CLOB or BLOB value can be updated from a number of points.

To remove these constraints, you can create separate copies of the BLOB or CLOB data for each column that needs to access it. You can use the **LOCOPY** function to create a copy of an existing smart large object.

You can also use the built-in functions **LOTOFILE**, **FILETOCLOB**, and **FILETOBLOB** to access smart-large-object values, as described in [Smart-Large-Object Functions](#). For more information on the BLOB and CLOB data types, see the *IBM Informix Guide to SQL: Reference*.

Related information:


```
SELECT . . .
      SUM(orders.ship_weight) as o2,
      COUNT(DISTINCT
        CASE WHEN orders.backlog MATCHES 'n'
              THEN orders.order_num END ) AS o3,
      . . .
```

Here the argument to **SUM** is a DECIMAL(8,2) column value, and the **COUNT DISTINCT** aggregate takes a **CASE** expression as its argument. Do not confuse CASE expressions with the CASE statement of SPL, which supports different syntax and functionality.

- [CASE expressions data type compatibility](#)
In a CASE expression, all the results should be of the same data type or be compatible data types.
- [Generic CASE Expressions](#)
A generic CASE expression tests for a true condition in a WHEN clause. If it finds a true condition, it returns the result specified in the THEN clause.
- [Linear CASE Expressions](#)

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CASE expressions data type compatibility

In a CASE expression, all the results should be of the same data type or be compatible data types.

If the results in all the WHEN ... THEN branch clauses are not of the same data type or compatible data types, an error occurs.

The following table shows which character data types are compatible and the data type that is returned for each combination.

Table 1. Data types returned from compatible character data types

Data type	NCHAR (>255)	NCHAR (<=255)	NVARCHAR	CHAR (<=255)	CHAR (>255)	VARCHAR	LVARCHAR (>255)	LVARCHAR (<=255)
NCHAR (>255)	NCHAR	NCHAR	NCHAR	NCHAR	NCHAR	NCHAR	NCHAR	NCHAR
NCHAR (<=255)	NCHAR	NCHAR	NVARCHAR	NCHAR	NCHAR	NVARCHAR	NCHAR	NCHAR
NVARCHAR	NCHAR	NVARCHAR	NVARCHAR	NVARCHAR	NCHAR	NVARCHAR	NCHAR	NVARCHAR
CHAR (<=255)	NCHAR	NCHAR	NVARCHAR	CHAR	CHAR	VARCHAR	CHAR	CHAR
CHAR (>255)	NCHAR	NCHAR	NCHAR	CHAR	CHAR	CHAR	CHAR	CHAR
VARCHAR	NCHAR	NVARCHAR	NVARCHAR	VARCHAR	CHAR	VARCHAR	CHAR	VARCHAR
LVARCHAR (>255)	NCHAR	NCHAR	NCHAR	CHAR	CHAR	CHAR	LVARCHAR	LVARCHAR
LVARCHAR (<=255)	NCHAR	NCHAR	NVARCHAR	CHAR	CHAR	VARCHAR	LVARCHAR	LVARCHAR

The following table shows which numeric data types are compatible and the data type that is returned for each combination.

Table 2. Data types returned from compatible numeric data types

Data type	INTEGER	SMALLINT	SERIAL	DECIMAL	FLOAT	SMALLFLOAT	MONEY	BIGINT	BIGSERIAL
INTEGER	INTEGER	INTEGER	INTEGER	DECIMAL	DECIMAL	DECIMAL	MONEY	DECIMAL	DECIMAL
SMALLINT	INTEGER	SMALLINT	INTEGER	DECIMAL	DECIMAL	DECIMAL	MONEY	DECIMAL	DECIMAL
SERIAL	INTEGER	INTEGER	SERIAL	DECIMAL	DECIMAL	DECIMAL	MONEY	DECIMAL	DECIMAL
DECIMAL	DECIMAL	DECIMAL	DECIMAL	DECIMAL	DECIMAL	DECIMAL	MONEY	DECIMAL	DECIMAL
FLOAT	DECIMAL	DECIMAL	DECIMAL	DECIMAL	FLOAT	FLOAT	MONEY	DECIMAL	DECIMAL
SMALLFLOAT	DECIMAL	DECIMAL	DECIMAL	DECIMAL	FLOAT	SMALLFLOAT	MONEY	DECIMAL	DECIMAL
MONEY	MONEY	MONEY	MONEY	MONEY	MONEY	MONEY	MONEY	MONEY	MONEY
BIGINT	DECIMAL	DECIMAL	DECIMAL	DECIMAL	DECIMAL	DECIMAL	MONEY	BIGINT	BIGINT
BIGSERIAL	DECIMAL	DECIMAL	DECIMAL	DECIMAL	DECIMAL	DECIMAL	MONEY	BIGINT	BIGSERIAL

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Generic CASE Expressions

A generic CASE expression tests for a true condition in a WHEN clause. If it finds a true condition, it returns the result specified in the THEN clause.

Generic CASE Expression

```
-----
V              (1)              I
```

```

|--CASE----WHEN--| Condition |-----THEN--+-expr-+-+----->
                                     '-NULL-'

>--+-----+---END-----|
  '-ELSE--+-expr-+-'
        '-NULL-'

```

Notes:

1. See [Condition](#)

Element	Description	Restrictions	Syntax
<i>expr</i>	Expression that returns some data type	Data type of <i>expr</i> in a THEN clause must be compatible with data types of expressions in other THEN clauses	Expression

The database server processes the WHEN clauses in the order that they appear in the statement. If the search condition of a WHEN clause evaluates to **TRUE**, the database server uses the value of the corresponding THEN expression as the result, and stops processing the CASE expression.

If no WHEN condition evaluates to **TRUE**, the database server uses the ELSE expression as the overall result. If no WHEN condition evaluates to **TRUE**, and no ELSE clause was specified, the returned CASE expression value is NULL. You can use the IS NULL condition to handle NULL results. For information on how to handle NULL values, see [IS NULL and IS NOT NULL Conditions](#).

The next example shows a generic CASE expression in the Projection clause.

In this example, the user retrieves the name and address of each customer as well as a calculated number that is based on the number of problems that exist for that customer:

```

SELECT cust_name,
       CASE
         WHEN number_of_problems = 0
           THEN 100
         WHEN number_of_problems > 0 AND number_of_problems < 4
           THEN number_of_problems * 500
         WHEN number_of_problems >= 4 and number_of_problems <= 9
           THEN number_of_problems * 400
         ELSE
           (number_of_problems * 300) + 250
       END,
       cust_address
FROM custtab

```

In a generic CASE expression, all the results should be of the same data type, or they should evaluate to a common compatible data type. If the results in all the WHEN clauses are not of the same data type, or if they do not evaluate to values of mutually compatible types, an error occurs. For more information on the compatibility of returned data types, see [CASE expressions data type compatibility](#).

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Linear CASE Expressions

A linear CASE expression compares the value of the expression that follows the CASE keyword with an expression in a WHEN clause.

Linear CASE Expression

```

.-----|.
V       |
|--CASE--expr---WHEN--expr--THEN--+-expr-+-+----->
                                     '-NULL-'

>--+-----+---END-----|
  '-ELSE--+-expr-+-'
        '-NULL-'

```

Element	Description	Restrictions	Syntax
<i>expr</i>	Expression that returns a value of some data type	Data type of <i>expr</i> that follows the WHEN keyword must be compatible with data type of the expression that follows the CASE keyword. Data type of <i>expr</i> in the THEN clause must be compatible with data types of expressions in other THEN clauses.	Expression

The database server evaluates the expression that follows the CASE keyword, and then processes the WHEN clauses sequentially. If an expression after the WHEN keyword returns the same value as the expression that follows the CASE keyword, the database server uses the value of the expression that follows the THEN keyword as the overall result of the CASE expression. Then the database server stops processing the CASE expression.

If none of the WHEN expressions return the same value as the expression that follows the CASE keyword, the database server uses the expression of the ELSE clause as the overall result of the CASE expression (or, if no ELSE clause was specified, the returned value of the CASE expression is NULL).

The next example shows a linear CASE expression in the projection list of the Projection clause of a SELECT statement. For each movie in a table of movie titles, the query returns the title, the cost, and the type of the movie. The statement uses a CASE expression to derive the type of each movie:

```

SELECT title, CASE movie_type
              WHEN 1 THEN 'HORROR'
              WHEN 2 THEN 'COMEDY'

```

In linear CASE expressions, the data types of WHEN clause expressions must be compatible with that of the expression that follows the CASE keyword

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The COALESCE function returns the first non-NULL value from a series of expressions.

COALESCE Function

```

      .------.
      v               |
|--COALESCE--(--expression--+---+---+---+---+---+---+---)-----
                        '-.--expression-'

```

Element	Description	Restrictions	Syntax
<i>expression</i>	An expression that returns a value of a compatible data type with the other expressions in the function	Cannot be a host variable or a BYTE or TEXT object	Expression

The expressions are evaluated in the order in which they are specified, and the result of the function is the first value that is not null. The result of the COALESCE function returns NULL only if all the arguments are null. The expressions can return any data type that can be cast to a common compatible data type.

Suppose that the **addr** column of the **employees** table has NULL values in some rows, and that you want to print the label `Address unknown` for these rows. Run the following SELECT statement to display the label `Address unknown` when the **addr** column has a NULL value:

```
SELECT fname, COALESCE (addr, 'Address unknown') AS address
FROM employees;
```

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The **NVL** expression returns different results, depending on whether its first argument evaluates to NULL.

NVL Function

```
|--NVL--(--expr1--,--expr2--)-----|
```

Element	Description	Restrictions	Syntax
<i>expr1 expr2</i>	Expressions that return values of a compatible data type	Cannot be a host variable or a BYTE or TEXT object	Expression

NVL evaluates *expression1*. If *expression1* is not NULL, then **NVL** returns the value of *expression1*. If *expression1* is NULL, **NVL** returns the value of *expression2*. The expressions *expression1* and *expression2* can be of any data type, as long as they can be cast to a common compatible data type.

Suppose that the **addr** column of the **employees** table has NULL values in some rows, and the user wants to be able to print the label `Address unknown` for these rows. The user enters the following SELECT statement to display the label `Address unknown` when the **addr** column has a NULL value:

```
SELECT fname, NVL (addr, 'Address unknown') AS address
FROM employees;
```

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The **NULLIF** expression returns different results, depending on whether its two arguments are equal.

NULLIF Function

```
|--NULLIF--(--expr1--,--expr2--)-----
```

Element	Description	Restrictions	Syntax
<i>expr1 expr2</i>	Expressions that return values of a compatible data type	Cannot be a BYTE or TEXT data type	Expression

NULLIF evaluates its two arguments, *expr1* and *expr2*.

- If their values are equal, then **NULLIF** returns NULL.
- If their values are not equal, then **NULLIF** returns *expr1*.

The *expr1* and *expr2* arguments can be of any data type for which a built-in comparison function exists, or any two data types that can be cast to a compatible data type that has a built-in comparison function.

The following example uses the **NULLIF** function to convert Boolean FALSE values ('f') to NULL values:

```
SELECT name, answer, NULLIF(answer, 'f') FROM booktab;
```

Here the first argument is a Boolean column expression that can have true ('t') or false ('f') values, and the second Boolean argument is always 'f' (for FALSE). For rows that have 'f' in the **answer** column, the value returned by the **NULLIF** function will be NULL (because the NULL value is returned when the arguments are equal). For rows that have 't' as the first argument, however, the value returned by **NULLIF** is always 't', because the two arguments cannot be equal when one is 't' and the other is 'f'; the first argument is returned when the two values are not equal.

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DECODE Function

The **DECODE** expression is similar to the CASE expression in that it can print different results depending on the values found in a specified column.

DECODE Function

```
      .-,------.
      V              | .-,--NULL-----.
|--DECODE--(--expr--,---when_expr--,--then_expr--+-----)---|
              '-NULL-----'      '-,--else_expr--'
```

Element	Description	Restrictions	Syntax
<i>expr</i> , <i>else_expr</i> , <i>then_expr</i> , <i>when_expr</i>	Expressions whose values and data types can be evaluated	Data types of <i>when_expr</i> and <i>expr</i> must be compatible, as must <i>then_expr</i> and <i>else_expr</i> . Value of <i>when_expr</i> cannot be a NULL.	Expression

The expressions *expr*, *when_expr*, and *then_expr* are required. **DECODE** evaluates *expr* and compares it to *when_expr*. If the value of *when_expr* matches the value of *expr*, then **DECODE** returns *then_expr*.

The expressions *when_expr* and *then_expr* are an expression pair, and you can specify any number of expression pairs in the **DECODE** function. In all cases, **DECODE** compares the first member of the pair against *expr* and returns the second member of the pair if the first member matches *expr*.

If no expression matches *expr*, **DECODE** returns *else_expr*. If no expression matches *expr* and you specified no *else_expr*, then **DECODE** returns NULL.

You can specify any data type for the arguments, but two restrictions exist:

- All instances of *when_expr* must have the same data type, or a common compatible type must exist. All instances of *when_expr* must also have the same (or a compatible) data type as *expr*.
- All instances of *then_expr* must have the same data type, or a common compatible type must exist. All instances of *then_expr* must also have the same (or a compatible) data type as *else_expr*.

The **DECODE** function uses the same data type compatibility rules as a CASE expression. For more information on the compatibility of returned data types, see [CASE expressions data type compatibility](#).

Example

Suppose that a user wants to convert descriptive values in the **evaluation** column of the **students** table to numeric values in the output. The following table shows the contents of the **students** table.

firstname	evaluation		firstname	evaluation
Edward	Great		Mary	Good
Joe	Not done		Jim	Poor

The user now enters a query with the **DECODE** function to convert the descriptive values in the **evaluation** column to numeric equivalents:

```
SELECT firstname, DECODE(evaluation,
    'Poor', 0,
    'Fair', 25,
    'Good', 50,
    'Very Good', 75,
    'Great', 100,
    -1) as grade
FROM students;
```

The following table shows the output of this SELECT statement.

firstname	evaluation		firstname	evaluation
Edward	100		Mary	50
Joe	-1		Jim	0

Constant Expressions

Certain expressions that return a fixed value are called *constant expressions*. These include variant function operators that read the system clock, but that are valid in contexts where literal constants are also valid.

Among these expressions are the following operators (or *system constants*) whose returned values are determined at runtime:

- **CURRENT** returns the current time and date from the system clock.
- **CURRENT_ROLE** returns the name of the role, if any, whose privileges are enabled for the current user.
- **CURRENT_USER** is a synonym for **USER**.
- **DEFAULT_ROLE** returns the name of the role, if any, that is the default role for the current user.
- **DBSERVERNAME** returns the name of the current database server.
- **SITENAME** is a synonym for **DBSERVERNAME**.
- **SYSDATE** reads the DATETIME value from the system clock like the **CURRENT** operator, but has a different default precision.
- **TODAY** returns the current calendar date from the system clock.
- **USER** returns the login name (also called the *authorization identifier*) of the current user.

Besides these operators, the term *constant expression* can also refer to a quoted string, to a literal value, or to the **UNITS** operator with its operands.

The Constant Expression segment has the following syntax.

Constant Expressions

```

(1)
|--+| Quoted String |-----+
|
| (2)
|+| Literal Number |-----+
|+--+USER-----+
| | '-CURRENT_USER-' |
| | (3) |
| | '-----+CURRENT_ROLE--+
| | '-DEFAULT_ROLE-' |
| (3) |
|'-----+--+SITENAME-----+
| | '-DBSERVERNAME-' |
|+--TODAY-----+
|+--+CURRENT--+-----+
| | '-SYSDATE-' '- precision -' |
| | (4) |
|+| Literal DATETIME |-----+
| | (5) |
|+| Literal INTERVAL |-----+
|+num--+UNITS--+time_unit-----+
|'-----+--+ sequence +--+ . +--+CURRVAL--+--+
| | '- owner-- . ' '- synonym --' '-NEXTVAL-' |
| | (6) |
|+| Literal Collection |-----+
| | (7) |
|+| Literal Row |-----+
|+literal opaque type-----+
|'-literal BOOLEAN-----+'

```

Notes:

1. See [Quoted String](#)
2. See [Literal Number](#)
3. Informix® extension
4. See [Literal DATETIME](#)
5. See [Literal INTERVAL](#)
6. See [Literal Collection](#)
7. See [Literal Row](#)

Element	Description	Restrictions	Syntax
<i>literal Boolean</i>	Literal representation of a BOOLEAN value	Must be either <i>t</i> (TRUE) or <i>f</i> (FALSE)	Quoted String
<i>literal opaque type</i>	Literal representation of value of an opaque data type	Must be recognized by the input support function of opaque type	Defined by UDT developer
<i>num</i>	How many of specified time units. See UNITS Operator .	If <i>num</i> is not an integer, the fractional part is truncated	Literal Number
<i>owner</i>	Name of the owner of sequence	Must own sequence	Owner name
<i>precision</i>	Precision of the returned DATETIME expression	On Windows systems the maximum scale of seconds is FRACTION(3).	DATETIME Field Qualifier
<i>sequence</i>	Name of a sequence	Must exist in current database	Identifier
<i>synonym</i>	Synonym for the name of a sequence	Must exist in current database	Identifier

Element	Description	Restrictions	Syntax
<i>time_unit</i>	Keyword to specify time unit: YEAR, MONTH, DAY, HOUR, MINUTE, SECOND, or FRACTION	Must be one of the keywords at left. Case insensitive but cannot be enclosed within quotes	See the Restrictions column.

- [Quoted String](#)
- [Literal Number](#)
A literal number specifies a numeric value.
- [USER or CURRENT_USER Operator](#)
- [CURRENT_ROLE Operator](#)
- [DEFAULT_ROLE Operator](#)
- [DBSERVERNAME and SITENAME Operators](#)
The **DBSERVERNAME** operator returns the SQL identifier of the database server, as defined by the DBSERVERNAME parameter in the ONCONFIG file for the Informix instance where the current database resides, or as specified in the **INFORMIXSERVER** environment variable. **SITENAME** is a keyword synonym for the **DBSERVERNAME** operator.
- [TODAY Operator](#)
- [CURRENT Operator](#)
- [SYSDATE Operator](#)
- [Literal DATETIME](#)
A literal DATETIME specifies the value of an DATETIME data type, including its qualifying time-units.
- [Literal INTERVAL](#)
A literal INTERVAL specifies the value of an INTERVAL data type, including its qualifying time-units.
- [UNITS Operator](#)
- [NEXTVAL and CURRVAL Operators](#)
- [Literal Row](#)
- [Literal Collection](#)

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Quoted String

The following examples show quoted strings as expressions:

```
SELECT 'The first name is ', fname FROM customer;

INSERT INTO manufact VALUES ('SPS', 'SuperSport');

UPDATE cust_calls SET res_dtime = '2007-1-1 10:45'
WHERE customer_num = 120 AND call_code = 'B';
```

For more information, see [Quoted String](#).

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Literal Number

A literal number specifies a numeric value.

The following examples show literal numbers as expressions:

```
INSERT INTO items VALUES (4, 35, 52, 'HRO', 12, 4.00);

INSERT INTO acreage VALUES (4, 5.2e4);

SELECT unit_price + 5 FROM stock;

SELECT -1 * balance FROM accounts;
```

For more information, see [Literal Number](#).

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USER or CURRENT_USER Operator

The **USER** operator returns a string containing the login name (also called the authorization identifier) of the current user who is running the process. The **CURRENT_USER** operator is a synonym of the **USER** operator.

The following statements show how you might use the **USER** operator:

```
INSERT INTO cust_calls VALUES
(221,CURRENT_USER,'B','Decimal point off', NULL, NULL);
```

```
SELECT * FROM cust_calls WHERE user_id = USER;

UPDATE cust_calls SET user_id = USER WHERE customer_num = 220;
```

The **USER** operator does not change the lettercase of a user ID. If you use **USER** in an expression and the current user is **Robertm**, the **USER** operator returns **Robertm**, not **robertm** or **ROBERTM**.

If you specify **USER** as a default column value, *column* must be of type CHAR, VARCHAR, NCHAR, NVARCHAR, or LVARCHAR.

If you specify **USER** as the default value for a column, the size of *column* should not be less than 32 bytes. You risk getting an error during operations such as INSERT or ALTER TABLE if the column length is too small to store the default value.

In an ANSI-compliant database, if you do not enclose the *owner* name in quotation marks, the name of the table owner is stored as uppercase letters. If you use the **USER** operator as part of a condition, you must be sure that the way the *user* name is stored matches what the **USER** operator returns with respect to lettercase.

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CURRENT_ROLE Operator

The **CURRENT_ROLE** operator returns a string that contains the name of the currently enabled role of the user who is running the session. This *role* was either set in the session explicitly, using the SET ROLE statement, or else implicitly as a default role when the current user connected to the database. If the user holds no role, or if no role that was granted to the user is currently enabled, **CURRENT_ROLE** returns a NULL value. If the user has been granted no role individually, but a default role has been granted to PUBLIC, and this default role has been explicitly or implicitly enabled, **CURRENT_ROLE** returns the name of this default role.

The next statement shows how you might use the **CURRENT_ROLE** operator:

```
select CURRENT_ROLE FROM systables WHERE tabid = 1;
```

The **CURRENT_ROLE** operator does not change the lettercase of the identifier of a role. If you use **CURRENT_ROLE** in an expression and your current role is **Czarina**, the **CURRENT_ROLE** operator returns **Czarina**, not **czarina**.

If you specify **CURRENT_ROLE** as the default value for a column, the column must have a CHAR, VARCHAR, LVARCHAR, NCHAR, or NVARCHAR data type. Because the name of a role is an authorization identifier, truncation might occur if the column length is less than 32 bytes.

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DEFAULT_ROLE Operator

The **DEFAULT_ROLE** operator evaluates to a string that contains the name of the default role that has been granted to the user who is running the session. This default role need not be currently enabled, but it must not have been revoked since the most recent GRANT DEFAULT ROLE statement that referenced the user or PUBLIC in the TO clause.

If no default role is explicitly defined for the current user, but PUBLIC has a default role, **DEFAULT_ROLE** returns the default role of PUBLIC.

If the user has no default role, or if the default role that was most recently granted to the user explicitly, or as PUBLIC, was subsequently revoked by the REVOKE DEFAULT ROLE statement, **DEFAULT_ROLE** returns a NULL value. If the user has been granted no default role individually, but a default role has been granted to PUBLIC, the **DEFAULT_ROLE** operator returns the name of this default role. If no default role is currently defined for the user nor for PUBLIC, however, **DEFAULT_ROLE** returns NULL.

The SET ROLE statement has no effect on the **DEFAULT_ROLE** operator, but any access privileges of the default role are not necessarily available to the user if SET ROLE has activated some other role, or if SET ROLE specified NULL or NONE as the current role of the user.

The next statements show how you might use the **DEFAULT_ROLE** operator:

```
select DEFAULT_ROLE from systables where tabid = 1;
```

DEFAULT_ROLE does not change the lettercase of the identifier of a role.

If you specify **DEFAULT_ROLE** as the default value for a column, the column must have a CHAR, VARCHAR, LVARCHAR, NCHAR, or NVARCHAR data type. Because the name of a role is an authorization identifier, truncation might occur if the column width is less than 32 bytes. (See [Owner name](#) for the syntax of authorization identifiers.)

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DBSERVERNAME and SITENAME Operators

The **DBSERVERNAME** operator returns the SQL identifier of the database server, as defined by the DBSERVERNAME parameter in the ONCONFIG file for the Informix® instance where the current database resides, or as specified in the **INFORMIXSERVER** environment variable. **SITENAME** is a keyword synonym for the **DBSERVERNAME** operator.

You can use the **DBSERVERNAME** operator to specify the location of a table, to put information into a table, or to extract information from a table. You can insert **DBSERVERNAME** into a simple character field or use it as a default value for a column.

If you specify **DBSERVERNAME** as a default column value in the CREATE TABLE or ALTER TABLE statements, the column must be a CHAR, VARCHAR, LVARCHAR, NCHAR, or NVARCHAR data type.

If you specify **DBSERVERNAME** or **SITENAME** as the default value for a column, the size of the column should be at least 128 bytes long. You risk getting an error message during INSERT and ALTER TABLE operations if the length of the column is too small to store the default value.

The following examples use **DBSERVERNAME** or **SITENAME** in DML statements.

- The first SELECT statement returns the name of the database server instance where the **customer** table resides. (Because the query is not restricted by a WHERE clause, it returns the same **DBSERVERNAME** value for every row in the table. If you include the DISTINCT keyword in the projection clause, the query returns **DBSERVERNAME** only once.)
- The second statement adds a row that contains the name of the current database server to a table.
- The third statement returns all rows that have the name of the current database server in the **host_tab.site_col** column.
- The last statement changes to the name of the current database server the value of the **customer.company** column in the row whose SERIAL value of **customer_num** is 120:

```
SELECT DBSERVERNAME FROM customer;

INSERT INTO host_tab VALUES ('1', SITENAME);

SELECT * FROM host_tab WHERE site_col = DBSERVERNAME;

UPDATE customer SET company = SITENAME
WHERE customer_num = 120;
```

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TODAY Operator

Use the **TODAY** operator to return the system date as a DATE data type. If you specify **TODAY** as a default column value, the column must be a DATE column.

The following examples show how you might use the **TODAY** operator in an INSERT, UPDATE, or SELECT statement:

```
UPDATE orders (order_date) SET order_date = TODAY
WHERE order_num = 1005;

INSERT INTO orders VALUES
(0, TODAY, 120, NULL, N, '1AUE217', NULL, NULL, NULL, NULL);

SELECT * FROM orders WHERE ship_date = TODAY;
```

For code examples of setting non-default time zones, see [CURRENT Operator](#).

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CURRENT Operator

The **CURRENT** operator returns a DATETIME value with the date and time of day, showing the current instant.

If you do not specify a DATETIME qualifier, the default qualifier is YEAR TO FRACTION(3). The USEOSTIME configuration parameter specifies whether or not the database server uses subsecond precision when it obtains the current time from the operating system. For more information on the USEOSTIME configuration parameter, see your *IBM® Informix® Administrator's Reference*.

You can use **CURRENT** in any context where a literal DATETIME is valid. (See [Literal DATETIME](#)). If you specify **CURRENT** as the default value for a column, it must be a DATETIME column and the qualifier of **CURRENT** must match the column qualifier, as the following example shows:

```
CREATE TABLE new_acct (col1 INT, col2 DATETIME YEAR TO DAY
DEFAULT CURRENT YEAR TO DAY);
```

CURRENT is always evaluated in the database server where the current database is located. If the current database is in a remote database server, the returned value is from the remote host.

SQL is not a procedural language, and **CURRENT** might not execute in the lexical order of its position in a statement. You should not use **CURRENT** to mark the start, the end, nor a specific point in the execution of an SQL statement.

If you use the **CURRENT** operator in more than once in a single statement, identical values might be returned by each instance of CURRENT. You cannot rely on **CURRENT** to return distinct values each time it executes.

The returned value is based on the system clock and is fixed when the SQL statement that specifies CURRENT starts execution. For example, any call to **CURRENT** from inside the SPL function that an EXECUTE FUNCTION (or EXECUTE PROCEDURE) statement invokes returns the value of the system clock when the SPL function starts.

On UNIX and Linux systems, the precision of the value returned by the CURRENT operator is determined by its DATETIME Qualifier, which can range from a single time unit (such as MONTH TO MONTH) up to YEAR TO FRACTION (5). The system clock on Windows, however, returns only millisecond precision. Even if you specify "FRACTION(5)" in the DATETIME Qualifier, the CURRENT operator on Windows supports no greater than "FRACTION(3)" precision.

If your platform does not provide a system call that returns the current time with subsecond precision, **CURRENT** returns a zero for the FRACTION field.

In the following example, the first statement uses **CURRENT** in a WHERE condition. The second statement uses **CURRENT** as an argument to the **DAY** function. The last query selects rows whose **call_dtime** value is within a range from the beginning of 2007 to the current instant:

```
DELETE FROM cust_calls WHERE res_dtime < CURRENT YEAR TO MINUTE;

SELECT * FROM orders WHERE DAY(ord_date) < DAY(CURRENT);

SELECT * FROM cust_calls WHERE call_dtime
    BETWEEN '2007-1-1 00:00:00' AND CURRENT;
```

For more information, see [DATETIME Field Qualifier](#).

Related information:

[USEOSTIME configuration parameter](#)

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SYSDATE Operator

The **SYSDATE** operator returns the current DATETIME value from the system clock. **SYSDATE** is identical to the **CURRENT** operator, except that the default precision of **SYSDATE** is YEAR TO FRACTION(5), while the default precision of **CURRENT** is YEAR TO FRACTION(3).

On Windows platforms that do not support a *seconds* scale greater than FRACTION(3), **SYSDATE** is in effect a synonym for the **CURRENT** operator,

You can use **SYSDATE** in any context where the **CURRENT** operator is valid.

The SQL statements in the following example use the **SYSDATE** operator to specify the default values for two DATETIME columns of a database table, and to insert a new row into the table:

```
CREATE TABLE tab1 (
id SERIAL,
value CHAR(20),
time1 DATETIME YEAR TO FRACTION(5) DEFAULT SYSDATE,
time2 DATETIME YEAR TO SECOND DEFAULT SYSDATE YEAR TO SECOND
);

INSERT INTO tab1 VALUES (0, 'description', SYSDATE, SYSDATE);
```

The following query accesses the table that was created in the previous example:

```
SELECT SYSDATE AS sysdate, * FROM tab1;
```

The results are sensitive to the date and time when the INSERT and SELECT statements are issued, but the query could return these values on September 23, 2007:

sysdate	2007-09-23 21:30:23.00000
id	1
value	description
time1	2007-09-23 21:29:27.00000
time2	2007-09-23 21:29:27

The next query accesses the same table, using **SYSDATE** in the WHERE clause as an argument to the **DAY** function:

```
SELECT *, DAY(time1) AS day FROM tab1
WHERE DAY(time1) = DAY(SYSDATE);
```

The query could return these values on September 23, 2007:

id	1
value	description
time1	2007-09-23 21:29:27.00000
time2	2007-09-23 21:29:27
day	23

Only Informix® supports **SYSDATE**. Except for its name and its default precision, the description of the **CURRENT** operator in this document also describes the **SYSDATE** operator.

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Literal DATETIME

A literal DATETIME specifies the value of an DATETIME data type, including its qualifying time-units.

The following examples show literal DATETIME values as expressions:

```
SELECT DATETIME (2007-12-6) YEAR TO DAY FROM customer;

UPDATE cust_calls SET res_dtime = DATETIME (2008-07-07 10:40)
    YEAR TO MINUTE
WHERE customer_num = 110
AND call_dtime = DATETIME (2008-07-07 10:24) YEAR TO MINUTE;
```

```
SELECT * FROM cust_calls
WHERE call_dtime
= DATETIME (2008-12-25 00:00:00) YEAR TO SECOND;
```

For more information, see [Literal DATETIME](#).

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Literal INTERVAL

A literal INTERVAL specifies the value of an INTERVAL data type, including its qualifying time-units.

The following examples each use a literal INTERVAL as an expression:

```
INSERT INTO manufact VALUES ('CAT', 'Catwalk Sports',
INTERVAL (16) DAY TO DAY);

SELECT lead_time + INTERVAL (5) DAY TO DAY FROM manufact;
```

The second example adds five days to each value of **lead_time** selected from the **manufact** table.

For more information, see [Literal INTERVAL](#).

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UNITS Operator

The UNITS operator specifies an INTERVAL value whose precision includes only one time unit. You can use UNITS in arithmetic expressions that increase or decrease one of the time units in an INTERVAL or DATETIME value.

If the *num* operand is not an integer, it is truncated to the largest whole number that is the same as (or nearer to zero than) the specified value when the database server evaluates the expression.

In the following example, the first SELECT statement uses the UNITS operator to select all the **manufacturer.lead_time** values, increased by five days. The second SELECT statement finds all the calls that were placed more than 30 days ago.

If the expression in the WHERE clause returns a value greater than 99 (maximum number of days), the query fails. The last statement increases the lead time for the ANZA manufacturer by two days:

```
SELECT lead_time + 5 UNITS DAY FROM manufact;

SELECT * FROM cust_calls WHERE (TODAY - call_dtime) > 30 UNITS DAY;

UPDATE manufact SET lead_time = 2 UNITS DAY + lead_time
WHERE manu_code = 'ANZ';
```

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NEXTVAL and CURRVAL Operators

You can access the value of a sequence using the **NEXTVAL** or **CURRVAL** operators in SQL statements. You must qualify **NEXTVAL** or **CURRVAL** with the name (or synonym) of a sequence object that exists in the same database, using the format *sequence.NEXTVAL* or *sequence.CURRVAL*. An expression can also qualify *sequence* by the *owner* name, as in **zelaine.myseq.CURRVAL**. You can specify the SQL identifier of *sequence* or a valid synonym, if one exists.

In an ANSI-compliant database, you must qualify the name of the *sequence* with the name of its owner (*owner.sequence*) if you are not the owner.

To use **NEXTVAL** or **CURRVAL** with a sequence, you must have the Select privilege on the sequence or have the DBA privilege on the database. For information about sequence-level privileges, see the [GRANT statement](#) statement.

Examples

In the following examples, it is assumed that no other user is concurrently accessing the sequence and that the user executes the statements consecutively.

These examples are based on the following sequence object and table:

```
CREATE SEQUENCE seq_2
INCREMENT BY 1 START WITH 1
MAXVALUE 30 MINVALUE 0
NOCYCLE CACHE 10 ORDER;

CREATE TABLE tab1 (col1 int, col2 int);
INSERT INTO tab1 VALUES (0, 0);
```

You can use **NEXTVAL** (or **CURRVAL**) in the Values clause of an INSERT statement, as the following example shows:

```
INSERT INTO tab1 (col1, col2)
VALUES (seq_2.NEXTVAL, seq_2.NEXTVAL);
```

In the previous example, the database server inserts an incremented value (or the first value of the sequence, which is 1) into the **col1** and **col2** columns of the table.

You can use **NEXTVAL** (or **CURRVAL**) in the SET clause of the UPDATE statement, as the following example shows:

```
UPDATE tab1
SET col2 = seq_2.NEXTVAL
WHERE col1 = 1;
```

In the previous example, the incremented value of the **seq_2** sequence, which is 2, replaces the value in **col2** where **col1** is equal to 1.

The following example shows how you can use **NEXTVAL** and **CURRVAL** in the Projection clause of the SELECT statement:

```
SELECT seq_2.CURRVAL, seq_2.NEXTVAL FROM tab1;
```

In the previous example, the database server returns two rows of incremented values, 3 and 4, from both the **CURRVAL** and **NEXTVAL** expressions. For the first row of **tab1**, the database server returns the incremented value 3 for **CURRVAL** and **NEXTVAL**; for the second row of **tab1**, it returns the incremented value 4.

- [Using NEXTVAL](#)
- [Using CURRVAL](#)
- [Concurrent Access to a Sequence](#)
- [Restrictions on sequence operators](#)

Related reference:

[ALTER SEQUENCE statement](#)
[CREATE SEQUENCE statement](#)
[RENAME SEQUENCE statement](#)

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Using NEXTVAL

To access a sequence for the first time, you must refer to *sequence*.**NEXTVAL** before you can refer to *sequence*.**CURRVAL**. The first reference to **NEXTVAL** returns the initial value of the sequence. Each subsequent reference to **NEXTVAL** increments the value of the sequence by the defined *step* and returns a new incremented value of the sequence.

You can increment a given sequence only once within a single SQL statement. Even if you specify *sequence*.**NEXTVAL** more than once within a single statement, the sequence is incremented only once, so that every occurrence of *sequence*.**NEXTVAL** in the same SQL statement returns the same value.

Except for the case of multiple occurrences within the same statement, every *sequence*.**NEXTVAL** expression increments the *sequence*, regardless of whether you subsequently commit or roll back the current transaction.

If you specify *sequence*.**NEXTVAL** in a transaction that is ultimately rolled back, some sequence numbers might be skipped.

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Using CURRVAL

Any reference to **CURRVAL** returns the current value of the specified sequence, which is the value that your last reference to **NEXTVAL** returned. After you generate a new value with **NEXTVAL**, you can continue to access that value using **CURRVAL**, regardless of whether another user increments the sequence.

If both *sequence*.**CURRVAL** and *sequence*.**NEXTVAL** occur in an SQL statement, the sequence is incremented only once. In this case, each *sequence*.**CURRVAL** and *sequence*.**NEXTVAL** expression returns the same value, regardless of the order of *sequence*.**CURRVAL** and *sequence*.**NEXTVAL** within the statement.

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Concurrent Access to a Sequence

A sequence always generates unique values within a database without perceptible waiting or locking, even when multiple users refer to the same sequence concurrently. When multiple users use **NEXTVAL** to increment the sequence, each user generates a unique value that other users cannot see.

When multiple users concurrently increment the same sequence, gaps occur between the values that each user sees. For example, one user might generate a series of values, such as 1, 4, 6, and 8, from a sequence, while another user concurrently generates the values 2, 3, 5, and 7 from the same sequence object.

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Restrictions on sequence operators

NEXTVAL and **CURRVAL** are valid only in SQL statements, not directly in SPL statements. (But SQL statements that use **NEXTVAL** and **CURRVAL** can be used in SPL routines.) The following restrictions apply to these operators in SQL statements:

- You must have Select privilege on the *sequence*.
- In a CREATE TABLE or ALTER TABLE statement, you cannot specify **NEXTVAL** or **CURRVAL** in the following contexts:
 - In the Default clause of a column definition
 - In the definition of a check constraint.
- In a SELECT statement, you cannot specify **NEXTVAL** or **CURRVAL** in the following contexts:
 - In the projection list when the DISTINCT keyword is used
 - In the WHERE, GROUP BY, or ORDER BY clauses
 - In a subquery
 - When the UNION operator combines SELECT statements.
- You also cannot specify **NEXTVAL** or **CURRVAL** in these contexts:
 - In fragmentation expressions
 - In reference to a remote sequence object in another database.

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Literal Row

The syntax for a literal representation of the value of a named or unnamed ROW data type is described in the section [Literal Row](#). The following examples show literal rows as expressions:

```
INSERT INTO employee VALUES
  (ROW('103 Baker St', 'San Francisco',
       'CA', 94500));
```

```
UPDATE rectangles
  SET rect = ROW(8, 3, 7, 20)
  WHERE area = 140;
```

```
EXEC SQL update table(:a_row)
  set x=0, y=0, length=10, width=20;
```

```
SELECT row_col FROM tab_b
  WHERE ROW(17, 'abc') IN (row_col);
```

For the syntax of expressions that evaluate to field values of a ROW data type, see [ROW constructors](#).

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Literal Collection

Informix® supports expressions that are literal representations of the values of built-in or user-defined collection data types. The following examples show literal collections as expressions:

```
INSERT INTO tab_a (set_col) VALUES ("SET{6, 9, 3, 12, 4}");
```

```
INSERT INTO TABLE(a_set) VALUES (9765);
```

```
UPDATE table1 SET set_col = "LIST{3}";
```

```
SELECT set_col FROM table1
  WHERE SET{17} IN (set_col);
```

For more information, see [Literal Collection](#). For the syntax of element values, see [Collection Constructors](#).

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Constructor Expressions

A *constructor* is a function that the database server uses to create an instance of a specific data type. The database server supports ROW constructors and collection constructors.

Constructor Expressions

```
      .-,------.
      v              (1) |
|---ROW--(---| Expression |---+---|
```

Notes:

1. See [Expression](#)
 2. See [Collection Constructors](#)
- [ROW constructors](#)
You use ROW constructors to generate values for ROW-type columns.
 - [Collection Constructors](#)

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ROW constructors

You use ROW constructors to generate values for ROW-type columns.

Suppose you create the following named ROW type and a table that contains the named ROW type **row_t** and an unnamed ROW type:

```
CREATE ROW TYPE row_t ( x INT, y INT);  
CREATE TABLE new_tab  
(  
  col1 row_t,  
  col2 ROW( a CHAR(2), b INT)  
);
```

When you define a column as a named ROW type or unnamed ROW type, you must use a ROW constructor to generate values for the ROW-type column. To create a value for either a named ROW type or unnamed ROW type, you must complete the following steps:

- Begin the expression with the ROW keyword.
- Specify a value for each field of the ROW type.
- Enclose the comma-separated list of field values within parentheses.

The format of the value for each field must be compatible with the data type of the ROW field to which it is assigned.

You can use any kind of expression as a value with a ROW constructor, including literals, functions, and variables. The following examples show the use of different types of expressions with ROW constructors to specify values:

```
ROW(5, 6.77, 'HMO')  
  
ROW(col1.lname, 45000)  
  
ROW('john davis', TODAY)  
  
ROW(USER, SITENAME)
```

The following statement uses literal numbers and quoted strings with ROW constructors to insert values into **col1** and **col2** of the **new_tab** table:

```
INSERT INTO new_tab  
VALUES  
(  
  ROW(32, 65)::row_t,  
  ROW('CA', 34)  
);
```

When you use a ROW constructor to generate values for a named ROW type, you must explicitly cast the ROW value to the appropriate named ROW type. The cast is necessary to generate a value of the named ROW type. To cast the ROW value as a named ROW type, you can use the cast operator (**::**) or the **CAST AS** keywords, as the following examples show:

```
ROW(4,5)::row_t  
CAST (ROW(3,4) AS row_t)
```

You can use a ROW constructor to generate ROW type values in INSERT, UPDATE, and SELECT statements. In the next example, the WHERE clause of a SELECT statement specifies a ROW type value that is cast as type **person_t**:

```
SELECT * FROM person_tab  
WHERE col1 = ROW('charlie', 'hunter')::person_t;
```

For more information on using ROW constructors in INSERT and UPDATE statements, see the INSERT and UPDATE statements in this document. For information on named ROW types, see the CREATE ROW TYPE statement. For information on unnamed ROW types, see the discussion of the ROW data type in the *IBM® Informix® Guide to SQL: Reference*. For task-oriented information on named ROW types and unnamed ROW types, see the *IBM Informix Database Design and Implementation Guide*.

Related reference:

[Literal Row](#)

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Collection Constructors

Collection Constructors

Notes:

- You can use collection constructors in the `WHERE` clause of the `SELECT` statement and the `VALUES` clause of the `INSERT` statement. You can also pass collection constructors to UDRs.

Keyword	Description
SET	Indicates a collection of elements with the following qualities: <ul style="list-style-type: none"> • The collection must contain unique values. • Elements have no specific order associated with them.
MULTISET	Indicates a collection of elements with the following qualities: <ul style="list-style-type: none"> • The collection can contain duplicate values. • Elements have no specific order associated with them.
LIST	Indicates a collection of elements with the following qualities: <ul style="list-style-type: none"> • The collection can contain duplicate values. • Elements have ordered positions.

You specify an empty collection with a set of empty braces (`{ }`).

An exception to this restriction can occur when some elements of a collection are VARCHAR data types but others are longer than 255 bytes. Here the collection constructor can assign a CHAR(*n*) type to all elements, for *n* the length in bytes of the longest element. (But see [Collection Data Types](#) for an example based on this exception, where the user avoids fixed-length CHAR elements by an explicit cast to the LVARCHAR data type.)

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```
CREATE FUNCTION f (a int) RETURNS int;
    RETURN a+1;
END FUNCTION;
CREATE TABLE tab1 (x SET(INT NOT NULL));
INSERT INTO tab1 VALUES
(
SET{10,
    1+2+3,
    f(10)-f(2),
    Sqrt(100) +POW(2,3),
    (SELECT tabid FROM systables WHERE tabname = 'sysusers'),
    'T'::BOOLEAN::INT}
);
SELECT * FROM tab1 WHERE
    x=SET{10,
        1+2+3,
        f(10)-f(2),
        Sqrt(100) +POW(2,3),
        (SELECT tabid FROM systables WHERE tabname = 'sysusers')},
```

```
'T'::BOOLEAN::INT}
};
```

This assumes that a cast from BOOLEAN to INT exists. (For a more restrictive syntax to specify collection values, see [Literal Collection](#).)

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NULL Keyword

The NULL keyword is valid in most contexts where you can specify a value. What it specifies, however, is the absence of any value (or an unknown or missing value).

NULL Keyword

```
|--NULL-----|
```

Within SQL, the keyword NULL is the only syntactic mechanism for accessing a NULL value. NULL is not equivalent to zero, nor to any specific value. In ascending ORDER BY operations, NULL values precede any non-NULL value; in descending sorts, NULL values follow any non-NULL value. In GROUP BY operations, all NULL values are grouped together. (Such groups might in fact be logically heterogeneous, if they include missing or unknown values.)

The keyword NULL is a global symbol in the syntactic context of expressions, meaning that its scope of reference is global.

Every data type, whether built-in or user-defined, can represent a NULL value. IBM® Informix® supports cast expressions in the projection list. This means that users can write expressions of the form `NULL::datatype`, in which *datatype* is any data type known to the database server.

IBM Informix supports the typed NULL keyword in general expressions. NULL alone in these scenarios results in a -201 syntax error. As a result, if null is defined as a column name or a procedure name, it must be referenced with a table alias. Otherwise, it returns a -201 syntax error. The behavior is summarized in the following examples and results:

```
create table tab1 (a int, null int);
create table tab2 (a int, b int);
```

Table 1. NULL behavior

Statement	Result
select null from tab1 where a = 1	-201 syntax error
select * from tab1 where null = a	-201 syntax error
select * from tab1 where tab1.null = a	Valid syntax
select * from tab1 where a = null	-201 syntax error
select * from tab2 where a = null	-201 syntax error
select * from tab2 where null = a	-201 syntax error
select * from tab2 where null = a	-201 syntax error
select NULL::int from tab1	Valid syntax
select NULL::int from tab1	Valid syntax
select 1 + NULL::int from tab1	Valid syntax
select 1 + NULL::int from tab2	Valid syntax
select NULL::int + 1 from tab1	Valid syntax

IBM Informix prohibits the redefinition of NULL, because allowing such definition would restrict the global scope of the NULL keyword. For this reason, any mechanism that restricts the global scope or redefines the scope of the keyword NULL will syntactically disable any cast expression involving a NULL value. You must ensure that the occurrence of the keyword NULL receives its global scope in all expression contexts.

For example, consider the following SQL code:

```
CREATE TABLE newtable
(
  null int
);

SELECT null, null::int FROM newtable;
```

The CREATE TABLE statement is valid, because the column identifiers have a scope of reference that is restricted to the table definition; they can be accessed only within the scope of a table.

The SELECT statement in the example, however, poses some syntactic ambiguities. Does the identifier **null** appearing in the projection list refer to the global keyword NULL, or does it refer to the column identifier **null** that was declared in the CREATE TABLE statement?

- If the identifier **null** is interpreted as the column name, the global scope of cast expressions with the NULL keyword will be restricted.
- If the identifier **null** is interpreted as the NULL keyword, the SELECT statement must generate a syntactic error for the first occurrence of **null** because the NULL keyword can appear only as a cast expression in the projection list.

A SELECT statement of the following form is valid because the NULL column of **newtable** is qualified with the table name:

```
SELECT newtable.null, null::int FROM newtable;
```

More involved syntactic ambiguities arise in the context of an SPL routine that has a variable named **null**. An example follows:

```
CREATE FUNCTION nulltest() RETURNING INT;  
  DEFINE a INT;  
  DEFINE null INT;  
  DEFINE b INT;  
  LET a = 5;  
  LET null = 7;  
  LET b = null;  
  RETURN b;  
END FUNCTION;  
  
EXECUTE FUNCTION nulltest();
```

When the preceding function executes in DB-Access, in the expressions of the LET statement, the identifier **null** is treated as the keyword NULL. The function returns a NULL value instead of 7.

Using **null** as a variable of an SPL routine would restrict the use of a NULL value in the body of the SPL routine. Therefore, the preceding SPL code is not valid, and causes IBM Informix to return the following error:

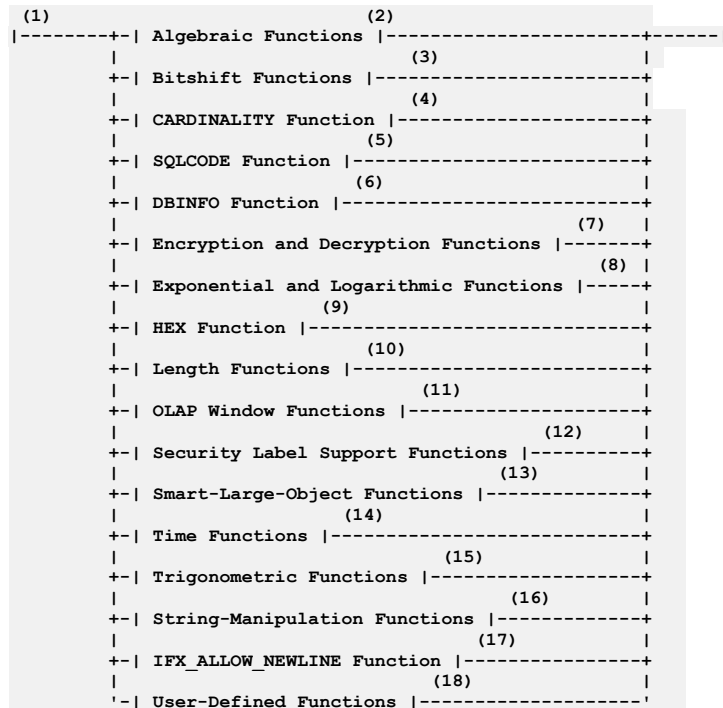
```
-947 Declaration of an SPL variable named 'null' conflicts  
with SQL NULL value.
```

In ESQ/C, you should use an indicator variable if there is the possibility that a SELECT statement will return a NULL value.

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Function Expressions

A function expression can return one or more values from built-in SQL functions or from user-defined functions, as the following diagram shows.



Notes:

1. Informix® extension
2. See [Algebraic Functions](#)
3. See [Bitshift Functions](#)
4. See [CARDINALITY Function](#)
5. See [SQLCODE Function \(SPL\)](#)
6. See [DBINFO Function](#)
7. See [Encryption and decryption functions](#)
8. See [Exponential and Logarithmic Functions](#)
9. See [HEX Function](#)
10. See [Length functions](#)
11. See [OLAP window expressions](#)
12. See [Security Label Support Functions](#)
13. See [Smart-Large-Object Functions](#)
14. See [Time Functions](#)
15. See [Trigonometric Functions](#)

16. See [String-Manipulation Functions](#)
17. See [IFX_ALLOW_NEWLINE Function](#)
18. See [User-Defined Functions](#)

The following examples show function expressions:

```
EXTEND (call_dtime, YEAR TO SECOND)
```

```
HEX (LENGTH(123))
```

```
MDY (12, 7, 1900 + cur_yr)
```

```
TAN (radians)
```

```
DATE (365/2)
```

```
ABS (-32)
```

```
LENGTH ('abc') + LENGTH (pvar)
```

```
EXP (3)
```

```
HEX (customer_num)
```

```
MOD (10,3)
```

- [Algebraic Functions](#)
- [Bitshift Functions](#)
Bitshift functions perform a bit shift operation on an integer or bigint value and return the shift result.
- [CARDINALITY Function](#)
The **CARDINALITY** function returns the number of elements in a collection column (SET, MULTISET, LIST).
- [SQLCODE Function \(SPL\)](#)
The **SQLCODE** function takes no arguments, but returns to its calling context the value of **sqlca.sqlcode** for the most recently executed SQL statement (whether static or dynamic) that the current SPL routine has executed. Only use **SQLCODE** in the context of a cursor.
- [DBINFO Function](#)
- [Encryption and decryption functions](#)
Informix supports built-in encryption and decryption functions.
- [DECRYPT CHAR Function](#)
- [DECRYPT BINARY Function](#)
- [ENCRYPT AES Function](#)
- [ENCRYPT TDES Function](#)
- [GETHINT Function](#)
- [Exponential and Logarithmic Functions](#)
Exponential and logarithmic functions take at least one argument and return a FLOAT data type.
- [NVL2 Function](#)
Returns the second argument when the first argument is not NULL. If the first argument is NULL, the third argument is returned.
- [HEX Function](#)
- [Length functions](#)
Use length functions to determine the length of a character column, string, or variable, or of the value returned by a character expression, or (for **CHAR_LENGTH** in multibyte locales) the number of logical characters.
- [Security Label Support Functions](#)
- [SIGN function](#)
The SIGN function returns an indicator of the sign of the argument.
- [Smart-Large-Object Functions](#)
The smart-large-object functions support objects of BLOB and CLOB data types:
- [Time Functions](#)
The time functions of Informix accept DATE or DATETIME arguments, or character representation of a DATE or DATETIME value. They typically return DATE or DATETIME values, or convert information that they extract from DATE or DATETIME values into character strings or integers.
- [TO_NUMBER Function](#)
The **TO_NUMBER** function can convert a number or a character expression representing a number value to a DECIMAL data type.
- [Trigonometric Functions](#)
The built-in trigonometric functions calculate ratios of the lengths of the sides of right triangles. Two supporting functions, **DEGREES** and **RADIANS**, can respectively convert the units of angular values from radians to degrees, and from degrees to radians.
- [String-Manipulation Functions](#)
String-manipulation functions perform various operations on strings of characters.
- [Case-Conversion Functions](#)
The case-conversion functions perform lettercase conversion on alphabetic characters. In the default locale, only the ASCII characters in the ranges **A - Z** and **a - z** can be modified by these functions, which enable you to perform case-insensitive searches in your queries and to specify the format of the output.
- [Substring functions](#)
The built-in SQL substring functions return substrings from character string arguments, or return positional information for operations on substrings.
- [FORMAT_UNITS Function](#)
The **FORMAT_UNITS** function can interpret strings that specify a number and the abbreviated names of units of memory or of mass storage.
- [IFX_ALLOW_NEWLINE Function](#)
The **IFX_ALLOW_NEWLINE** function sets a newline mode that allows newline characters in quoted strings or disallows newline characters in quoted strings within the current session.
- [User-Defined Functions](#)
A user-defined function (UDF) is a routine that you write in SPL or in a language external to the database, such as C or Java, and that returns a value to its calling context.

Algebraic Functions

Algebraic functions take one or more arguments of numeric data types. Besides supporting numeric arguments, the **CEIL** and **FLOOR** functions can also take character string arguments that can be converted to DECIMAL values, and the **ROUND** and **TRUNC** functions can also take DATE or DATETIME arguments.

Algebraic Functions

```
|-----ABS-----(--num_expression--)-----+-----|
| +-CEIL--+
| '-FLOOR-'
|
| .-----+
| |         |
| +-GREATEST--(---expression+---,---expression---+---)-----+
| |         |
| |         |
| +-LEAST--(---expression+---,---expression---+---)-----+
| +-MOD--(--dividend, divisor--)-----+
| +-POW--(--base, exponent--)-----+
| '-POWER-'
|
| .- , - 2 ---.
| +-ROOT--(--radicand+---,---index---)-----+
| |         |
| |         |
| +-ROUND+---(--+num_expression--+---+---,---factor---)-----+
| '-TRUNC-' '-date_expression-' '- , - factor-'
| +-ROUND+---(--date_expression--+---+---,---factor---)-----+
| '-TRUNC-' '- , ' +- DD ---+ ' '
| |         |
| |         |
| |         |
| |         |
| |         |
| |         |
| |         |
| +-ROUND+---(--datetime_expression--+---+---,---factor---)-----+
| '-TRUNC-' '- , ' +- MI ---+ ' '
| |         |
| |         |
| |         |
| |         |
| |         |
| |         |
| |         |
| +-SQRT--(--sqrt_radicand--)-----+-----|
```

Element	Description	Restrictions	Syntax
<i>base</i>	Value to be raised to the power specified in <i>exponent</i>	Must return a real number	Expression
<i>date_expression</i>	Expression that evaluates to (or is cast to) a DATE value	Must return a DATE value	Expression
<i>datetime_expression</i>	Expression that evaluates to (or is cast to) a DATETIME value	Must return a DATETIME value	Expression
<i>dividend</i>	Value to be divided by <i>divisor</i>	A real number	Expression
<i>divisor</i>	Value by which to divide <i>dividend</i>	A nonzero real number	Expression
<i>exponent</i>	Power to which to raise <i>base</i>	A real number	Expression
<i>factor</i>	Number of significant digits to replace with zero in the returned value. Default is to return the rounded or truncated integer part of the first argument.	Integer in range +32 to -32. Positive or unsigned values are applied to the right of the decimal point, and negative values are applied to the left.	Literal Number
<i>index</i>	Root to extract. The default is 2.	A nonzero real number	Expression
<i>num_expression</i>	Expression that evaluates to (or is cast to) a numeric value	A real number	Expression
<i>radicand</i>	Value whose root is to be returned	A real number	Expression
<i>sqrt_radicand</i>	Number with a real square root	A nonnegative real number	Expression

- [ABS Function](#)
- [CEIL Function](#)

The **CEIL** function takes as its argument a numeric expression, or a string that can be converted to a DECIMAL data type, and returns the DECIMAL(32) representation of the smallest integer that is greater than or equal to its single argument.

- [FLOOR Function](#)

The **FLOOR** function takes as its argument a numeric expression, or a string that can be converted to a DECIMAL data type, and returns the DECIMAL(32) representation of the largest integer that is smaller than or equal to its single argument.

- [GREATEST function](#)

The **GREATEST** function returns the maximum value in a list of expressions.

- [LEAST function](#)

The **LEAST** function returns the minimum value in a set of values.

- [MOD Function](#)

- [POW Function](#)

The **POW** function raises its first numeric argument, the *base*, to the power of its second numeric argument, the *exponent*. The returned value is a FLOAT data type.

- [ROOT Function](#)
The **ROOT** function extracts a positive real root value, returned as a FLOAT data type, from its first numeric expression argument, the *radicand*.
- [SQRT Function](#)
The **SQRT** function returns the positive square root of its argument, which must be a non-negative numeric expression.
- [ROUND Function](#)
The **ROUND** function can reduce the precision of its first numeric, MONEY, DATE, or DATETIME argument, and returns the rounded value. If the first argument is not a number, a MONEY value, or a point in time, it must be cast to a numeric, MONEY, DATE, or DATETIME data type.
- [TRUNC Function](#)
The **TRUNC** function can reduce the precision of its first numeric, DATE, or DATETIME argument by returning the truncated value. If the first argument is neither a number nor a point in time, it must be cast to a numeric, DATE, or DATETIME data type.

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ABS Function

The **ABS** function returns the absolute value of its numeric argument, returning the same data type as its argument. The query in the following example returns all orders for which a **ship_charge** greater than \$20 was paid in cash (+) or as store credit (-).

```
SELECT order_num, customer_num, ship_charge
FROM orders WHERE ABS(ship_charge) > 20;
```

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CEIL Function

The **CEIL** function takes as its argument a numeric expression, or a string that can be converted to a DECIMAL data type, and returns the DECIMAL(32) representation of the smallest integer that is greater than or equal to its single argument.

The following query returns 33 as the smallest integer that is larger than or equal to the **CEIL** argument of 32.3:

```
SELECT CEIL(32.3) FROM systables WHERE tabid = 1;
```

The next example returns -32 as the smallest integer that is larger than or equal to the **CEIL** argument of -32.3:

```
SELECT CEIL(-32.3) FROM systables WHERE tabid = 1;
```

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FLOOR Function

The **FLOOR** function takes as its argument a numeric expression, or a string that can be converted to a DECIMAL data type, and returns the DECIMAL(32) representation of the largest integer that is smaller than or equal to its single argument.

The following query returns 32 as the largest integer that is smaller than or equal to the **FLOOR** argument of 32.3:

```
SELECT FLOOR(32.3) FROM systables WHERE tabid = 1;
```

The next example returns -33 as the largest integer that is smaller than or equal to the **FLOOR** argument of -32.3:

```
SELECT FLOOR(-32.3) FROM systables WHERE tabid = 1;
```

These examples illustrate how the **FLOOR** and **CEIL** functions provide upper and lower bounds that differ by 1 when they have the same argument that has a nonzero fractional part. For an integer argument, **FLOOR** and **CEIL** return the same DECIMAL(32) representation of their argument.

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GREATEST function

The **GREATEST** function returns the maximum value in a list of expressions.

The arguments to this function must be comma-separated expressions that evaluate to compatible data types.

This is the syntax of the **GREATEST** function:

GREATEST Function

```

      .-,------.
      v            |
|--GREATEST--(--expression--,---expression+--)-----|

```


ROOT Function

The **ROOT** function extracts a positive real root value, returned as a FLOAT data type, from its first numeric expression argument, the *radicand*.

If you specify a second numeric argument as the *index*, which cannot be zero, then the returned value to the power *index* is equal (within rounding error) to the *radicand* argument. If only the *radicand* argument is supplied, 2 is the default *index* value. You cannot specify zero as the value of *index*.

The first SELECT statement in the following example, which uses the default *index* value of 2, returns the positive square root of the literal number 9. The second example returns the cube root of the literal number 64.

```
SELECT ROOT(9) FROM angles;      -- square root of 9
SELECT ROOT(64,3) FROM angles;  -- cube root of 64
```

Invoking **ROOT** with only a single argument is equivalent to invoking the **SQRT** function.

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SQRT Function

The **SQRT** function returns the positive square root of its argument, which must be a non-negative numeric expression.

The following example returns the square root of 9 for each row of the **angles** table:

```
SELECT SQRT(9) FROM angles;
```

The **SQRT** function is equivalent to **ROOT**(x), where 2 is the default value of the second argument to the **ROOT** function, specifying the index.

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ROUND Function

The **ROUND** function can reduce the precision of its first numeric, MONEY, DATE, or DATETIME argument, and returns the rounded value. If the first argument is not a number, a MONEY value, or a point in time, it must be cast to a numeric, MONEY, DATE, or DATETIME data type.

The following diagram shows the syntax of both the **ROUND** and **TRUNC** algebraic functions, which support the same syntax. Because their semantics differ, however, they can return different values from the same argument list. Only **ROUND** can return an absolute value larger than its first argument.

ROUND and TRUNC algebraic functions

```

      .- , - 0 ----.
|---+-ROUND-+-(-+-num_expression-+-+-----+---)-----+---|
| '-TRUNC- ' '-date_expression- ' '- , - factor- ' |
+-+--ROUND-+-(-+-date_expression-+-+-----+---)-----+---+
| '-TRUNC- ' '- , ' +- DD ----+ ' ' |
|                                     +- DAY ---+ |
|                                     +- MONTH + |
|                                     '- YEAR - ' |
|                                     .- , - 'DD' -----. |
| '-+--ROUND-+-(-+-datetime_expression-+-+-----+---)-----+---|
| '-TRUNC- ' '- , ' +- MI ----+ ' ' |
|                                     +- HH ----+ |
|                                     +- DAY ---+ |
|                                     +- MONTH + |
|                                     '- YEAR - ' |

```

Element	Description	Restrictions	Syntax
<i>date_expression</i>	Expression that evaluates to (or is cast to) a DATE value	Must return a DATE value	Expression
<i>datetime_expression</i>	Expression that evaluates to (or is cast to) a DATETIME value	Must return a DATETIME value	Expression
<i>factor</i>	Number of significant digits to replace with zero in the returned value. Default is to return the rounded or truncated integer part of the first argument.	Integer in range +32 to -32. Positive or unsigned values are applied to the right of the decimal point, and negative values are applied to the left.	Literal Number
<i>num_expression</i>	Expression that evaluates to (or is cast to) a numeric value	A real number	Expression

Usage

The **ROUND** function resembles the **TRUNC** function, whose syntax is also shown above. **ROUND** differs, however, in how it treats any portion of its first argument that is smaller than the least significant digit or time unit within the precision that its explicit or default second argument specifies.

- If the absolute value of this portion is equal to or greater than half of the smallest unit within the precision, the value of that digit or time unit is incremented by 1 in the value returned by **ROUND**. If this portion is less than half of a unit, however, it is discarded, and only the digits or time units of the first argument within the specified or default precision are returned.

That is, if the first argument is greater than zero,

- the **ROUND** function rounds down any portion of its first argument that is smaller than half a unit of the least significant digit or time unit within the precision of the second argument,
- but any portion of the first argument that is equal to or greater than half a unit is rounded up.

For example, `ROUND(3.5, 0) = 4` and `ROUND(3.4, 0) = 3`.

But if the first argument is less than zero,

- the **ROUND** function rounds up any portion of its first argument that is smaller than half a unit of the least significant digit or time unit within the precision of the second argument,
- but any portion of the first argument that is equal to or greater than half a unit is rounded down.

For example, `ROUND(-3.5, 0) = -4` and `ROUND(-3.4, 0) = -3`.

- The **TRUNC** function, in contrast, replaces with zero any digits less than the specified precision for numeric expressions. For DATE or DATETIME expressions, **TRUNC** replaces any time units smaller than the specified format string with 1 for *month* or *day* time units, or with zero for time units smaller than *day*.

The **ROUND** function can accept an optional second argument that specifies the precision of the returned value. The syntax and semantics of the second argument depend on whether the first argument is a number expression, a DATETIME expression, or DATE expression.

Rounding numeric and MONEY values

- When the first argument is a numeric expression, the returned value is a DECIMAL and the second argument can be an integer in the range from -32 to +32 inclusive, specifying the position (relative to the decimal point) of the last significant digit of the returned value. If you omit the *factor* specification when the first argument is numeric, **ROUND** returns the integer value of the first argument rounded to a scale of zero, or to the units place.

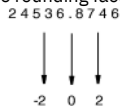
Positive-digit values specify rounding to the right of the decimal point; negative-digit values specify rounding to the left of the decimal point, as [Figure 1](#) shows:

Figure 1. Examples of negative, zero, and positive rounding factors

Expression:
`ROUND(24,536.8746, -2) = 24,500.00`

`ROUND(24,536.8746, 0) = 24,537.00`

`ROUND(24,536.8746, 2) = 24,536.87`



The following example uses the **ROUND** function with a column expression as its first argument and no second argument, so that the numeric expression is rounded to a scale of zero. This query returns the order number and rounded total price of items whose total price (rounded to the default scale of zero decimal places) is equal to \$124.00.

```
SELECT order_num , ROUND(total_price) FROM items
WHERE ROUND(total_price) = 124.00;
```

If you use a MONEY data type as the argument for the **ROUND** function and you round to an explicit or default scale of zero, the returned value is represented with .00 as the fractional part. The SELECT statement in the following example rounds 125.46 and a MONEY column value. The query returns 125 and a rounded price in the form xxx.00 for each row in the **items** table.

```
SELECT ROUND(125.46) , ROUND(total_price) FROM items;
```

Rounding DATE and DATETIME values

- When the first argument to **ROUND** is a DATETIME expression, the returned value is a DATETIME YEAR TO MINUTE data type and the second argument must be a quoted string that specifies the smallest significant time unit in the returned value. If you omit the second argument, the default format string is 'DD', specifying the nearest day, with the hour and minute rounded to 00:00. The following format strings are valid as the second argument:

Table 1. Format strings for DATETIME arguments to the ROUND function

Format String	Effect on Returned DATETIME Value
'YEAR'	Rounded to the beginning of the nearest year, with dates after June 30 rounded up to the next year. The <i>month</i> , <i>day</i> , <i>hour</i> , and <i>minute</i> values round to -01-01 00:00.
'MONTH'	Rounded to the beginning of the nearest month. Dates after the 15th are rounded up to the next month. The <i>day</i> , <i>hour</i> , and <i>minute</i> values round to 01 00:00.
'DD'	Rounded to the beginning (00:00 = midnight) of the nearest day. DATETIME values later than 12:00 noon are rounded up to the next day.
'DAY'	Rounded to the beginning of the nearest Sunday. Dates that fall on Wednesday, Thursday, Friday, or Saturday are rounded up to the next Sunday.
'HH'	Rounded to the beginning of the nearest hour. Time of day values with <i>minute:second</i> later than 29:59 are rounded up to the next hour. Minutes round to zero.
'MI'	Rounded to the beginning of the nearest minute. Time of day values with <i>second</i> later than 30 are rounded up to the next minute.

If you omit the format string specification after an initial DATETIME expression argument, the returned value is the value of the first argument rounded to the nearest day, as if you had specified 'DD' as the format string.

Examples that follow use the **ROUND** function with a column expression that returns a DATETIME YEAR TO FRACTION(5) value in a SELECT statement. In these queries, table **mytab** has only a single row, and in that row the value of **mytab.col_dt** is 2012-12-07 14:30:12.12300.

The following query specifies 'YEAR' as the DATETIME format string:

```
SELECT ROUND(col_dt, 'YEAR') FROM mytab;
```

The value returned is 2013-01-01 00:00.

The next query resembles the previous query, but casts the returned value to a DATE data type:

```
SELECT ROUND(col_dt, 'YEAR')::DATE FROM mytab;
```

The value returned is 01/01/2013.

This example specifies 'MONTH' as the DATETIME format string:

```
SELECT ROUND(col_dt, 'MONTH') FROM mytab;
```

The value returned is 2012-12-01 00:00.

This example rounds the DATETIME expression to YEAR TO HOUR precision:

```
SELECT ROUND(col_dt, 'HH') FROM mytab;
```

The value returned is 2012-12-07 15:00.

- When the first argument is a DATE expression, the returned value is also a DATE data type if the second argument is a quoted string that specifies the smallest time unit in the returned value. These are the same format strings as for rounding DATETIME values, except that 'HH' and 'MI' are not valid for DATE values. There is no default format string for rounding DATE arguments.

To return formatted DATE values, you must specify one of the following quoted strings as the second argument to the **ROUND** function:

Table 2. Format strings for DATE arguments to the ROUND function

Format String	Effect on Returned DATE Value
'YEAR'	Rounded to the beginning of the nearest year. Dates after June 30 are rounded up to the next year. The <i>month</i> and <i>day</i> values each round to 01.
'MONTH'	Rounded to the beginning of the nearest month. Dates after the 15th are rounded up to the next month. The returned <i>day</i> value is 01.
'DD'	The DATE value of the first <i>date_expression</i> argument is returned.
'DAY'	The value is rounded to the nearest Sunday. If the first argument is a Sunday, that date is returned. Dates that fall on Wednesday, Thursday, Friday, or Saturday are rounded up to the next Sunday.

If you specify no format string as the second argument when the first argument is a DATE data type, no format string takes effect as the default. No error is issued, but the first argument is treated as numeric expression that evaluates to an integer, rather than as a DATE value. Informix® stores DATE values internally as the integer count of days since 31 December 1899. For dates in the 21st century, integer equivalents to DATE values are 5-digit integers, ranging between approximately 37,000 and 74,000.

For example, the query `SELECT ROUND(TODAY) FROM systables` provides no format string for a DATE expression, and returns the integer 40999 if the query is issued on 1 April 2012.

If you apply a numeric format specification as the second argument, nonnegative numbers have no effect on DATE values, but the following example rounds the last two digits of the returned value to zero:

```
SELECT ROUND(TODAY, -2) FROM systables;
```

On 1 April 2012, the query above would return the integer value 40900.

On the next day, 2 April 2012, the same query would return the integer value 41000.

For applications where integer-format dates like 41000 are unhelpful, you can use the 'YEAR', 'MONTH', 'DAY', or 'DD' format strings as the second argument to the **ROUND** function to prevent the DATE argument from being processed as if it were a number expression. On 1 April 2012, the following query returns the DATE value 04/01/2012 if `MDY4` is the **DBDATE** environment variable setting:

```
SELECT ROUND(TODAY, 'DD') FROM systables WHERE tabid = 1;
```

In the following example, a query is issued on Tuesday, April 3, 2012:

```
SELECT ROUND(TODAY, 'DAY') FROM mytab;
```

The returned value is 03/31/2012, the current date rounded to the nearest Sunday.

If you are using a host variable to store a rounded point-in-time value in dynamic SQL, and the data type of the first argument is not known at prepare time, Informix assumes that a DATETIME data type is the first argument to the **ROUND** function and returns a DATETIME YEAR TO MINUTE rounded value. At execution time, after the statement is prepared, error -9750 is issued if a DATE value is supplied for the host variable. To prevent this error, you can specify the data type for the host variable by using a cast, as in this program fragment.

```
sprintf(query1, "
select round( ?::date, 'DAY') from mytab");
EXEC SQL prepare selectq from :query;
EXEC SQL declare select_cursor cursor for selectq;
EXEC SQL open select_cursor using :hostvar_date_input;

EXEC SQL fetch select_cursor into :var_date_output;
```

For the order of precedence among the Informix environment variables that can specify the display and data entry formats for the built-in chronological data types, see the topic [Precedence of DATE and DATETIME format specifications](#).

TRUNC Function

The **TRUNC** function can reduce the precision of its first numeric, DATE, or DATETIME argument by returning the truncated value. If the first argument is neither a number nor a point in time, it must be cast to a numeric, DATE, or DATETIME data type.

The **TRUNC** function can reduce the precision of its first numeric, DATE, or DATETIME argument by returning the truncated value. If the first argument is neither a number nor a point in time, it must be cast to a numeric, DATE, or DATETIME data type.

The **TRUNC** function resembles the **ROUND** function, but truncates (rather than rounds to the nearest whole number) any portion of its first argument that is smaller than the least significant digit or time unit within the precision that its second argument specifies.

- For numeric expressions, **TRUNC** replaces with zero any digits less than the specified precision.
- For DATE or DATETIME expressions, **TRUNC** replaces any time units smaller than the format specification with 1 for *month* or *day* time units, or with 0 for time units smaller than *day*.

The **TRUNC** function can accept an optional second argument that specifies the precision of the returned value.

- When the first argument is a numeric expression, the second argument must be an integer in the range from -32 to +32 inclusive, specifying the position (relative to the decimal point) of the last significant digit of the returned value. If you omit the *factor* specification when the first argument is numeric, **TRUNC** returns the value of the first argument truncated to a scale of zero, or to the units place. Positive digit values specify truncation to the right of the decimal point; negative digit values specify truncation to the left, as [Figure 1](#) shows.

Figure 1. Examples of negative, zero, and positive truncation factors

Expression: 2 4 5 3 6 . 8 7 4 6

TRUNC (24536.8746, -2) = 24500

TRUNC (24536.8746, 0) = 24536

TRUNC (24536.8746, 2) = 24536.87

-2 0 2

The following example calls the **TRUNC** function with a column expression that returns a numeric value in a SELECT statement. This statement displays the order number and truncated total price of items whose total price (truncated to the default scale of zero decimal places) is equal to \$124.00.

```
SELECT order_num , TRUNC(total_price) FROM items
WHERE TRUNC(total_price) = 124.00;
```

If a MONEY data type is the argument in a call to the **TRUNC** function that specifies a scale of zero, the fractional part becomes .00 in the returned value. For example, the following SELECT statement truncates 125.46 and a MONEY column value. It returns 125 and a truncated price in the form xxx.x00 for each row in the **items** table.

```
SELECT TRUNC(125.46) , TRUNC(total_price) FROM items;
```

- When the first argument to **TRUNC** is a DATETIME expression, the second argument must be a quoted string that specifies the smallest significant time unit in the returned value. Only the following format strings are valid as the second argument:

Table 1. Format strings for DATETIME arguments to the TRUNC function

Format String	Effect on Returned Value
'YEAR'	Truncated to the beginning of the year. The <i>month</i> , <i>day</i> , <i>hour</i> , and <i>minute</i> values truncate to 01-01 00:00.
'MONTH'	Truncated to the beginning of the first day of the month. The <i>hour</i> and <i>minute</i> values round to 00:00.
'DD'	Truncated to the beginning (00:00 = midnight) of the same day.
'DAY'	If the first argument is a Sunday, midnight (00:00) on that date is returned. For any other day of the week, midnight on the previous Sunday is returned.
'HH'	Truncated to the beginning of the hour. The <i>minute</i> value truncates to zero.
'MI'	Truncated to the beginning of the nearest minute. As for all of these format strings, time units smaller than <i>minute</i> are discarded.

If you omit the format string specification after an initial DATETIME expression argument, the returned value is the value of the first argument truncated to the day, as if you had specified 'DD' as the format string.

Examples that follow invoke the **TRUNC** function with a column expression that returns a DATETIME YEAR TO FRACTION(5) value in a SELECT statement. In these examples, table **mytab** has only a single row, and in that row the value of **mytab.col_dt** is 2006-12-07 14:30:12.12300.

This query specifies 'YEAR' as the DATETIME format string:

```
SELECT TRUNC(col_dt, 'YEAR') FROM mytab;
```

The value returned is 2006-01-01 00:00.

The next query resembles the previous query, but casts the truncated value to a DATE data type:

```
SELECT TRUNC(col_dt, 'YEAR')::DATE FROM mytab;
```

The value returned is 01/01/2006.

This example specifies 'MONTH' as the DATETIME format string:

```
SELECT TRUNC(col_dt, 'MONTH') FROM mytab;
```

The value returned is 2006-12-01 00:00.

The following example truncates the DATETIME expression to YEAR TO HOUR precision:


```
SELECT TRUNC(col_dt, 'HH') FROM mytab;
```

The value returned is 2006-12-07 14:00.

- When the first argument is a DATE expression, the second argument should generally be a quoted string that specifies the smallest time unit in the returned value. These are the same format strings as for truncating DATETIME values, except that 'HH' and 'MI' are not valid for dates, and there is no default format string for truncating DATE expression arguments.

To return formatted DATE values, you must use one of the following quoted strings as the second argument to the **TRUNC** function:

Table 2. Format strings for DATE arguments to the TRUNC function

Format String	Effect on Returned Value
'YEAR'	Truncated to the beginning of the year. The <i>month</i> and <i>day</i> values are each 01.
'MONTH'	Truncated to the beginning of the month. The <i>day</i> value is 01.
'DD'	The DATE value of the first <i>date_expression</i> argument is returned.
'DAY'	If the first argument is a Sunday, that date is returned. For any other day of the week, the date of the previous Sunday is returned.

If you specify no format string as the second argument when the first argument is a DATE data type, no format string takes effect as the default. No error is issued, but the first argument is treated as numeric expression that evaluates to an integer, rather than as a DATE value. Informix® stores DATE values internally as the integer count of days since 31 December 1899.

For example, the query `SELECT ROUND(TODAY) FROM systables` provides no format string for a DATE expression, and returns the integer 39538 if the query is issued on 1 April 2008.

If you apply a numeric format specification as the second argument, nonnegative numbers have no effect on DATE values, but the following example rounds the last two digits of the returned value to zero:

```
SELECT TRUNC(TODAY, -2) FROM systables;
```

For applications where integer dates like 39500 are unhelpful, use the 'YEAR', 'MONTH', 'DAY', or 'DD' format strings as the second argument to the **TRUNC** function, to prevent the DATE expression from being processed as if it were a number expression. On 1 April 2008, the following query returns the DATE value 04/01/2008 if MDY4/ is the setting of the **DBDATE** environment variable:

```
SELECT TRUNC(TODAY, 'DD') FROM systables;
```

If you are using a host variable to store a truncated point-in-time value in dynamic SQL, and the data type of the first argument is not known at prepare time, Informix assumes that a DATETIME data type is the first argument to the **TRUNC** function and returns a DATETIME YEAR TO MINUTE truncated value. At execution time, after the statement is prepared, error -9750 is issued if a DATE value is supplied for the host variable. To prevent this error, you can specify the data type for the host variable by using a cast, as in this program fragment.

```
sprintf(query2, "%s",
"select trunc( ?:date, 'DAY') from mytab");
EXEC SQL prepare selectq from :query2;
EXEC SQL declare select_cursor cursor for selectq;
EXEC SQL open select_cursor using :hostvar_date_input;

EXEC SQL fetch select_cursor into :var_date_output;
```

For the order of precedence among the Informix environment variables that can specify the display and data entry formats for the built-in chronological data types, see the topic [Precedence of DATE and DATETIME format specifications](#).

Note that the **TRUNC** function name is based on a use of the English word "truncate" that is different from its meaning in the TRUNCATE statement of SQL. The **TRUNC** function replaces the value of its first argument with another value that has a smaller precision or the same precision. The TRUNCATE statement deletes all of the rows from a database table, without dropping the table schema.

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Bitshift Functions

Bitshift functions perform a bit shift operation on an integer or bigint value and return the shift result.

The bitshift functions have the following syntax.

```
|---IFX_BIT_LEFTSHIFT---| (---operand--,---amount---)|
|---IFX_BIT_RIGHTSHIFT---|
```

Element	Description	Restrictions	Syntax
<i>operand</i>	Entity whose bits are to be shifted. Its type will also be function's return type.	Must be of type integer or bigint.	Expression
<i>amount</i>	Number of bits operand will be shifted by.	Integer value between 0 and number of bits in operand's type (or respective modulo of any other integer value).	Expression

- [IFX_BIT_LEFTSHIFT Function](#)

The **IFX_BIT_LEFTSHIFT** function performs a bit left shift operation on an integer or bigint value and returns the shift result

- [IFX_BIT_RIGHTSHIFT Function](#)
The **IFX_BIT_RIGHTSHIFT** function performs a bit right shift operation on an integer or bigint value and returns the shift result.

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IFX_BIT_LEFTSHIFT Function

The **IFX_BIT_LEFTSHIFT** function performs a bit left shift operation on an integer or bigint value and returns the shift result

The IFX_BIT_LEFTSHIFT function performs a bit left shift operation on an integer or bigint value and returns the shift result. It takes as arguments an integer or bigint operand and an integer operator. The type of the operand will be the function's return type. The operator determines the number of bits by which the passed in value gets shifted to the left, its value should range between 0 and 31 for integer operands, and between 0 and 63 for bigint operands (any other values might be taken as their modulo of 32 or 64 respectively, but that's not guaranteed).

The effect of ifx_bit_leftshift is equivalent to multiplying the operand by 2 to the power of operator, but is of course limited to the resulting type's capacity.

With both integer and bigint, the value with only the high bit set carries special meaning as it signifies a NULL value. Should the bit shift result in an integer 0x80000000, you'd receive error 1215, whereas a bigint result 0x8000000000000000 would be returned as NULL.

Examples:

operand	operator	result
1	4	16 (0x00000010)
3	2	12 (0x0000000c)
"0x800"::integer	5	65536 (0x00010000)
12345	26	-469762048 (0xe4000000)
1	31	error 1215
1::bigint	31	2147483648 (0x80000000)

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IFX_BIT_RIGHTSHIFT Function

The **IFX_BIT_RIGHTSHIFT** function performs a bit right shift operation on an integer or bigint value and returns the shift result.

The IFX_BIT_RIGHTSHIFT function performs a bit right shift operation on an integer or bigint value and returns the shift result. It takes as arguments an integer or bigint operand and an integer operator. The type of the operand will be the function's return type. The operator determines the number of bits by which the passed in value gets shifted to the right, its value should range between 0 and 31 for integer operands, and between 0 and 63 for bigint operands (any other values might be taken as their modulo of 32 or 64 respectively, but that's not guaranteed).

Example:

```
select name, IFX_BIT_RIGHTSHIFT(partnum, 20) as dbspace_num
from sysmaster:sysdatabases;
```

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CARDINALITY Function

The **CARDINALITY** function returns the number of elements in a collection column (SET, MULTiset, LIST).

The **CARDINALITY** function has the following syntax.

CARDINALITY Function

```
|--CARDINALITY--(--+collection_col+--)-+-----|
|'collection_var'|
```

Element	Description	Restrictions	Syntax
collection_col	An existing collection column	Must be declared as a collection data type	Identifier
collection_var	Host or program collection variable	Must be declared as a collection data type	Language specific

Suppose that the **set_col** SET column contains the following value:

```
{3, 7, 9, 16, 0}
```

The following SELECT statement returns 5 as the number of elements in the **set_col** column:

```
SELECT CARDINALITY(set_col)
FROM table1;
```

If the collection contains duplicate elements, **CARDINALITY** counts each individual element.

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SQLCODE Function (SPL)

The **SQLCODE** function takes no arguments, but returns to its calling context the value of **sqlca.sqlcode** for the most recently executed SQL statement (whether static or dynamic) that the current SPL routine has executed. Only use **SQLCODE** in the context of a cursor.

```
SQLCODE
|--SQLCODE-----|
```

You can use **SQLCODE** in expressions within SPL routines to identify the state of a dynamic cursor. This built-in function is useful in error handling and in contexts such as determining whether a query or function call has returned no rows, or when a cursor has reached the last row of the active set, or to identify other conditions when SPL program control should exit from a loop.

The following SPL program fragment illustrates the use of **SQLCODE** to detect the end of the active set of a cursor within a WHILE loop.

```
CREATE PROCEDURE ...
...
DEFINE myc1 ...
...
PREPARE p FOR "SELECT c1 FROM t1";
DECLARE cur FROM s;
OPEN cur;

FETCH cur INTO myc1;
WHILE (SQLCODE != 100)
  FETCH cur INTO myc1;
  -- process myc1
...
END WHILE;

END PROCEDURE;
```

The **SQLCODE** function is not needed in UDRs written in ESQL/C, which have direct access to the SQL Communications Area (**SQLCA**) through the GET DIAGNOSTICS statement of Dynamic SQL and by other mechanisms. The database server issues an error if the calling context of the built-in **SQLCODE** function is not an SPL routine.

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DBINFO Function

The following diagram shows the syntax of the **DBINFO** function.

```
DBINFO Function
|--DBINFO----->
>--(---'dbspace'---,---tblspace_num---+-----+---)-----|
|               '-expression---'                         |
|+---'sqlca.sqlerrd1'---+-----+---|
| '-sqlca.sqlerrd2'-    |                         |
| (1)                   |                         |
|+-----+---'sessionid'-----+---|
|   +---'cdrsession'-----+---|
|   +---'dbname'-----+---|
|   +---'dbhostname'-----+---|
|   +---'serial8'-----+---|
|   +---'bigserial'-----+---|
|   +---'get_tz'-----+---|
|   +---'utc_current'-----+---|
|   +---'utc_to_datetime'---,---+---+---+---+---+---+---|
|                               '-table.column-' |
|+---'version'---,---'parameter'-----+---|
```

Notes:

1. Informix® extension

Element	Description	Restrictions	Syntax
<i>column</i>	Name of a column in the <i>table</i>	Must exist in <i>table</i>	Identifier
<i>expression</i>	Expression that evaluates to <i>tblspace_num</i>	Can contain column names, SPL variables, host variables, or subqueries, but must return a numeric value	Expression

Element	Description	Restrictions	Syntax
<i>parameter</i>	Quoted string that specifies which part of the <i>version</i> string to return	For valid <i>parameter</i> values, see Using the 'version' Option	See the Restrictions column.
<i>table</i>	Table for which to display the dbspace name or containing an integer <i>column</i> of UTC values.	Must match the name of a table in the FROM clause of the query	Identifier
<i>tblspace_num</i>	Tblspace number (partition number) of a table	Must exist in the partnum column of the systables table for the database	Literal Number
<i>utc_value</i>	A UTC value to be converted to the DATETIME equivalent	Must be a numeric expression that evaluates to the number of seconds since 1970-01-01 00:00:00+00:00	Expression , Literal Number

- [DBINFO Options](#)
The **DBINFO** function is actually a set of functions that return different types of information about the database. To invoke each function, specify its option as the quoted-string argument after the **DBINFO** keyword. You can use any **DBINFO** option anywhere within SQL statements and within UDRs.
- [Using the \('dbspace', tblspace_num\) Option](#)
- [Using the 'sqlca.sqlerrd1' Option](#)
The **'sqlca.sqlerrd1'** option returns a single integer that provides the last serial value that is inserted into a table. To ensure valid results, use this option immediately following a singleton INSERT statement that inserts a single row with a serial value into a table.
- [Using the 'sqlca.sqlerrd2' Option](#)
- [Using the 'sessionid' Option](#)
- [Using the 'cdrsession' option](#)
The **'cdrsession'** option to the **DBINFO()** function detects if an INSERT, UPDATE, or DELETE statement is being performed as part of a replicated transaction.
- [Using the 'dbname' Option](#)
- [Using the 'dbhostname' Option](#)
You can use the **'dbhostname'** option to retrieve the host name of the database server to which a database client is connected.
- [Using the 'version' Option](#)
You can use the **'version'** option of the **DBINFO** function to retrieve information from the message log about the type and release version of the database server against which the client application is running.
- [Using the 'serial8' and 'bigserial' options](#)
The **'bigserial'** and **'serial8'** options respectively return a single integer that specifies the last SERIAL8 or BIGSERIAL value that was inserted into a table. To ensure valid results, use this option immediately following an INSERT statement that inserts a SERIAL8 or BIGSERIAL value.
- [Using the 'get_tz' Option](#)
The **'get_tz'** option returns the **\$TZ** string that shows the time zone of the current session.
- [Using the 'utc_current' Option](#)
The **'utc_current'** option returns the current value of Coordinated Universal Time (UTC) as an integer value that shows the number of seconds that have elapsed between 1970-01-01 00:00:00+00:00) and when the current SQL statement began to execute.
- [Using the 'utc_to_datetime' Option](#)
The **'utc_to_datetime'** option of the **DBINFO** function returns the UTC seconds to DATETIME value that the server would generate if the UNIX **time()** system call returned the value of the second parameter, taking into account the time zone of the database server.

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DBINFO Options

The **DBINFO** function is actually a set of functions that return different types of information about the database. To invoke each function, specify its option as the quoted-string argument after the **DBINFO** keyword. You can use any **DBINFO** option anywhere within SQL statements and within UDRs.

The following table shows the categories of database and database server information that Informix® can retrieve with valid **DBINFO** options.

- The **Arguments** column shows the parentheses-delimited argument list of each valid **DBINFO** option.
- The **Information Returned** column shows the type of database information that the **Arguments** option retrieves.
- The **Topic** column shows where you can find more information about the **Arguments** option.

Arguments	Information Returned	Topic
('dbhostname')	The host name of the database server to which a client application is connected	Using the 'dbhostname' Option
('dbname')	The identifier of the database to which a client application is connected	Using the 'dbname' Option
('dbspace' <i>tblspace_num</i>)	The name of a dbspace corresponding to a tblspace number	Using the ('dbspace', tblspace_num) Option
('get_tz')	The time zone of the session, \$TZ , as specified as a string by the client.	Using the 'get_tz' Option
('serial8')	The last SERIAL8 value inserted in a table	Using the 'serial8' and 'bigserial' options
('bigserial')	The last BIGSERIAL value inserted in a table	Using the 'serial8' and 'bigserial' options
('sessionid')	The session ID number of the current session	Using the 'sessionid' Option
('cdrsession')	Whether a thread is performing an Enterprise Replication operation	Using the 'cdrsession' option
('sqlca.sqlerrd1')	The last SERIAL value inserted in a table	Using the 'sqlca.sqlerrd1' Option

Arguments	Information Returned	Topic
('sqlca.sqlerrd2')	The number of rows processed by SELECT, INSERT, DELETE, UPDATE, EXECUTE PROCEDURE, and EXECUTE FUNCTION statements	Using the 'sqlca.sqlerrd2' Option
('utc_current')	The current UTC time value (as an integer number of seconds since 1970-01-01 00:00:00+00:00) when the SQL statement began to execute.	Using the 'utc_current' Option
('utc_to_datetime', table.column)	The DATETIME value corresponding to a specified integer column containing a UTC time value (as an integer number of seconds since 1970-01-01 00:00:00+00:00).	Using the 'utc_to_datetime' Option
('utc_to_datetime', utc_value)	The DATETIME value corresponding to a specified UTC time value (as an integer number of seconds since 1970-01-01 00:00:00+00:00).	Using the 'utc_to_datetime' Option
('version', 'parameter')	Type of the database server and its release version to which the client application is connected. (The call to DBINFO fails with an error if no <i>parameter</i> specifies a format for the version information.)	Using the 'version' Option

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Using the ('dbspace', tblspace_num) Option

The '**dbspace**' option returns a character string that contains the name of the dbspace that corresponds to a tblspace number. You must supply an additional parameter, either *tblspace_num* or an expression that evaluates to *tblspace_num*. The following example uses the '**dbspace**' option. First, it queries the **systables** system catalog table to determine the *tblspace_num* for the table **customer**, then it executes the function to determine the *dbspace* name.

```
SELECT tabname, partnum FROM systables
where tabname = 'customer';
```

If the query returns a partition number of 1048892, you insert that value into the second argument to find which dbspace contains the **customer** table, as the following example shows:

```
SELECT DBINFO ('dbspace', 1048892) FROM systables
where tabname = 'customer';
```

If the table for which you want to know the dbspace name is fragmented, you must query the **sysfragments** system catalog table to find out the *tblspace* number of each table fragment. Then you must supply each *tblspace* number in a separate **DBINFO** query to find out all the dbspaces across which a table is fragmented.

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Using the 'sqlca.sqlerrd1' Option

The '**sqlca.sqlerrd1**' option returns a single integer that provides the last serial value that is inserted into a table. To ensure valid results, use this option immediately following a singleton INSERT statement that inserts a single row with a serial value into a table.

Tip: To obtain the value of the last SERIAL8 value that is inserted into a table, use the '**serial8**' option of **DBINFO**. For more information, see [Using the 'serial8' and 'bigserial' options](#).

The following example uses the '**sqlca.sqlerrd1**' option:

```
EXEC SQL create table fst_tab (ordernum serial, partnum int);
EXEC SQL create table sec_tab (ordernum serial);
EXEC SQL insert into fst_tab VALUES (0,1);
EXEC SQL insert into fst_tab VALUES (0,4);
EXEC SQL insert into fst_tab VALUES (0,6);
EXEC SQL insert into sec_tab values (dbinfo('sqlca.sqlerrd1'));
```

This example inserts a row that contains a primary-key serial value into the **fst_tab** table, and then uses the **DBINFO** function to insert the same serial value into the **sec_tab** table. The value that the **DBINFO** function returns is the serial value of the last row that is inserted into **fst_tab**.

Because the SQLCA structure does not record serial values that are inserted by triggers, you cannot call the **DBINFO** function with the '**sqlca.sqlerrd1**', '**bigserial**', or '**serial8**' options to return a serial value that a triggered action inserts.

For more information about the SQL Communications Area (SQLCA) data structure, within which **sqlca.sqlerrd1** is a field, see the *IBM® Informix® Guide to SQL: Tutorial*.

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Using the 'sqlca.sqlerrd2' Option

The '**sqlca.sqlerrd2**' option returns a single integer that provides the number of rows that SELECT, INSERT, DELETE, UPDATE, EXECUTE PROCEDURE, and EXECUTE FUNCTION statements processed. To ensure valid results, use this option after SELECT, EXECUTE PROCEDURE, and EXECUTE FUNCTION statements have completed executing. In addition, to ensure valid results when you use this option within cursors, make sure that all rows are fetched before the cursors are closed.

The following example shows an SPL routine that uses the '**sqlca.sqlerrd2**' option to determine the number of rows that are deleted from a table:

```
CREATE FUNCTION del_rows (pnumb INT)
RETURNING INT;

DEFINE nrows INT;

DELETE FROM fst_tab WHERE part_number = pnumb;
LET nrows = DBINFO('sqlca.sqlerrd2');
RETURN nrows;

END FUNCTION;
```

For more information about the SQL Communications Area (SQLCA) data structure, within which **sqlca.sqlerrd2** is a field, see the *IBM® Informix® Guide to SQL: Tutorial*.

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Using the 'sessionid' Option

The '**sessionid**' option of the **DBINFO** function returns the session ID of your current session. When a client application makes a connection to the database server, the database server starts a session with the client and assigns a session ID for the client. The session ID serves as a unique identifier for a given connection between a client and a database server.

The database server stores the value of the session ID in a data structure in shared memory that is called the *session control block*. The session control block for a given session also includes the user ID, the process ID of the client, the name of the host computer, and a variety of status flags.

When you specify the '**sessionid**' option, the database server retrieves the session ID of your current session from the session control block and returns this value to you as an integer. Some of the System-Monitoring Interface (SMI) tables in the **sysmaster** database include a column for session IDs, so you can use the session ID that the **DBINFO** function obtained to extract information about your own session from these SMI tables. For further information on the session control block, see the *IBM® Informix® Administrator's Guide*. For further information on the **sysmaster** database and the SMI tables, see the *IBM Informix Administrator's Reference*.

In the following example, the user specifies the **DBINFO** function in a SELECT statement to obtain the value of the current session ID. The user poses this query against the **systables** system catalog table and uses a WHERE clause to limit the query result to a single row.

```
SELECT DBINFO('sessionid') AS my_sessionid
FROM systables
WHERE tabname = 'systables';
```

In the preceding example, the SELECT statement queries against the **systables** system catalog table. You can, however, obtain the session ID of the current session by querying against any system catalog table or user table in the database. For example, you can enter the following query to obtain the session ID of your current session:

```
SELECT DBINFO('sessionid') AS user_sessionid
FROM customer
WHERE customer_num = 101;
```

You can use the **DBINFO 'sessionid'** option not only in SQL statements but also in SPL routines. The following example shows an SPL function that returns the value of the current session ID to the calling program or routine:

```
CREATE FUNCTION get_sess()
RETURNING INT;
RETURN DBINFO('sessionid');
END FUNCTION;
```

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Using the 'cdrsession' option

The '**cdrsession**' option to the **DBINFO()** function detects if an INSERT, UPDATE, or DELETE statement is being performed as part of a replicated transaction.

You might want to design triggers, stored procedures, or user-defined routines to take different actions depending on whether a transaction is being performed as part of Enterprise Replication. The '**cdrsession**' option of the **DBINFO()** function returns 1 if the thread performing the database operation is an Enterprise Replication apply or sync thread; otherwise, the function returns 0.

The following example shows an SPL function that uses the '**cdrsession**' option to determine if a thread is performing an Enterprise Replication operation:

```
CREATE FUNCTION iscdr ()
RETURNING int;

DEFINE iscdrthread int;
SELECT DBINFO('cdrsession') into iscdrthread
from systables where tabid = 1;
RETURN iscdrthread;
```

Using the 'dbname' Option

You can use the **'dbname'** option to retrieve the name of the current database. This option returns the identifier of the database to which the client session is currently connected.

In the following example, the user enters the **'dbname'** option of **DBINFO** in a SELECT statement to retrieve the name of the database to which DB-Access is connected:

```
SELECT DBINFO('dbname')
FROM systables
WHERE tabid = 1;
```

The following table shows the result of this query.

(constant)
stores_demo

Using the 'dbhostname' Option

You can use the **'dbhostname'** option to retrieve the host name of the database server to which a database client is connected.

This option retrieves the physical computer name of the computer on which the database server is running.

In the following example, the user enters the **'dbhostname'** option of **DBINFO** in a SELECT statement to retrieve the host name of the database server to which DB-Access is connected:

```
SELECT DBINFO('dbhostname')
FROM systables
WHERE tabid = 1;
```

The following table shows the result of this query.

(constant)
rd_lab1

Using the 'version' Option

You can use the **'version'** option of the **DBINFO** function to retrieve information from the message log about the type and release version of the database server against which the client application is running.

You must include a *'parameter'* specification after the **'version'** option to indicate which part of the version string you want to retrieve.

If after **'version'** you specify **'full'** as the *parameter* value, **DBINFO** returns the complete version string, which is the same value that the **-V** option of the **oninit** utility displays. The following table lists all the valid *parameter* arguments to **DBINFO** that can retrieve version information about the database server:

- The **Arguments** column shows the parentheses-delimited argument list of each valid **DBINFO ('version', 'parameter')** combination.
- The **Part of Version String Returned** column shows which part of the version string each **Arguments** list returns.
- The **Example of Returned Value** column shows gives an example of what is returned by each value of *parameter* for the **Arguments** option.

Each example returns part of the complete version string Informix® Version 11.50.UC6.

Arguments	Part of Version String Returned	Example of Returned Value
('version', 'server-type')	Type of database server	Informix
('version', 'major')	Major version number of the current database server version	11
('version', 'minor')	Minor version number of the current database server version	50
('version', 'os')	Operating-system identifier within the version string: <ul style="list-style-type: none"> • T = 32-bit Windows platforms • U = UNIX 32-bit running on a 32-bit operating system • H = UNIX 32-bit running on a 64-bit operating system • F = All 64-bit platforms 	U

Arguments	Part of Version String Returned	Example of Returned Value
('version', 'level')	Interim release level of the current database server version	C6
('version', 'full')	Complete version string as it would be returned by oninit -V	Informix, Version 11.50.UC6

Important: Not all UNIX environments fit the word-length descriptions of operating- system (os) codes in the preceding table. For example, some U versions can run on 64-bit operating systems. Similarly, some F versions can run on operating systems with 32-bit kernels that support 64-bit applications.

The following example shows how to use the **'version'** option of **DBINFO** in a SELECT statement to retrieve the major version number of the database server that the DB-Access client is connected to:

```
SELECT DBINFO('version', 'major')
FROM systables
WHERE tabid = 1;
```

The following table shows the result of this query.

(constant)
7

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Using the 'serial8' and 'bigserial' options

The **'bigserial'** and **'serial8'** options respectively return a single integer that specifies the last SERIAL8 or BIGSERIAL value that was inserted into a table. To ensure valid results, use this option immediately following an INSERT statement that inserts a SERIAL8 or BIGSERIAL value.

Tip: To obtain the value of the last SERIAL value that is inserted into a table, use the **'sqlca.sqlerrd1'** option of **DBINFO()**. For more information, see [Using the 'sqlca.sqlerrd1' Option](#).

The following example uses the **'serial8'** option:

```
EXEC SQL CREATE TABLE fst_tab
(ordernum SERIAL8, partnum INT);
EXEC SQL CREATE TABLE sec_tab (ordernum SERIAL8);

EXEC SQL INSERT INTO fst_tab VALUES (0,1);
EXEC SQL INSERT INTO fst_tab VALUES (0,4);
EXEC SQL INSERT INTO fst_tab VALUES (0,6);

EXEC SQL INSERT INTO sec_tab
SELECT dbinfo('serial8')
FROM fst_tab WHERE partnum = 6;
```

This example inserts a row that contains a primary-key SERIAL8 value into the **fst_tab** table and then uses the **DBINFO** function to insert the same SERIAL8 value into the **sec_tab** table. The value that the **DBINFO** function returns is the SERIAL8 value of the last row that is inserted into **fst_tab**. The subquery in the last line contains a WHERE clause so that a single value is returned.

The SQLCA structure does not record serial values that are inserted by triggers. You cannot call the **DBINFO** function with the **'bigserial'** option to return the most recent BIGSERIAL value that was inserted directly by the triggered action of a trigger on a table (nor of an INSTEAD OF trigger on a view). For the same reason, the **DBINFO ('serial8')** function cannot return a SERIAL8 value that was inserted by a trigger on a table, nor by an INSTEAD OF trigger on a view.

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Using the 'get_tz' Option

The **'get_tz'** option returns the **\$TZ** string that shows the time zone of the current session.

The following example uses the **'get_tz'** option in a query of the **cust_calls** table of the **stores_demo** database:

```
EXEC SQL select first call_dtime, dbinfo('get_tz')
from cust_calls where customer_num = 106;
```

This example returns a string value of the session time zone and the first **call_dtime** value in the **cust_calls** table for which the **customer_num** value is 106.

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Using the 'utc_current' Option

The **'utc_current'** option returns the current value of Coordinated Universal Time (UTC) as an integer value that shows the number of seconds that have elapsed between 1970-01-01 00:00:00+00:00) and when the current SQL statement began to execute.

Unlike Universal Time (UT), which calculates the duration of seconds from the earth's rotation, UTC uses seconds of a fixed length, based on high-precision atomic clocks.

Because of variation in the earth's gradually diminishing rotation rate, intercalary *leap seconds* are introduced from time to time in UTC to reduce discrepancies with UT time. By default, Informix® ignores leap seconds in DATETIME and INTERVAL arithmetic. When Informix is supported by an operating system that takes leap seconds into account, however, the leap seconds are reflected in subsequent DATETIME and INTERVAL operations after the operating system adjusts the system clock for leap seconds.

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Using the 'utc_to_datetime' Option

The '**utc_to_datetime**' option of the **DBINFO** function returns the UTC seconds to DATETIME value that the server would generate if the UNIX **time()** system call returned the value of the second parameter, taking into account the time zone of the database server.

The '**utc_to_datetime**' option casts to a DATETIME value its last argument, which must be a numeric expression representing a Coordinated Universal Time (UTC) value. If this evaluates to a number with a fractional part, any fractional seconds are ignored.

In the first example below, the last argument is a UTC value represented as a literal integer. In the second example, the last argument is a column expression specifying an integer column that stores UTC values. In both examples, **DBINFO** casts the UTC value to a DATETIME value in the time zone of the database server:

```
DBINFO ('utc_to_datetime', 1299912999 )
DBINFO ('utc_to_datetime', timesheet.utc_checkin )
```

If the value of the last argument is negative, the function returns a DATETIME value from an earlier UNIX epoch, as in the next example:

```
SELECT DBINFO("utc_to_datetime", -2134567890.91234)
FROM 'sysmaster':"informix".sysdual;
```

This query returns the DATETIME value 1902-05-12 08:28:30.

These example times all assume that the server is in a specific time zone. The following query returns four DATETIME values:

```
SELECT
  DBINFO('utc_to_datetime', -32767) AS min_smallint,
  DBINFO('utc_to_datetime', +32767) AS max_smallint,
  DBINFO('utc_to_datetime', 1299912999),
  DBINFO("utc_to_datetime", -2134567890.91234)
FROM 'sysmaster':"informix".sysdual;
```

These are the returned DATETIME values from a server in the United States Pacific time zone:

```
1969-12-31 06:53:53  1970-01-01 01:06:07  2011-03-11 22:56:39
1902-05-12 01:28:30
# Server running in TZ=US/Pacific
```

These are the returned DATETIME values from the same query from a server in the UTC0 time zone:

```
1969-12-31 14:53:53  1970-01-01 09:06:07  2011-03-12 06:56:39
1902-05-12 08:28:30
# Server running in TZ=UTC0
```

Note that the DAY component in the third DBINFO result is different for the United States Pacific time zone and for the UTC0 time zone, because of the 8-hour offset between those two time zones.

The database server time zone can similarly affect the return value from other expressions for points in time, such as CURRENT, SYSDATE, and TODAY, whose DATETIME YEAR TO SECOND or DATE representation depends on the time zone of the server.

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Encryption and decryption functions

Informix® supports built-in encryption and decryption functions.

The encryption functions **ENCRYPT_AES** and **ENCRYPT_TDES** return an *encrypted_data* value that encrypts the *data* argument. Conversely, decryption functions **DECRYPT_CHAR** and **DECRYPT_BINARY** return a plain-text *data* value from the *encrypted_data* argument. Use this syntax to call these functions:

Encryption and Decryption Functions

```
|---+-ENCRYPT_AES---+--(--data---+-----+---+)-+---|
| '-ENCRYPT_TDES-'          '- , -password---+-----+-' |
| |                          '- , -hint-' |
| +---DECRYPT_CHAR---+--(--encrypted_data---+-----+---+)-+---|
| '-DECRYPT_BINARY-'          '- , -password-' |
| '-GETHINT--(--encrypted_data--)-+-----+---+-' |
```

Element	Description	Restrictions	Syntax
<i>data</i>	A plain text character string, variable, or large object of type BLOB or CLOB to be encrypted	Must be a character or BLOB data type	Expression

Element	Description	Restrictions	Syntax
<i>encrypted_data</i>	A character string or variable containing output from ENCRYPT_AES or from ENCRYPT_TDES	Decryption requires the encryption password	Expression
<i>hint</i>	A character string that you define here. Default is the value from the WITH HINT clause of the SET ENCRYPTION statement that defined <i>password</i> .	No more than 32 bytes	Quoted String
<i>password</i>	A character string that the encryption function defines. Default is the session password value defined by the SET ENCRYPTION statement	At least 6 bytes, but no more than 128 bytes	Quoted String

You can invoke these encryption and decryption functions from within DML statements or with the EXECUTE FUNCTION statement.

For distributed operations over a network, all participating database servers must support these (or equivalent) functions. If the network is not secure, the DBSA must enable the *encryption communication support module* (ENCCSM) to provide data encryption between the database server and client systems, in order to avoid transmitting passwords as plain text.

Encryption or decryption calls slow the performance of the SQL statement within which these functions are invoked, but have no effect on other statements. However, if you store encrypted data in a column that is an index key, or in a column on which a constraint is defined, Informix cannot enforce the constraint, and DML statements cannot use the index.

Similarly, do not encrypt a column whose value is referenced in the fragment key expression of a fragmented table.

You cannot encrypt the security label in a column of type IDSSECURITY label.

- [Column Level and Cell Level Encryption](#)
- [The Password and Hint Specifications](#)
- [Data Types, Encoding, and Size of Encrypted Values](#)
- [Example of Column Level Encryption](#)

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Column Level and Cell Level Encryption

The encryption and decryption functions can support two ways of using data encryption features, namely *column level* and *cell level* encryption.

- Column level encryption means that all values in a given column are encrypted with the same password (which can be a word or phrase), the same cipher, and the same cipher mode.
Users of this form of encryption should consider not using the *hint* feature of these functions, but instead store a mnemonic hint for remembering the password in some other location. Otherwise, the same *hint* will occupy disk space in every row that contains an encrypted value.
- Cell level encryption means that within a column of encrypted data many different passwords (or different ciphers or cipher modes) are used.
This use of encryption is also called *row-column level* or *set-column level* encryption. Compared to column-level encryption, this makes the task of data management more complex, because if different passwords are required for decrypting different rows of the same table, it is not possible to write a single SELECT statement to fetch all the decrypted data. In some situations, however, individual users may need this technique to protect personal data.

To protect data security and confidentiality, the database server does not store information in the system catalog to indicate whether any table (or any column or row) includes encrypted data. Similarly, the logical logs of Informix® do not record SET ENCRYPTION statements, nor calls to encryption or decryption functions. (The Trusted Facility feature for secure auditing, however, can use the 'STEP' audit-event mnemonic to record execution of the SET ENCRYPTION statement, and can use the 'CRPT' audit-event mnemonic to record successful or unsuccessful calls to **DECRYPT_CHAR** or **DECRYPT_BINARY**.)

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The Password and Hint Specifications

The SET ENCRYPTION statement or an encryption function can define a password and hint for the current session. The *password* must be specified as a character expression that returns at least 6 bytes, but no more than 128. The optional *hint* is specified as a character expression that returns no more than 32 bytes.

The purpose of the *hint* is to help users to remember the *password*. When you call **ENCRYPT_AES** or **ENCRYPT_TDES** with a *hint* argument, it is encrypted and embedded in the *encrypted_data*, from which **GETHINT** can retrieve it. But if you define *hint* as NULL, or omit *hint* when SET ENCRYPTION specified no default *hint* for the *session password*, no *hint* is embedded in the *encrypted_data*.

The *password* used for encryption and decryption is either the *password* argument to the function, or if you omit this argument, it is the *session password* specified in the last SET ENCRYPTION statement executed before you invoke the function.

The **DECRYPT_CHAR**, **DECRYPT_BINARY**, or **GETHINT** function call fails with an error if the *encrypted_data* argument is not in an encrypted format, or if the *password* argument to a decryption function is omitted when no *session password* value was set by SET ENCRYPTION. An error also results if the *password* used for decryption is not the same *password* used for encryption.

Encryption key management, which is critical to the secure operation of the database, is delegated entirely to the application. This implementation means that the *password* itself is not stored in the database. Without help from the user through the application, the database server cannot decrypt the encrypted data.

If you invoke any of these functions from a UDR, you might prefer to set a *session password* in the SET ENCRYPTION statement. Otherwise, *password* will be visible to users who can view the **sysprocbody.data** column in the system catalog.

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Data Types, Encoding, and Size of Encrypted Values

The *data* and corresponding *encrypted_data* arguments can be of any built-in character type (CHAR, LVARCHAR, NCHAR, NVARCHAR, or VARCHAR), or can be a smart large object of type BLOB or CLOB. (Use CLOB in place of TEXT, which these functions do not support.)

Corresponding *data* and *encrypted_data* values that the encryption or decryption functions return have the same character, BLOB, or CLOB data type, except in cases where encryption of a VARCHAR or NVARCHAR string would return an overflow error. For operations on CHAR, LVARCHAR, NCHAR, NVARCHAR, or VARCHAR data and on *encrypted_data* values, the encryption and decryption functions follow the data-type promotion rules of **CONCAT** and the other SQL string manipulation functions for the data type of their return value, as in the following examples.

- If the VARCHAR *data* argument to **ENCRYPT_TDES** (with no hint) is a 200 byte string, then Informix® automatically promotes the returned value to an LVARCHAR data type, because the encrypted value exceeds the 255 byte limit for VARCHAR objects.
- If the NVARCHAR *encrypted_data* argument to **ENCRYPT_AES** (with a hint) is a string 200 bytes long, then Informix automatically promotes the returned value to an NCHAR data type, because the encrypted value exceeds the 255 byte limit for NVARCHAR objects.

For more information about return type promotion for character strings that the encryption, decryption, and certain other string-manipulation functions return, see [Return Types from the CONCAT Function](#). The first table in that section describes *data* or *encrypted_data* arguments that are not smart large objects. (For smart large object arguments, the return type is a BLOB or CLOB object.)

The encryption or decryption function call returns overflow error -881, however, if the return value exceeds the 32,767-byte limit for CHAR, NCHAR strings, or the 32,739-byte limit for LVARCHAR strings. To avoid this error, use BLOB or CLOB objects as the *data* or *encrypted_data* argument, rather than a character data type, when the encryption or decryption operation requires an argument or a return value that might be larger than the (approximately 32Kb) limit for character data types.

Except for original *data* of BLOB or CLOB data types, the *encrypted_data* value is encoded in BASE64 format. An encrypted value requires more space than the corresponding plain text, because the database must also store the information (except for the encryption key) that is needed for decryption. If a *hint* is used, it adds to the length of *encrypted_data*.

The BASE64 encoding scheme stores 6 bits of input data as 8 bits of output. To encode N bytes of data, BASE64 requires at least $((4N+3)/3)$ bytes of storage, where the slash character (/) represents integer division. Padding and headers can increase BASE64 storage requirements above this $((4N+3)/3)$ ratio. [Example of Column Level Encryption](#) lists formulae to estimate the size of data values encrypted in BASE64 format. It typically requires changes to the schema of an existing table that will store BASE64 format encrypted data, especially if a hint will also be stored.

The following table shows how the data type of the input string corresponds to the data type of the value that **ENCRYPT_AES** or **ENCRYPT_TDES** returns:

Table 1. Data Types for ENCRYPT_AES and ENCRYPT_TDES Functions

Plain Text Data Type	Encrypted Data Type	Decryption Function
CHAR	CHAR	DECRYPT_CHAR
NCHAR	NCHAR	DECRYPT_CHAR
VARCHAR	VARCHAR or CHAR	DECRYPT_CHAR
NVARCHAR	NVARCHAR or NCHAR	DECRYPT_CHAR
LVARCHAR	LVARCHAR	DECRYPT_CHAR
BLOB	BLOB	DECRYPT_BINARY
CLOB	BLOB	DECRYPT_CHAR

Columns of type VARCHAR and NVARCHAR store no more than 255 bytes. If the *data* string is too long for these data types to store both the encrypted data and encryption overhead, then the value returned by the encryption function is automatically changed from VARCHAR or NVARCHAR into a fixed CHAR or NCHAR value, with no trailing blanks in the encoded encrypted value.

Encrypted values of type BLOB or CLOB are not in BASE64 encoding format, and their size increase after encryption is independent of the original data size. For BLOB or CLOB values, the encrypted size (in bytes) has the following formula, where N is the original size of the plain text, and H is the size of the unencrypted hint string, if encryption is performed by **ENCRYPT_TDES**:

$N + H + 24$ bytes.

For BLOB or CLOB values that **ENCRYPT_AES** encrypts, the overhead is larger:

$N + H + 32$ bytes.

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Example of Column Level Encryption

The following example illustrates how to use the built-in encryption and decryption functions of Informix® to create and use a table that stores encrypted credit card numbers in a column that has a character data type.

For purposes of this example, assume that the plain text of the values to be encrypted consists of strings of 16 digits. Because encryption functions support character data types, these values are stored in a CHAR column rather than in an INT, BIGINT, or INT8 column.

- [Calculating storage requirements for encrypted data](#)
- [Implementing column-level encryption](#)

Calculating storage requirements for encrypted data

The **LENGTH** function provides a convenient way to calculate the storage requirements of encrypted data directly:

```
EXECUTE FUNCTION LENGTH(ENCRYPT_TDES("1234567890123456", "simple password"));
```

This returns 55.

```
EXECUTE FUNCTION LENGTH(ENCRYPT_TDES("1234567890123456", "simple password",
"12345678901234567890123456789012"));
```

This returns 107.

```
EXECUTE FUNCTION LENGTH(ENCRYPT_AES("1234567890123456", "simple password"));
```

This returns 67.

```
EXECUTE FUNCTION LENGTH(ENCRYPT_AES("1234567890123456", "simple password",
"12345678901234567890123456789012"));
```

This returns 119.

The required storage size for encrypted data is sensitive to three factors:

- N, the number of bytes in the plain text
- whether or not a hint is provided
- which encryption function you use (**ENCRYPT_TDES** or **ENCRYPT_AES**)

The following formulae describe the four possible cases, and are not simplified:

- Encryption by **ENCRYPT_TDES()** with no hint:

$$\text{Encrypted size} = (4 \times ((8 \times (N + 8) / 8) + 10) / 3) + 11$$

- Encryption by **ENCRYPT_AES()** with no hint:

$$\text{Encrypted size} = (4 \times ((16 \times (N + 16) / 16) + 10) / 3) + 11$$

- Encryption by **ENCRYPT_TDES()** with a hint:

$$\text{Encrypted size} = (4 \times ((8 \times (N + 8) / 8) + 50) / 3) + 11$$

- Encryption by **ENCRYPT_AES()** with a hint:

$$\text{Encrypted size} = (4 \times ((16 \times (N + 16) / 16) + 50) / 3) + 11$$

The integer division (/) returns an integer quotient and discards any remainder.

Based on these formulae, the following table shows the encrypted size (in bytes) for selected ranges of values of N:

N	ENCRYPT_TDES No Hint	ENCRYPT_AES No Hint	ENCRYPT_TDES With Hint	ENCRYPT_AES With Hint
1 to 7	35	43	87	99
8 to 15	43	43	99	99
16 to 23	55	67	107	119
24 to 31	67	67	119	119
32 to 39	75	87	131	139
40 to 47	87	87	139	139
100	163	171	215	227
200	299	299	355	355
500	695	707	747	759

If the column size is smaller than the data size returned by encryption functions, the encrypted value is truncated when it is inserted. In this case, it will not be possible to decrypt the data, because the header will indicate that the length should be longer than the data value that the column contains.

These formulae and the values returned by the **LENGTH** function, however, indicate that the table schema in the next example can store the encrypted form of 16-digit credit card numbers (with a hint).

Implementing column-level encryption

The following steps create a table from which a user who knows the password can retrieve rows that include one column of encrypted data.

1. Create a database table containing at least one column of type BLOB, CLOB, or a character data type of sufficient length to store the encrypted values. For example, the following statement creates a table called **customer** in which the column **creditcard** can store encrypted credit card numbers:

```
CREATE TABLE customer (id CHAR(20), creditcard CHAR(107));
```

2. Specify a password (and optional hint) and insert encrypted data:

```
SET ENCRYPTION PASSWORD 'credit card number is encrypted'
WITH HINT 'Why is this difficult to read?';
INSERT INTO customer VALUES ('Alice',
    encrypt_tdes('1234567890123456'));
INSERT INTO customer VALUES ('Bob',
    encrypt_tdes('2345678901234567'));
```

3. Query the encrypted data, using a decryption function:

```
SELECT id, DECRYPT_CHAR(creditcard,
    'credit card number is encrypted') FROM customer;
```

The following query calls a decryption function in the WHERE clause, using the *session password* default, rather than an explicit *password* argument:

```
SELECT id FROM customer
WHERE DECRYPT_CHAR(creditcard) = '2345678901234567';
```

Column level encryption offers the coding convenience of passing the implicit *session password* for all rows with encrypted columns, and in multiple encryption and decryption function calls in the same SQL statement. Confidentiality of the data, however, requires users who know the password on encrypted columns to avoid compromising its secrecy. Triggers and UDRs, for example, should always use the *session password*, rather than explicit *password* arguments if they invoke the encryption or decryption functions.

The DBSA can manage highly confidential data with column level encryption. Informix® does not, however, prevent users with sufficient privileges from entering data encrypted by some other password into a table whose other rows use the designated column level encryption password.

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DECRYPT_CHAR Function

The **DECRYPT_CHAR** function accepts as its first argument an *encrypted_data* character string that can have any character type (CHAR, LVARCHAR, NCHAR, NVARCHAR, or VARCHAR). You must specify a *password* as its second argument, unless the SET ENCRYPTION statement has specified for this session the same *session password* by which the first argument was encrypted.

The **DECRYPT_CHAR** function also accepts as its first argument an *encrypted_data* large object of type BLOB or CLOB. You must specify a password as its second argument, unless the SET ENCRYPTION statement has specified as the default for this session the same *password* by which the first argument was encrypted. If the call to **DECRYPT_CHAR** is successful, it returns a CLOB large object that contains the plain text version of the *encrypted_data* argument.

If the call to **DECRYPT_CHAR** with an encrypted string argument is successful, it returns a character string that contains the plain text version of the *encrypted_data* argument. The following example returns a character string containing a decrypted value from the **ssid** column of the **engineers** table for the row whose **empno** value is 287:

```
SELECT DECRYPT_CHAR (ssid) FROM engineers WHERE empno = 287;
```

If the first argument to **DECRYPT_CHAR** is not an encrypted value, or if the second argument (or the default *password* specified by SET ENCRYPTION) is not the *password* that was used when the first argument was encrypted, Informix® issues an error, and the call to **DECRYPT_CHAR** fails. (See the description of the [GETHINT Function](#) for one possible action to take when you cannot remember the *password* that was used for encryption.)

Do not use **DECRYPT_CHAR** (or any other decryption function) to create a functional index on an encrypted column. This would store the decrypted values as plain text data in the database, defeating the purpose of encryption.

For additional information about using data encryption in column values of Informix databases, see [Encryption and decryption functions](#), and [SET ENCRYPTION PASSWORD statement](#).

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DECRYPT_BINARY Function

The **DECRYPT_BINARY** function accepts as its first argument an *encrypted_data* large object of type BLOB or CLOB. You must specify a *password* as its second argument, unless the SET ENCRYPTION statement has specified as the default for this session the same *password* by which the first argument was encrypted.

If the call to **DECRYPT_BINARY** is successful, it returns a BLOB or CLOB large object that contains the plain text version of the *encrypted_data* argument. The decrypted BLOB or CLOB object is temporarily stored in the default sbpace that the SBSPACENAME configuration parameter setting specifies.

If the first argument to **DECRYPT_BINARY** is an encrypted value of a character data type, Informix® invokes the **DECRYPT_CHAR** function and attempts to decrypt the specified value.

If the first argument to **DECRYPT_BINARY** is not an encrypted value, or if the second argument (or the default *password* specified by SET ENCRYPTION) is not the *password* that was used when the first argument was encrypted, Informix issues an error, and the call to **DECRYPT_BINARY** fails. (See the description of the [GETHINT Function](#) for one possible action to take when you cannot remember the *password* that was used for encryption.)

Do not use **DECRYPT_BINARY** (or any other decryption function) to create a functional index on an encrypted column. This would store the decrypted values as plain text data in the database, defeating the purpose of encryption.

ENCRYPT_AES Function

The **ENCRYPT_AES** function returns an encrypted value that it derives by applying the AES (Advanced Encryption Standard) algorithm to its first argument, which must be an unencrypted character expression or a smart large object (that is, a BLOB or CLOB data type). A character argument can have a length of up to 32640 bytes if an explicit or default *hint* is used, or 32672 bytes if no hint (or a NULL hint) is specified. Theoretical size limits on BLOB or CLOB arguments are many orders of magnitude larger, but practical limits might be imposed by your hardware, or by time required for encryption and decryption. The encrypted BLOB or CLOB object is temporarily stored in the default sbspace that the SBSPACENAME configuration parameter specifies.

You must specify a *password* as its second argument, unless a SET ENCRYPTION statement has specified a *session password*, which the database server uses by default if you omit the second argument. If a *session password* has been set, any *password* that you specify overrides the *session password* for the returned value of this function call. The explicit or default *password* will also be required for any subsequent decryption of the returned encrypted value. A valid *password* must have at least 6 bytes but no more than 128.

You can optionally specify a *hint* as the third argument. If the SET ENCRYPTION statement specified a default *hint* for this session, and you specify no hint, that default *hint* is stored in an encrypted form within the returned value. Any *hint* that you specify overrides the default *hint*. A valid *hint* can be no longer than 32 bytes. You can use consecutive quotation marks (") to specify a NULL *hint*. If you specify an explicit *hint*, you must also specify an explicit *password*.

The purpose of the *hint* is to help users to remember the *password*. For example, if the *password* is "buggy," you might define the hint as "whip." Neither string is restricted to a single word, but the size of the *hint* contributes to the size of the returned value. If you subsequently cannot remember the *hint*, use the returned value from **ENCRYPT_AES** as the argument to **GETHINT** to retrieve the *hint*.

The following example calls **ENCRYPT_AES** from the VALUES clause of an INSERT statement that stores in **tab1** a plain-text string and an *encrypted_data* value that **ENCRYPT_AES** returns from its 12-byte first argument. Here SET ENCRYPTION defines a *session password* and *hint* that are used as default second and third arguments to the **ENCRYPT_AES** function:

```
EXEC SQL SET ENCRYPTION PASSWORD 'CHARYBDIS' WITH HINT 'messina';
EXEC SQL INSERT INTO tab1 VALUES ('abcd', ENCRYPT_AES('111-222-3333'));
```

The call to **ENCRYPT_AES** fails with an error if the *password* argument is omitted when no *session password* has been set, or if the length of an explicit *password* argument is shorter than 6 bytes or longer than 128 bytes.

In some contexts, an error is issued if the encrypted returned value is too large to be stored by the data type that receives it.

For additional information about using data encryption in column values of Informix® databases, see [Encryption and decryption functions](#), and [SET ENCRYPTION PASSWORD statement](#).

ENCRYPT_TDES Function

The **ENCRYPT_TDES** function returns a value that is the result of encrypting a character expression, or a BLOB or CLOB value, by applying the TDES (Triple Data Encryption Standard, which is sometimes also called DES3) algorithm to its first argument. This algorithm is slower than the AES algorithm that is used by the **ENCRYPT_AES** function, but is considered somewhat more secure. The disk space required as encryption overhead resembles that of **ENCRYPT_AES**, but is somewhat smaller because of the smaller block size of ENCRYPT_TDES. (See "Calculating storage requirements for encrypted data" [Calculating storage requirements for encrypted data](#) for a discussion of how to estimate the size of encrypted character strings.) For BLOB or CLOB values, the encrypted object is temporarily stored in the default sbspace that the SBSPACENAME configuration parameter specifies.

Those differences in performance, tamper-resistance, and in the returned *encrypted_data* size that the previous paragraph lists are the practical differences between the **ENCRYPT_TDES** and **ENCRYPT_AES** functions, which otherwise follow the same rules, defaults, and restrictions that appear in the description of **ENCRYPT_AES** on the previous page in regard to the following features:

- The required first argument (the plain text *data* value to be encrypted)
- The explicit or default second argument (the *password* string that must also be an argument to **DECRYPT_CHAR** or **DECRYPT_BINARY** to decrypt the returned *encrypted_data* value). This must be specified unless a default *session password* has been set by the SET ENCRYPTION statement
- The optional third argument (the *hint* value) that might assist users who forget the *password*. If you subsequently cannot remember an explicit or default *hint* that was defined for *password*, you can use the returned value from **ENCRYPT_TDES** as the argument to **GETHINT** to retrieve the *hint*.

The following example calls **ENCRYPT_TDES** from the SET clause of an UPDATE statement. Here the *session password* is 'PERSEPHONE' and the *hint* string is "pomegranate", with column **colU** of table **tabU** the *data* argument. Because the WHERE clause condition of "1=1" is true for all rows of **tabU**, the effect of this statement is to replace every plain text **colU** value with encrypted strings returned by the algorithm that **ENCRYPT_TDES** implements:

```
EXEC SQL SET ENCRYPTION PASSWORD 'PERSEPHONE' WITH HINT 'pomegranate';
EXEC SQL UPDATE tabU SET colU = ENCRYPT_TDES (colU) WHERE 1=1;
```

This example assumes that the character data type of **colU** is of sufficient size to store the new encrypted values without truncation. (A more cautious example might execute an appropriate ALTER TABLE statement before the UPDATE.)

For additional information about using data encryption in column values of Informix® databases, see [Encryption and decryption functions](#), and [SET ENCRYPTION PASSWORD statement](#).

GETHINT Function

The **GETHINT** function returns a character string that a previously executed SET ENCRYPTION PASSWORD statement defined for the *password* that was used when *encrypted_data* was encrypted by the **ENCRYPT_AES** function or by the **ENCRYPT_TDES** function. This *hint* string typically provides information that helps the user to specify the *password* needed to return the plain text version of *encrypted_data* with the **DECRYPT_CHAR** or **DECRYPT_BINARY** decryption function. The *hint* string, however, should not be the same as the *password*. In the following example, a query returns the *hint* string into a host variable called **myhint**:

```
EXEC SQL SELECT GETHINT(creditcard) INTO :myhint
FROM customer WHERE id = :myid;
```

An error is returned, rather than a *hint* string, if the *encrypted_data* argument to the **GETHINT** function is not an encrypted string or an encrypted large object.

For additional information about using data encryption in column values of Informix® databases, see [Encryption and decryption functions](#), and [SET ENCRYPTION PASSWORD statement](#).

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Exponential and Logarithmic Functions

Exponential and logarithmic functions take at least one argument and return a FLOAT data type.

The exponential and logarithmic functions have the following syntax.

Exponential and Logarithmic Functions

```
|---+EXP--(--float_expression--)---+-----|
+-LN--(--float_expression--)---+
+-LOGN--(--float_expression--)---+
'-LOG10--(--float_expression--)--'
```

Element	Description	Restrictions	Syntax
<i>float_expression</i>	An argument to the EXP , LN , LOGN , or LOG10 functions. For the meaning of <i>float_expression</i> in these functions, see the individual heading for each function on the pages that follow.	The domain is the set of real numbers, and the range is the set of positive real numbers	Expression

- [EXP Function](#)
The **EXP** function returns the exponent of a numeric expression.
- [LN function](#)
The **LN** function is an alias for the **LOGN** function, and returns the natural logarithm of a numeric argument. This value is the inverse of the exponential value.
- [LOG10 Function](#)
- [LOGN Function](#)
The **LOGN** function returns the natural logarithm of a numeric argument.

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EXP Function

The **EXP** function returns the exponent of a numeric expression.

The following example returns the exponent of 3 for each row of the **angles** table:

```
SELECT EXP(3) FROM angles;
```

For this function, the base is always e, the base of natural logarithms, as the following example shows:

```
e=exp(1)=2.718281828459
```

When you want to use the base of natural logarithms as the base value, use the **EXP** function. If you want to specify a particular value to raise to a specific power, see the [POW Function](#).

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LN function

The **LN** function is an alias for the **LOGN** function, and returns the natural logarithm of a numeric argument. This value is the inverse of the exponential value.

LN Function

```
|--LN--(--float_expression--)-----|
```

The following query returns the natural logarithm of **population** for each row in the **history** table:

```
SELECT LN(population) FROM history WHERE country='US'
ORDER BY date;
```

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LOG10 Function

The **LOG10** function returns the log of a value to base 10. The following example returns the log base 10 of distance for each row of the **travel** table:

```
SELECT LOG10(distance) + 1 digits FROM travel;
```

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LOGN Function

The **LOGN** function returns the natural logarithm of a numeric argument.

This return value is the inverse of the exponential value that the **EXP** function returns from the same argument.

The following query returns the natural log of **population** for each row of the **history** table:

```
SELECT LOGN(population) FROM history WHERE country='US'
ORDER BY date;
```

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NVL2 Function

Returns the second argument when the first argument is not NULL. If the first argument is NULL, the third argument is returned.

NVL2 Function

```
|--NVL2--(--expression--,--result-expression--,--else-expression--)--|
```

The NVL2 function is a synonym for the following code:

```
CASE WHEN expression IS NOT NULL
THEN result-expression
ELSE else-expression
```

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HEX Function

The **HEX** function returns the hexadecimal encoding of an integer expression.

HEX Function

```
|----HEX--(--int_expression--)-----|
```

Element	Description	Restrictions	Syntax
<i>int_expression</i>	Expression for which you want the hexadecimal equivalent	Must be a literal integer or some other expression that returns an integer	Expression

The next example displays the data type and column length of the columns of the **orders** table in hexadecimal format. For MONEY and DECIMAL columns, you can then determine the precision and scale from the lowest and next-to-the-lowest bytes. For VARCHAR and NVARCHAR columns, you can determine the minimum space and maximum space from the lowest and next-to-the-lowest bytes. For more information about encoded information, see the *IBM® Informix Guide to SQL: Reference*.


```
SELECT colname, coltype, HEX(collength)
FROM syscolumns C, systables T
WHERE C.tabid = T.tabid AND T.tabname = 'orders';
```

The following example lists the names of all the tables in the current database and their corresponding tblspace number in hexadecimal format.

```
SELECT tabname, HEX(partnum) FROM systables;
```

The two most significant bytes in the hexadecimal number constitute the dbspace number. They identify the table in **oncheck** output in Informix®.

The **HEX** function can operate on an expression, as the next example shows:

```
SELECT HEX(order_num + 1) FROM orders;
```

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Length functions

Use length functions to determine the length of a character column, string, or variable, or of the value returned by a character expression, or (for **CHAR_LENGTH** in multibyte locales) the number of logical characters.

Length Functions

```
(1)
|-----+---LENGTH+-----+----->
| '-LEN---' |
| +-CHAR_LENGTH-----+ |
| '-CHARACTER_LENGTH-' |
| '-OCTET_LENGTH-----' |

(2)
>--(---| Quoted String |-----+---)-----|
| (3) (4) |
| +-----variable_name+ |
| '------column-----' |
| '-table.-' |
```

Notes:

1. Informix® extension
2. See [Quoted String](#)
3. ESQL/C
4. SPL Language

Element	Description	Restrictions	Syntax
<i>column</i>	Name of a column in <i>table</i>	Must have a character data type	Identifier
<i>table</i>	Name of the table in which the specified column occurs	Must exist	Identifier
<i>variable</i>	Host variable or SPL variable that contains a character string	Must have a character data type	See language-specific rules for names.

Each of these functions has a distinct purpose:

- **LENGTH** (also known as **LEN**)
- **OCTET_LENGTH**
- **CHAR_LENGTH** (also known as **CHARACTER_LENGTH**)
- [LENGTH Function](#)
The **LENGTH** function (also called **LEN**) returns the number of bytes in a character column, but excluding any trailing blank spaces.
- [OCTET_LENGTH Function](#)
- [CHAR_LENGTH Function](#)
The **CHAR_LENGTH** function returns the number of logical characters in its argument, which can be a character column, a character variable, or a quoted string. This built-in function can also be invoked as **CHARACTER_LENGTH**.

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LENGTH Function

The **LENGTH** function (also called **LEN**) returns the number of bytes in a character column, but excluding any trailing blank spaces.

For BYTE or TEXT columns, **LENGTH** returns the full number of bytes, including any trailing blank spaces.

In Informix® ESQL/C, **LENGTH** can also return the length of a character variable.

The following example illustrates the use of the **LENGTH** function:

- **SECLABEL_TO_CHAR** requires the security policy name and an expression that returns a IDSSECURITYLABEL object, such as the name of a column of that data type.
- **SECLABEL_BY_COMP** requires the security policy name and the values of the individual components of the security label.
- **SECLABEL_BY_NAME** requires the names of the security policy and of the security label.
- [SECLABEL_BY_NAME Function](#)
- [SECLABEL_BY_COMP Function](#)
- [SECLABEL_TO_CHAR Function](#)

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SECLABEL_BY_NAME Function

The **SECLABEL_BY_NAME** function enables users to provide a security label directly by specifying its name.

The following INSERT statement inserts a row into table **T1**, which is protected by the security policy called '**MegaCorp**'. The VALUES clause of the INSERT statement provides the security label '**mylabel**' for the row to be inserted by using the **SECLABEL_BY_NAME** function.

```
INSERT INTO T1 VALUES (SECLABEL_BY_NAME ('MegaCorp', 'mylabel'), 1, 'xyz');
```

The success of this **SECLABEL_BY_NAME** function call does not guarantee success of the INSERT operation in this example, because whether or not the user has sufficient security credentials to insert the label **mylabel** into the row is subject to the **IDSLBACWRITE** rules of the **MegaCorp** security policy.

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SECLABEL_BY_COMP Function

The **SECLABEL_BY_COMP** function returns an IDSSECURITYLABEL object, which is a security label in its internal encoded string format. This function enables users to provide a security label directly by specifying its component values.

If a security label component requires multiple values, then such multiple values can be specified by putting those values between parenthesis as in (value_1, value_2, ...). When a component in a particular security label needs to be empty, it can be specified by putting nothing between an opening and a closing parenthesis, as in (). Because the blank space (ASCII 32) is a valid character in an element value for a security component, any blank space appearing in the security label string is treated as part of the element value for that component.

The security label string is limited to a maximum of 32 kilobytes. An error is returned if the string length exceeds this limit.

The following INSERT statement inserts a row into table **T1** which is protected by the security policy called '**MegaCorp**' that has three components: '**level**', '**compartments**', and '**groups**'. Here the user provides a security label for the row to be inserted by specifying the **SECLABEL_BY_COMP** function. The security label in this example has the value '**VP**' for the **level** component, the value '**Marketing**' for the **compartments** component, and the value '**West**' for the **groups** component. In the arguments to **SECLABEL_BY_COMP**, colon symbols separate these security component element values, and quotation marks delimit the list of component values of the security label.

```
INSERT INTO T1
VALUES (SECLABEL_BY_COMP ('MegaCorp', 'VP:Marketing:West'), 1, 'xyz');
```

In the next example, the INSERT statement inserts a row in table **T1** which is protected by the same **MegaCorp** security policy, which has the same three components as in the previous example: **level**, **compartments**, and **groups**. The user provides the security label for the row to be inserted by specifying the policy name and a list of security component elements as arguments to the **SECLABEL_BY_COMP** function. Here the security label has the value '**Director**' for the **level** component, the values '**HR**' and '**Finance**' for the **compartments** component, and the value '**East**' for the **groups** component.

```
INSERT INTO T1
VALUES (SECLABEL_BY_COMP ('MegaCorp', 'Director:(HR,Finance):East'), 1, 'xyz');
```

The following example inserts a row into table **T1** which is protected by the **MegaCorp** security policy, whose three components are **level**, **compartments**, and **groups**. The **SECLABEL_BY_COMP** function specifies the security label for the row to be inserted. The security label in this example has the value '**CEO**' for level component, the empty set for the **compartments** component, and the value '**EntireRegion**' for the **groups** component.

```
INSERT INTO T1
VALUES (SECLABEL_BY_COMP ('MegaCorp', 'CEO:():EntireRegion'), 3, 'abc');
```

As in all of these examples, the success of the **SECLABEL_BY_COMP** function call does not guarantee the success of the INSERT statement, because the security credentials of the user are first compared to the security label that protects table **T1**, using the **IDSLBACWRITE** rules of the **MegaCorp** security policy, before the database server allows or denies write access for inserting the new row.

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SECLABEL_TO_CHAR Function

The **SECLABEL_TO_CHAR** function returns a security label in the security label string format.

The security credentials of the user executing this function can affect the output of the function. An element of a security label component is not included in the output if the user does not have read access to that element. A user has read access to an element if the security credentials of the user provide read access to data that is protected by a security label containing only that element and no other elements.

For the rule set **IDSLBACRULES**, only components of type TREE can contain elements to which a user does not have read access to a subset of elements. For other types of component, if any element blocks read access, then the user cannot read the row at all. Thus, only security components of type TREE can have a subset of security component elements excluded in this way.

For example, if the TREE type component of the security label of a user is {**A**} and the TREE type component of a row security label is {**A**, **B**}, then only component **A** is returned, and the user is not aware that **B** existed in the row security label. If the user holds an exemption on the **IDSLBACREADTREE** rule, however, the returned security components are both **A** and **B**.

In the next example, the **MegaCorp** security policy has a security label called **mylabel** that consists of a **level** component whose value is 'Director', and a **compartments** component with the values 'HR' and 'Finance.' A user to whom 'mylabel' was granted has inserted a row with that security label into table **T1**. In this context, the security label string returned by the **SECLABEL_TO_CHAR** function in the following SELECT statement on **T1** is as follows.

```
SELECT SECLABEL_TO_CHAR ('MegaCorp', C1) FROM T1;
```

Row returned:

```
'Director: (HR, Finance)'
```

The success of this query implies that the **SECLABEL_TO_CHAR** function succeeded, and that the security credentials of the user were sufficient, according to the **IDSLBACREAD** rules of the **MegaCorp** security policy, for the database server to allow read access to the values of the security policy name and of the security label components."

The security label string is limited to a maximum size of 32 kilobytes. If the length of the security label string to be returned exceeds this upper limit, a warning is issued, and a truncated 32 kilobyte string is returned.

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SIGN function

The SIGN function returns an indicator of the sign of the argument.

SIGN Function

```
|--SIGN-- (--expression--)-----|
```

If the argument is less than zero, -1 is returned. If the argument equals zero, 0 is returned. If the argument is greater than zero, 1 is returned. The result returned is always an integer with one of these values.

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Smart-Large-Object Functions

The smart-large-object functions support objects of BLOB and CLOB data types:

The smart-large-object functions have the following syntax:

Smart-Large-Object Functions

```
|---+-FILETOBLOB+--- (-- 'pathname'--,-- 'file_destination'--+-----+---) +---|
| '-FILETOCLOB-'      '-,-- 'table'--,-- 'column'-'      |
+-LOTOFILE-- (--+-BLOB_column+---,-- 'pathname'--,-- 'file_destination'--)-----+
|      '-CLOB_column-'      |
+-LOCOPY-- (--+-BLOB_column+---+-----+---)-----+
|      '-CLOB_column-'      '-,-- 'table'--,-- 'column'-'
```

Element	Description	Restrictions	Syntax
BLOB_column, CLOB_column	A column of type BLOB; a column of type CLOB	The <i>column</i> data type must be BLOB or CLOB	Identifier
column	Column within <i>table</i> for the copy of the BLOB or CLOB value	Must have CLOB or BLOB as its data type	Quoted String
file_destination	The system on which to put or get the smart large object	The only valid values are the strings 'server' or 'client'	Quoted String
pathname	Directory path and filename to locate the smart large object	No more than 256 bytes. Must exist on <i>file_destination</i> system. See also Pathnames with Commas .	Quoted String

Element	Description	Restrictions	Syntax
<i>table</i>	Table containing <i>column</i> for the copy of the BLOB or CLOB value	A comma (not a period) separates the ' <i>table</i> ' and ' <i>column</i> ' arguments	Quoted String

- [FILETOBLOB and FILETOCLOB Functions](#)
The **FILETOBLOB** function creates a BLOB value for data that is stored in a specified operating-system file. Similarly, the **FILETOCLOB** function creates a CLOB value for a data value that is stored in an operating-system file.
- [Pathnames with Commas](#)
- [LOTOFILE Function](#)
The **LOTOFILE** function copies a smart large object to an operating-system file.
- [LOCOPY Function](#)
The **LOCOPY** function creates a copy of a smart large object.

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FILETOBLOB and FILETOCLOB Functions

The **FILETOBLOB** function creates a BLOB value for data that is stored in a specified operating-system file. Similarly, the **FILETOCLOB** function creates a CLOB value for a data value that is stored in an operating-system file.

These functions determine the operating-system file to use from the following parameters:

- The *pathname* parameter identifies the directory path and name of the source file.
- The *file destination* parameter identifies the computer, '*client*' or '*server*', on which this file resides:
 - Set *file destination* to '*client*' to identify the client computer as the location of the source file. The *pathname* can be either a full pathname or relative to the current directory.
 - Set *file destination* to '*server*' to identify the server computer as the location of the source file. The *pathname* must be a full pathname.

The *table* and *column* parameters are optional:

- If you omit *table* and *column*, the **FILETOBLOB** function creates a BLOB value with the system-specified storage defaults, and the **FILETOCLOB** function creates a CLOB value with the system-specified storage defaults. These functions obtain the system-specific storage characteristics from either the ONCONFIG file or the sbspace. For more information on system-specified storage defaults, see the *IBM® Informix Administrator's Guide*.
- If you specify *table* and *column*, the **FILETOBLOB** and **FILETOCLOB** functions use the storage characteristics from the specified column for the BLOB or CLOB value that they create.

The **FILETOBLOB** function returns a handle value (a pointer) to the new BLOB value. Similarly, **FILETOCLOB** returns a handle value to the new CLOB value. Neither function actually copies the smart-large-object value into a database column. You must assign the BLOB or CLOB value to the appropriate column.

The **FILETOCLOB** function performs any code-set conversion that might be required when it copies the file from the client or server computer to the database.

The following INSERT statement uses the **FILETOCLOB** function to create a CLOB value from the value in the **smith.rsm** file:

```
INSERT INTO candidate (cand_num, cand_lname, resume)
VALUES (2, 'Smith', FILETOCLOB('smith.rsm', 'client'));
```

In the preceding example, the **FILETOCLOB** function reads the **smith.rsm** file in the current directory on the client computer and returns a handle value to a CLOB value that contains the data in this file. Because the **FILETOCLOB** function does not specify a table and column name, this new CLOB value has the system-specified storage characteristics. The INSERT statement then assigns this CLOB value to the **resume** column in the **candidate** table.

The following INSERT statement uses the **FILETOBLOB** function to create a BLOB value from the value in the **photos.xxx** file on the local database server, and insert that value into the **election2008** table of the **rdb** database, which is another database of the local database server:

```
INSERT INTO rdb:election2008 (cand_pic)
VALUES (FILETOBLOB('C:\tmp\photos.xxx', 'server',
'candidate', 'cand_photo'));
```

In the preceding example, the **FILETOBLOB** function reads the **photos.xxx** file in the specified directory on the local database server and returns a handle value to a BLOB value that contains the data in this file. The INSERT statement then assigns this BLOB value to the **cand_pic** column in the **election2008** table in the **rdb** database of the local database server. This new BLOB value has the storage characteristics of the **cand_photo** column in the **candidate** table in the local database.

In the following example, the new BLOB value has the storage characteristics of the **cand_pix** column in the **election96** table in the **rdb2** database, where **rdb1** and **rdb2** are databases of the local Informix® instance:

```
INSERT INTO rdb1:election2008 (cand_pic)
VALUES (FILETOBLOB('C:\tmp\photos.xxx', 'server',
'rdb2:election96', 'cand_pix'));
```

When you qualify the **FILETOBLOB** or **FILETOCLOB** function with the name of a remote database and a remote database server, the *pathname* and the *file destination* become relative to the remote database server.

When you specify **server** as the file destination, as the following example shows, the **FILETOBLOB** function looks for the source file (in this case, **photos.xxx**) on the remote database server:

```
INSERT INTO rdb@rserv:election (cand_pic)
VALUES (rdb@rserv:FILETOBLOB('C:\tmp\photos.xxx', 'server'));
```

When you specify `client` as the file destination, however, as in the following example, the **FILETOBLOB** function looks for the source file (in this case, **photos.xxx**) on the local client computer:

```
INSERT INTO rdb@rserv:election (cand_pic)
VALUES (rdb@rserv:FILETOBLOB('photos.xxx', 'client'));
```

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Pathnames with Commas

If a comma (,) symbol is within the *pathname* of the function, the database server expects the pathname to have the following format:

```
"offset, length, pathname"
```

For pathnames that contain a comma, you must also specify an offset and length, as in the following example:

```
FILETOBLOB("0,-1,/tmp/blob,x","server");
```

The first term in the quoted *pathname* string is an *offset* of 0, which instructs the database server to begin reading at the start of the file.

The second term is a *length* of -1, which instructs the database server to continue reading until the end of the entire file.

The third term is the */tmp/blob,x* *pathname*, specifying which file to read. (Notice the comma symbol that precedes the *x*.)

Because the *pathname* includes a comma, the comma-separated *offset* and *length* specifications are necessary in this example to avoid an error when **FILETOBLOB** is called. You do not need to specify *offset* and *length* for pathnames that include no comma, but including 0,-1, as the initial characters of the *pathname* string avoids this error for any valid *pathname*.

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LOTOFILE Function

The **LOTOFILE** function copies a smart large object to an operating-system file.

The first parameter specifies the BLOB or CLOB column to copy. The function determines what file to create from the following parameters:

- The *pathname* identifies the directory path and the source file name.
- The *file destination* identifies the computer, 'client' or 'server', on which this file resides:
 - Set *file destination* to 'client' to identify the client computer as the location of the source file. The *pathname* can be either a full pathname or a path relative to the current directory.
 - Set *file destination* to 'server' to identify the server computer as the location of the source file. The full pathname is required.

By default, the **LOTOFILE** function generates a filename of the form:

```
file.hex_id
```

In this format, *file* is the filename you specify in *pathname* and *hex_id* is the unique hexadecimal smart-large-object identifier. The maximum number of digits for a smart-large-object identifier is 17. Most smart large objects, however, would have an identifier with fewer digits.

For example, suppose that you specify a UNIX *pathname* value as follows:

```
'/tmp/resume'
```

If the CLOB column has the identifier **203b2**, then **LOTOFILE** creates the file:

```
/tmp/resume.203b2
```

For another example, suppose that you specify a Windows *pathname* value as follows:

```
'C:\tmp\resume'
```

If the CLOB column has an identifier of **203b2**, the **LOTOFILE** function would create the file:

```
C:\tmp\resume.203b2
```

To change the default filename, you can specify the following wildcards in the filename of the *pathname*:

- One or more contiguous question mark (?) characters in the filename can generate a unique filename. The **LOTOFILE** function replaces each question mark with a hexadecimal digit from the identifier of the BLOB or CLOB column.

For example, suppose that you specify a UNIX *pathname* value as follows:

```
'/tmp/resume??.txt'
```

The **LOTOFILE** function puts 2 digits of the hexadecimal identifier into the name. If the CLOB column has an identifier of **203b2**, the **LOTOFILE** function would create the file:

```
/tmp/resume20.txt
```

If you specify more than 17 question marks, **LOTOFILE** ignores them.

- An exclamation (!) point at the end of the filename indicates that the filename does not need to be unique. For example, suppose that you specify a Windows pathname value as follows:

```
'C:\tmp\resume.txt!'
```

The **LOTOFILE** function does not use the smart-large-object identifier in the filename, so it generates the following file:

```
C:\tmp\resume.txt
```

If the filename that you specify already exists, **LOTOFILE** returns an error.

The **LOTOFILE** function performs any code-set conversion that might be required when it copies a CLOB value from the database to a file on the client or server computer.

When you qualify **LOTOFILE** with the name of a remote database and a remote database server, the BLOB or CLOB column, the *pathname*, and the *file destination* become relative to the remote database server.

When you specify *server* as the file destination, as in the next example, the **LOTOFILE** function copies the smart large object from the remote database server to a source file in the specified directory on the remote database server:

```
rdb@rserv:LOTOFILE(blob_col, 'C:\tmp\photo.gif!', 'server')
```

If you specify *client* as the file destination, as in the following example, the **LOTOFILE** function copies the smart large object from the remote database server to a source file in the specified directory on the local client computer:

```
rdb@rserv:LOTOFILE(clob_col, 'C:\tmp\essay.txt!', 'client')
```

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LOCOPY Function

The **LOCOPY** function creates a copy of a smart large object.

The first parameter specifies the BLOB or CLOB column to copy. The *table* and *column* parameters are optional.

- If you omit *table* and *column* arguments, the **LOCOPY** function creates a smart large object with system-specified storage defaults, and copies the data in the BLOB or CLOB column into it.
The **LOCOPY** function obtains the system-specific storage defaults from either the ONCONFIG file or the sbspace. For more information on system-specified storage defaults, see the *IBM® Informix Administrator's Guide*.
- When you specify *table* and *column*, the **LOCOPY** function uses the storage characteristics from the specified *column* for the BLOB or CLOB value that it creates.

The **LOCOPY** function returns a handle value (a pointer) to the new BLOB or CLOB value. This function does *not* actually store the new smart-large-object value into a column in the database. You must assign the BLOB or CLOB value to the appropriate column.

The following Informix® ESQ/C code fragment copies the CLOB value in the **resume** column of the **candidate** table to the **resume** column of the **interview** table:

```
/* Insert a new row in the interviews table and get the
 * resulting SERIAL value (from sqlca.sqlerrd[1])
 */
EXEC SQL insert into interviews (intrv_num, intrv_time)
values (0, '09:30');
intrv_num = sqlca.sqlerrd[1];

/* Update this interviews row with the candidate number
 * and resume from the candidate table. Use LOCOPY to
 * create a copy of the CLOB value in the resume column
 * of the candidate table.
 */
EXEC SQL update interviews
SET (cand_num, resume) =
(SELECT cand_num,
LOCOPY(resume, 'candidate', 'resume')
FROM candidate
WHERE cand_lname = 'Haven')
WHERE intrv_num = :intrv_num;
```

In the preceding example, the **LOCOPY** function returns a handle value for the copy of the CLOB **resume** column in the **candidate** table. Because the **LOCOPY** function specifies a table and column name, this new CLOB value has the storage characteristics of this **resume** column. If you omit the table (**candidate**) and column (**resume**) names, the **LOCOPY** function uses the system-defined storage defaults for the new CLOB value. The UPDATE statement then assigns this new CLOB value to the **resume** column in the **interviews** table.

In the following example, the **LOCOPY** function executes on the local database and returns a handle value on the local server for the copy of the BLOB **cand_pic** column in the **election2008** table in **rdb**, which is another database of the local database server. The INSERT statement then assigns this new BLOB value to the **cand_photo** column in the local **candidate** table.

```
INSERT INTO candidate (cand_photo)
SELECT LOCOPY(cand_pic) FROM rdb:election2008;
```

When the **LOCOPY** function executes on the same database server as the original BLOB or CLOB column in a distributed query, it produces two copies of the BLOB or CLOB value, one in the remote database and the other in the local database, as the following two examples show.

In the first example, the **LOCOPY** function executes on the remote **rdb** database and returns a handle value in the remote database for the copy of the BLOB **cand_pic** column in the remote **election2008** table. The INSERT statement then assigns this new BLOB value to the **cand_photo** column in the local **candidate** table:

```
INSERT INTO candidate (cand_photo)
  SELECT rdb:LOCOPY(cand_pic)
  FROM rdb:election2008;
```

In the second example, the **LOCOPY** function executes on the local database and returns a handle value on the local database for the copy of the BLOB **cand_photo** column in the local **candidate** table. The INSERT statement then assigns this new BLOB value to the **cand_pic** column in the **election2008** table in the remote **rdb** database:

```
INSERT INTO rdb:election2008 (cand_pic)
  SELECT LOCOPY(cand_photo) FROM candidate;
```

The BLOB and CLOB arguments of the built-in **LOCOPY** function are built-in opaque data types. These can be values returned by cross-database DML operations or by cross-database function calls, but built-in opaque types do not support distributed operations across database server instances. If the local database and the **rdb** database are databases of different Informix instances, the INSERT statements in the previous two examples fail with error -999.

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Time Functions

The time functions of Informix® accept DATE or DATETIME arguments, or character representation of a DATE or DATETIME value. They typically return DATE or DATETIME values, or convert information that they extract from DATE or DATETIME values into character strings or integers.

See also the descriptions of the **ROUND** and **TRUNC** functions, which can change the precision of DATE or DATETIME values, in the section [Algebraic Functions](#).

Time Functions

```
|--DATE--(--non_date_expr--)-----+--|
|+-DAY-----+--(--date/dtime_expr--)-----+
| |+-LAST_DAY--+
| |+-MONTH-----+
| |+-QUARTER--+
| |+-WEEKDAY--+
| |'-YEAR-----'
|+-EXTEND--(--date/dtime_expr--+-----+--)|
| |'-,--first--TO--last-'
|+-MDY--(--month--,--day--,--year--)-----+
| |'-+-ADD_MONTHS--(--date/dtime_expr--,--integer--)-----+
| |+-MONTHS_BETWEEN--(--date/dtime_expr--,--date/dtime_expr--)-----+
| |+-NEXT_DAY--(--date/dtime_expr--,--weekday--)-----+
| |'-+-TO_CHAR--(--date/dtime_expr--+-----+--)'
| | |'-num_expr-----' | '-,--format_string-'
| |'-TO_DATE--(--char_expression-----'
```

Element	Description	Restrictions	Syntax
<i>char_expression</i>	Expression to be converted to a DATE or DATETIME value	Must be a literal, host variable, expression, or column of a character data type	Expression
<i>date/dtime_expr</i>	Expression that returns a DATE or DATETIME value	Can be host variable, expression, column, or constant.	Expression
<i>day</i>	Expression that returns the number of a day of the month	Must return integer > 0 but no greater than the number of days in the specified month	Expression
<i>first</i>	Largest time unit in the result. If you omit <i>first</i> and <i>last</i> , the default <i>first</i> is YEAR.	Must be a DATETIME qualifier keyword that specifies a time unit no smaller than <i>last</i>	DATETIME Field Qualifier
<i>format_string</i>	String that contains a format mask for the first argument	Must be a character data type that specifies a valid format. Can be a column, host variable, expression, or constant	Quoted String
<i>integer</i>	Expression that specifies a whole number of months	Must evaluate to positive or negative integer	Expression
<i>last</i>	Smallest time unit in the result	Must be a DATETIME qualifier keyword that specifies a time unit no smaller than <i>first</i>	DATETIME Field Qualifier
<i>month</i>	Expression that represents the number of the month	Must evaluate to an integer in the range from 1 to 12, inclusive	Expression
<i>non_date_expr</i>	Expression that represents a value to be converted to a DATE data type	Typically an expression that returns a CHAR, DATETIME, or INTEGER value that can be converted to a DATE data type	Expression
<i>num_expr</i>	Expression that evaluates to a real number	Must return a numeric data type	Expression
<i>weekday</i>	Abbreviated name of a day of the week	A character data type containing a valid abbreviation for a day of the week	Quoted String
<i>year</i>	Number expression that represents a year	Must evaluate to a 4-digit integer. You cannot use a 2-digit abbreviation.	Expression

- [ADD_MONTHS Function](#)
The **ADD_MONTHS** function takes a DATETIME or DATE expression as its first argument, and requires a second integer argument, specifying the number of months to add to the first argument value. The second argument can be positive or negative.
- [DATE Function](#)
The **DATE** function converts its argument to a DATE value.
- [DAY Function](#)
The **DAY** function takes a DATE or DATETIME argument and returns the day of the month as an integer in the range from 1 to the number of days in the current month.
- [MONTH Function](#)
The **MONTH** function returns an integer corresponding to the *month* portion of its DATE or DATETIME argument.
- [QUARTER Function](#)
The **QUARTER** function returns an integer in the range 1 through 4 that corresponds to the *quarter* of the calendar year that includes its DATE or DATETIME argument.
- [WEEKDAY Function](#)
The **WEEKDAY** function accepts a DATE or DATETIME argument, and returns an integer in the range from 0 to 6 that represents the day of the week.
- [YEAR Function](#)
The **YEAR** function takes a DATE or DATETIME argument and returns a four-digit integer that represents the year.
- [MONTHS_BETWEEN Function](#)
The **MONTHS_BETWEEN** function accepts two DATE or DATETIME expressions as arguments, and returns a signed DECIMAL value that quantifies the interval between those arguments in months, as if *month* were a unit of time.
- [LAST_DAY Function](#)
The **LAST_DAY** function requires a DATE or DATETIME expression as its only argument. It returns the date of the last day of the month that its argument specifies.
- [NEXT_DAY Function](#)
The **NEXT_DAY** function returns the earliest date that is later than its DATE or DATETIME first argument, and that falls on the day of the week that its second argument specifies. This second argument is a quoted string of three ASCII characters that abbreviates the English name of the day of the week.
- [EXTEND Function](#)
The **EXTEND** function adjusts the precision of a DATETIME or DATE value.
- [MDY Function](#)
The **MDY** function takes as its arguments three integer expressions that represent the *month*, *day*, and *year*, and returns a type DATE value.
- [TO_CHAR Function](#)
The **TO_CHAR** function converts an expression that evaluates to a DATE, DATETIME, or numeric value to a character string.
- [TO_DATE Function](#)
The **TO_DATE** function converts a character string to a DATETIME value. The function evaluates the *char_expression* first argument as a date, according to the date format that the *format_string* second argument specifies, and returns the equivalent date.

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ADD_MONTHS Function

The **ADD_MONTHS** function takes a DATETIME or DATE expression as its first argument, and requires a second integer argument, specifying the number of months to add to the first argument value. The second argument can be positive or negative.

The value returned is the sum of the DATE or DATETIME value of the first argument, as an INTERVAL UNITS MONTH value, based on the number of months that the second argument specifies.

The returned data type depends on the data type of the first argument:

- If the first argument evaluates to a DATE value, **ADD_MONTHS** returns a DATE value.
- If the first argument evaluates to a DATETIME value, **ADD_MONTHS** returns a DATETIME YEAR TO FRACTION(5) value, with the same values for time units smaller than *day* as in the first argument.

If the *day* and *month* time units in the first argument specify the last day of the month, or if the resulting month has fewer days than the *day* in the first argument, then the returned value is the last day of the resulting month. Otherwise, the returned value has the same day of the month as the first argument.

The returned value can be in a different year, if the resulting month is later than December (or for negative second arguments, earlier than January) of the year in the first argument.

The following query calls the **ADD_MONTHS** function twice in the Projection clause, using column expressions as arguments. Here the column names indicate the column data types, and the **DBDATE** setting is **MDY4/**:

```
SELECT a_serial, b_date, ADD_MONTHS(b_date, a_serial),
       c_datetime, ADD_MONTHS(c_datetime, a_serial)
FROM mytab WHERE a_serial = 7;
```

In this example **ADD_MONTHS** returns DATE and DATETIME values:

a_serial	7
b_date	07/06/2007
(expression)	02/06/2008
c_datetime	2007-10-06 16:47:49.00000
(expression)	2008-05-06 16:47:49.00000

If you use a host variable to store the argument to **ADD_MONTHS**, but the data type of the argument is not known at prepare time, Informix® assumes that the data type is DATETIME YEAR TO FRACTION(5). If at runtime, after the statement has been prepared, the user supplies a DATE value for the host variable, the database server issues error -9750. To prevent this error, specify the data type of the host variable by using a cast, as in this program fragment:

```
sprintf(query, ",
    \"select add_months(?:date, 6) from mytab\");
EXEC SQL prepare selectq from :query;
EXEC SQL declare select_cursor cursor for selectq;
EXEC SQL open select_cursor using :hostvar_date_input;
EXEC SQL fetch select_cursor into :var_date_output;
```

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DATE Function

The **DATE** function converts its argument to a DATE value.

Its non-DATE argument can be any expression that can be converted to a DATE value, usually a CHAR, DATETIME, or INTEGER value. The following WHERE clause specifies a quoted string as its CHAR argument:

```
WHERE order_date < DATE('12/31/07')
```

When the **DATE** function interprets a CHAR non-DATE expression, it expects this expression to conform to any DATE format that the **DBDATE** environment variable specifies. For example, suppose **DBDATE** is set to *Y2MD/* when you execute the following query:

```
SELECT DISTINCT DATE('02/01/2008') FROM ship_info;
```

This SELECT statement generates an error, because the **DATE** function cannot convert this string expression. The **DATE** function interprets the first part of the date string (02) as the year and the second part (01) as the month.

For the third part (2008), the **DATE** function encounters four digits when it expects a two-digit day (valid day values must be between 01 and 31). It therefore cannot convert the value. For the SELECT statement to execute successfully with the *Y2MD/* value for **DBDATE**, the argument would need to be '08/02/01'. For information on the format of **DBDATE**, see the *IBM® Informix Guide to SQL: Reference*.

For information on the order of precedence among Informix® environment variables that can specify the display and data entry format of DATE values, see the topic [Precedence of DATE and DATETIME format specifications](#).

When you specify a positive INTEGER value for the non-DATE expression, the **DATE** function interprets this as the number of days after December 31, 1899.

If the integer value is negative, the **DATE** function interprets the value as the number of days before December 31, 1899. The following WHERE clause specifies an INTEGER value for the non-DATE expression:

```
WHERE order_date < DATE(365)
```

The database server searches for rows with an **order_date** value less than December 31, 1900 (which is 12/31/1899 plus 365 days).

Related information:

[DBDATE environment variable](#)

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DAY Function

The **DAY** function takes a DATE or DATETIME argument and returns the day of the month as an integer in the range from 1 to the number of days in the current month.

The following statement fragment calls the **DAY** function with the **CURRENT** function as its argument to compare **order_date** column values to the current day of the month:

```
WHERE DAY(order_date) > DAY(CURRENT)
```

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MONTH Function

The **MONTH** function returns an integer corresponding to the *month* portion of its DATE or DATETIME argument.

Like the **DAY**, **YEAR**, **WEEKDAY**, and **QUARTER** built-in time functions, the **MONTH** function extracts information from a single DATE or DATETIME expression that is its argument. The return value is the ordinal position of that *month* within the sequence of months in a calendar year. On September 23, for example, the function expression **MONTH(TODAY)** returns 9,

The following example returns a number that can range from 1 through 12 to indicate the month when the order was placed:

```
SELECT order_num, MONTH(order_date) FROM orders;
```

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QUARTER Function

The **QUARTER** function returns an integer in the range 1 through 4 that corresponds to the *quarter* of the calendar year that includes its DATE or DATETIME argument.

For example, any date in January, February, or March returns the integer 1.

The argument must be an expression that evaluates to a DATE or DATETIME data type.

Examples of QUARTER function expressions

The following function expression returns 3, because August is in the third quarter of the year.

```
QUARTER('2014-08-25')
```

The following example returns a number that can range from 1 through 4 to indicate the quarter when the order was placed:

```
SELECT order_num, QUARTER(order_date) FROM orders;
```

The following query includes QUARTER function expressions whose arguments are the order_date column and the CURRENT operator. The WHERE clause restricts the result set to qualifying rows with order_date values in quarters earlier in the current year than the current quarter:

```
SELECT * FROM orders
WHERE (QUARTER(order_date) < QUARTER(CURRENT))
      AND YEAR(order_date) = YEAR(CURRENT);
```

During the first quarter, however, this query returns no rows, because there can be no data from a quarter with a value less than the current quarter. That is, there is no quarter of value zero.

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WEEKDAY Function

The **WEEKDAY** function accepts a DATE or DATETIME argument, and returns an integer in the range from 0 to 6 that represents the day of the week.

As the return value, zero (0) represents Sunday, one (1) represents Monday, and so on.

The following query returns all the orders that were paid on the same day of the week as the current date:

```
SELECT * FROM orders
WHERE WEEKDAY(paid_date) = WEEKDAY(CURRENT);
```

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YEAR Function

The **YEAR** function takes a DATE or DATETIME argument and returns a four-digit integer that represents the year.

The following example lists orders in which the **ship_date** is earlier than the beginning of the current year:

```
SELECT order_num, customer_num FROM orders
WHERE year(ship_date) < YEAR(TODAY);
```

Similarly, because a DATE value is a simple calendar date, you cannot add or subtract a DATE value with an INTERVAL value whose *last* qualifier is smaller than DAY. In this case, convert the DATE value to a DATETIME value.

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MONTHS_BETWEEN Function

The **MONTHS_BETWEEN** function accepts two DATE or DATETIME expressions as arguments, and returns a signed DECIMAL value that quantifies the interval between those arguments in months, as if *month* were a unit of time.

This function requires two arguments, each of which can be a DATE expression or a DATETIME expression.

The value returned is a DECIMAL data type, representing the difference between the two arguments, expressed as a DECIMAL value based on 31-day units. If the first argument is a point in time later than the second argument, the sign of the returned value is positive. If the first argument is earlier than the second argument, the sign of the returned value is negative. If both arguments are equal, the return value is zero.

If the dates of the arguments are both the same days of a month or are both the last days of a months, the result is a whole number. Otherwise, the fractional portion of the result is calculated, based on a month of 31 days. This fractional part can also include the difference in *hour*, *minute*, and *second* time units, unless

both arguments are DATE expressions.

The following query calls the **MONTHS_BETWEEN** function in the Projection clause, using two DATE values returned by **TO_DATE** expressions as arguments.

```
SELECT MONTHS_BETWEEN(TO_DATE('2-2-2005', '%m-%d-%Y'),
                      TO_DATE('1-1-2005', '%m-%d-%Y'))
AS lunations FROM systables WHERE tabid = 1;
```

The value returned by the query expresses the 32-day difference between the two DATE arguments as a positive number of 31-day months:

```
      months
1.03225806451613
```

The next example returns the DATETIME column expression arguments to **MONTHS_BETWEEN** expressions, and their differences in months for two rows of a table:

```
SELECT d_datetime, e_datetime,
       MONTHS_BETWEEN(d_datetime, e_datetime) AS months_between
FROM mytab1;
```

```
d_datetime    2007-11-01 09:00:00.00000
e_datetime    2007-12-07 14:30:12.12345
months_between -1.2009453405018
```

```
d_datetime    2007-12-13 09:40:30.00000
e_datetime    2007-11-13 08:40:30.00000
months_between 1.000000000000000
```

Here the first **MONTHS_BETWEEN** result includes differences in time units smaller than days. The second result has no fractional part, because the *day* time units of the arguments had the same value.

The **MONTHS_BETWEEN** expressions in the next example compares DATE and DATETIME values:

```
SELECT col_datetime, col_date,
       MONTHS_BETWEEN(col_datetime, col_date) AS months_between
FROM mytab2;
```

```
col_datetime    2008-12-13 08:40:30.00000
col_date        11/13/2007
months_between  13.000000000000000
```

Because both arguments specify the same day of the month, the result has no fractional part.

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LAST_DAY Function

The **LAST_DAY** function requires a DATE or DATETIME expression as its only argument. It returns the date of the last day of the month that its argument specifies.

The data type of this returned value is the same data type as the argument. The difference between the returned value and the argument is the number of days remaining in that month.

The following query returns the DATE representation of the current date, the date of the last day in the current month, and the integer number of days (calculated by subtracting the first DATE value from second) before the last day in the current month:

```
SELECT TODAY AS today, LAST_DAY(TODAY) AS last,
       LAST_DAY(TODAY) - TODAY AS days_left
FROM systables WHERE tabid = 1;
```

If the query were issued on 12 March 2018, with **MDY4** / as the **DBDATE** setting for the default locale, it would return the following information:

```
today      last      days_left
03/12/2018 03/31/2018      19
```

In the SELECT statement of this example, there is no name conflict in the Projection clause between the TODAY operator and the identifier **today**, because the AS keyword indicates to Informix® that **today** is a display label.

If you use a host variable to store the argument to **LAST_DAY**, but the data type of the argument is not known at prepare time, Informix assumes that the data type is DATETIME YEAR TO FRACTION(5). If at runtime, after the statement has been prepared, the user supplies a DATE value for the host variable, error -9750 is issued. To prevent this error, specify the data type of the host variable by using a cast, as in this program fragment:

```
sprintf(query, "\n
select last_day(??::date) from mytab");
EXEC SQL prepare selectq from :query;
EXEC SQL declare select_cursor cursor for selectq;
EXEC SQL open select_cursor using :hostvar_date_input;

EXEC SQL fetch select_cursor into :var_date_output;
```

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NEXT_DAY Function

The **NEXT_DAY** function returns the earliest date that is later than its DATE or DATETIME first argument, and that falls on the day of the week that its second argument specifies. This second argument is a quoted string of three ASCII characters that abbreviates the English name of the day of the week.

The **NEXT_DAY** function requires two arguments:

- a DATE or DATETIME expression that evaluates to a date earlier than the return value.
- a character string of at least three ASCII characters that correspond to upper case letters in the range from ASCII 65 through ASCII 90. These three letters encode the abbreviation English name for a day of the week.

Successful execution of this function returns the earliest calendar date that satisfies each of two conditions:

- The date is later than the date specified by the first argument.
- The date falls on the day of the week specified by the second argument.

NEXT_DAY accepts the following abbreviation strings for days of the week:

Table 1. Weekday abbreviations valid as arguments to the NEXT_DAY function

Day of Week	Abbreviation		Day of Week	Abbreviation
Sunday	'SUN'		Wednesday	'WED'
Monday	'MON'		Thursday	'THU'
Tuesday	'TUE'		Friday	'FRI'
			Saturday	'SAT'

Any characters that follow the 3rd character of these abbreviation strings are ignored. For example, both 'MONDAY' and 'MONTAG' are valid specification for the 2nd argument, each specifying the next Monday after the date in the first argument. Informix® issues an error, however, if the second argument is a string such as 'MODNAY' whose first three characters do not match one of the *weekday* abbreviations in the table above.

The following query, for example, includes a valid **NEXT_DAY** expression:

```
SELECT ship_date, NEXT_DAY(ship_date, 'SAT') AS next_saturday,  
       NEXT_DAY(ship_date, 'SAT') - ship_date AS num_days FROM orders;
```

The result set of this query might include the following data from the **orders** table:

ship_date	next_saturday	num_days
06/01/2006	06/03/2006	2
02/12/2007	02/17/2007	5
05/31/2007	06/02/2007	2
05/23/2007	05/26/2007	3

The value returned by **NEXT_DAY** has the same data type as the first argument. If this argument is a DATE type, **NEXT_DAY** returns a DATE value. If the first argument is a DATETIME type, **NEXT_DAY** returns a DATETIME YEAR TO FRACTION(5) value.

Because **ship_date** in the preceding example is a DATE column, the returned dates are formatted as DATE values, rather than in DATETIME format.

If you use a host variable to store the argument to **NEXT_DAY**, but the data type of the argument is not known at prepare time, Informix assumes that the data type is DATETIME YEAR TO FRACTION(5). If at runtime, after the statement has been prepared, the user supplies a DATE value for the host variable, error -9750 is issued. To prevent this error, specify the data type of the host variable by using a cast, as in this program fragment:

```
sprintf(query, "  
  \"select next_day(?:date, 'SUN') from mytab");  
EXEC SQL prepare selectq from :query;  
EXEC SQL declare select_cursor cursor for selectq;  
EXEC SQL open select_cursor using :hostvar_date_input;  
  
EXEC SQL fetch select_cursor into :var_date_output;
```

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EXTEND Function

The **EXTEND** function adjusts the precision of a DATETIME or DATE value.

The DATETIME or DATE expression that is its first argument cannot be a quoted string representation of a DATE value.

If you do not specify *first* and *last* qualifiers, the default qualifiers are YEAR TO FRACTION(3).

If the expression contains fields that are not specified by the time-unit qualifiers, those fields are discarded.

If the *first* qualifier specifies a larger (that is, more significant) time unit than what exists in the expression, the new fields are filled in with values returned by the **CURRENT** function. If the *last* qualifier specifies a smaller time unit (that is, less significant) than what exists in the expression, the new fields are filled in with constant values. A missing MONTH or DAY field is filled in with 1, and the missing HOUR to FRACTION fields are filled in with 0.

In the following expression, the **EXTEND** call returns the **call_dtime** column value with YEAR TO SECOND precision:

```
EXTEND (call_dtime, YEAR TO SECOND)
```

You can use the **EXTEND** function to perform addition or subtraction with a DATETIME value and an INTERVAL value that do not have the same time unit qualifiers. The next expression expands a literal DATETIME YEAR TO DAY value to a precision of YEAR TO MINUTE so that an interval YEAR TO MINUTE value can be subtracted from it:

```
EXTEND (DATETIME (2009-8-1) YEAR TO DAY, YEAR TO MINUTE)
- INTERVAL (720) MINUTE (3) TO MINUTE
```

You can use the **EXTEND** function to selectively update a subset of the time units in a DATETIME value. The UPDATE statement in the next example updates only the *hour* and *minute* time unit values in a DATETIME YEAR TO MINUTE column.

```
UPDATE cust_calls SET call_dtime = call_dtime -
  (EXTEND(call_dtime, HOUR TO MINUTE) - DATETIME (11:00)
   HOUR TO MINUTE) WHERE customer_num = 106;
```

Subtracting 11:00 from the DATETIME HOUR TO MINUTE value returned by **EXTEND** yields a positive or negative INTERVAL HOUR TO MINUTE value. Subtracting this difference from the original value in the **call_dtime** column forces the updated *hour* and *minute* time unit values to 11:00 in the **cust_calls.call_dtime** column.

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MDY Function

The **MDY** function takes as its arguments three integer expressions that represent the *month*, *day*, and *year*, and returns a type DATE value.

- The first argument represents the number of the month (1 to 12).
- The second argument represents the number of the day of the month (1 to 28, 29, 30, or 31, as appropriate for the month).
- The third argument represents the 4-digit year. You cannot use a 2-digit abbreviation.

Example of the MDY function in an UPDATE statement

The following example updates a row in the **orders** table whose purchase-order number is 8052 by changing its **paid_date** column value to the first day of the current month:

```
UPDATE orders SET paid_date = MDY(MONTH(TODAY), 1, YEAR(TODAY))
WHERE po_num = '8052';
```

Here the first and last arguments to the **MDY** function are time expressions that return integers corresponding to the current *month* and *year*. The second argument specifies the *day of the month* as a literal integer. Reversing the order of the first two arguments in this example would change the **paid_date** value to some day before January 13 of the current year, unless the same application also included error-checking code that identified that date as too early to be valid.

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TO_CHAR Function

The **TO_CHAR** function converts an expression that evaluates to a DATE, DATETIME, or numeric value to a character string.

The returned character string represents the data value that the first argument specifies, using a formatting mask that the second argument defines in a *format_string* that can include special formatting symbols and literal characters.

- The first argument to this function must be of a DATE, DATETIME, or built-in numeric data type, or a character string that can be converted to one of these data types. If the value of the initial DATE, DATETIME, or numeric argument is NULL, the function returns a NULL value.
- The second argument to this function is a character string that specifies a formatting mask. What set of special characters is appropriate for the formatting mask primarily depends on whether the first argument to the **TO_CHAR** function represents a point in time or a number.

Formatting DATE and DATETIME expressions

The *format_string* argument does not need to imply the same time units as the value in the first argument to the **TO_CHAR** function. When the precision implied in the *format_string* is different from the DATETIME qualifier in the first argument, the **TO_CHAR** function extends the DATETIME value as if it had called the **EXTEND** function.

In the following example, the user wants to convert the **begin_date** column of the **tab1** table to a character string. The **begin_date** column is defined as a DATETIME YEAR TO SECOND data type. The user uses a SELECT statement with the **TO_CHAR** function to perform this conversion:

```
SELECT TO_CHAR(begin_date, '%A %B %d, %Y %R') FROM tab1;
```

The symbols in the *format_string* of this example have the following meanings.

Symbol

Meaning

- %A Full weekday name, as defined in the locale
- %B Full month name, as defined in the locale
- %d

Day of the month as an integer (01 through 31). A single-digit value is preceded by a zero (0).

%Y Year as a 4-digit decimal number

%R Time in 24-hour notation (equivalent to %H:%M format, as defined below).

Note that the comma (,) that immediately follows the %d format specification in the example above is a literal character, rather than a separator of arguments to the **TO_CHAR** function. The second argument is the quoted string '%A %B %d, %Y %R' that defines the formatting mask for representing the first argument in the value that **TO_CHAR** returns.

Applying this *format_string* to the **begin_date** column value returns this result:

```
Wednesday July 25, 2013 18:45
```

The query in the next example calls **TO_CHAR** to apply the same format string to an **ADD_MONTHS** expression, and shows the results of the query:

```
SELECT ship_date, TO_CHAR(ADD_MONTHS(ship_date, 1), '%A %B %d, %Y %R')
AS survey_date FROM orders;
```

```
ship_date    03/12/2013
survey_date  Thursday April 12, 2013
```

In the query output above,

- the **ship_date** value is formatted according to the **DB_DATE** environment variable setting,
- and the **survey_date** value is formatted according to the '%A %B %d, %Y %R' formatting string argument to the **TO_CHAR** function.

Additional symbols that are valid in the *format_string* argument to the **TO_CHAR** function for DATE or DATETIME values include the following.

Symbol

Symbol	Meaning
%a	Abbreviated weekday name, as defined in the locale
%b	Abbreviated month name, as defined in the locale
%C	The century number (the year divided by 100 and truncated to an integer) as an integer (00 through 99)
%D	The same as the %m/%d/%y format
%e	Day of the month as a number (1 through 31). A single-digit value is preceded by a blank space.
%Fn	The value of the fraction of a second, with precision specified by the unsigned integer n. The default value of n is 2; the range of n is 0 ≤ n ≤ 5. This value overrides any width or precision that is specified between the % and F characters.
%h	Same as the %b format: abbreviated month name, as defined in the locale
%H	Hour as a 2-digit integer (00 through 23) (24-hour clock)
%I	Hour as a 2-digit integer (00 through 11) (12-hour clock)
%m	Month as an integer (01 through 12). Any single-digit value is preceded by a zero (0).
%M	Minute as a 2-digit integer (00 through 59)
%S	Second as a 2-digit integer (00 through 61). The second value can be up to 61 (instead of 59) to allow for the occasional leap second and double leap second.
%T	Time in the %H:%M:%S format
%w	Weekday as a number (0 through 6); 0 represents the locale equivalent of Sunday.
%y	Year as a 2-digit decimal number.

For example, suppose that on August 23, 2013, the DB-Access facility issued the following query:

```
SELECT TO_CHAR(CURRENT YEAR TO FRACTION(5), '%Y-%m-%d %H:%M:%S.%F')
FROM sysmaster:sysdual;
```

In this example, the format string argument specifies a user format with the following literal characters as separators between the DATETIME field values:

- ASCII 45 (-) hyphen to separate the year, month, and day values
- ASCII 32 () blank to separate the day from the hour
- ASCII 58 (:) colon to separate the hour, minute, and seconds
- ASCII 46 (.) period to separate the second from the fraction of a second.

This is the returned value in the specified DATETIME user format:

```
(expression) 2013-08-23 13:15:53.00
```

If you omit the *format_string* argument when a DATETIME or DATE expression is the first argument, the **TO_CHAR** function uses as a default the setting of the DBTIME or DBDATE environment variables to format the value represented in the first argument. In nondefault locales, the default format for DATETIME and DATE values is specified by environment variables such as GL_DATETIME and GL_DATE.

Important: For DATETIME user formats whose precision includes both SECOND and FRACTION data values, those fields are concatenated unless a separator character is explicitly defined between the %S and %F formatting directives. In version 11.70.xC7 and earlier Informix® releases, the %F directive inserted the ASCII 46 character (.) by default between the SECOND and FRACTION field values. In this release, however, the %F directive implies no default separator.

For the order of precedence among the Informix environment variables that can specify the display and data entry formats for the built-in chronological data types, see the topic [Precedence of DATE and DATETIME format specifications](#).

Formatting numeric and MONEY expressions

The *format_string* argument to the **TO_CHAR** function supports the same numeric formatting masks that are used for ESQL functions like **rfmtdec()**, **rfmtdouble()**, and **rfmtlong()**. A detailed description of the Informix numeric-formatting masks for numeric values (when formatting numeric expressions as strings) is in the *IBM® Informix ESQL/C Programmer's Manual*. Below is a short summary description of the numeric formatting masks.

A numeric-formatting mask specifies a format to apply to some numeric value when formatting a numeric expression as a string. This mask is a combination of the following formatting characters:

Symbol

Symbol	Meaning
*	This character fills with asterisks any positions in the display field that would otherwise be blank
&	This character fills with zeros any positions in the display field that would otherwise be blank
#	This character changes leading zeros to blanks. Use this character to specify the maximum leftward extent of a field.
<	This character left-justifies the numbers in the display field. It changes leading zeros to a NULL string.
,	This character indicates the symbol that separates groups of three digits (counting leftward from the units position) in the whole-number part of the value. By default, this symbol is a comma. You can set the symbol with the DBMONEY environment variable. In a formatted number, this symbol appears only if the integer part of the value has four or more digits.
.	This character indicates the symbol that separates the integer part of a money value from the fractional part. By default, this symbol is a period. You can set the symbol with the DBMONEY environment variable. You can have only one period in a format string.
-	This character is a literal. It appears as a minus sign when <i>expr1</i> is less than zero. When you group several minus (-) signs in a row, a single minus sign floats to the rightmost position that it can occupy; it does not interfere with the number and its currency symbol.
+	This character is a literal. It appears as a plus sign when <i>expr1</i> is greater than or equal to zero, and as a minus sign when <i>expr1</i> is less than zero. When you group several plus signs in a row, a single plus or minus sign floats to the rightmost position that it can occupy; it does not interfere with the number and its currency symbol.
(	This character is a literal. It appears as a left parenthesis (() to the left of a negative number. It is one of the pair of accounting parentheses that replace a minus sign for a negative number. When you group several in a row, a single left parenthesis floats to the rightmost position that it can occupy; it does not interfere with the number and its currency symbol.
)	This is one of the pair of accounting parentheses that replace a minus sign for a negative value.
\$	This character displays the currency symbol that precedes the numeric value. In the default locale, the currency symbol is the dollar sign (\$). You can set a nondefault currency symbol with the DBMONEY environment variable. When you group several dollar signs in a row, a single currency symbol floats to the rightmost position that it can occupy; it does not interfere with the number.

Any other characters in the formatting mask are reproduced literally in the formatted value that the **TO_CHAR** function returns.

In the next three examples, the value of the **d_int** column expression argument to the **TO_CHAR** function is -12344455.

This query specifies no formatting mask in a call to **TO_CHAR**:

```
SELECT TO_CHAR(d_int) FROM tab_numbers;
```

The following table shows the output of this SELECT statement.

(expression)
-12344455

The following query specifies a monetary format mask:

```
SELECT TO_CHAR(d_int, "$*****.**") FROM tab_numbers;
```

The following table shows the output of this SELECT statement.

(expression)
\$12344455.00

```
SELECT TO_CHAR(d_int, "-$*****.**") FROM tab_numbers;
```

The query returns - \$12344455.00.

```
SELECT TO_CHAR(12344455, "-$*****.**") FROM tab_numbers;
```


The following table shows the output of this SELECT statement.

(constant)
\$12344455.00

The currency (\$) symbol from the formatting mask argument is applied, but the minus (-) symbol has no effect, because the value of the first argument is greater than zero.

Note that the **TO_CHAR** function is a time expression only when its first argument is a DATE or DATETIME expression, or is a character string that can be formatted as a DATE or DATETIME expression. When a numeric or monetary value is its first argument, however, **TO_CHAR** returns a representation of the value of that argument as a character string, but it does not return a time expression.

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TO_DATE Function

The **TO_DATE** function converts a character string to a DATETIME value. The function evaluates the *char_expression* first argument as a date, according to the date format that the *format_string* second argument specifies, and returns the equivalent date.

If *char_expression* is NULL, then a NULL value is returned.

Any argument to the **TO_DATE** function must be of a built-in data type.

If you omit the *format_string* parameter, the **TO_DATE** function applies the default DATETIME format to the DATETIME value. The default DATETIME format is specified by the **GL_DATETIME** environment variable.

In the following example, the user wants to convert a character string to a DATETIME value in order to update the **begin_date** column of the **tab1** table with the converted value. The **begin_date** column is defined as a DATETIME YEAR TO SECOND data type. The user uses an UPDATE statement that contains a **TO_DATE** function to accomplish this result:

```
UPDATE tab1
SET begin_date = TO_DATE('Wednesday July 25, 2007 18:45',
'%A %B %d, %Y %R');
```

The *format_string* parameter in this example tells the **TO_DATE** function how to format the converted character string in the **begin_date** column. For a table that shows the effect of each format symbol in this format string, see [TO_CHAR Function](#).

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TO_NUMBER Function

The **TO_NUMBER** function can convert a number or a character expression representing a number value to a DECIMAL data type.

The **TO_NUMBER** function has this syntax:

TO_NUMBER Function

```
|--TO_NUMBER-- (--+-char_expr+--)-+-----|
          '-num_expr--'
```

Element	Description	Restrictions	Syntax
<i>char_expression</i>	Expression to be converted to a DECIMAL value	Must be a literal, host variable, expression, or column of a character data type	Expression
<i>num_expression</i>	Expression that evaluates to a real number	Must return a numeric data type	Expression

The **TO_NUMBER** function converts its argument to a DECIMAL data type. The argument can be the character string representation of a number or a numeric expression.

The following example retrieves a DECIMAL value that the **TO_NUMBER** function returns from the literal representation of a MONEY value:

```
SELECT TO_NUMBER('$100.00') from mytab;
```

The following table shows the output of this SELECT statement.

(expression)
100.00000000000000

In this example, the currency symbol is discarded from the '\$100.00' string.

The **TO_NUMBER** function is not required in most contexts, because by default, Informix® converts numbers that include a decimal point (and quoted strings in the format of a literal number that has a decimal point) to a DECIMAL data type. This function can be useful, however, when you are migrating SQL applications that were originally written for other database servers, if the application makes calls to a function of this name that returns a DECIMAL value.

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Trigonometric Functions

The built-in trigonometric functions calculate ratios of the lengths of the sides of right triangles. Two supporting functions, **DEGREES** and **RADIANS**, can respectively convert the units of angular values from radians to degrees, and from degrees to radians.

The built-in trigonometric functions have the following syntax.

Trigonometric Functions

```
|--+-+--COS-----+--(--radian_expr--)+-----+-----+-----+-----+
| +-COSH-----+
| +-SIN-----+
| +-SINH-----+
| +-TAN-----+
| +-TANH-----+
| '-DEGREES-'
| '-+-+--ASIN-----+--(--numeric_expr--)+--'
| +-ASINH--+
| +-ACOS--+
| +-ACOSH--+
| +-ATAN--+
| '-ATANH-'
+-ATAN2--(--y, x--)+-----+
| '-RADIANS--(--degree_expr--)+-----+-----+-----+-----+
```

Element	Description	Restrictions	Syntax
<i>degree_expr</i>	Expression that represents the number of degrees	Must return a value that can be converted to a DECIMAL type	Expression
<i>numeric_expr</i>	Expression that serves as the argument to the ASIN , ACOS , ATAN , ASINH , ACOSH or ATANH functions	Must return a value between -1 and 1, inclusive	Expression
<i>radian_expr</i>	Expression that represents the number of radians	Must return a numeric value	Expression
<i>x</i>	Expression that represents the x coordinate in the rectangular coordinate pair (x, y)	Must return a numeric value	Expression
<i>y</i>	Expression that represents the y coordinate in the rectangular coordinate pair (x, y)	Must return a numeric value	Expression

Sections that follow describe each of these built-in trigonometric functions.

- [COS Function](#)
The **COS** function returns the cosine of a radian expression.
- [COSH function](#)
The **COSH** function returns the hyperbolic cosine of the required argument, where the argument is an angle expressed in radians.
- [SIN Function](#)
The **SIN** function returns the sine of an angle that you specify as its radian expression argument.
- [SINH function](#)
The **SINH** function returns the hyperbolic sine of the argument, where the argument is an angle expressed in radians.
- [TAN Function](#)
The **TAN** function returns the value of the tangent of its radian expression argument.
- [TANH Function](#)
The **TANH** function returns the hyperbolic tangent of the argument, where the argument is an angle expressed in radians.
- [ACOS Function](#)
The **ACOS** function returns the arc cosine of a numeric expression.
- [ACOSH Function](#)
The **ACOSH** function returns the hyperbolic tangent of the specified numeric input.
- [ASIN Function](#)
The **ASIN** function returns the arc sine of a numeric expression argument.
- [ASINH Function](#)
The **ASINH** function returns the arc hyperbolic sine of the specified numeric input.
- [ATAN Function](#)
The **ATAN** function returns the arc tangent of a numeric expression.
- [ATANH Function](#)
The **ATANH** function returns the hyperbolic tangent of the specified numeric input.
- [ATAN2 Function](#)
The **ATAN2** function computes the angular component of the polar coordinates (r, q) associated with (x, y).
- [DEGREES function](#)
Use the **DEGREES** function to convert the value of an expression or host variable representing a number of radians to the equivalent number of degrees.
- [RADIANS function](#)
Use the **RADIANS** function to convert an expression or a host variable representing a number of degrees to the equivalent number of radians.

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COS Function

The **COS** function returns the cosine of a radian expression.

The following example returns the cosine of the values of the degrees column in the **anglestbl** table. The expression passed to the **COS** function in this example converts degrees to radians.

```
SELECT COS(degrees*180/3.1416) FROM anglestbl;
```

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COSH function

The **COSH** function returns the hyperbolic cosine of the required argument, where the argument is an angle expressed in radians.

COSH function

|--COSH--(--radian_expr--)-----|

Element	Description	Restrictions	Syntax
<i>radian_expr</i>	Expression that evaluates to an angular value in units of radians	Must be of a numeric data type	Expression

The following example returns the hyperbolic cosine of the values in the degrees column of the **anglestbl** table. The expression passed to the **COSH** function converts the degrees to radians.

```
SELECT COSH(degrees*180/3.1416) FROM anglestbl;
```

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SIN Function

The **SIN** function returns the sine of an angle that you specify as its radian expression argument.

The following query returns the sines of the values in each row of the **radians** column of the **anglestbl** table:

```
SELECT SIN(radians) FROM anglestbl;
```

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SINH function

The **SINH** function returns the hyperbolic sine of the argument, where the argument is an angle expressed in radians.

SINH Function

|--SINH--(--radian_expr--)-----|

The following example returns the hyperbolic sine of the values in the degrees column of the **anglestbl** table. The expression passed to the **SINH** function converts the degrees to radians.

```
SELECT SINH(degrees*180/3.1416) FROM anglestbl;
```

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TAN Function

The **TAN** function returns the value of the tangent of its radian expression argument.

This example returns the tangent of the values in the **radians** column of the **anglestbl** table:

```
SELECT TAN(radians) FROM anglestbl;
```

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TANH Function

The **TANH** function returns the hyperbolic tangent of the argument, where the argument is an angle expressed in radians.

TANH Function

```
|--TANH--(--radian_expr--)-----|
```

The following example returns the hyperbolic tangent of the values in the degrees column of the **anglestbl** table. The expression passed to the TANH function converts the degrees to radians.

```
SELECT TANH(degrees*180/3.1416) FROM anglestbl;
```

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ACOS Function

The **ACOS** function returns the arc cosine of a numeric expression.

The following example returns the arc cosine of the value (-0.73) in radians:

```
SELECT ACOS(-0.73) FROM anglestbl;
```

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ACOSH Function

The **ACOSH** function returns the hyperbolic tangent of the specified numeric input.

ACOSH Function

```
|--ACOSH--(--numeric_expr--)-----|
```

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ASIN Function

The **ASIN** function returns the arc sine of a numeric expression argument.

The following example returns the arc sine of the value (-0.73) in radians:

```
SELECT ASIN(-0.73) FROM anglestbl;
```

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ASINH Function

The **ASINH** function returns the arc hyperbolic sine of the specified numeric input.

ASINH Function

```
|--ASINH--(--numeric_expr--)-----|
```

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ATAN Function

The **ATAN** function returns the arc tangent of a numeric expression.

The following example returns the arc tangent of the value (-0.73) in radians:

```
SELECT ATAN(-0.73) FROM anglestbl;
```

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ATANH Function

The ATANH function returns the hyperbolic tangent of the specified numeric input.

ATANH Function

```
|--ATANH--(--numeric_expr--)-----|
```

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ATAN2 Function

The **ATAN2** function computes the angular component of the polar coordinates (*r*, *q*) associated with (*x*, *y*).

The following example compares *angles* to *q* for the rectangular coordinates (4, 5):

```
WHERE angles > ATAN2(4,5)    --determines q for (4,5) and
                             --compares to angles
```

You can determine the length of the radial coordinate *r* using the expression that the following example shows:

```
SQRT(POW(x,2) + POW(y,2))    --determines r for (x,y)
```

You can determine the length of the radial coordinate *r* for the rectangular coordinates (4,5) using the expression that the following example shows:

```
SQRT(POW(4,2) + POW(5,2))    --determines r for (4,5)
```

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DEGREES function

Use the **DEGREES** function to convert the value of an expression or host variable representing a number of radians to the equivalent number of degrees.

The *radian_expression* or host variable that is the only argument to this function must be a numeric data type (or a non-numeric data type that can be converted to a number) that the database server evaluates in units of radians, and converts to units of degrees.

The return value is a number of type DECIMAL (32, 255).

In both of the examples that follow, the argument to **DEGREES** evaluates to 6 radians, and the return value is 343.774677078494 degrees:

```
EXECUTE FUNCTION DEGREES (6);
EXECUTE FUNCTION DEGREES ("6");
```

The **DEGREES** function converts radians to degrees according to the following formula:

```
(number of radians) * (180/pi) = (number of degrees)
```

Here **pi** represents the ratio of the circumference of a circle to its diameter. Results of arithmetic calculations that use the transcendental number **pi** as the divisor of a rational number always include rounding error.

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RADIANS function

Use the **RADIANS** function to convert an expression or a host variable representing a number of degrees to the equivalent number of radians.

The return value is a number of type DECIMAL (32, 255).

The *degree_expression* that is the only argument to this function must have a numeric data type (or a non-numeric data type that can be converted to a number) that the database server evaluates in units of degrees, and converts to units of radians:

```
EXECUTE FUNCTION RADIANS (100);
EXECUTE FUNCTION RADIANS ("100");
```

In both of the examples above, the **RADIANS** argument evaluates to 100 degrees, and the return value is 1.745328251994 radians. You can use a **RADIANS** function expression as the argument to the **COS**, **SIN**, or **TAN** function to return the respective trigonometric values for that angle:

```
COS(RADIANS (100))
SIN(RADIANS ("100"))
TAN(RADIANS (100))
```

The **RADIANS** function converts degrees to radians according to the following formula:

Here **pi** represents the ratio of the circumference of a circle to its diameter. Results of arithmetic calculations that use the transcendental number **pi** as the dividend of a rational number always include rounding error.

String-Manipulation Functions

The string-manipulation functions are identified in the following diagram:

```

(1)
|--+| CONCAT Function |-----+
| (2) |
++| ASCII Function |-----+
| (3) |
++| TRIM Function |-----+
| (4) (5) |
+-----| LTRIM Function |-----+
| (4) (6) |
+-----| RTRIM Function |-----+
| (7) |
++| SPACE Function |-----+
| (8) |
++| REVERSE Function |-----+
| (4) (9) |
+-----| REPLACE Function |-----+
| (4) (10) |
+-----| LPAD Function |-----+
| (4) (11) |
+-----| RPAD Function |-----+
| (12) |
++| CHR Function |-----+
| (4) (13) |
+-----| Case-Conversion Functions |-----+
| (14) |
'--| Substring Functions |-----'

```

1. See [CONCAT Function](#)
2. See [ASCII Function](#)
3. See [TRIM Function](#)
4. Informix® extension
5. See [LTRIM Function](#)
6. See [RTRIM Function](#)
7. See [SPACE function](#)
8. See [REVERSE function](#)
9. See [REPLACE Function](#)
10. See [LPAD Function](#)
11. See [RPAD Function](#)
12. See [CHR Function](#)
13. See [Case-Conversion Functions](#)
14. See [Substring functions](#)

- [CONCAT Function](#)
- [Return Types from CONCAT and String Functions](#)
- [Return String Types in Distributed Transactions](#)
- [ASCII Function](#)
- [TRIM Function](#)
- [LTRIM Function](#)
- [RTRIM Function](#)
- [SPACE function](#)

- REVERSE function

- REPLACE Function

- LPAD Function

- [RPAD Function](#)

The **RPAD** function returns a copy of *source_string* that is right-padded to the total number of characters that the *length* argument specifies.

- [CHR Function](#)
This function accepts an unsigned integer argument, and returns a single logical character.

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CONCAT Function

The **CONCAT** function accepts two expressions as arguments, and returns a single character string that appends the string representation of the value returned by its second argument to the string representation of the value returned by its first argument.

CONCAT Function

```
|--CONCAT-- (--expr_1--, --expr_2--) -----|
```

Element	Description	Restrictions	Syntax
<i>expr_1, expr_2</i>	Expressions whose string representations of their values are to be concatenated	Cannot return a complex, user-defined, or large object type. If a host variable, it must be long enough to store the resulting combined strings.	Expression

Each arguments to the **CONCAT** function can evaluate to a character, number, or time data type. If either or both of the concatenated arguments is null, the function returns a NULL value.

Unlike other built-in string manipulation functions of Informix®, the **CONCAT** function cannot be overloaded.

CONCAT is the operator function of the concatenation (||) operator. For a given pair of expression arguments, **CONCAT** returns the same string as that operator returns from the same expressions as operands. See [Concatenation Operator](#) for additional information about concatenation operations, and for restrictions on the SQL and Dynamic SQL statements in which you can invoke the **CONCAT** function.

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Return Types from CONCAT and String Functions

The data type of the return value from a successful call to the **CONCAT** function (or from the concatenation (||) operator, or from a call to other built-in string-manipulation functions that follow the same rules as **CONCAT** for determining their return type) depends on the data types of the arguments and on the length of the resulting string. The order of the two arguments is not significant in determining the return type.

Informix® applies the following rules for the return type from operations that concatenate values that arguments of more than one data type specify:

- If one of the types is National Language Support (namely NCHAR and NVARCHAR):
 - the return type is NVARCHAR if the resulting length is less than 255 bytes
 - the return type is NCHAR otherwise.
- If one of the arguments is VARCHAR or a number type,
 - the return type is VARCHAR if the resulting length is less than 255 bytes
 - the return type is LVARCHAR otherwise.
- An exception to these rules, however, can occur in certain cross-server operations in which a remote routine is executed locally, and a concatenation expression is evaluated locally before its return value is sent to a remote database server. For remote servers that do not support the LVARCHAR data type in distributed transactions, the concatenated result is sent as a CHAR data type if sending the LVARCHAR type returns an error. Informix database server instances earlier than Version 11.10 require a CHAR return value in this scenario.
(See also [Return String Types in Distributed Transactions](#) for the data types that can be returned from concatenation expressions that are evaluated by remote Informix database server instances earlier than Version 11.50.xC2.)

In the following table, the rows list the valid data types of the first argument to the **CONCAT** function, and the columns list the type of the second argument. The cell at the intersection of each row and column shows the possible returned type or types. The row and the column labelled as **Other** represent arguments that evaluate to non-character types, such as number or time data types like DECIMAL or DATE.

Table 1. Return Types from Operations on Two Arguments (in Version 11.50.xC2 or Later)

	NCHAR	NVARCHAR	CHAR	VARCHAR	LVARCHAR	Other
NCHAR	nchar	nvarchar or nchar	nchar	nvarchar or nchar	nvarchar or nchar	nvarchar or nchar
NVARCHAR	nvarchar or nchar	nvarchar or nchar	nvarchar or nchar	nvarchar or nchar	nvarchar or nchar	nvarchar or nchar
CHAR	nchar	nvarchar or nchar	char	varchar or lvarchar	lvarchar	varchar or lvarchar
VARCHAR	nvarchar or nchar	nvarchar or nchar	varchar or lvarchar	varchar or lvarchar	lvarchar	varchar or lvarchar
LVARCHAR	nvarchar or nchar	nvarchar or nchar	lvarchar	lvarchar	lvarchar	lvarchar
Other	nvarchar or nchar	nvarchar or nchar	varchar or lvarchar	varchar or lvarchar	lvarchar	varchar or lvarchar

For string manipulation functions other than **CONCAT**, arguments of DATE, DATETIME, or MONEY data types always return an NVARCHAR or NCHAR value, depending on the length of the resulting string.

This table is symmetrical, because the order of arguments has no effect on the return data type. User-defined data types, large-object types, complex types, and other extended data types are not valid as arguments to the built-in string-manipulation functions or operators.

This table also describes the return data types of expressions that use the concatenation (||) operator.

Not shown here is the result of concatenation operations in which the sum of the argument lengths exceeds the approximately 32Kb limit for CHAR, NCHAR, and VARCHAR data types. This returns error -881, rather than a concatenated data value. Because the maximum VARCHAR size is 32,739 bytes, and the CHAR and NCHAR limits are both 32,767 bytes, error -881 is usually associated with VARCHAR and NVARCHAR objects, whose limit is 255 bytes, but automatic return type promotion can reduce the incidence of this error.

The following string-manipulation functions support the same rules as **CONCAT** for return type promotion:

- **LPAD**
- **RPAD**
- **REPLACE**
- **SUBSTR**
- **SUBSTRING**
- **TRIM**
- **LTRIM**
- **RTRIM**

The following table summarizes how Informix determines the return type from these string manipulating functions, based on the argument types:

Table 2. String Manipulation Functions that Support Return Type Promotion

Function	How the Return Type of the Function is Determined
CONCAT, ||	Return type is based on both arguments. Refer to Table 1 .
SUBSTR, SUBSTRING	Return type is the same as the <i>source_string</i> type. If <i>source_string</i> is a host variable, the return type is NVARCHAR or NCHAR, depending on the length of the result.
TRIM, LTRIM, RTRIM	Return type depends on the source type and the returned length: <ul style="list-style-type: none">• NVARCHAR <i>returns</i> NVARCHAR• VARCHAR <i>returns</i> VARCHAR• CHAR <i>returns</i> VARCHAR (if length <= 255 bytes)• CHAR <i>returns</i> VARCHAR (if length > 255 bytes)• NCHAR <i>returns</i> NVARCHAR (if length <= 255 bytes)• NCHAR <i>returns</i> NVARCHAR (if length > 255 bytes)• VARCHAR <i>returns</i> VARCHAR
LPAD, RPAD	Return type is based on the <i>source_string</i> and <i>pad_string</i> arguments. If <i>pad_string</i> is not specified, the return type is based on the data type of <i>source_string</i> .
REPLACE	Return type is based on the <i>source_string</i> and <i>old_string</i> arguments (and on the <i>new_string</i> argument, if that is specified). If any argument is a host variable, the return type is NCHAR.
ENCRYPT_AES, ENCRYPT_TDES, DECRYPT_BINARY, DECRYPT_CHAR,	For arguments that are not BLOB or CLOB variables, the return type is based on the data types of the <i>data</i> and <i>encrypted_data</i> arguments. Refer to Table 1 .

- [Data-type promotion in NLSCASE INSENSITIVE databases](#)
In databases that have the NLSCASE INSENSITIVE property, the database server disregards the lettercase of NCHAR and NVARCHAR values. Expressions in which functions or operators avoid overflow errors by performing an implicit cast can produce different results from what a case-sensitive database would return, if the expression evaluates to an NCHAR or NVARCHAR data type.

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Data-type promotion in NLSCASE INSENSITIVE databases

In databases that have the NLSCASE INSENSITIVE property, the database server disregards the lettercase of NCHAR and NVARCHAR values. Expressions in which functions or operators avoid overflow errors by performing an implicit cast can produce different results from what a case-sensitive database would return, if the expression evaluates to an NCHAR or NVARCHAR data type.

When a string function or a string operator on which the database server supports data-type promotion returns a value that would produce an overflow error for the default VARCHAR or NVARCHAR data type of the expression, the database server performs an implicit cast on the return value, as indicated in the first table of the topic [Return Types from CONCAT and String Functions](#):

- If the none of the arguments or operands are NCHAR or NVARCHAR data types, the expression evaluates to a CHAR, VARCHAR, or VARCHAR data type.
- If any argument or operand is an NCHAR or NVARCHAR data type, the expression evaluates to an NCHAR or NVARCHAR data type.

In databases that have the NLSCASE INSENSITIVE property, operations on CHAR, VARCHAR, or VARCHAR data types are case-sensitive, but operations on NCHAR or NVARCHAR data types are case-insensitive. Data-type promotion also produces case-insensitive results (rather than case-sensitive) from evaluating an expression that includes CHAR, VARCHAR, or VARCHAR components, if the same expression also includes NCHAR or NVARCHAR character strings.

The following example illustrates this behavior in a NLSCASE INSENSITIVE database, in which table **t1** has a character column of each of the five built-in character data types. The table stores three rows, in which each column stores the same lettercase variants of a 3-letter character string:

```
CREATE DATABASE db NLSCASE INSENSITIVE;  
CREATE TABLE t1 (  
  c1 NCHAR(20),  
  c2 NVARCHAR(20),  
  c3 CHAR(20),
```



```

c4 VARCHAR(20),
c5 LVARCHAR(20)) ;
INSERT INTO t1 values ('ibm', 'ibm', 'ibm', 'ibm', 'ibm');
INSERT INTO t1 values ('Ibm', 'Ibm', 'Ibm', 'Ibm', 'Ibm');
INSERT INTO t1 values ('IBM', 'IBM', 'IBM', 'IBM', 'IBM');

```

The following query retrieves the values from an NCHAR column, using an equality predicate for a literal string whose letters are all lowercase:

```
SELECT c1 FROM t1 WHERE c1 = 'ibm';
```

Because NCHAR values are not case sensitive in this database, the query returns the column **c1** value from every row:

```

c1
ibm
Ibm
IBM

```

The following query on the same table returns the same case-insensitive results from CHAR column **c3** that the WHERE clause casts to an NCHAR value:

```
SELECT c1 FROM t1 WHERE c3 = 'ibm'::NCHAR(10);
```

After the cast, the **c3** values become case insensitive, so that every row in **c3** matches the string 'ibm', and the WHERE condition is true for every row in **c1**:

```

c1
ibm
Ibm
IBM

```

Because case-insensitive operations disregard differences in letter case among strings where the same letters appear in the same sequence, as in the previous example, care must be taken in databases that have the NLSCASE INSENSITIVE property to avoid contexts where data type-promotion applies case-insensitive rules to operations that you expected to be case sensitive.

See also the section [Duplicate rows in NLSCASE INSENSITIVE databases](#).

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Return String Types in Distributed Transactions

In cross-database distributed queries that access tables in different databases of the same Informix®Informix instance, the same types are returned by **CONCAT** (and by other built-in string manipulation functions that follow the same rules for return type promotion) that the section [Return Types from the CONCAT Function](#) describes.

The same types are also returned in cross-server distributed queries, if every participating Informix instance that evaluates these string-manipulation function expressions is no earlier than Version 11.50.xC2.

For cross-server distributed operations in which the return value is evaluated on a remote Informix instance earlier than Version 11.50.xC2, the following table (in the same format as the table for Version 11.50.xC2 and later) lists the possible return data types (or -881 overflow error) for the specified data types of arguments to the string-manipulation function (or for operands of the concatenation (||) operator:

Table 1. Return Types from Distributed Operations (in Version 11.50.xC1 and earlier)

	NCHAR	NVARCHAR	CHAR	VARCHAR	LVARCHAR	Other
NCHAR	nchar	nvarchar or EM -881	nchar	nchar	nchar	nchar
NVARCHAR	nchar or EM -881	nvarchar or EM -881	nvarchar or EM -881	nvarchar or EM -881	nvarchar or EM -881	nvarchar or EM -881
CHAR	nchar	nvarchar or EM -881	char	varchar or EM -881	char	char
VARCHAR	nchar	nvarchar or EM -881	varchar or EM -881	varchar or EM -881	varchar or EM -881	varchar or EM -881
LVARCHAR	nchar	nvarchar or EM -881	char	varchar or EM -881	char	char
Other	nchar	nvarchar or EM -881	char	varchar or EM -881	char	char

The following are among the differences between the return values in this release and what Informix versions earlier than 11.50.xC2 return:

- Earlier releases accept LVARCHAR arguments, but cannot return LVARCHAR values.
- If the result is longer than the maximum size of the argument of the longest data type, earlier releases do not support data-type promotion, but issue error -881. (This is typically with VARCHAR or NVARCHAR arguments, if the length of the resulting string would be greater than 255 bytes.)

For all versions of Informix, error -881 is issued if the length of a returned string exceeds 32Kb.

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ASCII Function

The **ASCII** function returns the decimal representation of the first character in a character string, based on its codepoint in the ASCII character set.

ASCII Function

```
|--ASCII--(--char_expr--)-----|
```

Element	Description	Restrictions	Syntax
<i>char_expr</i>	Expression that evaluates to a character data type	Must be of type CHAR, LVARCHAR, NCHAR, NVARCHAR, or VARCHAR	Identifier

The **ASCII** function takes a single argument of any character data type. It returns an integer value, based on the first character of the argument, corresponding to the decimal representation of the codepoint of that character within the ASCII character set.

If the argument is NULL, or if the argument is an empty string, the **ASCII** function returns a NULL value.

The following query returns the ASCII value of uppercase H:

```
SELECT ASCII("HELLO") FROM systables WHERE tabid = 1;
```

The following table shows the output of this SELECT statement.

(constant)
72

The following query returns the ASCII value of lowercase h:

```
SELECT ASCII("hello") FROM systables WHERE tabid = 1;
```

The following table shows the output of this SELECT statement.

(constant)
104

The following query returns the **ASCII** output from an empty string argument:

```
SELECT ASCII("") FROM systables WHERE tabid = 1;
```

The following table shows the NULL output of this SELECT statement.

(constant)

The following query returns the **ASCII** output from a NULL argument:

```
SELECT ASCII(NULL) FROM systables WHERE tabid = 1;
```

The following table shows the NULL output of this SELECT statement.

(constant)

The **ASCII** function interprets this argument as a NULL expression, rather than as a value that begins with uppercase N.

For a table of the numeric values of the codepoints in the ASCII character set, see [Collating Order for U.S. English Data](#).

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TRIM Function

The **TRIM** function removes specified leading or trailing pad characters from a string. (See also the descriptions of the **LTRIM** and **RTRIM** functions, which provide similar functionality, but support a different syntax.)

TRIM Function

```
|--TRIM----->
>--(+-----+--source_expression)--|
| .-BOTH-----|
| '-+--TRAILING-+-----+--FROM-|
| '-LEADING--' '-pad_char-
```

Element	Description	Restrictions	Syntax
<i>pad_char</i>	Expression that evaluates to a single character or NULL. The default is a blank space (= ASCII 32).	Must be a character expression	Expression
<i>source_expression</i>	Character expression, including a character column name, or a call to another TRIM function	Cannot be a DISTINCT data type	Expression

The **TRIM** function returns a character string identical to its *source_expression* argument, except that any leading or trailing pad characters, as specified by the LEADING, TRAILING, or BOTH keywords, are deleted. If no trim qualifier (LEADING, TRAILING, or BOTH) is specified, BOTH is the default. If no *pad_char* is specified, a single blank space (the ASCII 32 character) is the default, and leading or trailing blank spaces, as specified by the qualifying keyword, are deleted from the returned value.

If either the *pad_char* or the *source_expression* evaluates to NULL, the result of the **TRIM** function is NULL.

The data type of the returned value depends on the *source_expression* argument:

- If the argument is longer than 255 bytes, the returned value is of type LVARCHAR.
- If the argument has 255 bytes or fewer, the data type of the returned value depends on the data type of the argument:
 - If the argument is of type CHAR or VARCHAR, a VARCHAR value is returned.
 - If the argument is of type NCHAR or NVARCHAR, an NVARCHAR value is returned.
 - If the argument is of type LVARCHAR, an LVARCHAR value is returned.

The length of the returned value is 255 bytes or fewer for VARCHAR or NVARCHAR *source_expression* arguments, and no more than 32,739 bytes for CHAR, NCHAR, or LVARCHAR arguments.

The following example shows some generic uses for the **TRIM** function:

```
SELECT TRIM (c1) FROM tab;
SELECT TRIM (TRAILING '#' FROM c1) FROM tab;
SELECT TRIM (LEADING FROM c1) FROM tab;
UPDATE c1='xyz' FROM tab WHERE LENGTH(TRIM(c1))=5;
SELECT c1, TRIM(LEADING '#' FROM TRIM(TRAILING '%' FROM
'###abc%%')) FROM tab;
```

In Dynamic SQL, when you use the DESCRIBE statement with a SELECT statement that calls the **TRIM** function in the Projection list, the data type of the trimmed column that DESCRIBE returns depends on the data type of the *source_expression*, for SQL data type constants defined in the **sqltypes.h** header file of the Informix® ESQL/C source file. For further information on the GLS aspects of the **TRIM** function in Informix ESQL/C, see the *IBM® Informix GLS User's Guide*.

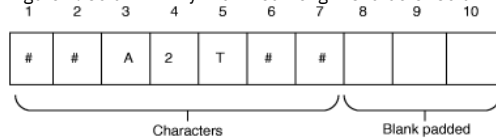
- [Fixed Character Columns](#)

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Fixed Character Columns

The **TRIM** function can be specified on fixed-length character columns. If the length of the string is not completely filled, the unused characters are padded with blank space. [Figure 1](#) shows this concept for the column entry '##A2T##', where the column is defined as CHAR(10).

Figure 1. Column Entry in a Fixed-Length Character Column

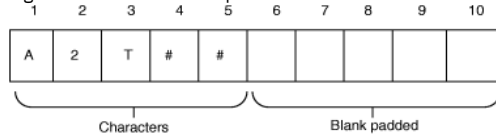


If you want to trim the sharp sign (#) *pad_char* from the column, you need to consider the blank padded spaces as well as the actual characters.

For example, if you specify the keyword BOTH, the result from the trim operation is A2T##, because the **TRIM** function does not match the blank padded space that follows the string. In this case, the only sharp signs (#) trimmed are those that precede the other characters. The SELECT statement is shown, followed by [Figure 2](#), which presents the result.

```
SELECT TRIM(LEADING '#' FROM col1) FROM tab;
```

Figure 2. Result of TRIM Operation



This SELECT statement removes all occurrences of the sharp (#) sign:

```
SELECT TRIM(BOTH '#' FROM TRIM(TRAILING ' ' FROM col1)) FROM tab;
```

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LTRIM Function

The **LTRIM** function removes specified leading pad characters from a string.

LTRIM Function

```
|--LTRIM--(--source_string--+-----+--)------|
          '-,--pad_string-'
```

Element	Description	Restrictions	Syntax
<i>pad_string</i>	Expression that specifies one or more characters to delete from <i>source_string</i>	Must be a character expression	Expression
<i>source_string</i>	Expression that specifies a character string from which characters in <i>pad_string</i> are deleted	Pad characters to the right of any character not in <i>pad_string</i> are not deleted	Expression

The first argument to the **LTRIM** function must be a character expression from which to delete leading pad characters. The optional second argument is a character expression that evaluates to a string of pad characters. If no second argument is provided, only blank characters are regarded as pad characters.

The return data type of the **LTRIM** function is based on its *source_string* argument, using the return type promotion rules that the section [Return Types from the CONCAT Function](#) describes.

The value returned contains a substring of *source_string*, but from which any leading pad characters to the left of the first non-pad character have been removed. If a host variable is used, an LVARCHAR data type is returned.

The **LTRIM** function scans a copy of the *source_string* from the left, deleting any leading characters that appear in the *pad_string*. If no *pad_string* argument is specified, only leading blanks are deleted from the returned value. When the first non-pad character is encountered, the function returns its result string and terminates.

In the following example, the *pad_string* is 'Hello':

```
SELECT LTRIM('Hellohello world!', 'Hello') FROM mytab;
```

The following table shows the output of this SELECT statement.

(constant)
hello world!

Here the first five characters of the *source_string* were dropped because they matched characters in the *pad_string*, but the function terminated after it encountered the lowercase h character, which preserved the trailing 'ello' pad characters to its right.

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RTRIM Function

The **RTRIM** function removes specified trailing pad characters from a string.

RTRIM Function

```
--RTRIM--(--source_string--+-----+--)------|
              '-,--pad_string-'
```

Element	Description	Restrictions	Syntax
<i>pad_string</i>	Expression that specifies one or more characters to delete from <i>source_string</i>	Must be a character expression	Expression
<i>source_string</i>	Expression that specifies a character string from which characters in <i>pad_string</i> are deleted	Pad characters to the left of any character not in <i>pad_string</i> are not deleted	Expression

The first argument to the **RTRIM** function must be a character expression from which to delete trailing pad characters. The optional second argument is a character expression that evaluates to a string of pad characters. If no second argument is provided, only blank characters are regarded as pad characters.

The return data type of the **LTRIM** function is based on its *source_string* argument, using the return type promotion rules that the section [Return Types from the CONCAT Function](#) describes.

The value returned contains a substring of *source_string*, but from which any trailing pad characters to the right of the first non-pad character have been removed. If a host variable is used, an LVARCHAR data type is returned.

The **RTRIM** function scans a copy of the *source_string* from the right, deleting any trailing characters that appear in the *pad_string*. If no *pad_string* argument is specified, only trailing blanks are deleted from the returned value. When the first non-pad character is encountered, the function returns its result string and terminates.

In the following example, the *pad_string* is ' theend!*#?':

```
SELECT RTRIM('good night... *!#?theend ', ' theend!*#?') AS closing FROM mytab;
```

The following table shows the output of this SELECT statement.

(constant)
good night...

Here the last fifteen characters of the *source_string* were dropped because they matched characters in the *pad_string*, but the function terminated after it encountered the period (.) characters, which preserved the leading ' thn ' pad characters to the left.

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SPACE function

The **SPACE** function creates a character string of a specified number of blank spaces. The maximum length of the returned string value can be 32,739 blank characters.

The function has this syntax:

SPACE Function

```
--SPACE--(--expression--)-----|
```

Element	Description	Restrictions	Syntax
<i>expression</i>	Expression that evaluates to a non-negative whole number < 256	Must be an expression, constant, column, or host variable of a built-in integer type, or one that can be converted to an integer	Expression

The argument to the **SPACE** function must be of a built-in data type.

The **SPACE** function returns an LVARCHAR string of the specified number of blank (ASCII 32) characters.

If the argument evaluates to a NULL value, or to a number less than 1, this function returns a NULL value, rather than an empty string.

In the following example, the **SPACE** function returns a single-character blank string:

```
SELECT SPACE(1) FROM tabula_rasa;
```

The following table shows the output from this SELECT statement, which is a single blank character:

(constant)

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REVERSE function

The **REVERSE** function accepts a character expression as its argument, and returns a string of the same length, but with the ordinal positions of every logical character reversed.

This is the syntax of the **REVERSE** function:

REVERSE Function

```
--REVERSE--(--source_string--)-----|
```

Element	Description	Restrictions	Syntax
<i>source_string</i>	Expression that evaluates to a character string	Must be an expression, constant, column, or host variable of a type that can be converted to a character type	Expression

The argument to the **REVERSE** function cannot have a user-defined data type. The built-in CHAR, LVARCHAR, NCHAR, NVARCHAR, and VARCHAR types are valid.

The **REVERSE** function returns a string of the same data type as its *source_string* argument.

If the expression that you specify as the argument evaluates to NULL, the return value is NULL.

For an argument that evaluates to string of *N* characters, the ordinal position *p* of each character in the *source_string* becomes $(N + 1 - p)$ in the returned string. This inverts the sequence of characters from their original order in the *source_string*, so that the return value begins with the last character of the *source_string*, and ends with the first character of the *source_string*.

For example, the function expression **REVERSE('Mood')** returns the string **doOM** from the quoted-string argument. In both single-byte and multibyte code sets, only the ordinal positions are reversed, not the characters themselves. In the function expression above, 'd' does not become 'b', and each logical character in a multibyte code set (for example, **utf8**, or **GB2312-80**) is repositioned as a single logical unit.

If the argument evaluates to a single-character or to an empty *source_string*, the return value and the *source_string* are identical, as if the **REVERSE** function had no effect. For strings that include multiple characters, this equality is true only when the *source_string* is a palindrome. For character strings where $\text{MOD}(N, 2) = 1$, the character in ordinal position $(N+1) / 2$ has the same middle position in both the *source_string* and in the returned string.

In the following example, the **REVERSE** function reverses a quoted string argument:

```
SELECT REVERSE('Able was I ere I saw Elba.') FROM Mirror_Table;
```

The following table shows the output of this SELECT statement.

(constant)
.ablE was I ere I saw elbA

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REPLACE Function

The **REPLACE** function replaces specified characters within a source string with different characters.

REPLACE Function

```
|--REPLACE--(--source_string--,--old_string--+-----+---)--|
'|,--new_string-'
```

Element	Description	Restrictions	Syntax
<i>new_string</i>	Character or characters that replace <i>old_string</i> in the return string	Must be an expression, constant, column, or host variable of a data type that can be converted to a character data type	Expression
<i>old_string</i>	Character or characters in <i>source_string</i> that are to be replaced by <i>new_string</i>	Must be an expression, constant, column, or host variable of a data type that can be converted to a character data type	Expression
<i>source_string</i>	String of characters argument to the REPLACE function	Must be an expression, constant, column, or host variable of a data type that can be converted to a character data type	Expression

Any argument to the **REPLACE** function must be of a built-in data type.

The **REPLACE** function returns a copy of *source_string* in which every occurrence of *old_string* is replaced by *new_string*. If you omit the *new_string* option, every occurrence of *old_string* is omitted from the return string.

The return data type is its *source_string* argument. If a host variable is the source, the return value is either NVARCHAR or NCHAR, according to the length of the returned string, using the return type promotion rules that the section [Return Types from the CONCAT Function](#) describes.

In the following example, the **REPLACE** function replaces every occurrence of *xz* in the source string with *t*:

```
SELECT REPLACE('Mighxzy xzime', 'xz', 't')
FROM mytable;
```

The following table shows the output of this SELECT statement.

(constant)
Mighty time

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LPAD Function

The **LPAD** function returns a copy of *source_string* that is left-padded to the total number of characters specified by *length*.

LPAD Function

```
|--LPAD--(--source_string--,--length--+-----+---)-----|
'|,--pad_string-'
```

Element	Description	Restrictions	Syntax
<i>length</i>	Integer value that specifies total number of characters in the returned string	Must be an expression, constant, column, or host variable of a data type that can be converted to an integer data type	Literal Number
<i>pad_string</i>	String that specifies the pad character or characters	Must be an expression, constant, column, or host variable of a data type that can be converted to a character data type	Expression
<i>source_string</i>	String that serves as input to the LPAD function	Must be an expression, constant, column, or host variable of a data type that can be converted to a character data type	Expression

Any argument to the **LPAD** function must be of a built-in data type.

The *pad_string* parameter specifies the character or characters to be used for padding the source string. The sequence of pad characters occurs as many times as necessary to make the return string the storage length specified by *length*.

The series of pad characters in *pad_string* is truncated if it is too long to fit into *length*. If you specify no *pad_string*, the default value is a single blank (ASCII 32) character.

The return data type is based on the three arguments, using the return type promotion rules that the section [Return Types from the CONCAT Function](#) describes.

In the following example, the user specifies that the source string is to be left-padded to a total length of 16 characters. The user also specifies that the pad characters are a series consisting of a hyphen and an underscore (-_).

```
SELECT LPAD('Here we are', 16, '-_') FROM mytable;
```

The following table shows the output of this SELECT statement.

(constant)
- _Here we are

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RPAD Function

The **RPAD** function returns a copy of *source_string* that is right-padded to the total number of characters that the *length* argument specifies.

RPAD Function

```
|--RPAD--(--source_string--,--length--+-----+---)-----|
              '-,--pad_string'
```

Element	Description	Restrictions	Syntax
<i>length</i>	The total number of characters in the returned string	Must be an expression, constant, column, or host variable that returns an integer	Literal Number
<i>pad_string</i>	String that specifies the pad character or characters	Must be an expression, column, constant, or host variable of a data type that can be converted to a character data type	Expression
<i>source_string</i>	String that serves as input to the RPAD function	Same as for <i>pad_string</i>	Expression

Any argument to the **RPAD** function must be of a built-in data type.

The *pad_string* parameter specifies the pad character or characters to be used to pad the source string.

The series of pad characters occurs as many times as necessary to make the return string reach the length that *length* specifies. The series of pad characters in *pad_string* is truncated if it is too long to fit into *length*. If you omit the *pad_string* parameter, the default value is a single blank space (the ASCII 32 character).

The return data type is based on the *source_string* and *pad_string* arguments, if both are specified. If a host variable is the source, the return value is either NVARCHAR or NCHAR, according to the length of the returned string, using the return type promotion rules that the section [Return Types from the CONCAT Function](#) describes.

The UNLOAD feature of DB-Access truncates trailing blanks in CHAR or NCHAR columns, even if the **RPAD** function has appended blank characters to the data value. You must explicitly cast the CHAR or NCHAR value to a VARCHAR, LVARCHAR, or NVARCHAR data type if you need UNLOAD to preserve trailing blank characters or nonprintable characters in a value that **RPAD** returns.

In the following example, the user specifies that the source string is to be right-padded to a total length of 18 characters. The user also specifies that the pad characters to be used are a sequence consisting of a question mark and an exclamation point (?!)

```
SELECT RPAD('Where are you', 18, '?!')
FROM mytable;
```

The following table shows the output of this SELECT statement.

(constant)
Where are you?!?!?

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CHR Function

This function accepts an unsigned integer argument, and returns a single logical character.

The **CHR** function has this syntax:

CHR Function

```
|--CHR--(--expression--)-----|
```

Element	Description	Restrictions	Syntax
<i>expression</i>	Expression that evaluates to a nonnegative whole number less than 256	Must be an integer in the range 0 through 255 (inclusive)	Expression

The data type of the return value is VARCHAR(1).

The argument can be SMALLINT, INTEGER, SERIAL, INT8, SERIAL8, BIGINT, or BIGSERIAL. The argument must evaluate to a whole number in the range 0 through 255.

If the argument is an integer in the range 0 through 127, the return value is the corresponding single-byte ASCII code point. For a listing of the characters corresponding to the ASCII code points 0 through 127, see [Collating Order for U.S. English Data](#).

If the argument is an integer in the range 128 through 255, the return value is the corresponding 2-byte code point in the default code set.

- On UNIX platforms, the default code set is ISO8859-1.
- On Windows platforms, the default code set is Microsoft 1252.

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Case-Conversion Functions

The case-conversion functions perform lettercase conversion on alphabetic characters. In the default locale, only the ASCII characters in the ranges A – Z and a – z can be modified by these functions, which enable you to perform case-insensitive searches in your queries and to specify the format of the output.

The case-conversion functions are **UPPER**, **LOWER**, and **INITCAP**. The following diagram shows the syntax of these case-conversion functions.

Case-Conversion Functions

```
|---+UPPER---+---(--expression--)-----|
+-LOWER---+
'-INITCAP-'
```

Element	Description	Restrictions	Syntax
<i>expression</i>	Expression returning a character string	Must be a built-in character type. If a host variable, its length must be long enough to store the converted string.	Expression

The *expression* must return a character data type. When a column expression is specified, the column data type returned by the database server is that of *expression*. For example, if the input type is CHAR, the output type is also CHAR.

Argument to these functions must be of the built-in data types.

In all locales, the byte length returned from the description of a column with a case-conversion function is the input byte length of the source string. If you use a case-conversion function with a multibyte *expression* argument, the conversion might increase or decrease the length of the string. If the byte length of the result string exceeds the byte length *expression*, the database server truncates the result string to fit into the byte length of *expression*.

Only characters designated as ALPHA class in the locale file are converted, and this occurs only if the locale recognizes the construct of lettercase.

If *expression* evaluates to NULL, the result of a case-conversion function is also NULL.

The database server treats a case-conversion function as an SPL routine in the following instances:

- If it has no argument
- If it has one argument, and that argument is a named argument
- If it has more than one argument
- If it appears in the Projection list with a host variable as an argument

If none of the conditions in the preceding list are met, the database server treats a case-conversion function as a system function.

The following example uses all the case-conversion functions in the same query to specify multiple output formats for the same value:

Input value:

SAN Jose

Query:

```
SELECT City, LOWER(City), LOWER("City"),
       UPPER (City), INITCAP(City)
FROM Weather;
```

Query output:

SAN Jose san jose city SAN JOSE San Jose

- [UPPER Function](#)
- [LOWER Function](#)
- [INITCAP Function](#)
- [Case-conversion functions in NLSCASE INSENSITIVE databases](#)

The **UPPER** and **LOWER**, case-conversion functions were designed to support case-insensitive queries in a case-sensitive database. They are less often needed in databases that have the NLSCASE INSENSITIVE attribute, because the NCHAR and NVARCHAR data types can support case-insensitive queries without calling these functions. You can invoke the case-conversion functions in NLSCASE INSENSITIVE databases, where their effects on CHAR, LVARCHAR, and VARCHAR data types are the same as in case-sensitive databases.

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UPPER Function

The **UPPER** function accepts an *expression* argument and returns a character string in which every lowercase alphabetical character in the *expression* is replaced by a corresponding uppercase alphabetic character.

The following example uses the **UPPER** function to perform a case-insensitive search on the **lname** column for all employees with the last name of **Curran**:

```
SELECT title, INITCAP(fname), INITCAP(lname) FROM employees
WHERE UPPER (lname) = "CURRAN"
```

Because the **INITCAP** function is specified in the projection list, the database server returns the results in a mixed-case format. For example, the output of one matching row might read: accountant James Curran.

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LOWER Function

The **LOWER** function accepts an *expression* argument and returns a character string in which every uppercase alphabetic character in the *expression* is replaced by a corresponding lowercase alphabetic character.

The following example shows how to use the **LOWER** function to perform a case-insensitive search on the **City** column. This statement directs the database server to replace all instances (that is, any variation) of the words `san jose`, with the mixed-case format, `San Jose`.

```
UPDATE Weather SET City = "San Jose"
WHERE LOWER (City) = "san jose";
```

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INITCAP Function

The **INITCAP** function returns a copy of the *expression* in which every word in the *expression* begins with an uppercase letter. With this function, a *word* begins after any character other than a letter. Thus, in addition to a blank space, symbols such as commas, periods, colons, and so on, introduce a new word.

For an example of the **INITCAP** function, see [UPPER Function](#).

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Case-conversion functions in NLSCASE INSENSITIVE databases

The **UPPER** and **LOWER**, case-conversion functions were designed to support case-insensitive queries in a case-sensitive database. They are less often needed in databases that have the NLSCASE INSENSITIVE attribute, because the NCHAR and NVARCHAR data types can support case-insensitive queries without calling these functions. You can invoke the case-conversion functions in NLSCASE INSENSITIVE databases, where their effects on CHAR, LVARCHAR, and VARCHAR data types are the same as in case-sensitive databases.

In a database created with the NLSCASE INSENSITIVE option, the database server disregards the lettercase of NCHAR and NVARCHAR values. Expressions that call case-conversion functions can return different results from what a case-sensitive database would return, if the expression references NCHAR or NVARCHAR objects, or if the database server evaluates the expression with an explicit or implicit cast to an NCHAR or NVARCHAR data type.

When the **UPPER**, **LOWER**, or **INITCAP** function is used in evaluating a string expression in a database with the NLSCASE INSENSITIVE property, the database server invokes the function, and applies to its return value the data-type promotion rules that are summarized in the topic [Return Types from CONCAT and String Functions](#).

- If the expression evaluates to a CHAR, LVARCHAR, or VARCHAR data type, the database server can use that result in case-sensitive operations, if those operations do not involve NCHAR or NVARCHAR objects.
- If the expression evaluates to an NCHAR or NVARCHAR value after the **UPPER**, **LOWER**, or **INITCAP** function has executed, the case of letters in this result is disregarded in subsequent operations that use this return value from the expression.

The following example illustrates this behavior in an NLSCASE INSENSITIVE database, in which table **t1** has a character column of each of the five built-in character data types. The table stores three rows, in which each column stores the same lettercase variants of a 3-letter character string:

```
CREATE DATABASE db NLSCASE INSENSITIVE;
CREATE TABLE t1 (
  c1 NCHAR(20),
  c2 NVARCHAR(20),
  c3 CHAR(20),
  c4 VARCHAR(20),
  c5 LVARCHAR(20));
INSERT INTO t1 values ('ibm', 'ibm', 'ibm', 'ibm', 'ibm');
INSERT INTO t1 values ('Ibm', 'Ibm', 'Ibm', 'Ibm', 'Ibm');
INSERT INTO t1 values ('IBM', 'IBM', 'IBM', 'IBM', 'IBM');
```

In the following example, the database server applies the **UPPER** function to the NCHAR column **c1** and then applies a case-insensitive rule to return all values in that column that match the `'IBM'` string constant.

```
SELECT c1 FROM t1 WHERE UPPER(c1) = 'IBM';
```

Because NCHAR values are not case sensitive in this database, the query returns the column **c1** value from every row in the table, because in each row the sequence of letters matches the string constant, using a case-insensitive rule that ignores the letter case of the column values:

```
c1
ibm
Ibm
IBM
```

The same result set (namely `'ibm'`, `'Ibm'`, and `'IBM'`) would be also returned by the following modifications to the same query on the same table:

- If the projection clause specified any other column, rather than **c1**, because every column stores the same values, and the NCHAR value that **UPPER** returns makes the WHERE clause true for all lettercase variants of the string `'IBM'` in this database.

- If the 'IBM' string in the WHERE clause were any other lettercase variant of the same sequence of letters, because NCHAR data types are not processed by case-sensitive rules in this database.
- If the NVARCHAR column **c2**, rather than NCHAR column **c1**, were the argument to the case-conversion function, because both NCHAR or NVARCHAR are case-insensitive data types in this database.
- If the case-conversion function **LOWER** or **INITCAP**, rather than **UPPER**, were applied to column **c1**, because every (case-variant) value that NCHAR column matches 'IBM' in this database.
- If no case-conversion function were called, but the WHERE condition instead specified **c1 = 'IBM'**, because case-conversion functions have no effect as query filters on NCHAR or NVARCHAR arguments in this NLSCASE INSENSITIVE database.

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Substring functions

The built-in SQL substring functions return substrings from character string arguments, or return positional information for operations on substrings.

Substring Functions

```

      (1)                                (2)
|-----| CHARINDEX function |-----|
| (1)      | INSTR function | (3)      |
+-----+
| (4)      |
+-----+
| LEFT function | (5)      |
+-----+
| RIGHT function | (6)      |
+-----+
| SUBSTR function | (7)      |
+-----+
| SUBSTRB function | (8)      |
+-----+
| SUBSTRING function | (9)      |
+-----+
| SUBSTRING_INDEX function |-----|

```

Notes:

1. Informix® extension
2. See [CHARINDEX function](#)
3. See [INSTR function](#)
4. See [LEFT function](#)
5. See [RIGHT function](#)
6. See [SUBSTR function](#)
7. See [SUBSTRB function](#)
8. See [SUBSTRING function](#)
9. See [SUBSTRING_INDEX function](#)

Sections that follow describe the syntax and usage of these substring functions.

- [CHARINDEX function](#)
The **CHARINDEX** function searches a character string for the first occurrence of a target substring, where the search begins at a specified or default character position within the source string.
- [INSTR function](#)
The **INSTR** function searches a character string for a specified substring, and returns the character position in that string where an occurrence of that a substring ends, based on a count of substring occurrences.
- [LEFT function](#)
The **LEFT** function returns a substring consisting of the leftmost *N* characters from a string argument.
- [RIGHT function](#)
The **RIGHT** function returns a substring consisting of the rightmost *N* characters from a string argument.
- [SUBSTR function](#)
- [SUBSTRB function](#)
Returns a substring of a string, beginning at a specified position in the string.
- [SUBSTRING function](#)
- [SUBSTRING_INDEX function](#)
The **SUBSTRING_INDEX** function searches a character string for a specified delimiter character, and returns a substring of the leading or trailing characters, based on a count of a delimiter that you specify as an argument to the function.

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CHARINDEX function

The **CHARINDEX** function searches a character string for the first occurrence of a target substring, where the search begins at a specified or default character position within the source string.

The **CHARINDEX** function has this syntax:

CHARINDEX function

```
--CHARINDEX-- (--substring--,--source--+-----+--)--|
               '-,--start_position-'
```

Element	Description	Restrictions	Syntax
<i>source_string</i>	Expression that evaluates to a character string	Must be an expression, constant, column, or host variable of a built-in character type, or a type that can be converted to a character type	Expression
<i>start_position</i>	Ordinal position to begin the search in <i>source</i> , where 1 is the first logical character	Must be an expression, constant, column, or host variable of a built-in integer type, or that can be converted to an integer	Expression
<i>substring</i>	Expression that evaluates to a character string	Must be an expression, constant, column, or host variable of a built-in character data type, or that can be converted to a character type	Expression

Arguments to **CHARINDEX** cannot be user-defined data types.

If either *source* or the *substring* is NULL, this function returns NULL.

If the optional *start_position* value is less than 1, or if you omit this argument, none, the search for *substring* begins at the first logical character in the *source*, as if you had specified 1 as the starting position.

If no expression matching the *substring* is found, **CHARINDEX** returns zero (0). Otherwise it returns the ordinal position of the first logical character in the first occurrence of *substring*.

If you specify a *start_position* greater than 1, any *substring* that begins before *start_position* is ignored, and the function returns one of the following values:

- either the position of the first logical character in the first matching substring whose ordinal position is equal to or greater than *start_position*,
- or else zero (0), if no occurrence of *substring* in *source* begins at or follows *start_position*, or if *start_position* is greater than the number of logical characters in *source*.

In locales that support multibyte character sets, the return value is the ordinal value among logical characters in the *source*. In single-byte locales, such as the default locale, the return value is equivalent to the byte position, where the first byte is in position 1.

In databases created with the NLSCASE INSENSITIVE option, if either *source* or *substring* is an NCHAR or NVARCHAR data type, the database server ignores variants in letter case in determining whether a given substring of *source* matches the target *substring*.

The following function expression returns 9:

```
CHARINDEX('com','www.ibm.com')
```

In the example above, **CHARINDEX** begins its search at the default starting position of 1.

The following function expression returns 2:

```
CHARINDEX('w','www.ibm.com',2)
```

In the example above, because the last argument begins the search at position 2, **CHARINDEX** ignores two other matching substrings:

- 'w' in position 1, because the search begins at 2,
- and 'w' in position 3, because the function returns the position of only the first occurrence of a matching substring.

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INSTR function

The **INSTR** function searches a character string for a specified substring, and returns the character position in that string where an occurrence of that a substring ends, based on a count of substring occurrences.

The **INSTR** function has this syntax:

INSTR function

```
--INSTR-- (--source_string--,--substring--+-----+--)--|
               '-,--start--+-----+-'
               '-,--count-'
```

Element	Description	Restrictions	Syntax
<i>count</i>	Expression that evaluates to an integer > 0	Must be an expression, constant, column, or host variable of a built-in integer type, or that can be converted to an integer.	Expression
<i>source_string</i>	Expression that evaluates to a character string	Must be an expression, constant, column, or host variable of a built-in character data type, or that can be converted to a character type	Expression

Element	Description	Restrictions	Syntax
<i>start</i>	Ordinal position to begin the search in <i>source_string</i> , where 1 is the first logical character	Must be an expression, constant, column, or host variable of a built-in integer type, or that can be converted to a positive or negative integer	Expression
<i>substring</i>	Expression that evaluates to a character string	Must be an expression, constant, column, or host variable of a built-in character data type, or that can be converted to a character type	Expression

Arguments to **INSTR** cannot be user-defined data types.

The function returns NULL in each of these cases:

- *count* is less than or equal to zero (0).
- *source_string* is NULL or of zero length.
- *substring* is NULL or of zero length.

The return value is zero (0) in each of the following cases:

- if no occurrences of *substring* are found in *source_string*,
- if *start* is greater than the length of *source_string*.
- If fewer than *count* occurrences of *substring* are in the *source_string*,

If you omit the optional *count* argument, the default *count* value is 1.

In locales that support multibyte character sets, the return value is the ordinal value among logical characters in the *source_string*. In single-byte locales, such as the default locale, the return value is equivalent to the byte position, where the first byte is in position 1.

The start position

If *start* is omitted or is specified as zero, the search for *substring* begins at character position 1. If *start* is negative, the search for occurrences of *substring* begins at the end of *source_string*, and proceeds towards the beginning.

- In a left-to-right locale, a negative *start* value specifies a right-to-left search.
- In a right-to-left locale, a negative *start* value specifies a left-to-right search.

In both types of locales, however, the search begins at the logical character position within *source_string* that corresponds to the absolute value of *start*. In a right-to-left locale, a negative *start* value specifies a left-to-right search.

Examples of INSTR function expressions

The following expressions are all based on the same *source_string* and *substring*. This example returns 3, as the character position of the first 'er' substring:

```
INSTR("wwerw.ibm.cerom", "er")
```

In the example above, both *start* and *count* default to 1.

The next example starts the search at the 2nd character position, with a default *count* of 1:

```
INSTR("wwerw.ibm.cerom", "er", 2)
```

The expression above returns 3, the position of the first character in the first 'er' substring that a left-to-right search encounters.

The next example specifies a count of 2, starting the search in the first character of the *source_string*:

```
INSTR("wwerw.ibm.cerom", "er", 1, 2)
```

The expression above returns 12, the character position where the second 'er' begins.

The following example specifies -5 as the starting position, and the *count* specifies the first occurrence of "er" between the 5th position and the beginning of the *source_string*:

```
INSTR("wwerw.ibm.cerom", "er", -5, 1)
```

This returns 3, corresponding to the occurrence of the "er" substring that begins in that position. The negative *start* argument specifies a right-to-left search, but the return value is 3, because the reading direction of strings and substrings in the default locale is left-to-right.

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LEFT function

The **LEFT** function returns a substring consisting of the leftmost *N* characters from a string argument.

The function has this syntax:

LEFT function

```
|--LEFT--(--source_string--,--position--)-----|
```

Element	Description	Restrictions	Syntax
<i>position</i>	Ordinal position (from the left) in the string; this character and all to the left are to be returned	Must be an expression, constant, column, or host variable of a built-in integer type, or that can be converted to an integer	Expression
<i>source_string</i>	Expression that evaluates to a character string	Must be an expression, constant, column, or host variable of a data type that can be converted to a character type	Expression

The arguments to the **LEFT** function cannot be user-defined data types.

In left-to-right locales, such as the default U.S. English locale, this function returns a substring of leading characters from the *source_string*. In locales for right-to-left languages, such as Arabic, Farsi, or Hebrew, this function returns a substring of trailing characters from the *source_string*.

What the **LEFT** function returns depends on the number of logical characters in *source_string* and on the value of *position*:

- If *source_string* evaluates to a string with more than *position* characters, the return value is a substring of *source_string*, consisting of all characters to the left of the specified *position*.
- If *source_string* evaluates to a string with no more than *position* characters, the return value is the entire *source_string*.
- If *source_string* evaluates to NULL, or if *position* is zero or negative, then NULL is returned.
- If no *position* argument is specified, no string value is returned, and an exception is issued.

The return data type is the same as its *source_string* argument. If a host variable is the source, the return value is either NVARCHAR or NCHAR, according to the length of the returned string, using the return type promotion rules that the section [Return Types from the CONCAT Function](#) describes.

The following function expression requests the first five characters of a quoted string:

```
LEFT('www.ibm.com',5)
```

In this example, the **LEFT** function returns the substring `www.i`.

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RIGHT function

The **RIGHT** function returns a substring consisting of the rightmost *N* characters from a string argument.

The function has this syntax:

RIGHT function

```
|--RIGHT--(--source_string--,--position--)-----|
```

Element	Description	Restrictions	Syntax
<i>position</i>	Ordinal position (from the right) in the string; this character and all to the right are to be returned	Must be an expression, constant, column, or host variable of a built-in integer type, or that can be converted to an integer	Expression
<i>source_string</i>	Expression that evaluates to a character string	Must be an expression, constant, column, or host variable of a data type that can be converted to a character type	Expression

The arguments to the **RIGHT** function cannot be user-defined data types.

In left-to-right locales, such as the default U.S. English locale, this function returns a substring of trailing characters from the *source_string*. In locales for right-to-left languages, such as Arabic, Farsi, or Hebrew, this function returns a substring of leading characters from the *source_string*.

What the **RIGHT** function returns depends on the number of logical characters in *source_string* and on the value of *position*:

- If *source_string* evaluates to a string with more than *position* characters, the return value is a substring of *source_string*, consisting of all characters to the right of the specified *position*.
- If *source_string* evaluates to a string with no more than *position* characters, the return value is the entire *source_string*.
- If *source_string* evaluates to NULL, or if *position* is zero or negative, then NULL is returned.
- If no *position* argument is specified, no string value is returned, and an exception is issued.

The return data type is the same as its *source_string* argument. If a host variable is the source, the return value is either NVARCHAR or NCHAR, according to the length of the returned string, using the return type promotion rules that the section [Return Types from the CONCAT Function](#) describes.

The following function expression requests the last five characters of a quoted string:

```
RIGHT('www.ibm.com',5)
```

In this example, the **RIGHT** function returns the substring `m.com`.

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SUBSTR function

The **SUBSTR** function has the same purpose as the **SUBSTRING** function (to return a subset of a source string), but it uses different syntax.

SUBSTR Function

```
|--SUBSTR--(--source_string--,--start_position--+-----+--)|
              '-,--length-'
```

Element	Description	Restrictions	Syntax
<i>length</i>	Number of characters to be returned from <i>source_string</i>	Must be an expression, literal, column, or host variable that returns an integer	Expression
<i>source_string</i>	String that serves as input to the SUBSTR function	Must be an expression, literal, column, or host variable of a data type that can be converted to a character data type	Expression
<i>start_position</i>	Column position in <i>source_string</i> where the SUBSTR function starts to return characters	Must be an integer expression, literal, column, or host variable. Can have a plus sign (+), a minus sign (-), or no sign.	Literal Number

Any argument to the **SUBSTR** function must be of a built-in data type.

The **SUBSTR** function returns a subset of *source_string*. The subset begins at the column position that *start_position* specifies. The following table shows how the database server determines the starting position of the returned subset based on the input value of the *start_position*.

Value of Start_Position	How the Database Server Determines the Starting Position of the Returned Subset
Positive	Counts forward from the first character in <i>source_string</i>
Zero (0)	Counts forward from the first character in <i>source_string</i> (that is, treats a <i>start_position</i> of 0 as equivalent to 1)
Negative	Counts backward from an origin that immediately follows the last character in <i>source_string</i> . A value of -1 returns the last character in <i>source_string</i> .

The *length* parameter specifies the number of logical characters (not the number of bytes) in the subset. If you omit the *length* parameter, the **SUBSTR** function returns the entire portion of *source_string* that begins at *start_position*.

If you specify a negative *start_position* whose absolute value is greater than the number of characters in *source_string*, or if *length* is greater than the number of characters from *start_position* to the end of *source_string*, **SUBSTR** returns NULL. (In this case, the behavior of **SUBSTR** is different from that of the **SUBSTRING** function, which returns all the characters from *start_position* to the last character of *source_string*, rather than returning NULL.)

The return data type is that of the *source_string* argument. If a host variable is the source, the return value is either NVARCHAR or NCHAR, according to the length of the returned string, using the return type promotion rules that the section [Return Types from the CONCAT Function](#) describes.

The following example specifies that the string of characters to be returned begins at a starting position 3 characters before the end of a 7-character *source_string*. This implies that the starting position is the fifth character of *source_string*. Because the user does not specify a value for *length*, the database server returns a string that includes all characters from character-position 5 to the end of *source_string*.

```
SELECT SUBSTR('ABCDEFG', -3)
FROM mytable;
```

The following table shows the output of this SELECT statement.

(constant)
EFG

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SUBSTRB function

Returns a substring of a string, beginning at a specified position in the string.

SUBSTRB Function

```
|--SUBSTRB--(--source_string--,--starting_position--+-----+--)|
              '-,--length-'
```

Element	Description
---------	-------------

Element	Description
<i>length</i>	<p>An expression that specifies the length of the result in bytes. If specified, the expression must return a value that is a built-in numeric, CHAR, or VARCHAR data type. If the value is not of type INTEGER, it is implicitly cast to INTEGER before the function is evaluated. If the value of <i>length</i> is greater than the number of bytes from the starting position to the end of the string, the length of the result is equal to is the length of the first argument minus the starting position, plus one.</p> <p>If the value of <i>length</i> is less than or equal to zero, the result of SUBSTRB is a NULL string.</p> <p>The default for <i>length</i> is the number of bytes from the position specified by <i>starting_position</i> to the last byte of the string.</p> <p>When <i>length</i> is specified, the length of the result string is truncated to the value of <i>length</i>. In the following example, where <i>my_string</i> is a 10-byte string, the result string is limited to 5 bytes:</p> <pre>substrB(my_string, 3, 5)</pre> <p>If, in the preceding example, <i>my_string</i> is a 4-byte string and the starting position is the third byte, a 2-byte string is returned. If <i>length</i> is not specified, the length of the result is the length of <i>source_string</i> beginning from the <i>starting_position</i>. In the following example, where <i>my_string</i> is a 10-byte string, an 8-byte string is returned:</p> <pre>substrB(my_string, 3)</pre>
<i>source_string</i>	<p>An expression that specifies the string from which the result is derived. The expression must return a value that is a built-in string, numeric, or datetime data type. If the value is not a string data type, it is implicitly cast to NVARCHAR before the function is evaluated. A NULL value is returned for a zero length result.</p>
<i>starting_position</i>	<p>An expression that specifies the starting position in string of the beginning of the result substring. The expression must return a value that is a built-in numeric, CHAR, or VARCHAR data type. If the value is not of type INTEGER, it is implicitly cast to an INTEGER before the function is evaluated.</p> <p>If <i>starting_position</i> is positive, then the starting position is calculated from the beginning of the string. If <i>starting_position</i> is greater than the <i>length</i> of string, then a null string is returned. If <i>starting_position</i> is negative, then the starting position is calculated from the end of the string and by counting backwards the number of bytes. If the absolute value of <i>starting_position</i> is greater than the <i>length</i> of <i>source_string</i>, then a null string is returned. If <i>starting_position</i> is 0, then a starting position of 1 is used.</p> <p>Note: All units of <i>length</i> and <i>starting_position</i> are expressed in terms of bytes, even for strings encoded in multibyte code sets. SUBSTR uses the logical character size for multibyte strings. For example, if <i>starting_position</i> is 2 in the legacy SUBSTR and the first character of a multibyte string requires 3 bytes of storage, the 2 represents the fourth byte in the string. In SUBSTRB, the 2 represents the second byte in the string.</p>

If *source_string* is a CHAR or VARCHAR data type, the result of the function is a VARCHAR data type. Informix® does not support multiple code pages; instead, Informix JDBC or ODBC translates the code page to the database.

If any argument is null, the result is the null value.

In dynamic SQL, *source_string*, *starting_position*, and *length* can be represented by a host variable. If a host variable is used for *source_string*, the data type of the operand is VARCHAR, and the operand can be nullable.

Though not explicitly stated in the result definitions above, the semantics imply that if *source_string* is a multi-byte character string, the result might contain fragments of multi-byte characters, depending on the values of *starting_position* and *length*. For example, the result could possibly begin with the second byte of a multi-byte character, or end with the first byte of a multi-byte character. The SUBSTRB function detects these partial characters and replaces each byte of an incomplete character with a single blank character. SUBSTRB returns a fixed number of bytes; with SUBSTR, the number of returned varies according to the multibyte string.

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SUBSTRING function

The **SUBSTRING** function returns a subset of a character string.

SUBSTRING Function

```
|--SUBSTRING--(--source_string--FROM--start_position--+-+-----+---)--|
                    '-FOR--length-'
```

Element	Description	Restrictions	Syntax
<i>length</i>	Number of characters to return from <i>source_string</i>	Must be an expression, constant, column, or host variable that returns an integer	Literal Number
<i>source_string</i>	String argument to the SUBSTRING function	Must be an expression, constant, column, or host variable whose value can be converted to a character data type	Expression
<i>start_position</i>	Position in <i>source_string</i> of first returned character	Must be an expression, constant, column, or host variable that returns an integer	Literal Number

Any argument to the **SUBSTRING** function must be of a built-in data type.

The return data type is that of the *source_string* argument. If a host variable is the source, the return value is either NVARCHAR or NCHAR, according to the length of the returned string, using the return type promotion rules that the section [Return Types from the CONCAT Function](#) describes.

The subset begins at the column position that *start_position* specifies. The following table shows how the database server determines the starting position of the returned subset based on the input value of the *start_position*.

Value of Start_Position	How the Database Server Determines the Starting Position of the Return Subset
Positive	Counts forward from the first character in <i>source_string</i> For example, if <i>start_position</i> = 1, the first character in the <i>source_string</i> is the first character in the returned subset.
Zero (0)	Counts from one position before (that is, to the left of) the first character in <i>source_string</i> For example, if <i>start_position</i> = 0 and <i>length</i> = 1, the database server returns NULL, whereas if <i>length</i> = 2, the database server returns the first character in <i>source_string</i> .
Negative	Counts backward from one position after (that is, to the right of) the last character in <i>source_string</i> For example, if <i>start_position</i> = -1, the starting position of the returned subset is the last character in <i>source_string</i> .

In locales for languages with a right-to-left writing direction, such as Arabic, Farsi, or Hebrew, *right* should replace *left* in the preceding table.

The size of the subset is specified by *length*. The *length* parameter refers to the number of logical characters, rather than to the number of bytes. If you omit the *length* parameter, or if you specify a *length* that is greater than the number of characters from *start_position* to the end of *source_string*, the **SUBSTRING** function returns the entire portion of *source_string* that begins at *start_position*. The following example specifies that the subset of the source string that begins in column position 3 and is two characters long should be returned:

```
SELECT SUBSTRING('ABCDEFGH' FROM 3 FOR 2) FROM mytable;
```

The following table shows the output of this SELECT statement.

(constant)
CD

In the following example, the user specifies a negative *start_position* for the return subset:

```
SELECT SUBSTRING('ABCDEFGH' FROM -3 FOR 7)
FROM mytable;
```

The database server starts at the -3 position (four positions before the first character) and counts forward for 7 characters. The following table shows the output of this SELECT statement.

(constant)
ABC

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SUBSTRING_INDEX function

The **SUBSTRING_INDEX** function searches a character string for a specified delimiter character, and returns a substring of the leading or trailing characters, based on a count of a delimiter that you specify as an argument to the function.

The **SUBSTRING_INDEX** function has this syntax:

SUBSTRING_INDEX function

```
|--SUBSTRING_INDEX--(--source_string--,--delimiter--,--count--)--|
```

Element	Description	Restrictions	Syntax
<i>source_string</i>	Expression that evaluates to a character string	Must be an expression, constant, column, or host variable of a built-in character data type, or that can be converted to a character type	Expression
<i>count</i>	Expression that evaluates to a positive or negative integer	Must be an expression, constant, column, or host variable of a built-in integer type, or that can be converted to an integer.	Expression
<i>delimiter</i>	Expression that evaluates to a character string	Must be an expression, constant, column, or host variable of a built-in character data type, or that can be converted to a character type	Expression

Arguments to **SUBSTRING_INDEX** cannot be user-defined data types.

This function returns NULL in each of the following cases:

- *source_string* is NULL
- *delimiter* is NULL
- *count* = zero (0).

If the search finds fewer than *count* delimiters in the *source_string*, the return value is the entire *source_string*.

The return value has the same data type as the *source_string*.

For *source_string*, the sign of *count* determines whether the returned value is a substring of the leading characters or of the trailing characters in *source_string*:

- The last character in the returned substring immediately precedes the Nth occurrence of that delimiter in a substring of leading characters, for N = *count*.

For example, the function expression

```
SUBSTRING_INDEX("www.ibm.com", ".", 2)
```

returns the leading characters `www.ibm` because `count > 0`.

- The first character in the returned substring immediately precedes the Nth occurrence of that delimiter in a substring of trailing characters, for `N = count < 0`.

For example, the function expression

```
SUBSTRING_INDEX("www.ibm.com", ".", -2)
```

returns the trailing characters `ibm.com` because `count < 0`.

The examples above apply to left-to-right locales, such as the default U.S. English locale, in which a negative value of `count` causes this function to return a substring of trailing characters from the `source_string`, and a positive value of `count` causes this function to return a substring of leading characters from the `source_string`.

In locales for right-to-left languages such as Arabic, Farsi, or Hebrew, the opposite is true. This function returns a substring of leading characters from the `source_string` if `count` has a negative value, and returns a substring of trailing characters if `count` has a positive value.

In locales that support multibyte character sets, the return value is the ordinal value among logical characters in the `source_string`. In single-byte locales, such as the default locale, the return value is equivalent to the byte position, where the first byte is in position 1.

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FORMAT_UNITS Function

The **FORMAT_UNITS** function can interpret strings that specify a number and the abbreviated names of units of memory or of mass storage.

This built-in function can accept one, two, or three quoted string arguments. You can invoke **FORMAT_UNITS** in SQL statements that process size specifications expressed by standard abbreviations for bytes or for larger units (such as kilobytes, megabytes, gigabytes, and so forth) of memory or of mass storage.

The **FORMAT_UNITS** function can also be called internally in the **sysadmin** database by the SQL administration API **ADMIN** and **TASK** functions, which are described in the *IBM® Informix Administrator's Reference*.

FORMAT_UNITS Function

```
|--FORMAT_UNITS-- (--+ '--number--units--'-----+--)--|
      '--+ '--number--'--+-- '--units--'--+-----+--'
      'number-----'          '-+-- '--precision--'--+-'
                          '-precision-----'
```

Element	Description	Restrictions	Syntax
<i>number</i>	Expression that evaluates to the number of storage or memory <i>units</i>	Must be a literal number or a quoted string specifying a number that can be converted to FLOAT	Expression
<i>precision</i>	Integer number of significant digits to return from <i>number</i>	Must be a literal number or a quoted string specifying an integer	Expression
<i>units</i>	Abbreviation of a unit of storage or memory; the default is 'B' (for bytes)	Must begin with 'B', 'K', 'M', 'G', 'T', 'P', or 'PB' (or the lowercase forms of these letters). Any trailing characters are ignored.	Quoted String

This built-in function can accept one, two, or three arguments. The returned value is a character string that shows the specified *number* and an appropriate format label that shows the storage units. If you specify a *precision* as the last argument, the *number* is returned with that precision. Otherwise, the *number* is formatted to precision 3 (%3.31f) by default.

The same notation also applies to arguments to all SQL administration API **ADMIN** and **TASK** commands (except for commands that emulate the Enterprise Replication **cdr** utility) that specify sizes of memory, of disk storage, or of address offsets:

Notation

Corresponding Units

'B' or 'b'
Bytes (= 2 to the power 0)

'K' or 'k'
Kilobytes (= 2 to the power 10)

'M' or 'm'
Megabytes (= 2 to the power 20)

'G' or 'g'
Gigabytes (= 2 to the power 30)

'T' or 't'
Terabytes (= 2 to the power 40)

'PB'
Petabytes (= 2 to the power 50)

'P'
Pages (= 2 kilobytes or 4 kilobytes, depending on the base page size of the system)

The initial letter in the *unit* specification ('B', 'K', 'M', 'G' or 'T') determines the units of measure, and any trailing characters are ignored. An exception, however, is if the initial letter 'P' (or 'p') is immediately followed by 'B' or 'b' in the string, because in this case the string is interpreted as petabytes. Any other

If one argument provides both the *number* and *units* specifications, Informix® ignores any whitespace that separates the *number* specification from the *units* specification within the same argument to the **FORMAT_UNITS**, or SQL administration API **ADMIN** or **TASK** functions. For example, the specifications '128M' and '128 m' are both interpreted as 128 megabytes.

```
EXECUTE FUNCTION FORMAT_UNITS('1024 M');
```

(expression)
1.00 GB

(expression)
1.00 MB

(expression)
100 MB

```
EXECUTE FUNCTION FORMAT_UNITS(1024, 'k');
```

(expression)
1.00 MB

```
size 117 MB
free 8.05 MB
```

```
EXECUTE FUNCTION FORMAT UNITS(1024, 'k', 4);
```

(expression)
1.000 MB

```
size    117.2 MB
free    8.049 MB
```

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In the following example, assume that you did not specify any value for the `ALLOW_NEWLINE` parameter in the `ONCONFIG` file, so, by default, newline characters are not allowed in quoted strings in any session. After you start a new session, you can enable newline characters in quoted strings in that session by executing the **IFX_ALLOW_NEWLINE** function:

In ESQ/C, the newline mode that is set by the `ALLOW_NEWLINE` parameter in the `ONCONFIG` file or by the execution of the **IFX_ALLOW_NEWLINE** function in a session applies only to quoted-string literals in SQL statements. The newline mode does not apply to quoted strings contained in host variables in SQL statements. Host variables can contain newline characters within string data regardless of the newline mode currently in effect.

For further information on how the **IFX_ALLOW_NEWLINE** function affects quoted strings, see [Quoted String](#). For further information on the **ALLOW_NEWLINE** parameter in the ONCONFIG file, see the *IBM® Informix® Administrator's Reference*.

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A UDF as an expression has the following syntax:

```

      |-----|
      v                                             |
|--function--(-----+----->
      |                                     (1) |
      |-----+----| Expression |-----'
      '-parameter-- = '

>+-----+-----)-----|
  |                                     (2) |
  |--| Statement-Local Variable Declaration |-----'

```

1. See [Expression](#)
2. See [Statement-Local Variable Declaration](#)

Element	Description	Restrictions	Syntax
<i>function</i>	Name of the function	Function must exist	Database Object Name
<i>parameter</i>	Name of an argument that was declared in a CREATE FUNCTION statement	If you use the <i>parameter</i> = option for any argument in the called function, you must use it for all arguments	Identifier

The following examples show some user-defined function expressions. The first example omits the *parameter* option when it lists the function argument:

This second example uses the *parameter* option to specify the argument value:

When you use the *parameter* option, the *parameter* name must match the name of the corresponding parameter in the function registration. For example, the preceding example assumes that the `read_address()` function was registered as follows:

A *statement-local variable* (SLV) enables an application to transmit a value from a user-defined function call to another part of the same SQL statement.

1. Write one or more OUT parameters (and for UDRs written in the Java or in the SPL language, INOUT parameters) for the user-defined function.
For information about how to write a UDR with OUT or INOUT parameters, see *IBM® Informix® User-Defined Routines and Data Types Developer's Guide*.
2. When you register the user-defined function, specify the **OUT** keyword before each OUT parameter, and the **INOUT** keyword before each INOUT parameter.
For more information, see [Specifying INOUT Parameters for a User-Defined Routine](#), and [Specifying OUT Parameters for User-Defined Routines](#).

3. Declare the SLV in a function expression that calls the user-defined function with each OUT and INOUT parameter.
The call to the user-defined function must be made within a WHERE clause. For information about the syntax to declare the SLV, see [Statement-Local Variable Declaration](#).
4. Use the SLV that the user-defined function has initialized within the SQL statement.
After the call to the user-defined function has initialized the SLV, you can use this value in other parts of the same SQL statement in which the SLV was declared, including subqueries of the query whose WHERE clause includes the SLV declaration. For information about the use of an SLV within the SELECT statement, see [Statement-Local Variable Expressions](#).

Besides using a SLV to retrieve a value from an OUT or INOUT parameter, you can also use a local variable or a parameter of an SPL routine to retrieve values from an SPL or C routine that has OUT or INOUT parameters.

- [Statement-Local Variable Declaration](#)
The Statement-Local Variable Declaration declares a statement-local variable (SLV) in a call to a user-defined function that defines one or more OUT or INOUT parameters.

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Statement-Local Variable Declaration

The Statement-Local Variable Declaration declares a statement-local variable (SLV) in a call to a user-defined function that defines one or more OUT or INOUT parameters.

A Statement-Local Variable Declaration has this syntax:

Statement-Local Variable Declaration

```
--slv_name-- # +--| Built-In Data Type |-----+-----+
               +-opaque_data_type-----+
               +-distinct_data_type-----+
               |                           |
               |                           | (2) |
               '-| Complex Data Type |-----'
```

Notes:

1. See [Built-In Data Types](#)
2. See [Complex Data Type](#)

Element	Description	Restrictions	Syntax
<i>distinct_data_type</i>	Name of a distinct data type	The distinct data type must already exist in the database	Identifier
<i>opaque_data_type</i>	Name of an opaque data type	The opaque data type must already exist in the database	Identifier
<i>slv_name</i>	Name of a statement local variable you are defining	The <i>slv_name</i> is valid only for the life of the statement, and must be unique within the statement	Identifier

You can declare an SLV in a call to a user-defined function if both of the following conditions are true:

- The UDF has one or more OUT or INOUT parameters
- The SLV is declared when the UDF is invoked in the WHERE clause of a query.

The SLV declaration in the WHERE clause assigns the value of an OUT or INOUT parameter to the SLV, with the sharp (#) symbol between the identifier of the SLV and its declared data type. The UDF can be written in the SPL, C, or Java™ language. For example, if you register a function with the following CREATE FUNCTION statement, you can assign the value of its **y** parameter, which is an OUT parameter, to an SLV in a WHERE clause:

```
CREATE FUNCTION find_location(a FLOAT, b FLOAT, OUT y INTEGER)
RETURNING VARCHAR(20)
EXTERNAL NAME "/usr/lib/local/find.so"
LANGUAGE C;
```

In this example, **find_location()** accepts two FLOAT values that represent a latitude and a longitude and return the name of the nearest city with an extra value of type INTEGER that represents the population rank of the city.

You can now call **find_location()** in a WHERE clause:

```
SELECT zip_code t FROM address
WHERE address.city = find_location(32.1, 35.7, rank # INT)
AND rank < 101;
```

The function expression passes two FLOAT values to **find_location()** and declares an SLV named **rank** of type INT. In this case, **find_location()** will return the name of the city nearest latitude 32.1 and longitude 35.7 (which might be a heavily populated area) whose population rank is between 1 and 100. The statement then returns the zip code that corresponds to that city.

The SLV can be declared only in a call to the UDF in the WHERE clause of the SELECT statement. The scope of reference of the SLV includes other parts of the same SELECT statement. The following SELECT statement, however, is *invalid* because the SLV declaration is in the projection list of the Projection clause, rather than in the WHERE clause:

```
-- invalid SELECT statement
SELECT title, contains(body, 'dog and cat', rank # INT), rank
```

```
FROM documents;
```

The data type that you specify when you declare the SLV must be the same data type as the corresponding OUT or INOUT parameter in the CREATE FUNCTION statement. If you use different but compatible data types, such as INTEGER and FLOAT, the database server automatically performs the cast between the data types.

SLVs share the name space with UDR variables and the column names of the table involved in the SQL statement. Therefore, the database uses the following descending order of precedence to resolve name conflicts among the following objects:

- UDR variables
- Column names
- SLVs

After the call to the UDF assigns the value of an OUT or INOUT parameter to the SLV, you can reference the SLV in other parts of the same query. For more information, see [Statement-Local Variable Expressions](#).

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Statement-Local Variable Expressions

The Statement-Local Variable Expression specifies a statement-local variable (SLV) that you can use elsewhere in the same SELECT statement.

Statement-Local Variable Expressions

```
|--SLV_variable-----|
```

Element	Description	Restrictions	Syntax
<i>SLV_variable</i>	Statement-local variable (SLV) assigned in a call to a user-defined function in the same query	The <i>SLV_variable</i> exists only while the query is executing. Its name must be unique within the query	Identifier

You define an SLV in the call to a user-defined function in the WHERE clause of the SELECT statement. This user-defined function must be defined with one or more OUT or INOUT parameters. The call to the user-defined function assigns the value of the OUT or INOUT parameters to the SLVs. For more information, see [Statement-Local Variable Declaration](#).

Once the user-defined function assigns its OUT or INOUT parameters to the SLVs, you can use these values in other parts of the same SELECT statement, subject to the following scope-of-reference rules:

- The SLV is *read-only* throughout the query (or subquery) in which it is defined.
- The scope of an SLV extends from the query in which the SLV is defined down into all nested subqueries.
- In nested queries, the scope of an SLV does not extend upwards.
In other words, if a query contains one or more subqueries, an SLV that is defined in the query is also visible to all the subqueries of that query. But if the SLV is defined in the subquery, it is not visible to the parent query.
- In queries that include the UNION operator, the SLV is only visible in the query in which it is defined.
The SLV is not visible to any other queries specified in the UNION.
- For INSERT, DELETE, and UPDATE statements, an SLV is not visible outside the SELECT portion of the statement.
Within this SELECT portion of a DML statement, all the above scoping rules apply.

Important: A statement-local variable is in scope only for the duration of a single SQL statement.

The following SELECT statement calls the **find_location()** function in a WHERE clause and defines the **rank** SLV. Here **find_location()** accepts two values that represent a latitude and a longitude and return the name of the nearest city with an extra value of type INTEGER that represents the population rank of the city.

```
SELECT zip_code_t FROM address
WHERE address.city = find_location(32.1, 35.7, rank # INT)
AND rank < 101;
```

When execution of the **find_location()** function completes successfully, the function has initialized the **rank** SLV. The SELECT then uses this **rank** value in a second WHERE clause condition. In this example, the Statement-Local Variable Expression is the variable **rank** in the second WHERE clause condition:

```
rank < 101
```

The number of OUT and INOUT parameters and SLVs that a UDF can have is not restricted. (Releases of Informix® earlier than Version 9.4 restricted user-defined functions to a single OUT parameter and no INOUT parameters, thereby restricting the number of SLVs to no more than one.)

If the user-defined function that initializes the SLVs is *not* executed in an iteration of the statement, the SLVs each have a value of NULL. Values of SLVs do not persist across iterations of the statement. At the start of each iteration, the database server sets the SLV values to NULL.

The following partial statement calls two user-defined functions with OUT parameters, whose values are referenced with the SLV names **out1** and **out2**:

```
SELECT...
WHERE func_2(x, out1 # INTEGER) < 100
AND (out1 = 12 OR out1 = 13)
AND func_3(a, out2 # FLOAT) = "SAN FRANCISCO"
AND out2 = 3.1416;
```

If a function assigns one or more OUT or INOUT parameter values from another database of the local database server to SLVs, the values must be of built-in data types, or DISTINCT data types whose base types are built-in data types (and that you cast explicitly to built-in data types), or must be opaque UDTs that you cast

explicitly to built-in data types. All the opaque UDTs, DISTINCT types, type hierarchies, and casts must be defined exactly the same way in all of the participating databases.

For more information on how to write a user-defined function with OUT or INOUT parameters, see *IBM® Informix User-Defined Routines and Data Types Developer's Guide*.

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Aggregate Expressions

An aggregate expression uses an aggregate function to summarize selected database data. The built-in aggregate functions have the following syntax.

Aggregate Expressions

```
|--+-+--COUNT( * )-----+--+-+--|
| '-+-AVG-----+--(-----+--+-+--|
| +-COUNT-----+ +-| Aggregate Scope Qualifiers |--)-----+ |
| +-MAX-----+ | .-ALL-. (1) | |
| +-MIN-----+ '-----+--| Subset of Expression |-----)-' |
| +-SUM-----+ | | |
| +-RANGE-----+ | | |
| +-STDEV-----+ | | |
| '-VARIANCE-' | | |
| | (2) | |
| '-| User-Defined Aggregates |-----+--+-+--|
```

Aggregate Scope Qualifiers

```
.-ALL-----|
|-----+--column-----+--+-+--|
| +-DISTINCT--+ +-table .---+ |
| '-UNIQUE---' +-alias .---+ |
| | +-view .---+ |
| | '-synonym .-' |
```

Notes:

1. See [Subset of Expressions Valid in an Aggregate Expression](#)
2. See [User-Defined Aggregates](#)

Element	Description	Restrictions	Syntax
<i>column</i>	Column to which aggregate function is applied	See headings for individual keywords on pages that follow	Identifier
<i>alias, synonym, table, view</i>	Synonym, table, view, or alias that contains <i>column</i>	<i>Synonym</i> and the <i>table</i> or <i>view</i> to which it points must exist	Identifier

You cannot use an aggregate expression in a condition that is part of a WHERE clause unless you use the aggregate expression within a subquery. You cannot apply an aggregate function to a BYTE or TEXT column. For other general restrictions, see [Subset of Expressions Valid in an Aggregate Expression](#).

An aggregate function returns one value for a set of queried rows. The following examples show aggregate functions in SELECT statements:

```
SELECT SUM(total_price) FROM items WHERE order_num = 1013;
```

```
SELECT COUNT(*) FROM orders WHERE order_num = 1001;
```

```
SELECT MAX(LENGTH(fname) + LENGTH(lname)) FROM customer;
```

If you use an aggregate function and one or more columns in the projection list of the Projection clause, you must include all the column names that are not used as part of an aggregate or time expression in the GROUP BY clause.

- [Types of Aggregate Expressions](#)
- [Subset of Expressions Valid in an Aggregate Expression](#)
- [Including or excluding duplicates in the result set](#)
You can use the ALL, DISTINCT, or UNIQUE keywords to qualify the scope of an aggregate function.
- [AVG Function](#)
The **AVG** function returns the average of all values in the specified column or expression.
- [Overview of COUNT Functions](#)
The **COUNT** function is actually a set of functions that enable you to count column values in different ways, according to arguments after the COUNT keyword.
- [COUNT\(*\) function](#)
The **COUNT (*)** function returns the number of rows that satisfy the WHERE clause of a SELECT statement.
- [COUNT DISTINCT and COUNT UNIQUE functions](#)
The **COUNT DISTINCT** and **COUNT UNIQUE** functions return unique values.
- [COUNT column Function](#)
- [Arguments to the COUNT Functions](#)
- [MAX Function](#)
The **MAX** function returns the largest value in the specified column or expression.
- [MIN Function](#)

- [SUM Function](#)
- [RANGE Function](#)
The **RANGE** function returns the range of values for a numeric column expression argument.
- [STDEV Function](#)
- [VARIANCE Function](#)
The **VARIANCE** function returns an estimate of the population variance, as the standard deviation squared.
- [Error Checking in ESQ/C](#)
- [Summary of Aggregate Function Behavior](#)
- [User-Defined Aggregates](#)
You can create your own aggregate expressions with the CREATE AGGREGATE statement and then invoke these aggregates wherever you can invoke the built-in aggregates.
- [Aggregate expressions in grid queries](#)
Aggregate expressions in grid queries require the database server that issues the grid query to combine aggregate results from multiple grid servers.

Related information:

[Functions in SELECT statements](#)

[Handle character data](#)

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Types of Aggregate Expressions

SQL statements can include *built-in* aggregates and *user-defined* aggregates. The built-in aggregates include all the aggregates shown in the syntax diagram in [Aggregate Expressions](#) except for the “User-Defined Aggregates” category. User-defined aggregates are any new aggregates that the user creates with the CREATE AGGREGATE statement.

- [Built-in Aggregates](#)
- [User-Defined Aggregates](#)

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Built-in Aggregates

Built-in aggregates are aggregate functions that are defined by the database server, such as AVG, SUM, and COUNT. These aggregates work only with built-in data types, such as INTEGER and FLOAT. You can extend these built-in aggregates to work with extended data types. To extend built-in aggregates, you must create UDRs that overload several binary operators.

After you overload the binary operators for a built-in aggregate, you can use that aggregate with an extended data type in an SQL statement. For example, if you have overloaded the **plus** operator for the SUM aggregate to work with a specified row type and assigned this row type to the **complex** column of the **complex_tab** table, you can apply the SUM aggregate to the **complex** column:

```
SELECT SUM(complex) FROM complex_tab;
```

For more information on how to extend built-in aggregates, see *IBM® Informix® User-Defined Routines and Data Types Developer's Guide*. For information on how to invoke built-in aggregates, see the descriptions of individual built-in aggregates in the following pages.

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User-Defined Aggregates

A user-defined aggregate is an aggregate that you define to perform an aggregate computation that the database server does not provide. For example, you can create a user-defined aggregate named SUMSQ that returns the sum of the squared values of a specified column. User-defined aggregates can work with built-in data types or extended data types or both, depending on how you define the support functions for the user-defined aggregate.

To create a user-defined aggregate, use the CREATE AGGREGATE statement. In this statement you name the new aggregate and specify the support functions for the aggregate. Once you create the new aggregate and its support functions, you can use the aggregate in SQL statements. For example, if you created the SUMSQ aggregate and specified that it works with the FLOAT data type, you can apply the SUMSQ aggregate to a FLOAT column named **digits** in the **test** table:

```
SELECT SUMSQ(digits) FROM test;
```

For more information on how to create user-defined aggregates, see [CREATE AGGREGATE statement](#) and the discussion of user-defined aggregates in *IBM® Informix® User-Defined Routines and Data Types Developer's Guide*. For information on how to invoke user-defined aggregates, see [User-Defined Aggregates](#).

Related reference:

[CREATE AGGREGATE statement](#)

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Subset of Expressions Valid in an Aggregate Expression

As indicated in the diagrams for [Aggregate Expressions](#) and [User-Defined Aggregates](#), not all expressions are available when you use an aggregate expression. The argument of an aggregate function, for example, cannot itself contain an aggregate function. You cannot use aggregate functions in the following contexts:

- In a WHERE clause, but with these two exceptions:
 - unless the aggregate is specified in the Projection clause of a subquery within the WHERE clause,
 - or unless the aggregate is on a correlated column from a parent query, and the WHERE clause is in a subquery within a HAVING clause.
- As an argument to an aggregate function.
The following nested aggregate expression is not valid:

```
MAX (AVG (order_num))
```

- On a column of any of the following data types:
 - Large object (BLOB, BYTE, CLOB, TEXT)
 - Collection data types (LIST, MULTISSET, SET)
 - ROW data types (named or unnamed)
 - OPAQUE data types (except with user-defined aggregate functions that support opaque types).

You cannot use a column that is a collection data type as an argument to the following aggregate functions:

- **AVG**
- **SUM**
- **MIN**
- **MAX**

Expression or *column* arguments to built-in aggregates (except for **COUNT**, **MAX**, **MIN**, and **RANGE**) must return numeric or INTERVAL data types, but **RANGE** also accepts DATE and DATETIME arguments.

For **SUM** and **AVG**, you cannot use the difference between two DATE values directly as the argument to an aggregate, but you can use DATE differences as operands within arithmetic expression arguments. For example:

```
SELECT . . . AVG(ship_date - order_date);
```

returns error -1201, but the following equivalent expression is valid:

```
SELECT . . . AVG((ship_date - order_date)*1);
```

The following query fragment uses valid syntax to declare aliases for two column expressions:

```
SELECT . . .  
    SUM(orders.ship_charge) as o2,  
    COUNT(DISTINCT  
        CASE WHEN orders.backlog MATCHES 'n'  
              THEN orders.order_num END ) AS o3,  
    . . .
```

Here the argument to **SUM** is a MONEY(6) column value, and the **COUNT DISTINCT** aggregate takes a **CASE** expression as its argument.

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Including or excluding duplicates in the result set

You can use the ALL, DISTINCT, or UNIQUE keywords to qualify the scope of an aggregate function.

If you include an aggregate scope qualifier, it must be the first item in the argument list.

The ALL keyword specifies that all values selected from the column or expression, including any duplicate values, are used in the calculation. Because ALL is the default scope for aggregate functions, the following two aggregate expressions are equivalent, and their return value is based on the value of all qualifying rows in the **ship_weight** column:

```
AVG(ship_weight)  
AVG(ALL ship_weight)
```

Including the DISTINCT keyword as the first argument to the aggregate function restricts its subsequent arguments to unique values from the specified column. The UNIQUE and DISTINCT keywords are synonyms in this context. The following two aggregate expressions are equivalent, and their return value is based on the set of unique values in qualifying rows of the **ship_weight** column:

```
AVG(DISTINCT ship_weight)  
AVG(UNIQUE ship_weight)
```

If several qualifying rows have the same **ship_weight** value, only one instance of that value is included in calculating the value of the aggregate. If a query includes the DISTINCT or UNIQUE keyword (rather than the ALL keyword or no keyword) in the Projection clause whose Select list also includes an aggregate function whose argument list begins with the DISTINCT or UNIQUE keyword, the database server issues an error, as in the following example: .

```
SELECT DISTINCT AVG(DISTINCT ship_weight)  
FROM orders;
```

That is, it is not valid in the same query for both the Projection clause and for an aggregate function to restrict the result set to unique values.

If the Projection clause does not specify the DISTINCT or UNIQUE keyword of the SELECT statement, however, the query can include one or more aggregate functions that each includes the DISTINCT or UNIQUE keyword as the first specification in the argument list, as in the following example:

```
SELECT AVG(UNIQUE ship_weight), COUNT (DISTINCT customer_num)  
FROM orders;
```


AVG Function

The **AVG** function returns the average of all values in the specified column or expression.

You can apply the **AVG** function only to number columns. The query in the following example finds the average price of a helmet:

```
SELECT AVG(unit_price) FROM stock WHERE stock_num = 110;
```

The return value is calculated by dividing the sum of **unit_price** values by the cardinality of the qualifying rows.

If you use the **DISTINCT** or **UNIQUE** keyword as the first argument, the average (meaning the *mean*) is calculated from only the distinct values in the specified column or expression. In the following example, only one instance of any duplicate values is included when the sum and the cardinality are calculated:

```
SELECT AVG(DISTINCT unit_price) FROM stock WHERE stock_num = 110;
```

If the data set included no duplicate values, both examples above return the same **AVG** value.

NULL values are ignored unless every value in the column or expression is NULL. If every value is NULL, the **AVG** function returns NULL for that column or expression.

Related reference:

[OLAP window aggregate functions](#)

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Overview of COUNT Functions

The **COUNT** function is actually a set of functions that enable you to count column values in different ways, according to arguments after the **COUNT** keyword.

Each form of the **COUNT** function is explained in the following subsections. For a comparison of the different forms of the **COUNT** function, see [Arguments to the COUNT Functions](#).

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COUNT(*) function

The **COUNT (*)** function returns the number of rows that satisfy the **WHERE** clause of a **SELECT** statement.

The following example finds how many rows in the **stock** table have the value **HRO** in the **manu_code** column:

```
SELECT COUNT(*) FROM stock WHERE manu_code = 'HRO';
```

The following example queries one of the System Monitoring Interface (SMI) tables to find the number of extents in the **customer** table:

```
SELECT COUNT(*) FROM sysextents WHERE dbs_name = 'stores' AND tablename = 'customer';
```

You can use **COUNT(*)** as the Projection clause in queries of this general format to obtain information from the SMI tables. For information about **sysextents** and other SMI tables, see the *IBM® Informix® Administrator's Reference* chapter that describes the **sysmaster** database.

If the **SELECT** statement does not have a **WHERE** clause, the **COUNT (*)** function returns the total number of rows in the table. The following example finds how many rows are in the **stock** table:

```
SELECT COUNT(*) FROM stock;
```

If the **SELECT** statement contains a **GROUP BY** clause, the **COUNT (*)** function reflects the number of values in each group. The following example is grouped by the first name; the rows are selected if the database server finds more than one occurrence of the same name:

```
SELECT fname, COUNT(*) FROM customer GROUP BY fname
HAVING COUNT(*) > 1;
```

If the value of one or more rows is NULL, the **COUNT (*)** function includes the NULL columns in the count unless the **WHERE** clause explicitly omits them.

Related reference:

[OLAP window aggregate functions](#)

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COUNT DISTINCT and COUNT UNIQUE functions

The **COUNT DISTINCT** and **COUNT UNIQUE** functions return unique values.

The **COUNT DISTINCT** function returns the number of unique values in the column or expression, as the following example shows.

```
SELECT COUNT (DISTINCT item_num) FROM items;
```

If the **COUNT DISTINCT** function encounters NULL values, it ignores them unless every value in the specified column is NULL. If every column value is NULL, the **COUNT DISTINCT** function returns zero (0).

The UNIQUE keyword has the same meaning as the DISTINCT keyword in **COUNT** functions. The UNIQUE keyword instructs the database server to return the number of unique non-NULL values in the column or expression. The following example calls the **COUNT UNIQUE** function, but it is equivalent to the preceding example that calls the **COUNT DISTINCT** function:

```
SELECT COUNT (UNIQUE item_num) FROM items;
```

If the Projection clause does not specify the DISTINCT or UNIQUE keyword of the SELECT statement, the query can include multiple COUNT functions that each includes the DISTINCT or UNIQUE keyword as the first specification in the argument list, as in the following example:

```
SELECT COUNT (UNIQUE item_num), COUNT (DISTINCT order_num) FROM items;
```

Related reference:

[OLAP window aggregate functions](#)

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COUNT column Function

The **COUNT column** function returns the total number of non-NULL values in the column or expression, as the following example shows:

```
SELECT COUNT (item_num) FROM items;
```

The ALL keyword can precede the specified column name for clarity, but the query result is the same whether you include the ALL keyword or omit it.

The following example shows how to include the ALL keyword in the **COUNT column** function:

```
SELECT COUNT (ALL item_num) FROM items;
```

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Arguments to the COUNT Functions

The **COUNT** function accepts as its argument the same expressions that are allowed in the argument list of other built-in aggregate functions, as well as the asterisk (*) notation that only **COUNT** supports. The following categories of built-in expressions are supported as the argument to **COUNT**, as illustrated in the following examples:

- Arithmetic Expressions

```
COUNT(times(informix.sysfragments.evalpos,2))  
  
SELECT COUNT(a+1), COUNT(2*a), COUNT(5/a), COUNT(times(a, 2)) FROM myTable;
```

- Bitwise Logical Functions

```
COUNT(BITAND(informix.systables.flags,1))  
  
SELECT COUNT(BITAND(a,1)), COUNT(BITOR(8, 20)), COUNT(BITXOR(41, 33)),  
COUNT(BITANDNOT(20,-20)), COUNT(BITNOT(8)) FROM myTable;
```

- Cast Expressions

```
COUNT(NULL::int)
```

- Conditional Expressions

```
COUNT(CASE WHEN stock.description = "baseball gloves" THEN 1 ELSE NULL END)  
  
SELECT COUNT(CASE WHEN s=14 THEN 1 ELSE NULL END) AS cnt14 FROM all_types;  
SELECT COUNT(NVL(ch, 'Addr unk')) FROM all_types;  
SELECT COUNT(NULLIF(ch, NULL)) FROM all_types;
```

- Constant Expressions

```
COUNT(CURRENT_ROLE)  
COUNT(DATETIME (2007-12-6) YEAR TO DAY)  
  
SELECT COUNT("XX"), COUNT(99),COUNT("t") FROM sysmaster:sysdual;  
SELECT COUNT(SET{6, 9, 9, 4}) FROM sysmaster:sysdual;  
SELECT COUNT("ROW(7, 3, 6.0, 2.0)") FROM sysmaster:sysdual;  
SELECT COUNT(USER), COUNT(CURRENT), COUNT(SYSDATE) from sysmaster:sysdual;  
SELECT COUNT(CURRENT_ROLE), COUNT(DEFAULT_ROLE) from sysmaster:sysdual;  
SELECT COUNT(DBSERVERNAME), COUNT(TODAY), COUNT(CURRENT) from sysmaster:sysdual;  
SELECT COUNT(DATETIME (2007-12-6) YEAR TO DAY) from sysmaster:sysdual;  
SELECT COUNT(INTERVAL (16) DAY TO DAY) FROM sysmaster:sysdual;  
SELECT COUNT(5 UNITS DAY) FROM sysmaster:sysdual;
```

- Function Expressions

```
COUNT (LENGTH ('abc') + LENGTH (stock.description)
COUNT (DBINFO ('sessionid'))
COUNT (user_proc()) --> Here proc() is a user-defined routine.
```

- Column Expressions

```
COUNT (informix.sysfragauth.fragment)
```

You can also use the asterisk (*) character, or a column name, or a column name with the ALL, DISTINCT, or UNIQUE aggregate scope qualifiers as the argument to the **COUNT** function to retrieve different types of information about a table. The table below summarizes the meaning of each of the following forms of the **COUNT** function with an asterisk or column name argument.

COUNT Function	Description
COUNT (*)	Returns the number of rows that satisfy the query. If you do not specify a WHERE clause, this function returns the total number of rows in the table.
COUNT (DISTINCT) or COUNT (UNIQUE)	Returns the number of unique non-NULL values in the specified column
COUNT (column) or COUNT (ALL column)	Returns the total number of non-NULL values in the specified column

Some examples can help to show the differences among the various forms of the **COUNT** function that reference a column. Most of the following examples query against the **ship_instruct** column of the **orders** table in the **stores_demo** demonstration database. For information on the schema of the **orders** table and the data values in the **ship_instruct** column, see the description of the demonstration database in the *IBM® Informix® Guide to SQL: Reference*.

- [Examples of the COUNT\(*\) Function](#)
- [Examples of the COUNT DISTINCT Function](#)
- [Examples of the COUNT column Function](#)

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Examples of the COUNT(*) Function

In the following example, the user wants to know the total number of rows in the **orders** table. So the user calls the **COUNT(*)** function in a SELECT statement without a WHERE clause:

```
SELECT COUNT (*) AS total_rows FROM orders;
```

The following table shows the result of this query.

total_rows
23

In the following example, the user wants to know how many rows in the **orders** table have a NULL value in the **ship_instruct** column. The user calls the **COUNT(*)** function in a SELECT statement with a WHERE clause, and specifies the IS NULL condition in the WHERE clause:

```
SELECT COUNT (*) AS no_ship_instruct FROM orders
WHERE ship_instruct IS NULL;
```

The following table shows the result of this query.

no_ship_instruct
2

In the following example, the user wants to know how many rows in the **orders** table have the value **express** in the **ship_instruct** column. So the user calls the **COUNT(*)** function in the projection list and specifies the equals (=) relational operator in the WHERE clause.

```
SELECT COUNT (*) AS ship_express FROM ORDERS
WHERE ship_instruct = 'express';
```

The following table shows the result of this query.

ship_express
6

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Examples of the COUNT DISTINCT Function

In the next example, the user wants to know how many unique non-NULL values are in the **ship_instruct** column of the **orders** table. The user calls the **COUNT DISTINCT** function in the projection list of the SELECT statement:

```
SELECT COUNT (DISTINCT ship_instruct) AS unique_notnulls
FROM orders;
```

The following table shows the result of this query.

unique_notnulls
16

Examples of the COUNT column Function

In the following example the user wants to know how many non-NULL values are in the **ship_instruct** column of the **orders** table. The user invokes the **COUNT(column)** function in the Projection list of the SELECT statement:

```
SELECT COUNT(ship_instruct) AS total_notnulls FROM orders;
```

The following table shows the result of this query.

total_notnulls
21

A similar query for non-NULL values in the **ship_instruct** column can include the ALL keyword in the parentheses that follow the COUNT keyword:

```
SELECT COUNT(ALL ship_instruct) AS all_notnulls FROM orders;
```

The following table shows that the query result is the same whether you include or omit the ALL keyword (because ALL is the default).

all_notnulls
21

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MAX Function

The **MAX** function returns the largest value in the specified column or expression.

Using the DISTINCT keyword does not change the results. The query in the following example finds the most expensive item that is in stock but has not been ordered:

```
SELECT MAX(unit_price) FROM stock
WHERE NOT EXISTS (SELECT * FROM items
WHERE stock.stock_num = items.stock_num AND
stock.manu_code = items.manu_code);
```

NULLs are ignored unless every value in the column is NULL. If every column value is NULL, the **MAX** function returns a NULL for that column.

Related reference:

[OLAP window aggregate functions](#)

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MIN Function

The **MIN** function returns the lowest value in the column or expression. Using the DISTINCT keyword does not change the results. The following example finds the least expensive item in the **stock** table:

```
SELECT MIN(unit_price) FROM stock;
```

NULL values are ignored unless every value in the column is NULL. If every column value is NULL, the **MIN** function returns a NULL for that column.

Related reference:

[OLAP window aggregate functions](#)

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SUM Function

The **SUM** function returns the sum of all the values in the specified column or expression, as the following example shows:

```
SELECT SUM(total_price) FROM items WHERE order_num = 1013;
```

If you include the DISTINCT or UNIQUE keyword, the returned sum is for only distinct values in the column or expression:

```
SELECT SUM(DISTINCT total_price) FROM items WHERE order_num = 1013;
```

NULL values are ignored unless every value in the column is NULL. If every column value is NULL, the **SUM** function returns a NULL for that column. You cannot use the **SUM** function with a non-numeric column.

Related reference:

[OLAP window aggregate functions](#)

RANGE Function

The **RANGE** function returns the range of values for a numeric column expression argument.

It calculates the difference between the maximum and the minimum values, as follows:

```
range(expr) = max(expr) - min(expr);
```

You can apply the **RANGE** function only to numeric columns. The following query finds the range of ages for a population:

```
SELECT RANGE(age) FROM u_pop;
```

As with other aggregates, the **RANGE** function applies to the rows of a group when the query includes a GROUP BY clause, as the next example shows:

```
SELECT RANGE(age) FROM u_pop GROUP BY birth;
```

Because DATE values are stored internally as integers, you can use the **RANGE** function on DATE columns. With a DATE column, the return value is the number of days between the earliest and latest dates in the column.

NULL values are ignored unless every value in the column is NULL. If every column value is NULL, the **RANGE** function returns a NULL for that column.

Important: All computations for the **RANGE** function are performed in 32-digit precision, which should be sufficient for many sets of input data. The computation, however, loses precision or returns incorrect results when all of the input data values have 16 or more digits of precision.

Related reference:

[OLAP window aggregate functions](#)

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STDEV Function

The **STDEV** function computes the standard deviation of a data set, which is the square root of the **VARIANCE** function. You can apply the **STDEV** function only to numeric columns. The next query finds the standard deviation:

```
SELECT STDEV(age) FROM u_pop WHERE u_pop.age > 0;
```

As with the other aggregates, the **STDEV** function applies to the rows of a group when the query includes a GROUP BY clause, as this example shows:

```
SELECT STDEV(age) FROM u_pop GROUP BY birth WHERE STDEV(age) > 0;
```

NULL values are ignored unless every value in the specified column is NULL. If every column value is NULL, **STDEV** returns a NULL for that column.

Important: All computations for the **STDEV** function are performed in 32-digit precision, which should be sufficient for many sets of input data. The computation, however, loses precision or returns incorrect results when all of the input data values have 16 or more digits of precision.

You cannot use this function on columns of type DATE.

Within a SELECT Statement with GROUP BY clause, **STDEV** returns a zero variance for a count of 1. You can omit this special case through appropriate query construction (for example, "HAVING COUNT (*) > 1"). Otherwise, a data set that has only a few cases might block the rest of the query result.

Related reference:

[OLAP window aggregate functions](#)

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VARIANCE Function

The **VARIANCE** function returns an estimate of the population variance, as the standard deviation squared.

VARIANCE calculates the following value:

$$(\text{SUM}(x_i^2) - (\text{SUM}(x_i)^2) / N) / (N - 1)$$

In this formula,

- x_i is each value in the column,
- and N is the total number of non-NULL values in the column (unless all values are NULL, in which case the variance is logically undefined, and the **VARIANCE** function returns NULL).

You can apply the **VARIANCE** function only to numeric columns.

The following query estimates the variance of **age** values for a population:

```
SELECT VARIANCE(age) FROM u_pop WHERE u_pop.age > 0;
```

As with the other aggregates, the **VARIANCE** function applies to the rows of a group when the query includes a GROUP BY clause, as in this example:

```
SELECT VARIANCE(age) FROM u_pop GROUP BY birth
WHERE VARIANCE(age) > 0;
```

As previously noted, **VARIANCE** ignores NULL values unless every qualified row is NULL for a specified column. If every value is NULL, then **VARIANCE** returns a NULL result for that column. (This typically indicates missing data, and is not necessarily a good estimate of underlying population variance.)

If N, the total number of qualifying non-NULL column values, equals 1, then the **VARIANCE** function returns zero (another implausible estimate of the true population variance). To omit this special case, you can modify the query. For example, you might include a **HAVING COUNT (*) > 1** clause. Important: All calculations for the **VARIANCE** function are performed in 32-digit precision, which should be sufficient for many sets of input data. The calculation, however, loses precision or returns incorrect results when all of the input data values have 16 or more digits of precision. Although DATE values are stored internally as an integer, you cannot use the **VARIANCE** function on columns of data type DATE.

Related reference:

[OLAP window aggregate functions](#)

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Error Checking in ESQL/C

Aggregate functions always return exactly one row. If no rows are selected, the function returns a NULL. You can use the **COUNT (*)** function to determine whether any rows were selected, and you can use an indicator variable to determine whether any selected rows were empty. Fetching a row with a cursor that is associated with an aggregate function always returns one row; hence, 100 for end of data is never returned into the **sqlcode** variable for a first FETCH attempt.

You can also use the GET DIAGNOSTICS statement for error checking.

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Summary of Aggregate Function Behavior

An example can help to summarize the behavior of the aggregate functions. Assume that the **testtable** table has a single INTEGER column that is named **num**. The contents of this table are as follows.

num
2
2
2
3
3
4
(NULL)

You can use aggregate functions to obtain information about the **num** column and the **testtable** table. The following query uses the **AVG** function to obtain the average of all the non-NULL values in the **num** column:

```
SELECT AVG(num) AS average_number FROM testtable;
```

The following table shows the result of this query.

average_number
2.666666666666667

You can use the other aggregate functions in SELECT statements that are similar to the preceding example. If you enter a series of SELECT statements that have different aggregate functions in the projection list and do not include a WHERE clause, you receive the results that the following table shows.

Function	Results		Function	Results
COUNT (*)	7		MAX	4
COUNT (DISTINCT)	3		MAX(DISTINCT)	4
COUNT (ALL num)	6		MIN	2
COUNT (num)	6		MIN(DISTINCT)	2
AVG	2.666666666666667		RANGE	2
AVG (DISTINCT)	3.000000000000000		SUM	16
STDEV	0.74535599249993		SUM(DISTINCT)	9
VARIANCE	0.555555555555556			

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User-Defined Aggregates

You can create your own aggregate expressions with the `CREATE AGGREGATE` statement and then invoke these aggregates wherever you can invoke the built-in aggregates.

The following diagram shows the syntax for invoking a user-defined aggregate.

User-Defined Aggregates

```

      .-ALL-----
|--aggregate--(+-----+-----+-----+column-----+----->
| +-DISTINCT+ +-table.---+ |
| | '-UNIQUE---' +-view.---+ | |
| | | '-synonym.-' |
| | .-ALL-. (1) |
| '+-----+--| Subset of Expression |-----'

>+-----+-----+-----+-----+-----+-----+-----+-----+
| '-,--setup expr-'

```

Notes:

1. See [Subset of Expressions Valid in an Aggregate Expression](#)

Element	Description	Restrictions	Syntax
<i>aggregate</i>	Name of the user-defined aggregate to invoke	The <i>aggregate</i> and the support functions defined for <i>aggregate</i> must exist	Identifier
<i>column</i>	Name of a column within <i>table</i>	Must exist and have a numeric data type	Quoted String
<i>setup_expr</i>	Set-up expression that customizes <i>aggregate</i> for a specific invocation	Cannot be a lone host variable. Any columns referenced in <i>setup_expr</i> must be in the GROUP BY clause of the query	Expression
<i>synonym, table, view</i>	Synonym, table, or view in which <i>column</i> occurs	The <i>synonym</i> and the table or view to which it points must exist	Identifier

Use the **DISTINCT** or **UNIQUE** keywords to specify that the user-defined aggregate is to be applied only to unique values in the named column or expression. Use the **ALL** keyword to specify that the aggregate is to be applied to all values in the named column or expression.

If you omit the DISTINCT, UNIQUE, and ALL keywords, ALL is the default. For further information on the DISTINCT, UNIQUE, and ALL keywords, see [Including or excluding duplicates in the result set](#).

When you specify a setup expression, this value is passed to the **INIT** support function that was defined for the user-defined aggregate in the CREATE AGGREGATE statement.

In the following example, you apply the user-defined aggregate named **my_avg** to all values of the **quantity** column in the **items** table:

```
SELECT my_avg(quantity) FROM items
```

In the following example, you apply the user-defined aggregate named **my_sum** to unique values of the **quantity** column in the **items** table. You also supply the value 5 as a setup expression. This value might specify that the initial value of the sum that **my_avg** will compute is 5.

```
SELECT my sum(DISTINCT quantity, 5) FROM items
```

In the following example, you apply the user-defined aggregate named **my_max** to all values of the **quantity** column in the remote **items** table:

```
SELECT my max(remote.quantity) FROM rdb@rserv:items remote
```

If the **my_max** aggregate is defined as EXECUTEANYWHERE, then the distributed query can be pushed to the remote database server, **rserv**, for execution. If the **my_max** aggregate is not defined as EXECUTEANYWHERE, then the distributed query scans the remote **items** table and computes the **my_max** aggregate on the local database server.

You cannot qualify a user-defined aggregate with the name of a remote database server, as the following example shows. In this case, the database server returns an error:

```
SELECT rdb@rserv:my_max(remote.quantity)
FROM rdb@rserv:items remote
```

For further information on user-defined aggregates, see [CREATE AGGREGATE statement](#) and the discussion of user-defined aggregates in *IBM® Informix® User-Defined Routines and Data Types Developer's Guide*.

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Aggregate expressions in grid queries

Aggregate expressions in grid queries require the database server that issues the grid query to combine aggregate results from multiple grid servers.

Grid queries are distributed SELECT statements that return the logical UNION or UNION ALL on qualifying rows of database tables that have identical schemas in databases of a grid. Grid queries are described in the [GRID clause](#) topic and in the .

Aggregate expressions in grid queries require the database server that issues the Grid query to combine aggregate results from multiple grid servers. Because the Grid query that you specify is converted into a UNION or UNION ALL query across multiple grid servers, each aggregate is calculated independently on each

participating server within the specified grid or region. These individual aggregates are returned to the database server that issued the grid query, which calculates their combined UNION or UNION ALL value.

In order to calculate a global aggregation from these individual aggregates, the grid query must be a subquery. For example, suppose we wanted to see for the southeast region (**SW_USA** in the following example) the total sales and the average sale. Because it is not correct to take the average of a group of averages if the number of qualifying rows varies across data sets within the grid, the correct grid query needs to resemble this:

```
SELECT SUM(amt) AS total_sales ,
       SUM(amt) / SUM(cnt) AS avg_sale FROM
(
  SELECT COUNT(*) cnt, SUM(amt) amt
  FROM sales GRID ALL 'SW_USA'
);
```

total_sales	avg_sale
\$8300.00	\$103.75

In this example, the projection list of the grid query specifies a COUNT(*) expression (aliased as **cnt**) and an aggregate amount **SUM(amt)** (aliased as **amt**) from the **sales** table of each grid server within the southeast region (encoded as 'SW_USA'). Using these values from each of the remote grid servers, the local grid server can calculate an average for the region. This is accomplished by adding up the total sales by evaluating the expression **SUM(amt)** and dividing that value by the total count **SUM(cnt)**, where **cnt** and **amt** are columns in the result set of the grid subquery.

Note that the GRID ALL keywords specify a UNION ALL of the qualifying rows from each participating grid server, to avoid eliminating duplicate rows.

Related concepts:

[Selecting Aggregate Function Expressions](#)

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OLAP window expressions

You can include On-Line Analytical Processing (OLAP) expressions in a SELECT statement to operate on subsets of the rows in the result set of a query or subquery. You can use OLAP window expressions to examine subsets of the qualifying rows for patterns, trends, or exceptions in the data.

OLAP window expressions allow application developers to compose analytic business queries more easily and efficiently. For example, moving averages and moving sums can be calculated over various intervals. Aggregations and ranks can be reset as selected column values change. Complex ratios can be expressed in simple terms.

Syntax

OLAP window expressions

```
|---+| OLAP numbering function |--| OVER clause for numbering function |-----+--|
|
|
+--| OLAP ranking function |--| OVER clause for ranking functions |-----+
|
|
'-| OLAP aggregation function |--| OVER clause for aggregation functions |-----'
```

Notes:

1. See [OLAP numbering function expression](#).
2. See [OLAP ranking function expressions](#).
3. See [OLAP aggregation function expressions](#).

OLAP window expressions are valid in these clauses of the SELECT statement:

- The Select list of the Projection clause
- The ORDER BY clause of the SELECT statement
- Subquery specifications in the Projection clause

OLAP window expressions require an OLAP window function and an OVER clause.

OLAP window function

The OLAP window function identifies an operation for the database server to perform on rows in the query result set. OLAP window functions fit into the following functional categories:

- The OLAP numbering function assigns a unique row number to each row:
 - ROW_NUMBER and ROWNUMBER, which are synonyms
- OLAP ranking functions assign a rank to each row:
 - LAG
 - LEAD
 - RANK
 - DENSE_RANK
 - PERCENT_RANK
 - CUME_DIST
 - NTILE

- OLAP aggregation functions aggregate row data:
 - FIRST_VALUE
 - LAST_VALUE
 - RATIO_TO_REPORT
 - AVG
 - COUNT
 - MAX
 - MIN
 - RANGE
 - STDEV
 - SUM
 - VARIANCE

OVER clause

The OVER clause defines the result set on which the specified operation is performed. The OVER clause has the following capabilities:

- Define window partitions with the PARTITION BY clause. OLAP window partitions are subsets of the rows in the query result set that are based on the values of one or more column expressions that are listed in the PARTITION BY clause.
- Order rows with the ORDER BY clause. If you include the PARTITION BY clause, you order results within each window partition. Otherwise, you order the whole result.
- Define window frames with the ROWS or RANGE specification for OLAP window aggregation functions. A window frame defines a set of rows within a window partition. The aggregation function operates on the contents of the moving window frame instead of on the whole partition.

For example, the following query contains the OLAP aggregation function SUM:

```
SELECT c,d,
       SUM(d) OVER (
         PARTITION BY a,b
         ORDER BY c,d
         ROWS BETWEEN 1 PRECEDING AND 1 FOLLOWING)
FROM table1;
```

The PARTITION BY clause creates window partitions for each set of values of columns **a** and **b**.

The ORDER BY clause orders the data within each window partition by the values of the columns **c** and **d**.

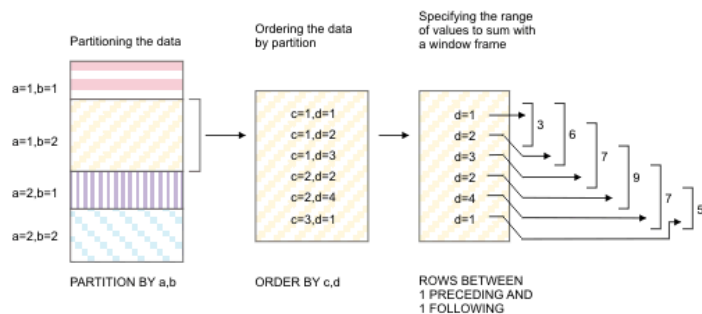
The window frame clause that starts with the ROWS keyword creates a window frame that consists of three rows: the current row, the row that precedes the current row, and the row that follows the current row. The current row is the reference point for the window frame. The following table shows how the window frame moves through the result set as each row becomes the current row in turn.

Table 1. Window frames in the result set

Row number	First frame	Second frame	Third frame	Fourth frame	Fifth frame	Sixth frame
1	Current® row	Current row - 1				
2	Current row + 1	Current row	Current row - 1			
3		Current row + 1	Current row	Current row - 1		
4			Current row + 1	Current row	Current row - 1	
5				Current row + 1	Current row	Current row - 1
6					Current row + 1	Current row

The SUM function adds the values of **d** column for the three rows for each window partition that is in the scope of the query.

The following illustration shows how the query partitions, orders, and aggregates the data.



The query returns the values of columns **c** and **d** for the single window partition and the sum of up to three values of column **d**:

c	d	(sum)
1	1	3
1	2	6
1	3	7
2	2	9
2	4	7
3	1	5

The first value in the **sum** column is the sum of the first and second values (1 + 2 = 3) in the **d** column. No preceding value for the current row exists for the first value.

The third value in the **sum** column is the sum of the second, third, and fourth values ($2 + 3 + 2 = 7$) in the **d** column.

- [OLAP numbering function expression](#)
The OLAP numbering function expression returns a sequential number for each row in the result set of a single query.
- [OLAP ranking function expressions](#)
You can include OLAP ranking function expressions to calculate ordinal ranks that can be applied to each row in the partitioned result set of a query or subquery.
- [OLAP aggregation function expressions](#)
OLAP aggregation function expressions can return aggregate information about rows in the partitioned results of a query.
- [OVER clause for OLAP window expressions](#)
The OVER clause defines the result set on which an OLAP window expression is performed.

[Selecting OLAP window expressions](#)
[OLAP window functions in the ORDER BY clause of SELECT statements](#)

Creating a shard cluster

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The OLAP numbering function expression returns a sequential number for each row in the result set of a single query.

Syntax

Notes:

1. See [OVER clause for OLAP window expressions](#)

The keywords `ROW_NUMBER` and `ROWNUMBER` are synonyms for the same function. This numbering function is like a simplified `RANK` function that does not require a window `ORDER` clause and that does not detect duplicate values. The `ROW_NUMBER` function always returns a unique value for each row in each OLAP window partition.

The ROW_NUMBER function takes no argument, but you must include the empty parentheses after the ROW_NUMBER (or ROWNUMBER) keyword.

The ROW_NUMBER function returns an unsigned integer for every row in each OLAP partition. The sequence of row numbers in each partition starts with 1, and each successive row is incremented by 1, whether consecutive rows in a window partition have the same or different column values.

If the window PARTITION clause is not specified, the complete result set is numbered from 1 to n , where n is the number of qualifying rows that the query or subquery returns.

The OLAP window that the OVER clause defines for numbering functions has this syntax:

- The window PARTITION clause is optional. If none is specified, the scope of the numbering function is the entire result set of the query or subquery, rather than partitioned subsets.
- The window ORDER clause is optional. If none is specified, the returned row numbers are based on the default order of the rows as processed by the query. If a window ORDER clause is specified, the ORDER BY specification determines the row number assignments.
- The window Frame clause is not supported for OLAP numbering functions.

If the OVER clause that defines the OLAP window for the ROW_NUMBER function omits both the window PARTITION clause and window ORDER clause, you must include the empty parentheses after the OVER keyword.

Part VIII: SQL programming 885

The following query partitions the rows in the product table by distinct package types (pkg_type) and assigns row numbers that restart at 1 for each partition.

```
SELECT ROW_NUMBER()
       OVER(PARTITION BY pkg_type ORDER BY prod_name)
       AS rownum, prod_name, pkg_type
FROM product;
```

ROWNUM	PROD_NAME	PKG_TYPE
1	Aroma Sounds CD	Aroma designer box
2	Aroma Sounds Cassette	Aroma designer box
1	Christmas Sampler	Gift box
2	Coffee Sampler	Gift box
3	Easter Sampler Basket	Gift box
4	Spice Sampler	Gift box
5	Tea Sampler	Gift box
1	Aroma Roma	No pkg
2	Aroma baseball cap	No pkg
3	Aroma t-shirt	No pkg
4	Assam Gold Blend	No pkg
5	Assam Grade A	No pkg
6	Breakfast Blend	No pkg
7	Cafe Au Lait	No pkg
8	Coffee Mug	No pkg
9	Colombiano	No pkg
10	Darjeeling Number 1	No pkg
11	Darjeeling Special	No pkg
12	Demitasse Ms	No pkg
13	Earl Grey	No pkg
...		

Because the window ORDER clause specifies the prod_name column as the sorting key, in the default (ASC) order, the returned row numbers are based on the alphabetical order of the product names. For example, the three "Aroma" products are numbered 1, 2, and 3 within the "No pkg" partition. (Uppercase letters sort above lowercase in the default ASCII collation.)

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OLAP ranking function expressions

You can include OLAP ranking function expressions to calculate ordinal ranks that can be applied to each row in the partitioned result set of a query or subquery.

OLAP ranking function expressions are OLAP window expressions that you can include in the Projection list of a SELECT statement, or the ORDER BY clause of a SELECT statement.

Syntax

OLAP ranking function expressions

```
--| OLAP ranking function |--| OVER clause for ranking functions |--|
```

OLAP ranking function

```
(1)
|---+| LAG function |-----+-----|
|      (1)      |
|---+| LEAD function |-----+-----|
|      (2)      |
|---+| RANK function |-----+-----|
|      (3)      |
|---+| DENSE_RANK function |-----+-----|
|      (4)      |
|---+| PERCENT_RANK function |-----+-----|
|      (5)      |
|---+| CUME_DIST function |-----+-----|
|      (6)      |
|---+| NTILE function |-----+-----|
```

OVER clause for ranking functions

```
(7)
|--OVER--(---+-----+-----+---| Window ORDER clause |-----)--|
|      (7)      |
|---+| Window PARTITION clause |-----|
```

Notes:

1. See [LAG and LEAD functions](#)
2. See [RANK function](#)
3. See [DENSE_RANK function](#)
4. See [PERCENT_RANK function](#)
5. See [CUME_DIST function](#)
6. See [NTILE function](#)

Usage

The ranking values that these functions return are dependent on the window ORDER clause within the OVER clause. The ORDER clause defines the columns or expressions that the database server uses to calculate the ranking values.

If you omit the window PARTITION clause, the scope of the ranking function is the entire result set of the query or subquery, rather than partitioned subsets of results.

- LAG and LEAD functions

The LAG and LEAD functions are OLAP ranking functions that return the value of their *expression* argument for the row at a specified offset from the current row within the current window partition.

- RANK function

The RANK function is an OLAP ranking function that calculates a ranking value for each row in an OLAP window. The return value is an ordinal number, which is based on the required ORDER BY expression in the OVER clause.

- DENSE_RANK function

The DENSE_RANK function is an OLAP ranking function that calculates a ranking value for each row in an OLAP window. The return value is an ordinal number, which is based on the required ORDER BY expression in the OVER clause.

- PERCENT RANK function

The PERCENT_RANK function is an OLAP ranking function that calculates a ranking value for each row in an OLAP window, normalized to a range from 0 to 1.

- CUME DIST function

The CUME_DIST function is an OLAP ranking function that calculates a cumulative distribution as a percentile ranking for each row. The rank is expressed as a decimal fraction that ranges from 0 to 1.

- NTILE function

The NTILE function is an OLAP ranking function that classifies the rows in each partition into N ranked categories, called tiles, where each category includes an approximately equal number of rows.

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LAG and LEAD functions

The LAG and LEAD functions are OLAP ranking functions that return the value of their *expression* argument for the row at a specified offset from the current row within the current window partition.

Syntax

LAG and LEAD functions

```
|--+-LAG--+--+ (--expression---+RESPECT NULLS--+--+-----+--+)+--+>
|'-LEAD-' | '-IGNORE NULLS--' '|-,--offset-+-----+-' |
| | | '-,--default-' |
| '-(--expression-+-----+--) --+RESPECT NULLS+----+' |
| | | '-,--offset-+-----+-' | '-IGNORE NULLS--' |
| | | '-,--default-' |
(1)
>--| OVER clause for Ranking functions |-----|
```

Notes:

1. See [OVER clause](#) for OLAP window expressions

Element	Description	Restrictions	Syntax
<i>default</i>	Value to return if <i>offset</i> goes beyond the scope of the current window partition	If <i>default</i> is not specified, the value of NULL is returned for any out-of-scope row.	Column Expressions
<i>expression</i>	Column name, alias, or constant expression to return for the row at <i>offset</i> rows from the current row	If <i>expression</i> references a column, the column must also be in the select list of the Projection clause.	Column Expressions
<i>offset</i>	Non-negative integer constant defining an offset from the position of the current row	Requires a window PARTITION clause. If zero, specifies the current row. If <i>offset</i> is not specified, the value 1 is used.	Literal integer

Usage

The *expression* argument is required. The data type of the return value from the LAG or LEAD function is the data type of the expression.

Based on the sort order that the window ORDER clause imposes for each window partition, the LEAD and LAG functions return the value of the expression for every row at *offset* rows from the current row:

- For the LAG function, the *offset* indicates the row that precedes the current row by *offset* rows.

- For the LEAD function, the *offset* indicates the row that follows the current row by *offset* rows.

If the OVER clause includes no window PARTITION clause, these functions return the *expression* values for the entire result set of the query.

If a window PARTITION clause is specified, the second argument to the LAG function (*offset*) means *offset* rows before the current row and within the current partition. For the LEAD function, the second argument means *offset* rows after the current row and within the current partition.

For both functions, if *offset* is not specified, the value 1 is used. If you specify the optional third argument (*default*), which can be an expression, its value is returned if the *offset* goes beyond the scope of the current partition. Otherwise, the NULL value is returned. When the third argument is specified, the second argument must also be specified.

Handling NULL values

In a LAG or LEAD function expression, the optional RESPECT NULLS or IGNORE NULLS keywords can be specified in either of two locations:

- In the argument list
- Immediately following the closing parenthesis that delimits the argument list

The database server issues an exception, however, if you include RESPECT NULLS or IGNORE NULLS in both of these locations within the same LAG or LEAD expression.

The RESPECT NULLS and IGNORE NULLS keywords have these effects:

- If you specify the RESPECT NULLS keywords, rows whose *expression* evaluates to NULL are included when *offset* rows are counted.
- If you specify the IGNORE NULLS keywords, any row whose *expression* evaluates to NULL is not included when *offset* rows are counted.

If you specify IGNORE NULLS and all of the *expression* values for the rows in the window partition are NULL, the LAG or LEAD function returns the *default* value for each row. The function returns the NULL value if no *default* argument is specified.

Example: LEAD and LAG functions

In the following query, the LAG function and the LEAD function each defines an OLAP window that partitions employees by department and lists their salary. The LAG function shows how much more compensation each employee receives, compared to the employee in the same department with the next lower salary value. The LEAD function shows how much less each employee receives, compared to the employee in the same department with the next higher salary value.

```
SELECT name, salary, LAG(salary)
      OVER (PARTITION BY dept ORDER BY salary),
      LEAD(salary, 1, 0)
      OVER (PARTITION BY dept ORDER BY salary)
FROM employee;
```

name	salary	(lag)	(lead)
John	35,000		38,400
Jack	38,400	35,000	41,200
Julie	41,200	38,400	45,600
Manny	45,600	41,200	47,300
Nancy	47,300	45,600	49,500
Pat	49,500	47,300	51,300
Ray	51,300	49,500	0

The first row with name John has a NULL value for the LAG function because no default value is specified. The last row with name Ray has a 0 value for the LEAD function because 0 is specified as the default value of the third argument in the LEAD function.

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RANK function

The RANK function is an OLAP ranking function that calculates a ranking value for each row in an OLAP window. The return value is an ordinal number, which is based on the required ORDER BY expression in the OVER clause.

Syntax

RANK function

```
|--RANK -( ) -| OVER clause for ranking functions |-----|
(1)
```

Notes:

1. See [OVER clause for OLAP window expressions](#)

Usage

The rank of a row is defined as 1 plus the number of rows whose rankings precede that of the row. If two or more rows have the same value, these rows get the same rank as well. Results can have a gap in the sequence of consecutive ranked values. For example, if two rows are ranked 1, the next ranking is 3. The DENSE_RANK function uses a different rule for ranking rows that include non-unique values.

The RANK function takes no argument, but the empty parentheses must be specified. If the OVER clause specifies the optional window PARTITION clause, the rankings are calculated within the subset of rows that each partition defines.

Example: RANK function

The following query ranks sales people by the amount of their sales. The ranks are not consecutive because ties in sales amounts are both assigned the same rank value, and the next rank value is skipped.

```
SELECT emp_num, sales,
       RANK() OVER (ORDER BY sales) AS rank
FROM sales;
```

emp_num	sales	rank
101	2,000	1
102	2,400	2
103	2,400	2
104	2,500	4
105	2,500	4
106	2,650	6

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DENSE_RANK function

The DENSE_RANK function is an OLAP ranking function that calculates a ranking value for each row in an OLAP window. The return value is an ordinal number, which is based on the required ORDER BY expression in the OVER clause.

Syntax

```
DENSE_RANK function
|---+--DENSE_RANK +--( )----->
      '-DENSERANK -'

                                     (1)
>--| OVER clause for Ranking functions |-----|
```

Notes:

1. See [OVER clause for OLAP window expressions](#)

Usage

The rank of a row is defined as 1 plus the number rankings that precede the ranking of the row. If two or more rows have the same value, these rows get the same rank. However, in contrast to the RANK function, if two or more rows tie, there is no gap in the sequence of ranked values. For example, if two rows are ranked 1, the next ranking is still 2.

This function takes no argument, but the empty parentheses must be specified. If the OVER clause specifies the optional window PARTITION clause, the DENSE_RANK rankings are calculated within the subset of rows that each window partition defines.

Example: DENSE_RANK function

The following query ranks sales people by the amount of their sales. Ranks are consecutive even if multiple sales amounts have the same rank.

```
SELECT emp_num, sales,
       DENSE_RANK() OVER (ORDER BY sales) AS dense_rank,
FROM sales;
```

emp_num	sales	dense_rank
101	2,000	1
102	2,400	2
103	2,400	2
104	2,500	3
105	2,500	3
106	2,650	4

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PERCENT_RANK function

The PERCENT_RANK function is an OLAP ranking function that calculates a ranking value for each row in an OLAP window, normalized to a range from 0 to 1.

Each PERCENT_RANK value is computed as the row's RANK minus 1, divided by the number of rows in the partition minus 1. Values closer to 1 generally represent higher rankings and values closer to 0 generally represent lower rankings.

Syntax

PERCENT_RANK function

```
|--PERCENT_RANK -( ) -| OVER clause for Ranking functions |-----|  
                                (1)
```

Notes:

1. See [OVER clause for OLAP window expressions](#)

Usage

This function takes no argument, but the empty parentheses must be specified. If the optional window PARTITION clause is also specified, the rankings are calculated within the subset of rows that each partition defines. If there is a single row in the partition, its PERCENT_RANK value is 0.

Example: PERCENT_RANK function

The following query ranks sales people by the amount of their sales.

```
SELECT emp_num, sales,  
       PERCENT_RANK() OVER (ORDER BY sales) AS per_rank  
FROM sales;
```

emp_num	sales	per_rank
101	2,000	0
102	2,400	0.2
103	2,400	0.2
104	2,500	0.6
105	2,500	0.6
106	2,650	1.0

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CUME_DIST function

The CUME_DIST function is an OLAP ranking function that calculates a cumulative distribution as a percentile ranking for each row. The rank is expressed as a decimal fraction that ranges from 0 to 1.

Syntax

CUME_DIST function

```
|--CUME_DIST -( ) -| OVER clause for Ranking functions |-----|  
                                (1)
```

Notes:

1. See [OVER clause for OLAP window expressions](#)

Usage

The CUME_DIST function calculates the number of rows that are ranked lower than or equal to the current row, including the current row, which is divided by the total number of rows in the partition. Values closer to 1 represent higher rankings and values closer to 0 represent lower rankings.

This function takes no argument, but the empty parentheses must be specified. If the optional window PARTITION clause is also specified, the rankings are calculated within the subset of rows that each partition defines. If there is a single row in the partition, its CUME_DIST value is 1.

Example: CUME_DIST function

The following query shows the cumulative distribution of the amount of sales per sales person.

```
SELECT emp_num, sales,  
       CUME_DIST() OVER (ORDER BY sales) AS cume_dist  
FROM sales;
```

emp_num	sales	cume_dist
101	2,000	0.166666667

102	2,400	0.500000000
103	2,400	0.500000000
104	2,500	0.833333333
105	2,500	0.833333333
106	2,650	1.000000000

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NTILE function

The NTILE function is an OLAP ranking function that classifies the rows in each partition into N ranked categories, called tiles, where each category includes an approximately equal number of rows.

Syntax

```
NTILE function
|--NTILE--(--unsigned--)>
(1)
>--| OVER clause for Ranking functions |
```

Notes:

1. See [OVER clause for OLAP window expressions](#)

Element	Description	Restrictions	Syntax
<i>unsigned</i>	Unsigned integer that specifies how many categories, or tiles, to rank	Cannot be zero	Literal integer

Usage

The number of ranked categories, or tiles, is set by the unsigned integer argument to the function, and on the ORDER BY expression in the OVER clause.

For example, the following ranking function expression returns percentile rankings from 1 to 100 for the values in the **dollars** column for all the rows in the query result set:

```
NTILE(100) OVER(ORDER BY dollars)
```

When the argument is 4, the returned values sort the rows in each partition that the OVER clause defines into four quartiles. When a set of values is not divisible by the specified integer argument, the NTILE function puts leftover rows in the lower-ranked tiles.

Example: NTILE function

The following query ranks employees in departments by employee salary, and calculates the tile number of 1 through 5 for each department.

```
SELECT name, salary,
       NTILE(5) OVER (PARTITION BY dept ORDER BY salary)
FROM employee;
```

name	salary	(ntile)
John	35,000	1
Jack	38,400	1
Julie	41,200	2
Manny	45,600	2
Nancy	47,300	3
Pat	49,500	4
Ray	51,300	5

The salaries are ordered from lowest to highest because the default ordering direction for the ORDER BY clause is ascending. If you include the DESC keyword in the ORDER BY clause, the salaries are ordered from highest to lowest.

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OLAP aggregation function expressions

OLAP aggregation function expressions can return aggregate information about rows in the partitioned results of a query.

OLAP aggregation function expressions are OLAP window expressions that you can include in the Projection list of a SELECT statement, or the ORDER BY clause of a SELECT statement.

Syntax

Element	Description	Restrictions	Syntax
<i>expression</i>	Column name, alias, or constant expression	If <i>expression</i> references a column, the column must also be in the select list of the Projection clause	Column Expressions

Usage

The return data type of the FIRST_VALUE function is the data type of the specified expression. The result can be NULL. If IGNORE NULLS is specified, all rows where the expression value for the row evaluates to a NULL value are not considered in the calculation. If IGNORE NULLS is specified and all values in the OLAP window are NULL, the FIRST_VALUE function returns the NULL value.

The RESPECT NULLS or IGNORE NULLS option can be specified either within the parentheses immediately following the expression, or outside the parentheses, but only one such specification is allowed.

Example: FIRST_VALUE function

The following statement returns stock prices by day and the differences in the stock prices from the first value, 18.25, in the window partition.

```
SELECT price, price - FIRST_VALUE(price)
      OVER (PARTITION BY year ORDER BY tradingday)
      AS diff_price
FROM stock_price
WHERE tradingday between '2012-11-01' and '2012-11-07' ;
```

price	diff_price
18.25	0
18.37	0.12
19.03	0.78
18.59	0.34
18.21	-0.04

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LAST_VALUE function

The LAST_VALUE window aggregation function returns the value of a specified expression for the last row in each OLAP window partition.

Syntax

```
LAST_VALUE function

|--LAST_VALUE--+--(--expression--)-----+--RESPECT NULLS+-----+
|               |               '-IGNORE NULLS--' |
|               |               '-(--expression--+--RESPECT NULLS+---)-----'
|               |               '-IGNORE NULLS--'
|
|               (1)
>--| OVER clause for aggregation functions |-----|
```

Notes:

1. See [OVER clause for OLAP window expressions](#)

Element	Description	Restrictions	Syntax
<i>expression</i>	Column name, alias, or constant expression	If <i>expression</i> references a column, the column must also be in the select list of the Projection clause	Column Expressions

Usage

The return data type of the LAST_VALUE function is the data type of the specified expression. The result can be NULL. If IGNORE NULLS is specified, all rows where the expression value for the row evaluates to a NULL value are not considered in the calculation. If IGNORE NULLS is specified and all values in the OLAP window are NULL, the LAST_VALUE function returns the NULL value.

The RESPECT NULLS or IGNORE NULLS option can be specified either within the parentheses immediately following the expression, or outside the parentheses, but only one such specification is allowed.

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RATIO_TO_REPORT function

The `RATIO_TO_REPORT` function calculates the fractional ratio of each row to the rest of the rows in the window partition, based on the numeric argument to the function.

Syntax

```
RATIO_TO_REPORT function

|---+RATIO_TO_REPORT+---(--expression--)----->
  '-RATIO_TO_REPORT---'

                                     (1)

>---| OVER clause for aggregation functions |-----|
```

Notes:

1. See [OVER clause for OLAP window expressions](#)

Element	Description	Restrictions	Syntax
<i>expression</i>	Column name, alias, or constant expression	The <i>expression</i> must evaluate to a numeric data type. DATE, DATETIME, and INTERVAL columns are not valid. If <i>expression</i> references a column, the column must also be in the select list of the Projection clause.	Column Expressions

Usage

This function calculates the ratio of values for a specified numeric column in a row versus the sum of values from all rows in each partition in an OLAP window frame. The name `RATIO_TO_REPORT` is a keyword synonym for `RATIO_TO_REPORT`.

As with all OLAP window aggregation functions, the Window PARTITION, Window ORDER, and Window Frame clauses are optional. The ratios can be applied either to partitioned rows or to the complete query result set. If a window Frame clause is also specified, then the calculated ratio applies to all rows from the current window frame.

The required *expression* argument must specify a column of a numeric data type, or else be a constant expression that evaluates to a numeric data type. If *expression* is not a numeric data type, the function fails with Error Message -25862.

If the sum of *expression* values for all the rows in the current window partition is zero, this function returns the NULL value for each row in that partition.

If another OLAP aggregation function, such as SUM or MAX, has an empty OVER clause, or if the OVER clause contains only a single window PARTITION specification, the result of the OLAP function is the same for every row in the partition. This is not the case, however, for `RATIO_TO_REPORT`, because different rows in the same window partition are assigned different ratios, totaling 1 (approximately) for each partition. To convert ratios to percentages, multiply the function expression by 100, as in the following example.

Example: RATIO_TO_REPORT function

The following example calculates the decimal fraction of each city's sales, based on all rows that the query returns, as a single report that shows the sales totals for each city, in descending order.

```
SELECT city, SUM(dollars) AS SALES,
       RATIO_TO_REPORT(SUM(dollars)) OVER() *100 AS RATIO_DOLLARS
FROM sales, store, period
WHERE sales.store_id = store.store_id
   AND sales.period_id = period.period_id
GROUP BY city
ORDER BY sales DESC;
```

CITY	SALES	RATIO_DOLLARS
San Jose	896931.15	12.58
Atlanta	514830.00	7.22
Miami	507022.35	7.11
Los Angeles	503493.10	7.06
Phoenix	437863.00	6.14
New Orleans	429637.75	6.03
Cupertino	424215.00	5.95
Boston	421205.75	5.91
Houston	417261.00	5.85
New York	397102.50	5.57
Los Gatos	394086.50	5.53
Philadelphia	392377.75	5.50
Milwaukee	389378.25	5.46
Detroit	305859.75	4.29
Chicago	294982.75	4.14
Hartford	236772.75	3.32
Minneapolis	165330.75	2.32

In the example above, the *expression* argument to `RATIO_TO_REPORT` is the numeric aggregate function expression `SUM(dollars)`. The last row of the output indicates that the **sales** value for the **city** Minneapolis is approximately 2.32% of the total sales that the query reports.

If the OVER clause includes the Window Frame clause, MAX returns a value for each set of rows in a window frame.

When a column expression is specified as argument to COUNT, NULL values are ignored unless every value in the specified column expression is NULL. If every value is NULL, MAX returns a NULL value for that column or expression. When COUNT(*) is specified, NULL values are counted the same as other values.

MIN function

The MIN function returns the lowest value in the column or expression in a window partition of the query results, for each partition that the OLAP window OVER clause defines. If the OVER clause includes the Window Frame clause, the MIN function returns a value for each set of rows.

Specifying the DISTINCT or UNIQUE keyword has no effect on the results, but (as with the other built-in aggregate functions) no Window ORDER or window Frame clause is allowed.

If the OVER clause includes the Window Frame clause, MIN returns a value for each set of rows in a window frame.

NULL values are ignored unless every value in the specified column expression is NULL. If every value is NULL, MIN returns a NULL value for that column expression.

RANGE function

The RANGE function returns the range of values in the column or expression in a window partition of the query results, for each partition that the OLAP window OVER clause defines. If the OVER clause includes the Window Frame clause, RANGE returns a value for each set of rows in a window frame.

The RANGE function calculates the difference between the maximum and the minimum values, as follows:

```
range(expr) = max(expr) - min(expr)
```

You can apply the RANGE function only to numeric column expressions. The following query finds the range of ages for a population:

```
SELECT RANGE(age) OVER () FROM u_pop;
```

Because DATE values are stored internally as integers, you can use the RANGE function on DATE column. With a DATE column, the return value is the number of days between the earliest and latest dates in the column expression.

NULL values are ignored unless every value in the column expression is NULL. If every column expression value is NULL, the RANGE function returns a NULL for that column expression.

STDEV function

The STDEV function returns the standard deviation of a column or expression, using the following formula:

```
SQRT((SUM(Xi2) - (SUM(Xi)2)/N) / (N - 1))
```

In this formula, X_i is each column expression value in the window partition or frame that the OVER clause specifies, and N is the total number of non-NULL values in the column expression.

If the OVER clause includes the Window Frame clause, the STDEV function returns a value for each set of rows in a window frame.

NULL values are ignored, unless every value in the specified column expression is NULL. If every column expression value is NULL, the STDEV function returns NULL for that column expression.

You can apply the STDEV function only to numeric column expressions. You cannot use this function on column expressions of type DATE.

SUM function

The SUM function calculates and returns the sum of all the values of a column expression in a window partition of the query results, for the rows in each partition that is defined in the OLAP window OVER clause.

If you use the DISTINCT (or UNIQUE) keyword as the first item in the argument list, the sum is for only distinct values in the column or expression, and no Window ORDER or Window Frame clause is allowed.

NULL values are ignored, unless every value is NULL. If every value is NULL, the SUM function returns the NULL value for that column or expression.

You cannot use the SUM function with a nonnumeric column or expression.

VARIANCE function

The VARIANCE function calculates and returns the mean squared error as an estimate of the population variance of the values in a specified numeric column or expression for the partitions of query results that are defined in the OVER clause that follows the OLAP window VARIANCE expression.

If the OVER clause includes the Window Frame clause, the VARIANCE function returns a value for each set of rows, using the following formula:

```
(SUM(Xi2) - (SUM(Xi)2)/N) / (N - 1)
```

In this formula,

- X_i is each column value in the window partition or frame that the OVER clause specifies,
- and N is the total number of non-NULL values in the column (unless all values are NULL, in which case the variance is logically undefined, and the VARIANCE function returns NULL).

You can apply the VARIANCE function only to numeric columns.

Example: AVG function with partitioning

In the following example, the AVG function is used in an OLAP window aggregation expression to return the rolling average **closeprice** column values during the year 2012 for two window partitions, based on **ABC** and on **XYZ** values in the **symbol** column as the partitioning keys.

```
SELECT symbol, tradingdate,
       AVG(closeprice) OVER (PARTITION BY symbol
                           ORDER BY tradingdate
                           ROWS BETWEEN 29 PRECEDING AND CURRENT ROW)
FROM   dailystockdata
WHERE  symbol IN ('ABC', 'XYZ')
      AND tradingdate BETWEEN '2012-01-01' AND '2012-12-31';
```

The window ORDER clause specifies the **tradingdate** column value as the sorting key, and the window Frame clause defines a rolling window that is based on the average of 30 consecutive **tradingdate** values, ending with the **tradingdate** of the current row.

Example: AVG function without partitioning

The following query returns the stock price ordered by day and the average of the prices of the current day, the day before, and the day after. The result set is not partitioned because the query does not include a PARTITION BY clause.

```
SELECT price,
       AVG(price) OVER (ORDER BY tradingday
                       ROWS BETWEEN 1 PRECEDING AND 1 FOLLOWING)
FROM   stock_price
WHERE  tradingday BETWEEN '2012-11-01' AND '2012-11-07';
```

price	(avg)
18.25	18.31
18.37	18.31
	18.37
	19.03
19.03	18.81
18.59	18.61
18.21	18.40

The first value in the **avg** column is the average of the first two values in the **price** column, because no preceding values exist for the first value of the **price** column.

The second value in the **avg** column is the average of the first two values in the **price** column, because the third row of the **price** column does not have a value.

The third value in the **avg** column is equal to the second value in the **price** column because the third and fourth rows in the **price** column do not have values.

Example: COUNT function

The following query returns the shipping date, the shipping charge, and the number of orders for each order by customer. The query results are partitioned by customer number and limited to customer numbers that are less than or equal to 110.

```
SELECT customer_num, ship_date, ship_charge,
       COUNT(*) OVER (PARTITION BY customer_num)
FROM   orders
WHERE  customer_num <= 110;
```

customer_num	ship_date	ship_charge	(count(*))
101	05/26/2008	\$15.30	1
104	05/23/2008	\$10.80	4
104	07/03/2008	\$5.00	4
104	06/01/2008	\$10.00	4
104	07/10/2008	\$12.20	4
106	05/30/2008	\$19.20	2
106	07/03/2008	\$12.30	2
110	07/06/2008	\$13.80	2
110	07/16/2008	\$6.30	2

Customer 104 appears in the list four times. The value in the **count** column is always 4 for customer 104.

Related reference:

[AVG Function](#)

[COUNT\(*\) function](#)

[COUNT DISTINCT and COUNT UNIQUE functions](#)

[MAX Function](#)

[MIN Function](#)

[RANGE Function](#)

[STDEV Function](#)

[VARIANCE Function](#)

[SUM Function](#)

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OVER clause for OLAP window expressions

The OVER clause defines the result set on which an OLAP window expression is performed.

Syntax

```
OVER clause

|---+---| OVER clause for numbering functions |---+-----|
  +-| OVER clause for ranking functions |-----+
  '-| OVER clause for aggregation functions |-|

OVER clause for numbering functions

|--OVER--(+-----+-----+-----+-----+-----+--)|
      '-| Window PARTITION clause |-| '-| Window ORDER clause |-|

OVER clause for ranking functions

|--OVER--(+-----+-----+-----+-----+-----+--)| Window ORDER clause |--)|
      '-| Window PARTITION clause |-|

OVER clause for aggregation functions

|--OVER--(+-----+-----+-----+-----+-----+-->
      '-| Window PARTITION clause |-|

>---+-----+-----+-----+-----+-----+---)|
      '-| Window ORDER clause |--+-----+-----+
          '-| Window Frame clause |-|

Window PARTITION clause

      .-+-----+
      V      |
|--PARTITION BY---partition_key+-----|

Window ORDER clause

      .-+-----+
      V      |
|--ORDER BY---sorting_key+-----+-----+
          '-DESC-' '-NULLS--+FIRST--'
                      '-LAST--'

Window Frame clause

|---+---RANGE+---+---UNBOUNDED PRECEDING+-----+---|
  '-ROWS--' | +-offset--PRECEDING---+ |
            | '-CURRENT ROW-----' |
            '-BETWEEN---UNBOUNDED PRECEDING+---AND---UNBOUNDED FOLLOWING+---'
              +-offset--PRECEDING---+ +-offset--PRECEDING---+
              +-offset--FOLLOWING---+ +-offset--FOLLOWING---+
              '-CURRENT ROW-----'   '-CURRENT ROW-----'
```

Element	Description	Restrictions	Syntax
<i>offset</i>	Unsigned integer that represents the offset from the position of the current row	Cannot be negative. If zero, specifies the current row	Literal integer.
<i>partition_key</i>	Column name, alias, or constant expression by which to partition rows	Must be in the select list of the Projection clause	Column Expressions
<i>sorting_key</i>	Column name, alias, or constant expression by which to sort rows	Same restrictions as for <i>partition_key</i> . For RANGE window frames, only a single sorting key is allowed, and the data type must be numeric, DATE, or DATETIME.	Column Expressions

If the OVER clause is empty, you must still include the empty parentheses.

Window PARTITION clause

An OLAP window partition is a subset of the rows that are returned by a query. Each partition is defined by one or more column expressions in the PARTITION BY specification of the OVER clause that defines the window. The database server applies the specified OLAP window function to all of the rows in each window partition. If no partitions are defined in the OVER clause, the window function is applied to every row in the result set of the query.

Window ORDER clause

The database server sorts the rows in each window partition according to the sort key (or multiple sort keys) in the window ORDER clause. If you specify no ascending (ASC) or descending (DESC) order, ASC is the default. If no ORDER clause is specified, the order of the qualifying rows is the order in which the rows were retrieved.

Window Frame clause

The window Frame clause can return subsets, called *aggregation groups*, of the rows in each window partition. A window frame is defined by a specific number of rows or by a range of values.

Row-based window frame

The ROWS keyword creates a row-based window frame that consists of a specific number of rows that precede or follow the current row, or both. The offset represents the number of rows to return. The following example returns seven rows that include the six rows that precede the current row:

```
AVG(price) OVER (ORDER BY year, day  
ROWS BETWEEN 6 PRECEDING AND CURRENT ROW)
```

In a row-based window frame clause, offsets are expressed as unsigned integers because the keyword FOLLOWING specifies a positive offset from the current rows, and the keyword PRECEDING specifies a negative offset from the current row. The keyword UNBOUNDED refers to all of the rows from the current row to the limit of the window partition. As the first term after the ROWS keyword in a window Frame specification, UNBOUNDED PRECEDING means that the starting boundary is the first row in the partition, and UNBOUNDED FOLLOWING means that the ending boundary is the last row in the partition.

Value-based window frame

The RANGE keyword creates a value-based frame clause that consists of the current row plus the rows that meet the criteria that is set by the sorting key in the ORDER clause and fit into the specified offset. The offset represents the number of units of the data type of the sorting key. The sorting key must be a numeric, DATE, or DATETIME data type. For example, if the sorting key is a DATE data type, the offset represents a specific number of days. The following example returns the count of the number of rows that have a ship date within 2 days of the current row plus the current row:

```
COUNT(*) OVER (ORDER BY ship_date  
RANGE BETWEEN 2 PRECEDING AND 2 FOLLOWING)
```

Value-based window frames define rows within a window partition that contain a specified range of numeric values. The window ORDER clause of the OVER function defines the numeric, DATE, or DATETIME column to which the RANGE specification is applied, relative to the current row value for that column. Only a single sorting key is allowed in the ORDER clause of value-based window frames.

In both the row-based and value-based cases, the OLAP function is calculated on the contents of this window frame, rather than the fixed contents of the whole partition. The window frame does not need to contain the current row. For example, the following specification defines a window frame that contains only the row before the current row:

```
ROWS BETWEEN 1 PRECEDING AND 1 PRECEDING
```

If you specify no window ORDER clause for a window aggregation function, then by default, the result set is not restricted, which is equivalent to the following window frame specification:

```
ROWS BETWEEN UNBOUNDED PRECEDING AND UNBOUNDED FOLLOWING
```

If you specify an ORDER clause but no window frame clause for a window aggregation function, then by default, all rows that precede the current row and the current row are returned, which is equivalent to the following window frame specification:

```
ROWS BETWEEN UNBOUNDED PRECEDING AND CURRENT ROW
```

Example: SUM function without a window frame

The following query returns the sales by quarter for one year and the cumulative sum of the sales by quarter.

```
SELECT sales, SUM(sales) OVER (ORDER BY quarter)  
FROM sales WHERE year = 2013
```

sales	(sum)
120	120
135	255
127	382
153	535

The sum of the sales for the fourth quarter is equal to the sales in all four quarters.

Because the query does not include a window frame clause, the SUM function operates on the entire result set, as specified by the FROM clause.

Example: Row-based window frame

The following query returns players that are partitioned by teams and ordered by the number of points. Within each partition, the number of points for the player and the previous player are averaged:

```
SELECT team, player, points,  
AVG(points) OVER(PARTITION BY team ORDER BY points  
ROWS 1 PRECEDING AND CURRENT ROW) AS olap_avg  
FROM points;
```

TEAM	PLAYER	POINTS	OLAP_AVG
A	Singh	7	7.000000000000
A	Smith	14	10.500000000000
B	Osaka	8	8.000000000000
B	Ricci	12	10.000000000000
B	Baxter	18	15.000000000000
C	Chun	13	13.000000000000
D	Kwan	9	9.000000000000
D	Tran	16	12.500000000000

Example: Range-based window frame

The following query returns players that are partitioned by teams and ordered by age. Within each partition, the number of points for each player and any player who is up to 9 years older is averaged:


```
SELECT player, age, team, points,
       AVG(points) OVER(PARTITION BY team ORDER BY age
                        RANGE BETWEEN CURRENT ROW AND 9 FOLLOWING) AS olap_avg
FROM points_age;
```

PLAYER	AGE	TEAM	POINTS	OLAP_AVG
Singh	25	A	7	10.500000000000
Smith	26	A	14	14.000000000000
Baxter	27	B	18	13.000000000000
Osaka	35	B	8	10.000000000000
Ricci	40	B	12	12.000000000000
Chun	21	C	13	13.000000000000
Kwan	22	D	9	12.500000000000
Tran	31	D	16	16.000000000000

In partition A, the average for Singh includes the points for Smith, because Smith is one year older than Singh. The average for Smith does not include the points from Singh, because Singh is younger than Smith.

In partition B, the average for Baxter includes the points for Osaka, who is 8 years older than Baxter, but not for Ricci, who is 13 years older than Baxter.

In partition D, the average for Kwan includes the points for Tran, because Tran is 9 years older than Kwan.

Example: Window frame without the current row

The following query calculates the average number of points for the preceding two rows in the partition:

```
SELECT player, age, team, points,
       AVG(points) OVER(PARTITION BY team ORDER BY age
                        ROWS BETWEEN 2 PRECEDING AND 1 PRECEDING) AS olap_avg
FROM points_age;
```

PLAYER	AGE	TEAM	POINTS	OLAP_AVG
Singh	25	A	7	NULL
Smith	26	A	14	7.000000000000
Baxter	27	B	18	NULL
Osaka	35	B	8	18.000000000000
Ricci	40	B	12	13.000000000000
Chun	21	C	13	NULL
Kwan	22	D	9	NULL
Tran	31	D	16	9.000000000000

In partition B, the average for Ricci is based on the points totals for Baxter and Osaka: $(18 + 8) / 2 = 13$. When the current row has no preceding rows to use for the calculation, the result is NULL.

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INTERVAL Field Qualifier

The INTERVAL field qualifier specifies the precision, in time units, for an INTERVAL value. Use the INTERVAL Field Qualifier segment whenever you see a reference to an INTERVAL field qualifier in a syntax diagram.

Syntax

INTERVAL Field Qualifier

```
|--+-+--DAY--+-+-----+-+--TO DAY-----+-+--+--|
| |      '-(precision)-'  +-TO HOUR-----+ | |
| |                               +-TO MINUTE-----+ | |
| |                               +-TO SECOND-----+ | |
| |                               '-TO FRACTION--+-+-----+-' | |
| |                               '-( scale )-' | |
| +-HOUR--+-+-----+-+--TO HOUR-----+-+--+--|
| |      '-(precision)-'  +-TO MINUTE-----+ | |
| |                               +-TO SECOND-----+ | |
| |                               '-TO FRACTION--+-+-----+-' | |
| |                               '-( scale )-' | |
| +-MINUTE--+-+-----+-+--TO MINUTE-----+-+--+--|
| |      '-(precision)-'  +-TO SECOND-----+ | |
| |                               '-TO FRACTION--+-+-----+-' | |
| |                               '-( scale )-' | |
| +-SECOND--+-+-----+-+--TO SECOND-----+-+--+--|
| |      '-(precision)-'  '-TO FRACTION-' | |
| |      '-FRACTION--TO FRACTION--+-+-----+-' | |
| |      '-( scale )-' | |
| +-+--YEAR--+-+-----+-+--TO YEAR--+-+--+--|
| |      '-(precision)-'  '-TO MONTH-' | |
| |      '-MONTH--+-+-----+-+--TO MONTH--+-+--+--|
| |      '-(precision)-' |
```

Element	Description	Restrictions	Syntax
---------	-------------	--------------	--------

Element	Description	Restrictions	Syntax
<i>scale</i>	Integer number of digits in FRACTION field. Default is 3.	Must be in the range from 1 to 5	Literal Number
<i>precision</i>	Integer number of digits in the largest time unit that the INTERVAL includes. For YEAR, the default is 4. For all other time units except FRACTION, the default is 2.	Must be in the range from 1 to 9	Literal Number

Usage

This segment specifies the precision and scale of an INTERVAL data type.

A keyword specifying the *largest* time unit must be the first keyword, and a keyword specifying the *smallest* time unit must follow the TO keyword. These can be the same keyword. This segment resembles the syntax of a [DATETIME Field Qualifier](#), but with these exceptions:

- If the largest time unit keyword is YEAR or MONTH, the smallest time unit keyword cannot specify a time unit smaller than MONTH.
- You can specify up to 9-digit *precision* after the first time unit, unless FRACTION is the first time unit (in which case no *precision* is valid after the first FRACTION keyword, but you can specify up to 5 digits of *scale* after the second FRACTION keyword).

Because *year* and *month* are not fixed-length units of time, the database server treats INTERVAL data types that include the YEAR or MONTH keywords in their qualifiers as incompatible with INTERVAL data types whose qualifiers are time units smaller than MONTH. The database server supports no implicit casts between these two categories of INTERVAL data types.

The next two examples show YEAR TO MONTH qualifiers of INTERVAL data types. The first example can hold an interval of up to 999 years and 11 months, because it gives 3 as the precision of the YEAR field. The second example uses the default precision on the YEAR field, so it can hold an interval of up to 9,999 years and 11 months.

YEAR (3) TO MONTH

YEAR TO MONTH

When you want a value to specify only one kind of time unit, the first and last qualifiers are the same. For example, an interval of whole years is qualified as YEAR TO YEAR or YEAR (5) TO YEAR, for an interval of up to 99,999 years.

The following examples show several forms of INTERVAL field qualifiers:

YEAR (5) TO MONTH

DAY (5) TO FRACTION (2)

DAY TO DAY

FRACTION TO FRACTION (4)

For information about how to specify INTERVAL field qualifiers and how to use INTERVAL data in arithmetic and relational operations, see the related reference, INTERVAL data type.

Related concepts:

[Precedence of DATE and DATETIME format specifications](#)

Related reference:

[INTERVAL Field Qualifier](#)

Related information:

[INTERVAL data type](#)

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Literal Collection

Use the Literal Collection segment to specify values for a collection data type. For the syntax of expressions that return values of individual elements within a collection, see [Collection Constructors](#).

Syntax

Literal Collection

```
|----+--SET-----+--(-| Literal Data |-)-----|
      +-MULTISET+
      '-LIST-----'
```

Literal Data

```
      .-',-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      v      (1)
|----+--| Element Literal Value |-----+-----+-----+-----+-----+-----+
      |      (2)
      '-| Nested Quotation Marks |-----| Literal Collection |--| Nested Quotation Marks |-----'
```

Notes:

1. See [Element Literal Value](#)
2. See [Nested Quotation Marks](#)

Usage

You can specify literal collection values for SET, MULTISSET, or LIST data types.

To specify a single literal-collection value, specify the collection type and the literal values. The following SQL statement inserts four integer values into a column called **set_col** that was declared as `SET (INT NOT NULL)`:

```
INSERT INTO table1 (set_col) VALUES (SET{6, 9, 9, 4});
```

Specify an empty collection with an empty pair of braces ({}) symbols. This example inserts an empty list into a column **list_col** that was declared as `LIST (INT NOT NULL)`:

```
INSERT INTO table2 (list_col) VALUES ('LIST{}');
```

A pair of single (') or double (") quotation marks can delimit the collection. Double quotation marks are not valid, however, in databases where delimited identifiers are enabled, except to delimit SQL identifiers.

If you are passing a literal collection as an argument to an SPL routine, make sure that there is a blank space between the parentheses that surround the arguments and quotation marks that indicate the beginning and end of the literal collection.

- [Element Literal Value](#)
- [Nested Quotation Marks](#)

Related reference:

[Literal Row](#)

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Element Literal Value

The diagram for [Literal Collection](#) refers to this section. Elements of a collection can be literal values for the following data types.

For a Collection of Type	Literal Value Syntax
BOOLEAN	<code>t</code> or <code>f</code> , representing TRUE or FALSE as a quoted string
CHAR, VARCHAR, NCHAR, NVARCHAR, CHARACTER VARYING, LVARCHAR, DATE	Quoted String
DATETIME	Literal DATETIME
DECIMAL, MONEY, FLOAT, INTEGER, INT8, SMALLFLOAT, SMALLINT	Literal Number
INTERVAL	Literal INTERVAL
Opaque data types	Quoted String . The string literal must be recognized by the input support function for the associated opaque type.
Row Type	Literal Row . When the collection element type is a named ROW type, you do not need to cast the inserted values to the named ROW type.

Important: You cannot specify the simple-large-object data types (BYTE and TEXT) as the element type for a collection.

Quoted strings must be specified with a different type of quotation mark than the quotation marks that encompass the collection, so that the database server can parse the quoted strings. Thus, if you use double (") quotation marks to specify the collection, use single (') quotation marks to specify individual, quoted-string elements. (In databases where delimited identifiers are enabled, however, double quotation marks are not valid, except to delimit SQL identifiers.)

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Nested Quotation Marks

The diagram for [Literal Collection](#) refers to this section.

A *nested collection* is a collection that is the element type for another collection.

Whenever you nest collection literals, use nested quotation marks. In these cases, you must follow the rule for nesting quotation marks. Otherwise, the database server cannot correctly parse the strings.

The general rule is that you must double the number of quotation marks for each new level of nesting. For example, if you use double (") quotation marks for the first level, you must use two double quotation marks for the second level, four double quotation marks for the third level, eight for the fourth level, sixteen for the fifth level, and so on.

Likewise, if you use single (') quotation marks for the first level, you must use two single quotation marks for the second level and four single quotation marks for the third level. There is no limit to the number of levels you can nest, as long as you follow this rule.

Element	Description	Restrictions	Syntax
<i>dd</i>	Day of month, expressed in digits	$1 \leq dd \leq 28, 29, 30, \text{ or } 31$	Literal Number
<i>ffff</i>	Fraction of a second, expressed in digits	$0 \leq ffff \leq 99999$	Literal Number
<i>hh</i>	Hour of day, expressed in digits	$0 \leq hh \leq 23$	Literal Number
<i>mi</i>	Minute of hour, expressed in digits	$0 \leq mi \leq 59$	Literal Number
<i>mo</i>	Month of year, expressed in digits	$1 \leq mo \leq 12$	Literal Number
<i>space</i>	Blank space (ASCII 32)	Exactly 1 blank character	Literal blank space
<i>ss</i>	Second of minute, in digits	$0 \leq ss \leq 59$	Literal Number
<i>yyyy</i>	Year, expressed in digits	No more than 4 digits	Literal Number

Usage

You must specify both a numeric date and a DATETIME field qualifier for this date in the Literal DATETIME segment. The DATETIME field qualifier must correspond to the numeric date you specify. For example, if you specify a numeric date that includes a year as the largest unit and a minute as the smallest unit, you must also specify YEAR TO MINUTE as the DATETIME field qualifier.

If you specify two digits for the year, the database server uses the setting of the **DBCENTURY** environment variable to expand the abbreviated year value to four digits. If the **DBCENTURY** is not set, the first two digits of the current year are used to expand the abbreviated year value.

The following examples show literal DATETIME values:

```
DATETIME (07-3-6) YEAR TO DAY
```

```
DATETIME (09:55:30.825) HOUR TO FRACTION
```

```
DATETIME (07-5) YEAR TO MONTH
```

The following example shows a literal DATETIME value used with the EXTEND function:

```
EXTEND (DATETIME (2007-8-1) YEAR TO DAY, YEAR TO MINUTE)
- INTERVAL (720) MINUTE (3) TO MINUTE
```

- [Precedence of DATE and DATETIME format specifications](#)
- [Casting Numeric Date and Time Strings to DATE Data Types](#)

Related information:

[DATETIME data type](#)

[DBCENTURY environment variable](#)

[GL_DATETIME environment variable](#)

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Precedence of DATE and DATETIME format specifications

The Informix® environment variables whose settings can specify the display and data entry formats for values of DATE data types have the following order of precedence, if different settings are in conflict, or if no format is specified:

1. DBDATE
2. GL_DATE
3. Information defined in the client locale (if CLIENT_LOCALE is set)
4. Default date format is `%m/%d/%iY` (if DBDATE and GL_DATE are not set, and no locale is specified)

Informix environment variables can specify the display and data entry formats for values of DATETIME data types. Their explicit or default settings have the following descending order of precedence (from highest to lowest), if different settings are in conflict, or if no format is specified:

1. DBDATE and DBTIME
2. GL_DATETIME
3. Information defined in the client locale (if CLIENT_LOCALE is set)
4. Default DATETIME format is `%iY-%m-%d %H:%M:%S` (if CLIENT_LOCALE, DBTIME and GL_DATETIME are not set).

If GL_DATETIME is set to a nondefault value, you must also set the USE_DTV environment variable to 1 before you can process localized **DATETIME** values correctly in the following contexts:

- **dbexport** utility
- **dbimport** utility
- LOAD statement of DB-Access
- UNLOAD statement of DB-Access
- DML operations on objects defined by the CREATE EXTERNAL TABLE statement.

For details of how you can set these environment variables to define formats for chronological data values, see the *IBM® Informix GLS User's Guide* and *IBM Informix Guide to SQL: Reference*.

Related reference:

- [Literal Numbers and the MONEY Data Type](#)

Related information:

[DECIMAL](#)

[FLOAT\(p\)](#)

[INTEGER data type](#)

[MONEY\(p,s\) data type](#)

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Integer Literals

An integer has no fractional part and cannot include a decimal point. Built-in data types of SQL that can be exactly represented as literal integers include BIGINT, BIGSERIAL, DECIMAL(p, 0), INT, INT8, SERIAL, SERIAL8, and SMALLINT.

If you use the representation of a number in a base other than 10 (such as a binary, octal, or hexadecimal) in any context where a literal integer is valid, the database server will attempt to interpret the value as a base-10 literal integer. For most data values, the result will be incorrect.

The following examples show some valid literal integers:

10 -27 +25567

Thousands separators (such as comma symbols) are not valid in literal integers, nor in any other literal number.

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Fixed-Point Decimal Literals

Fixed-point decimal literals can exactly represent DECIMAL(p,s) and MONEY values. These can include a decimal point:

-123.456 00123456 +123456.0

The digits to the right of the decimal point in these examples are the fractional portions of the numbers.

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Floating-Point Decimal Literals

Floating-point literals can exactly represent FLOAT, SMALLFLOAT, and DECIMAL(p) values, using a decimal point or exponential notation, or both. They can approximately represent real numbers in exponential notation. The next examples show floating point numbers:

-123.45E6 1.23456E2 123456.0E-3

The E in the previous examples is the symbol for exponential notation. The digit that follows E is the value of the exponent. For example, the number 3E5 (or 3E+5) means 3 multiplied by 10 to the fifth power, and the number 3E-5 means 3 multiplied by the reciprocal of 10 to the fifth power.

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Literal Numbers and the MONEY Data Type

When you use a literal number as a MONEY value, do not include a currency symbol or include commas. The **DBMONEY** environment variable or the locale file can format how MONEY values are displayed in output.

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Literal Row

The Literal Row segment specifies the syntax for literal values of named and unnamed ROW data types.

For expressions that evaluate to field values within a ROW data type, see [ROW constructors](#).

Syntax

Literal Row


```

      .,------.
      V          |
|---+ ' ROW--(-----| Field Literal Value |---+---) '---+-----|
      |          |
      |          V          |
      |---+ ' ROW--(-----| Field Literal Value |---+---) '---+-----|

Field Literal Value

(1)
|---+| Quoted String |-----+-----|
|    |               |             |
+-+| Literal Number |-----+
+-+USER-----+
|    |               |             |
+-+| Literal DATETIME |-----+
|    |               |             |
+-+| Literal INTERVAL |-----+
|    |               |             |
+-+| Literal Collection |-----+
+-+literal_opaque_type-----+
+-+'literal_BOOLEAN'-----+
+-+ROW(-| Literal Row |-)-----+

```

Notes:

1. See [Quoted String](#)
2. See [Literal Number](#)
3. See [Literal DATETIME](#)
4. See [Literal INTERVAL](#)
5. See [Literal Collection](#)

Element	Description	Restrictions	Syntax
<i>literal_opaque_type</i>	Literal representation for an opaque data type	Must be a literal that is recognized by the input support function for the associated opaque data type	Defined by the developer of the opaque data type
<i>literal_BOOLEAN</i>	Literal representation of a BOOLEAN value	Must be either 't' (= TRUE) or 'f' (= FALSE) specified as a quoted string	Quoted String

Usage

You can specify literal values for named ROW and unnamed ROW data types. A ROW constructor introduces a literal ROW value, which can optionally be enclosed between quotation marks.

The format of the value for each field of the ROW type must be compatible with the data type of the corresponding field.

Important: You cannot specify simple-large-object data types (BYTE or TEXT) as the field type for a row.

Fields of a row can be literal values for the data types in the following table.

For a Field of Type	Literal Value Syntax
BOOLEAN	t or f, representing TRUE or FALSE
CHAR, VARCHAR, LVARCHAR, NCHAR, NVARCHAR, CHARACTER VARYING, DATE	Quoted String
DATETIME	Literal DATETIME
BIGINT, DECIMAL, MONEY, FLOAT, INTEGER, INT8, SMALLFLOAT, SMALLINT	Literal Number
INTERVAL	Literal INTERVAL
Opaque data types	Quoted String The string must be a literal that is recognized by the input support function for the associated opaque type.
Collection type (SET, MULTISSET, LIST)	Literal Collection For information on literal collection values as variable or column values, see Nested Quotation Marks . For information on literal collection values for a ROW type, see Literals for Nested Rows .
Another ROW type (named or unnamed)	For information on ROW type values, see Literals for Nested Rows .

- [Literals of an Unnamed Row Type](#)
- [Literals of a Named Row Type](#)
- [Literals for Nested Rows](#)

Related reference:

[CREATE ROW TYPE statement](#)
[INSERT statement](#)
[UPDATE statement](#)
[SELECT statement](#)
[ROW constructors](#)

Literals of an Unnamed Row Type

To specify a literal value for an unnamed ROW type, introduce the literal row with the ROW constructor; you must enclose the values between parentheses. For example, suppose that you define the **rectangles** table as follows:

```
CREATE TABLE rectangles
(
    area FLOAT,
    rect ROW(x INTEGER, y INTEGER, length FLOAT, width FLOAT),
)
```

The following INSERT statement inserts values into the **rect** column of the **rectangles** table:

```
INSERT INTO rectangles (rect)
VALUES ("ROW(7, 3, 6.0, 2.0)")
```

Literals of a Named Row Type

To specify a literal value for a named ROW type, introduce the literal row with the ROW type constructor and enclose the literal values for each field in parentheses. In addition, you can cast the row literal to the appropriate named ROW type to ensure that the row value is generated as a named ROW type. The following statements create the named ROW type **address_t** and the **employee** table:

```
CREATE ROW TYPE address_t
(
    street CHAR(20),
    city CHAR(15),
    state CHAR(2),
    zipcode CHAR(9)
);
```

```
CREATE TABLE employee
(
    name CHAR(30),
    address address_t
);
```

The following INSERT statement inserts values into the **address** column of the **employee** table:

```
INSERT INTO employee (address)
VALUES (
"ROW('103 Baker St', 'Tracy', 'CA', 94060)::address_t")
```

Literals for Nested Rows

If the literal value is for a nested row, specify the ROW type constructor for each row level. If you include quotation marks as delimiters, they should enclose the outermost row. For example, suppose that you create the **emp_tab** table:

```
CREATE TABLE emp_tab
(
    emp_name CHAR(10),
    emp_info ROW( stats ROW(x INT, y INT, z FLOAT))
);
```

The following INSERT statement adds a row to the **emp_tab** table:

```
INSERT INTO emp_tab VALUES ('joe boyd', "ROW(ROW(8,1,12.0))" );
```

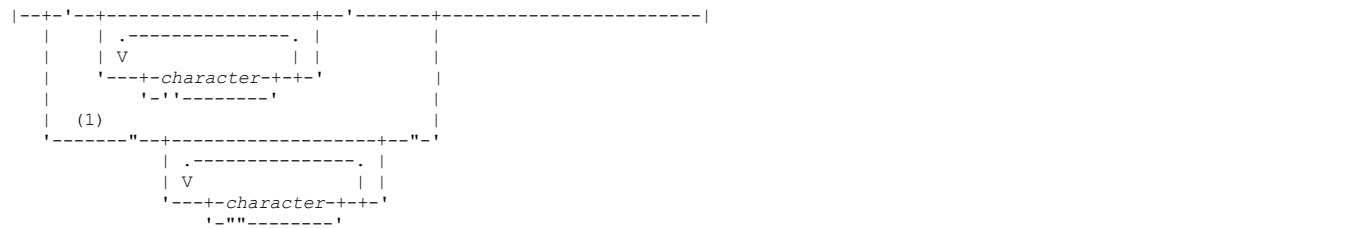
Similarly, if the row-string literal contains a nested collection, only the outermost literal row can be enclosed between quotation marks. Do not put quotation marks around an inner, nested collection type.

Quoted String

A quoted string is a string literal between quotation marks. Use this segment whenever you see a reference to a quoted string in a syntax diagram.

Syntax

Quoted String



Notes:

- ## 1. Informix® extension

Element	Description	Restrictions	Syntax
<i>character</i>	Code set element within quoted string	Cannot enclose between double quotation marks if the DELIMIDENT environment variable is set	Literal value from the keyboard

Usage

Use quoted strings to specify string literals in data-manipulation statements and other SQL statements. For example, you can use a quoted string in an INSERT statement to insert a value into a column of a character data type.

- [Restrictions on Specifying Characters in Quoted Strings](#)
- [The DELIMIDENT Environment Variable](#)
- [Newline Characters in Quoted Strings](#)
- [Using Quotation Marks in Strings](#)
- [DATETIME and INTERVAL Values as Strings](#)
- [LIKE and MATCHES in a Condition](#)
- [Inserting Values as Quoted Strings](#)
- [Numeric Operations on Character Columns](#)

Avoid comparing number literals to character columns. It requires that all of the strings compared be converted to numbers, which takes much longer than comparing two strings.

Related information:

DELIMIDENT environment variable

Specify quoted strings

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Restrictions on Specifying Characters in Quoted Strings

You must observe the following restrictions on *character* in quoted strings:

- If you are using the ASCII code set, you can specify any printable ASCII character, including a single (') quotation mark or double (") quotation mark. For restrictions that apply to using quotation marks in quoted strings, see [Using Quotation Marks in Strings](#).
- In some locales, you can specify non-ASCII characters, including multibyte characters, that the locale supports. See the discussion of quoted strings in the *IBM® Informix® GLS User's Guide*.
- If you enable newline characters for quoted strings, you can embed newline characters in quoted strings. For further information, see [Newline Characters in Quoted Strings](#).
- You can enter DATETIME and INTERVAL data values as quoted strings. For the restrictions that apply to entering DATETIME and INTERVAL data in quoted-string format, see [DATETIME and INTERVAL Values as Strings](#).
- Quoted strings that are used with the LIKE or MATCHES keyword in a search condition can include wildcard characters that have a special meaning in the search condition. For further information, see [LIKE and MATCHES in a Condition](#).
- When you insert a value that is a quoted string, you must observe a number of restrictions. For further information, see [Inserting Values as Quoted Strings](#).

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The DELIMIDENT Environment Variable

If the **DELIMIDENT** environment variable is set on the database server, you cannot use double quotation marks (") to delimit literal strings. If **DELIMIDENT** is set, the database server interprets strings enclosed in double quotation marks as SQL identifiers, not as literal strings. If **DELIMIDENT** is not set, a string between double quotation marks is interpreted as a literal string, not an identifier. For further information, see [Using Quotation Marks in Strings](#), and the description of **DELIMIDENT** in *IBM® Informix Guide to SQL: Reference*.

DELIMIDENT is also supported on client systems, where it can be set to *y*, to *n*, or to no setting.

- *y* specifies that client applications must use single quotation mark (') symbols to delimit literal strings, and must use double quotation mark (") symbols only around delimited SQL identifiers. Delimited identifiers can support a larger character set than is valid for undelimited identifiers. Letters within delimited strings or delimited identifiers are case-sensitive.
- *n* specifies that client applications can use double quotation mark (") or single quotation mark (') symbols to delimit character strings, but not to delimit SQL identifiers. If the database server encounters a string delimited by double or single quotation mark symbols in a context where an SQL identifier is required, it issues an error. An owner name, however, that qualifies an SQL identifier can be delimited by single quotation mark (') symbols. You must use a pair of the same quotation mark symbols to delimit a character string.
- Specifying **DELIMIDENT** with no value on the client system requires client applications to use the **DELIMIDENT** setting that is the default for their application programming interface (API).

Client APIs of Informix® use the following default **DELIMIDENT** settings:

- For OLE DB and .NET, the default **DELIMIDENT** setting is *y*
- For ESQ/C, JDBC, and ODBC, the default **DELIMIDENT** setting is *n*
- APIs that have ESQ/C as an underlying layer, such as Informix 4GL, the DataBlade API (LIBDMI), and the C++ API, behave as ESQ/C, and use 'n' as the default if no value for **DELIMIDENT** is specified on the client system.

Even if **DELIMIDENT** is set, you can use single quotation mark (') symbols to delimit *authorization identifiers* as the owner name component of a database object name, as in the following example:

```
RENAME COLUMN 'Owner'.table2.collum3 TO column3;
```

The general rule, however, is that when **DELIMIDENT** is set, the SQL parser interprets strings delimited by single quotation marks as string literals, and interprets character strings delimited by double quotation marks (") as SQL identifiers.

Related information:

[DELIMIDENT environment variable](#)

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Newline Characters in Quoted Strings

By default, the string constant must be written on a single line. That is, you cannot use embedded newline characters in a quoted string. You can, however, override this default behavior in one of two ways:

- To enable newline characters in quoted strings in all sessions, set the ALLOW_NEWLINE parameter to 1 in the ONCONFIG file.
- To enable newline characters in quoted strings for the current session, execute the built-in function **IFX_ALLOW_NEWLINE**.

This enables newline characters in quoted strings for the current session:

```
EXECUTE PROCEDURE IFX_ALLOW_NEWLINE('T');
```

If newline characters in quoted strings are not enabled for a session, the following statement is invalid and returns an error:

```
SELECT 'The quick brown fox
       jumped over the old gray fence'
FROM customer
WHERE customer_num = 101;
```

If you enable newline characters in quoted strings for the session, however, the statement in the preceding example is valid and executes successfully.

For more information on the **IFX_ALLOW_NEWLINE** function, see [IFX_ALLOW_NEWLINE Function](#). For more information on the ALLOW_NEWLINE parameter in the ONCONFIG file, see your *IBM® Informix® Administrator's Reference*.

Related information:

[ALLOW_NEWLINE configuration parameter](#)

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Using Quotation Marks in Strings

The single quotation mark (') has no special significance in string literals delimited by double quotation marks. Conversely, double quotation mark (") has no special significance in strings delimited by single quotation marks. For example, these strings are valid:

```
"Nancy's puppy jumped the fence"
'Billy told his kitten, "No!" '
```

A string delimited by double quotation marks can include a double quotation mark character by preceding it with another double quotation mark, as the following string shows:

```
"Enter ""y"" to select this row"
```

When the **DELIMIDENT** environment variable is set, double quotation marks can only delimit SQL identifiers, not strings. For more information on delimited identifiers, see [Delimited Identifiers](#).

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DATETIME and INTERVAL Values as Strings

You can enter DATETIME and INTERVAL data in the literal forms described in the [Literal DATETIME](#) and [Literal INTERVAL](#), or you can enter them as quoted strings.

Valid literals that are entered as character strings are converted automatically into DATETIME or INTERVAL values.

These statements enter INTERVAL and DATETIME values as quoted strings:

```
INSERT INTO cust_calls(call_dtime) VALUES ('2007-5-4 10:12:11');
INSERT INTO manufact(lead_time) VALUES ('14');
```

The format of the value in the quoted string must exactly match the format specified by the INTERVAL or DATETIME qualifiers of the column. For the first INSERT in the preceding example, the **call_dtime** column must be defined with the qualifiers YEAR TO SECOND for the INSERT statement to be valid.

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LIKE and MATCHES in a Condition

Quoted strings with the LIKE or MATCHES keyword in a condition can include wildcard characters. For a complete description of how to use wildcard characters, see [Condition](#).

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Inserting Values as Quoted Strings

In the default locale, if you are inserting a value that is a quoted string, you must adhere to the following restrictions:

- Enclose CHAR, VARCHAR, NCHAR, NVARCHAR, DATE, DATETIME, INTERVAL, and LVARCHAR values in quotation marks.
- Specify DATE values in the *mm/dd/yyyy* format (or in the format that the **DBDATE** or **GL_DATE** environment variable specifies, if set).
- You cannot insert strings longer than 32 kilobytes.
- Numbers with decimal values must include a decimal separator. Comma (,) is not valid as a decimal separator in the default locale.
- MONEY values cannot include a dollar sign (\$) or commas.
- You can enter NULL in a column only if it accepts null values.

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Numeric Operations on Character Columns

Avoid comparing number literals to character columns. It requires that all of the strings compared be converted to numbers, which takes much longer than comparing two strings.

For example, suppose that you wish to find all customers within the 356 telephone exchange code:

```
SELECT lname FROM customer WHERE phone [5,7] = '356';
```

Notice that the operand whose value is 356 is enclosed in quotes. The quotes indicate that the database server must handle the filter as a character string. By contrast, when the operand is not in quotes, the server treats each retrieved value as a number, and must implicitly cast each value retrieved from the table to a numeric data type.

The following example causes implicit data type conversion of the **phone** substrings:

```
SELECT lname FROM customer WHERE phone [5,7] = 356;
```

If the UPDATE STATISTICS MEDIUM or UPDATE STATISTICS HIGH statement has been run on this column, the query optimizer tries to determine the selectivity of the predicate by matching the constant in the query with a substring of values saved in the distribution bin. Requiring data type conversion of every row in a character column so that it can be compared to a numeric filter needlessly increases the cost of the query that omits quotation mark delimiters around 356, compared to cost of the query in the first example.

Queries that compare character strings to numbers can fail with EM -1213 if the database server cannot convert the string. If you cannot avoid applying numeric filters to character values, only attempt such operations on character columns whose characters are restricted to digits in the range ASCII 0x30 through 0x39, and decimal point (ASCII 0x2e). This range is also known as *seminumeric*.

The database server does not use an index when DML statements compare a character column with a noncharacter value that is not equal in length to the character column.

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Relational Operator

A relational operator compares two expressions quantitatively. Use the Relational Operator segment whenever you see a reference to a relational operator in a syntax diagram.

Syntax

Relational Operator

```
|---+ < -----+-----|
|+- <= -----+
|+- > -----+
|+-+ = -+-+
| ' - == ' |
|+- >= -----+
|+- <> -----+
| (1) |
|-----+!= |
```

Notes:

1. Informix® extension

Usage

The relational operators of SQL have the following meanings.

Relational Operator	Meaning
---------------------	---------

<	Less than
<=	Less than or equal to
>	Greater than
= or ==	Equal to
>=	Greater than or equal to
<> or !=	Not equal to

Usage

For number expressions, *greater than* means to the right on the real line.

For DATE and DATETIME expressions, *greater than* means later in time.

For INTERVAL expressions, *greater than* means a longer span of time.

For CHAR, VARCHAR, and LVARCHAR expressions, *greater than* means *after* in code-set order.

For NCHAR and NVARCHAR expressions, *greater than* means *after* in the localized collation order, if one exists; otherwise, *greater than* means *after* in code-set order.

Locale-based collation order, if one is defined for the locale, is used for NCHAR and NVARCHAR expressions. So for NCHAR and NVARCHAR expressions, *greater than* means *after* in the locale-based collation order. For more information on locale-based collation order and the NCHAR and NVARCHAR data types, see the *IBM® Informix GLS User's Guide*.

For information on how relational operator expressions with NCHAR and NVARCHAR operands in databases that have the NLCASE INSENSITIVE property differ from their behavior in databases that are case sensitive, see the topic [NCHAR and NVARCHAR expressions in case-insensitive databases](#).

- [Using Operator Functions in Place of Relational Operators](#)
- [Collating Order for U.S. English Data](#)
- [Support for ASCII Characters in Nondefault Code Sets \(GLS\)](#)
- [Literal Numbers as Operands](#)

Related information:

[Create a comparison condition](#)
[Relational-operator conditions](#)

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Using Operator Functions in Place of Relational Operators

Each relational operator is bound to a particular operator function, as the table shows. The operator function accepts two values and returns a boolean value of true, false, or unknown.

Relational Operator Associated Operator Function

<	lessthan()
<=	lessthanorequal()
>	greaterthan()
>=	greaterthanorequal()
= or ==	equal()
<> or !=	notequal()

Connecting two expressions with a relational operator is equivalent to invoking the operator function on the expressions. For example, the next two statements both select orders with a shipping charge of \$18.00 or more.

The >= operator in the first statement implicitly invokes the **greaterthanorequal()** operator function:

```
SELECT order_num FROM orders
WHERE ship_charge >= 18.00;

SELECT order_num FROM orders
WHERE greaterthanorequal(ship_charge, 18.00);
```

The database server provides the operator functions associated with the relational operators for all built-in data types. When you develop a user-defined data type, you must define the operator functions for that type for users to be able to use the relational operator on the type.

If you define **lessthan()**, **greaterthan()**, and the other operator functions for a user-defined type, then you should also define **compare()**. Similarly, if you define **compare()**, then you should also define **lessthan()**, **greaterthan()**, and the other operator functions. All of these functions must be defined in a consistent manner, to avoid the possibility of incorrect query results when UDT values are compared in the WHERE clause of a SELECT.

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Collating Order for U.S. English Data

If you are using the default locale (U.S. English), the database server uses the code-set order of the default code set when it compares the character expressions that precede and follow the relational operator.

On UNIX, the default code set is the ISO8859-1 code set, which consists of the following sets of characters:

- The ASCII characters have code points in the range of 0 to 127.
This range contains control characters, punctuation symbols, English-language characters, and numerals.
- The 8-bit characters have code points in the range 128 to 255.
This range includes many non-English-language characters (such as é, ñ, ö, and ñ) and symbols (such as £, ©, and ¢).

In Windows, the default code set is Microsoft 1252. This code set includes both the ASCII code set and a set of 8-bit characters.

This table lists the ASCII code set. The **Num** columns show ASCII code point numbers, and the **Char** columns display corresponding ASCII characters. In the default locale, ASCII characters are sorted according to their code-set order. Thus, lowercase letters follow uppercase letters, and both follow digits. In this table, ASCII 32 is the blank character, and the caret symbol (^) stands for the CTRL key. For example, ^X means CONTROL-X.

Num	Char	Num	Char	Num	Char	Num	Char	Num	Char	Num	Char	Num	Char
0	^@	20	^T	40	(	60	<	80	P	100	d	120	x
1	^A	21	^U	41	)	61	=	81	Q	101	e	121	y
2	^B	22	^V	42	*	62	>	82	R	102	f	122	z
3	^C	23	^W	43	+	63	?	83	S	103	g	123	{
4	^D	24	^X	44	,	64	@	84	T	104	h	124	|
5	^E	25	^Y	45	-	65	A	85	U	105	i	125	}
6	^F	26	^Z	46	.	66	B	86	V	106	j	126	~
7	^G	27	esc	47	/	67	C	87	W	107	k	127	del
8	^H	28	^\	48	0	68	D	88	X	108	l		
9	^I	29	^]	49	1	69	E	89	Y	109	m		
10	^J	30	^^	50	2	70	F	90	Z	110	n		
11	^K	31	^_	51	3	71	G	91	[	111	o		
12	^L	32		52	4	72	H	92	\	112	p		
13	^M	33	!	53	5	73	I	93	]	113	q		
14	^N	34	"	54	6	74	J	94	^	114	r		

Num	Char	Num	Char	Num	Char	Num	Char	Num	Char	Num	Char	Num	Char
15	^O	35	#	55	7	75	K	95	_	115	s		
16	^P	36	\$	56	8	76	L	96	\	116	t		
17	^Q	37	%	57	9	77	M	97	a	117	u		
18	^R	38	&	58	:	78	N	98	b	118	v		
19	^S	39	'	59	;	79	O	99	c	119	w		

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Support for ASCII Characters in Nondefault Code Sets (GLS)

Most code sets for nondefault locales (called *nondefault code sets*) support the ASCII characters. In a nondefault locale, the database server uses ASCII code-set order for ASCII data in CHAR and VARCHAR expressions, if the code set supports these ASCII characters. If the current collation (as specified by **DB_LOCALE** or by SET COLLATION) supports a localized collating order, however, that localized order is used when the database server sorts NCHAR or NVARCHAR values.

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Literal Numbers as Operands

You might obtain unexpected results if a literal number that you specify as an operand is not in a format that can exactly represent the data type of another value with which it is compared by a relational operator. Because of rounding errors, for example, a relational operator like = or the **equals()** operator function generally cannot return **TRUE** if one operand returns a FLOAT value and the other an INTEGER. For information about which of the built-in data types store values that can be exactly represented as literal numbers, see the section [Literal Number](#).

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Other syntax segments

These topics describe *syntax segments*, which are language elements, such as database object names or optimizer directives, that appear as a subdiagram reference in the syntax diagrams of some SQL or SPL statements.

Most segments that can occur in only one statement are described in [SQL statements](#) or [SPL statements](#) within the description of the statement. For the sake of clarity, ease of use, and comprehensive treatment, however, most segments that can occur in various SQL or SPL statements, and that are not data types nor expressions, are discussed separately here.

The previous chapter described the syntax segments that specify data types and expressions. This chapter describes additional syntax segments that are neither data types, expressions, nor complete SQL statements or SPL statements. These segments are referenced in various syntax diagrams that appear in [SQL statements](#) and in other chapters of this document.

- [Arguments](#)
- [Collection-Derived Table](#)
A *collection-derived table* is a virtual table in which the values in the rows of the table are equivalent to elements of a collection. Use this segment where you see a reference to Collection-Derived Table in a syntax diagram. This syntax is an extension to the ANSI/ISO standard for SQL.
- [Database Name](#)
- [Database Object Name](#)
- [External Routine Reference](#)
Include the External Routine Reference clause when you write an external routine. This option is not available for SPL routines.
- [Identifier](#)
An *identifier* specifies the unqualified name of a database object, such as an access method, aggregate, alias, blob space, cast, column, constraint, correlation, data type, index, operator class, partition, procedure, table, trigger, sequence, synonym, or view. Use the Identifier segment whenever you see a reference to an identifier in a syntax diagram.
- [Jar Name](#)
Use the Jar Name segment to specify the name of a jar ID. Use this segment whenever you see a reference to Jar Name in a syntax diagram.
- [Optimizer Directives](#)
The Optimizer Directives segment specifies keywords that you can use to partially or fully specify the query plan of the optimizer. Use this segment whenever you see a reference to Optimizer Directives in a syntax diagram.
- [Owner name](#)
The owner name specifies the owner of a database object. Use this segment whenever you see a reference to Owner Name in a syntax diagram.
- [Purpose Options](#)
- [Return Clause](#)
- [Routine modifier](#)
A routine modifier specifies characteristics of how a user-defined routine (UDR) behaves.
- [Routine Parameter List](#)
- [Shared-Object Filename](#)
Use a shared-object filename to specify a pathname to an executable object file when you register or alter an external routine.
- [Specific Name](#)

- [Statement Block](#)

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Arguments

Use the Argument segment to pass a specific value as input to a routine. Use this segment wherever you see a reference to an *argument* in a syntax diagram.

Syntax

Argument

```

(1)
|-----+-----| Subset of Expression |-----+
|'-parameter---'  +-NULL-----+
|               '-(--singleton_select--)-----'
```

Notes:

1. See [Subset of Expressions Valid as an Argument](#)

Element	Description	Restrictions	Syntax
<i>parameter</i>	A parameter whose value you specify	Must match a name that CREATE FUNCTION or CREATE PROCEDURE statement declared	Identifier
<i>singleton_select</i>	Embedded query that returns a single value	Must return exactly one value of a data type and length compatible with <i>parameter</i>	SELECT statement

Usage

The CREATE PROCEDURE or CREATE FUNCTION statement can define a parameter list for a UDR. If the parameter list is not empty, you must enter arguments when you invoke the UDR. An *argument* is a specific value whose data type is compatible with that of the corresponding UDR parameter.

When you execute a UDR, you can enter arguments in either of two ways:

- With a parameter name (in the form *parameter name = expression*), even if the arguments are not in the same order as the parameters
- By position, with no *parameter* name, where each *expression* is in the same order as the parameter to which the argument corresponds. (This is sometimes called *ordinal* format.)

You cannot mix these two ways of specifying arguments within a single invocation of a routine. If you specify a *parameter* name for one argument, for example, you must use parameter names for all the arguments.

In the following example, both statements are valid for a user-defined procedure that expects three character arguments, **t**, **d**, and **n**:

```

EXECUTE PROCEDURE add_col (t='customer', d='integer',
n='newint');

EXECUTE PROCEDURE add_col ('customer','newint','integer');
```

- [Comparing Arguments to the Parameter List](#)
- [Subset of Expressions Valid as an Argument](#)
- [Arguments to UDRs in Remote Databases](#)

UDRs are valid in cross-database and in cross-server distributed operations in most contexts where a UDR is valid in the local database, but every participating database must have the same logging mode.

Related reference:

[ALTER FUNCTION statement](#)
[ALTER PROCEDURE statement](#)
[ALTER ROUTINE statement](#)
[CALL](#)
[CREATE FUNCTION statement](#)
[CREATE FUNCTION FROM statement](#)
[CREATE PROCEDURE FROM statement](#)
[EXECUTE FUNCTION statement](#)
[EXECUTE PROCEDURE statement](#)
[Routine Parameter List](#)

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Comparing Arguments to the Parameter List

When you create or register a UDR with CREATE PROCEDURE or CREATE FUNCTION, you declare a *parameter list* with the names and data types of the parameters that the UDR expects. (Parameter names are optional for external routines written in the C or Java™ languages.) See [Routine Parameter List](#) for details of declaring parameters.

User-defined routines can be *overloaded*, if different routines have the same identifier, but have different numbers of declared parameters. For more information about overloading, see [Routine Overloading and Routine Signatures](#).

If you attempt to execute a UDR with more arguments than the UDR expects, you receive an error.

If you invoke a UDR with fewer arguments than the UDR expects, the omitted arguments are said to be *missing*. The database server initializes missing arguments to their corresponding default values. This initialization occurs before the first executable statement in the body of the UDR.

If missing arguments have no default values, Informix® issues an error.

Named parameters cannot be used to invoke UDRs that overload data types in their routine signatures. Named parameters are valid in resolving non-unique routine names only if the signatures have different numbers of parameters:

```
func( x::integer, y );    -- VALID if only these 2 routines
func( x::integer, y, z ); -- have the same 'func' identifier

func( x::integer, y );    -- NOT VALID if both routines have
func( x::float, y );      -- same identifier and 2 parameters
```

For both ordinal and named parameters, the routine with the fewest parameters is executed if two or more UDR signatures have multiple numbers of defaults:

```
func( x, y default 1 )
func( x, y default 1, z default 2 )
```

If two registered UDRs that are both called **func** have the signatures shown above, then the statement `EXECUTE func(100)` invokes **func(100,1)**.

You cannot supply a subset of default values using named parameters unless they are in the positional order of the routine signature. That is, you cannot skip a few arguments and rely on the database server to supply their default values.

For example, given the signature:

```
func( x, y default 1, z default 2 )
```

you can execute:

```
func( x=1, y=3 )
```

but you cannot execute:

```
func( x=1, z=3 )
```

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Subset of Expressions Valid as an Argument

The diagram for [Arguments](#) refers to this section.

You can use any expression as an argument, except an aggregate function. If you use a subquery or function call as an argument, the subquery or function must return a single value of the appropriate data type and size. For the syntax and usage of SQL expressions, see [Expression](#).

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Arguments to UDRs in Remote Databases

UDRs are valid in cross-database and in cross-server distributed operations in most contexts where a UDR is valid in the local database, but every participating database must have the same logging mode.

Excluding BIGSERIAL, BYTE, SERIAL, SERIAL8, and TEXT, the data types that are valid as arguments to cross-server UDRs include the built-in SQL data types that are not opaque, as listed in [Data Types in Distributed Queries](#), and these additional built-in opaque and DISTINCT data types:

- BOOLEAN
- LVARCHAR
- DISTINCT of built-in types that are not opaque
- DISTINCT of BOOLEAN
- DISTINCT of LVARCHAR
- DISTINCT of the DISTINCT types listed above.

These data types can be arguments to SPL, C, or Java™ language UDRs, if the UDRs are defined in all the participating databases. Any implicit or explicit casts defined over these data types must be duplicated across all the participating Informix® instances. The DISTINCT data types must have exactly the same data type hierarchy defined in all databases that participate in the distributed query.

The same data types are valid as arguments in calls to UDRs in other databases of the same Informix instance, as well as arguments of the following additional types:

- BLOB

- All the UDRs, UDTs, DISTINCT data types, DISTINCT type hierarchies, casts, and cast functions must be registered in all of the participating databases. For more information on DISTINCT types in distributed operations, see [DISTINCT Types in Distributed Operations](#).
-
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A *collection-derived table* is a virtual table in which the values in the rows of the table are equivalent to elements of a collection. Use this segment where you see a reference to Collection-Derived Table in a syntax diagram. This syntax is an extension to the ANSI/ISO standard for SQL.

```

Collection-Derived Table
(1)
|--TABLE----->
>--+collection_expr+-----+--+
|          +-AS--alias+ | .,----- | |
|          'alias-----' | v | |
|          '-----derived_column+---' | |
| (2) (3) | |
| '-----collection_var+---' | |
| (3) | |
| '-----row var-----' |

```

Notes:

1. Informix® extension
2. Stored Procedure Language
3. ESQL/C

Element	Description	Restrictions	Syntax
<i>alias</i>	Temporary name for a collection-derived table whose scope is a SELECT statement. The default is implementation dependent.	If potentially ambiguous, you must precede <i>alias</i> with the AS keyword. See Aliases for Tables or Views .	Identifier
<i>collection_expr</i>	Any expression that evaluates to the elements of a single collection	See Restrictions with the Collection-Expression Format .	Expression
<i>collection_var, row_var</i>	Name of a typed or untyped collection variable, or Informix ESQL/C row variable that holds the collection-derived table	Must have been declared in the Informix ESQL/C program or (for <i>collection_var</i>) in an SPL routine	See the <i>IBM Informix ESQL/C Programmer's Manual</i> or DEFINE .
<i>derived_column</i>	Temporary name for a derived column in a table	If the underlying collection is not of a ROW data type, you can specify only one derived-column name	Identifier

A collection-derived table can appear where a *table* name is valid in the UPDATE statement, in the FROM clause of the SELECT or DELETE statement, or in the INTO clause of an INSERT statement.

Use the collection-derived-table segment to accomplish these tasks:

- Access the elements of a collection as you would the rows of a table.
- Specify a collection variable to access, instead of a table name.
- Specify an ESQL/C **row** variable to access, instead of a table name.

The **TABLE** keyword converts a collection into a virtual table. You can use the collection expression format to query a collection column, or you can use the **collection** variable or **row** variable format to manipulate the data in a collection column.

- [Accessing a Collection Through a Virtual Table](#)
- [Table Expressions in the FROM Clause](#)
- [Restrictions with the Collection-Expression Format](#)
- [Row Type of the Resulting Collection-Derived Table](#)
- [Accessing a Collection Through a Collection Variable](#)
- [Using a Collection Variable to Manipulate Collection Elements](#)
- [Accessing a Nested Collection](#)
- [Accessing a Row Variable](#)

Related reference:
[DECLARE statement](#)

[DELETE statement](#)
[DESCRIBE statement](#)
[FETCH statement](#)
[INSERT statement](#)
[PUT statement](#)
[SELECT statement](#)
[UPDATE statement](#)
[DEFINE](#)
[FOREACH](#)

Related information:

[Handle collections](#)
[Complex data types](#)

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Accessing a Collection Through a Virtual Table

When you use the collection expression format of the collection-derived table segment to access the elements of a collection, you can select elements of the collection directly through a virtual table. You can use this format in the FROM clause of a SELECT statement. The FROM clause can be in either a query or a subquery.

With this format you can use joins, aggregates, the WHERE clause, expressions, the ORDER BY clause, and other operations that are not available when you use the collection-variable format. This format reduces the need for multiple cursors and temporary tables.

Examples of possible collection expressions include column references, scalar subquery, dotted expression, functions, operators (through overloading), collection subqueries, literal collections, collection constructors, cast functions, and so on.

The following example uses a SELECT statement in the FROM clause whose result set defines a virtual table consisting of the fifty-first through seventieth qualifying rows, ordered by the **employee_id** column value.

```
SELECT * FROM TABLE(MULTISET(SELECT SKIP 50 FIRST 20 * FROM employees
ORDER BY employee_id)) vt(x,y), tab2 WHERE tab2.id = vt.x;
```

The following example uses a join query to create a virtual table of no more than twenty rows (beginning with the 41st row), ordered by value in the **salary** column of the collection-derived table:

```
SELECT emp_id, emp_name, emp_salary
FROM TABLE(MULTISET(SELECT SKIP 40 LIMIT 20 id, name, salary
FROM e1, e2
WHERE e1.id = e2.id ORDER BY salary ))
AS etab(emp_id, emp_name, emp_salary);
```

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Table Expressions in the FROM Clause

Informix® supports ANSI/ISO standard syntax for table expressions in the FROM clause of SELECT queries and subqueries as a substitute for the Informix-extension collection-derived table syntax. The keywords TABLE and MULTISET were required in version 10.00 and in earlier releases. These extensions to the ANSI/ISO standard for SQL are supported but no longer required for collection-derived table specifications in the FROM clause of SELECT statements.

The following two queries return the same result set, but only the second query complies with the ANSI/ISO standard:

```
SELECT * FROM TABLE(MULTISET(SELECT col1 FROM tab1 WHERE col1 = 100))
AS vtab(c1),
(SELECT col1 FROM tab1 WHERE col1 = 10) AS vtab1(vc1) ORDER BY c1;

SELECT * FROM (SELECT col1 FROM tab1 WHERE col1 = 100) AS vtab(c1),
(SELECT col1 FROM tab1 WHERE col1 = 10) AS vtab1(vc1)
ORDER BY c1;
```

The same SELECT statement can combine instances of both the Informix-extension and ANSI/ISO syntax for derived tables:

```
SELECT * FROM (SELECT col1 FROM tab1 WHERE col1 = 100) AS vtab(c1),
TABLE(MULTISET(SELECT col1 FROM tab1 WHERE col1 = 10)) AS vtab1(vc1)
ORDER BY c1;
```

The subquery must be delimited by parentheses in both formats, but the outer set of parentheses () that immediately follows the TABLE keyword and encloses the MULTISET collection subquery specification is an extension to the ANSI/ISO syntax. This ANSI/ISO syntax is valid only in the FROM clause of the SELECT statement. You cannot omit these keywords and parentheses from a collection subquery specification in any other context.

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Restrictions with the Collection-Expression Format

When you use the collection-expression format, certain restrictions apply:

- A collection-derived table is read-only.
 - It cannot be the target of INSERT, UPDATE, or DELETE statements.
To perform insert, update, and delete operations, you must use the collection-variable format.
 - It cannot be the underlying table of an updatable cursor or view.
- In the FROM clause of the SELECT statement, the CALL keyword of SPL cannot precede the TABLE keyword of a table expression.
- If the collection is a LIST data type, the resulting collection-derived table does not preserve the order of the elements in the LIST.
- The underlying collection expression cannot evaluate to NULL.
- The collection expression cannot contain a reference to a collection on a remote database server.
- The collection expression cannot contain column references to tables that appear in the same FROM clause. That is, the collection-derived table must be independent of other tables in the FROM clause.
For example, the following statement returns an error because the collection-derived table, `TABLE (parents.children)`, refers to the **parents** table, which is also referenced in the FROM clause:

```
SELECT COUNT(*)
FROM parents, TABLE(parents.children) c_table
WHERE parents.id = 1001;
```

To counter this restriction, you might write a query that contains a subquery in the Projection clause:

```
SELECT (SELECT COUNT(*)
FROM TABLE(parents.children) c_table)
FROM parents WHERE parents.id = 1001;
```

- [Additional Restrictions That Apply to ESQL/C](#)

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Additional Restrictions That Apply to ESQL/C

In addition to the previously described restrictions, the following restrictions also apply when you use the collection-expression format with Informix® ESQL/C:

- You cannot specify an untyped COLLECTION as the host-variable data type.
- You cannot use the format `TABLE (?)`.
The data type of the underlying collection variable must be determined statically. To counter this restriction, you can explicitly cast the variable to a typed collection data type (SET, MULTISET, or LIST) that the database server recognizes. For example,

```
TABLE(CAST(? AS type))
```

- You cannot use the format `TABLE (:hostvar)`.
To counter this restriction, you must explicitly cast the variable to a typed collection data type (SET, MULTISET, or LIST) that the database server recognizes. For example,

```
TABLE(CAST(:hostvar AS type))
```

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Row Type of the Resulting Collection-Derived Table

If you do not specify a derived-column name, the behavior of the database server depends on the data types of the elements in the underlying collection.

Although a collection-derived table appears to contain columns of individual data types, these columns are, in fact, the fields of a ROW data type. The data type of the ROW type as well as the column name depend on several factors.

If the data type of the elements of the underlying collection expression is *type*, the database server determines the ROW type of the collection-derived table by the following rules:

- If *type* is a ROW data type, and no derived-column list is specified, then the ROW type of the collection-derived table is *type*.
- If *type* is a ROW data type and a derived column list is specified, then the ROW type of the collection-derived table is an unnamed ROW type whose column data types are the same as those of *type* and whose column names are taken from the derived column list.
- If *type* is not a ROW data type, the ROW type of the collection-derived table is an unnamed ROW type that contains one column of *type* and whose name is specified in the derived column list. If no name is specified, the database server assigns an implementation-dependent name to the column.

The extended examples that the following table shows illustrate these rules. The table uses the following schema for its examples:

```
CREATE ROW TYPE person (name CHAR(255), id INT);
CREATE TABLE parents
(
  name CHAR(255),
  id INT,
  children LIST (person NOT NULL)
);
CREATE TABLE parents2
(
  name CHAR(255),
  id INT,
```

```
children_ids LIST (INT NOT NULL)
);
```

ROW Type	Explicit Derived-Column List	Resulting ROW Type of the Collection-Derived Table	Code Example
Yes	No	Type	<pre>SELECT (SELECT c_table.name FROM TABLE(parents.children) c_table WHERE c_table.id = 1002) FROM parents WHERE parents.id = 1001;</pre> <p>In this example, the ROW type of c_table is parents.</p>
Yes	Yes	Unnamed ROW type of which the column type is <i>Type</i> and the column name is the name in the derived-column list	<pre>SELECT (SELECT c_table.c_name FROM TABLE(parents.children) c_table(c_name, c_id) WHERE c_table.c_id = 1002) FROM parents WHERE parents.id = 1001;</pre> <p>In this example, the ROW type of c_table is ROW(c_name CHAR(255), c_id INT).</p>
No	No	Unnamed ROW that contains one column of <i>Type</i> that is assigned an implementation-dependent name	In the following example, if you do not specify c_id , the database server assigns a name to the derived column. In this case, the ROW type of c_table is ROW(server_defined_name INT) .
No	Yes	Unnamed ROW type that contains one column of <i>Type</i> whose name is in the derived-column list	<pre>SELECT (SELECT c_table.c_id FROM TABLE(parents2.child_ids) c_table (c_id) WHERE c_table.c_id = 1002) FROM parents WHERE parents.id = 1001;</pre> <p>Here the ROW type of c_table is ROW(c_id INT).</p>

The following program fragment creates a collection-derived table using an SPL function that returns a single value:

```
CREATE TABLE wanted(person_id int);
CREATE FUNCTION
    wanted_person_count (person_set SET (person NOT NULL))
RETURNS INT;
RETURN( SELECT COUNT (*)
        FROM TABLE (person_set) c_table, wanted
        WHERE c_table.id = wanted.person_id);
END FUNCTION;
```

The next program fragment shows the more general case of creating a collection-derived table using an SPL function that returns multiple values:

```
-- Table of categories and child categories,
-- allowing any number of levels of subcategories
CREATE TABLE CategoryChild (
    categoryId      INTEGER,
    childCategoryId SMALLINT
);

INSERT INTO CategoryChild VALUES (1, 2);
INSERT INTO CategoryChild VALUES (1, 3);
INSERT INTO CategoryChild VALUES (1, 4);
INSERT INTO CategoryChild VALUES (2, 5);
INSERT INTO CategoryChild VALUES (2, 6);
INSERT INTO CategoryChild VALUES (5, 7);
INSERT INTO CategoryChild VALUES (7, 8);
INSERT INTO CategoryChild VALUES (7, 9);
INSERT INTO CategoryChild VALUES (4, 10);

-- "R" == ROW type
CREATE ROW TYPE categoryLevelR (
    categoryId      INTEGER,
    level           SMALLINT );

-- DROP FUNCTION categoryDescendants (
--     INTEGER, SMALLINT );
CREATE FUNCTION categoryDescendants (
    pCategoryId INTEGER,
    pLevel      SMALLINT DEFAULT 0 )
RETURNS MULTISET (categoryLevelR NOT NULL)

-- "p" == Prefix for Parameter names
-- "l" == Prefix for Local variable names
DEFINE lCategoryId LIKE CategoryChild.categoryId;
DEFINE lRetSet MULTISET (categoryLevelR NOT NULL);
DEFINE lCatRow categoryLevelR;

-- TRACE ON;
-- Must initialize collection before inserting rows
LET lRetSet = 'MULTISET{}' :: MULTISET (categoryLevelR NOT NULL);

FOREACH
SELECT childCategoryId INTO lCategoryId
FROM CategoryChild WHERE categoryId = pCategoryId;
INSERT INTO TABLE (lRetSet)
VALUES (ROW (lCategoryId, pLevel+1)::categoryLevelR);

-- INSERT INTO TABLE (lRetSet);
-- EXECUTE FUNCTION categoryDescendantsR ( lCategoryId,
-- pLevel+1 );
-- Need to iterate over results and insert into SET.
-- See the SQL Tutorial, pg. 10-52:
-- "Tip: You can only insert one value at a time
```

```

-- into a simple collection."
FOREACH
EXECUTE FUNCTION categoryDescendantsR ( lCategoryId, pLevel+1 )
  INTO lCatRow;
  INSERT INTO TABLE (lRetSet)
    VALUES (lCatRow);
END FOREACH;
END FOREACH;

RETURN lRetSet;
END FUNCTION
;

-- "R" == recursive
-- DROP FUNCTION categoryDescendantsR (INTEGER, SMALLINT);
CREATE FUNCTION categoryDescendantsR (
  pCategoryId INTEGER,
  pLevel      SMALLINT DEFAULT 0
)
RETURNS categoryLevelR;
DEFINE lCategoryId LIKE CategoryChild.categoryId;
DEFINE lCatRow     categoryLevelR;

FOREACH
  SELECT childCategoryId
  INTO   lCategoryId
  FROM   CategoryChild
  WHERE  categoryId = pCategoryId
  RETURN ROW (lCategoryId, pLevel+1)::categoryLevelR WITH RESUME;

  FOREACH
  EXECUTE FUNCTION categoryDescendantsR ( lCategoryId, pLevel+1 )
    INTO lCatRow
    RETURN lCatRow WITH RESUME;
  END FOREACH;
END FOREACH;
END FUNCTION;

-- Test the functions:
SELECT lev, col
FROM   TABLE ((
  categoryDescendants (1, 0)
)) AS CD (col, lev);

```

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Accessing a Collection Through a Collection Variable

When you use the collection-variable format of the collection-derived table segment, you use a host or program variable to access and manipulate the elements of a collection. This format allows you to modify the contents of a variable as you would a table in the database, and then update the actual table with the contents of the **collection** variable.

You can use the collection-variable format (the TABLE keyword preceding a **collection** variable) in place of the name of a table, synonym, or view in the following SQL statements (or in the FOREACH statement of SPL):

- The FROM clause of the SELECT statement to access an element of the **collection** variable
- The INTO clause of the INSERT statement to add a new element to the **collection** variable
- The DELETE statement to remove an element from the **collection** variable
- The UPDATE statement to modify an existing element in the **collection** variable
- The DECLARE statement to declare a Select or Insert cursor to access multiple elements of the Informix® ESQL/C **collection** host variable
- The FETCH statement to retrieve a single element from a **collection** host variable that is associated with a Select cursor
- The PUT statement to retrieve a single element from a **collection** host variable that is associated with an Insert cursor
- The FOREACH statement to declare a cursor to access multiple elements of an SPL collection variable and to retrieve a single element from this **collection** variable

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Using a Collection Variable to Manipulate Collection Elements

When you use data manipulation statements (SELECT, INSERT, UPDATE, or DELETE) of Informix® in conjunction with a **collection** variable, you can modify one or more elements in a collection.

To modify elements in a collection

1. Create a **collection** variable in your SPL routine or Informix ESQL/C program. For information on how to declare a **collection** variable in Informix ESQL/C, see the *IBM Informix ESQL/C Programmer's Manual*. For information on how to define a **COLLECTION** variable in SPL, see [DEFINE](#).
2. In Informix ESQL/C, allocate memory for the collection; see [ALLOCATE COLLECTION statement](#).
3. Optionally, use a SELECT statement to select a COLLECTION column into the **collection** variable. If the variable is an untyped COLLECTION variable, you must perform a SELECT from the COLLECTION column before you use the variable in the collection-derived table segment. The SELECT statement allows the database server to obtain the collection data type.

4. Use the appropriate data manipulation statement with the collection-derived table segment to add, delete, or update elements in the collection variable. To insert more than one element or to update or delete a *specific* element of a collection, you must use a cursor for the collection variable.
 - For more information on how to use an update cursor with ESQL/C, see [DECLARE statement](#).
 - For more information on how to use an update cursor with SPL, see [FOREACH](#).
5. After the collection variable contains the correct elements, use an INSERT or UPDATE statement on the table or view that holds the actual collection column to save the changes that the collection variable holds.
 - With UPDATE, specify the collection variable in the SET clause.
 - With INSERT, specify the collection variable in the VALUES clause.

The collection variable stores the elements of the collection. It has no intrinsic connection, however, with a database column. Once the collection variable contains the correct elements, you must then save the variable into the actual collection column of the table with either an INSERT or an UPDATE statement.

- [Example of Deleting from a Collection in ESQL/C](#)
- [Example of Deleting from a Collection](#)
- [Example of Updating a Collection](#)
- [Example of Inserting a Value into a Multiset Collection](#)

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Example of Deleting from a Collection in ESQL/C

Suppose that the **set_col** column of a row in the **table1** table is defined as a SET and for one row contains the values {1, 8, 4, 5, 2}. The following Informix® ESQL/C code fragment uses an update cursor and a DELETE statement with a WHERE CURRENT OF clause to delete the element whose value is 4:

```
EXEC SQL BEGIN DECLARE SECTION;
  client collection set(smallint not null) a_set;
  int an_int;
EXEC SQL END DECLARE SECTION;
...
EXEC SQL allocate collection :a_set;
EXEC SQL select set_col into :a_set from table1 where int_col = 6;
EXEC SQL declare set_curs cursor for
  select * from table(:a_set) for update;

EXEC SQL open set_curs;
while (i < coll_size)
{
  EXEC SQL fetch set_curs into :an_int;
  if (an_int = 4)
  {
    EXEC SQL delete from table(:a_set) where current of set_curs;
    break;
  }
  i++;
}

EXEC SQL update table1 set set_col = :a_set
  where int_col = 6;
EXEC SQL deallocate collection :a_set;
EXEC SQL close set_curs;
EXEC SQL free set_curs;
```

After the DELETE statement executes, this collection variable contains the elements {1, 8, 5, 2}. The UPDATE statement at the end of this code fragment saves the modified collection into the **set_col** column. Without this UPDATE statement, element 4 of the collection column is not deleted.

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Example of Deleting from a Collection

Suppose that the **set_col** column of a row in the **table1** table is defined as a SET and one row contains the values {1, 8, 4, 5, 2}. The following SPL code fragment uses a FOREACH loop and a DELETE statement with a WHERE CURRENT OF clause to delete the element whose value is 4:

```
CREATE PROCEDURE test6()
  DEFINE a SMALLINT;
  DEFINE b SET(SMALLINT NOT NULL);
  SELECT set_col INTO b FROM table1
    WHERE id = 6;
  -- Select the set in one row from the table
  -- into a collection variable
  FOREACH cursor1 FOR
    SELECT * INTO a FROM TABLE(b);
    -- Select each element one at a time from
    -- the collection derived table b into a
    IF a = 4 THEN
      DELETE FROM TABLE(b)
        WHERE CURRENT OF cursor1;
      -- Delete the element if it has the value 4
    EXIT FOREACH;
```



```

    END IF;
  END FOREACH;

  UPDATE table1 SET set_col = b
  WHERE id = 6;
  -- Update the base table with the new collection

```

```
END PROCEDURE;
```

This SPL routine declares two SET variables, **a** and **b**, each to hold a set of SMALLINT values. The first SELECT statement copies a SET column from one row of **table1** into variable **b**. The routine then declares a cursor called **cursor1** that copies one element at a time from **b** into SET variable **a**. When the cursor is positioned on the element whose value is 4, the DELETE statement removes that element from SET variable **b**. Finally, the UPDATE statement replaces the row of **table1** with the new collection that is stored in variable **b**.

For information on how to use collection variables in an SPL routine, see the *IBM® Informix® Guide to SQL: Tutorial*.

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Example of Updating a Collection

Suppose that the **set_col** column of a table called **table1** is defined as a SET and that it contains the values {1, 8, 4, 5, 2}. The following Informix® ESQL/C program changes the element whose value is 4 to a value of 10:

```

main
{
  EXEC SQL BEGIN DECLARE SECTION;
  int a;
  collection b;
  EXEC SQL END DECLARE SECTION;

  EXEC SQL allocate collection :b;
  EXEC SQL select set_col into :b from table1
  where int_col = 6;

  EXEC SQL declare set_curs cursor for
  select * from table(:b) for update;
  EXEC SQL open set_curs;
  while (SQLCODE != SQLNOTFOUND)
  {
    EXEC SQL fetch set_curs into :a;
    if (a = 4)
    {
      EXEC SQL update table(:b) (x)
      set x = 10 where current of set_curs;
      break;
    }
  }
  EXEC SQL update table1 set set_col = :b
  where int_col = 6;
  EXEC SQL deallocate collection :b;
  EXEC SQL close set_curs;
  EXEC SQL free set_curs;
}

```

After you execute this Informix ESQL/C program, the **set_col** column in **table1** contains the values {1, 8, 10, 5, 2}.

This Informix ESQL/C program defines two **collection** variables, **a** and **b**, and selects a SET from **table1** into **b**. The WHERE clause ensures that only one row is returned. Then the program defines a Collection cursor, which selects elements one at a time from **b** into **a**. When the program locates the element with the value 4, the first UPDATE statement changes that element value to 10 and exits the loop.

In the first UPDATE statement, **x** is a derived-column name used to update the current element in the collection-derived table. The second UPDATE statement updates the base table **table1** with the new collection.

For information on how to use **collection** host variables in Informix ESQL/C programs, see the discussion of complex data types in the *IBM® Informix ESQL/C Programmer's Manual*.

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Example of Inserting a Value into a Multiset Collection

Suppose the Informix® ESQL/C host variable **a_multiset** has the following declaration:

```

EXEC SQL BEGIN DECLARE SECTION;
  client collection multiset(integer not null) a_multiset;
EXEC SQL END DECLARE SECTION;

```

The following INSERT statement adds a new MULTiset element of 142,323 to **a_multiset**:

```

EXEC SQL allocate collection :a_multiset;
EXEC SQL select multiset_col into :a_multiset from table1
  where id = 107;

```

```
EXEC SQL deallocate collection :a multiset;
```

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Accessing a Nested Collection

If the element of the collection is itself a complex type (**collection** or **row** type), the collection is a *nested collection*. For example, suppose the Informix® ESQ/C **collection** variable, **a_set**, is a nested collection that is defined as follows:

```
EXEC SQL BEGIN DECLARE SECTION;
    client collection set(list(integer not null)) a_set;
    client collection list(integer not null) a_list;
    int an_int;
EXEC SQL END DECLARE SECTION;
```

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Accessing a Row Variable

The TABLE keyword can make the Informix® ESQL/C **row** variable a collection-derived table. That is, a row appears as a table in an SQL statement. For a **row** variable, think of the collection-derived table as a table of one row, with each field of the **row** type being a column of the row. Use the TABLE keyword in place of the name of a table, synonym, or view in these SQL statements:

- The FROM clause of the SELECT statement to access a field of the **row** variable
- The UPDATE statement to modify an existing field in the **row** variable

The DELETE and INSERT statements do not support a **row** variable in the collection-derived-table segment.

For example, suppose an ESQL/C host variable **a_row** has the following declaration:

```
EXEC SQL BEGIN DECLARE SECTION;
    row(x int, y int, length float, width float) a_row;
EXEC SQL END DECLARE SECTION;
```

The following ESQL/C code fragment adds the fields in the **a_row** variable to the **row_col** column of the **tab_row** table:

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Database Name

Use the Database Name segment to specify the name of a database. Use this segment when you see a reference to a database name in a syntax diagram.

Syntax

Database Name

```
|-----dbname-----|
| | '-@dbservername-' |
| | '-//dbservername/--dbname-' |
| | (1) |
| | '-----db_var-----' |
```

Notes:

1. ESQL/C only

Element	Description	Restrictions	Syntax
---------	-------------	--------------	--------

Element	Description	Restrictions	Syntax
<i>dbname</i>	Database name (with no pathname nor database server name)	Must be unique among the names of databases of the database server	Identifier
<i>dbservername</i>	Database server on which the database <i>dbname</i> resides	Must exist. No blank space can separate @ from <i>dbservername</i> .	Identifier
<i>db_var</i>	Host variable whose value specifies a database environment	Variable must be a fixed-length character data type	Language specific

Usage

Database names are not case sensitive. You cannot use delimited identifiers for a database name.

The identifiers *dbname* and *dbservername* can each have a maximum of 128 bytes.

If the name of a database server is a delimited identifier or if it includes uppercase letters, that database server cannot participate in cross-server distributed DML operations. To avoid this restriction, use only undelimited names that include no uppercase letters when you declare the name or the alias of a database server.

In a nondefault locale, *dbname* can include alphabetic characters from the code set of the locale. In a locale that supports a multibyte code set, keep in mind that the maximum length of the database name refers to the number of bytes, not the number of characters. For more information on the GLS aspects of naming databases, see the *IBM® Informix® GLS User's Guide*.

- [Using Keywords as Table Names](#)

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Using Keywords as Table Names

You can choose a database on another database server as your current database by specifying a database server name. The database server that *dbservername* specifies must match the name of a database server that is listed in your **sqlhosts** information.

- [Using the @ Symbol](#)
- [Using a Path-Type Naming Notation](#)
- [Using a Host Variable](#)

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Using the @ Symbol

The @ symbol is a literal character. If you specify a database server name, blank spaces are not valid between the @ symbol and the database server name. Either put a blank space between *dbname* and the @ symbol, or omit the blank space.

The following examples show valid database specifications, qualified by the database server name:

```
empinfo@personnel
empinfo @personnel
```

In these examples, **empinfo** is the name of the database and **personnel** is the name of the database server.

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Using a Path-Type Naming Notation

If you specify a pathname, do not put blank spaces between the quotation marks, slashes, and names. The following example specifies a valid UNIX pathname:

```
'//personnel/empinfo'
```

Here **empinfo** is the *dbname* and **personnel** is the name of the database server.

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Using a Host Variable

You can use a host variable within an ESQL/C application to store a value that represents a database environment.

Related reference:

Database Object Name

Use the Database Object Name segment to specify the name of a database object, such as a column, table, view, or user-defined routine. Use this segment whenever you see a reference to a database object name.

Syntax

Database Object Name

```
|----->
| (1)
|-----database-----;
|
|-----@dbservername-----
|
|-----object-----|
| (2)
|-----Owner Name----- .
|----- .-object-----|
```

Notes:

1. Informix® extension
2. See [Owner name](#)

Element	Description	Restrictions	Syntax
<i>database</i>	Database where <i>object</i> resides	Must exist.	Database Name
<i>dbservername</i>	Database server of <i>database</i>	Must exist. No space after @.	Identifier
<i>object</i>	Name of a database object	See Usage .	Identifier

Usage

A database object name can include qualifiers and separator symbols to specify a database, a server, an owner, and (for some objects) another object of which the current database object is a component. For example, this expression specifies the **unit-price** column of the **stock** table, owned by user **informix**, in the **stores_demo** database of a database server called **butler**:

```
stores_demo@butler:informix.stock.unit_price
```

If you are creating or renaming a database object, the new name that you declare must be unique among objects of the same type in the database. Thus, the name of a new view must be unique among the names and synonyms of tables, views, and sequence objects that already exist in the same database. (But a view can have the same name as a view in a different database of the same server, or the same name as a trigger, for example, because these are different types of objects.)

In an ANSI-compliant database, the *owner.object* combination must be unique in the database for the type of object. A database object specification must include the owner name for a database object that you do not own. For example, if you specify a table that you do not own, you must also specify the owner of the table. The owner of all the system catalog tables is **informix**.

In Informix, the uniqueness requirement does not apply to the name of a user defined routine (UDR). For more information, see [Routine Overloading and Routine Signatures](#).

Characters from the code set of your database locale are valid in database object names. For more information, see *IBM® Informix GLS User's Guide*.

- [Specifying a Database Object in an External Database](#)
- [Routine Overloading and Routine Signatures](#)
- [Owners of Objects Created by UDRs](#)

Specifying a Database Object in an External Database

Besides objects in the local database to which you are currently connected, you can also specify a database object in another database of the local database server, or in a database of a remote database server.

- [Specifying a Database Object in a Cross-Database Query](#)
- [Specifying a Database Object in a Cross-Server Query](#)

To specify an object in a database of a remote database server, you must use a *fully-qualified identifier* that specifies the database, the database server instance, and the owner (if the external database is ANSI compliant), in addition to the database object name.

Specifying a Database Object in a Cross-Database Query

To specify an object in another database of the local database server, you must qualify the identifier of the object with the name of the database (and of the owner, if the external database is ANSI compliant), as in this example:

```
corp_db:hrdirector.executives
```

In this example, the name of the external database is **corp_db**. The name of the owner of the table is **hrdirector**. The name of the table is **executives**. Here the colon (:) separator is required after the *database* qualifier.

In Informix®, queries and other data manipulation language (DML) operations on other databases of the local database server can access most of the *built-in opaque data types*, as listed in [Data Types in Cross-Database Transactions](#). DML operations can also access user-defined data types (UDTs) that can be cast to built-in types, as well as DISTINCT types that are based on built-in types, if each DISTINCT types and UDT is cast explicitly to a built-in type, and if all the DISTINCT types, UDTs, and casts are defined in all of the participating databases. The same data-type restrictions also apply to the arguments and to the returned values of a user-defined routine (UDR) that accesses other databases of the local Informix instance, if the UDR is defined in all of the participating databases.

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Specifying a Database Object in a Cross-Server Query

To specify an object in a database of a remote database server, you must use a *fully-qualified identifier* that specifies the database, the database server instance, and the owner (if the external database is ANSI compliant), in addition to the database object name.

For example, **hr_db@remoteoffice:hrmanager.employees** is a fully-qualified table name.

- Here the database name is **hr_db**,
- the @ separator (ASCII 64), with no blank spaces, is required between the *database* and *database server* qualifiers,
- the database server name is **remoteoffice**,
- the : separator (ASCII 58), with no blank spaces, is required between the *database server* and *owner* qualifiers,
- the authorization identifier of the table *owner* is **hrmanager**,
- the . separator (ASCII 46), with no blank spaces, is required between the *owner* and *table* qualifiers,
- and the *table* name is **employees**.

Cross-server queries can access columns of built-in data types that are not opaque data types, but they cannot access UDTs nor complex data types. Among built-in opaque types, only BOOLEAN, BSON, JSON, VARCHAR, and DISTINCT types based on those base types, can be accessed or returned by DML statements or by UDRs in the databases of remote server instances. (For more information about the DISTINCT and built-in OPAQUE data types that Informix® supports in cross-server operations, see [Data Types in Cross-Server Transactions](#).)

If a UDR exists on a remote database server instance, you must specify a fully-qualified identifier for the UDR. The following SQL statement invokes a routine in the same remote database as the previous example, where the authorization identifier of the owner of the routine is **johan**, and the identifier of the UDR is **suggestion_box**:

```
EXECUTE FUNCTION hr_db@remoteoffice:johan.suggestion_box(0) :
```

You can refer to a remote database object only in the following SQL statements:

- CREATE DATABASE
- CREATE SYNONYM
- CREATE VIEW
- DATABASE
- DELETE
- EXECUTE FUNCTION
- EXECUTE PROCEDURE
- INFO
- INSERT
- LOAD
- LOCK TABLE
- MERGE
- SELECT
- UNLOAD
- UNLOCK TABLE
- UPDATE

In distributed MERGE operations, source tables can be in the database of a remote server instance, but the target table must be in a database of the local Informix instance.

For information on the support in these statements across databases of the local server, or across database servers, refer to the *IBM® Informix Guide to SQL: Tutorial*.

If the name of a database server is a delimited identifier or if it includes uppercase letters, that database server cannot participate in distributed DML operations. To avoid this restriction, use only undelimited names that include no uppercase letters when you declare the name or the alias of a database server.

Restrictions on remote user-defined routines

The EXECUTE FUNCTION or EXECUTE PROCEDURE statement can invoke a routine in the database of a remote server instance in most contexts where a UDR is valid in the local database, but every participating database must have the same logging mode.

Cross-server operations require exactly one *coordinator* to connect to one or more database server instances as subordinate *participants* that process branches of the operation that reads or modifies objects in their databases.

Only the database server instance that initiated the cross-server operation as the coordinator can establish a connection with another database server. A distributed operation that invokes UDRs on one or more remote database servers can have a logical topology of connections resembling a star schema, but not a snowflake schema. In the one-to-many relationship between the coordinator and participants, only the coordinator can be the calling context for invoking remote UDRs.

If the EXECUTE FUNCTION or EXECUTE PROCEDURE statement calls a remote routine that in turn attempts to execute a remote routine on a third database server instance, the distributed operation fails with error -556. A UDR called from a participant server cannot invoke a UDR on a third server, and cannot reference any object on a third server.

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Routine Overloading and Routine Signatures

Because of routine overloading, the name of a user-defined routine does not need to be unique to the database. You can define more than one UDR with the same name, provided that the *routine signature* for each UDR is different.

UDRs are uniquely identified by their signatures. The signature of a UDR includes the following items of information:

- The type of routine (function or procedure)
- The identifier of the routine
- The cardinality, data type, and order of the parameters
- In an ANSI-compliant database, the owner name

For any given UDR, at least one item in the routine signature must be unique among all the UDRs registered in the database.

In a database that is not ANSI-compliant, two routines that have different owners cannot have the same signature, except in the special cases of the **sysdbopen()** and **sysdbclose()** routines. For information about the effects of these session configuration routines when their owners connect to or disconnect from a database where these routines are defined, see [IFX_REPLACE_MODULE Function](#).

- [Specifying an Existing UDR](#)

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Specifying an Existing UDR

To reference an existing UDR by a name that does not uniquely identify the UDR, you must also specify the parameter data types after the UDR name, in the same order that they were declared when the UDR was created. Informix® then uses routine resolution rules to identify the instance of the UDR to alter, drop, or execute. As an alternative, you can specify its *specific name*, if one was declared when the UDR was created. Specific names are described in the section [Specific Name](#). For more details of routine resolution, see [Comparing Arguments to the Parameter List](#), and *IBM® Informix User-Defined Routines and Data Types Developer's Guide*.

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Owners of Objects Created by UDRs

When a DDL statement within an owner-privileged UDR creates a new database object, the owner of the routine (rather than the user who executes it, if that user is not the owner of the routine) becomes the owner of the new database object. For a DBA-privileged UDR, however, the user who executes the routine (and who must hold DBA privilege) becomes the owner of any objects that the UDR creates.

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External Routine Reference

Include the External Routine Reference clause when you write an external routine. This option is not available for SPL routines.

Syntax

External Routine Reference

```
(1)  
|--EXTERNAL NAME--| Shared-Object Filename |-----LANGUAGE----->
```

Notes:

- ## Usage

This segment specifies the following information about an external routine:

- Pathname to the executable object code, stored in a shared-object file
For C routines, this file is either a DLL or a shared library, depending on your operating system.
- For Java routines, this file is a jar file. Before you can create a UDR written in the Java language, you must assign a jar identifier to the external jar file with the **sqlj.install_jar** procedure. For more information, see [sqlj.install_jar](#).
- The name of the programming language in which the UDR is written
 - The parameter style of the UDR
By default, the parameter style is INFORMIX. (This implies that if you specify OUT or INOUT parameters, the OUT or INOUT values are passed by reference.)
 - The VARIANT or NOT VARIANT option. If you specify neither, the default is VARIANT. If the routine includes any statement of SQL it is a VARIANT routine. If a DDL statement that includes the External Routine Reference clause also includes the Routine Modifier clause, do not classify the same UDR as VARIANT in one of these clauses and as NOT VARIANT in the other.

Example

```
CREATE FUNCTION delete_order(int) RETURNING int
EXTERNAL NAME 'informix.demo_jar:delete_order.delete_order()'
LANGUAGE JAVA;
```

- Related reference:**

Shared-Object Filename

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VARIANT or NOT VARIANT Option

By default, user-defined functions are variant. If you specify NOT VARIANT when you create or modify a function, it cannot contain any SQL statements.

To register a nonvariant function, add the NOT VARIANT option in this clause or in the Routine Modifier clause that is discussed in [Routine modifier](#). If you specify the modifier in both contexts, however, you must use the same modifier (either VARIANT or NOT VARIANT) in both clauses.

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Example of a C User-Defined Function

The next example registers an external function named **equal()** that takes two **point** data type values as arguments. In this example, **point** is an opaque data type that specifies the **x** and **y** coordinates of a two-dimensional point.

The function returns a single value of type `BOOLEAN`. The external name specifies the path to the C shared-object file where the object code of the function is stored. The external name indicates that the library contains another function, `point1_equal()`, which is invoked while `equal()` executes.

Identifier

Syntax

1. See [Delimited Identifiers](#)

Usage

- [Use of Uppercase Characters](#)
- [Use of Keywords as Identifiers](#)
- [Support for Non-ASCII Characters in Identifiers](#)
- [Delimited Identifiers](#)
- [Enabling Delimited Identifiers](#)
- [Potential Ambiguities and Syntax Errors](#)
- [Using the Names of Built-In Functions as Column Names](#)
- [Using Keywords as Column Names](#)
- [Using ALL, DISTINCT, or UNIQUE as a Column Name](#)

- Using INTERVAL or DATETIME as a Column Name
- Using rowid as a Column Name
- Using keywords as table names

The database server issues an error in contexts where the unqualified identifier of a table object is also a valid keyword of SQL. You can disambiguate the table name by qualifying it with the authorization identifier of the owner of the table.

Related information:

Non-ASCII characters in identifiers

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Use of Uppercase Characters

You can specify the name of a database object with uppercase characters, but the database server shifts these to lowercase characters unless the **DELIMITIDENT** environment variable is set and the identifier of the database object is enclosed between double (") quotation marks. In this case, the database server treats the name of the database object as a delimited identifier and preserves the uppercase characters in the name, as described in [Delimited Identifiers](#).

If the name of a database server includes uppercase letters, that database server cannot participate in distributed DML operations. To avoid this restriction, use only un delimited names that include no uppercase letters when you declare the name or the alias of a database server.

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Use of Keywords as Identifiers

Although you can use almost any word as an identifier, syntactic ambiguities can result from using keywords as identifiers in SQL statements. The statement might fail or might not produce the expected results. For a discussion of the syntactic ambiguities that can result from using keywords as identifiers and an explanation of workarounds for these problems, see [Potential Ambiguities and Syntax Errors](#).

Delimited identifiers provide the easiest and safest way to use a keyword as an identifier without syntactic ambiguities. No workarounds are necessary for a keyword as a delimited identifier. For the syntax and usage of delimited identifiers, see [Delimited Identifiers](#). Delimited identifiers require, however, that your code always use single (') quotation marks, rather than double (") quotation marks, to delimit character-string literals.

For the keywords of the implementation of SQL in Informix®, see [Keywords of SQL for IBM Informix](#).

Tip: If an error message seems unrelated to the statement that caused the error, check to see if the statement uses a keyword as an unlimited identifier.

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Support for Non-ASCII Characters in Identifiers

In a nondefault locale, you can use any alphabetic character that your locale recognizes as a *letter* in an SQL identifier. This feature enables you to use non-ASCII characters in the names of some database objects. For objects that support non-ASCII characters, see the *IBM® Informix® GLS User's Guide*.

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Delimited Identifiers

By default, the character set of a valid SQL identifier is restricted to letters, digits, underscore, and dollar-sign symbols. If you set the **DELIMIDENT** environment variable, however, SQL identifiers can also include additional characters from the code set implied by the setting of the **DB_LOCALE** environment variable.

Delimited Identifier

```

      .----- .
      v       |
|--"-----+--"-----|
      +-letter-----+
      +-digit-----+
      +-underscore---+
      +-other character-'

```

Element	Description	Restrictions	Syntax
<i>digit</i>	Integer in the range 0 to 9	Cannot be the first character	Literal Number
<i>letter</i>	Letter that forms part of the delimited identifier	Letters in delimited identifiers are case-sensitive	Literal value entered from the keyboard.
<i>other_character</i>	Nonalphanumeric character, such as #, \$, or blank space	Must be an element in the code set of the database locale	Literal value entered from the keyboard.

Element	Description	Restrictions	Syntax
<i>underscore</i>	Underscore (<code>_</code>) symbol in the delimited identifier	Cannot include more than 128	Literal value entered from the keyboard.

If the database supports delimited identifiers, any double quotation marks (`"`) enclose an SQL identifier in your code, and only single (`'`) quotation marks, rather than double (`"`) quotation marks, delimit character-string literals.

Delimited identifiers enable you to declare names that are otherwise identical to SQL keywords, such as `TABLE`, `WHERE`, `DECLARE`, and so on. The only type of object for which you cannot specify a delimited identifier is a database name.

Letters in delimited identifiers are case sensitive. If you are using the default locale, *letter* must be an upper- or lowercase character in the range a to z or A to Z (in the ASCII code set). If you are using a nondefault locale, *letter* must be an alphabetic character that the locale supports. For more information, see [Support for Non-ASCII Characters in Delimited Identifiers \(GLS\)](#).

Delimited identifiers are compliant with the ANSI/ISO standard for SQL.

When you create a database object, avoid including leading blank spaces or other white-space characters between the first delimiting quotation mark and the first nonblank character of the delimited identifier. (Otherwise, you might not be able to reference the object in some contexts.)

If the name of a database server is a delimited identifier or if it includes uppercase letters, that database server cannot participate in distributed DML operations. To avoid this restriction, use only undelimited names that include no uppercase letters when you declare the name or the alias of a database server.

- [Support for Nonalphanumeric Characters](#)
- [Support for Non-ASCII Characters in Delimited Identifiers \(GLS\)](#)

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Support for Nonalphanumeric Characters

By default, ASCII letters, digits, and the underscore (ASCII 95) character are supported in SQL identifiers and in storage object identifiers for all locales. To include additional characters from the codeset implied by the **DB_LOCALE** setting in the names of database objects, you must use delimited identifiers.

You cannot, however, use delimited identifiers, however, to specify characters that are not letters, digits, or the underscore (`_`) character when you declare or reference the names of storage objects, such as `dbspaces`, `partitions`, `blobspaces`, or `sbspaces`.

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Support for Non-ASCII Characters in Delimited Identifiers (GLS)

When you are using a nondefault locale whose code set supports non-ASCII characters, you can specify those non-ASCII characters in most delimited identifiers. The rule is that if you can specify non-ASCII characters in the undelimited form of the identifier, you can also specify non-ASCII characters in the delimited form of the same identifier. For a list of identifiers that support non-ASCII characters and for information on non-ASCII characters in delimited identifiers, see the *IBM® Informix® GLS User's Guide*.

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Enabling Delimited Identifiers

To use delimited identifiers, you must set the **DELIMIDENT** environment variable. While **DELIMIDENT** is set, strings enclosed in double quotation marks (`"`) are treated as identifiers of database objects, and strings enclosed in single quotation marks (`'`) are treated as literal strings. If the **DELIMIDENT** environment variable is not set, however, strings enclosed in double quotation marks are also treated as literal strings.

If **DELIMIDENT** is set, the `SELECT` statement in the following example must be in single quotation marks in order to be treated as a quoted string:

```
PREPARE ... FROM 'SELECT * FROM customer';
```

If a delimited identifier is used in the `SELECT` statement that defines a view, then the **DELIMIDENT** environment variable must be set in order for the view to be accessed, even if the view name itself contains no special characters.

On UNIX and Linux systems, you can set **DELIMIDENT** by the procedures for setting environment variables that are described in *IBM® Informix® Guide to SQL: Reference*.

On Windows systems, you can set **DELIMIDENT** in various ways, which generally have the following descending order of precedence:

1. The setting of **DELIMIDENT** in the connection string when connecting
2. The setting of the `SQL_INFX_ATTR_DELIMIDENT` connection attribute before connecting
3. The setting of **DELIMIDENT** in `setnet32` with the **Use my settings** box selected
4. The setting of **DELIMIDENT** in `setnet32` with the **Use my settings** box cleared
5. The setting of **DELIMIDENT** on the command line before running the application
6. The setting of **DELIMIDENT** in Windows as a user variable
7. The setting of **DELIMIDENT** in Windows as a system variable

8. The default value (of no support for delimited identifiers).

This general order of precedence for Windows clients is sensitive, however, to the API through which you connect to the database, which can also affect the meaning of the setting and the default value. Refer to the documentation of your specific API for more information about the **DELIMIDENT** setting in Windows.

- [Examples of Delimited Identifiers](#)
- [Using Double Quotation Marks in a Delimited Identifier](#)

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Examples of Delimited Identifiers

The next example shows how to create a table with a case-sensitive name:

```
CREATE TABLE "Proper_Ranger" (...);
```

The following example creates a table whose name includes a white-space character. If the table name were not enclosed by double (") quotation marks, and if **DELIMIDENT** were not set, you could not use a blank space in the identifier.

```
CREATE TABLE "My Customers" (...);
```

The next example creates a table that has a keyword as the table name:

```
CREATE TABLE "TABLE" (...);
```

The following example for Informix® shows how to delete all the rows from a table that is named FROM when you omit the keyword FROM in the DELETE statement:

```
DELETE "FROM";
```

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Using Double Quotation Marks in a Delimited Identifier

To include a double quotation mark (") character within a delimited identifier, you must precede the double quotation mark (") with another double quotation mark ("). The following statement fragment specifies **My "Good" Data** as a table name:

```
CREATE TABLE "My " "Good" " Data" (...);
```

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Potential Ambiguities and Syntax Errors

does not recommend using any keyword of SQL as an identifier, because to do so tends to make your code more difficult to read and to maintain. If you ignore this potential problem for human readers, however, you can use almost any keyword as an SQL identifier, but various syntactic ambiguities can occur. An ambiguous statement might not produce the desired results. The following sections identify some potential ambiguities and workarounds when keywords are declared as identifiers, or when different database objects have the same identifier.

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Using the Names of Built-In Functions as Column Names

The following two examples show a workaround for using a built-in function as a column name in a SELECT statement. This workaround applies to the built-in aggregate functions (AVG, COUNT, MAX, MIN, SUM) as well as the function expressions (algebraic, exponential and logarithmic, time, HEX, length, DBINFO, trigonometric, and TRIM functions).

Using **avg** as a column name causes the next example to fail because the database server interprets **avg** as an aggregate function rather than as a column name:

```
SELECT avg FROM mytab; -- fails
```

If the **DELIMIDENT** environment variable is set, you could use **avg** as a column name as the following example shows:

```
SELECT "avg" from mytab; -- successful
```

The workaround in the following example removes ambiguity by including a table name with the column name:

```
SELECT mytab.avg FROM mytab;
```

If you use the keyword TODAY, CURRENT, SYSDATE, or USER as a column name, ambiguity can occur, as the following example shows:

```
CREATE TABLE mytab (user char(10),
  CURRENT DATETIME HOUR TO SECOND, TODAY DATE);

INSERT INTO mytab VALUES('josh', '11:30:30', '1/22/2008');

SELECT user, current, today FROM mytab;
```

The database server interprets **user**, **current**, and **today** in the SELECT statement as the built-in functions USER, CURRENT, and TODAY. Thus, instead of returning josh, 11:30:30, 1/22/2008, the SELECT statement returns the current user name, the current time, and the current date. The SYSDATE keyword has a similar effect in databases of Informix®.

If you want to select the actual columns of the table, you must write the SELECT statement in one of the following ways:

```
SELECT mytab.user, mytab.current, mytab.today FROM mytab;

EXEC SQL select * from mytab;
```

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Using Keywords as Column Names

Specific workarounds exist for using a keyword as a column name in a SELECT statement or other SQL statement. In some cases, more than one suitable workaround might be available.

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Using ALL, DISTINCT, or UNIQUE as a Column Name

If you want to use the ALL, DISTINCT, or UNIQUE keywords as column names in a SELECT statement, you can take advantage of a workaround.

First, consider what happens when you try to use one of these keywords without a workaround. In the following example, using **all** as a column name causes the SELECT statement to fail because the database server interprets **all** as a keyword rather than as a column name:

```
SELECT all FROM mytab -- fails;
```

You must use a workaround to make this SELECT statement execute successfully. If the **DELIMIDENT** environment variable is set, you can use **all** as a column name by enclosing **all** in double quotation marks. In the following example, the SELECT statement executes successfully because the database server interprets **all** as a column name:

```
SELECT "all" from mytab; -- successful
```

The workaround in the following example uses the keyword ALL with the column name **all**:

```
SELECT ALL all FROM mytab;
```

The examples that follow show workarounds for using the keywords UNIQUE or DISTINCT as a column name in a CREATE TABLE statement.

The next example fails to declare a column named **unique** because the database server interprets **unique** as a keyword rather than as a column name:

```
CREATE TABLE mytab (unique INTEGER); -- fails
```

The following workaround uses two SQL statements. The first statement creates the column **mycol**; the second statement renames the column **mycol** to **unique**:

```
CREATE TABLE mytab (mycol INTEGER);

RENAME COLUMN mytab.mycol TO unique;
```

The workaround in the following example also uses two SQL statements. The first statement creates the column **mycol**; the second alters the table, adds the column **unique**, and drops the column **mycol**:

```
CREATE TABLE mytab (mycol INTEGER);

ALTER TABLE mytab
  ADD (unique INTEGER),
  DROP (mycol);
```

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Using INTERVAL or DATETIME as a Column Name

The examples in this section show workarounds for using the keyword INTERVAL (or DATETIME) as a column name in a SELECT statement.

Using **interval** as a column name causes the following example to fail because the database server interprets **interval** as a keyword and expects it to be followed by an INTERVAL qualifier:

```
SELECT interval FROM mytab; -- fails
```

If the **DELIMIDENT** environment variable is set, you could use **interval** as a column name, as the following example shows:

```
SELECT "interval" from mytab; -- successful
```

The workaround in the following example removes ambiguity by specifying a table name with the column name:

```
SELECT mytab.interval FROM mytab;
```

The workaround in the following example includes an owner name with the table name:

```
SELECT josh.mytab.interval FROM josh.mytab;
```

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Using rowid as a Column Name

Every nonfragmented table has a virtual column named **rowid**. To avoid ambiguity, you cannot use **rowid** as a column name. Performing the following actions causes an error:

- Creating a table or view with a column named **rowid**
- Altering a table by adding a column named **rowid**
- Renaming a column to **rowid**

You can, however, use the term **rowid** as a table name.

```
CREATE TABLE rowid (column INTEGER, date DATE, char CHAR(20));
```

Important: It is recommended that you use primary keys as an access method, rather than exploiting the **rowid** column.

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Using keywords as table names

The database server issues an error in contexts where the unqualified identifier of a table object is also a valid keyword of SQL. You can disambiguate the table name by qualifying it with the authorization identifier of the owner of the table.

Examples that follow illustrate owner-name qualifiers as workarounds when the keyword **STATISTICS**, **OUTER**, or **FROM** has been declared as a table name or synonym. (These examples also apply if any of those keywords is the identifier of a view.)

Using **statistics** as a table identifier causes the following UPDATE statement example to fail. An exception occurs because the database server interprets **statistics** as a keyword in a syntactically incorrect UPDATE **STATISTICS** statement, rather than as the target table name in an UPDATE statement:

```
UPDATE statistics SET mycol = 10; -- fails
```

The workaround in the following example qualifies the table name with the owner name, to avoid that ambiguity:

```
UPDATE josh.statistics SET mycol = 10;
```

Using **outer** as a table name causes the following example to fail, because the database server interprets **outer** as a keyword for performing a syntactically incorrect outer join:

```
SELECT mycol FROM outer; -- fails
```

The following successful example uses owner naming to avoid ambiguity:

```
SELECT mycol FROM josh.outer;
```

The following DELETE statement, whose target table was created with **from** as its identifier, returns a syntax error:

```
DELETE from; -- fails
```

Because **FROM** is also an optional keyword that immediately precedes the name of the table whose records are to be destroyed, the database server expects a table name after **FROM**. Finding none, it issues an exception.

The following example, in contrast, deletes all the rows from what it correctly recognizes as the **from** table, because that table name is qualified by the name of its owner:

```
DELETE zelaine.from;
```

If the **DELIMIDENT** environment variable is set on the database server, an alternative workaround is to use double quotation marks (") as delimiters.

```
DELETE "from";
```

This avoids the exception by indicating that **from** is an SQL identifier, rather than a string literal or an SQL keyword.

Despite the availability of these workarounds, your code will be easier for humans to read and to maintain if you avoid declaring SQL keywords as the identifiers of tables, views, or other database objects.

- [Workarounds that Use the Keyword AS](#)
- [Using AS with Column Labels](#)

- [Using AS with Table Aliases](#)
 - [Fetching Cursors that have Keywords as Names](#)
 - [Declaring keywords as names for variables in UDRs](#)
- If you use some keywords as identifiers for variables in a user-defined routine (UDR), you can create ambiguous syntax:
- [Using CURRENT, DATETIME, INTERVAL, and NULL in INSERT](#)
 - [Using NULL and SELECT in a Condition](#)
 - [Declaring Keywords or Routine Names as SPL Variables](#)
 - [Variables that Conflict with Column Names](#)
 - [Using ON, OFF, or PROCEDURE with TRACE](#)
 - [Using GLOBAL as the Name of a Variable](#)
 - [Using EXECUTE, SELECT, or WITH as Cursor Names](#)
 - [SELECT Statements in WHILE and FOR Statements](#)
 - [SET keyword in the ON EXCEPTION statement of SPL](#)

If you include an SQL statement that begins with the keyword `SET` in the `ON EXCEPTION` statement, you must enclose it in a `BEGIN ... END` statement block.

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Workarounds that Use the Keyword AS

In some cases, although a statement is not ambiguous and the syntax is correct, the database server returns a syntax error. The preceding pages show existing syntactic workarounds for several situations. You can use the `AS` keyword to provide a workaround for the exceptions.

You can use the `AS` keyword in front of column labels or table aliases.

The following example uses the `AS` keyword with a column label:

```
SELECT column_name AS display_label FROM table_name;
```

The following example uses the `AS` keyword with a table alias:

```
SELECT select_list FROM table_name AS table_alias;
```

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Using AS with Column Labels

The examples in this section show workarounds that use the `AS` keyword with a column label. The first two examples show how you can use the keyword `UNITS` (or `YEAR`, `MONTH`, `DAY`, `HOURL`, `MINUTE`, `SECOND`, or `FRACTION`) as a column label.

Using **units** as a column label causes the next example to fail because the database server interprets it as part of an `INTERVAL` expression in which the **mycol** column is the operand of the `UNITS` operator:

```
SELECT mycol units FROM mytab;
```

The workaround in the following example includes the `AS` keyword:

```
SELECT mycol AS units FROM mytab;
```

The following example uses the `AS` or `FROM` keyword as a column label.

Using **as** as a column label causes the following example to fail because the database server interprets **as** as identifying **from** as a column label and thus finds no required `FROM` clause:

```
SELECT mycol as from mytab; -- fails
```

The following successful example repeats the `AS` keyword:

```
SELECT mycol AS as from mytab;
```

Using **from** as a column label causes the following example to fail because the database server expects a table name to follow the first **from**:

```
SELECT mycol from FROM mytab; -- fails
```

This example uses the `AS` keyword to identify the first **from** as a column label:

```
SELECT mycol AS from FROM mytab;
```

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Using AS with Table Aliases

Examples in this section show workarounds that use the `AS` keyword with a table alias. The first pair shows how to use the `ORDER`, `FOR`, `GROUP`, `HAVING`, `INTO`, `UNION`, `WITH`, `CREATE`, `GRANT`, or `WHERE` keyword as a table alias.

Using **order** as a table alias causes the following example to fail because the database server interprets **order** as part of an ORDER BY clause:

```
SELECT * FROM mytab order; -- fails
```

The workaround in the following example uses the keyword AS to identify **order** as a table alias:

```
SELECT * FROM mytab AS order;
```

The next two examples show how to use the keyword WITH as a table alias.

Using **with** as a table alias causes the next example to fail because the database server interprets **with** as part of the WITH CHECK OPTION syntax:

```
EXEC SQL select * from mytab with; -- fails
```

The workaround in the following example uses the keyword AS to identify **with** as a table alias:

```
EXEC SQL select * from mytab as with; -- succeeds
```

The next two examples use the keyword CREATE as a table alias. Using **create** as a table alias causes the next example to fail because the database server interprets the keyword as part of the syntax to create a new database object, such as a table, synonym, or view:

```
EXEC SQL select * from mytab create; -- fails
```

```
EXEC SQL select * from mytab as create; -- succeeds
```

The workaround uses the keyword AS to identify **create** as a table alias. (Using grant as an alias would similarly fail, but is valid after the AS keyword.)

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Fetching Cursors that have Keywords as Names

In a few situations, no workaround exists for the syntactic ambiguity that occurs when a keyword is used as an identifier in an SQL program.

In the following example, the FETCH statement specifies a cursor named **next**. The FETCH statement generates a syntax error because the preprocessor interprets **next** as a keyword, signifying the next row in the active set and expects a cursor name to follow **next**. This occurs whenever the keyword NEXT, PREVIOUS, PRIOR, FIRST, LAST, CURRENT, RELATIVE, or ABSOLUTE is used as a cursor name:

```
/* This code fragment fails */
EXEC SQL declare next cursor for
    select customer_num, lname from customer;
EXEC SQL open next;
EXEC SQL fetch next into :cnum, :lname;
```

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Declaring keywords as names for variables in UDRs

If you use some keywords as identifiers for variables in a user-defined routine (UDR), you can create ambiguous syntax:

The following constant expressions and other SQL keywords might produce unexpected results as variable names.

- CURRENT
- CURRENT_ROLE
- CURRENT_USER
- DATETIME
- DEFAULT_ROLE
- GLOBAL
- INTERVAL
- NULL
- OFF
- OUT
- PROCEDURE
- SELECT
- SYSDATE
- TODAY
- UNITS
- USER

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Using CURRENT, DATETIME, INTERVAL, and NULL in INSERT

A UDR cannot insert a variable that was declared using the CURRENT, DATETIME, INTERVAL, or NULL keywords as the name. For example, if you declare a variable called **null**, when you try to insert the value **null** into a column, you receive a syntax error, as the following example shows:

```
CREATE PROCEDURE problem()
. . .
DEFINE null INT;
LET null = 3;
INSERT INTO tab VALUES (null); -- error, inserts NULL, not 3
```

Related reference:

[DEFINE](#)

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Using NULL and SELECT in a Condition

If you declare a variable with the name **null** or **select**, including it in a condition that uses the IN keyword is ambiguous. The following example shows three conditions that cause problems: in an IF statement, in a WHERE clause of a SELECT statement, and in a WHILE condition:

```
CREATE PROCEDURE problem()
. . .
DEFINE x,y,select, null, INT;
DEFINE pname CHAR[15];
LET x = 3; LET select = 300;
LET null = 1;
IF x IN (select, 10, 12) THEN LET y = 1; -- problem if

IF x IN (1, 2, 4) THEN
SELECT customer_num, fname INTO y, pname FROM customer
WHERE customer IN (select , 301 , 302, 303); -- problem in

WHILE x IN (null, 2) -- problem while
. . .
END WHILE;
```

You can use the variable **select** in an IN list if you ensure it is not the first element in the list. The workaround in the following example corrects the IF statement that the preceding example shows:

```
IF x IN (10, select, 12) THEN LET y = 1; -- problem if
```

No workaround exists to using **null** as a variable name and attempting to use that variable in an IN condition.

Related reference:

[DEFINE](#)

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Declaring Keywords or Routine Names as SPL Variables

If you declare a variable with the same name as a keyword or as the name of a routine, ambiguities can occur. Informix® uses the following rules for resolving name conflicts among SPL variables, UDR names, and built-in SQL function names.

- Variable names that are declared in DEFINE statements take the highest precedence.
- User-defined routines defined in CREATE PROCEDURE or CREATE FUNCTION statements take precedence over built-in SQL functions.
- Procedures declared with the PROCEDURE keyword in the DEFINE statement take precedence over built-in SQL functions.
- Built-in SQL functions take precedence over SPL procedures that exist in the database but that are not explicitly identified as procedures in the DEFINE statement.

Do not use the name of a built-in SQL function as an SPL variable if you might need to invoke the SQL function. For example, do not declare a variable with the name **count** or **max**, if you might also need to call those aggregate functions.

Related reference:

[DEFINE](#)

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Variables that Conflict with Column Names

If you use the same identifier for an SPL variable and a column name, then within the scope of reference of the variable, the database server interprets any instance of the unqualified identifier as a variable. To use the identifier to specify a column name, use *table.column* notation to qualify the column name with the table name. In the following example, the procedure variable **lname** is the same as the column name. In the following SELECT statement, **customer.lname** is a column in the database and **lname** is an SPL variable:

```
CREATE PROCEDURE table_test()
DEFINE lname CHAR(15);
LET lname = "Miller";
SELECT customer.lname FROM customer INTO lname
WHERE customer_num = 502;
```


This example is valid, but relying on the rules of precedence of Informix® to resolve name conflicts between SPL variables and column names might make your code difficult for human readers to interpret and to maintain. An alternative to reusing the same identifier as a variable and as a column name is for the DEFINE statement to declare some prefix to the identifier, such as **v_lname** in this example, to indicate that this variable stores the value of the column **lname**.

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Using ON, OFF, or PROCEDURE with TRACE

If you define an SPL variable called **on**, **off**, or **procedure**, and you attempt to use it in a TRACE statement, the value of the variable is not traced. Instead, the TRACE ON, TRACE OFF, or TRACE PROCEDURE statements execute. You can trace the value of the variable by specifying the variable in a more complex expression.

The following example shows both the ambiguous syntax and workarounds that use arithmetic or string expressions that evaluate to the variable:

```
DEFINE on, off, procedure INT;

TRACE on;                --ambiguous
TRACE 0+ on;  --ok
TRACE off;               --ambiguous
TRACE ' '|off;--ok

TRACE procedure; --ambiguous
TRACE 0+procedure;--ok
```

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Using GLOBAL as the Name of a Variable

If you attempt to define a variable with the name **global**, the define operation fails. The syntax that the following example shows conflicts with the syntax for defining global variables:

```
DEFINE global INT; -- fails;
```

If the **DELIMIDENT** environment variable is set, you could use **global** as a variable name, as the following example shows:

```
DEFINE "global" INT; -- successful
```

Important: Although workarounds that the preceding sections show can avoid compilation or runtime syntax conflicts from keywords used as identifiers, keep in mind that such identifiers tend to make code more difficult to understand and to maintain.

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Using EXECUTE, SELECT, or WITH as Cursor Names

Do not use an EXECUTE, SELECT, or WITH keyword as the name of a cursor. If you try to use one of these keywords as the name of a cursor in a FOREACH statement, the cursor name is interpreted as a keyword in the FOREACH statement. No workaround exists.

The following example does not work:

```
DEFINE execute INT;
FOREACH execute FOR SELECT col1 -- error, looks to parser like
    INTO var1 FROM tab1;        -- 'FOREACH EXECUTE PROCEDURE'
```

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SELECT Statements in WHILE and FOR Statements

If you use a SELECT statement in a WHILE or FOR loop, and if you need to enclose it in parentheses, enclose the entire SELECT statement in a BEGIN...END statement block. The SELECT statement in the first WHILE statement in the following example is interpreted as a call to the procedure **var1**; the second WHILE statement is interpreted correctly:

```
DEFINE var1, var2 INT;
WHILE var2 = var1
    SELECT col1 INTO var3 FROM TAB -- error, interpreted as call var1()
    UNION
    SELECT co2 FROM tab2;
END WHILE;

WHILE var2 = var1
    BEGIN
        SELECT col1 INTO var3 FROM TAB -- ok syntax
        UNION
        SELECT co2 FROM tab2;
```

```
END
END WHILE;
```

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SET keyword in the ON EXCEPTION statement of SPL

If you include an SQL statement that begins with the keyword `SET` in the `ON EXCEPTION` statement, you must enclose it in a `BEGIN ... END` statement block.

The following list shows some of the SQL statements that begin with the keyword `SET`:

- `SET AUTOFREE`
- `SET CONNECTION`
- `SET CONSTRAINTS`
- `SET DATASKIP`
- `SET DEBUG FILE`
- `SET DEFERRED_PREPARE`
- `SET DESCRIPTOR`
- `SET ENCRYPTION`
- `SET ENVIRONMENT`
- `SET EXPLAIN`
- `SET INDEXES`
- `SET ISOLATION`
- `SET LOCK MODE`
- `SET LOG`
- `SET OPTIMIZATION`
- `SET PDQPRIORITY`
- `SET PLOAD FILE`
- `SET ROLE`
- `SET STATEMENT CACHE`
- `SET TABLE`
- `SET TRANSACTION`
- `SET TRIGGERS`

The following examples show the incorrect and correct use of a `SET LOCK MODE` statement inside an `ON EXCEPTION` statement.

The following `ON EXCEPTION` statement returns an error because the `SET LOCK MODE` statement is not enclosed in a `BEGIN ... END` statement block:

```
ON EXCEPTION IN (-107)
  SET LOCK MODE TO WAIT; -- error, value expected, not 'lock'
END EXCEPTION;
```

The following `ON EXCEPTION` statement executes successfully because the `SET LOCK MODE` statement is enclosed in a `BEGIN ... END` statement block:

```
ON EXCEPTION IN (-107)
  BEGIN
    SET LOCK MODE TO WAIT; -- ok
  END
END EXCEPTION;
```

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Jar Name

Use the Jar Name segment to specify the name of a jar ID. Use this segment whenever you see a reference to Jar Name in a syntax diagram.

Syntax

Jar Name

```
| -+-----+---jar_id-----|
  '-+-----+---package--.-'
    '-database--.-'
```

Element	Description	Restrictions	Syntax
<i>database</i>	Database in which to install or access <i>jar_id</i> . Default is the current database.	Fully qualified <i>database.package.jar_id</i> identifier must not exceed 255 bytes	Database Name
<i>jar_id</i>	The .jar file that contains the Java™ class to be accessed	File must exist in <i>database.package</i>	Identifier
<i>package</i>	Name of the package	Package must exist in <i>database</i>	Identifier

If a jar name is specified as a character string argument to the **sqlj.install_jar**, **sqlj.replace_jar**, or **sqlj.remove_jar** procedures, then any identifiers in the jar name that are delimited identifiers will include the surrounding double quotation mark characters. For descriptions of these procedures, see [related concept SQLJ Driver Built-In Procedures](#).

Before you can access a *jar_id* in any way (including its use in a CREATE FUNCTION or CREATE PROCEDURE statement), it must be defined in the current database with the **install_jar()** procedure. For more information, see [EXECUTE PROCEDURE statement](#).

Related concepts:

[SQLJ Driver Built-In Procedures](#)

Related information:

[Update JAR file names](#)

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Optimizer Directives

The Optimizer Directives segment specifies keywords that you can use to partially or fully specify the query plan of the optimizer. Use this segment whenever you see a reference to Optimizer Directives in a syntax diagram.

Syntax

Optimizer Directives

```

      .-|-----|
      V      (1)      |
|---|---|---| Access-Method Directives |-----|
+-|+-|+-| |      (2)      |
+-|+-|+-| | Join-Order Directive |-----|
+-|+-|+-| | |      (3)      |
+-|+-|+-| | Join-Method Directives |-----|
+-|+-|+-| | |      (4)      |
+-|+-|+-| | Star-Join Directives |-----|
+-|+-|+-| | |      (5)      |
+-|+-|+-| | Optimization-Goal Directives |-----|
+-|+-|+-| | |      (6)      |
+-|+-|+-| | Explain-Mode Directives |-----|
+-|+-|+-| | |      (7)      |
+-|+-|+-| | Statement cache directive |-----|

>---|-----|
+-|+-|+-|
+-|+-|+-|
+-|+-|+-|
```

Notes:

1. See [Access-Method Directives](#)
2. See [Join-Order Directive](#)
3. See [Join-Method Directives](#)
4. See [Star-Join Directives](#)
5. See [Optimization-Goal Directives](#)
6. See [Explain-Mode Directives](#)
7. See [Statement cache directive](#)

Usage

Use one or more optimizer directives to partially or fully specify the query plan of the optimizer. The scope of the directive is the current query only.

Directives are enabled by default. To obtain information about how specified directives are processed, view the output of the SET EXPLAIN statement. To disable directives, set the **IFX_DIRECTIVES** environment variable to 0, or set the DIRECTIVES parameter in the ONCONFIG file to 0.

The syntax diagram above is simplified, and does not show that the closing comment indicator must follow the same comment style as the opening comment indicator. For more information, see [Optimizer Directives as Comments](#).

- [Optimizer Directives as Comments](#)
Optimizer directives require valid comment indicators as delimiters.
- [Restrictions on Optimizer Directives](#)
- [Access-Method Directives](#)
Use the access-method directives to specify the manner in which the optimizer should search the tables.
- [Join-Order Directive](#)
Use the ORDERED join-order directive to force the optimizer to join tables or views in the order in which they are referenced in the FROM clause of the query.
- [Join-Method Directives](#)
- [Star-Join Directives](#)
- [Optimization-Goal Directives](#)
- [Explain-Mode Directives](#)
- [Statement cache directive](#)
Use the statement cache directive to prevent the statement from being stored in the statement cache. The AVOID_STMT_CACHE optimizer directive forces

the optimizer to reoptimize the statement every time that the statement is run.

- [External Directives](#)

You can use the SAVE EXTERNAL DIRECTIVES statement to store optimizer directives in the **sysdirectives** table of the system catalog. Informix® applies these external directives automatically to subsequent queries and subqueries that match a specified SELECT statement.

Related reference:

[SET OPTIMIZATION statement](#)

[SET STATEMENT CACHE statement](#)

[SAVE EXTERNAL DIRECTIVES statement](#)

Related information:

[Environment variable portal](#)

[Optimizer directives](#)

[IFX_DIRECTIVES environment variable](#)

[IFX_EXTDIRECTIVES environment variable](#)

[EXT_DIRECTIVES configuration parameter](#)

[DIRECTIVES configuration parameter](#)

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Optimizer Directives as Comments

Optimizer directives require valid comment indicators as delimiters.

The closing delimiter you use depends on the opening delimiter:

- If { is the opening delimiter, you must use } as the closing delimiter.
- If /* are the opening delimiters, you must use */ as the closing delimiters.
- If -- are the opening delimiters, then no closing delimiter is needed.

An optimizer directive or a list of optimizer directives immediately follows the DELETE, SELECT, or UPDATE keyword in the form of a comment. After the comment symbol, the first character in an optimizer directive is always a plus (+) sign. No blank space or other white-space character is allowed between the comment indicator and the plus sign.

You can use any of the following comment indicators:

- A double hyphen (--) delimiter
The double hyphen needs no closing symbol because it specifies only the remainder of the current line as comment. When you use this style, include the optimizer directive on only the current line.
- Braces ({ . . . }) delimiters
The comment extends from the left brace ({) until the next right (}) brace; this can be in the same line or in some subsequent line.
- C-language style slash and asterisk (/* . . . */) delimiters
The comment extends from the initial slash-asterisk (/*) pair until the next asterisk-slash (*/) characters in the same line or in some subsequent line.

In Informix® ESQL/C, the **-keepcomment** command option to the **esql** compiler must be specified when you use C-style comments.

For additional information, see [How to Enter SQL Comments](#).

If you specify multiple directives in the same query, you must separate them with a blank space, a comma, or by any character that you choose. It is recommended that you separate successive directives with a comma.

If the query declares an alias for a table, use the alias (rather than the actual table name) in the optimizer directive specification. Because system-generated index names begin with a blank character, use quotation marks to delimit such names.

Syntax errors in an optimizer directive do not cause a valid query to fail. You can use the SET EXPLAIN statement to obtain information related to such errors.

In distributed queries, optimizer directives can reference objects in other databases of the same server instance by using the *database:table* or *database:owner.table* notation to qualify the name of a table in another database of the local database server.

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Restrictions on Optimizer Directives

You can specify optimizer directives for any query in a DELETE, SELECT, or UPDATE statement, unless it includes any of the following syntax elements:

- A query accessing a table in a database of a remote database server instance
- In Informix® ESQL/C, a statement with the WHERE CURRENT OF *cursor* clause

For queries that use ANSI/ISO-compliant syntax to specify a join, the query optimizer does not follow some directives:

- The join-method directives (USE_NL, AVOID_NL, USE_HASH, AVOID_HASH, /BUILD, and /PROBE) are ignored, except in cases where the optimizer rewrites the query so that it is no longer uses the ANSI/ISO syntax.
 - The join-order directive (ORDERED) is ignored in ANSI-compliant joined queries that specify the RIGHT OUTER JOIN or FULL OUTER JOIN keywords.
-

Access-Method Directives

Use the access-method directives to specify the manner in which the optimizer should search the tables.

Access-Method Directives

```
|---+++-INDEX_ALL---+--(-| Table Reference |-----+--+>
|   | '-MULTI_INDEX-' |           |.-,.....-|.    |
|   | '-INDEX-----' |           | V             |    |
|                                   |'-++-index---+--+-'|
|                                   |- "index"-'|
|                                   |.-,.....-.|
|                                   |V               |
++-AVOID_INDEX---+--(-| Table Reference |--++-index---+--+--+
+AVOID_INDEX_SJ++          |- "index"-'|
+'-INDEX_SJ-----'
+'FULL-----+--(-| Table Reference |-------+
+AVID_FULL-----+
+'-AVOID_MULTI_INDEX-'

>--)-+-----+-----|- 
      '-comments-
```

Table Reference

```
|---alias---+-----|
+synonym+
'-table---'
```

Element	Description	Restrictions	Syntax
<i>alias</i>	Temporary alternative table name declared in the FROM clause	If an <i>alias</i> is declared, it must be used (rather than <i>table</i> or <i>synonym</i>)	Identifier
<i>comments</i>	Optional text that documents the directive	Must be outside the parentheses but inside the comment symbols	Character string
<i>index</i>	Index for which to specify the directive	Must exist. With AVOID_INDEX, AVOID_INDEX_SJ, and INDEX_SJ, at least one <i>index</i> is required	Identifier
<i>synonym, table</i>	Name or synonym of a table to which the directive applies	Synonym and the table to which it points must exist	Identifier

Use commas or blank spaces to separate elements within the parentheses.

The following table describes each of the access-method directives and indicates how it affects the query plan of the optimizer.

Keywords	Effect	Optimizer Action
AVOID_FULL	No full-table scan on the listed table	The optimizer considers the various indexes it can scan. If no index exists, the optimizer performs a full-table scan.
AVOID_INDEX	Does not use any of the specified indexes	The optimizer considers the remaining indexes and a full-table scan. If all indexes for a table are specified, optimizer uses a full-table scan to access the table.
AVOID_INDEX_SJ	Does not use an index self-join path for the specified indexes	The optimizer does not consider the specified index for scanning the table in an index self-join path.
AVOID_MULTI_INDEX	Does not use a multi-index scan path for the specified table	The optimizer does not consider a multi-index scan path for the specified table.
FULL	Performs a full-table scan	Even if an index exists on a column, the optimizer uses a full-table scan to access the table.
INDEX	Uses the index specified to access the table	If more than one index is specified, the optimizer chooses the index that yields the least cost. If no indexes are specified, then all the available indexes are considered.
INDEX_ALL <i>or</i> MULTI_INDEX	Access the table using the specified indexes (Multi-index scan)	These keywords are synonyms. For usage information, see "Multi-index scans" below.
INDEX_SJ	Use the specified index to scan the table in an index self-join path.	The optimizer is forced to scan the table using an index self-join path with the specified index (or to choose the least costly index in a list of indexes for an index self-join path).

Both the `AVOID_FULL` and `INDEX` keywords specify that the optimizer should avoid a full scan of a table. It is recommended, however, that you use the `AVOID_FULL` keyword to specify the intent to avoid a full scan on the table.

The `AVOID_MULTI_INDEX` directive does not accept a list of indexes as its argument. This is because the `AVOID_INDEX` directive also prevents the specified index from being used in a multi-index scan execution path.

Multi-index scans

Up to sixteen (16) indexes can be defined on a table. A search path based on an access method that uses more than one index on the same table is called a *multi-index scan*. The `MULTI_INDEX` or `INDEX_ALL` directive forces the query optimizer to consider a multi-index scan to search the specified table for qualifying rows. The argument list for the `MULTI_INDEX` or `INDEX_ALL` directive has these semantics:

- If you specify a table as the only argument to the directive, the optimizer considers all of the available indexes on that table, and uses all of them (or a subset) when it searches the table for qualifying rows.
- If you specify a table and only a single index, the optimizer considers using only that index to scan the table.
- If you specify a table and more than one index, the optimizer considers a search path that uses all of the specified indexes.

Multi-index scan with skip-scan access methods

A multi-index scan path accesses a table by a *skip-scan* access method, using a sorted list of ROWIDs. The sorted list is typically generated from a multi-index scan access method, using all of the indexes that the `INDEX_ALL` or `MULTI_INDEX` directive specifies.

For example, if the query predicates specify `col1 <= 10` and `col2 BETWEEN 15 AND 25`, then the execution plan can use two indexes: the first index on **col1**, and the second index on **col2**. Each index scan returns all ROWIDs that satisfy the search condition for the respective index. The logical intersection of the two lists of ROWIDs includes only the rows that satisfy both search conditions. The database server then sorts the combined ROWID list, and uses this sorted list to scan the table for the result set of the query.

If the query includes predicates on more than two indexed columns, the list of ROWIDs that each index scan returns must be combined to produce a sorted ROWID list of all the qualifying rows.

Because each ROWID represents the physical location of a row (on which page and in which slot), the execution path simply accesses that physical location to retrieve the row. As the term "skip-scan" suggests, there are typically gaps from one ROWID to the next in the sorted list, so that the database server "skips" from one qualifying row to the next qualifying row of the result set.

The list of sorted ROWIDs can be generated from multiple index scans, as described above, or from a single index scan. In the case of a single index, the skip-scan execution path takes these actions:

1. The single index scan creates an unsorted list of the ROWIDs of all qualifying rows.
2. This unsorted list is sorted by ROWID value.
3. The database server then retrieves the qualifying rows in the order of their ROWIDs.

A skip-scan access method resembles a sequential scan, but can sometimes be more efficient. A sequential scan retrieves every row in the table, but a skip-scan only retrieves the rows that have qualifying ROWIDs.

Restrictions on multi-index scan paths for query execution

The transaction isolation level affects whether the `MULTI_INDEX` or `INDEX_ALL` directive can force a multi-index scan execution path, which is not available while the isolation level is Cursor Stability, or is Committed Read with the `LAST COMMITTED` option. (This directive is supported, however, in the Dirty Read and Repeatable Read isolation levels, and in Committed Read without the `LAST COMMITTED` option.)

The following additional restrictions apply to multi-index scan access paths:

- The indexes must be B-tree indexes. These can be attached or detached indexes.
- These directives are ignored for R-tree indexes, functional indexes, and indexes based on the Virtual Index Interface (VII).
- The table cannot be a remote table, a pseudo-table, a system catalog table, an external table, or a hierarchical table.
- A multi-index scan cannot support join predicates as index filters in the underlying index scans.
- A multi-index scan ignores all columns of a composite index except the leading column.
- DML statements that perform cascade deletes or declare statement local variables (SLVs) cannot use a multi-index scan.
- Update queries that activate a `FOR EACH ROW` triggered action cannot use a multi-index scan.
- In ANSI-compliant databases, the `MULTI_INDEX` or `INDEX_ALL` directive is not followed for a `SELECT` statement that has no `ORDER BY` clause, no `GROUP BY` clause, and no `FOR READ ONLY` clause, if the `FROM` clause specifies only a single table. (In this special case, the query has implicit cursor behavior that conflicts with a multi-index scan access path.)

Combinations of access method directives

In general, you can specify only one access-method directive per table. Only the following combinations of access-method directives are valid for the same table in the same query:

- `INDEX, AVOID_INDEX_SJ`
- `AVOID_FULL, AVOID_INDEX`
- `AVOID_FULL, AVOID_INDEX_SJ`
- `AVOID_INDEX, AVOID_INDEX_SJ`
- `AVOID_FULL, AVOID_INDEX, AVOID_INDEX_SJ`
- `AVOID_FULL, AVOID_MULTI_INDEX`
- `AVOID_INDEX, AVOID_MULTI_INDEX`
- `AVOID_INDEX_SJ, AVOID_MULTI_INDEX`
- `AVOID_FULL, AVOID_INDEX_SJ, AVOID_MULTI_INDEX`
- `AVOID_INDEX, AVOID_INDEX_SJ, AVOID_MULTI_INDEX`

When you specify both the `AVOID_FULL` and `AVOID_INDEX` access-method directives, the optimizer avoids performing a full scan of the table and it avoids using the specified index or indexes. This combination of negative directives allows the optimizer to use indexes that are created after the access-method directives are specified.

Because the optimizer automatically considers the index self-join path if you specify the `INDEX` or `AVOID_FULL` directive, use the `INDEX_SJ` directive only to force an index self-join path using the specified index (or choosing the least costly index in a comma-separated list of indexes). The `INDEX_SJ` directive can improve performance when a multicolumn index includes columns that provide only low selectivity as index key filters.

Specifying the `INDEX_SJ` directive circumvents the usual optimizer requirement for data distribution statistics on the lead keys of the index. This directive causes the optimizer to consider an index self-join path, even if data distribution statistics are not available for the leading index key columns. In this case, the optimizer only includes the minimum number of index key columns as lead keys to satisfy the directive.

For example, if an index is defined on columns **c1**, **c2**, **c3**, **c4**, and the query specifies filters on all four of these columns but no data distributions are available on any column, then specifying INDEX_SJ on this index will result in column **c1** being used as the lead key in an index self-join path. If you want the optimizer to use an index but not to consider the index self-join path, then you must specify an INDEX or AVOID_FULL directive to choose the index, and you must also specify an AVOID_INDEX_SJ directive to prevent the optimizer from considering any other index self-join path.

If `AVOID_INDEX_SJ` is used together with the `INDEX` directive, either as an explicit `INDEX` directive or as the equivalent `AVOID_FULL` and `AVOID_INDEX` combination, the indexes specified in the `AVOID_INDEX_SJ` directive must be a subset of the indexes specified in the `INDEX` directive. For more information about the effects of the `INDEX_SJ` and `AVOID_INDEX_SJ` directives, see the chapter of the *IBM® Informix® Performance Guide* that describes optimizer directives.

Specifying the `MULTI_INDEX` or `INDEX_ALL` directive circumvents the usual optimizer requirement for statistics on the specified table. The optimizer normally requires at least low level statistics on the table before considering multi-index scan path on the table.

Examples of Access Method Directives

Suppose that you have a table named **emp** that contains the columns **emp_no**, **dept_no**, and **job_no**, and for which the following indexes **ids_dept_no** index is defined on the **dept_no** column, and the **idx_job_no** index is defined on the **job_no** column. When you perform a **SELECT** that includes the **emp** table in the **FROM** clause, you might direct the optimizer to access the table in one of the following ways:

- Example using a positive directive:

```
SELECT {+INDEX(emp idx_dept_no)} ...
```

In the example above, the `access-method` directive forces the optimizer to consider an execution path that scans the `idx_dept_no` index on the `dept_no` column.

In the following example the `access-method` directive forces the optimizer to consider using a multi-index scan, based on the combined results of scanning both the `idx_dept_no` index on the `dept_no` column and the `idx_job_no` index on the `job_no` column.

```
SELECT {+MULTI INDEX(emp idx dept no ids job no)} ...
```

- Example using negative directives:

```
SELECT {+AVOID INDEX(emp idx loc no, idx job no), AVOID FULL(emp)} ...
```

This example includes multiple access-method directives. These directives force a scan of the **idx_dept_no** index on the **dept_no** column by instructing the optimizer not to scan the **idx_loc_no** and **idx_job_no** indexes, and not to perform a full scan of the **emp** table. If a new **idx_emp_no** index, however, is created for table **emp**, these directives do not prevent the optimizer from considering it.

Note also that the term *negative directive* refers to the string "AVOID_" in an access method directive, and has nothing to do with the + symbol following the comment indicator that begins every optimizer directive.

Related information:

Optimizer directives

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Join-Order Directive

Use the **ORDERED** join-order directive to force the optimizer to join tables or views in the order in which they are referenced in the **FROM** clause of the query.

Join-Order Directive

```
|--ORDERED--+-----+-----+-----+-----+-----+-----+-----+-----+
               '-comments-'
```

Element	Description	Restrictions	Syntax
<i>comments</i>	Text to document the directive	Must appear between comment symbols	Character string

For example, the following query forces the database server to join the **dept** and **job** tables and then join the result with the **emp** table:

```
SELECT --+ ORDERED
       name, title, salary, dname
FROM dept, job, emp WHERE title = 'clerk' AND loc = 'Palo Alto'
AND emp.dno = dept.dno
AND emp.job= job.job;
```

Because no predicates occur between the **dept** table and the **job** table, this query forces the database server to construct a Cartesian product.

When your query involves a view, the placement of the ORDERED join-order directive determines whether you are specifying a partial- or total-join order.

- Specifying partial-join order when you create a view

For all subsequent queries on the view, the database server joins the base tables contiguously in the order specified in the view definition. When used in a view, the **ORDERED** directive does not affect the join order of other tables named in the **FROM** clause in a query.

- Because of ordering requirements for OUTER joins, in ANSI-compliant joined queries that specify the RIGHT OUTER JOIN or FULL OUTER JOIN keywords, the ORDERED join-order directive is ignored, but it is listed under *Directives Not Followed* in the explain output file.

Default name and location of the output file on Windows

Join-Method Directives

```

      .-,'-----'.
      V              (1) |
|---+-+USE_NL+---+----| Table Reference |-----+-->
|   '-AVOID_NL-'     |                  |
|                     .-,'-----'.
|                     V              (1) |
|'-+-+AVOID_HASH+---+----| Table Reference |-----+--+
|   '-USE_HASH---'          '+-/BUILD+-'
|                          '-/PROBE-'
>--)-+-+-----+-----|
|       '-comments-'

```

1. See [Access-Method Directives](#)

The following table describes each of the join-method directives.

- **/BUILD**
With the `USE_HASH` directive, this keyword indicates that the specified table be used to construct a hash table. With the `AVOID_HASH` directive, this keyword indicates that the specified table *not* be used to construct a hash table.
- **/PROBE**
With the `USE_HASH` directive, this keyword indicates that the specified table be used to probe the hash table. With the `AVOID_HASH` directive, this keyword indicates that the specified table *not* be used to probe the hash table. You can specify multiple probe tables as long as there is at least one table for which you do not specify `PROBE`.

For the optimizer to find an efficient join query plan, you must at least run UPDATE STATISTICS LOW for every table that is involved in the join, so as to provide appropriate cost estimates. Otherwise, the optimizer might choose to broadcast the entire table to all instances, even if the table is large.

If neither the /BUILD nor the /PROBE keyword is specified, the optimizer uses cost estimates to determine the role of the table.

In this example, the USE_HASH directive forces the optimizer to construct a hash table on the **dept** table and consider only the hash table to join **dept** with the other tables. Because no other directives are specified, the optimizer can choose the least expensive join methods for the other joins in the query.

```
SELECT /** USE_HASH (dept /BUILD)
The optimizer must use dept to construct a hash table */
name, title, salary, dname
FROM emp, dept, job WHERE loc = 'Phoenix'
AND emp.dno = dept.dno AND emp.job = job.job;
```

Join-method optimizer directives that you specify for an ANSI-compliant joined query are ignored, but they are listed under *Directives Not Followed* in the explain output file.

Related concepts:

[Default name and location of the explain output file on UNIX](#)

[Default name and location of the output file on Windows](#)

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Star-Join Directives

Use the star-join directives to specify the manner in which the optimizer should join tables that have a star schema.

Star-Join Directives

```
.,-----
v      |
|---+--AVOID_FACT--(-----| Table Reference |---+-->
+--FACT--(--| Table Reference |--)-----+
+--STAR_JOIN-----+
'-AVOID_STAR_JOIN-----'
```

>---+-----|

'-comments-'

Table Reference

```
|---+--alias-----|
+--synonym--+
'-table---'
```

Element	Description	Restrictions	Syntax
<i>alias</i>	Temporary alternative table name declared in the FROM clause	If an <i>alias</i> is declared, it must be used (rather than <i>table</i> or <i>synonym</i>)	Identifier
<i>comments</i>	Optional text that documents the directive	Must be outside the parentheses but inside the comment symbols	Character string
<i>synonym, table</i>	Name or synonym of a table to which the directive applies	Synonym and the table to which it points must exist	Identifier

In AVOID_FACT directives that specify more than one table, use a comma or blank space to separate consecutive elements within the parentheses.

The following table describes each of the star-join directives and indicates how it affects the query plan of the optimizer.

Keywords	Effect	Optimizer Action
AVOID_FACT	At least one table must be specified. Do not use the table (or any table in the list of tables) as a fact table in star-join optimization.	The optimizer does not consider a star-join execution plan that treats the specified table (or any of the tables in the list of tables) as a fact table.
AVOID_STAR_JOIN	The optimizer does not consider a star-join execution plan.	The optimizer chooses a query execution plan that is not a star-join plan.
FACT	Exactly one table must be specified. Only consider the specified table as a fact table in the star-join execution plan.	These optimizer considers a query plan in which the specified table is a fact table in a star-join execution plan.
STAR_JOIN	Favor a star-join plan, if one is possible.	The optimizer favors a star-join execution plan, if available.

The star-join directives require that the parallel database query feature (PDQ) be enabled. Star join query optimization is disabled when PDQ is off.

The star-join directives require that all tables in the query have at least low level statistics. If table statistics are not available for any table in the query, star-join query optimization is disabled.

The SET OPTIMIZATION ENVIRONMENT STAR_JOIN DISABLED statement of SQL disables star-join optimization in the current session. (For additional information about optimization environment settings, see [ENVIRONMENT Options](#).)

Specifying the FACT directive alone does not automatically favor a star-join execution plan. You can direct the optimizer to prefer a star-join execution plan with a specific fact table by specifying a combination of a STAR_JOIN directive and a FACT directive.

You can view the star join optimization path of a query in the output file of the SET EXPLAIN statement, or by using IBM® Data Studio to obtain Visual Explain output.

In cluster environments, the star-join optimizer directives are valid on these types of secondary servers:

- Shared disk secondary servers (SDS)
- Remote standalone secondary servers (RSS)
- High-availability data replication secondary servers (HDR).

Restrictions on star-join directives

The following restrictions apply to queries that attempt to join tables that have star-schema dependencies:

- The parallel database query (PDQ) feature must be enabled for star-join directives to be valid.
- All tables in the query must have at least low level statistics.
- Star-join directives do not support joins of more than one fact table.
- Star-join directives are not valid while the transaction isolation level is Committed Read Last Committed or Cursor Stability. (All other transaction isolation levels are supported.)

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Optimization-Goal Directives

Use optimization-goal directives to specify the measure that is used to determine the performance of a query result.

Optimization-Goal Directives

```
|--+-ALL_ROWS-----+-----|
  '-FIRST_ROWS-'   '-comments-'
```

Element	Description	Restrictions	Syntax
comments	Text documenting the directive	Must appear between comment symbols	Character string

The two optimization-goal directives are:

- FIRST_ROWS
This tells the optimizer to choose a plan that optimizes the process of finding only the first screenful of rows that satisfies the query. Use this option to decrease initial response time for queries that use an interactive mode or that require the return of only a few rows.
- ALL_ROWS
This directive tells the optimizer to choose a plan that optimizes the process of finding all rows that satisfy the query.

This form of optimization is the default.

An optimization-goal directive takes precedence over the **OPT_GOAL** environment variable setting and over the OPT_GOAL configuration parameter.

For information about how to set the optimization goal for an entire session, see the SET OPTIMIZATION statement.

You cannot use an optimization-goal directive in the following contexts:

- In a view definition
- In a subquery

The following query returns the names of the employees who earned the top fifty bonuses. The optimization-goal directive directs the optimizer to return the first screenful of rows as fast as possible.

```
SELECT {+FIRST_ROWS
      Return the first screenful of rows as fast as possible}
LIMIT 50 fname, lname FROM employees ORDER BY bonus DESC;
```

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Explain-Mode Directives

Use the explain-mode directives to test and debug query plans and to print information about the query plan to the explain output file.

Explain-Mode Directives

```
|--EXPLAIN-----+-----|
  '-+-----AVOID_EXECUTE-' '-comments-'
```

'-', -'

Element	Description	Restrictions	Syntax
comments	Text documenting the directive	Must appear between comment symbols	Character string

The following table lists the effect of each explain-mode directive.

Keyword

Effect

EXPLAIN

Turns SET EXPLAIN ON for the specified query

AVOID_EXECUTE

Prevents the data manipulation statement from executing; instead, the query plan is printed to the explain output file

The EXPLAIN directive is primarily useful for testing and debugging query plans. It is redundant when SET EXPLAIN ON is already in effect. It is not valid in a view definition or in a subquery.

The next query executes and prints the query plan to the explain output file:

```
SELECT {+EXPLAIN}  
  c.customer_num, c.lname, o.order_date  
FROM customer c, orders o WHERE c.customer_num = o.customer_num;
```

The AVOID_EXECUTE directive prevents execution of a query on either the local or remote site, if a remote table is part of the query. This directive does not prevent nonvariant functions in a query from being evaluated.

The next query does returns no data, but writes its query plan to the explain output file:

```
SELECT {+EXPLAIN, AVOID_EXECUTE}  c.customer_num, c.lname, o.order_date  
FROM customer c, orders o WHERE c.customer_num = o.customer_num;
```

You must use both the EXPLAIN and AVOID_EXECUTE directives to see the query plan of the optimizer (in the explain output file) without executing the query. The comma (,) separating these two directives is optional.

If you omit the EXPLAIN directive when you specify the AVOID_EXECUTE directive, no error is issued, but no query plan is written to the explain output file and no DML statement is executed.

You cannot use the explain-mode directives in the following contexts:

- In a view definition
- In a trigger
- In a subquery

They are valid, however, in a SELECT statement within an INSERT statement.

Related concepts:

[Default name and location of the explain output file on UNIX](#)

[Default name and location of the output file on Windows](#)

[Complete-Connection Level Settings and Output Examples](#)

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Statement cache directive

Use the statement cache directive to prevent the statement from being stored in the statement cache. The AVOID_STMT_CACHE optimizer directive forces the optimizer to reoptimize the statement every time that the statement is run.

Statement cache directive

```
|--AVOID_STMT_CACHE--+-----+-----+-----+-----+  
'-comments-'
```

Element	Description	Restrictions	Syntax
comments	Text documenting the directive	Must appear between comment symbols	Character string

The AVOID_STMT_CACHE directive is useful for those statements whose query plans can change significantly depending on the values of the placeholders that are passed to the database server when the statements are run. Using a cached query plan for those sorts of statements might result in poor performance.

For example, the following statement is not stored in the statement cache:

```
SELECT {+AVOID_STMT_CACHE}  
  c.customer_num, c.lname, o.order_date  
FROM customer c, order o  
WHERE c.customer_num = o.customer_num;
```

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External Directives

You can use the SAVE EXTERNAL DIRECTIVES statement to store optimizer directives in the **sysdirectives** table of the system catalog. Informix® applies these external directives automatically to subsequent queries and subqueries that match a specified SELECT statement.

The EXT_DIRECTIVES configuration parameter and the **IFX_EXTDIRECTIVES** environment variable can be set to control whether external directives are enabled or disabled for the database server instance or for the session. Setting either of these to zero disables external directives; setting both to 1 enables external directives.

You can also use the EXTDIRECTIVES option of the SET ENVIRONMENT statement to enable or disable external directives during a session. For more information, see [Enabling or disabling external directives for a session](#).

Related concepts:
[Default name and location of the explain output file on UNIX](#)
[Default name and location of the output file on Windows](#)

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Owner name

The owner name specifies the owner of a database object. Use this segment whenever you see a reference to Owner Name in a syntax diagram.

Syntax



Notes:

1. Informix® extension

Element	Description	Restrictions	Syntax
owner	User name of the owner of an object in a database	Maximum length is 32 bytes	Must conform to the rules of your operating system.

Usage

In an ANSI-compliant database, you must specify the *owner* of any database object that you do not own. In reference to the owner of database objects, the ANSI/ISO synonym for owner name is *authorization identifier*. (In reference to schema objects, however, the ANSI/ISO term for what the Informix documentation calls an *owner name* is *schema name*.)

In databases that are not ANSI-compliant, the *owner* name is optional. You do not need to specify *owner* when you create database objects or use data access statements. If you do not specify *owner* when you create a database object, the database server assigns your login name as the owner of the object, in most cases. For exceptions to this rule, see [Ownership of Created Database Objects](#) in the CREATE FUNCTION statement description, and [Ownership of Created Database Objects](#) in the CREATE PROCEDURE statement description. When a DDL statement in an owner-privileged UDR creates a new database object, the owner of the routine (rather than the user who executes it, if that user is not the owner of the routine) becomes the owner of the new database object.

If you specify *owner* in data-access statements, the database server checks it for correctness. Without quotation marks, *owner* is case insensitive. The following four queries all can access data from the table **kaths.tab1**:

```
SELECT * FROM tab1;
SELECT * FROM kaths.tab1;
SELECT * FROM KATHS.tab1;
SELECT * FROM Kaths.tab1;
```

In an ANSI-compliant database, only the owner of the table, user **kaths**, can issue the first of these example queries, which specifies an unqualified table name, but any user who holds the Select privilege on **tab1** can issue that query in a database that is not ANSI-compliant. For more information about owner names in ANSI-compliant databases, see [ANSI-Compliant Database Restrictions and Case Sensitivity](#).

A *role* that the CREATE ROLE statement declares is an authorization identifier, and is therefore subject to the syntax restrictions on owner names, but a role cannot be the owner of a database object. Similarly, the keyword PUBLIC, which specifies the group of all users, cannot be the owner of a database object, except in the special cases of the **sysdbopen()** and **sysdbclose()** procedures. For more information about these built-in session configuration UDRs, see [Session Configuration Procedures](#).

- [Using Quotation Marks](#)
- [Referencing Tables Owned by User informix](#)
- [ANSI-Compliant Database Restrictions and Case Sensitivity](#)
- [Setting ANSIOWNER for an ANSI-Compliant Database](#)

- [Default Owner Names](#)
- [Summary of Lettercase Rules for Owner Names](#)

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Using Quotation Marks

Within quotation marks, *owner* is case sensitive. Quotation marks instruct the database server to read or store the name exactly as typed when you create or access a database object. For example, suppose that you have a table whose owner is *Sam*. You can use either one of the following two statements to access data in the table:

```
SELECT * FROM table1;
SELECT * FROM 'Sam'.table1;
```

The first query succeeds because the owner name is not required. The second query succeeds because the specified owner name matches the owner name as it is stored in the database.

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Referencing Tables Owned by User informix

If you use the owner name as one of the selection criteria to access database object information from one of the system catalog tables, the owner name is case sensitive. To preserve lettercase, you must enclose *owner* in single or double quotation marks, and you must type the owner name exactly as it is stored in the system catalog table. Of the following two examples, only the second successfully accesses information on the table **Kaths.table1**.

```
SELECT * FROM systables WHERE tabname = 'tab1' AND owner = 'kaths';
SELECT * FROM systables WHERE tabname = 'tab1' AND owner = 'Kaths';
```

User **informix** is the owner of the system catalog tables, and in an ANSI-compliant database you must specify **informix** as a qualifier when SQL statements reference system catalog tables, unless you are user **informix**:

```
SELECT * FROM "informix".systables WHERE tabname = 'tab1' AND owner = 'Kaths';
```

Informix® accepts any of the following notations to specify a system catalog table of an ANSI-compliant database:

- "informix".system_table
- informix.system_table
- 'informix'.system_table

Of these three formats, however, only the first, where the *owner* is specified as a delimited identifier, is directly interoperable with most other database servers. For the format with no delimiters, the ANSI/ISO standard for SQL upshifts the lowercase letters to **INFORMIX**, and the same standard does not support single (') quotation marks as valid delimiters for owner names or for schema names.

In contrast, Informix treats the name **informix** as a special case, and preserves lowercase letters when **informix** is specified, with or without delimiters, whether or not the database is ANSI-compliant. To write SQL code that is portable to non-Informix database servers, however, you should always delimit the owner names of database objects between double (") quotation marks.

The following SQL examples use undelimited owner names:

```
CREATE TABLE informix.t1(i SERIAL NOT NULL);
CREATE TABLE someone.t1(i SERIAL NOT NULL);
```

If these statements execute successfully, the first table has **informix** registered in **systables** as the owner, and the second has **SOMEONE** registered as the owner. When the owner name is delimited by quotation marks in SQL statements, the specified lettercase of *owner* is preserved, but the lettercase does not matter when the owner name is undelimited, because Informix upshifts most undelimited owner names, but downshifts the undelimited **informix** (or **INFORMIX**) owner name to **informix**.

For example, suppose that after the previous two CREATE TABLE statements execute successfully, user **informix** issues the following statement:

```
CREATE TABLE INFORMIX.t1(i SERIAL NOT NULL);
```

This statement fails, because the combination of *owner* name and *table* name is not unique, if the previously registered table **t1** that is owned by **informix** already exists in the database.

Tip: The USER operator returns the login name of the current user exactly as it is stored on the system. If the owner name is stored differently from the login name (for example, a mixed-case owner name and an all lowercase login name), the `owner = USER` syntax fails.

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ANSI-Compliant Database Restrictions and Case Sensitivity

The following table describes how the database server reads and stores *owner* when you create, rename, or access a database object.

Owner Name Specification	What the ANSI-Compliant Database Server Does
--------------------------	--

Owner Name Specification	What the ANSI-Compliant Database Server Does
Omitted	Reads or stores <i>owner</i> exactly as the login name is stored in the system, but returns an error if the user is not the <i>owner</i> .
Specified without quotation marks	Reads or stores <i>owner</i> in uppercase letters
Enclosed between quotation marks	Reads or stores <i>owner</i> exactly as entered. See also Using Quotation Marks and Referencing Tables Owned by User Informix .

If you specify the owner name when you create or rename a database object in an ANSI-compliant database, you must include the owner name in data access statements. You must include the owner name when you access a database object that you do not own.

Because the database server automatically shifts *owner* to uppercase letters if not between quotation marks, case-sensitive errors can cause queries to fail. For example, if you are user **nancy** and you use the following statement, the resulting view has the name **nancy.njcust**:

```
CREATE VIEW 'nancy'.njcust AS
SELECT fname, lname FROM customer WHERE state = 'NJ';
```

The following SELECT statement fails because it tries to match the name **NANCY.njcust** to the actual owner and table name of **nancy.njcust**:

```
SELECT * FROM nancy.njcust;
```

In a distributed query, if the owner name is not between quotation marks, the remote database follows the lettercase convention of the local database. If the local database is ANSI-compliant, then the remote database processes the owner name in *uppercase*. If the local database is not ANSI compliant, then the remote database processes the owner name in *lowercase*.

Tip: When you use the owner name as one of the selection criteria in a query (for example, WHERE owner = 'kaths'), make sure that the quoted string matches the owner name exactly as it is stored in the database. If the database server cannot find the database object or database, you might need to modify the query so that the quoted string uses uppercase letters (for example, WHERE owner = 'KATHS').

Because owner name is an authorization identifier, rather than an SQL identifier, you can enclose *owner* between single-quotation marks (') in SQL statements of a database where the **DELIMIDENT** environment variable specifies support for delimited identifiers, thereby requiring double-quotation marks (") around SQL identifiers.

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Setting ANSIOWNER for an ANSI-Compliant Database

The default behavior of an ANSI-compliant database is to replace any lowercase letters with uppercase letters in any *owner* specification that is not enclosed in quotation marks. You can prevent this by setting the **ANSIOWNER** environment variable to 1 before the database server is initialized. This preserves whatever lettercase you use when you specify the *owner* string without quotation marks.

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Default Owner Names

If you create a database object without explicitly specifying an owner name in a database that is not ANSI-compliant, your authorization identifier (as the default owner of the object) is stored in the system catalog of the database as if you had specified your authorization identifier within quotation marks (that is, preserving the lettercase).

If you create a database object without explicitly specifying an owner name in a database that is ANSI-compliant, any lowercase letters in your authorization identifier (as the default owner of the object) are stored in the system catalog of the database in uppercase characters, unless the **ANSIOWNER** environment variable was set to 1 before the database server was initialized. If **ANSIOWNER** was set to 1, however, the database stores the default owner of the object as your authorization identifier, with its lettercase preserved.

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Summary of Lettercase Rules for Owner Names

To create a database object, such as a table called **mytab**, a user whose login name is **Otho** can declare the name of the new database object in any of the following ways:

1. CREATE TABLE mytab . . .
2. CREATE TABLE Otho.mytab . . .
3. CREATE TABLE "Otho".mytab . . .

The format in which an un delimited *owner* name (as in the second example) is stored in the **owner** column of the **systables** system catalog table is dependent on whether or not the local database is an ANSI-compliant database.

- In case 1, no *owner* name is specified. The implicit owner of the table is **Otho**, the user who created the table, and that owner name is stored in the **systables** table in the same format (**Otho**) as the user ID of the owner, independent of the ANSI-compliance status of the database.
- In case 2, an un delimited *owner* name is specified. The **systables** table stores all letters in the *owner* name in lowercase (here as **otho**) for databases that are not ANSI-compliant databases. For ANSI-compliant databases in which **ANSIOWNER** is not set to 1, **systables** table stores all *owner* name letters in uppercase (here as **OTHO**). If **ANSIOWNER** is set to 1, however, the name is stored in the same lettercase as specified in the DDL statement (here as **Otho**).

- In case 3, the delimited *owner* name is stored in the **systables** table in the same format in which it was specified (here as **Otho**), independent of the ANSI-compliance status of the database.

Note that user identifiers are case sensitive, but database object names are case insensitive. Therefore, the same user cannot own both a table **tab** and a table **TAB**.

In addition to the CREATE TABLE statement in these examples, all SQL statements and SPL statements follow these rules where a table name can be specified. For example, when using DROP TABLE, the format in which owner name appears while the statement is being processed is dependent upon the same conditions:

- whether an explicit owner name is specified.
- if an explicit owner name is specified, whether quotation marks delimit the owner name.
- if an explicit owner name is not delimited by quotation marks, whether or not the database is ANSI compliant.
- if the database is ANSI compliant, whether or not **ANSIOWNER** was set to 1 before the database was initialized.

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Purpose Options

The CREATE ACCESS_METHOD, CREATE XADATASOURCE TYPE, and ALTER ACCESS_METHOD statements of Informix® can specify purpose options for user-defined routines with the following syntax.

Syntax

Purpose Options

```
|--task-- = -external_routine-----|
+-value-- = -+-string_value--+
|           '-numeric_value-' |
'-flag-----'
```

Element	Description	Restrictions	Syntax
<i>external_routine</i>	User-defined routine that performs a <i>task</i>	Must be registered in the database	Database Object Name
<i>flag</i>	Keyword indicating which feature a flag enables	The interface specifies flag names	<i>Flag</i> Purpose Category in the table in Purpose Functions, Flags, and Values .
<i>numeric_value</i>	A value of a real number	Must be within the range of a numeric data type	Literal Number
<i>string_value</i>	A value that is expressed as one or more characters	Characters must be from the code set of the database	Quoted String .
<i>task</i>	Keyword that identifies a purpose function	Keywords to which you can assign a function (whose name cannot match the keyword)	<i>Task</i> Purpose Category in the table in Purpose Functions, Flags, and Values .
<i>value</i>	Keyword that identifies configuration information	Predefined configuration keywords to which you can assign values	<i>Value</i> Purpose Category in the table in Purpose Functions, Flags, and Values .

Usage

Informix supports purpose options in two contexts:

- Defining or modifying primary and secondary access methods for local or remote tables, views, and indexes
- Defining access methods for XA-compliant external data sources.
- [Purpose Options for Access Methods](#)
- [Purpose Functions, Flags, and Values](#)
Purpose functions, methods, and flags defined the attributes of access methods.
- [Purpose Options for XA Data Source Types](#)

Related reference:

[ALTER ACCESS_METHOD statement](#)
[CREATE ACCESS_METHOD statement](#)
[CREATE XADATASOURCE TYPE statement](#)
[CREATE OPCLASS statement](#)

Related information:

[Purpose-function reference](#)
[Develop an access method](#)
[Purpose-function reference](#)
[Develop an access method](#)

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Purpose Options for Access Methods

A registered access method is a set of attributes, including a name and options called *purpose options*, that you can use to accomplish the following tasks:

- Specify which functions perform data access and manipulation tasks, such as opening, reading, and closing a data source.
- Set configuration options, such as a storage-space type.
- Set flags, such as enabling rowid interpretation.

You specify purpose options when you create an access method with the CREATE ACCESS_METHOD statement. To change the purpose options of an access method, use the ALTER ACCESS_METHOD statement.

Each *task*, *value*, or *flag* keyword corresponds to a column name in the **sysams** system catalog table. The keywords let you set the following attributes:

- Purpose function
A *purpose-function attribute* maps the name of a user-defined function or method to a *task* keyword, such as **am_create**, **am_beginscan**, or **am_getnext**. For a complete list of these keywords, see the “Task” category in the table in [Purpose Functions, Flags, and Values](#). The *external_routine* specifies the corresponding function (C) that you supply for the access method. Example setting:

```
am_create = FS_create
```

- Purpose flag
A *purpose flag* indicates whether an access method supports a given SQL statement or keyword. Example setting:

```
am_rowids
```

- Purpose value
These string, character, or numeric values provide configuration information that a flag cannot supply. Example setting:

```
am_sptype = 'X'
```

To enable a user-defined function or method as a purpose function, you must first register the C function or Java™ method that performs the appropriate tasks, using the CREATE FUNCTION statement, and then set the purpose keyword equal to the registered function or method name. This creates a new access method. An example on page [ALTER ACCESS_METHOD statement](#) adds a purpose method to an existing access method.

To enable a purpose flag, specify the name without a corresponding value.

To clear a purpose-option setting in the **sysams** table, use the DROP clause of the ALTER ACCESS_METHOD statement.

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Purpose Functions, Flags, and Values

Purpose functions, methods, and flags defined the attributes of access methods.

The following table describes the possible settings for the **sysams** columns that contain purpose functions or methods, flags, and values. The entries appear in the same order as the corresponding **sysams** columns.

Table 1. Purpose functions, purpose flags, and purpose values

Keyword	Explanation	Category	Default
am_sptype	A character that specifies from what type of storage space a primary or secondary-access method can access data. The am_sptype character can have any of the following settings: <ul style="list-style-type: none">• 'X' indicates the method accesses only extspaces.• 'S' indicates the method accesses only sbspaces.• 'A' indicates the method can access extspaces and sbspaces. Valid only for a new access method. You cannot change or add an am_sptype value with ALTER ACCESS_METHOD. Do not set am_sptype to 'D' or attempt to store a virtual table in a dbspace.	Value	Virtual-Table Interface (C): 'A'
am_defopclass	The default operator class for a secondary-access method. The access method must exist before you can define its operator class, so you set this value in the ALTER ACCESS_METHOD statement.	Value	None
am_keyscan	A flag that, if set, indicates that am_getnext returns rows of index keys for a secondary-access method. If a query selects only the columns in the index key, the database server uses the row of index keys that the secondary-access method puts in shared memory, without reading the table.	Flag	Not set
am_unique	A flag to set if a secondary-access method checks for unique keys	Flag	Not set
am_cluster	A flag that you set if a primary- or secondary-access method supports clustering of tables	Flag	Not set
am_rowids	A flag that you set if a primary-access method can retrieve a row from a specified address	Flag	Not set

Keyword	Explanation	Category	Default
am_readwrite	A flag to set if a primary-access method supports data changes. The default setting, not set, indicates that the virtual data is read-only. For the C Virtual-Table Interface, set this flag if your application writes data, to avoid the following problems: <ul style="list-style-type: none"> An INSERT, DELETE, UPDATE, or ALTER FRAGMENT statement causes an SQL error. Function am_insert, am_delete, or am_update is not run. 	Flag	Not set
am_parallel	A flag that the database server sets to indicate which purpose functions or methods can run in parallel in a primary or secondary-access method. If set, the hexadecimal am_parallel bitmap contains one or more of the following bit settings: <ul style="list-style-type: none"> The 1 bit is set for parallelizable scan. The 2 bit is set for parallelizable delete. The 4 bit is set for parallelizable update. The 8 bit is set for parallelizable insert. Insertions, deletions, and updates are not supported in the Java™ Virtual-Table Interface.	Flag	Not set
am_expr_pushdown	A flag that enables the use of parameter descriptors.	Flag	Not set
am_costfactor	A value by which the database server multiplies the cost that the am_scancost purpose function or method returns for a primary or secondary-access method. An am_costfactor value from 0.1 to 0.9 reduces the cost to a fraction of the value that am_scancost calculates. An am_costfactor value of 1.1 or greater increases the am_scancost value.	Value	1.0
am_create	A keyword that you associate with a user-defined function or method (UDR) name that creates a virtual table or virtual index	Task	None
am_drop	A keyword that you associate with the name of a UDR that drops a virtual table or virtual index	Task	None
am_open	A keyword that you associate with the name of a UDR that makes a fragment, extspace, or sbspace available	Task	None
am_close	A keyword that you associate with the name of a UDR that reverses the initialization that am_open performs	Task	None
am_insert	A keyword that you associate with the name of a UDR that inserts a row or an index entry	Task	None
am_delete	A keyword that you associate with the name of a UDR that deletes a row or an index entry	Task	None
am_update	A keyword that you associate with the name of a UDR that changes the values in a row or key	Task	None
am_stats	A keyword that you associate with the name of a UDR that builds statistics based on the distribution of values in storage spaces	Task	None
am_scancost	A keyword that you associate with the name of a UDR that calculates the cost of qualifying and retrieving data	Task	None
am_check	A keyword that you associate with the name of a UDR that tests the physical structure of a table or performs an integrity check on an index	Task	None
am_beginscan	A keyword that you associate with the name of a UDR that sets up a scan	Task	None
am_endscan	A keyword that you associate with the name of a UDR that reverses the setup that am_beginscan initializes	Task	None
am_rescan	A keyword that you associate with the name of a UDR that scans for the next item from a previous scan to complete a join or subquery	Task	None
am_getnext	A keyword that you associate with the name of the required UDR that scans for the next item that satisfies a query	Task	None
am_getbyid	A keyword that you associate with the name of a UDR that fetches data from a specific physical address; am_getbyid is available only for primary-access methods	Task	None
am_truncate	A keyword that you associate with the name of a UDR that deletes all rows of a virtual table (primary-access method) or that deletes all corresponding keys in a virtual index (secondary-access method)	Task	None

The following rules apply to the purpose-option specifications in the CREATE ACCESS_METHOD and ALTER ACCESS_METHOD statements:

- To specify multiple purpose options in one statement, separate them with commas.
- The CREATE ACCESS_METHOD statement must specify a user-defined function or method name that corresponds to the **am_getnext** keyword. The ALTER ACCESS_METHOD statement cannot drop the function or method name that corresponds to **am_getnext** but can modify it.
- The ALTER ACCESS_METHOD statement cannot add, drop, or modify the **am_sptype** value.
- You can specify the **am_defopclass** value only with the ALTER ACCESS_METHOD statement. You must first register a secondary-access method with the CREATE ACCESS_METHOD statement before you can assign a default operator class.

Purpose Options for XA Data Source Types

The CREATE XADATASOURCE TYPE statement specifies purpose functions that provide access to data from external data sources that comply with the X/Open XA standards. These functions also enable external data to be processed in accordance with the transactional semantics of Informix®. Only databases that use transaction logging, such as ANSI-compliant databases and Informix databases that support explicit transactions, can support transaction coordination.

The following statement creates a new XA data source type called **MQSeries®**, owned by user **informix**.

```
CREATE XADATASOURCE TYPE 'informix'.MQSeries(
    xa_flags      = 1,
    xa_version    = 0,
    xa_open       = informix.mqseries_open,
    xa_close      = informix.mqseries_close,
    xa_start      = informix.mqseries_start,
    xa_end        = informix.mqseries_end,
    xa_rollback   = informix.mqseries_rollback,
    xa_prepare    = informix.mqseries_prepare,
    xa_commit     = informix.mqseries_commit,
    xa_recover    = informix.mqseries_recover,
    xa_forget     = informix.mqseries_forget,
    xa_complete   = informix.mqseries_complete);
```

These values represent the fields in the XA Switch Structure, as listed in the file **\$INFORMIXDIR/incl/public/xa.h**. The order of specifications in this example follows the order of column names in the **sysxasourcetypes** system catalog table, but they can be listed in any order, provided that no item is repeated. The **xa_flags** and **xa_version** values must be numbers; the rest must be names of UDRs that the Transaction Manager can invoke. These UDRs must already exist in the database before you can issue a CREATE XADATASOURCE TYPE statement that references them among its purpose option specifications.

The DROP FUNCTION or DROP ROUTINE statement cannot drop a UDR that is listed among the purpose options of a CREATE XADATASOURCE TYPE statement until all of the XA datasource types that were defined using the UDR are dropped.

For information about how to use the UDRs in the previous example to coordinate transactions with external XA data sources, see the *IBM® Informix DataBlade API Programmer's Guide*.

For information about the MQDataBlade module, see the *IBM Informix Database Extensions User's Guide*.

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Return Clause

The Return clause specifies the data type of a value or values that a user-defined function returns. You can use this segment in UDR definitions.

Syntax

Return Clause

```
|---+---RETURNING+---+----->
|'-RETURNS---'|

(1)
>---+---| Subset of SQL Data Types |-----+---+-----+---+---|
| '-REFERENCES---+---BYTE+---+-----' '-AS--parameter-' |
| | '-TEXT-' | | | |
| | | | |
| | (2) V | | (1) | |
| |-----+---| Subset of SQL Data Types |-----+---+-----+---+---|
| | '-REFERENCES---+---BYTE+---+-----' '-AS--parameter-' |
| | '-TEXT-' | |
```

Notes:

1. See [Subset of SQL Data Types](#)
2. Stored Procedure Language only

Element	Description	Restrictions	Syntax
<i>parameter</i>	Name that you declare here for a returned parameter of the UDR	Must be unique among returned <i>parameter</i> names of the UDR. If any returned value of the UDR has a name, then all must have names.	Identifier

Usage

For compatibility with earlier Informix® releases, you can create SPL functions with the CREATE PROCEDURE statement. (That is, you can include a Return clause in CREATE PROCEDURE statements.) Use CREATE FUNCTION, however, to create new SPL routines that return one or more values.

After the Return clause has indicated what data types are to be returned, you can use the RETURN statement of SPL at any point in the statement block to return SPL variables that correspond to the values in the Return clause.

- [Limits on Returned Values](#)
- [Subset of SQL Data Types](#)
The built-in SQL data types that a user-defined function (UDF) can return are language-dependent.
- [Using the REFERENCES Clause to Point to a Simple Large Object](#)
- [Returning a value from another database](#)
The value returned from another database by a user-defined function (UDF) is restricted to a smaller set of data types than the return value of a function that accesses only the local database. Similarly, functions that access databases of other server instances are more restricted in the data types of their return values than functions that return values from other databases of the local database server.
- [Named Return Parameters](#)
- [Cursor and Noncursor Functions](#)

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Limits on Returned Values

An SPL function can specify more than one data type in the Return clause.

An external function (a function written in the C or the Java™ language) can specify only one data type in the Return clause, but an external function can return more than one row of data if it is an iterator function. For more information, see [ITERATOR](#).

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Subset of SQL Data Types

The built-in SQL data types that a user-defined function (UDF) can return are language-dependent.

For more information, see the table that follows. See also [Data Type](#).

UDFs written in a given language can return values of any built-in data type except the types that are marked with an X in the following table.

Data Type	C	Java™	SPL
BIGSERIAL	X	X	X
BLOB	X		
CLOB	X		
BYTE	X	X	
TEXT	X	X	
BSON	?	X	?
JSON	?	X	?
COLLECTION		X	
LIST		X	
MULTISET		X	
ROW		X	
SET		X	
SERIAL	X	X	X
SERIAL8	X	X	X

In Informix®, if you use a complex data type in the Return clause, the calling user-defined routine must define variables of the appropriate complex types to hold the values that the C or SPL user-defined function returns.

User-defined functions can return a value of opaque or distinct data types that are defined in the database.

The default precision of a DECIMAL value that an SPL function returns is 16 digits. For a function to return a DECIMAL with a different number of significant digits, you must specify the returned precision explicitly in the *data type* specification of the Return clause.

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Using the REFERENCES Clause to Point to a Simple Large Object

A user-defined function cannot return a BYTE or TEXT value (collectively called *simple large objects*) directly. A user-defined function can, however, use the REFERENCES keyword to return a descriptor that contains a pointer to a BYTE or TEXT object. The following example shows how to select a TEXT column within an SPL routine and then return the value:

```
CREATE FUNCTION sel_text()
  RETURNING REFERENCES text;
DEFINE blob_var REFERENCES text;
SELECT blob_col INTO blob_var
  FROM blob_table WHERE key_col = 10;
RETURN blob_var;
END FUNCTION;
```

For simple large objects that are column values from the Projection list of a query, as in this example, the pointer in the returned descriptor references the **sysblobs.spacename** value from the system catalog, based on the BYTE or TEXT column definition.

For simple large objects that do not correspond to columns of permanent tables, however, the pointer references the dbspace of the database in which the UDR is defined. This is the default storage location for a BYTE or TEXT object that a UDR returns, when no location from the **sysblobs** table is known to the database server.

The DB-Access session in the following example creates two routines, **udr1** and **udr2**, that each return the descriptor of a TEXT object:

```
CREATE DATABASE db WITH LOG;

CREATE TABLE t (c2 TEXT);
CREATE TABLE t1 (c2 TEXT);
LOAD FROM "t.unl" INSERT INTO t;

CREATE FUNCTION udr1 ( param_1
  REFERENCES TEXT DEFAULT NULL )
  RETURNING REFERENCES TEXT
  WITH (NOT VARIANT)
  DEFINE var1 REFERENCES TEXT;
  ON EXCEPTION
    RETURN param_1;
  END EXCEPTION;
  SELECT t.c2 udr1_col1
    INTO var1 FROM t;
  RETURN var1;
END FUNCTION;

CREATE PROCEDURE udr2 ( OUT param_1
  REFERENCES TEXT DEFAULT NULL )
  RETURNING INT;
  SELECT t.c2 udr1_col1
    INTO param_1 FROM t;
  RETURN 1;
END PROCEDURE;

SELECT udr1(t.c2) query_1_col1 FROM t
  INTO TEMP mytemp;

SELECT c2, slv1 FROM t1
  WHERE udr2(slv1#TEXT) > 0
  INTO TEMP mytemp;
```

In the SELECT statements that call these UDRs, the TEXT object that each query returns to the **mytemp** temporary table are stored in the dbspace of the **db** database.

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Returning a value from another database

The value returned from another database by a user-defined function (UDF) is restricted to a smaller set of data types than the return value of a function that accesses only the local database. Similarly, functions that access databases of other server instances are more restricted in the data types of their return values than functions that return values from other databases of the local database server.

For UDFs that access tables or views outside the local database, only the following data types are valid as return values:

Return data types in distributed function calls

```
>>+-built-in_non-opaque-----+><
| (1) |
+-----+opaque_UDT-----+
| +-built-in_opaque-+ |
| +-BLOB-----+ |
| +-CLOB-----+ |
+-BOOLEAN-----+
+-BSON-----+
+-JSON-----+
| .- (--2048--)-. |
+-LVARCHAR--+--(--max--)-+
+-DISTINCT OF--+--+-BOOLEAN-----+
| .-----+ | +-BSON-----+
| V | +-JSON-----+
|-----+ | +-LVARCHAR--+--(--max--)-+
|-----+ | +-built-in_non-opaque-----+
|-----+ |
+-distinct--DISTINCT OF-
```

Notes:

1. Not valid in cross-server operations

Element	Description	Restrictions	Syntax
<i>built-in_non-opaque</i>	Atomic built-in data type that is not opaque	Type cannot be complex, serial, BYTE, or TEXT	Data Type
<i>built-in_opaque</i>	Atomic built-in data type that is opaque. Note 1 does not apply to BOOLEAN, BSON, JSON, or LVARCHAR.	See built-in opaque data types list in Data Types in Cross-Database Transactions	Data Type
<i>distinct</i>	DISTINCT type whose base type is another DISTINCT type	Root of this hierarchy must be a BSON, BOOLEAN, JSON, LVARCHAR, or an atomic <i>built-in_non-opaque</i> data type	DISTINCT Types in Distributed Operations
<i>max</i>	Maximum size in bytes. Default is 2048.	Must be an integer, where $1 \leq max \leq 32,739$	Literal Number
<i>opaque_UDT</i>	A user-defined opaque data type	Must be cast explicitly to a built-in type by a cast defined in every participating database	Identifier

Important:

The diagram above shows the generalized logical hierarchy of the base types for any DISTINCT data type. Using the **DISTINCT OF** keywords recursively, however, as in the diagram above, is not valid SQL syntax. The CREATE DISTINCT TYPE statement must specify exactly one base type for the new DISTINCT type. To create a hierarchy of DISTINCT data types, you must issue a separate CREATE DISTINCT TYPE statement for every DISTINCT type in the hierarchy. For the SQL syntax to define a new DISTINCT data type, see the topic [CREATE DISTINCT TYPE statement](#).

Usage

Whether UDFs can return data from other databases depends on

- the transaction-logging status of the participating databases,
- and the data type of the returned value or values,

For a function invoked in one database to return a value from another database, both participating databases must be of compatible transaction-logging types:

- A function invoked in a database that was not created as MODE ANSI cannot retrieve data from an ANSI-compliant database.
- Conversely, a function called in an ANSI-compliant database cannot retrieve data from a database that was not created as MODE ANSI, whether or not the non-ANSI database supports transaction logging.
- A function call in a database without transaction logging can retrieve data only from unlogged databases.
- A function from a database with explicit transaction logging cannot retrieve data from an unlogged database. It can return data only from databases with explicit logging.

In the last case, a UDF called in a database that supports explicit transactions can return a value from another non-ANSI database that uses buffered or unbuffered logging, whether or not both databases use the same buffered or unbuffered logging mode.

If the databases are of incompatible logging types, however, the valid data types of return values is an empty set, rather than any of the types that the syntax diagram identifies.

Sections that follow describe what data types can be returned in distributed function calls.

Return values from cross-database operations

If the Return clause specifies a value (or multiple values, in the case of an SPL function) from another database of the local Informix® instance, the following data types are supported as the return data type:

- Built-in data types that are not opaque or complex
- Most of the *built-in opaque data types*, as listed in [Data Types in Cross-Database Transactions](#)
- Any DISTINCT type based on a supported built-in type
- Any DISTINCT type based on one of those DISTINCT types
- Any user-defined type (UDT) that is cast explicitly to one of the supported built-in types.

The UDF and all of the DISTINCT types, opaque UDTs, data type hierarchies, and casts must have exactly the same definitions in each of the participating databases. The same data-type restrictions apply to a value that an external function returns from another database of the local Informix instance.

For more information about data types that are supported in distributed operations across two or more databases of the same database server, see [Data Types in Cross-Database Transactions](#). For the data type hierarchies that are valid for DISTINCT data types in distributed transactions, see [DISTINCT Types in Distributed Operations](#).

Return values from cross-server operations

From databases of other Informix instances, however, UDFs can specify only the following as a parameter or as a returned data type:

- Built-in data types that are not opaque
- BOOLEAN
- BSON
- JSON
- LVARCHAR
- DISTINCT of built-in types that are not opaque
- DISTINCT of BOOLEAN
- DISTINCT of BSON

- DISTINCT of JSON
- DISTINCT of LVARCHAR
- DISTINCT of the DISTINCT types in this list.

The definitions of the UDF and of any data type hierarchies, casts, and DISTINCT types must be exactly the same in each of the participating databases. Except for the BOOLEAN, DISTINCT, BSON, JSON, and LVARCHAR data types that are identified in the previous list, UDFs cannot return any other built-in opaque data type or opaque UDTs in cross-server function calls.

For more information about data types that are supported in distributed operations across two or more Informix instances, see [Data Types in Cross-Server Transactions](#). For the data type hierarchies that are valid for DISTINCT data types in distributed transactions, see [DISTINCT Types in Distributed Operations](#).

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Named Return Parameters

You can declare names for the returned parameters of an SPL routine, or a name for the single value that an external function can return.

If an SPL routine returns more than one value, you must either declare names for all of the returned parameters, or else none of them can have names. The names must be unique. Here is an example of named parameters:

```
CREATE PROCEDURE p (inval INT DEFAULT 0)
RETURNING INT AS serial_num,
          CHAR(10) AS name,
          INT AS points;
RETURN (inval + 1002), "Newton", 100;
END PROCEDURE;
```

Executing this UDR would return:

serial_num	name	points
1002	Newton	100

There is no relationship between the names of returned parameters and the names of any variables in the body of the routine. For example, you can define a function to return an INTEGER as **xval**, but in the body of the same function, a variable declared as **xval** could be of the data type INTERVAL YEAR TO MONTH.

- [Using the LIKE Clause](#)

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Using the LIKE Clause

Use the LIKE clause to avoid recreating the SPL whenever the tables in the RETURNING clause changes.

If you want to change any of the columns in the SPL routine, you can use **LIKE** syntax with the **RETURN** clause. Here is an example of named parameters with **LIKE** syntax:

```
CREATE PROCEDURE p (inval INT DEFAULT 0)
RETURNING serial_num LIKE testtab.serial_num,
          name LIKE testtab.name,
          points LIKE testtab.points;
RETURN (inval + 1002), "Newton", 100;
END PROCEDURE;
```

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Cursor and Noncursor Functions

A *cursor* function can fetch returned values one by one by iterating the generated result set of returned values. Such a function is an *implicitly iterated function*.

A function that returns only one set of values (such as one or more columns from a single row of a table) is a *noncursor* function.

The Return clause is valid in a cursor function or in a noncursor function. In the following example, the Return clause can return zero (0) or one value in a noncursor function. In a cursor function, however, it returns more than one row from a table, and each returned row contains zero or one value:

```
RETURNING INT;
```

In the following example, the Return clause can return zero (0) or two values if it occurs in a noncursor function. In a cursor function, however, it returns more than one row from a table, and each returned row contains zero or two values:

```
RETURNING INT, INT;
```

In both of the preceding examples, the receiving function or program must be written appropriately to accept the information that the function returns.

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Adding or Modifying a Routine Modifier

Notes:

- | Element | Description | Restrictions | Syntax |
|--------------------|---|--|---------------------------------|
| <i>class_name</i> | Virtual processor (VP) class in which to run the external routine | Any C UDR must run in the CPU VP or in a user-defined VP class | Quoted String . |
| <i>cost</i> | CPU use cost for each invocation of a C-language UDR. Default is 0. | Integer; $1 \leq cost \leq 2^{31}-1$ (highest cost). | Literal Number |
| <i>cost_func</i> | Name of a companion user-defined cost function to run | Must have same owner as the UDR. Execute privilege is needed to run. | Identifier |
| <i>neg_func</i> | Negator function that can be invoked instead of the UDR | Must have same owner as the UDR. Execute privilege is needed to run. | Identifier |
| <i>sel_func</i> | Name of a companion user-defined selectivity function to invoke | Must have same owner as the UDR. Execute privilege is needed to run. | Identifier |
| <i>selectivity</i> | CPU use cost for each invocation of a C-language UDR. Default is 0. | See Concept of Selectivity . | Literal Number |
| <i>stack_size</i> | Size (in bytes) of stack of the thread that runs the C-language UDR | Must be a positive integer | Literal Number |

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The following sections describe the modifiers that you can use to help the database server optimally execute a UDR.

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CLASS

Use the CLASS modifier to specify the name of a virtual-processor (VP) class in which to run an external routine. A user-defined VP class must be defined before the UDR can be invoked.

You can execute C UDRs in the following types of VP classes:

- The CPU virtual-processor class (CPU VP)
- A user-defined virtual-processor class.

If you omit the CLASS modifier to specify a VP class for a UDR written in C, the UDR runs in the CPU VP. User-defined VP classes protect the database server from ill-behaved C UDRs. An ill-behaved C UDR has at least one of the following characteristics:

- It runs in the CPU VP for a long time without yielding.
- It is not thread safe.
- It calls an unsafe operating-system routine.

A well-behaved C UDR has none of these characteristics. Execute only well-behaved C UDRs in the CPU VP.

Warning: Execution of an ill-behaved C UDR in the CPU VP can cause serious interference with the operation of the database server, and the UDR might not produce correct results. For a discussion of ill-behaved UDRs, see the *IBM® Informix® DataBlade API Programmer's Guide*.

By default, a UDR written in Java™ runs in a Java virtual processor class (JVP). Therefore, the CLASS modifier is optional for a UDR written in Java. However, use the CLASS modifier when you register a UDR written in Java to improve readability of your SQL statements.

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COSTFUNC (C)

Use the COSTFUNC modifier to specify the cost of a UDR. The cost of the UDR is an estimate of the time required to execute it.

Occasionally, the cost of a UDR depends on its inputs. In that case, you can use a user-defined function to calculate a cost that depends on input values.

To execute *cost_func*, you must have Execute privilege on it and on the UDR.

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HANDLESNULLS

Use the HANDLESNULLS modifier to specify that a C UDR can handle NULL values that are passed to it as arguments. If you do not specify HANDLESNULLS for a C language UDR, and if you pass to it an argument that has a NULL value, the UDR does not execute and returns a NULL value.

By default, a C language UDR does *not* handle NULL values.

The HANDLESNULLS modifier is not available for SPL routines because SPL routines handle NULL values by default.

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INTERNAL

Use the INTERNAL modifier with an external routine to specify that an SQL or SPL statement cannot call the external routine. An external routine that is specified as INTERNAL is not considered during routine resolution. Use the INTERNAL modifier for external routines that define access methods, language managers, and so on.

By default, an external routine is *not* internal; that is, an SQL or SPL statement can call the routine.

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ITERATOR

Use the ITERATOR modifier with external functions to specify that the function is an *iterator function*. An iterator function is a function that returns a single element per function call to return a set of data; that is, it is called with an initial call and zero or more subsequent calls until the set is complete.

By default, an external C or Java™ language function is *not* an iterator function.

An SPL iterator function requires the RETURN WITH RESUME statement, rather than the ITERATOR modifier.

In ESQ/C, an iterator function requires a cursor. The cursor allows the client application to retrieve the values one at a time with the FETCH statement.

For more information on how to write iterator functions, see *IBM® Informix® User-Defined Routines and Data Types Developer's Guide* and the *IBM Informix DataBlade API Programmer's Guide*.

For information about using an iterator function with a virtual table interface in the FROM clause of a query, see [Iterator Functions](#).

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NEGATOR

Use the NEGATOR modifier with UDRs that return Boolean values.

The NEGATOR modifier designates another user-defined function, called a *negator function*, as a companion to the current function. A negator function takes the same arguments as its companion function, in the same order, but returns the Boolean complement.

That is, if a function returns TRUE for a given set of arguments, its negator function returns FALSE when passed the same arguments, in the same order. For example, the following functions are negator functions:

```
equal (a ,b)
notequal (a ,b)
```

Both functions take the same arguments, in the same order, but return complementary Boolean values. When it is more efficient to do so, the query optimizer can use the negator function instead of the function that you specify.

To invoke a user-defined function that has a negator function, you must have the Execute privilege on both functions. In addition, the function must have the same owner as its negator function.

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PARALLELIZABLE

Use the PARALLELIZABLE modifier to indicate that an external routine can be executed in parallel in the context of a parallelizable data query (PDQ).

By default, an external routine is non-parallelizable; that is, it executes in sequence.

If your UDR has a complex or smart large object data type as either a parameter or a returned value, you cannot use the PARALLELIZABLE modifier.

If you specify the PARALLELIZABLE modifier for an external routine that cannot be parallelizable, the database server returns a runtime error.

A C language UDR that calls only PDQ thread-safe DataBlade API functions is parallelizable. These categories of DataBlade API functions are PDQ thread safe:

- Data handling
An exception in this category is that collection manipulation functions (**mi_collection_***) are not PDQ thread safe.
- Session, thread, and transaction management
- Function execution
- Memory management
- Exception handling
- Callbacks
- Miscellaneous

For details of the DataBlade API functions that are included in each category, see the *IBM® Informix® DataBlade API Function Reference*.

If your C language UDR calls a function that is not included in one of these categories, it is not PDQ thread safe and is therefore not parallelizable.

To parallelize Java™ language UDR calls, the database server must have multiple instances of JVPs. UDRs written in the Java language and that open a JDBC connection are not parallelizable.

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PERCALL_COST (C)

Use the PERCALL_COST modifier to specify the approximate CPU usage cost that a UDR incurs each time it executes.

The optimizer uses the cost you specify to determine the order in which to evaluate SQL predicates in the UDR for best performance. For example, the following query has two predicates joined by a logical AND:

```
SELECT * FROM tab1 WHERE func1() = 10 AND func2() = 'abc' ;
```

In this example, if one predicate returns FALSE, the optimizer need not evaluate the other predicate.

The optimizer uses the specified cost to order the predicates so that the least expensive predicate is evaluated first. The CPU usage cost must be an integer between 1 and $2^{31}-1$, with 1 the lowest cost and $2^{31}-1$ the most expensive.

To calculate an approximate cost per call, add the following two figures:

- The number of lines of code executed each time the UDR is called
- The number of predicates that require an I/O access

The default cost per execution is 0. When you drop the PERCALL_COST modifier, the cost per execution returns to 0.

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SELCONST (C)

Use the SELCONST modifier to specify the selectivity of a UDR. The selectivity of the UDR is an estimate of the fraction of the rows that the query will select.

The value of selectivity constant, **selconst**, is a floating-point number between 0 and 1 that represents the fraction of the rows for which you expect the UDR to return TRUE.

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SELFUNC (C)

Use the SELFUNC modifier with a C UDR to name a companion user-defined function, called a selectivity function, to the current UDR. The selectivity function provides selectivity information about the current UDR to the optimizer.

The selectivity of a UDR is an estimate of the fraction of the rows that the query will select. That is, it is an estimate of the number of times the UDR will execute.

To execute *sel_func*, you must have Execute privilege on it and on the UDR.

- [Concept of Selectivity](#)
- [Restrictions on the SELFUNC Modifier](#)

The selectivity function that you specify with the SELFUNC modifier has specific requirements.

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Concept of Selectivity

Selectivity is an attribute of queries that performs a search based on an equality condition. The selectivity of the query depends inversely on the proportion of qualifying rows. The smaller the proportion of qualifying rows among all the rows in FROM clause table objects, the more selective is the query.

For example, the following query has a search condition based on the **customer_num** column in the **customer** table:

```
SELECT * FROM customer WHERE customer_num = 102;
```

Because each row in the table has a different customer number, this query is highly selective. In contrast, the following query has low selectivity:

```
SELECT * FROM customer WHERE state = 'CA';
```

Because most of the rows in the **customer** table are for customers in California, more than half of the rows in the table would be returned.

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Restrictions on the SELFUNC Modifier

The selectivity function that you specify with the SELFUNC modifier has specific requirements.

The selectivity function that you specify must satisfy the following criteria:

- It must take the same number of arguments as the current UDR.
- The data type of each argument must be SELFUNCARGS.
- It must return a value of type FLOAT between 0 and 1, which represents the percentage of selectivity of the function. (1 is highly selective; 0 is not at all selective.)
- It can be written in any language that the database server supports.

A user who invokes the UDR must have the Execute privilege both on that UDR and on the selectivity function that the SELFUNC modifier specifies.

Both the UDR and the selectivity function must have the same owner.

For information on how to use the **mi_funcarg*** functions to extract information about the arguments of a selectivity function, see the *IBM® Informix® DataBlade API Programmer's Guide*.

STACK (C)

Use the STACK modifier with a C UDR to override the default stack size that the STACKSIZE configuration parameter specifies.

The STACK modifier specifies the size (in bytes) of the thread stack, which a user thread that executes the UDR uses to hold information such as routine arguments and returned values from functions.

A UDR needs to have enough stack space for all its local variables. For a particular UDR, you might need to specify a stack size larger than the default size to prevent stack overflow.

When a UDR that includes the STACK modifier executes, the database server allocates a thread-stack size of the specified number of bytes. Once the UDR completes execution, subsequent UDRs execute in threads with a stack size that the STACKSIZE configuration parameter specifies (unless any of these subsequent UDRs have also specified the STACK modifier).

For more information about the thread stack, see your *IBM® Informix® Administrator's Guide* and the *IBM Informix DataBlade API Function Reference*.

Related information:

[Stacks](#)

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VARIANT and NOT VARIANT

Use the VARIANT and NOT VARIANT modifiers with C user-defined functions and SPL functions. A function is *variant* if it returns different results when it is invoked with the same arguments or if it modifies a database or variable state. For example, a function that returns the current date or time is a variant function.

By default, user-defined functions are variant. If you specify NOT VARIANT when you create or modify a user-defined function, the function cannot contain any SQL statements.

If the user-defined function is nonvariant, the database server might cache the returned values of expensive functions. You can create functional indexes only on nonvariant functions. For more information on functional indexes, see [CREATE INDEX statement](#).

In ESQ/C, you can specify VARIANT or NOT VARIANT in this clause or in the EXTERNAL Routine Reference. For more information, see [External Routine Reference](#). If you specify the modifier in both places, however, you must use the same modifier in both clauses.

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Routine Parameter List

Use the appropriate part of the Routine Parameter List segment whenever you see a reference to a Routine Parameter List in a syntax diagram.

Syntax

Routine Parameter List

```

      .-|-----|.
      V .-IN---. |
|-----+---| Parameter |-----|
      +-OUT---+
      '-INOUT-'

```

Parameter

```

|---+parameter+----->
| (1) |
|-----|

```

```

(2)
>---+---| Subset of SQL Data Type |-----+---|
| '-LIKE--table--column-----' '-DEFAULT--value-' |
| '-REFERENCES--BYTE-----'
| '-TEXT-' '-DEFAULT NULL-'

```

Notes:

1. External routines only
2. See [Subset of SQL Data Types](#)

Element	Description	Restrictions	Syntax
---------	-------------	--------------	--------

Element	Description	Restrictions	Syntax
<i>column</i>	Name of a column whose data type is declared for <i>parameter</i>	Must exist in the specified table	Database Object Name
<i>parameter</i>	Name of a parameter of the UDR	Name is required for SPL routines	Identifier
<i>table</i>	Table that contains <i>column</i>	The table must exist in the database	Identifier
<i>value</i>	Default used if UDR is called with no value for <i>parameter</i>	Must be a literal, of the same data type as <i>parameter</i> . For opaque types, an input function must be defined	Literal Number

Usage

A *parameter* is a formal argument in the declaration of a UDR. (When you subsequently invoke a UDR that has parameters, you must substitute a specific argument value for the parameter, unless the parameter has a default value.)

The name of the parameter is optional for external routines of IBM® Informix®.

When you create a UDR, you declare a *name* and *data type* for each parameter. You can specify the data type directly, or use the LIKE or REFERENCES clause to specify the data type. You can optionally specify a default value.

You can define any number of SPL routine parameters, but the total length of all parameters passed to an SPL routine must be less than 2 gigabytes.

No more than nine arguments to a UDR written in the Java™ language can be DECIMAL data types of SQL that the UDR declares as BigDecimal data types of the Java language.

Any C language UDR that returns an opaque data type must specify **opaque_type** in the `var binary` declaration of the C host variable.

- [Subset of SQL Data Types](#)
- [Using the LIKE Clause](#)
- [Using the REFERENCES Clause](#)
- [Using the DEFAULT Clause](#)
- [Specifying OUT Parameters for User-Defined Routines](#)
- [Specifying INOUT Parameters for a User-Defined Routine](#)

UDRs that are written in the SPL, C, or Java languages can also support INOUT parameters. When the UDR is invoked, a value for each INOUT parameter is passed by reference as an argument to the UDR.

Related reference:

[Arguments](#)

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Subset of SQL Data Types

Serial and large-object data types are not valid as parameters. A UDR can declare a parameter of any other data type defined in the database, including any built-in data types except BIGSERIAL, BLOB, BYTE, CLOB, SERIAL, SERIAL8, or TEXT.

On Informix®, a parameter can also be a complex data type or a UDT, but complex data types are not valid for parameters of external UDRs written in the Java™ language.

For information about the data types of Informix that are valid as parameters or return values of routines that access tables or views outside the local database, see [Returning a value from another database](#).

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Using the LIKE Clause

Use the LIKE clause to specify that the data type of a parameter is the same as a column defined in the database. If the ALTER TABLE statement changes the data type of the column, the data type of the parameter also changes.

In Informix®, if you use the LIKE clause to declare any parameter, you cannot overload the UDR. For example, suppose you create the following user-defined procedure:

```
CREATE PROCEDURE cost (a LIKE tableX.colY, b INT)
. . .
END PROCEDURE;
```

You cannot create another procedure named **cost()** in the same Informix database with two arguments. You can, however, create a procedure named **cost()** with a number of arguments other than two. (Another way to circumvent this restriction on the LIKE clause is through user-defined data types.)

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Using the REFERENCES Clause

Use the REFERENCES clause to specify that a parameter contains BYTE or TEXT data. The REFERENCES keyword allows you to use a pointer to a BYTE or TEXT object as a parameter. If you use the DEFAULT NULL option in the REFERENCES clause, and you call the UDR without a parameter, a NULL value is used as the default value.

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Using the DEFAULT Clause

Use the DEFAULT keyword followed by an expression to specify a default value for a parameter. If you provide a default value for a parameter, and the UDR is called with fewer arguments than were defined for that UDR, the default value is used. If you do not provide a default value for a parameter, and the UDR is called with fewer arguments than were defined for that UDR, the calling application receives an error.

The following example shows a CREATE FUNCTION statement that specifies a default value for a parameter. This function finds the square of the *i* parameter. If the function is called without specifying the argument for the *i* parameter, the database server uses the default value 0 for the *i* parameter.

```
CREATE FUNCTION square_w_default
(i INT DEFAULT 0) {Specifies default value of i}
RETURNING INT; {Specifies return of INT value}
DEFINE j INT; {Defines routine variable j}
LET j = i * i; {Finds square of i and assigns it to j}
RETURN j; {Returns value of j to calling module}
END FUNCTION;
```

Warning: When you specify a date value as the default value for a parameter, make sure to specify 4 digits instead of 2 digits for the year. When you specify a 2-digit year, the **DBCENTURY** environment variable setting can affect how the database server interprets the date value, so the UDR might not use the default value that you intended. For more information, see the *IBM® Informix® Guide to SQL: Reference*.

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Specifying OUT Parameters for User-Defined Routines

When you register a user-defined routine of Informix®, you can use the OUT keyword to specify that any parameter in the list is an OUT parameter. Each OUT parameter corresponds to a value the routine returns indirectly, through a pointer. The value that the routine returns through the pointer is an extra value, in addition to any values that it returns explicitly.

After you have registered a user-defined function that has one or more OUT parameters, you can use the function with a statement-local variable (SLV) in a SELECT statement. (For information about statement-local variables, see [Statement-Local Variable Expressions](#).)

If you specify any OUT parameters, and you use Informix-style parameters, the arguments are passed to the OUT parameters by reference. The OUT parameters are not significant in determining the routine signature.

For example, the following declaration of a C user-defined function allows you to return an extra value through the *y* parameter:

```
int my_func( int x, int *y );
```

Register the C function with a CREATE FUNCTION statement similar to this:

```
CREATE FUNCTION my_func( x INT, OUT y INT )
RETURNING INT
EXTERNAL NAME "/usr/lib/local_site.so"
LANGUAGE C
END FUNCTION;
```

In the next example, this Java™ method returns an extra value by passing an array:

```
public static String allVarchar(String arg1, String[] arg2)
throws SQLException
{
    arg2[0] = arg1;
    return arg1;
}
```

To register this as a UDF, use a statement similar to the following example:

```
CREATE FUNCTION all_varchar(VARCHAR(10), OUT VARCHAR(7))
RETURNING VARCHAR(7)
WITH (class = "jvp")
EXTERNAL NAME 'informix.testclasses.jlm.Param.allVarchar(java.lang.String,
java.lang.String[ ])'
LANGUAGE JAVA;
```

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Specifying INOUT Parameters for a User-Defined Routine

UDRs that are written in the SPL, C, or Java™ languages can also support INOUT parameters. When the UDR is invoked, a value for each INOUT parameter is passed by reference as an argument to the UDR.

When the UDR completes execution, it can return a modified value for the INOUT parameter to the calling context. The INOUT parameter can be of any data type that Informix® supports, including user-defined and complex data types, with the following exceptions:

- Serial types (BIGSERIAL, SERIAL, and SERIAL8)
- Simple large object types (BYTE and TEXT).

In the following example, the CREATE PROCEDURE statement registers a C routine that has a single INOUT parameter:

```
CREATE PROCEDURE CALC ( INOUT param1 float )
EXTERNAL NAME "$INFORMIXDIR/etc/myudr.so(calc)"
LANGUAGE C;
```

An SPL routine can invoke other UDRs that have OUT or INOUT parameters, if those UDRs are written in the SPL or C language. An SPL routine cannot, however, invoke a Java UDR whose arguments include OUT or INOUT parameters.

Support for invoking UDRs that have named or unnamed ROW arguments from an SPL routine has the following dependencies on the parameter type of the ROW argument, and on the programming language of the invoked UDR:

- SPL routines can invoke C UDRs that have ROW arguments that are IN parameters, but cannot invoke C UDRs that have ROW arguments that are OUT or INOUT parameters.
- SPL routines can invoke SPL UDRs that have ROW arguments of any parameter type, including IN, OUT, and INOUT.

You can assign INOUT parameters to statement-local variables (SLVs), which the section [Statement-Local Variable Expressions](#) describes.

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Shared-Object Filename

Use a shared-object filename to specify a pathname to an executable object file when you register or alter an external routine.

Syntax

Shared-Object File

```
      (1)                (2)
|---+-----| C Shared-Object File |-----+-----|
|  (3)                (4) |
'-----| Java Shared-Object File |-----'
```

Notes:

1. C only
2. See [C Shared-Object File](#)
3. Java™ only
4. See [Java Shared-Object File](#)

Usage

If the IFX_EXTEND_ROLE configuration parameter is set to 1 or to ON, only users to whom the DBSA has granted the built-in EXTEND role are authorized to use this segment. (Whether or not IFX_EXTEND_ROLE is enabled, you must hold the Resource privilege or the DBA privilege on the database, and you must also hold the Usage privilege on the external programming language in which the UDR is written, before you can create, drop, or alter an external UDR.)

The Database Server Administrator should include in the DB_LIBRARY_PATH configuration parameter settings every file system where the security policy authorizes DataBlade modules and UDRs to reside. Unless DB_LIBRARY_PATH is absent or has no setting, the database server cannot access a file that this segment specifies unless its pathname begins with a string that exactly matches one of the values of DB_LIBRARY_PATH.

For example, if "\$INFORMIXDIR/extend" is one of the DB_LIBRARY_PATH values on a Linux system, then shared-object files can have pathnames within the \$INFORMIXDIR/extend file system or its subdirectories. This directory is also the file system where built-in DataBlade modules reside, and the default location where the DataBlade Developers Kit creates user-defined DataBlade modules.

The syntax by which you specify a shared-object filename depends on whether the external routine is written in the C language or in the Java language. Sections that follow describe each of these external languages.

For more information about the context in which a shared-object filename appears within EXTERNAL NAME clause of the ALTER FUNCTION, ALTER PROCEDURE, ALTER ROUTINE, CREATE FUNCTION, and CREATE PROCEDURE statements, see the related reference, External Routine Reference.

- [C Shared-Object File](#)
To specify the location of a C shared-object file, you can specify the path to the dynamically-loaded executable file within a quoted pathname or as a variable.

- To specify the name of a Java shared-object file, specify the name of the static Java method to which the UDR corresponds and the location of the Java binary that defines the method.

1. See [Jar Name](#)

Element	Description	Restrictions	Syntax
<i>class_id</i>	Java class whose method implements the UDR	Class must exist in the .jar file that Jar Name identifies	Must conform to rules for Java identifiers
<i>java_type</i>	Java data type for a parameter in the Java-method signature	Must be defined in a JDBC class or by an SQL-to-Java mapping	Must conform to rules for Java identifiers
<i>method_id</i>	Name of the Java method that implements the UDR	Must exist in the Java class that <i>java_class_name</i> specifies	Must conform to rules for Java identifiers
<i>package_id</i>	Name of package that contains the Java class	Must exist	Must conform to rules for Java identifiers
<i>quote</i>	Single (') or double (") quotation mark delimiters	Opening and closing quotation marks must match	Literal symbol (' or ") entered at the keyboard

Before you can create a UDR written in the Java language, you must assign a jar identifier to the external jar file with the **sqlj.install_jar** procedure. (For more information, see [sqlj.install_jar](#).) You can include the Java signature of the method that implements the UDR in the shared-object filename.

- If you do *not* specify the Java signature, the routine manager determines the *implicit* Java signature from the SQL signature in the CREATE FUNCTION or CREATE PROCEDURE statement.
It maps SQL data types to the corresponding Java data types with the JDBC and SQL-to-Java mappings. For information on mapping user-defined data types to Java data types, see [sqlj.setUDTextName](#).
- If you do specify the Java signature, the routine manager uses this *explicit* Java signature as the name of the Java method to use.

For example, if the Java method **explosiveReaction()** implements the Java UDR **sql_explosive_reaction()** as discussed in [sqlj.install_jar](#), its shared-object filename could be:

```
course_jar:Chemistry.explosiveReaction
```

The preceding shared-object filename provides an implicit Java signature. The following shared-object filename is the equivalent with an explicit Java signature:

```
course_jar:Chemistry.explosiveReaction(int)
```

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Specific Name

Use a specific name to declare an identifier for a UDR that is unique in the database or name space. Use the Specific Name segment whenever you see a reference to a specific name in a syntax diagram.

Syntax

Specific Name

```
|-----+-----specific_id-----|  
'-owner--.-'
```

Element	Description	Restrictions	Syntax
<i>owner</i>	Owner of the UDR	No more than 32 bytes. Must be same as <i>owner</i> of function or procedure name of this UDR. See also Restrictions on the Owner Name .	Owner name
<i>specific_id</i>	Unique name of the UDR	Must be no more than 128 bytes long. See also Restrictions on the Specific Name .	Identifier

Usage

A *specific name* is a unique identifier that the CREATE PROCEDURE or CREATE FUNCTION statement declares as an alternative name for a UDR.

Because you can overload routines, a database can have more than one UDR with the same name and different parameter lists. You can assign a UDR a specific name that uniquely identifies the specific UDR.

If you declare a specific name when you create the UDR, you can later use that name when you alter, drop, grant, or revoke privileges, or update statistics on that UDR. Otherwise, you need to include the parameter data types with the UDR name, if the name alone does not uniquely identify the UDR.

- [Restrictions on the Owner Name](#)
- [Restrictions on the Specific Name](#)

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Restrictions on the Owner Name

When you declare a specific name, the *owner* must be the same *authorization identifier* that qualifies the function name or procedure name of the UDR that you create. That is, whether or not you specify the owner name to qualify either the UDR name or the specific name or both, the names of the *owner* must match.

When you specify no owner name in the DDL statement that creates a UDR, Informix® uses the login name of the user who creates the UDR. Therefore, if you specify the owner name in one location and not the other, the owner name that you specify must match your user ID.

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Restrictions on the Specific Name

In a database that is not ANSI-compliant, *specific_id* must be unique among routine names within the database. Two UDRs cannot have the same *specific_id*, even if they have different owners.

In an ANSI-compliant database, the combination *owner.specific_id* must be unique. That is, the specific name must be unique among UDRs that have the same owner.

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Statement Block

Use a statement block to specify SPL and SQL operations to take place when an SPL statement that includes this segment is executed.

Syntax

Statement Block

```
.-----  
v-----  
|-----+-----+----->  
|         |         (1) |  
|'-| DEFINE Statement |-----'  
  
.-----  
v-----  
>-----+-----+----->  
|         |         (2) |  
|'-| ON EXCEPTION Statement |-----'  
  
.-----  
v-----  
>-----+-----+-----+-----|  
|         |         (3) |  
+--| EXECUTE FUNCTION Statement |-----+  
|         |         (4) |  
+--| EXECUTE PROCEDURE Statement |-----+  
|         |         (5) |  
+--| Subset of SPL Statements |-----+  
|         |         (6) |  
+--| Subset of SQL Statements |-----;--+  
|'-BEGIN--| Statement Block |--END-----'
```

Notes:

1. See [DEFINE](#)
2. See [ON EXCEPTION](#) and [Identifier](#)
3. See [EXECUTE FUNCTION statement](#)
4. See [EXECUTE PROCEDURE statement](#)
5. See [Subset of SPL Statements Valid in the Statement Block](#)
6. See [SQL Statements Valid in SPL Statement Blocks](#)

Usage

SPL and SQL statements can appear in a *statement block*, a set of zero or more statements that can define the scope of a variable or of the ON EXCEPTION statement. If a statement block is empty, no operation takes place when control of execution within the SPL routine passes to the empty SPL statement block.

- [Subset of SPL Statements Valid in the Statement Block](#)
- [SQL Statements Valid in SPL Statement Blocks](#)
- [Nested Statement Blocks](#)
- [Restrictions on SPL Routines in Data-Manipulation Statements](#)
- [Transactions in SPL Routines](#)
- [Support for roles and user identity](#)

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Subset of SPL Statements Valid in the Statement Block

The diagram for the [Statement Block](#) refers to this section. You can use any of the following SPL statements in the statement block:

- <<Label >>
- CALL
- CASE
- CONTINUE
- EXIT
- FOR
- FOREACH
- GOTO
- IF
- LET
- LOOP
- RAISE EXCEPTION
- RETURN
- SYSTEM
- TRACE
- WHILE

GOTO and <<Label >>, however, are not valid in ON EXCEPTION statement blocks.

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SQL Statements Valid in SPL Statement Blocks

The diagram for the [Statement Block](#) refers to this section. Most SQL statements are valid in SPL statement blocks, except for the statements that are listed below. The following SQL statements are *not* valid in an SPL statement block:

- CLOSE DATABASE
- CONNECT
- CREATE DATABASE
- CREATE FUNCTION
- CREATE FUNCTION FROM
- CREATE PROCEDURE
- CREATE PROCEDURE FROM
- CREATE ROUTINE FROM
- DATABASE
- DISCONNECT
- DROP DATABASE
- EXECUTE
- FLUSH
- INFO
- LOAD
- OUTPUT
- PUT
- RENAME DATABASE
- SET AUTOFREE
- SET CONNECTION
- UNLOAD
- UPDATE STATISTICS

For example, you cannot close the current database or connect to a new database within an SPL routine. Similarly, you cannot drop the current SPL routine within the same routine. You can, however, drop another SPL routine.

Only two forms of the SELECT statement are valid in queries within SPL routines:

- You can use the INTO TEMP clause to put the result of the SELECT statement into a temporary table.
- You can use the SELECT ... INTO form of the SELECT statement to put the resulting values into SPL variables.

When you include the ORDER BY clause in the SELECT ... INTO TEMP or the SELECT ... INTO *variable* statement, you imply that the query returns more than one row. The database server issues an error if you specify the ORDER BY clause without a FOREACH loop to process the returned rows individually within the SPL routine.

If an SPL routine is called as part of a data-manipulation language (DML) statement, additional restrictions exist. For more information, see [Restrictions on SPL Routines in Data-Manipulation Statements](#).

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Nested Statement Blocks

You can use the BEGIN and END keywords to delimit a statement block that is nested within another statement block.

- [Scope of Reference of SPL Variables and Exception Handlers](#)

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Scope of Reference of SPL Variables and Exception Handlers

The BEGIN and END keywords can limit the scope of SPL variables and exception handlers. Declarations of variables and definitions of exception handlers inside a BEGIN and END statement block are local to that statement block and are not visible from outside the statement block. The following code uses a BEGIN and END statement block to delimit the scope of reference of variables:

```
CREATE DATABASE demo;
CREATE TABLE tracker (
  who_submitted CHAR(80), -- Show what code was running.
  value INT, -- Show value of the variable.
  sequential_order SERIAL -- Show order of statement execution.
);
CREATE PROCEDURE demo_local_var()
DEFINE var1, var2 INT;
LET var1 = 1;
LET var2 = 2;
INSERT INTO tracker (who_submitted, value)
VALUES ('var1 param before sub-block', var1);
BEGIN
  DEFINE var1 INT; -- same name as global parameter.
  LET var1 = var2;
  INSERT INTO tracker (who_submitted, value)
  VALUES ('var1 var defined inside the "IF/BEGIN".', var1);
END
INSERT INTO tracker (who_submitted, value)
VALUES ('var1 param after sub-block (unchanged!)', var1);
END PROCEDURE;
EXECUTE PROCEDURE demo_local_var();
SELECT sequential_order, who_submitted, value FROM tracker
ORDER BY sequential_order;
```

This example declares three variables, two of which are named **var1**. (Name conflicts are created here to illustrate which variables are visible. Using the same name for different variables is generally not recommended, because conflicting names of variables can make your code more difficult to read and to maintain.)

Because of the statement block, only one **var1** variable is in scope at a time.

The **var1** variable that is declared inside the statement block is the only **var1** variable that can be referenced from within the statement block.

The **var1** variable that is declared outside the statement block is not visible within the statement block. Because it is out of scope, it is unaffected by the change in value to the **var1** variable that takes place inside the statement block. After all the statements run, the outer **var1** still has a value of 1.

The **var2** variable is visible within the statement block because it was not superseded by a name conflict with a block-specific variable.

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Restrictions on SPL Routines in Data-Manipulation Statements

If you call the SPL routine in a SQL statement that is not a data-manipulation language (DML) statement (namely EXECUTE FUNCTION or EXECUTE PROCEDURE), the SPL routine can execute any statement that is not listed in the section [SQL Statements Valid in SPL Statement Blocks](#).

If you call the SPL routine as part of a DML statement (namely, an INSERT, UPDATE, DELETE, MERGE, or SELECT statement), the routine cannot execute any of the following SQL statements:

- ALTER ACCESS_METHOD
- ALTER FRAGMENT
- ALTER INDEX
- ALTER SEQUENCE
- ALTER TABLE
- BEGIN WORK
- COMMIT WORK
- CREATE ACCESS_METHOD
- CREATE AGGREGATE
- CREATE DISTINCT TYPE
- CREATE OPAQUE TYPE
- CREATE OPCLASS
- CREATE ROLE
- CREATE ROW TYPE
- CREATE SEQUENCE
- CREATE TRIGGER
- DELETE
- DROP ACCESS_METHOD

- DROP AGGREGATE
- DROP INDEX
- DROP OPCLASS
- DROP ROLE
- DROP ROW TYPE
- DROP SEQUENCE
- DROP SYNONYM
- DROP TABLE
- DROP TRIGGER
- DROP TYPE
- DROP VIEW
- INSERT
- MERGE
- RENAME COLUMN
- RENAME DATABASE
- RENAME SEQUENCE
- RENAME TABLE
- ROLLBACK WORK
- SET CONSTRAINTS
- TRUNCATE
- UPDATE

IBM® Informix® issues error -675 if an SPL routine whose calling context is a DML statement attempts to execute any of the SQL statements listed above. These restrictions do not apply to an SPL routine that is invoked by a trigger, because in this case the SPL routine is not called by the DML statement, and therefore can include any SQL statement, such as UPDATE, INSERT and DELETE, that is not listed among the [SQL Statements Valid in SPL Statement Blocks](#).

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Transactions in SPL Routines

In a database that is not ANSI-compliant, you can use the BEGIN WORK and COMMIT WORK statements in an SPL statement block to start a transaction, to finish a transaction, or start and finish a transaction in the same SPL routine. If you start a transaction in a routine that is executed remotely, you must finish the transaction before the routine exits.

As previously noted, however, the ROLLBACK WORK statement is not valid in an SPL statement block.

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Support for roles and user identity

You can use roles with SPL routines. You can execute role-related SQL statements (CREATE ROLE, DROP ROLE, GRANT, REVOKE, and SET ROLE) and a user who holds the SETSESSIONAUTH privilege can issue SET SESSION AUTHORIZATION statements in an SPL routine. Within an SPL routine, you can also use the GRANT statement

- to grant discretionary access privileges to roles,
- or grant label-based access credentials (LBAC) to roles,
- or grant other roles to roles.

An SPL routine can also use the REVOKE statement to cancel the access privileges, the LBAC credentials, or the roles that a role holds. Access privileges, roles, and LBAC credentials that a user has acquired in an SPL routine by enabling a role or by a SET SESSION AUTHORIZATION statement are not automatically relinquished after the SPL routine that granted the privilege, role, or LBAC credential completes execution. What was granted persists until a subsequent REVOKE operation cancels the effect of the GRANT operation.

For further information about roles, see the [CREATE ROLE statement](#), [DROP ROLE statement](#), [GRANT statement](#), [REVOKE statement](#), and [SET ROLE statement](#) in Chapter 2.

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Built-in routines

Use build-in routines in SQL statements to perform specialized tasks.

These built-in routines can be classified according to the tasks that they perform:

- Interval functions
 - **TO_DSINTERVAL()**
 - **TO_YMINTERVAL()**
- Session configuration procedures
 - **SYSDbClose()**

- **SYSDbOpen()**
- BSON processing functions

Functions for converting BSON field values into SQL data types

 - **BSON_value_bigint**
 - **BSON_value_boolean**
 - **BSON_value_date**
 - **BSON_value_double**
 - **BSON_value_int**
 - **BSON_value_lvarchar**
 - **BSON_value_timestamp**
 - **BSON_value_varchar**
 - **BSON_value_objectid**

Functions for DML operations on BSON data

 - **BSON_get**
 - **BSON_size**
 - **BSON_update**

Function for converting table columns into BSON or JSON documents

 - **genBSON()**
- DataBlade module management functions
 - **SYSBldPrepare()**
 - **SYSBldRelease()**
- Visual Explain output generation function
 - **Explain_SQL()**
- UDR definition routines
 - **ifx_Replace_Module()**
 - **ifx_Unload_Module()**
- Java™ Virtual Processor (JVP) class control function
 - **jvpControl()**
- SQLJ Driver Built-In Procedures
 - **sqlj.Alter_Java_Path()**
 - **sqlj.Install_jar()**
 - **sqlj.Remove_jar()**
 - **sqlj.Replace_jar()**
 - **sqlj.SetUDTextName()**
 - **sqlj.UnsetUDTextName()**
- DRDA Support Functions
 - **sysibm.Metadata()**
 - **sysibm.sqlcaMessage()**
- Extended Utilities
 - **UUID()**
 - **replaceAll(String input, String pattern, String replacement)**
 - **encodeBase64(Blob binaryData)**
- [Interval functions](#)

Use the interval functions to return an INTERVAL value from arguments that include a number and a character-string representing time units and separators in INTERVAL qualifiers. These functions are useful in CREATE TABLE, CREATE INDEX, and ALTER FRAGMENT statements that define or modify range-interval distributed storage strategies for indexes and tables.
- [Session Configuration Procedures](#)
- [BSON processing functions](#)

BSON processing functions manipulate BSON data. Some SQL statements require function expressions that call these built-in functions.
- [DataBlade Module Management Functions](#)

From sessions connected to Informix databases that support explicit transaction logging, you can register or unregister DataBlade modules by issuing SQL statements that call the built-in **SYSBldPrepare()** function. Another built-in function, **SYSBldRelease()**, returns the version string of the **SYSBldPrepare()** function in the local database.
- [The EXPLAIN SQL Routine](#)

The IBM® Data Studio Administration Edition can use the EXPLAIN_SQL routine to obtain a query plan in XML format, interpret the XML, and render the plan visually.
- [UDR Definition Routines](#)
- [jvpcontrol Function](#)
- [SQLJ Driver Built-In Procedures](#)
- [DRDA Support Functions](#)
- [Extended Utilities](#)

Interval functions convert a number or a string to an `INTERVAL DAY TO SECOND` or `INTERVAL YEAR TO MONTH` literal, or of whatever valid precision the time units in the second argument specify. These functions do not, however, support `FRACTION` or `.FRACTION` as the last time unit in their second argument.

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The **TO_DSINTERVAL** function converts a string representing a time unit to an INTERVAL DAY TO SECOND literal value. This function can also accept a number and a string as its arguments, and return an INTERVAL value with a single time-unit precision of DAY, HOUR, MINUTE, or SECOND.

Syntax

```
|--TO_DSINTERVAL--(--' DD HH:MM:SS '--)-----|
```

Usage

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The following examples show how different values for the **TO_DSINTERVAL** function are interpreted.
The following examples specify an interval of one day:

```
TO_DSINTERVAL('1 00:00:00')
TO_DSINTERVAL(1, 'DAY')
NUMTODSINTERVAL(1, 'DAY')
```

The following examples specify an interval of one hour:

```
TO_DSINTERVAL('0 01:00:00')
TO_DSINTERVAL(1, 'HOUR')
NUMTODSINTERVAL(1, 'HOUR')
```

The following examples specify an interval of one minute and 30 seconds:

```
TO_DSINTERVAL('0 00:01:30')
TO_DSINTERVAL(1.5, 'MINUTE')
NUMTODSINTERVAL(1.5, 'MINUTE')
```

The following example shows how to use an expression as a numeric value:

```
TO_DSINTERVAL(10+10+100, 'DAY')
```

Related reference:

[Interval fragment clause](#)

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TO_YMINTERVAL function

The **TO_YMINTERVAL** function converts a string representing a time unit to an INTERVAL YEAR TO MONTH literal value. This function can also accept a number and a string as its arguments, and return an INTERVAL value with a single time-unit precision of YEAR or MONTH.

You can use the **TO_YMINTERVAL** function with a single argument (or with two arguments, its synonym, **NUMTOYMINTERVAL**) to specify an interval range value when you are defining a range-interval storage distribution strategy to fragment a table or an index.

Syntax

Numeric to INTERVAL

```
|---+--TO_YMINTERVAL----- (--number--,---'--YEAR--'---)-----|
      '-NUMTOYMINTERVAL-'          '-'--MONTH--'--'
```

String to INTERVAL

```
|--TO_YMINTERVAL--(--' YY -MM '--)-----|
```

Element	Description	Restrictions	Syntax
<i>number</i>	The number of years or months in the interval. This can be an expression, including a column expression, that resolves (or can be cast) to one of the valid data types.	Must be one of the following data types: <ul style="list-style-type: none"> • INT • BIGINT • SMALLINT • INT8 • DECIMAL • REAL • FLOAT • SERIAL • SERIAL8 • BIGSERIAL 	Literal number
<i>MM</i>	Two digits specifying the number of months in the interval. A hyphen (-) must precede the first digit.	Must be one of the following data types: <ul style="list-style-type: none"> • CHAR • NCHAR • VARCHAR • NVARCHAR • LVARCHAR 	Literal string
<i>YY</i>	Two digits specifying the number of years in the interval.	Must be one of the following data types: <ul style="list-style-type: none"> • CHAR • NCHAR • VARCHAR • NVARCHAR • LVARCHAR 	Literal string

Usage

You can use the **TO_YMINTERVAL** function to specify an interval value when you fragment a table or index by an interval. The **TO_YMINTERVAL** function is valid in any context that a built-in routine is allowed. The **NUMTOYMINTERVAL** function is a synonym to the **TO_YMINTERVAL** function for converting numeric values.

Examples

The following examples show how different values for the **TO_YMINTERVAL** function are interpreted.

The following examples specify an interval of one year:

```
TO_YMINTERVAL('01-00')
TO_YMINTERVAL(1, 'YEAR')
NUMTOYMINTERVAL(1, 'YEAR')
```

The following examples specify an interval of one month:

```
TO_YMINTERVAL('00-01')
TO_YMINTERVAL(1, 'MONTH')
NUMTOYMINTERVAL(1, 'MONTH')
```

The following examples specify an interval of one year and six months:

```
TO_YMINTERVAL('01-06')
TO_YMINTERVAL(1.5, 'YEAR')
NUMTOYMINTERVAL(1.5, 'YEAR')
```

The following example shows how to use an expression as a numeric value:

```
TO_YMINTERVAL(10+10+100, 'YEAR')
```

The following example defines table **t2** with a range interval fragmentation scheme. Here DATETIME column **dt1** is the fragmentation key, and the return value from **NUMTOYMINTERVAL** defines the interval size as 25 years. Rows with **dt1** values for years later than 2005 but earlier than 2031 will be stored in the range fragment **p1**:

```
CREATE TABLE t2 (c1 int, d1 date, dt1 DATETIME YEAR TO FRACTION)
  FRAGMENT BY RANGE (dt1) INTERVAL (NUMTOYMINTERVAL (25, 'YEAR'))
  PARTITION p1 VALUES <
    DATETIME (2006-01-01 00:00:00.00000) YEAR TO FRACTION(5) IN dbs1;
```

If a row is inserted in which the **YEAR** value in **dt1** is less than 2006 or greater than 2030, the database server will automatically create a new interval fragment, where the size of its range is 25 years. For more information about the syntax and semantics of range interval fragmentation, see [Interval fragment clause](#).

Related reference:

[Interval fragment clause](#)

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Session Configuration Procedures

These built-in SPL procedures enable the Database Administrator to execute SQL and SPL statements automatically when a user connects to or disconnects from the database.

These routines are called "built-in" procedures in this document because the database server recognizes their names and treats them differently from how it treats other routines, but the database server does not create these routines automatically. To use their features, the DBA must issue the **CREATE PROCEDURE** statement or the **CREATE PROCEDURE FROM** statement to define the actions of these routines and to register them in the database. Only the DBA or user **informix** can create, alter, or drop these routines.

If the DBA specifies the login ID of a user as the *owner* of one of these procedures, the database server executes it when the specified user connects to or disconnects from the database. If the DBA specifies **PUBLIC** as the owner, that routine is automatically executed when a user who is not the owner of any of these built-in session configuration procedures connects to or disconnects from the database. Different databases of the same database server instance can specify either the same or different session configuration procedures for individual users or for **PUBLIC**. These built-in procedures are useful in setting the session environment or activating a role for users of applications whose code cannot easily be modified.

These are the built-in session configuration procedures:

- **sysdbclose**
- **sysdbopen**

Instances of the **SYSDbOpen** and **SYSDbClose** routines can be defined for individual users, for roles, and for the **PUBLIC** group in every Informix® database.

- [Using SYSDbOPEN and SYSDbCLOSE Procedures](#)
To set the initial environment for one or more sessions, create and install the **sysdbopen()** SPL procedure. The typical effect of this procedure is to initialize the properties of a session without requiring the properties to be explicitly defined within the session.
- [Configure session properties at connection or access time](#)
You can use a **sysdbopen()** procedure to change the properties of a database server session at connection or access time without changing the application that the session runs. This is useful if you cannot modify the source code of an application to set environment options or session variables, or to include session-related SQL statements, for example, because the SQL statements contain vendor-acquired code.
- [Configuring session properties](#)
Only a DBA or user **informix** can create or alter **sysdbopen()** or **sysdbclose()** in the **ALTER PROCEDURE**, **ALTER ROUTINE**, **CREATE PROCEDURE**, **CREATE**

Related reference:[USE SHARDING session environment option](#)[Copyright© 2020 HCL Technologies Limited](#)

Using SYSDBOPEN and SYSDBCLOSE Procedures

To set the initial environment for one or more sessions, create and install the **sysdbopen()** SPL procedure. The typical effect of this procedure is to initialize the properties of a session without requiring the properties to be explicitly defined within the session.

Setting the initial environment for one or more sessions is useful if users access databases through client applications that cannot modify application code or set environment options or environment variables.

The **sysdbopen** procedure is executed whenever users successfully issue the DATABASE or CONNECT statement to explicitly connect to a database where the procedures are installed. (But when a user who is connected to the local database calls a remote UDR or performs a distributed DML operation that references a remote database object by using the *database:object* or *database@server:object* notation, no **sysdbopen** procedure is invoked in the remote database.)

These procedures are exceptions to the general rule that Informix® ignores the name of the owner of a UDR when a routine is invoked in a database that is not ANSI-compliant. For UDRs other than **sysdbopen** and **sysdbclose**, multiple versions of UDRs that have the same SQL identifier but that have different *owner* names cannot be registered in the same database unless the CREATE DATABASE statement that created the database also included the WITH LOG MODE ANSI keywords.

You can also create the **sysdbclose** SPL procedure, which is executed when a user issues the CLOSE DATABASE or DISCONNECT statement to disconnect from the database. If a PUBLIC.**sysdbclose** procedure is registered in the database, and no *user.sysdbclose* procedure is registered for the current user, then the PUBLIC.**sysdbclose** procedure is executed automatically when that *user* disconnects from the database.

You can include valid SQL or SPL language statements that are appropriate when a database is opened or closed. The general restrictions on SQL statements that are valid in SPL procedures also apply to these routines. See the following sections for restrictions on SQL and SPL statements within SPL routines:

- [Subset of SPL Statements Valid in the Statement Block.](#)
- [SQL Statements Valid in SPL Statement Blocks.](#)
- [Restrictions on SPL Routines in Data-Manipulation Statements.](#)

Important: The **sysdbopen** and **sysdbclose** procedures are exceptions to the scope rule for stored procedures. In ordinary UDR procedures, the scope of variables and statements is local. SET PDQPRIORITY and SET ENVIRONMENT statement settings do not persist when these SPL procedures exit. In **sysdbopen** and **sysdbclose** procedures, however, statements that set the session environment remain in effect until another statement resets the options, or the session ends. For example, the following procedure sets the transaction isolation level to Repeatable Read, and sets the **OPTCOMPIND** environment variable to instruct the query optimizer to prefer nested-loop joins. When a user who owns no *user.sysdbopen* procedure connects to the database, this routine will be executed:

```
CREATE PROCEDURE public.sysdbopen ()
SET ISOLATION TO REPEATABLE READ;
SET ENVIRONMENT OPTCOMPIND '1';
END PROCEDURE;
```

Procedures do not accept arguments or return values. The **sysdbopen** and **sysdbclose** procedures must be registered in each database in which you want to execute them. The DBA can create the following four categories of **sysdbopen** and **sysdbclose** procedures.

Procedure Name	Description
<i>user.sysdbopen</i>	This procedure is executed when the specified <i>user</i> opens the database as the current database.
public.sysdbopen	If no <i>user.sysdbopen</i> procedure applies, this procedure is executed when any user opens the database as the current database. To avoid duplicating SPL code, you can call this procedure from a user-specific procedure.
<i>user.sysdbclose</i>	This procedure is executed when the specified <i>user</i> closes the database, disconnects from the database server, or the user session ends. If <i>user.sysdbclose</i> did not exist when the session opened the database, however, the procedure is not executed when the session closes the database.
public.sysdbclose	If no <i>user.sysdbclose</i> procedure applies, this procedure is executed when the user closes or disconnects from the database server, or when the session ends. If public.sysdbclose did not exist when the session opened the database, however, the procedure is not executed when the session closes the database.

The database server calls *user.sysdbclose* procedure, if it exists in the database, or **public.sysdbclose** if this exists and no version owned by *user* exists, when the CLOSE DATABASE or DISCONNECT statement explicitly terminates the connection. If the application terminates without issuing the CLOSE DATABASE or DISCONNECT statement, the database server forces an implicit close of the database and executes the **sysdbclose** procedure, if a UDR with that name is owned by the user or by PUBLIC.

Make sure that you set file access permissions appropriately to allow intended users to execute the SPL procedure statements. For example, if the SPL procedure executes a command that writes output to a local directory, permissions must be set to allow users to write to this directory. If you want the procedure to continue if permission failures occur, include an ON EXCEPTION error handler for this condition.

For more information about the SQL statements that can appear in SPL routines, and about SPL support for transactions and for roles, see the section [Statement Block](#).

Warning: If a **sysdbclose** procedure fails, the failure is ignored. If a **sysdbopen** procedure fails, however, the database cannot be opened.

To avoid situations in which a database cannot be opened, take the following precaution while you are writing and debugging a **sysdbopen** procedure:

- Set the **IFX_NODBPROC** environment variable before you connect to the database. When **IFX_NODBPROC** is set, the procedure is not executed, and failures cannot prevent the database from opening.

Failures from these procedures can be generated by the system or simulated within the procedures by the **RAISE EXCEPTION** statement of SPL. If the **sysdbopen** routine that is invoked for a user at connection time includes this statement, that user cannot connect to the database. For more information, refer to the description of [RAISE EXCEPTION](#).

For security reasons, non-DBAs cannot prevent execution of these procedures. For some applications, however, such as *ad hoc* query applications, users can execute commands and SQL statements that subsequently change the environment.

A default role defined in the **sysdbopen** procedure takes precedence over any other role that the user holds when a user establishes a connection to a database in which **sysdbopen** successfully specifies a default role for that user.

Any database objects that are created by DDL statements in a **user.sysdbopen** or **user.sysdbclose** procedure are owned by the connected **user**, and any object created within **PUBLIC.sysdbopen** or within **PUBLIC.sysdbclose** is owned by the **PUBLIC** userid, unless the object name is fully qualified by some other owner name when the object name is declared in the DDL statement.

For ANSI-compliant databases, an explicit **COMMIT WORK** statement is required at the end of the **sysdbopen** or **sysdbclose** definition in the **CREATE PROCEDURE** statement, to prevent any implicit transactions of SQL statements that the **sysdbopen** or **sysdbclose** procedure executes from being rolled back when the procedure terminates. (Omitting the **COMMIT WORK** statement does not cause the connection to fail, but does waste resources in opening and then rolling back the transactions.)

For a list of SQL statements that are not valid in these procedures, see [SQL Statements Valid in SPL Statement Blocks](#). For a list of the SPL statements that are valid in these procedures, see [Subset of SPL Statements Valid in the Statement Block](#).

For general information about how to write and install SPL procedures, refer to the section about SPL routines in *IBM® Informix Guide to SQL: Tutorial*.

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Configure session properties at connection or access time

You can use a **sysdbopen()** procedure to change the properties of a database server session at connection or access time without changing the application that the session runs. This is useful if you cannot modify the source code of an application to set environment options or session variables, or to include session-related SQL statements, for example, because the SQL statements contain vendor-acquired code.

To change the properties of a session, design custom **sysdbopen()** and **sysdbclose()** procedures for various databases to support the applications of specific users or of the **PUBLIC** group. The **sysdbopen()** and **sysdbclose()** procedures can contain a sequence of **SET**, **SET ENVIRONMENT**, **SQL**, or **SPL** statements that the database server executes for the user or for the **PUBLIC** group when the database opens or closes.

For example, for **user1**, you can define procedures that contain **SET PDQPRIORITY**, **SET ISOLATION LEVEL**, **SET LOCK MODE**, **SET ROLE**, or **SET EXPLAIN ON** statements that execute whenever **user1** opens the database with a **DATABASE** or **CONNECT TO** statement.

Any settings of the session environment variables **PDQPRIORITY** and **OPTCOMPIND** that are specified by **SET ENVIRONMENT** statements within **sysdbopen()** procedures persist for the duration of the session. **SET PDQPRIORITY** and **SET ENVIRONMENT OPTCOMPIND** statements, which are not persistent for regular procedures, are persistent when **sysdbopen()** procedures contain them.

The **user.sysdbclose()** procedure runs when the user who is the owner of the procedure disconnects from the database (or else when **PUBLIC.sysdbclose()** runs, if it exists and no **sysdbclose()** procedure is owned by the current user).

In custom **sysdbopen()** and **sysdbclose()** procedures, IBM® Informix® does not ignore the name of the owner of a UDR when a routine is invoked in a database that is not ANSI-compliant.

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Configuring session properties

Only a DBA or user **informix** can create or alter **sysdbopen()** or **sysdbclose()** in the **ALTER PROCEDURE**, **ALTER ROUTINE**, **CREATE PROCEDURE**, **CREATE PROCEDURE FROM**, **CREATE ROUTINE FROM**, **DROP PROCEDURE**, or **DROP ROUTINE** statements of SQL.

You can set up **sysdbopen()** procedures that change the properties of a session at connection or access time without changing the application that the session runs. This is useful if you cannot modify the source code of an application to set environment options or environment variables or to include session-related SQL statements, for example, because the SQL statements contain vendor-acquired code.

Follow these steps to set up a **sysdbopen()** and **sysdbclose()** procedure to configure session properties:

1. Set the **IFX_NODBPROC** environment variable to any value, including 0, to cause the database server to bypass and prevent the execution of the **sysdbopen()** or **sysdbclose()** procedure.
2. Write the **CREATE PROCEDURE** or **CREATE PROCEDURE FROM** statement to define the procedure for a particular user or the **PUBLIC** group.
3. Test the procedure, for example, by using **sysdbclose()** in an **EXECUTE PROCEDURE** statement.
4. Unset the **IFX_NODBPROC** environment variable to enable the database server to run the **sysdbopen()** or **sysdbclose()** procedure.

Examples of SYSDBOPEN procedures

The following procedure sets the role and the PDQ priority for a specific user, and enables the **NOVALIDATE** session environment variable:

```
CREATE PROCEDURE oltp_user.sysdbopen()
    SET ROLE TO oltp;
    SET PDQPRIORITY 5;
    SET ENVIRONMENT NOVALIDATE '1';
END PROCEDURE;
```

The following procedure sets the role and the PDQ priority for the PUBLIC group, and sets the RETAINUPDATELOCKS session environment variable to CURSOR STABILITY:

```
CREATE PROCEDURE PUBLIC.sysdbopen()
    SET ROLE TO others;
    SET PDQPRIORITY 1;
    SET ENVIRONMENT
    RETAINUPDATELOCKS 'CURSOR STABILITY';
END PROCEDURE
```

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BSON processing functions

BSON processing functions manipulate BSON data. Some SQL statements require function expressions that call these built-in functions.

You do not need to use these functions when you operate on BSON data through MongoDB API commands.

Use the following built-in functions in SQL statements to return the values of the specified field as standard SQL data types:

- `BSON_VALUE_BIGINT()` function
- `BSON_VALUE_BOOLEAN()` function
- `BSON_VALUE_DATE()` function
- `BSON_VALUE_DOUBLE()` function
- `BSON_VALUE_INT()` function
- `BSON_VALUE_LVARCHAR()` function
- `BSON_VALUE_OBJECTID()` function
- `BSON_VALUE_TIMESTAMP()` function
- `BSON_VALUE_VARCHAR()` function

Each function converts the values in a field in a BSON column to the SQL data type that is specified in the name of the function, except the `BSON_VALUE_OBJECTID` function, which returns a string. The returned values do not require casts to JSON.

Use the following functions to manipulate BSON field-value pairs:

- `BSON_GET()` function
- `BSON_UPDATE()` function

The `BSON_SIZE()` function returns the size of field values in BSON documents.

The `genBSON` function converts SQL data into BSON documents.

- [BSON_GET function](#)
The `BSON_GET` function is a built-in SQL function that retrieves field-value pairs for the specified field in a BSON column.
- [BSON_SIZE function](#)
The `BSON_SIZE` function is a built-in SQL function that returns the storage size of a field in a BSON column. The size is returned as an integer, in units of bytes. If the field is not specified, the function returns the size of the entire BSON column.
- [BSON_UPDATE function](#)
The `BSON_UPDATE` function is a built-in SQL function that updates the contents of a BSON column with MongoDB update operators.
- [BSON_VALUE_BIGINT function](#)
The `BSON_VALUE_BIGINT` function is a built-in SQL function that converts a whole number, up to a maximum absolute size of $2^{63} - 1$ bytes, in a BSON field to a `BIGINT` data type. The function returns an integer, in units of bytes.
- [BSON_VALUE_BOOLEAN function](#)
The `BSON_VALUE_BOOLEAN` function is a built-in SQL function that converts two-state values that correspond to a `Ⓣ` (for true) or `Ⓕ` (for false) in a BSON field to an opaque `BOOLEAN` data type. The function returns string values.
- [BSON_VALUE_DATE function](#)
The `BSON_VALUE_DATE` function is a built-in SQL function that converts values that correspond to a date in a BSON field to the `DATE` data type. The function returns integer string values.
- [BSON_VALUE_DOUBLE function](#)
The `BSON_VALUE_DOUBLE` function is a built-in SQL function that numeric values in a BSON field to the `DOUBLE PRECISION` data type. The function returns string values that require eight bytes of storage.
- [BSON_VALUE_INT function](#)
The `BSON_VALUE_INT` function is a built-in SQL function that converts a whole number, up to a maximum absolute size of $2^{32} - 1$ bytes, in a BSON field to an `INT` data type. The function returns integers in the range -2 147 483 647 to 2 147 483 647 bytes.
- [BSON_VALUE_LVARCHAR function](#)
The `BSON_VALUE_LVARCHAR` function is a built-in SQL function that converts a character string that is fewer than 32 740 bytes in a BSON field to an `LVARCHAR` data type. The function returns string values.
- [BSON_VALUE_OBJECTID function](#)
The `BSON_VALUE_OBJECTID` function is a built-in SQL function that returns the `ObjectId` values in a BSON document as strings.
- [BSON_VALUE_TIMESTAMP function](#)
The `BSON_VALUE_TIMESTAMP` function is a built-in SQL function that converts a time stamp in a BSON field to the built-in `DATETIME` data type.
- [BSON_VALUE_VARCHAR function](#)
The `BSON_VALUE_VARCHAR` function is a built-in SQL function that converts character strings whose size is fewer than 255 bytes in a BSON field to a

VARCHAR data type. The function returns string values.

- [genBSON function](#)

The **genBSON** function provides an efficient method for copying data from an Informix® database into a JSON or BSON document store format.

Related concepts:

[BSON and JSON built-in opaque data types](#)

[Using the return value of a function as an index key](#)

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BSON_GET function

The **BSON_GET** function is a built-in SQL function that retrieves field-value pairs for the specified field in a BSON column.

Syntax

BSON_GET function

```
>>-BSON_GET--(--bson_column--,--"--field--"--+-----+--)-><
      '-,--"--new_field--"-'
```

Element	Description	Restrictions	Syntax
<i>bson_column</i>	Name of a BSON column	Must exist	Identifier
<i>field</i>	A string that represents a field name to search for in the BSON column. Can be a multilevel identifier.		Quoted String , Column Expressions
<i>new_field</i>	A string that represents the name to assign to the returned field.		Quoted String

Usage

Use the **BSON_GET** function to retrieve the field-value pairs for a specific field, which you can then manipulate with SQL statements. You can specify to rename the returned field.

Example: Return field-value pairs for a field

The following example returns the field-value pairs for the **name** field:

```
CREATE DATABASE testdb WITH LOG;
CREATE TABLE bson_table(bson_col BSON);

INSERT INTO bson_table VALUES('{id:100,name:"Joe"}'::JSON::BSON);
INSERT INTO bson_table VALUES('{id:101,name:"Mike"}'::JSON::BSON);
INSERT INTO bson_table VALUES('{id:102,name:"Nick"}'::JSON::BSON);

SELECT bson_get(bson_col,"name")::json FROM bson_table;

(expression)  {"name":"Joe"}
(expression)  {"name":"Mike"}
(expression)  {"name":"Nick"}

3 row(s) retrieved.
```

Example: Return field-value pairs for a field with a new field name

The following statement returns the field-value pairs with a field name of **first_name** instead of **name**:

```
SELECT bson_get(bson_col,"name","first_name")::json FROM bson_table;

(expression)  {"first_name":"Joe"}
(expression)  {"first_name":"Mike"}
(expression)  {"first_name":"Nick"}

3 row(s) retrieved.
```

Example: Update values in multiple fields

The following example updates the value of the **id** field and the **name** field where the value of the **name** field is Joe:

```
UPDATE bson_table
  SET bson_col = '{"id":300,"name":"Sr Joe"}'::JSON::BSON
  WHERE BSON_GET(bson_col,"name") = '{"name":"Joe"}'::JSON::BSON;

1 row(s) updated.

> SELECT bson_col::JSON FROM bson_table;

(expression) {"id":300,"name":"Sr Joe"}
(expression) {"id":101,"name":"Mike"}
(expression) {"id":102,"name":"Nick"}

3 row(s) retrieved.
```

Example: Create an index on a field

The following statement creates an index on the **name** field in a BSON column:

```
CREATE INDEX idx1 ON bson_table(BSON_GET(bson_col, "name")) USING BSON;
```

Related reference:

[Indexing a BSON field](#)

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BSON_SIZE function

The **BSON_SIZE** function is a built-in SQL function that returns the storage size of a field in a BSON column. The size is returned as an integer, in units of bytes. If the field is not specified, the function returns the size of the entire BSON column.

Syntax

BSON_SIZE function

```
>>-BSON_SIZE--(--bson_column--,--"--field--"--)-----><
```

Element	Description	Restrictions	Syntax
<i>bson_column</i>	Name of a BSON column	Must exist	Identifier
<i>field</i>	A string that represents a field name to search for in the BSON column. Can be a multilevel identifier.		Quoted String , Column Expressions

Usage

The *field* parameter can be a simple SQL identifier. The statements in the following example create a table with a BSON column, insert three documents, and then return the length of the specific field-value name from the BSON column.

```
CREATE DATABASE testdb WITH LOG;
CREATE TABLE IF NOT EXISTS bson_table (bson_col BSON);

INSERT INTO bson_table VALUES ('{id:100,name:"Joe"}'::JSON::BSON);
INSERT INTO bson_table VALUES ('{id:101,name:"Mike"}'::JSON::BSON);
INSERT INTO bson_table VALUES ('{id:102,name:"Nick"}'::JSON::BSON);

SELECT BSON_SIZE(bson_col,"name") FROM bson_table;

(expression)
      8
      9
      9

3 row(s) retrieved.
```

In the following query of the same table, the field value is specified as an empty string, which returns the total size of all the BSON objects that are in the BSON column.

```
SELECT BSON_SIZE(bson_col,"") FROM bson_table;

(expression)
      27
      28
      28
```

3 row(s) retrieved.

The previous examples show simple field-name value pairs, but the *field* parameter in BSON_SIZE expressions for BSON columns with more complex structures can be specified as a multilevel identifier in dot notation.

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BSON_UPDATE function

The BSON_UPDATE function is a built-in SQL function that updates the contents of a BSON column with MongoDB update operators.

Syntax

BSON_UPDATE function

```
>>-BSON_UPDATE--(--bson_column--,--"--update_doc--")-----><
```

Element	Description	Restrictions	Syntax
<i>bson_column</i>	Name of a BSON column	Must exist	Identifier
<i>update_doc</i>	<p>A JSON or BSON document that contains one or more update operations.</p> <p>The following MongoDB API update operators are allowed:</p> <ul style="list-style-type: none">• \$set• \$inc• \$unset <p>The following MongoDB API array update operators are allowed:</p> <ul style="list-style-type: none">• \$addToSet• \$pop• \$pullAll• \$push <p>The following array update operator modifiers are allowed:</p> <ul style="list-style-type: none">• \$each• \$position• \$slice• \$sort	<p>You can use each update operator only once in the <i>update_doc</i>. JavaScript expressions are not allowed.</p>	Quoted String

Usage

Use the BSON_UPDATE function to update a BSON document with the supported MongoDB API update operators. Update operations are run sequentially: the original document is updated and then the updated document is the input to the next update operator. The BSON_UPDATE function returns the final BSON document.

To include JavaScript expressions in your update operations, evaluate the expressions on the client side and supply the final result of the expression in a field-value pair.

If you attempt to use a MongoDB API update operator that is not supported, you receive the following error message:

9659: The server does not support the specified UPDATE operation on JSON documents.

Example: Update one value

The following example updates the value of the **id** field with the \$set operator, where the value of the **name** field matches Joe:

```
CREATE DATABASE testdb WITH LOG;
CREATE TABLE bson_table(bson_col BSON);

INSERT INTO bson_table VALUES('{id:150,name:"Joe"}'::JSON::BSON);
INSERT INTO bson_table VALUES('{id:101,name:"Mike"}'::JSON::BSON);
INSERT INTO bson_table VALUES('{id:102,name:"Nick"}'::JSON::BSON);

UPDATE bson_table
SET bson_col = bson_update(bson_col, '{$set:{id:150}}')
WHERE BSON_GET(bson_col,"name") = '{"name":"Joe"}'::JSON::BSON;
```

```

1 row(s) updated.

> SELECT bson_col::JSON FROM bson_table;

(expression)  {"id":150,"name":"Joe"}

(expression)  {"id":101,"name":"Mike"}

(expression)  {"id":102,"name":"Nick"}

3 row(s) retrieved.

```

Example: Update multiple values

The following statement shows what the result of using the \$set operator to update the name Nick to Nick2, and using the \$inc operator to increase Nick's ID number by 200:

```

SELECT bson_update(bson_col, '{"$set":{"name":"Nick2"},"$inc":{"id":200}}')::JSON
FROM bson_table
WHERE BSON_GET(bson_col,"name") = '{"name":"Nick"}'::JSON::BSON;

(expression)  {"id":302,"name":"Nick2"}

```

Example: Update an array to add an item

The following statement adds an item to an array with the \$push operator:

```

SELECT bson_update(c, '{$push:{ar:"four"}}')::json
FROM t;

(expression)
{"_id":1,"position":{"x":10,"y":30},"ar":["one",2,"three","four"]}

1 row(s) retrieved.

```

Example: Update an array with multiple operators

The following statement sets the value of two positions in the array with the \$set operator, adds three values to the array with the \$push operator and the \$each modifier, and then sorts values in the array in descending order with the \$sort modifier:

```

SELECT bson_update(c, '{$set:{ar.0":1, "ar.2":3},
                      $push:{ar:{$each:[6, 4, 5], $sort:-1}}}')::json
FROM t;

(expression)
{"_id":1,"position":{"x":10,"y":30},"ar":[6,5,4,3,2,1]}

1 row(s) retrieved.

```

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BSON_VALUE_BIGINT function

The BSON_VALUE_BIGINT function is a built-in SQL function that converts a whole number, up to a maximum absolute size of $2^{63}-1$ bytes, in a BSON field to a BIGINT data type. The function returns an integer, in units of bytes.

Use the BSON_VALUE_BIGINT function to return or operate on large integer data in a field in a BSON column with SQL statements.

Syntax

BSON_VALUE_BIGINT function

```
>>-BSON_VALUE_BIGINT--(--bson_column--,--field--)--><
```

Element	Description	Restrictions	Syntax
<i>bson_column</i>	Name of a BSON column	Must exist	Identifier
<i>field</i>	A string that represents a field name to search for in the BSON column. Can be a multilevel identifier.		Quoted String , Column Expressions

Usage

The *field* parameter can be a simple SQL identifier. The statements in the following example create a table with a BSON column, insert three documents, and then return the value of the *id* field. The documents are explicitly cast to JSON and then implicitly cast to BSON.

```
CREATE DATABASE testdb WITH LOG;
CREATE TABLE IF NOT EXISTS bson_table (bson_col BSON);

INSERT INTO bson_table VALUES ('{id:100,name:"Joe"}'::JSON);
INSERT INTO bson_table VALUES ('{id:101,name:"Mike"}'::JSON);
INSERT INTO bson_table VALUES ('{id:102,name:"Nick"}'::JSON);

SELECT BSON_VALUE_BIGINT(bson_col,"id") FROM bson_table;
```

```
(expression)
      100
      101
      102
```

3 row(s) retrieved.

This example shows simple field-name value pairs, but the *field* parameter in BSON_VALUE_BIGINT expressions for BSON columns with more complex structures can be specified as a multilevel identifier in dot notation.

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BSON_VALUE_BOOLEAN function

The BSON_VALUE_BOOLEAN function is a built-in SQL function that converts two-state values that correspond to a *t* (for true) or *f* (for false) in a BSON field to an opaque BOOLEAN data type. The function returns string values.

Use the BSON_VALUE_BOOLEAN function to return or operate on two-state data in a field in a BSON column with SQL statements.

Syntax

BSON_VALUE_BOOLEAN function

```
>>-BSON_VALUE_BOOLEAN--(--bson_column--,--"--field--"--)-----><
```

Element	Description	Restrictions	Syntax
<i>bson_column</i>	Name of a BSON column	Must exist	Identifier
<i>field</i>	A string that represents a field name to search for in the BSON column. Can be a multilevel identifier.		Quoted String , Column Expressions

Usage

The *field* parameter can be a simple SQL identifier. The statements in the following example create a table with a BSON column, insert three documents, and then return the value of the *veritas* field. The documents are explicitly cast to JSON and then implicitly cast to BSON.

```
CREATE DATABASE testdb WITH LOG;
CREATE TABLE IF NOT EXISTS bson_table (bson_col BSON);

INSERT INTO bson_table VALUES ('{id:7000,veritas:"t"}'::JSON);
INSERT INTO bson_table VALUES ('{id:7001,veritas:"f"}'::JSON);
INSERT INTO bson_table VALUES ('{id:7002,veritas:"t"}'::JSON);

SELECT BSON_VALUE_BOOLEAN(bson_col,"veritas") FROM bson_table;
```

```
(expression)
      t
      f
      t
```

3 row(s) retrieved.

This example shows simple field-name value pairs, but the *field* parameter in BSON_VALUE_BOOLEAN expressions for BSON columns with more complex structures can be specified as a multilevel identifier in dot notation.

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BSON_VALUE_DATE function

The BSON_VALUE_DATE function is a built-in SQL function that converts values that correspond to a date in a BSON field to the DATE data type. The function returns integer string values.

Use the BSON_VALUE_DATE function to return or operate on date and time data in a field in a BSON column with SQL statements.

Syntax

BSON_VALUE_DATE function

```
>>-BSON_VALUE_DATE--(--bson_column--,--"--field--")-----><
```

Element	Description	Restrictions	Syntax
<i>bson_column</i>	Name of a BSON column	Must exist	Identifier
<i>field</i>	A string that represents a field name to search for in the BSON column. Can be a multilevel identifier.		Quoted String , Column Expressions

Usage

The *field* parameter can be a simple SQL identifier. The statements in the following example create a table with a BSON column and, insert three documents. The documents are explicitly cast to JSON and then implicitly cast to BSON.

```
CREATE DATABASE testdb WITH LOG;
CREATE TABLE IF NOT EXISTS bson_table (bson_col BSON);

INSERT INTO bson_table
VALUES ('{id:1234,join_date:ISODate("2013-05-18T00:33:14.000Z")}'::JSON);
INSERT INTO bson_table
VALUES ('{id:1235,join_date:ISODate("2012-09-12T00:13:44.000Z")}'::JSON);
INSERT INTO bson_table
VALUES ('{id:1236,join_date:ISODate("2014-08-10T00:11:44.000Z")}'::JSON);
```

The following statement returns the value of the *id* field for all dates earlier than October 5, 2012:

```
SELECT bson_col.id::json FROM bson_table
WHERE bson_col.join_data::date >DATE("10/05/2012");

(expression) {"id":1234}
(expression) {"id":1236}
```

2 row(s) retrieved.

The following statements return the value of the *join_date* field:

```
SELECT bson_col.id::json, bson_value_date(bson_col, "join_date") FROM bson_table
WHERE bson_value_date(bson_col, "join_date")::date = '05/18/2013';

(expression) {"id":1234}
(expression) 2013-05-18 00:33:14.00000
```

1 row(s) retrieved.

The following statement creates an index on the *join_date* field in the BSON column:

```
CREATE INDEX idx_joindt ON bson_table (bson_value_date(bson_col,"join_date"))
USING bson;
```

This example shows simple field-name value pairs, but the *field* parameter in BSON_VALUE_DATE expressions for BSON columns with more complex structures can be specified as a multilevel identifier in dot notation.

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BSON_VALUE_DOUBLE function

The BSON_VALUE_DOUBLE function is a built-in SQL function that numeric values in a BSON field to the DOUBLE PRECISION data type. The function returns string values that require eight bytes of storage.

Use the BSON_VALUE_DOUBLE function to return or operate on numeric data in a field in a BSON column with SQL statements.

Syntax

BSON_VALUE_DOUBLE function

```
>>-BSON_VALUE_DOUBLE--(--bson_column--,--"--field--")-----><
```

Element	Description	Restrictions	Syntax
<i>bson_column</i>	Name of a BSON column	Must exist	Identifier

Element	Description	Restrictions	Syntax
<i>field</i>	A string that represents a field name to search for in the BSON column. Can be a multilevel identifier.		Quoted String , Column Expressions

Usage

The *field* parameter can be a simple SQL identifier. The statements in the following example create a table with a BSON column, insert three documents, and then return the value of the *id* field. The documents are explicitly cast to JSON and then implicitly cast to BSON.

```
CREATE DATABASE testdb WITH LOG;
CREATE TABLE IF NOT EXISTS bson_table(bson_col BSON);

INSERT INTO bson_table VALUES('{id:7000,veritas:"t"}'::JSON);
INSERT INTO bson_table VALUES('{id:7001,veritas:"f"}'::JSON);
INSERT INTO bson_table VALUES('{id:7002,veritas:"t"}'::JSON);

SELECT BSON_VALUE_DOUBLE(bson_col,"id") FROM bson_table;
```

```
(expression)
      7000.000000000
      7001.000000000
      7002.000000000
```

3 row(s) retrieved.

This example shows simple field-name value pairs, but the *field* parameter in BSON_VALUE_DOUBLE expressions for BSON columns with more complex structures can be specified as a multilevel identifier in dot notation.

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BSON_VALUE_INT function

The BSON_VALUE_INT function is a built-in SQL function that converts a whole number, up to a maximum absolute size of $2^{32}-1$ bytes, in a BSON field to an INT data type. The function returns integers in the range -2 147 483 647 to 2 147 483 647 bytes.

Use the BSON_VALUE_INT function to return or operate on numeric data in a field in a BSON column with SQL statements.

Syntax

BSON_VALUE_INT function

```
>>-BSON_VALUE_INT--(--bson_column--,--"--field--")-----><
```

Element	Description	Restrictions	Syntax
<i>bson_column</i>	Name of a BSON column	Must exist	Identifier
<i>field</i>	A string that represents a field name to search for in the BSON column. Can be a multilevel identifier.		Quoted String , Column Expressions

Usage

The *field* parameter can be a simple SQL identifier. The statements in the following example create a table with a BSON column, insert three documents, and then return the value of the *id* field. The documents are explicitly cast to JSON and then implicitly cast to BSON.

```
CREATE DATABASE testdb WITH LOG;
CREATE TABLE IF NOT EXISTS bson_table(bson_col BSON);

INSERT INTO bson_table VALUES('{id:100,name:"Joe"}'::JSON);
INSERT INTO bson_table VALUES('{id:101,name:"Mike"}'::JSON);
INSERT INTO bson_table VALUES('{id:102,name:"Nick"}'::JSON);

SELECT BSON_VALUE_INT(bson_col,"id") FROM bson_table;
```

```
(expression)
      100
      101
      102
```

3 row(s) retrieved.

This example shows simple field-name value pairs, but the *field* parameter in BSON_VALUE_INT expressions for BSON columns with more complex structures can be specified as a multilevel identifier in dot notation.

BSON_VALUE_LVARCHAR function

The `BSON_VALUE_LVARCHAR` function is a built-in SQL function that converts a character string that is fewer than 32 740 bytes in a BSON field to an LVARCHAR data type. The function returns string values.

Use the `BSON_VALUE_LVARCHAR` function to return or operate on character data in a field in a BSON column with SQL statements.

Syntax

`BSON_VALUE_LVARCHAR` function

```
>>-BSON_VALUE_LVARCHAR--(--bson_column--,--"--field--")-----><
```

Element	Description	Restrictions	Syntax
<i>bson_column</i>	Name of a BSON column	Must exist	Identifier
<i>field</i>	A string that represents a field name to search for in the BSON column. Can be a multilevel identifier.		Quoted String , Column Expressions

Usage

The *field* parameter can be a simple SQL identifier. The statements in the following example create a table with a BSON column, insert three documents, and then return the value of the **name** field. The documents are explicitly cast to JSON and then implicitly cast to BSON.

```
CREATE DATABASE testdb WITH LOG;
CREATE TABLE IF NOT EXISTS bson_table(bson_col BSON);

INSERT INTO bson_table VALUES('{id:100,name:"Joe"}'::JSON);
INSERT INTO bson_table VALUES('{id:101,name:"Mike"}'::JSON);
INSERT INTO bson_table VALUES('{id:102,name:"Nick"}'::JSON);

SELECT BSON_VALUE_LVARCHAR(bson_col,"name") FROM bson_table;
```

```
(expression)
Joe
Mike
Nick
```

3 row(s) retrieved.

This example shows simple field-name value pairs, but the *field* parameter in `BSON_VALUE_LVARCHAR` expressions for BSON columns with more complex structures can be specified as a multilevel identifier in dot notation.

BSON_VALUE_OBJECTID function

The `BSON_VALUE_OBJECTID` function is a built-in SQL function that returns the ObjectId values in a BSON document as strings.

Syntax

`BSON_VALUE_OBJECTID` function

```
>>-BSON_VALUE_OBJECTID--(--bson_column--,--"--_id--")-----><
```

Element	Description	Restrictions	Syntax
<i>bson_column</i>	Name of a BSON column	Must exist	Identifier

Usage

The first field in BSON documents that you create with MongoDB commands is the **_id** field. The **_id** field contains a generated ObjectId value that is a unique identifier for the document. Use the `BSON_VALUE_OBJECTID` function to retrieve ObjectId values as strings.

Example

The following MongoDB command that is run through the wire listener inserts a BSON document into the **products** table:

```
"db.products.insert({item:"card", qty:15})"
```

The following statement returns the entire contents of the **products** table:

```
SELECT data::json FROM products;
```

```
(expression)
{"_id":ObjectID("54befb9eedbc233cd3a4b2fb"),"item":"card","qty":15.000000}
1 row(s) retrieved.
```

The following statement returns the ObjectID value from the **products** table:

```
SELECT BSON_VALUE_OBJECTID(data,"_id") FROM products;
```

```
(expression)      54befb9eedbc233cd3a4b2fb
1 row(s) retrieved.
```

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BSON_VALUE_TIMESTAMP function

The **BSON_VALUE_TIMESTAMP** function is a built-in SQL function that converts a time stamp in a BSON field to the built-in DATETIME data type.

Syntax

BSON_VALUE_TIMESTAMP function

```
>>-BSON_VALUE_TIMESTAMP--(--bson_column--,--"--field--"--)-----<<
```

Element	Description	Restrictions	Syntax
<i>bson_column</i>	Name of a BSON column	Must exist	Identifier
<i>field</i>	A string that represents a field name to search for in the BSON column. Can be a multilevel identifier.		Quoted String , Column Expressions

Usage

Use the **BSON_VALUE_TIMESTAMP** function to return or operate on time stamp data in a field in a BSON column with SQL statements.

Example

The following statements create and populate a BSON column, and then convert the time stamps in the **when** field to DATETIME data:

```
CREATE DATABASE testdb WITH LOG;
CREATE TABLE IF NOT EXISTS bson_table(bson_col BSON);

INSERT INTO bson_table VALUES('{"id:36000,when:"12:09:2015"}'::JSON::BSON);
INSERT INTO bson_table VALUES('{"id:36001,when:"09:23:2015"}'::JSON::BSON);
INSERT INTO bson_table VALUES('{"id:36002,when:"05:18:2015"}'::JSON::BSON);

SELECT BSON_VALUE_TIMESTAMP(bson_col,"when") FROM bson_table;

(expression)
      12:09:2015
      09:23:2015
      05:18:2015

3 row(s) retrieved.
```

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BSON_VALUE_VARCHAR function

The **BSON_VALUE_VARCHAR** function is a built-in SQL function that converts character strings whose size is fewer than 255 bytes in a BSON field to a VARCHAR data type. The function returns string values.

Use the **BSON_VALUE_VARCHAR** function to return or operate on character data in a field in a BSON column with SQL statements.

Syntax

BSON_VALUE_VARCHAR function

```
>>-BSON_VALUE_VARCHAR--(--bson_column--,--"--field--")-----><
```

Element	Description	Restrictions	Syntax
<i>bson_column</i>	Name of a BSON column	Must exist	Identifier
<i>field</i>	A string that represents a field name to search for in the BSON column. Can be a multilevel identifier.		Quoted String , Column Expressions

Usage

The *field* parameter can be a simple SQL identifier. The statements in the following example create a table with a BSON column, insert three documents, and then return the value of the **name** field. The documents are explicitly cast to JSON and then implicitly cast to BSON.

```
CREATE DATABASE testdb WITH LOG;
CREATE TABLE IF NOT EXISTS bson_table(bson_col BSON);

INSERT INTO bson_table VALUES('{id:100,name:"Joe"}'::JSON);
INSERT INTO bson_table VALUES('{id:101,name:"Mike"}'::JSON);
INSERT INTO bson_table VALUES('{id:102,name:"Nick"}'::JSON);

SELECT BSON_VALUE_VARCHAR(bson_col,"name") FROM bson_table;
```

```
(expression)
Joe
Mike
Nick
```

3 row(s) retrieved.

This example shows simple field-name value pairs, but the *field* parameter in BSON_VALUE_VARCHAR expressions for BSON columns with more complex structures can be specified as a multilevel identifier in dot notation.

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genBSON function

The **genBSON** function provides an efficient method for copying data from an Informix® database into a JSON or BSON document store format.

The **genBSON** function copies data from a database table and converts it to BSON format, based on the column name and the column data type. The column name becomes the field name. The SQL column type indicates which BSON type is used. The SQL data value becomes the field value.

Syntax

GENBSON function

```
>>-BSON--GENBSON-----><
```

```
>--(--rowtype--+-----+--)-><
      |      .-0-----|
      |-,--+keep_nulls--+-----+-'
                        |      .-skip_id-. |
                        |-,--+0-----+-'
```

Element	Description	Restrictions	Syntax
<i>keep_nulls</i>	Indicates whether to convert NULL values of SQL into a field-value pair (1) or to omit (0) the BSON field-value pair if the SQL value is NULL. Default is (0) no NULL field-value pairs.	Only 0 or 1 is valid.	Literal Number or any SQL expression that evaluates to 0 or 1
<i>rowtype</i>	Describes the columns to be converted	Restricted to the supported SQL data types listed below	Literal Row
<i>skip_id</i>	By default, (0) creates a field that is named _id where the associated value is an ObjectId. Setting this value to (1) omits the _id field-value pair.	Only 0 or 1 is valid.	Literal Number

Usage

The **genBSON** function can convert most built-in data types of SQL to BSON field values. The following tables summarize the data type mapping that **genBSON** performs on built-in data types of SQL.

Table 1. **genBSON** conversion

of SQL character and interval data types into BSON/JSON document store types.

SQL type	BSON/JSON type
CHAR	String
LVARCHAR	String
NCHAR	String
NVARCHAR	String
SMALLFLOAT	String
INTERVAL	String

Table 2. **genBSON** conversion of SQL number, complex, date, and datetime data types into BSON/JSON document store types.

SQL type	BSON/JSON type
SMALLINT	Integer
INT	Integer
BIGINT	Long
BIGSERIAL	Long
INT8	Long
SERIAL8	Long
MONEY	Double
DECIMAL	Double
FLOAT	Double
SMALLFLOAT	Double
BSON	BSON – sub document
ROW type	Sub document
COLLECTION	Array
DATE	Date – MongoDB specific type
DATETIME	Date – MongoDB specific type

Built-in large object data types and other SQL types that are not listed are not supported as input to the **genBSON** function.

Example: Convert a table

The following example selects all columns of a table and converts them to a JSON document.

This **genBSON** function uses the built-in row type that exists for all tables. This example selects from the **systables** system catalog entries for the table, and asks **genBSON** to convert all columns. By accepting all defaults, any column with NULL values is omitted. The **_id** field is added to the document:

```
SELECT FIRST 1 genbson( systables )::JSON FROM systables;
```

```
{ "_id": ObjectId("5319412b64d5b83f00000003"),
  "tablename": "systables",
  "owner": "informix",
  "partnum": 1048580,
  "tabid": 1,
  "rowsize": 500,
  "ncols": 26,
  "nindexes": 2,
  "nrows": 266.000000,
  "created": 41702,
  "version": 65539,
  "tabtype": "T",
  "locklevel": "R",
  "npused": 23.000000,
  "fextsize": 16,
  "nextsize": 16,
  "flags": 0,
  "type_xid": 0,
  "am_id": 0,
  "pagesize": 2048,
  "ustlowts": ISODate("2014-03-05T14:46:00.000Z"),
  "secpolicyid": 0,
  "protgranularity": "",
  "statlevel": "" }
```

Example: Convert specific columns

The following example illustrates how to select a subset of columns in a table, and convert them to a JSON document.

This statement creates a row type that contains the **tablename** and **tabid** columns from the system catalog table **systables**, and creates the **_id** field:

```
SELECT FIRST 1 genbson( ROW(tabname, tabid))::JSON FROM systables;  
  
{ "_id": ObjectId("5319414764d5b83f00000005"), "tablename": "systables", "tabid": 1 }
```

The following similar statement creates a row type that contains the **tablename**, **tabid**, and **site** columns from the system catalog table **systables**, allows SQL NULL columns, and omits the addition of the **_id** field:

```
SELECT FIRST 1 genbson( ROW(tabname, tabid, site), 1, 1)::JSON  
FROM systables;  
  
(expression) { "tablename": "systables", "tabid": 1, "site": null }
```

Example: Convert multiple data types

Here is a simple example to show the supported data types and how the **genBSON** function converts them to BSON.

The following statements create and populate the **mytypes** table, which has columns of different data types:

```
CREATE TABLE mytypes  
(  
  c_char          char(20),  
  c_varchar       varchar(92),  
  c_null          char(200),  
  c_varchar1      varchar(92,10),  
  c_smallint      smallint,  
  c_int           integer,  
  c_serial        serial,  
  c_date          date,  
  c_bigint        bigint,  
  c_bigserial     bigserial,  
  c_float         float,  
  c_smallfloat    smallfloat,  
  c_decimal       decimal(10,4),  
  c_int8          int8,  
  c_lvarchar      lvarchar,  
  c_bson          BSON,  
  c_coll_int      SET(INTEGER NOT NULL),  
  c_uname_row     ROW( fname CHAR(10), lname VARCHAR(20), age INTEGER),  
  c_datetime      DATETIME YEAR TO FRACTION(5),  
  c_interval      INTERVAL DAY(3) TO DAY  
  
INSERT INTO mytypes  
VALUES  
(  
  "john",  
  "Tim",  
  NULL,  
  "Scott",  
  27,  
  200000,  
  0,  
  "1/1/2014",  
  500000000000,  
  0,  
  123.123,  
  2468.2468,  
  12345.6789,  
  1234567890,  
  "long text data",  
  "{ key: 27 }"::JSON,  
  "SET{ 1, 2, 3, 4, 5, 6, 7 }",  
  ROW("JOHN", "MILL", 7),  
  '2007-7-27 10:12:11',  
  INTERVAL (16) DAY TO DAY  

```

The following statement returns the contents of the **mytypes** table with the value of the **c_bson** column in the **c_bson2** column:

```
SELECT FIRST 1 *, c_bson::JSON AS c_bson2 FROM mytypes;  
  
c_char          john  
c_varchar       Tim  
c_null            
c_varchar1      Scott  
c_smallint      27  
c_int           200000  
c_serial        1  
c_date          01/01/2014  
c_bigint        500000000000  
c_bigserial     1  
c_float         123.1230000000  
c_smallfloat    2468.246830000  
c_decimal       12345.6789  
c_int8          1234567890  
c_lvarchar      long text data
```



```

c_bson
c_coll_int      SET{1      ,2      ,3      ,4      ,5      ,6      ,7      }
c_uname_row      ROW('JOHN', 'MILL', 7      )
c_datetime      2007-07-27 10:12:11.00000
c_interval      16
c_bson2          {"key":27}

1 row(s) retrieved.

```

The following statement returns the contents of the **mytypes** table as a JSON document:

```

SELECT FIRST 1 genbson( mytypes )::JSON FROM mytypes;

{"_id":ObjectId("5319922755d0a64400000000"),
 "c_char": "john",
 "c_varchar": "Tim",
 "c_varchar1": "Scott",
 "c_smallint": 27,
 "c_int": 200000,
 "c_serial": 1,
 "c_date": ISODate("2014-01-01T00:00:00.000Z"),
 "c_bigint": 50000000000,
 "c_bigserial": 1,
 "c_float": 123.123000,
 "c_smallfloat": 2468.246826,
 "c_decimal": 12345.678900,
 "c_int8": 1234567890,
 "c_lvvarchar": "long text data",
 "c_bson": {"key":27},
 "c_coll_int": [1,2,3,4,5,6,7],
 "c_uname_row": {"fname": "JOHN",
 "lname": "MILL", "age": 7},
 "c_datetime": ISODate("2007-07-27T10:12:11.000Z"),
 "c_interval": "16"}

1 row(s) retrieved.

```

Example: Copy a table into a BSON column

The following example illustrates how to copy the contents of the **mytable** table into the BSON column of the **mybson** table:

```

CREATE TABLE mybson ( c1 serial, c2 bson);
INSERT INTO mybson SELECT 0, genbson( mytypes ) FROM mytypes;
SELECT c1, c2::JSON FROM mybson;

```

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DataBlade Module Management Functions

From sessions connected to Informix® databases that support explicit transaction logging, you can register or unregister DataBlade modules by issuing SQL statements that call the built-in **SYSBldPrepare()** function. Another built-in function, **SYSBldRelease()**, returns the version string of the **SYSBldPrepare()** function in the local database.

Registration and unregistration of DataBlade modules through SQL function calls is an alternative to using the **BladeManager** utility. The **BladeManager** utility can perform various DataBlade module tasks that include registering, unregistering, and displaying information about DataBlade modules. This utility supports both a command-line interface and a graphical user interface. For more information about using the BladeManager utility, see your IBM® Informix DataBlade Module Installation and Registration Guide.

- [The SYSBldPrepare Function](#)

SYSBldPrepare() is a function signature that Informix defines in all databases. You can use it to register or to unregister DataBlade modules, as an alternative to using the **BladeManager** utility.

- [The SYSBldRelease Function](#)

SYSBldRelease() is a function signature that Informix defines in all databases of the server instance. You can invoke this function with the EXECUTE FUNCTION statement of SQL or with the CALL statement of SPL to return the version string of the **SYSBldPrepare()** function.

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The SYSBldPrepare Function

SYSBldPrepare() is a function signature that Informix® defines in all databases. You can use it to register or to unregister DataBlade modules, as an alternative to using the **BladeManager** utility.

The **SYSBldPrepare()** function has this definition:

```

CREATE FUNCTION informix.sysbldprepare (CHAR(64), CHAR(18))
  RETURNS INTEGER
  EXTERNAL NAME '$INFORMIXDIR/extend/ifxmngr/ifxmngr.bld(SYSBldCustomPrepare)'
  LANGUAGE C;

```

The returned integer shows whether the function call succeeded (0) or failed (nonzero).

The following restrictions apply to the database in which you invoke this built-in function:

- The minimum STACKSIZE in the configuration file of the Informix instance should be at least 64K. (On some systems, the default stack size is 32K, but 64K is recommended for databases that use the **SYSBldPrepare()** function.
- The function call cannot reference a remote database. You can only register or unregister a DataBlade module in the local database to which you are currently connected.
- The database must support explicit transactions. You cannot invoke this function in an ANSI/ISO-compliant database, or in a database that does not support transaction logging.
- In an Enterprise Replication cluster environment, the Informix instance that supports the database cannot be a remote secondary server, because such servers cannot directly support DDL operations, like those that this function performs. If a DataBlade module needs to be registered or unregistered on a secondary server, you must register or unregister that module on the primary server that the secondary server replicates.

This is the calling syntax of **SYSBldPrepare()**:

```
SYSBldPrepare Function

>>-EXECUTE FUNCTION SYSBLDPREPARE--(--'----->

>--+--+| Module Reference |+--+--'--'--CREATE+--+--'--)--;-----><
| +-file-----+
| '-builtin-----'
| '-| Module Reference |--'--'--DROP-----'

Module Reference

|--module--+-.--major--.--minor--.--os_code--C--interim+-----|
+-.--major--.--minor--.--os_code--C--*-----+
+-.--major--.--minor--.--os_code--*-----+
+-.--major--.--minor--.--*-----+
+-.--major--.--minor--*-----+
+-.--major--.--*-----+
+-.--major--*-----+
+-.--*-----+
+_*-----'
```

Element	Description	Restrictions	Syntax
<i>module</i>	Name of a DataBlade module to register or unregister	For 'CREATE' <i>module</i> must be installed in \$INFORMIXDIR/extend . For 'DROP' it must be registered in the current database.	String literal
<i>file</i>	Name of a file that lists one or more DataBlade modules, each in Module Reference format	Must exist in directory \$INFORMIXDIR/extend/ifxmngr	Character string with no suffix
<i>major</i>	Integer specifying a major Informix release version	Must match the major version of an installed or registered DataBlade module or wildcard	Literal number
<i>minor</i>	Integer specifying a minor Informix release version	Must match the minor version of an installed or registered DataBlade module or wildcard	Literal number
<i>os_code</i>	Uppercase letter code for a supported operating system	Valid options are F, H, T, or U. These codes are described in Chapter 1 of <i>DataBlade Module Installation and Registration Guide</i> .	Literal character
<i>interim</i>	Integer specifying an interim Informix release version	Must match the interim version of an installed or registered DataBlade module or wildcard	Literal number

You can invoke this function with the EXECUTE FUNCTION statement of SQL, or with the CALL statement of SPL. .

The first argument to **SYSBldPrepare()** specifies what DataBlade module or file to process. The second argument specifies whether to register ('CREATE') or to unregister ('DROP') what the first argument specifies. If 'DROP' is the second argument, the first argument must specify a DataBlade module, not a file.

Specifying a File as the First Argument

If 'CREATE' is the second argument, the first argument must be either a single module reference or the name of a text file that specifies a list of one or more module references, each in the format of the Module Reference syntax segment in the syntax diagram above. (The text file cannot, however, list the name of another text file that lists module references.) By specifying a valid file as the first argument, you can register a set of DataBlade modules by a single call to the **SYSBldPrepare()** function.

The file can be one that you created, or it can be the **builtin** file that the database server creates. The **builtin** file includes a list of DataBlade modules that Informix classifies as built-in. These built-in DataBlade modules are distributed with Informix and are installed in the **\$INFORMIXDIR/extend** file system, but they cannot be accessed until they are registered in the database. Updates by users to this **builtin** file, which the database server maintains, are not supported.

Version Strings and Asterisk (*) Notation in Module References

When the first argument begins with the name of a DataBlade module, you can also specify the complete version string after a period (.) separator. A complete version string has in the same format as the return value of the **DBINFO('version full')** function of SQL or of the **oninit -V** utility, but is based on DataBlade module release versions.

The DataBlade module name or version string can be truncated with the asterisk (*) wildcard. How **SYSBldPrepare()** interprets the asterisk symbol depends on the second argument:

- If 'CREATE' is the second argument, the asterisk matches the highest installed version of the specified module.
- If 'DROP' is the second argument, the asterisk matches the registered version of the module among the DataBlade modules that are registered in the local database. No more than one version of a given DataBlade module can be registered in the database, so an asterisk that replaces the version string specifies the version that is registered.

Any asterisk symbol in a Module Reference that is not the last character is interpreted as a literal character, rather than as a wildcard.

Where **SYSBldPrepare()** searches for a module that the first argument specifies depends on the second argument:

- If 'CREATE' is the second argument, the function searches among the modules that are installed in the **\$INFORMIXDIR/extend** directory.
- If 'DROP' is the second argument, the function searches for the specified version of the module among the DataBlade modules that are registered in the local database. Because no more than one version of a given DataBlade module can be registered in the database, an asterisk that replaces the version string specifies the version that is registered.

Registering and Unregistering DataBlade Modules

The second argument to this function must be either 'CREATE' or 'DROP':

- Use 'CREATE' to register the installed DataBlade module (or the set of installed DataBlade modules listed in a file) that the first argument specifies.
- Use 'DROP' to unregister the registered DataBlade module that the first argument specifies. The 'DROP' option cannot unregister more than one DataBlade module in a single call to **SYSBldPrepare()**.

Successful invocation of the **SYSBldPrepare()** function with 'CREATE' as its second argument also registers any DataBlade modules on which the module specified in the first argument is dependent.

The following SQL statement uses asterisk notation to unregister the highest version of the Node extension that is registered in the database:

```
EXECUTE FUNCTION sysbldprepare ('Node.*', 'drop');
```

Unlike registration operations, a call to **SYSBldPrepare()** that specifies 'DROP' as the second argument has no automatic effect on any DataBlade module that the first argument does not specify. The 'DROP' argument does not implicitly unregister other DataBlade modules that have dependency relationships with the module specified by the first argument.

Using SYSBldPrepare() in Transactions

The **SYSBldPrepare()** function internally uses explicit transactions. If you issue the BEGIN WORK statement to begin a transaction in which you invoke **SYSBldPrepare()**, the status of any changes to the database by DML or DDL statements in the same transaction, but before the call to **SYSBldPrepare()**, is unpredictable. Changes from your DML or DDL operations might be committed when the internal transaction of **SYSBldPrepare()** is committed, thereby depriving you of any opportunity to roll back these changes by error-handling logic that follows the function call in the lexical order of SQL statements. To avoid this situation, do not invoke **SYSBldPrepare()** within transactions that you begin explicitly.

Exceptions in Calls to SYSBldPrepare()

The **SYSBldPrepare()** function issues an error if you attempt to use the 'DROP' option to unregister a DataBlade module on which another DataBlade module that is currently registered in the database depends. For example, you cannot use this function to unregister the R-tree DataBlade module while the Spatial DataBlade module is still registered.

Informix also issues an error if **SYSBldPrepare()** attempts to unregister a DataBlade module that is not registered in the database.

The next example shows an attempt to register a DataBlade module that is not installed and the resulting error message:

```
EXECUTE FUNCTION sysbldprepare ('node.2.33', 'create');

(U0001) - registerBlade - Unable to register node.2.33
- DataBlade module not found
- check online log and sysblderrorlog table for more information
```

If the IFX_EXTEND_ROLE configuration parameter is set to ON, authorization to invoke this routine is available only to the Database Server Administrator (DBSA), and others to whom the DBSA has granted the EXTEND role. By default, the DBSA is user **informix**.

Exceptions that occur while this function is executing can result in diagnostic error messages from **SYSBldPrepare()** that are not Informix error messages. Refer to the *IBM® Informix DataBlade Module Installation and Registration Guide* for information about error messages that **SYSBldPrepare()** can issue.

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The SYSBldRelease Function

SYSBldRelease() is a function signature that Informix® defines in all databases of the server instance. You can invoke this function with the EXECUTE FUNCTION statement of SQL or with the CALL statement of SPL to return the version string of the **SYSBldPrepare()** function.

The **SYSBldRelease()** function has this definition:

```
CREATE FUNCTION informix.sysbldrelease()
RETURNS LVARCHAR
```

```
EXTERNAL NAME
'$INFORMIXDIR/extend/%SYSBLDDIR%/ifxmngr.bld(MackRelease) '
LANGUAGE C NOT VARIANT;
GRANT EXECUTE ON FUNCTION SYSBldRelease() TO PUBLIC;
```

This function takes no arguments. It returns the version string and compilation date of the **SYSBldPrepare()** function. The returned version string has this format:

```
major.minor.os_codeCinterim
```

Here C is a literal character, and the *major*, *minor*, *os_code*, and *interim* version string elements have the same semantics that these terms have in the Module Reference segment of the **SYSBldPrepare()** function, but with no asterisk (***) wildcard notation.

SYSBldRelease() is useful when you contact Support with **SYSBldPrepare()** issues.

The **SYSBldPrepare()** function needs to have been called at least once in the same database before **SYSBldRelease()** can return the correct version string of **SYSBldPrepare()**. The call to **SYSBldPrepare()** does not need to be in the same session as the call to **SYSBldRelease()**.

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The EXPLAIN_SQL Routine

The IBM® Data Studio Administration Edition can use the EXPLAIN_SQL routine to obtain a query plan in XML format, interpret the XML, and render the plan visually.

IBM Data Studio consists of a set of tools to use for administration, data modeling, and building queries from data that comes from data servers. The EXPLAIN_SQL routine prepares a query and returns a query plan in XML.

If you plan to use IBM Data Studio to obtain Visual Explain output, you must create and specify a default sbspace name for the SBSPACENAME configuration parameter in your ONCONFIG file. The EXPLAIN_SQL routine creates BLOB objects in this sbspace.

For information on using IBM Data Studio, see the IBM Data Studio documentation.

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UDR Definition Routines

The UDR definition routines are built-in routines that enable users to perform various tasks for developing or modifying external user-defined routines of Informix®, or for enabling IBM Data Server Driver for JDBC and SQL procedures to access Informix and IBM® DB2® databases through the Distributed Relational Database Architecture™ (DRDA) protocol.

These are the built-in UDR definition routines:

- **ifx_replace_module()**
- **ifx_unload_module()**
- **jvpcontrol()**
- **sqlj.alter_java_path()**
- **sqlj.install_jar()**
- **sqlj.remove_jar()**
- **sqlj.replace_jar()**
- **sqlj.setUDTextName()**
- **sqlj.unsetUDTextName()**
- **sysibm.Metadata()**
- **sysibm.SQLCAMessage()**

Authorization to Use UDR Definition Routines

If the IFX_EXTEND_ROLE configuration parameter is set to 'On' or 1, authorization to use the built-in routines that manipulate shared objects is available only to the Database Server Administrator, and to users to whom the DBSA has granted the EXTEND role. IFX_EXTEND_ROLE is enabled by default.

For databases in which this security feature is not needed, see the description of IFX_EXTEND_ROLE in your *IBM Informix Administrator's Reference* for information on how the DBSA can disable this configuration parameter by resetting it. For the syntax of granting the EXTEND role to individual users or to the PUBLIC group, see the topic [Granting the EXTEND Role](#).

- [IFX_REPLACE_MODULE Function](#)
- [IFX_UNLOAD_MODULE Function](#)

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IFX_REPLACE_MODULE Function

The **IFX_REPLACE_MODULE** function replaces a loaded shared-object file of a UDR written in the C language with a new version that has a different name or location. If the **IFX_EXTEND_ROLE** configuration parameter is set to 'On' or 1, authorization to use this function is available only to the Database Server Administrator (DBSA), and to users whom the DBSA has granted the **EXTEND** role.

IFX_REPLACE_MODULE Function

```
|--IFX_REPLACE_MODULE-- (--old_module--,--new_module--,--"C"--)|
```

Argument	Description	Restrictions	Syntax
<i>new_module</i>	Full pathname of the new shared-object file to replace the shared-object file that <i>old_module</i> specifies	The shared-object file must exist with the specified pathname, which can be no more than 255 bytes long	Quoted String
<i>old_module</i>	Full pathname of the shared-object file to replace with the shared-object file that <i>new_module</i> specifies	The shared-object file must exist with the specified pathname, which can be no more than 255 bytes long	Quoted String

The **IFX_REPLACE_MODULE** function is a DBA-privileged function that returns an integer value to indicate the status of the shared-object-file replacement operation:

- Zero (0) to indicate success
- A negative integer to indicate an error.

Do not use the **IFX_REPLACE_MODULE** function to reload a module of the same name. If the full names of the old and new modules that you send to **IFX_REPLACE_MODULE** are the same, then unpredictable results can occur.

After **IFX_REPLACE_MODULE** completes execution, the database server ages out the *old_module* shared-object file; that is, all statements subsequent to the **IFX_REPLACE_MODULE** function will use UDRs in the *new_module* shared-object file, and the old module will be unloaded when any statements that were using it are complete. Thus, for a brief time, both the *old_module* and the *new_module* shared-object files could be resident in memory. If this aging out behavior is undesirable, use the **IFX_UNLOAD_MODULE** function to unload the shared-object file completely.

On UNIX, for example, suppose you want to replace the **circle.so** shared library, which contains UDRs written in the C language. If the old version of this library resides in the **/usr/apps/opaque_types** directory and the new version in the **/usr/apps/shared_libs** directory, then the following EXECUTE FUNCTION statement executes the **IFX_REPLACE_MODULE** function:

```
EXECUTE FUNCTION ifx_replace_module(  
  "/usr/apps/opaque_types/circle.so",  
  "/usr/apps/shared_libs/circle.so", "C");
```

On Windows, for another example, suppose you want to replace the **circle.dll** dynamic link library, which contains C UDRs. If the old version of this library resides in the C:\usr\apps\opaque_types directory and the new version in the C:\usr\apps\DLLs directory, then the following EXECUTE FUNCTION statement executes the **IFX_REPLACE_MODULE** function:

```
EXECUTE FUNCTION ifx_replace_module(  
  "C:\usr\apps\opaque_types\circle.dll",  
  "C:\usr\apps\DLLs\circle.dll", "C");
```

To execute the **IFX_REPLACE_MODULE** function in IBM® Informix® ESQL/C applications, you must associate the function with a cursor.

For more information on how to use **IFX_REPLACE_MODULE** to replace a shared-object file, see the chapter on how to design a UDR in *IBM Informix User-Defined Routines and Data Types Developer's Guide*. For information on how to use the **IFX_UNLOAD_MODULE** function, see the section [IFX_UNLOAD_MODULE Function](#).

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IFX_UNLOAD_MODULE Function

The **IFX_UNLOAD_MODULE** function unloads the shared-object file of a UDR written in the C language from shared memory.

IFX_UNLOAD_MODULE Function

```
|--IFX_UNLOAD_MODULE-- (--module_name--,--"C"--)|
```

Argument	Description	Restrictions	Syntax
<i>module_name</i>	Full pathname of file to unload	Shared-object file must exist and be unused. Pathname can be up to 255 bytes long.	Quoted String

The **IFX_UNLOAD_MODULE** function is an owner-privileged function whose owner is user **informix**. It returns an integer value to indicate the status of the shared-object-file unload operation:

- Zero (0) to indicate success
- A negative integer to indicate an error.

The **IFX_UNLOAD_MODULE** function can only unload an unused shared-object file; that is, when no executing SQL statements (in any database) are using any UDRs in the specified shared-object file. If any UDR in the shared-object file is currently in use, then **IFX_UNLOAD_MODULE** raises an error.

On UNIX, for example, suppose you want to unload the **circle.so** shared library, which contains C UDRs. If this library resides in the **/usr/apps/opaque_types** directory, you can use the following EXECUTE FUNCTION statement to execute the **IFX_UNLOAD_MODULE** function:

```
EXECUTE FUNCTION ifx_unload_module(  
  "/usr/apps/opaque_types/circle.so", "C");
```

On Windows, for example, suppose you want to unload the **circle.dll** dynamic link library, which contains C UDRs. If this library is in the **C:\usr\apps\opaque_types** directory, you can use the following EXECUTE FUNCTION statement to execute the **IFX_UNLOAD_MODULE** function:

```
EXECUTE FUNCTION ifx_unload_module
('C:\usr\apps\opaque_types\circle.dll', 'C');
```

For more information about using the built-in **IFX_REPLACE_MODULE()** and **IFX_UNLOAD_MODULE()** UDR definition routines, see the *IBM® Informix® User-Defined Routines and Data Types Developer's Guide* and the *IBM Informix DataBlade API Programmer's Guide*.

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jvpcontrol Function

The **jvpcontrol()** function is a built-in iterative function that you can use to obtain information about a Java™ Virtual Processor (JVP) class.

The jvpcontrol Function

```
|--informix.jvpcontrol-- (--"--+--MEMORY--+--jvp_id--")-----|
                        '-THREADS-'
```

Argument	Description	Restrictions	Syntax
jvp_id	Name of the Java Virtual Processor (JVP) class about which you seek information	The specified Java Virtual Processor class must exist	Identifier

You must associate this function with the equivalent of a cursor in the Java language.

- [Using the MEMORY Keyword](#)
- [Using the THREADS Keyword](#)

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Using the MEMORY Keyword

When you specify the MEMORY keyword, the **jvpcontrol** function returns the memory usage on the JVP class that you specify. The following example requests information about the memory usage of the JVP class named **4**:

```
EXECUTE FUNCTION INFORMIX.JVPCONTROL ("MEMORY 4");
```

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Using the THREADS Keyword

When you specify the THREADS keyword, the **jvpcontrol** function returns a list of the threads running on the JVP class that you specify. The following example requests information about the threads running on the JVP class named **4**:

```
EXECUTE FUNCTION INFORMIX.JVPCONTROL ("THREADS 4");
```

For more information about using **jvpcontrol()** and the built-in **sqlj** routines, see the *IBM® J/Foundation Developer's Guide/J/Foundation Developer's Guide*.

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SQLJ Driver Built-In Procedures

Use the SQLJ Driver built-in procedures for one of the following tasks:

- To install, replace, or remove a set of Java™ classes
- To specify a path for Java class resolution for Java classes that are included in a JAR file
- To map or remove the mapping between a user-defined type and the Java type to which it corresponds

SQLJ Driver Built-In Procedures

```

              (1)
|--+--| sqlj.install_JAR |-----+-----|
|      |               |             |
|      |               |             |
+-+--| sqlj.replace_JAR |-----+-----+
|      |               |             |
|      |               |             |
+-+--| sqlj.remove_JAR |-----+-----+
|      |               |             |
              (4) |
```

```

+-| sqlj.alter_java_path |-----+
|                          (5) |
+-| sqlj.SetUDTextName |-----+
|                          (6) |
'-| sqlj.unsetUDTextName |-----'

```

Notes:

1. See [sqlj.install_jar](#)
2. See [sqlj.replace_jar](#)
3. See [sqlj.remove_jar](#)
4. See [sqlj.alter_java_path](#)
5. See [sqlj.setUDTextName](#)
6. See [sqlj.unsetUDTextName](#)

A client application must specify the 'sqlj' owner name to invoke these functions from an ANSI-compliant database.

The SQLJ built-in procedures are stored in the **sysprocedures** system catalog table. They are grouped under the **sqlj** schema.
 Tip: For any Java static method, the first built-in procedure that you execute must be the **sqlj.install_jar()** procedure. You must install the JAR file before you can create a UDR or map a user-defined data type to a Java type. Similarly, you cannot use any of the other SQLJ built-in procedures until you have used **sqlj.install_jar()**.

- [sqlj.install_jar](#)
- [sqlj.replace_jar](#)
- [sqlj.remove_jar](#)
- [sqlj.alter_java_path](#)
- [sqlj.setUDTextName](#)
- [sqlj.unsetUDTextName](#)

Related reference:

[Jar Name](#)

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sqlj.install_jar

Use the **sqlj.install_jar()** procedure to install a JAR file in the current database and assign to it a JAR identifier.

```

sqlj.install_jar

|--sqlj.install_jar----->

(1)      .- 0 ----.
>--(--jar_file--,--| Jar Name |-----,--+deploy+--)------|

```

Notes:

1. See [Jar Name](#)

Argument	Description	Restrictions	Syntax
deploy	Integer that causes the procedure to search for deployment descriptor files in the JAR file	None	Literal Number
jar_file	URL of the JAR file that contains the Java™ language UDR	Maximum length of the URL is 255 bytes	Quoted String

For example, consider a Java class **Chemistry** that contains the following static method **explosiveReaction()**:

```
public static int explosiveReaction(int ingredient)
```

Here the **Chemistry** class resides in this JAR file on the server computer:

```
/students/data/Courses.jar
```

You can install all classes in the **Courses.jar** file in the current database with the following call to the **sqlj.install_jar()** procedure:

```
EXECUTE PROCEDURE
sqlj.install_jar("file://students/data/Courses.jar", "course_jar");
```

The **sqlj.install_jar()** procedure assigns the JAR ID, **course_jar**, to the **Courses.jar** file that it has installed in the current database.

After you define a JAR ID in the database, you can use that JAR ID when you create and execute a UDR written in the Java language. (You must hold the Resource privilege or the DBA privilege on the database, and also hold the Usage privilege on the Java language, before you can create or drop a Java UDR.)

When you specify a nonzero number for the third argument, the database server searches through any included deployment descriptor files. For example, you might want to include descriptor files that include SQL statements to register and grant privileges on UDRs in the JAR file.

If the IFX_EXTEND_ROLE configuration parameter is enabled (which is its default setting), only the DBSA or users who hold the EXTEND role are able to execute the **sqlj.install_jar()** procedure. When IFX_EXTEND_ROLE is disabled, any user can execute **sqlj.install_jar()**.

- [File Permissions on Jar Files](#)

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File Permissions on Jar Files

After **sqlj.install_jar()** installs a JAR file in the database and declares a JAR ID for the file, Informix® can access that JAR file only if the user who installed the Informix instance (typically, user 'informix') has permission to read the directory where the JAR file resides. On UNIX systems, for example, this implies that an attempt to read a JAR file that has 600 permissions fails with a `FILENOTFOUND` exception. The same operation can succeed, however, after the **chmod** utility sets the permissions to 660 (`rw-rw----`).

You must hold the Resource privilege or the DBA privilege on the database, and also hold the Usage privilege on the Java™ language, before you can create or drop a Java UDR.

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sqlj.replace_jar

Use the **sqlj.replace_jar()** procedure to replace a previously installed JAR file with a new version. When you use this syntax, you provide only the new JAR file and assign to it the JAR ID for which you want to replace the file.

```
sqlj.replace_jar

(1)
|--sqlj.replace_jar--(--jar_file--,--| Jar Name |-----)-----|
```

Notes:

1. See [Jar Name](#)

Argument	Description	Restrictions	Syntax
<i>jar_file</i>	URL of the JAR file that contains the UDR written in Java™	The maximum length of the URL is 255 bytes	Quoted String

If you attempt to replace a JAR file that is referenced by one or more UDRs, the database server generates an error. You must drop the referencing UDRs before replacing the JAR file.

For example, the following call replaces the **Courses.jar** file, which had previously been installed for the **course_jar** identifier, with the **Subjects.jar** file:

```
EXECUTE PROCEDURE
  sqlj.replace_jar("file://students/data/Subjects.jar",
    "course_jar");
```

Before you replace the **Course.jar** file, you must drop the user-defined function **sql_explosive_reaction()** with the DROP FUNCTION (or DROP ROUTINE) statement. (You must hold the Resource privilege or the DBA privilege on the database, and also hold the Usage privilege on the Java language, before you can create or drop a Java UDR.)

If the IFX_EXTEND_ROLE configuration parameter is enabled (which is its default setting), only the DBSA or users who hold the EXTEND role are able to execute the **sqlj.replace_jar()** procedure. When IFX_EXTEND_ROLE is disabled, any user can execute **sqlj.replace_jar()**.

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sqlj.remove_jar

Use the **sqlj.remove_jar()** procedure to remove a previously installed JAR file from the current database. You must hold the Resource privilege or the DBA privilege on the database, and also hold the Usage privilege on the Java™ language, before you can create or drop a Java UDR.

```
sqlj.remove_jar

(1)      .- 0 ----.
|--sqlj.remove_jar--(--| Jar Name |-----,--+deploy-+--)-----|
```

Notes:

1. See [Jar Name](#)

Argument	Description	Restrictions	Syntax
----------	-------------	--------------	--------

Argument	Description	Restrictions	Syntax
<i>deploy</i>	Integer that causes the procedure to search for deployment descriptor files in the JAR file	None	Literal Number

If you attempt to remove a JAR file that is referenced by one or more UDRs, the database server generates a 46003 error. You must drop the referencing UDRs before you replace the JAR file. An invalid JAR file name generates a 46002 error.

For example, the following SQL statements remove the JAR file that is associated with the **course_jar** JAR ID:

```
DROP FUNCTION sql_explosive_reaction;
EXECUTE PROCEDURE sqlj.remove_jar("course_jar");
```

When you specify a nonzero number for the second argument, the database server searches through any included deployment descriptor files. For example, you might want to include descriptor files that include SQL statements to revoke privileges on UDRs in the associated JAR file and drop them from the database.

If the IFX_EXTEND_ROLE configuration parameter is enabled (which is its default setting), only the DBSA or users who hold the EXTEND role are able to run the **sqlj.remove_jar()** procedure. When IFX_EXTEND_ROLE is disabled, any user can run **sqlj.remove_jar()**.

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sqlj.alter_java_path

Use **sqlj.alter_java_path()** to specify the *jar-file path* to use when the routine manager resolves related Java™ classes for the JAR file of a UDR written in the Java language.

sqlj.alter_java_path

|--sqlj.alter_java_path----->

```

      (1)      V      |      (1)
>--(--| Jar Name |----- (---package_id.---+--- * -----+---,--| Jar Name |-----) --|
                                     '-class_id-'

```

Notes:

1. See [Jar Name](#)

Argument	Description	Restrictions	Syntax
<i>class_id</i>	Java class that contains method to implement the UDR	Java class must exist in the JAR file that <i>jar_id</i> specifies. Identifier must not exceed 255 bytes.	Language specific
<i>package_id</i>	Name of the package that contains the Java class	The fully qualified identifier of <i>package_id.class_id</i> must not exceed 255 bytes	Language specific

The JAR IDs that you specify, namely the JAR ID for which you are altering the JAR-file path and the resolution JAR ID, must both have been installed with the **sqlj.install_jar** procedure. When you invoke a UDR written in the Java language, the routine manager attempts to load the Java class in which the UDR resides. At this time, it must resolve the references that this Java class makes to other Java classes.

The three types of such class references are these:

1. References to Java classes that the JVPCLASSPATH configuration parameter specifies (such as Java system classes like **java.util.Vector**)
2. References to classes that are in the same JAR file as the UDR
3. References to classes that are outside the JAR file that contains the UDR.

The routine manager implicitly resolves classes of type 1 and 2 in the preceding list. To resolve type 3 references, it examines all the JAR files in the JAR file path that the latest call to **sqlj.alter_java_path()** specified.

The routine manager issues an exception if it cannot resolve a class reference. The routine manager checks the JAR file path for class references *after* it performs the implicit type 1 and type 2 resolutions.

If you want a Java class to be loaded from the JAR file that the JAR file path specifies, make sure the Java class is *not* present in the JVPCLASSPATH configuration parameter. Otherwise, the system loader picks up that Java class first, which might result in a different class being loaded than what you expect.

Suppose that the **sqlj.install_jar()** procedure and CREATE FUNCTION have been executed as the preceding sections describe. The following SQL statement invokes **sql_explosive_reaction()** function in the **course_jar** JAR file:

```
EXECUTE PROCEDURE alter_java_path("course_jar",
    "(professor/*, prof_jar)");
EXECUTE FUNCTION sql_explosive_reaction(10000);
```

The routine manager attempts to load the class **Chemistry**. It uses the path that the call to **sqlj.alter_java_path()** specifies to resolve any class references. Therefore, it checks the classes that are in the **professor** package of the JAR file that **prof_jar** identifies.

If the IFX_EXTEND_ROLE configuration parameter is enabled (which is its default setting), only the DBSA or users who hold the EXTEND role are able to execute the **sqlj.alter_java_path()** procedure. When IFX_EXTEND_ROLE is disabled, any user can execute **sqlj.alter_java_path()**. (But regardless of the IFX_EXTEND_ROLE setting, you must hold the Resource privilege or the DBA privilege on the database, and also hold the Usage privilege on the Java language, before you can create or drop a Java UDR.)

sqlj.setUDTextName

Use the **sqlj.setUDTextName()** procedure to define the mapping between a user-defined data type and a Java™ class.

```
sqlj.SetUDTextName
|--sqlj.SetUDTextName----->
      .-----
      v               |
>--(--data_type--,---+-----+---class_id--)-----|
      '-package_id,-'
```

Argument	Description	Restrictions	Syntax
<i>class_id</i>	Java class that contains the Java data type	Qualified name <i>package_id.class_id</i> must not exceed 255 bytes	Language-specific rules for Java identifiers
<i>data_type</i>	User-defined type for which to create a mapping	Name must not exceed 255 bytes	Identifier
<i>package_id</i>	Name of package that contains the <i>class_id</i> Java class	Same length restrictions as <i>class_id</i>	Language-specific rules for Java identifiers

You must have registered the user-defined data type in the CREATE DISTINCT TYPE, CREATE OPAQUE TYPE, or CREATE ROW TYPE statement.

To look up the Java class for a user-defined data type, the database server searches in the JAR-file path, which the **sqlj.alter_java_path()** procedure has specified. For more information on the JAR-file path, see [sqlj.alter_java_path](#).

The SQLJ Driver looks in the path that **CLASSPATH** specifies in the client environment before it asks the database server for the name of the Java class.

The **setUDTextName()** routine is an extension to the SQLJ:SQL *Routines Using the Java Programming Language* specification.

If the IFX_EXTEND_ROLE configuration parameter is enabled (which is its default setting), only the DBSA or users who hold the EXTEND role are able to execute the **setUDTextName()** procedure. When IFX_EXTEND_ROLE is disabled, any user can execute **setUDTextName()**. (But regardless of the IFX_EXTEND_ROLE setting, you must hold the Resource privilege or the DBA privilege on the database, and also hold the Usage privilege on the Java language, before you can create or drop a Java UDR.)

sqlj.unsetUDTextName

Use the **sqlj.unsetUDTextName()** routine to remove the mapping from a user-defined data type to a Java™ class.

```
sqlj.unsetUDTextName
|--sqlj.unsetUDTextName--(--data_type--)-----|
```

Argument	Description	Restrictions	Syntax
<i>data_type</i>	User-defined data type for which to remove the mapping	Must exist	Identifier

This routine removes the SQL-to-Java mapping and consequently removes any cached copy of the Java class from shared memory of the database server.

The **unsetUDTextName()** routine is an extension to the SQLJ:SQL *Routines Using the Java Programming Language* specification.

If the IFX_EXTEND_ROLE configuration parameter is enabled (which is its default setting), only the DBSA or users who hold the EXTEND role are able to execute the **unsetUDTextName()** procedure. When IFX_EXTEND_ROLE is disabled, any user can execute **unsetUDTextName()**. (But regardless of the IFX_EXTEND_ROLE setting, you must hold the Resource privilege or the DBA privilege on the database, and also hold the Usage privilege on the Java language, before you can create or drop a Java UDR.)

DRDA Support Functions

Informix® provides built-in functions that support the Distributed Relational Database Architecture™ (DRDA) protocol when the Informix instance is configured as a DRDA application server. This is accomplished by setting DBSERVERALIASES to DRDA in the configuration file.

- The **sysibm.Metadata** function provides database metadata information to IBM Data Server Driver for JDBC and SQL client applications.
- The **sysibm.SCLCAMEssage** function supports DRDA error handling.

The **Metadata** and **sqlcaMessage** routines are created automatically if the database server is configured to support the DRDA protocol. The Informix implementation of these functions conforms to the DR Level 5 SQLAM 7 standard

- [Metadata Function](#)
- [sysibm.SQLCAMEssage Function](#)

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Metadata Function

The **sysibm.Metadata** function is an SPL routine that can be called by IBM Data Server Driver for JDBC and SQL applications to dynamically retrieve database metadata. The **Metadata** routine is automatically created in every database of Informix® instances that are configured as DRDA application servers. The client application must specify the '**sysibm**' owner name to invoke this function from an ANSI-compliant database.

It has the following routine definition:

```
create procedure sysibm.METADATA() returning
integer as allProceduresAreCallable,
integer as allTablesAreSelectable,
integer as nullsAreSortedHigh,
integer as nullsAreSortedLow,
integer as nullsAreSortedAtStart,
integer as nullsAreSortedAtEnd,
integer as usesLocalFiles,
integer as usesLocalFilePerTable,
integer as storesUpperCaseIdentifiers,
integer as storesLowerCaseIdentifiers,
integer as storesMixedCaseIdentifiers,
integer as storesLowerCaseQuotedIdentifiers,
integer as storesMixedCaseQuotedIdentifiers,
lvarchar(4096) as getSQLKeywords,
varchar(100) as getNumericFunctions,
varchar(100) as getStringFunctions,
varchar(100) as getSystemFunctions,
varchar(100) as getTimeDateFunctions,
varchar(25) as getSearchStringEscape,
varchar(25) as getExtraNameCharacters,
integer as supportsAlterTableWithAddColumn,
integer as supportsAlterTableWithDropColumn,
integer as supportsConvert,
varchar(255) as supportsConvertType,
integer as supportsDifferentTableCorrelationNames,
integer as supportsExpressionsInOrderBy,
integer as supportsOrderByUnrelated,
integer as supportsGroupBy,
integer as supportsGroupByUnrelated,
integer as supportsGroupByBeyondSelect,
integer as supportsMultipleResultSets,
integer as supportsMultipleTransactions,
integer as supportsCoreSQLGrammar,
integer as supportsExtendedSQLGrammar,
integer as supportsANSI92IntermediateSQL,
integer as supportsANSI92FullSQL,
integer as supportsIntegrityEnhancementFacility,
integer as supportsOuterJoins,
integer as supportsFullOuterJoins,
integer as supportsLimitedOuterJoins,
varchar(50) as getSchemaTerm,
varchar(50) as getProcedureTerm,
varchar(50) as getCatalogTerm,
integer as isCatalogAtStart,
varchar(50) as getCatalogSeparator,
integer as supportsSchemasInDataManipulation,
integer as supportsSchemasInProcedureCalls,
integer as supportsSchemasInTableDefinitions,
integer as supportsSchemasInIndexDefinitions,
integer as supportsSchemasInPrivilegeDefinitions,
integer as supportsCatalogsInDataManipulation,
integer as supportsCatalogsInProcedureCalls,
integer as supportsCatalogsInTableDefinitions,
integer as supportsCatalogsInIndexDefinitions,
integer as supportsCatalogsInPrivilegeDefinitions,
integer as supportsPositionedDelete,
integer as supportsPositionedUpdate,
integer as supportsSelectForUpdate,
integer as supportsStoredProcedures,
integer as supportsSubqueriesInComparisons,
integer as supportsUnion,
integer as supportsUnionAll,
integer as supportsOpenCursorsAcrossCommit,
integer as supportsOpenCursorsAcrossRollback,
integer as supportsOpenStatementsAcrossCommit,
integer as supportsOpenStatementsAcrossRollback,
integer as getMaxBinaryLiteralLength,
integer as getMaxCharLiteralLength,
integer as getMaxColumnNameLength,
```

```

integer as getMaxColumnsInGroupBy,
integer as getMaxColumnsInIndex,
integer as getMaxColumnsInOrderBy,
integer as getMaxColumnsInSelect,
integer as getMaxColumnsInTable,
integer as getMaxConnections,
integer as getMaxCursorNameLength,
integer as getMaxIndexLength,
integer as getMaxSchemaNameLength,
integer as getMaxProcedureNameLength,
integer as getMaxCatalogNameLength,
integer as getMaxRowSize,
integer as doesMaxRowSizeIncludeBlobs,
integer as getMaxStatementLength,
integer as getMaxStatements,
integer as getMaxTableNameLength,
integer as getMaxTablesInSelect,
integer as getMaxUserNameLength,
integer as getDefaultTransactionIsolation,
integer as supportsTransactions,
varchar(50) as supportsTransactionIsolationLevel,
integer as supportsDataDefinitionAndDataManipulationTransactions,
integer as supportsDataManipulationTransactionsOnly,
integer as dataDefinitionCausesTransactionCommit,
integer as dataDefinitionIgnoredInTransactions,
varchar(100) as supportsResultSetType,
varchar(100) as supportsResultSetConcurrency,
varchar(100) as ownUpdatesAreVisible,
varchar(100) as ownDeletesAreVisible,
varchar(100) as ownInsertsAreVisible,
varchar(100) as othersUpdatesAreVisible,
varchar(100) as othersDeletesAreVisible,
varchar(100) as othersInsertsAreVisible,
varchar(100) as updatesAreDetected,
varchar(100) as deletesAreDetected,
varchar(100) as insertsAreDetected,
integer as supportsBatchUpdates,
integer as supportsSavepoints,
integer as supportsGetGeneratedKeys

```

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sysibm.SQLCAMessage Function

By default, IBM Data Server Driver for JDBC and SQL for Informix® does not return localized error messages. Detailed and localized error messages from the server are expected, however, when property “retrieveMessagesFromServerOnGetMessage=true” is set in the connection URL.

The **SQLCAMessage** function is an SPL routine that supports the retrieval of detailed error message text from remote IBM® DB2® or Informix database servers to client applications that use the Distributed Relational Database Architecture™ (DRDA) protocol. The **SQLCAMessage** routine is automatically created in every database of Informix instances that are configured as DRDA application servers. The IBM Data Server Driver for JDBC and SQL client application must specify the 'sysibm' owner name to invoke this function from an ANSI-compliant database.

The **SQLCAMessage** function retrieves localized error messages, based on the **SQLSTATE** code in the SQL Communications Area (SQLCA).

The definition of this function uses IN, OUT, and INOUT parameters:

```

CREATE function sysibm.SQLCAMessage (
    IN SQLCode          INTEGER,
    IN SQLErrml         SMALLINT,
    IN SQLErrmc         VARCHAR(70),
    IN SQLErrp         CHAR(8),
    IN SQLErrd0         INTEGER,
    IN SQLErrd1         INTEGER,
    IN SQLErrd2         INTEGER,
    IN SQLErrd3         INTEGER,
    IN SQLErrd4         INTEGER,
    IN SQLErrd5         INTEGER,
    IN SQLWarn          CHAR(11),
    IN SQLState         CHAR(5),
    IN MessageFileName  VARCHAR(20),
    INOUT Locale        VARCHAR(33),
    OUT Message         LVARCHAR(4096),
    OUT Rcode           INTEGER)
RETURNING INTEGER
EXTERNAL NAME '(SQLCAMessage)'
LANGUAGE C

```

To invoke the function, you can use this syntax:

```

sysibm.SQLCAMessage

|--'sysibm'.SQLCAMessage--(--error_code-- , -input_locale-- , -message_file--)--|

```

Argument	Description	Restrictions	Syntax
<i>error_number</i>	The SQLCODE value of the error,	Must exist	Expression
<i>input_locale</i>	Name of the input locale for receiving the message. Default is the U.S. English locale (en_us).	Must exist	Identifier
<i>message_file</i>	Name of the message file	Must exist	Pathname

The function retrieves the text from the specified *message_file* for the specified **SQLCODE** and *input_locale*. The return code indicates the success or failure of the call to execute the **SQLCAMessage** routine.

The Informix DRDA application server attempts to retrieve the error message text using the specified input parameters:

- **SQLCODE**
- *input_locale*, and
- *message_file*

The Informix DRDA application server attempts to retrieve the error message text using the specified input parameters: The default message file (**errmsgtxt**) is used if the **MessageFileName** argument *message_file* is NULL. The default locale (**en_us**) is used to retrieve the error message if retrieval using the specified *input_locale* is unsuccessful. The token array is used to replace the tokens in the retrieved message text, if applicable.

If the retrieval is successful,

- **SQLCODE** is removed from the error message,
- the error message is copied to the OUT parameter '**Message**'
- the locale used for retrieving the message is copied to INOUT parameter '**Locale**'.

If the retrieval is unsuccessful, the error message text "Message not found" is copied to the **Message** parameter.

For both cases, the OUT parameter **Rcod** is set to the return code for executing this SPL routine.

Detailed message for **ISAM** errors are supplied from the **SQLERRD[0]** value. **ISAM** error messages are concatenated to actual error message string and returned to the application.

For the codes of **SQLSTATE** values for which the **SQLCAMessage** function can return the corresponding error message text, see [List of SQLSTATE Codes](#).

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Extended Utilities

The extended utility support functions run as Java UDR's to provide extended functionality.

You must execute the function declaration in each database you wish to use. You can choose your own SQL function name for these if you do not wish to use the names provided in the examples.

To setup your database to use these utilities, you must execute the **Setup Syntax** as a DBA.

- [Character Utilities](#)
- [Explain Utilities](#)
- [Large Object Utilities](#)
- [J/Foundation Function Utilities](#)

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Character Utilities

- [UUID](#)
Generate a universally unique id that is 36 characters long using the underlying Java UUID class and its secure random number generate to create the id.
- [replaceAll function](#)
Replace all allows you to replace a pattern from a character string with a replacement character string.
- [encodeBase64 function](#)
Base 64 encoding allows you to encode binary data from a Blob into the standard Base64 character encoding to be processed as a string/character array.

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Explain Utilities

- [getExplain](#)
Runs a query plan on the given query. It performs a fully execution on the query to generate the complete query plan, fetches the plan from the server and returns it as an LVARCHAR.

Large Object Utilities

Large objects like CLOB/BLOB extra functions to help manage and convert data to/from.

- [lobSize](#)
Returns the size of any BLOB/CLOB object as a BIGINT.
- [concat](#)
Appends any character field (char/varchar/lvarchar) to a new CLOB object.
- [toClob](#)
Converts any character field (char/varchar/lvarchar) into a CLOB.
- [append](#)
Appends any character field (char/varchar/lvarchar) to an existing CLOB object.
- [toString](#)
Returns the LVARCHAR characters from a CLOB. The CLOB must be 32,000 bytes or less in size.

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J/Foundation Function Utilities

J/Foundation Function Utilities

Generate functions can help you learn what functions are available in J/foundation as well as help with the syntax needed to register and name the function in your database. Each generate function creates a series of valid SQL that is output as an LVARCHAR which you can edit/validate before executing in your database to enable the function.

- [generateCreateFunctionStatements](#)
Generate automatically the CREATE FUNCTION statements for all the extended utilities packaged with J/Foundation.
- [generateGrantStatements](#)
Generates a set of generic GRANT statements for the built-in Java UDRs.
- [generateDropFunctionStatements](#)
Generates a set of DROP statements for the built-in Java UDRs

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Appendixes

- [Keywords of SQL for IBM Informix](#)
This appendix lists the keywords in the IBM® Informix implementation of SQL for .

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Keywords of SQL for IBM Informix

This appendix lists the keywords in the IBM® Informix® implementation of SQL for .

The ISO standard SQL language has many keywords. Some are designated as *reserved words* and others as *non-reserved words*. In ISO SQL, reserved words cannot be used as identifiers for database objects, such as tables, columns, and so on. To use a reserved word as a name in a valid SQL statement requires a delimited identifier ([Delimited Identifiers](#)) that you enclose between double (" ") quotation marks.

In contrast, the dialect of SQL that IBM Informix database servers implement has few reserved words in the sense of a character string that obeys the rules for identifiers ([Identifier](#)) but always produces a compilation error or runtime error when used as an identifier. Your application might encounter restricted functionality, however, or unexpected results, if you define an SPL routine that has the same name as a built-in SQL function, expression, or operator.

Do not declare any of the keywords in this appendix as SQL identifiers. If you do, errors or syntactic ambiguities can occur if the identifier appears in a context where the keyword is valid. In addition, your code will be more difficult to read and to maintain. Informix reserves the prefixes **ifx_** and **sys** for built-in routines and database objects. Do not use keywords of C or C++ (or of any other programming language that you will be using in an embedded mode) in your database structures. The notations IFX_* and SYS* (where * is a wildcard character for "any string") in the alphabetized lists that follow. These indicate that those prefixes should be avoided in user-defined identifiers of database objects. (Keywords of SQL that begin with those suffixes are not listed in this appendix, whose goal is to assist IBM Informix users in avoiding names that are used internally by the database server.)

If you receive an error message that seems unrelated to the SQL statement that caused the error, review this appendix to see whether a keyword is used as an identifier.

To avoid using a keyword as an identifier, you can qualify the identifier with an owner name or modify the identifier. For example, rather than name a database object **CURRENT**, you might name it **o_current** or **juanita.current**. For a discussion of potential problems in using keywords as identifiers, and of additional workarounds for specific keywords, see [Use of Keywords as Identifiers](#). See also *IBM Informix Guide to SQL: Tutorial* for more information about using keywords as identifiers in SQL applications.

A

- AAO
- ABS
- ABSOLUTE
- ACCELERATE
- ACCESS
- ACCESS_METHOD
- ACCOUNT
- ACOS
- ACOSH
- ACTIVE
- ADD
- ADDRESS
- ADD_MONTHS
- ADMIN
- AFTER
- AGGREGATE
- ALIGNMENT
- ALL
- ALL_ROWS
- ALLOCATE
- ALTER
- AND
- ANSI
- ANY
- APPEND
- AQT
- ARRAY
- AS
- ASC
- ASCII
- ASIN
- ASINH
- ASYNC
- AT
- ATAN
- ATAN2
- ATANH
- ATTACH
- ATTRIBUTES
- AUDIT
- AUTHENTICATION
- AUTHID
- AUTHORIZATION
- AUTHORIZED
- AUTO
- AUTOFREE
- AUTOLOCATE
- AUTO_READAHEAD
- AUTO_REPREPARE
- AUTO_STAT_MODE
- AVG
- AVOID_EXECUTE
- AVOID_FACT
- AVOID_FULL
- AVOID_HASH
- AVOID_INDEX
- AVOID_INDEX_SJ
- AVOID_MULTI_INDEX
- AVOID_NL
- AVOID_STAR_JOIN

B

- BARGROUP
- BASED
- BEFORE
- BEGIN
- BETWEEN

- BIGINT
- BIGSERIAL
- BINARY
- BITAND
- BITANDNOT
- BITNOT
- BITOR
- BITXOR
- BLOB
- BLOBDIR
- BOOLEAN
- BOTH
- BOUND_IMPL_PDQ
- BSON
- BUCKETS
- BUFFERED
- BUILTIN
- BY
- BYTE

C

- CACHE
- CALL
- CANNOTHASH
- CARDINALITY
- CASCADE
- CASE
- CAST
- CEIL
- CHAR
- CHAR_LENGTH
- CHARACTER
- CHARACTER_LENGTH
- CHARINDEX
- CHECK
- CHR
- CLASS
- CLASS_ORIGIN
- CLEANUP
- CLIENT
- CLOB
- CLOBDIR
- CLOSE
- CLUSTER
- CLUSTER_TXN_SCOPE
- COBOL
- CODESET
- COLLATION
- COLLECTION
- COLUMN
- COLUMNS
- COMMIT
- COMMITTED
- COMMUTATOR
- COMPONENT
- COMPONENTS
- COMPRESSED
- CONCAT
- CONCURRENT
- CONNECT
- CONNECTION
- CONNECTION_NAME
- CONNECT_BY_ISCYCLE
- CONNECT_BY_ISLEAF
- CONNECT_BY_ROOT
- CONST
- CONSTRAINT
- CONSTRAINTS
- CONSTRUCTOR
- CONTEXT
- CONTINUE
- COPY
- COS
- COSH
- COSTFUNC

- COUNT
- CRCOLS
- CREATE
- CROSS
- CUME_DIST
- CURRENT
- CURRENT_ROLE
- CURRENT_USER
- CURRVAL
- CURSOR
- CYCLE

D

- DATA
- DATABASE
- DATAFILES
- DATASKIP
- DATE
- DATETIME
- DAY
- DBA
- DBDATE
- DBINFO
- DBPASSWORD
- DBSA
- DBSERVERNAME
- DBSECADM
- DBSSO
- DEALLOCATE
- DEBUG
- DEBUGMODE
- DEBUG_ENV
- DEC
- DECIMAL
- DECLARE
- DECODE
- DECRYPT_BINARY
- DECRYPT_CHAR
- DEC_T
- DEFAULT
- DEFAULTESCCHAR
- DEFAULT_ROLE
- DEFAULT_USER
- DEFERRED
- DEFERRED_PREPARE
- DEFINE
- DEGREES
- DELAY
- DELETE
- DELETING
- DELIMITED
- DELIMITER
- DELUXE
- DENSERANK
- DENSE_RANK
- DESC
- DESCRIBE
- DESCRIPTOR
- DETACH
- DIAGNOSTICS
- DIRECTIVES
- DIRTY
- DISABLE
- DISABLED
- DISCARD
- DISCONNECT
- DISK
- DISTINCT
- DISTRIBUTE_BINARY
- DISTRIBUTESREFERENCES
- DISTRIBUTIONS
- DOCUMENT
- DOMAIN
- DONOTDISTRIBUTE
- DORMANT

- DOUBLE
- DROP
- DTIME_T

E

- EACH
- ELIF
- ELSE
- ENABLE
- ENABLED
- ENCRYPT_AES
- ENCRYPT_TDES
- ENCRYPTION
- END
- ENUM
- ENVIRONMENT
- ERKEY
- ERROR
- ESCAPE
- EXCEPT
- EXCEPTION
- EXCLUSIVE
- EXEC
- EXECUTE
- EXECUTEANYWHERE
- EXEMPTION
- EXISTS
- EXIT
- EXP
- EXPLAIN
- EXPLICIT
- EXPRESS
- EXPRESSION
- EXTDIRECTIVES
- EXTEND
- EXTENT
- EXTERNAL
- EXTTYPEID
- EXTTYPELENGTH
- EXTYPENAME
- EXTTYPEOWNERLENGTH
- EXTTYPEOWNERNAME
-

F

- FACT
- FALLBACK
- FALSE
- FAR
- FETCH
- FILE
- FILETOBLOB
- FILETOCLOB
- FILLFACTOR
- FILTERING
- FINAL
- FIRST
- FIRST_ROWS
- FIRST_VALUE
- FIXCHAR
- FIXED
- FLOAT
- FLOOR
- FLUSH
- FOLLOWING
- FOR
- FORCE
- FORCED
- FORCE_DDL_EXEC
- FOREACH
- FOREIGN
- FORMAT

- FORMAT_UNITS
- FORTRAN
- FOUND
- FRACTION
- FRAGMENT
- FRAGMENTS
- FREE
- FROM
- FULL
- FUNCTION

G

- G
- GB
- GENBSON
- GENERAL
- GET
- GETHINT
- GIB
- GLOBAL
- GO
- GOTO
- GRANT
- GREATERTHAN
- GREATERTHANOREQUAL
- GRID
- GRID_NODE_SKIP
- GROUP

H

- HANDLESNULLS
- HASH
- HAVING
- HDR
- HDR_TXN_SCOPE
- HEX
- HIGH
- HINT
- HOLD
- HOME
- HOUR

I

- IDATA
- IDSLBACREADARRAY
- IDSLBACREADSET
- IDSLBACREADTREE
- IDSLBACRULES
- IDSLBACWRITEARRAY
- IDSLBACWRITESSET
- IDSLBACWRITETREE
- IDSSECURITYLABEL
- IF
- IFX_*
- ILENGTH
- IMMEDIATE
- IMPLICIT
- IMPLICIT_PDQ
- IN
- INACTIVE
- INCREMENT
- INDEX
- INDEXES
- INDEX_ALL
- INDEX_SJ
- INDICATOR
- INFORMIX
- INFORMIXCONRETRY
- INFORMIXCONTIME
- INIT
- INITCAP

- INLINE
- INNER
- INOUT
- INSENSITIVE
- INSERT
- INSERTING
- INSTEAD
- INSTR
- INT
- INT8
- INTEG
- INTEGER
- INTERNAL
- INTERNALLENGTH
- INTERSECT
- INTERVAL
- INTO
- INTRVL_T
- IS
- ISCANONICAL
- ISOLATION
- ITEM
- ITERATOR
- ITYPE

J - K

- JAVA
- JOIN
- JSON
- K
- KB
- KEEP
- KEY
- KIB

L

- LABEL
- LABELEQ
- LABELGE
- LABELGLB
- LABELGT
- LABELLE
- LABELLT
- LABELLUB
- LABELTOSTRING
- LAG
- LANGUAGE
- LAST
- LAST_DAY
- LAST_VALUE
- LATERAL
- LEAD
- LEADING
- LEFT
- LEN
- LENGTH
- LESSTHAN
- LESSTHANOREQUAL
- LET
- LEVEL
- LIKE
- LIMIT
- LIST
- LISTING
- LOAD
- LOCAL
- LOCATOR
- LOCK
- LOCKS
- LOCOPY
- LOC_T
- LOG
- LOG10

- LOGN
- LONG
- LOOP
- LOTOFILE
- LOW
- LOWER
- LPAD
- LTRIM
- LVARCHAR

M

- M
- MATCHED
- MATCHES
- MAX
- MAXERRORS
- MAXLEN
- MAXVALUE
- MB
- MDY
- MEDIAN
- MEDIUM
- MEMORY
- MEMORY_RESIDENT
- MERGE
- MESSAGE_LENGTH
- MESSAGE_TEXT
- MIB
- MIN
- MINUS
- MINUTE
- MINVALUE
- MOD
- MODE
- MODERATE
- MODIFY
- MODULE
- MONEY
- MONTH
- MONTHS_BETWEEN
- MORE
- MULTISSET
- MULTI_INDEX

N

- NAME
- NCHAR
- NEAR_SYNC
- NEGATOR
- NEW
- NEXT
- NEXT_DAY
- NEXTVAL
- NLSCASE
- NO
- NOCACHE
- NOCYCLE
- NOMAXVALUE
- NOMIGRATE
- NOMINVALUE
- NONE
- NON_RESIDENT
- NON_DIM
- NOORDER
- NORMAL
- NOT
- NOTEMPLATEARG
- NOTEQUAL
- NOVALIDATE
- NTILE
- NULL
- NULLABLE
- NULLIF

- NULLS
- NUMBER
- NUMERIC
- NUMROWS
- NUMTODSINTERVAL
- NUMTOYMINTERVAL
- NVARCHAR
- NVL

O

- OCTET_LENGTH
- OF
- OFF
- OLD
- ON
- ONLINE
- ONLY
- OPAQUE
- OPCLASS
- OPEN
- OPTCOMPIND
- OPTIMIZATION
- OPTION
- OR
- ORDER
- ORDERED
- OUT
- OUTER
- OUTPUT
- OVER
- OVERRIDE

P

- PAGE
- PARALLELIZABLE
- PARAMETER
- PARTITION
- PASCAL
- PASSEDBYVALUE
- PASSWORD
- PDQPRIORITY
- PERCALL_COST
- PERCENT_RANK
- PIPE
- PLI
- PLOAD
- POLICY
- POW
- POWER
- PRECEDING
- PRECISION
- PREPARE
- PREVIOUS
- PRIMARY
- PRIOR
- PRIVATE
- PRIVILEGES
- PROBE
- PROCEDURE
- PROPERTIES
- PUBLIC
- PUT

Q

- QUARTER

R

- RADIANS
- RAISE
- RANGE

- RANK
- RATIOREPORT
- RATIO_TO_REPORT
- RAW
- READ
- REAL
- RECORDEND
- REFERENCES
- REFERENCING
- REGISTER
- REJECTFILE
- RELATIVE
- RELEASE
- REMAINDER
- RENAME
- REOPTIMIZATION
- REPEATABLE
- REPLACE
- REPLICATION
- RESOLUTION
- RESOURCE
- RESTART
- RESTRICT
- RESUME
- RETAIN
- RETAINUPDATELOCKS
- RETURN
- RETURNED_SQLSTATE
- RETURNING
- RETURNS
- REUSE
- REVERSE
- REVOKE
- RIGHT
- ROBIN
- ROLE
- ROLLBACK
- ROLLFORWARD
- ROLLING
- ROOT
- ROUND
- ROUTINE
- ROW
- ROWID
- ROWIDS
- ROWNUMBER
- ROWS
- ROW_COUNT
- ROW_NUMBER
- RPAD
- RTRIM
- RULE

S

- SAMEAS
- SAMPLES
- SAMPLING
- SAVE
- SAVEPOINT
- SCHEMA
- SCALE
- SCROLL
- SECLABEL_BY_COMP
- SECLABEL_BY_NAME
- SECLABEL_TO_CHAR
- SECOND
- SECONDARY
- SECURED
- SECURITY
- SECTION
- SELCONST
- SELECT
- SELECTING
- SELECT_GRID
- SELECT_GRID_ALL

- SELFUNC
- SELFUNCARGS
- SENSITIVE
- SEQUENCE
- SERIAL
- SERIAL8
- SERIALIZABLE
- SERVER
- SERVER_NAME
- SERVERUUID
- SESSION
- SET
- SETSESSIONAUTH
- SHARE
- SHORT
- SIBLINGS
- SIGNED
- SIN
- SITENAME
- SIZE
- SKIP
- SMALLFLOAT
- SMALLINT
- SOME
- SOURCEID
- SOURCETYPE
- SPACE
- SPECIFIC
- SQL
- SQLCODE
- SQLCONTEXT
- SQLERROR
- SQLSTATE
- SQLWARNING
- SQRT
- STABILITY
- STACK
- STANDARD
- START
- STAR_JOIN
- STATCHANGE
- STATEMENT
- STATIC
- STATISTICS
- STATLEVEL
- STATUS
- STDEV
- STEP
- STOP
- STORAGE
- STORE
- STRATEGIES
- STRING
- STRINGTOLABEL
- STRUCT
- STYLE
- SUBCLASS_ORIGIN
- SUBSTR
- SUBSTRING
- SUBSTRING_INDEX
- SUM
- SUPPORT
- SYNC
- SYNONYM
- SYS*

T

- T
- TABLE
- TABLES
- TAN
- TASK
- TB
- TEMP
- TEMPLATE

- TEST
- TEXT
- THEN
- TIB
- TIME
- TO
- TODAY
- TO_CHAR
- TO_DATE
- TO_DSINTERVAL
- TO_NUMBER
- TO_YMINTERVAL
- TRACE
- TRAILING
- TRANSACTION
- TRANSITION
- TREE
- TRIGGER
- TRIGGERS
- TRIM
- TRUE
- TRUNC
- TRUNCATE
- TRUSTED
- TYPE
- TYPEDEF
- TYPEID
- TYPENAME
- TYPEOF

U

- UID
- UNBOUNDED
- UNCOMMITTED
- UNDER
- UNION
- UNIQUE
- UNIQUECHECK
- UNITS
- UNKNOWN
- UNLOAD
- UNLOCK
- UNSIGNED
- UPDATE
- UPDATING
- UPON
- UPPER
- USAGE
- USE
- USELASTCOMMITTED
- USER
- USE_DWA
- USE_HASH
- USE_NL
- USING
- USTLOW_SAMPLE

V

- VALUE
- VALUES
- VAR
- VARCHAR
- VARIABLE
- VARIANCE
- VARIANT
- VARYING
- VERCOLS
- VIEW
- VIOLATIONS
- VOID
- VOLATILE

- WAIT
- WARNING
- WEEKDAY
- WHEN
- WHENEVER
- WHERE
- WHILE
- WITH
- WITHOUT
- WORK
- WRITE
- WRITEDOWN
- WRITEUP
- XADATASOURCE
- XID
- XLOAD
- XUNLOAD
- YEAR

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Guide to SQL: Reference

These topics contain the reference information for the system catalog tables, data types, and environment variables of the IBM® Informix® dialect of the SQL language, as implemented in IBM Informix. These topics also include information about the stores_demo, sales_demo, and superstore_demo databases that are included with IBM Informix.

This information is intended for the following users:

- Database users
- Database administrators
- Database security administrators
- Database application programmers.

This information assumes that you have the following background:

- A working knowledge of your computer, your operating system, and the utilities that your operating system provides.
- Some experience working with relational databases or exposure to database concepts.
- Some experience with computer programming.

These topics are taken from the *IBM Informix Guide to SQL: Reference*.

- [System catalog tables](#)
The *system catalog* consists of tables and views that describe the structure of the database. Sometimes called the *data dictionary*, these table objects contain everything that the database knows about itself. Each system catalog table contains information about specific elements in the database. Each database has its own system catalog.
- [Data types](#)
Every column in a table in a database is assigned a data type. The data type precisely defines the kinds of values that you can store in that column.
- [Environment variables](#)
Various *environment variables* affect the functionality of your IBM Informix products. You can set environment variables that identify your terminal, specify the location of your software and define other parameters.
- [Appendixes](#)

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System catalog tables

The *system catalog* consists of tables and views that describe the structure of the database. Sometimes called the *data dictionary*, these table objects contain everything that the database knows about itself. Each system catalog table contains information about specific elements in the database. Each database has its own system catalog.

These topics provide information about the structure, content, and use of the system catalog tables. It also contains information about the Information Schema, which provides information about the tables, views, and columns in all the databases of the IBM® Informix® instance to which your user session is currently connected.

- [Objects That the System Catalog Tables Track](#)
- [Using the system catalog](#)
- [Structure of the System Catalog](#)
- [SYSAGGREGATES](#)

- [SYSAMS](#)
The **sysams** system catalog table contains information that is required for using built-in access methods and those created by the CREATE ACCESS_METHOD statement of SQL.
- [SYSATTRTYPES](#)
- [SYSAUTOLOCATE](#)
The **sysautolocate** system catalog table indicates which dbspaces are available for automatic table fragmentation.
- [SYSBLOBS](#)
- [SYSCASTS](#)
- [SYSCHECKS](#)
- [SYSCHECKUDRDEP](#)
- [SYSCOLATTRIBS](#)
The **syscolattribs** system catalog table describes the characteristics of smart large objects, namely CLOB and BLOB data types.
- [SYSCOLAUTH](#)
- [SYSCOLDEPEND](#)
- [SYSCOLUMNS](#)
The **syscolumns** system catalog table describes each column in the database.
- [SYSCONSTRAINTS](#)
- [SYSDEFAULTS](#)
The **sysdefaults** system catalog table lists the user-defined defaults that are placed on each column in the database. One row exists for each user-defined default value.
- [SYSDEPEND](#)
- [SYSDIRECTIVES](#)
- [SYSDISTRIB](#)
The **sysdistrib** system catalog table stores data-distribution information for the query optimizer to use. Data distributions provide detailed table and column information to the optimizer to improve the choice of execution paths of SELECT statements.
- [SYSDOMAINS](#)
- [SYSERRORS](#)
- [SYSEXTCOLS](#)
The **sysextcols** system catalog table contains a row that describes each of the internal columns in external table **tabid** of format type (**fmttype**) FIXED.
- [SYSEXTDFILES](#)
The **sysextdfiles** system catalog table contains identifying codes and the paths of external tables.
- [SYSEXTERNAL](#)
For each external table, a single row exists in the **sysexternal** system catalog table.
- [SYSFRAGAUTH](#)
- [SYSFRAGDIST](#)
The **sysfragdist** system catalog table stores fragment-level column statistics for fragmented tables and indexes. One row exists for each table fragment or index fragment.
- [SYSFRAGMENTS](#)
The **sysfragments** system catalog table stores fragmentation information and LOW mode statistical distributions for individual fragments of tables and indexes. One row exists for each table fragment or index fragment.
- [SYSINDEXES](#)
The **sysindexes** table is a view on the **sysindices** table. It contains one row for each index in the database.
- [SYSINDICES](#)
The **sysindices** system catalog table describes the indexes in the database. It stores LOW mode statistics for all indexes, and contains one row for each index that is defined in the database.
- [SYSINHERITS](#)
- [SYSLANGAUTH](#)
- [SYSLOGMAP](#)
- [SYSOBJSTATE](#)
- [SYSOPCLASSES](#)
- [SYSPROCAUTH](#)
- [SYSPROCBODY](#)
- [SYSPROCCOLUMNS](#)
- [SYSPROCEDURES](#)
The **sysprocedures** system catalog table lists the characteristics for each function and procedure that is registered in the database. It contains one row for each routine.
- [SYSPROCPAN](#)
- [SYSREFERENCES](#)
- [SYSROLEAUTH](#)
- [SYSROUTINELANGS](#)
- [SYSSECLABELAUTH](#)
- [SYSSECLABELCOMPONENTS](#)
- [SYSSECLABELCOMPONENTELEMENTS](#)
- [SYSSECLABELNAMES](#)
- [SYSSECLABELS](#)
- [SYSSECPOLICIES](#)
- [SYSSECPOLICYCOMPONENTS](#)
- [SYSSECPOLICYEXEMPTIONS](#)
- [SYSSEQUENCES](#)
- [SYSSURROGATEAUTH](#)
The **sys surrogateauth** system catalog table stores trusted user and surrogate user information.
- [SYSSYNONYMS](#)
- [SYSSYNTABLE](#)
- [SYSTABAMDATA](#)
- [SYSTABAUTH](#)

- [SYSTABLES](#)
The **systable**s system catalog table contains a row for each table object (a table, view, synonym, or in IBM Informix, a sequence) that has been defined in the database, including the tables and views of the system catalog.
- [SYSTRACECLASSES](#)
- [SYSTRACEMSGS](#)
The **sysracemsgs** system catalog table stores internationalized trace messages that you can use in debugging user-defined routines.
- [SYSTRIGBODY](#)
- [SYSTRIGGERS](#)
- [SYSUSERS](#)
The **sysusers** system catalog table lists the authorization identifier of every individual user, or public for the PUBLIC group, who holds database-level access privileges. This table also lists the name of every role that holds access privileges on any object in the database.
- [SYSVIEWS](#)
- [SYSVIOLATIONS](#)
The **sysviolations** system catalog table stores information about constraint violations for base tables.
- [SYSXADATASOURCES](#)
The **sysxadatasources** system catalog table stores XA data sources.
- [SYSXASOURCETYPES](#)
The **sysxasourcetypes** system catalog table stores XA data source types.
- [SYSXTDDESC](#)
- [SYSXTDTYPEAUTH](#)
The **sysxtdtypeauth** system catalog table identifies the privileges on each UDT (user-defined data type).
- [SYSXTDTYPES](#)
The **sysxtdtypes** system catalog table has an entry for each UDT (user-defined data type), including opaque and distinct data types and complex data types (named ROW types, unnamed ROW types, and COLLECTION types), that is defined in the database.
- [Information Schema](#)

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Objects That the System Catalog Tables Track

The system catalog tables maintain information about the database, including the following categories of database objects:

- Tables, views, synonyms, and table fragments
- Columns, constraints, indexes, and index fragments
- Distribution statistics for tables, indexes, and fragments
- Triggers on tables, and INSTEAD OF triggers on views
- Procedures, functions, routines, and associated messages
- Authorized users, roles, and privileges to access database objects
- LBAC security policies, components, labels, and exemptions
- Data types and casts
- User-defined aggregate functions
- Access methods and operator classes
- Sequence objects
- Storage spaces for BLOB and CLOB objects
- External optimizer directives
- Inheritance relationships
- XA data sources and XA data source types
- Trusted user and surrogate user information

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Using the system catalog

IBM® Informix® automatically generate the system catalog tables when you create a database. You can query the system catalog tables as you would query any other table in the database. The system catalog tables for a newly created database are located in a common area of the disk called a *dbspace*. Every database has its own system catalog tables. All tables and views in the system catalog have the prefix **sys** (for example, the **systable**s system catalog table).

Not all tables with the prefix **sys** are true system catalog tables. For example, the **syscdr** database supports the Enterprise Replication feature. Non-catalog tables, however, have a **tabid** >= 100. System catalog tables all have a **tabid** < 100. See later in this section and [SYSTABLES](#) for more information about **tabid** numbers that the database server assigns to tables, views, synonyms, and (in IBM Informix) sequence objects.

Tip: Do not confuse the system catalog tables of a database with the tables in the **sysmaster**, **sysutils**, **syscdr**, or (for IBM Informix) the **sysadmin** and **sysuser** databases. The names of tables in those databases also have the **sys** prefix, but they contain information about an entire database server, which might manage multiple databases. Information in the **sysadmin**, **sysmaster**, **sysutils**, **syscdr**, and **sysuser** tables is primarily useful for database server administrators (DBSAs). See also the *IBM Informix Administrator's Guide* and *IBM Informix Administrator's Reference*.

The database server accesses the system catalog constantly. Each time an SQL statement is processed, the database server accesses the system catalog to determine system privileges, add or verify table or column names, and so on.

For example, the following CREATE SCHEMA block adds the **customer** table, with its indexes and privileges, to the **stores_demo** database. This block also adds a view, **california**, which restricts the data of the **customer** table to only the first and last names of the customer, the company name, and the telephone number for all customers who reside in California.

```

CREATE SCHEMA AUTHORIZATION maryl
CREATE TABLE customer (customer_num SERIAL(101), fname CHAR(15),
    lname CHAR(15), company CHAR(20), address1 CHAR(20), address2 CHAR(20),
    city CHAR(15), state CHAR(2), zipcode CHAR(5), phone CHAR(18))
GRANT ALTER, ALL ON customer TO cathl WITH GRANT OPTION AS maryl
GRANT SELECT ON customer TO public
GRANT UPDATE (fname, lname, phone) ON customer TO nhowe
CREATE VIEW california AS
    SELECT fname, lname, company, phone FROM customer WHERE state = 'CA'
CREATE UNIQUE INDEX c_num_ix ON customer (customer_num)
CREATE INDEX state_ix ON customer (state)

```

To process this CREATE SCHEMA block, the database server first accesses the system catalog to verify the following information:

- The new table and view names do not already exist in the database. (If the database is ANSI-compliant, the database server verifies that the new names do not already exist for the specified owners.)
- The user has permission to create tables and grant user privileges.
- The column names in the CREATE VIEW and CREATE INDEX statements exist in the **customer** table.

In addition to verifying this information and creating two new tables, the database server adds new rows to the following system catalog tables:

- **systables**
- **syscolumns**
- **sysviews**
- **sysabauth**
- **syscolauth**
- **sysindexes**
- **sysindices**

Rows added to the systables system catalog table

The following two new rows of information are added to the **systables** system catalog table after the CREATE SCHEMA block is run.

Column name	First row	Second row
tabname	customer	california
owner	maryl	maryl
partnum	16778361	0
tabid	101	102
rowsize	134	134
ncols	10	4
nindexes	2	0
nrows	0	0
created	01/26/2007	01/26/2007
version	1	0
tabtype	T	V
locklevel	P	B
npused	0	0
fextsize	16	0
nextsize	16	0
flags	0	0
site		
dbname		

Each table recorded in the **systables** system catalog table is assigned a **tabid**, a system-assigned sequential number that uniquely identifies each table in the database. The system catalog tables receive 2-digit **tabid** numbers, and the user-created tables receive sequential **tabid** numbers that begin with 100.

Rows added to the syscolumns system catalog table

The CREATE SCHEMA block adds 14 rows to the **syscolumns** system catalog table. These rows correspond to the columns in the table **customer** and the view **california**, as the following example shows.

colname	tabid	colno	coltype	collength	colmin	colmax
customer_num	101	1	262	4		
fname	101	2	0	15		
lname	101	3	0	15		
company	101	4	0	20		
address1	101	5	0	20		
address2	101	6	0	20		

colname	tabid	colno	coltype	collength	colmin	colmax
city	101	7	0	15		
state	101	8	0	2		
zipcode	101	9	0	5		
phone	101	10	0	18		
fname	102	1	0	15		
lname	102	2	0	15		
company	102	3	0	20		
phone	102	4	0	18		

In the **syscolumns** table, each column within a table is assigned a sequential column number, **colno**, that uniquely identifies the column within its table. In the **colno** column, the **fname** column of the **customer** table is assigned the value 2 and the **fname** column of the view **california** is assigned the value 1.

The **colmin** and **colmax** columns are empty. These columns contain values when a column is the first key (or the only key) in an index, has no NULL or duplicate values, and the UPDATE STATISTICS statement has been run.

Rows added to the sysviews system catalog table

The database server also adds rows to the **sysviews** system catalog table, whose **viewtext** column contains each line of the CREATE VIEW statement that defines the view. In that column, the **x0** that precedes the column names in the statement (for example, **x0.fname**) operates as an alias that distinguishes among the same columns that are used in a self-join.

Rows added to the systabauth system catalog table

The CREATE SCHEMA block also adds rows to the **systabauth** system catalog table. These rows correspond to the user privileges granted on **customer** and **california** tables, as the following example shows.

grantor	grantee	tabid	tabauth
maryl	public	101	su-idx--
maryl	cathl	101	SU-IDXAR
maryl	nhowe	101	--*-----
	maryl	102	SU-ID---

The **tabauth** column specifies the table-level privileges granted to users on the **customer** and **california** tables. This column uses an 8-byte pattern, such as **s** (Select), **u** (Update), ***** (column-level privilege), **i** (Insert), **d** (Delete), **x** (Index), **a** (Alter), and **r** (References), to identify the type of privilege. In this example, the user **nhowe** has column-level privileges on the **customer** table. A hyphen (-) means the user has not been granted the privilege whose position the hyphen occupies within the **tabauth** value.

If the **tabauth** privilege code is in uppercase (for example, **s** for Select), the user has this privilege and can also grant it to others; but if the privilege code is lowercase (for example, **s** for Select), the user cannot grant it to others.

Rows added to the syscolauth system catalog table

In addition, three rows are added to the **syscolauth** system catalog table. These rows correspond to the user privileges that are granted on specific columns in the **customer** table as the following example shows.

grantor	grantee	tabid	colno	colauth
maryl	nhowe	101	2	-u-
maryl	nhowe	101	3	-u-
maryl	nhowe	101	10	-u-

The **colauth** column specifies the column-level privileges that are granted on the **customer** table. This column uses a 3-byte, pattern such as **s** (Select), **u** (Update), and **r** (References), to identify the type of privilege. For example, the user **nhowe** has Update privileges on the second column (because the **colno** value is 2) of the **customer** table (indicated by **tabid** value of 101).

Rows added to the sysindexes or the sysindices table

The CREATE SCHEMA block adds two rows to the **sysindexes** system catalog table (the **sysindices** table for IBM Informix). These rows correspond to the indexes created on the **customer** table, as the following example shows.

idxname	c_num_ix	state_ix
owner	maryl	maryl
tabid	101	101
idxtype	U	D
clustered		
part1	1	8
part2	0	0

idxname	c_num_ix	state_ix
part3	0	0
part4	0	0
part5	0	0
part6	0	0
part7	0	0
part8	0	0
part9	0	0
part10	0	0
part11	0	0
part12	0	0
part13	0	0
part14	0	0
part15	0	0
part16	0	0
levels		
leaves		
nunique		
clust		
idxflags		

In this table, the **idxtype** column identifies whether the created index requires unique values (u) or accepts duplicate values (d). For example, the **c_num_ix** index on the **customer.customer_num** column is unique.

- [Accessing the system catalog](#)
- [Update system catalog data](#)

If you use the UPDATE STATISTICS statement to update the system catalog before executing a query or other data manipulation language (DML) statement, you can ensure that the information available to the query execution optimizer is current.

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Accessing the system catalog

Normal user access to the system catalog is read-only. Users with Connect or Resource privileges cannot alter the catalog, but they can access data in the system catalog tables on a read-only basis using standard SELECT statements.

For example, the following SELECT statement displays all the table names and corresponding **tabid** codes of user-created tables in the database:

```
SELECT tabname, tabid FROM systables WHERE tabid > 99
```

When you use DB-Access, only the tables that you created are displayed. To display the system catalog tables, enter the following statement:

```
SELECT tabname, tabid FROM systables WHERE tabid < 100
```

You can use the **SUBSTR** or the **SUBSTRING** function to select only part of a source string. To display the list of tables in columns, enter the following statement:

```
SELECT SUBSTR(tabname, 1, 18), tabid FROM systables
```

Although user **informix** can modify most system catalog tables, you should not update, delete, or insert any rows in them. Modifying the content of system catalog tables can affect the integrity of the database. However, you can safely use the ALTER TABLE statement to modify the size of the next extent of system catalog tables. Changing the next extent size does not affect extents that already exist.

For certain catalog tables of IBM® Informix®, however, it is valid to add entries to the system catalog tables. For instance, in the case of the **syserrors** system catalog table and the **systracemsgs** system catalog table, a DataBlade module developer can directly insert entries that are in these system catalog tables.

Related concepts:

[Update system catalog data](#)

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Update system catalog data

If you use the UPDATE STATISTICS statement to update the system catalog before executing a query or other data manipulation language (DML) statement, you can ensure that the information available to the query execution optimizer is current.

In IBM® Informix®, the optimizer determines the most efficient strategy for executing SQL queries and other DML operations. The optimizer allows you to query the database without requiring you to consider fully which tables to search first in a join or which indexes to use. The optimizer uses information from the system catalog to determine the best query strategy.

When you delete or modify a table, the database server does not automatically update the related statistical data in the system catalog. For example, if you delete one or more rows in a table with the DELETE statement, the **nrows** column in the **systables** system catalog table, which holds the number of rows for that table, is not updated automatically.

The UPDATE STATISTICS statement causes the database server to recalculate data in the **systables**, **sysdistrib**, **syscolumns**, and **sysindices** system catalog tables, and in the **sysindexes** view. (For operations on fragmented tables where the STATLEVEL attribute is set to FRAGMENT, it also updates the **sysfragdist** and **sysfragments** system catalog tables.) After you run UPDATE STATISTICS, the **systables** system catalog table holds the correct value in the **nrows** column. If you specify MEDIUM or HIGH mode when you run UPDATE STATISTICS, the **sysdistrib** and (for fragment-level statistics) the **sysfragdist** system catalog tables hold the updated column-distribution data.

Whenever you modify a data table extensively, use the UPDATE STATISTICS statement to update data in the system catalog. For more information about the UPDATE STATISTICS statement, see the *IBM Informix Guide to SQL: Syntax*.

Related concepts:

[Accessing the system catalog](#)

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Structure of the System Catalog

The following system catalog tables describe the database objects in a database.

System Catalog Tables
SYSAGGREGATES
SYSAMS
SYSATTRTYPES
SYSAUTOLOCATE
SYSBLOBS
SYSCASTS
SYSCHECKS
SYSCHECKKUDRDEP
SYSCOLATTRIBS
SYSCOLAUTH
SYSCOLDEPEND
SYSCOLUMNS
SYSCONSTRAINTS
SYSDEFAULTS
SYSDPEND
SYSDIRECTIVES
SYSDISTRIB
SYSDOMAINS
SYSERRORS
SYSEXTCOLS
SYSEXTDFILES
SYSEXTERNAL
SYSFRAGAUTH
SYSFRAGDIST
SYSFRAGMENTS
SYSINDEXES
SYSINDICES
SYSINHERITS
SYSLANGAUTH
SYSLOGMAP
SYSOBJSTATE
SYSOPCLASSES

System Catalog Tables
SYSPROCAUTH
SYSPROCBODY
SYSPROCCOLUMNS
SYSPROCEDURES
SYSPROCPLAN
SYSREFERENCES
SYSROLEAUTH
SYSROUTINELANGS
SYSSECLABELAUTH
SYSSECLABELCOMPONENTS
SYSSECLABELCOMPONENTELEMENTS
SYSSECLABELNAMES
SYSSECLABELS
SYSSECPOLICIES
SYSSECPOLICYCOMPONENTS
SYSSECPOLICYEXEMPTIONS
SYSSEQUENCES
SYSSURROGATEAUTH
SYSSYNONYMS
SYSSYNTABLE
SYSTABAMDATA
SYSTABAUTH
SYSTABLES
SYSTRACECLASSES
SYSTRACEMSGS
SYSTRIGBODY
SYSTRIGGERS
SYSUSERS
SYSVIEWS
SYSVIOLATIONS
SYSXADATASOURCES
SYSXASOURCETYPES
SYSXTDDESC
SYSXTDTYPEAUTH
SYSXTDTYPES

In case-sensitive databases that use the default database locale (U. S. English, ISO **8859-1** code set), character columns in these tables are CHAR and VARCHAR data types. For all other locales, character columns are the NLS data types, NCHAR and NVARCHAR. For information about differences in the collation order of character data types, see the *IBM Informix GLS User's Guide*. See also the [Data types](#) chapter of this publication.

Character columns in databases that are not case-sensitive

In databases that are created with the NLSCASE INSENSITIVE keywords and that use the default database locale (U. S. English, ISO **8859-1** code set), character columns in system catalog tables are CHAR and VARCHAR data types, which support case-sensitive queries. For all other database locales, character column data types in the system catalog tables are the NLS data types, NCHAR and NVARCHAR, but with the following specific exceptions:

Table_name.Column_name	Data type
sysams.am_sptype	CHAR(3)
syscolauth.colauth	CHAR(3)
sysdefaults.class	CHAR(1)
sysfragauth.fragauth	CHAR(6)
sysinherits.class	CHAR(1)
syslangauth.langauth	CHAR(1)
sysprocauth.procauth	CHAR(1)

sysprocedures.mode	CHAR(1)
systabauth.tabauth	CHAR(9)
systriggers.event	CHAR(1)
sysxtdtypeauth.auth	CHAR(2)

In each of these columns, case-sensitive encoding can record information that utilities of the database server require in queries on those system catalog tables. In a database that is case-insensitive, queries might return incorrect results from data stored in NCHAR or NVARCHAR columns, if different attributes of database objects are encoded as different cases of the same letter. To avoid the loss of information, CHAR data types are used for the system catalog columns listed above.

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SYSAGGREGATES

The **sysaggregates** system catalog table records user-defined aggregates (UDAs). The **sysaggregates** table has the following columns.

Table 1. SYSAGGREGATES table column descriptions

Column	Type	Explanation
name	VARCHAR(128)	Name of the aggregate
owner	CHAR(32)	Name of the owner of the aggregate
aggid	SERIAL	Unique code identifying the aggregate
init_func	VARCHAR(128)	Name of initialization UDR
iter_func	VARCHAR(128)	Name of iterator UDR
combine_func	VARCHAR(128)	Name of combine UDR
final_func	VARCHAR(128)	Name of finalization UDR
handlesnulls	BOOLEAN	NULL-handling indicator: <ul style="list-style-type: none"> t = handles NULLs f = does not handle NULLs

Each user-defined aggregate has one entry in **sysaggregates** that is uniquely identified by its identifying code (the **aggid** value). Only user-defined aggregates (aggregates that are not built in) have entries in **sysaggregates**.

Both a simple index on the **aggid** column and a composite index on the **name** and **owner** columns require unique values.

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SYSAMS

The **sysams** system catalog table contains information that is required for using built-in access methods and those created by the CREATE ACCESS_METHOD statement of SQL.

The **sysams** table has the following columns.

Table 1. SYSAMS table column descriptions

Column	Type	Explanation
am_name	VARCHAR(128, 0)	Name of the access method
am_owner	CHAR(32)	Name of the owner of the access method
am_id	INTEGER	Unique identifying code for an access method This corresponds to the am_id columns in the systables , sysindices , and sysopclasses tables.
am_type	CHAR(1)	Type of access method: P = Primary; S = Secondary
am_sptype	CHAR(3)	Types of spaces where the access method can exist: <ul style="list-style-type: none"> A means the access method supports extspaces and sbspaces. If the access method is built in, such as a B-tree, it also supports dbspaces. D or d means the access method supports dbspaces only. DS means the access method supports dbspaces and sbspaces. S or s means the access method supports sbspaces only. X or x means the access method supports extspaces only. sx means the access method supports sbspaces and extspaces.
am_defopclass	INTEGER	Unique identifying code for default-operator class Value is the opclassid from the entry for this operator class in the sysopclasses table.

Column	Type	Explanation
am_keyscan	INTEGER	Whether a secondary access method supports a key scan (An access method supports a key scan if it can return a key and a rowid from a call to the am_getnext function.) (0 = FALSE; Non-zero = TRUE)
am_unique	INTEGER	Whether a secondary access method can support unique keys (0 = FALSE; Non-zero = TRUE)
am_cluster	INTEGER	Whether a primary access method supports clustering (0 = FALSE; Non-zero = TRUE)
am_rowids	INTEGER	Whether a primary access method supports rowids (0 = FALSE; Non-zero = TRUE)
am_readwrite	INTEGER	Whether a primary access method can both read and write (0 = access method is read-only; Non-zero = access method is read/write)
am_parallel	INTEGER	Whether an access method supports parallel execution (0 = FALSE; Non-zero = TRUE)
am_costfactor	SMALLFLOAT	The value to be multiplied by the cost of a scan to normalize it to costing done for built-in access methods The scan cost is the output of the am_scancost function.
am_create	INTEGER	The routine specified for the AM_CREATE purpose for this access method Value = procid for the routine in the sysprocedures table.
am_drop	INTEGER	The routine specified for the AM_DROP purpose function for this access method
am_open	INTEGER	The routine specified for the AM_OPEN purpose function for this access method
am_close	INTEGER	The routine specified for the AM_CLOSE purpose function for this access method
am_insert	INTEGER	The routine specified for the AM_INSERT purpose function for this access method
am_delete	INTEGER	The routine specified for the AM_DELETE purpose function for this access method
am_update	INTEGER	The routine specified for the AM_UPDATE purpose function for this access method
am_stats	INTEGER	The routine specified for the AM_STATS purpose function for this access method
am_scancost	INTEGER	The routine specified for the AM_SCANCOST purpose function for this access method
am_check	INTEGER	The routine specified for the AM_CHECK purpose function for this access method
am_beginscan	INTEGER	The routine specified for the AM_BEGINSCAN purpose function for this access method
am_endscan	INTEGER	The routine specified for the AM_ENDSCAN purpose function for this access method
am_rescan	INTEGER	The routine specified for the AM_RESCAN purpose function for this access method
am_getnext	INTEGER	The routine specified for the AM_GETNEXT purpose function for this access method
am_getbyid	INTEGER	The routine specified for the AM_GETBYID purpose function for this access method
am_build	INTEGER	The routine specified for the AM_BUILD purpose function for this access method
am_init	INTEGER	The routine specified for the AM_INIT purpose function for this access method
am_truncate	INTEGER	The routine specified for the AM_TRUNCATE purpose function for this access method
am_expr_pushdown	INTEGER	Whether parameter descriptors are supported (0 = FALSE; Non-zero = TRUE)

For each of the columns that contain a routine for a purpose function, the value is the **sysprocedures.procid** value for the corresponding routine.

A composite index on the **am_name** and **am_owner** columns in this table allows only unique values. The **am_id** column has a unique index.

For information about access method functions, see the documentation of your access method.

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SYSATTRTYPES

The **sysattrtypes** system catalog table contains information about members of a complex data type. Each row of **sysattrtypes** contains information about elements of a collection data type or fields of a row data type.

The **sysattrtypes** table has the following columns.

Table 1. SYSATTRTYPES table column descriptions

Column	Type	Explanation
extended_id	INTEGER	Identifying code of an extended data type Value is the same as in the sysxdtypes table (SYSXDTYPES).
seqno	SMALLINT	Identifying code of an entry having extended_id type
levelno	SMALLINT	Position of member in collection hierarchy
parent_no	SMALLINT	Value in the seqno column of the complex data type that contains this member
fieldname	VARCHAR(128)	Name of the field in a row type Null for other complex data types

Column	Type	Explanation
fieldno	SMALLINT	Field number sequentially assigned by system (from left to right within each row type)
type	SMALLINT	Code for the data type See the description of syscolumns.coltype (page SYSCOLUMNS).
length	SMALLINT	Length (in bytes) of the member
xtd_type_id	INTEGER	Code identifying this data type See the description of sysxdtypes.extended_id (SYSXDTYPES).

Two indexes on the **extended_id** column and the **xtd_type_id** column allow duplicate values. A composite index on the **extended_id** and **seqno** columns allows only unique values.

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SYSAUTOLOCATE

The **sysautolocate** system catalog table indicates which dbspaces are available for automatic table fragmentation.

Table 1. SYSAUTOLOCATE table column descriptions

Column	Type	Explanation
dbnum	INTEGER	The ID number of the dbspace. 0 indicates multiple dbspaces.
dbname	VARCHAR(128,0)	The name of the dbspace. An asterisk (*) indicates multiple dbspaces.
pagesize	SMALLINT	The page size of the dbspace. 0 indicates multiple page sizes.
flags	INTEGER	<ul style="list-style-type: none"> 1 = On. The dbspace is available for automatic table fragmentation. 2 = Off. The dbspace is not available for automatic table fragmentation.

You add or remove dbspace from the list of available dbspace by running the **task()** or **admin()** SQL administration API function with one of the **autolocate** database arguments.

The **sysautolocate** system catalog table does not necessarily list every dbspace. For example, if all dbspaces are available for automatic table fragmentation, the table contains one row:

dbnum	dbname	pagesize	flags
0	*	0	1

If all but one dbspace is available, the table contains two rows, for example:

dbnum	dbname	pagesize	flags
0	*	0	1
12	db12	8	2

If all but two dbspaces are unavailable, the table contains three rows, for example:

dbnum	dbname	pagesize	flags
0	*	0	2
12	db12	8	1
13	db13	4	1

Related information:

[autolocate database argument: Specify dbspaces for automatic location and fragmentation \(SQL administration API\)](#)

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SYSBLOBS

The **sysblobs** system catalog table specifies the storage location of BYTE and TEXT column values. Its name is based on a legacy term for BYTE and TEXT columns, blobs (also known as *simple large objects*), and does not refer to the BLOB data type of IBM® Informix®. The **sysblobs** table contains one row for each BYTE or TEXT column, and has the following columns.

Table 1. SYSBLOBS table column descriptions

Column	Type	Explanation
spacename	VARCHAR(128)	Name of partition, dbspace, or family
type	CHAR(1)	Code identifying the type of storage media: M = Magnetic
tabid	INTEGER	Code identifying the table
colno	SMALLINT	Column number within its table

A composite index on **tabid** and **colno** allows only unique values.

For information about the location and size of chunks of blobspaces, dbspaces, and sbspaces for TEXT, BYTE, BLOB, and CLOB columns, see the *IBM Informix Administrator's Guide* and the *IBM Informix Administrator's Reference*.

SYSCASTS

The **syscasts** system catalog table describes the casts in the database. It contains one row for each built-in cast, each implicit cast, and each explicit cast that a user defines. The **syscasts** table has the following columns.

Table 1. SYSCASTS table column descriptions

Column	Type	Explanation
owner	CHAR(32)	Owner of cast (user informix for built-in casts and <i>user</i> name for implicit and explicit casts)
argument_type	SMALLINT	Source data type on which the cast operates
argument_xid	INTEGER	Code for the source data type specified in the argument_type column
result_type	SMALLINT	Code for the data type returned by the cast
result_xid	INTEGER	Data type code of the data type named in the result_type column
routine_name	VARCHAR(128)	Function or procedure implementing the cast
routine_owner	CHAR(32)	Name of owner of the function or procedure specified in the routine_name column
class	CHAR(1)	Type of cast: E = Explicit cast I = Implicit cast S = Built-in cast

If **routine_name** and **routine_owner** have NULL values, this indicates that the cast is defined without a routine. This can occur if both of the data types specified in the **argument_type** and **result_type** columns have the same length and alignment, and are passed by reference, or passed by value.

A composite index on columns **argument_type**, **argument_xid**, **result_type**, and **result_xid** allows only unique values. A composite index on columns **result_type** and **result_xid** allows duplicate values.

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SYSCHECKS

The **syschecks** system catalog table describes each check constraint defined in the database. Because the **syschecks** table stores both the ASCII text and a binary encoded form of the check constraint, it contains multiple rows for each check constraint. The **syschecks** table has the following columns.

Table 1. SYSCHECKS table column descriptions

Column	Type	Explanation
constrid	INTEGER	Unique code identifying the constraint
type	CHAR(1)	Form in which the check constraint is stored: B = Binary encoded s = Select T = Text
seqno	SMALLINT	Line number of the check constraint
checktext	CHAR(32)	Text of the check constraint

The text in the **checktext** column associated with B type in the type column is in computer-readable format. To view the text associated with a particular check constraint, use the following query with the appropriate **constrid** code:

```
SELECT * FROM syschecks WHERE constrid=10 AND type='T'
```

Each check constraint described in the **syschecks** table also has its own row in the **sysconstraints** table.

A composite index on the **constrid**, **type**, and **seqno** columns allows only unique values.

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SYSCHECKUDRDEP

The **syscheckudrdep** system catalog table describes each check constraint that is referenced by a user-defined routine (UDR) in the database. The **syscheckudrdep** table has the following columns.

Table 1. SYSCHECKUDRDEP table column descriptions

Column	Type	Explanation
udr_id	INTEGER	Unique code identifying the UDR
constraint_id	INTEGER	Unique code identifying the check constraint

Each check constraint described in the **syscheckudrdep** table also has its own row in the **sysconstraints** system catalog table, where the **constrid** column has the same value as the **constraint_id** column of **syscheckudrdep**.

A composite index on the **udr_id** and **constraint_id** columns requires that combinations of these values be unique.

SYSCOLATTRIBS

The **syscolattribs** system catalog table describes the characteristics of smart large objects, namely CLOB and BLOB data types.

It contains one row for each sbspace referenced in the PUT clause of the CREATE TABLE statement or of the ALTER TABLE statement.

Table 1. SYSCOLATTRIBS table column descriptions

Column	Type	Explanation
tabid	INTEGER	Code uniquely identifying the table
colno	SMALLINT	Number of the column that contains the smart large object
extentsize	INTEGER	Pages in smart-large-object extent, expressed in KB
flags	INTEGER	Integer representation of the combination (by addition) of hexadecimal values of the following parameters: <ul style="list-style-type: none"> • LO_NOLOG (0x00000001 = 1) = The smart large object is not logged. • LO_LOG (0x00000010 = 2) = Logging of smart large objects conforms to current log mode of the database. • LO_KEEP_LASTACCESS_TIME (0x00000100 = 4) = Keeps a record of when this column was most recently accessed by a user. • LO_NOKEEP_LASTACCESS_TIME (0x00001000 = 8) = No record is kept of when this column was most recently accessed by a user. • HI_INTEG (0x00010000 = 16) = Sbspace data pages have headers and footers to detect incomplete writes and data corruption. • MODERATE_INTEG (0x00100000 = 32) = Data pages have headers but no footers.
flags1	INTEGER	Reserved for future use
sbspace	VARCHAR(128)	Name of the sbspace

A composite index on the **tabid**, **colno**, and **sbspace** columns allows only unique combinations of these values.

SYSCOLAUTH

The **syscolauth** system catalog table describes each set of discretionary access privileges granted on a column. It contains one row for each set of column-level privileges that are currently granted to a user, to a role, or to the PUBLIC group on a column in the database. The **syscolauth** table has the following columns.

Column	Type	Explanation
grantor	VARCHAR(32)	Authorization identifier of the grantor
grantee	VARCHAR(32)	Authorization identifier of the grantee
tabid	INTEGER	Code uniquely identifying the table
colno	SMALLINT	Column number within the table
colauth	CHAR(3)	3-byte pattern specifying column privileges: s or S = Select, u or U = Update, r or R = References

If the **colauth** privilege code is uppercase (for example, s for Select), a user who has this privilege can also grant it to others. If the **colauth** privilege code is lowercase (for example, s for Select), the user who has this privilege cannot grant it to others. A hyphen (-) indicates the absence of the privilege corresponding to that position within the **colauth** pattern.

A composite index on the **tabid**, **grantor**, **grantee**, and **colno** columns allows only unique values. A composite index on the **tabid** and **grantee** columns allows duplicate values.

SYSCOLDEPEND

The **syscoldepend** system catalog table tracks the table columns specified in check constraints and in NOT NULL constraints. Because a check constraint can involve more than one column in a table, the **syscoldepend** table can contain multiple rows for each check constraint; one row is created for each column involved in the constraint. The **syscoldepend** table has the following columns.

Column	Type	Explanation
constrid	INTEGER	Code uniquely identifying the constraint

Column	Type	Explanation
tabid	INTEGER	Code uniquely identifying the table
colno	SMALLINT	Column number within the table

A composite index on the **constrid**, **tabid**, and **colno** columns allows only unique values. A composite index on the **tabid** and **colno** columns allows duplicate values.

See also the **syscheckudrdep** system catalog table in [SYSCHECKUDRDEP](#), which lists every check constraint that is referenced by a user-defined routine.

See also the **sysreferences** table in [SYSREFERENCES](#), which describes dependencies of referential constraints.

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SYSCOLUMNS

The **syscolumns** system catalog table describes each column in the database.

One row exists for each column that is defined in a table or view.

Table 1. The SYSCOLUMNS table

Column	Type	Explanation
colname	VARCHAR(128)	Column name
tabid	INTEGER	Identifying code of table containing the column
colno	SMALLINT	Column number The system sequentially assigns this (from left to right within each table).
coltype	SMALLINT	Code indicating the data type of the column: <ul style="list-style-type: none"> • 0 = CHAR • 1 = SMALLINT • 2 = INTEGER • 3 = FLOAT • 4 = SMALLFLOAT • 5 = DECIMAL • 6 = SERIAL ¹ • 7 = DATE • 8 = MONEY • 9 = NULL • 10 = DATETIME • 11 = BYTE • 12 = TEXT • 13 = VARCHAR • 14 = INTERVAL • 15 = NCHAR • 16 = NVARCHAR • 17 = INT8 • 18 = SERIAL8 ¹ • 19 = SET • 20 = MULTISSET • 21 = LIST • 22 = ROW (unnamed) • 23 = COLLECTION • 40 = LVARCHAR fixed-length opaque types ² • 41 = BLOB, BOOLEAN, CLOB variable-length opaque types ² • 43 = LVARCHAR (client-side only) • 45 = BOOLEAN • 52 = BIGINT • 53 = BIGSERIAL ¹ • 2061 = IDSSECURITYLABEL ^{2, 3} • 4118 = ROW (named)
collength	Any of the following data types: <ul style="list-style-type: none"> • Integer-based • Varying-length character • Time • Fixed-point • Simple-large-object • IDSSECURITYLABEL 	The value depends on the data type of the column. For some data types, the value is the column length (in bytes). See Storing Column Length for more information.
colmin	INTEGER	Minimum column length (in bytes)

Column	Type	Explanation
colmax	INTEGER	Maximum column length (in bytes)
extended_id	INTEGER	Data type code, from the sysxdtypes table, of the data type specified in the coltype column
seclabelid	INTEGER	The label ID of the security label associated with the column if it is a protected column. NULL otherwise.
colattr	SMALLINT	HIDDEN 1 - Hidden column ROWVER 2 - Row version column ROW_CHKSUM 4 - Row key column ER_CHECKVER 8 - ER row version column UPGRD1_COL 16 - ER auto primary key column UPGRD2_COL 32 - ER auto primary key column UPGRD3_COL 64 - ER auto primary key column PK_NOTNULL 128 - NOT NULL by PRIMARY KEY

Note:

- ¹ In DB-Access, an offset value of 256 is always added to these **coltype** codes because DB-Access sets SERIAL, SERIAL8, and BIGSERIAL columns to NOT NULL.
- ² The built-in opaque data types do not have a unique **coltype** value. They are distinguished by the **extended_id** column in the [SYSXTDTYPES](#) system catalog table.
- ³ DISTINCT OF VARCHAR(128).

A composite index on **tabid** and **colno** allows only unique values.

The **coltype** codes can be incremented by bitmaps showing the following features of the column.

Bit Value	Significance When Bit Is Set
0x0100	NULL values are not allowed
0x0200	Value is from a host variable
0x0400	Float-to-decimal for networked database server
0x0800	DISTINCT data type
0x1000	Named ROW type
0x2000	DISTINCT type from LVARCHAR base type
0x4000	DISTINCT type from BOOLEAN base type
0x8000	Collection is processed on client system

For example, the **coltype** value 4118 for named row types is the decimal representation of the hexadecimal value 0x1016, which is the same as the hexadecimal **coltype** value for an unnamed row type (0x016), with the named-row-type bit set. The file **\$INFORMIXDIR/incl/esql/sqltypes.h** contains additional information about **syscolumns.coltype** codes.

The following table lists the **coltype** values for the built-in opaque data types:

NOT NULL constraints

Similarly, the **coltype** value is incremented by 256 if the column does not allow NULL values. To determine the data type for such columns, subtract 256 from the value and evaluate the remainder, based on the possible **coltype** values. For example, if the **coltype** value is 262, subtracting 256 leaves a remainder of 6, indicating that the column has a SERIAL data type.

Storing the column data type

The database server stores the **coltype** value as bitmap, as listed in [SYSCOLUMNS](#).

- [Storing column length](#)
- [Storing Maximum and Minimum Values](#)

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Storing column length

The **collength** column value depends on the data type of the column.

Integer-based data types

A **collength** value for a BIGINT, BIGSERIAL, DATE, INTEGER, INT8, SERIAL, SERIAL8, or SMALLINT column is machine-independent. The database server uses the following lengths for these integer-based data types of the SQL language.

Integer-based data types	Length (in bytes)
SMALLINT	2
DATE, INTEGER, and SERIAL	4
INT8 and SERIAL8	10
BIGINT and BIGSERIAL	8

Varying-length character data types

For IBM® Informix® columns of the LVARCHAR type, **collength** has the value of *max* from the data type declaration, or 2048 if no maximum was specified.

For VARCHAR or NVARCHAR columns, the *max_size* and *min_space* values are encoded in the **collength** column using one of these formulas:

- If the **collength** value is positive:

$$\text{collength} = (\text{min_space} * 256) + \text{max_size}$$

- If the **collength** value is negative:

$$\text{collength} + 65536 = (\text{min_space} * 256) + \text{max_size}$$

Time data types

As noted previously, DATE columns have a value of 4 in the **collength** column.

For columns of type DATETIME or INTERVAL, **collength** is determined using the following formula:

$$(\text{length} * 256) + (\text{first_qualifier} * 16) + \text{last_qualifier}$$

The length is the physical length of the DATETIME or INTERVAL field, and *first_qualifier* and *last_qualifier* have values that the following table shows.

Field qualifier	Value	Field qualifier	Value
YEAR	0	FRACTION(1)	11
MONTH	2	FRACTION(2)	12
DAY	4	FRACTION(3)	13
HOURL	6	FRACTION(4)	14
MINUTE	8	FRACTION(5)	15
SECOND	10		

For example, if a DATETIME YEAR TO MINUTE column has a length of 12 (such as YYYY:DD:MO:HH:MI), a *first_qualifier* value of 0 (for YEAR), and a *last_qualifier* value of 8 (for MINUTE), then the **collength** value is 3080 (from $(256 * 12) + (0 * 16) + 8$).

Fixed-point data types

The **collength** value for a MONEY or DECIMAL (*p*, *s*) column can be calculated using the following formula:

$$(\text{precision} * 256) + \text{scale}$$

Simple-large-object data types

If the data type of the column is BYTE or TEXT, **collength** holds the length of the descriptor.

Related concepts:

[Storing Maximum and Minimum Values](#)

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Storing Maximum and Minimum Values

The **colmin** and **colmax** values hold the second-smallest and second-largest data values in the column, respectively. For example, if the values in an indexed column are 1, 2, 3, 4, and 5, the **colmin** value is 2 and the **colmax** value is 4. Storing the second-smallest and second-largest data values lets the query optimizer make assumptions about the range of values in the column and, in turn, further refine search strategies.

The **colmin** and **colmax** columns contain values only if the column is indexed and the UPDATE STATISTICS statement has explicitly or implicitly calculated the column distribution. If you store BYTE or TEXT data in the tblspace, the **colmin** value is encoded as -1.

The **colmin** and **colmax** columns are valid only for data types that fit into four bytes: SMALLFLOAT, SMALLINT, INTEGER, and the first four bytes of CHAR. The values for all other noninteger column types are the initial four bytes of the maximum or minimum value, which are treated as integers.

It is better to use UPDATE STATISTICS MEDIUM than to depend on **colmin** and **colmax** values. UPDATE STATISTICS MEDIUM gives better information and is valid for all data types.

IBM® Informix® does not calculate **colmin** and **colmax** values for user-defined data types. These columns, however, have values for user-defined data types if a user-defined secondary access method supplies them.

Related reference:

[Storing column length](#)

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SYSCONSTRAINTS

The **sysconstraints** system catalog table lists the constraints placed on the columns in each database table. An entry is also placed in the **sysindexes** system catalog table (or **sysindices** view for IBM® Informix®) for each unique, primary key, or referential constraint that does not already have a corresponding entry in **sysindexes** or **sysindices**. Because indexes can be shared, more than one constraint can be associated with an index. The **sysconstraints** table has the following columns.

Table 1. SYSCONSTRAINTS table column descriptions

Column	Type	Explanation
constrid	SERIAL	Code uniquely identifying the constraint
constrname	VARCHAR(128)	Name of the constraint
owner	VARCHAR(32)	Name of the owner of the constraint
tabid	INTEGER	Code uniquely identifying the table
constrtype	CHAR(1)	Code identifying the constraint type: <ul style="list-style-type: none">• C = Check constraint• N = Not NULL• P = Primary key• R = Referential• T = Table• U = Unique
idxname	VARCHAR(128)	Name of index corresponding to constraint
collation	CHAR(32)	Collating order at the time when the constraint was created.

A composite index on the **constrname** and **owner** columns allows only unique values. An index on the **tabid** column allows duplicate values, and an index on the **constrid** column allows only unique values.

For check constraints (where **constrtype** = C), the **idxname** is always NULL. Additional information about each check constraint is contained in the **syschecks** and **syscoldepend** system catalog tables.

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SYSDEFAULTS

The **sysdefaults** system catalog table lists the user-defined defaults that are placed on each column in the database. One row exists for each user-defined default value.

The **sysdefaults** table has the following columns:

Table 1. SYSDEFAULTS table column descriptions

Column	Type	Explanation
tabid	INTEGER	Code uniquely identifying a table. When the class column contains the code P, then the tabid column references a procedure ID not a table ID.
colno	SMALLINT	Code uniquely identifying a column.
type	CHAR(1)	Code identifying the type of default value: <ul style="list-style-type: none">• C = Current®• L = Literal value• N = NULL• S = Dbservername or Sitename• T = Today• U = User
default	CHAR(256)	If sysdefaults.type = L, a literal default value.

Column	Type	Explanation
class	CHAR(1)	Code identifying what kind of column: <ul style="list-style-type: none"> T = table t = ROW type P = procedure

If no default is specified explicitly in the CREATE TABLE or the ALTER TABLE statement, then no entry exists for that column in the **sysdefaults** table.

If you specify a literal for the default value, it is stored in the **default** column as ASCII text. If the literal value is not of one of the data types listed in the next paragraph, the **default** column consists of two parts. The first part is the 6-bit representation of the binary value of the default value structure. The second part is the default value in ASCII text. A blank space separates the two parts.

If the data type of the column is not CHAR, NCHAR, NVARCHAR, or VARCHAR, or (for IBM® Informix®) BOOLEAN or LVARCHAR, a binary representation of the default value is encoded in the **default** column.

A composite index on the **tabid**, **colno**, and **class** columns allows only unique values.

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SYSDEPEND

The **sysdepend** system catalog table describes how each view or table depends on other views or tables. One row exists in this table for each dependency, so a view based on three tables has three rows. The **sysdepend** table has the following columns.

Table 1. SYSDEPEND table column descriptions

Column	Type	Explanation
btoid	INTEGER	Code uniquely identifying the base table or view
btype	CHAR(1)	Base object type: T = Table V = View
dtoid	INTEGER	Code uniquely identifying a dependent table or view
dtype	CHAR(1)	Code for the type of dependent object; currently, only view (V = View) is implemented

The **btoid** and **dtoid** columns are indexed and allow duplicate values.

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SYSDIRECTIVES

The **sysdirectives** table stores external optimizer directives that can be applied to queries. Whether queries in client applications can use these optimizer directives depends on the setting of the **IFX_EXTDIRECTIVES** environment variable on the client system, as described in Chapter 3, and on the EXT_DIRECTIVES setting in the configuration file of the database server.

The **sysdirectives** table has the following columns:

Table 1. SYSDIRECTIVES table column descriptions

Column	Type	Explanation
id	SERIAL	Unique code identifying the optimizer directive
query	TEXT	Text of the query as it exists in the application
directives	TEXT	Text of the optimizer directive, without comments
directive_code	BYTE	Encoded directive
active	SMALLINT	Integer code that identifies whether this entry is active (= 1) or test only (= 2)
hash_code	SMALLINT	For internal use only

NULL values are not valid in the **query** column. There is a unique index on the **id** column.

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SYSDISTRIB

The **sysdistrib** system catalog table stores data-distribution information for the query optimizer to use. Data distributions provide detailed table and column information to the optimizer to improve the choice of execution paths of SELECT statements.

The **sysdistrib** table has the following columns.

Table 1. SYSDISTRIB table column descriptions

Column	Type	Explanation
tabid	INTEGER	Code identifying the table from which data values were gathered
colno	SMALLINT	Column number in the source table
seqno	INTEGER	Ordinal number for multiple entries
constructed	DATETIME YEAR TO FRACTION(5)	Date when the data distribution was created
mode	CHAR(1)	Optimization level: M = Medium H = High
resolution	SMALLFLOAT	Specified in the UPDATE STATISTICS statement
confidence	SMALLFLOAT	Specified in the UPDATE STATISTICS statement
encdat	STAT	Statistics information
type	CHAR(1)	Type of statistics: A = encdat has ASCII-encoded histogram in fixed-length character field S = encdat has user-defined statistics
smplsize	SMALLFLOAT	A value greater than zero up to 1.0 indicating a proportion of the total rows in the table that UPDATE STATISTICS samples. Values greater than 1.0 indicate the actual number of rows used that UPDATE STATISTICS samples. A value of zero indicates that no sample size is specified. UPDATE STATISTICS HIGH always updates statistics for all rows.
rowssmpld	FLOAT	Number of rows in the sample
constr_time	DATETIME YEAR TO FRACTION(5)	Time when the distribution was recorded
ustnrows	FLOAT	Rows in fragment when distribution was calculated.
ustbuildduration	INTERVAL HOUR TO FRACTION(5)	Time spent calculating the distribution statistics for this column
nupdates	FLOAT	Number of updates to the table
ndeletes	FLOAT	Number of deletes to the table
ninserts	FLOAT	Number of inserts to the table

Information is stored in the **sysdistrib** table when an UPDATE STATISTICS statement with mode MEDIUM or HIGH is executed for a table. (UPDATE STATISTICS LOW does not insert a value into the **mode** column.)

Only user **informix** can select the **encdat** column.

Each row in the **sysdistrib** system catalog table is keyed by the **tabid** and **colno** for which the statistics are collected.

For built-in data type columns, the **type** field is set to A. The **encdat** column stores an ASCII-encoded histogram that is broken down into multiple rows, each of which contains 256 bytes.

In IBM® Informix®, for columns of user-defined data types, the **type** field is set to S. The **encdat** column stores the statistics collected by the **statcollect** user-defined routine in multirepresentational form. Only one row is stored for each **tabid** and **colno** pair. A composite index on the **tabid**, **colno**, and **seqno** columns requires unique combinations of values.

The following three DML counter columns record counts of how many DML operations modifying data rows were performed on the table at the time of generation of column distribution statistics:

- UPDATE operations in **nupdates**
- DELETE operations in **ndeletes**
- and INSERT operations in **ninserts**

These counts can also include rows modified by MERGE statements.

These DML counter columns store the values of the counters from the server partition that exists when distribution statistics are generated. If the AUTO_STAT_MODE configuration parameter, or the AUTO_STAT_MODE session environment setting, or the AUTO keyword of the UPDATE STATISTICS statement has enabled selective updating of data distribution statistics, the **ninserts**, **ndeletes**, and **ninserts** values can affect whether UPDATE STATISTICS operations refresh existing data distribution statistics. When the UPDATE STATISTICS statement runs in MEDIUM or HIGH mode against the table, the database server compares the stored values in these columns with the current values in the partition. Column distribution statistics for the table are not updated if the sum of the stored values differs from the sum of these current **sysdistrib** DML counter values from the partition page by less than the threshold specified by the setting of the STATCHANGE table attribute or of the STATCHANGE configuration parameter.

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SYSDOMAINS

The **sysdomains** view is not used. It displays columns of other system catalog tables. It has the following columns.

Table 1. SYSDOMAINS table column descriptions

Column	Type	Explanation
id	SERIAL	Unique code identifying the domain
owner	CHAR(32)	Name of the owner of the domain
name	VARCHAR(128)	Name of the domain

Column	Type	Explanation
type	SMALLINT	Code identifying the type of domain

There is no index on this view.

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SYSERRORS

The **syserrors** system catalog table stores information about error, warning, and informational messages returned by DataBlade modules and user-defined routines using the **mi_db_error_raise()** DataBlade API function.

For a description of an error message, use the **finderr** utility or go to [Error messages](#).

The **syserrors** table has the following columns.

Column	Type	Explanation
sqlstate	CHAR(5)	SQLSTATE value associated with the error.
locale	CHAR(36)	The locale with which this version of the message is associated (for example, en_us.8859-1)
level	SMALLINT	Reserved for future use
seqno	SMALLINT	Reserved for future use
message	VARCHAR(255)	Message text

To create a new message, insert a row directly into the **syserrors** table. By default, all users can view this table, but only users with the DBA privilege can modify it.

A composite index on the **sqlstate**, **locale**, **level**, and **seqno** columns allows only unique values.

Related information:

[Using the SQLSTATE Error Status Code](#)

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SYSEXTCOLS

The **sysextcols** system catalog table contains a row that describes each of the internal columns in external table **tabid** of format type (**fmttype**) FIXED.

The **sysextcols** table has the following columns.

Column	Type	Explanation
tabid	INTEGER	Unique identifying code of a table
colno	SMALLINT	Code identifying the column
exttype	SMALLINT	Code identifying an external column type
extstart	SMALLINT	Starting position of column in the external data file
extlength	SMALLINT	External column length (in bytes)
nullstr	CHAR(256)	Represents NULL in external data
decprec	SMALLINT	Precision for external decimals
extstype	VARCHAR(128,0)	External type name

No entries are stored in **sysextcols** for DELIMITED or IBM® Informix® format external files.

You can use the DBSCHEMA utility to write out the description of the external tables. To query these system catalog tables about an external table, use the **tabid** as stored in **systables** with **tabtype** = 'E'.

An index on the **tabid** column allows duplicate values.

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SYSEXTDFILES

The **sysextdfiles** system catalog table contains identifying codes and the paths of external tables.

For each external table, at least one row exists in the **sysextdfiles** system catalog table, which has the following columns.

Column	Type	Explanation
tabid	INTEGER	Unique identifying code of an external table

Column	Type	Explanation
dfentry	CHAR(469)	Absolute source or target file path
blobdir	CHAR(344)	Absolute or relative directory name
clobdir	CHAR(344)	Absolute or relative directory name

You can use DBSCHEMA to write out the description of the external tables. To query these system catalog tables about an external table, use the **tabid** as stored in **systables** with **tabtype** = 'E'.

An index on the **tabid** column allows duplicate values.

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SYSEXTERNAL

For each external table, a single row exists in the **sysexternal** system catalog table.

The **tabid** column associates the external table record in this system catalog table with an entry in **systables**.

Column	Type	Explanation
tabid	INTEGER	Unique identifying code of an external table
fmttype	CHAR(1)	Type of format: D = (delimited) F = (fixed) I = (IBM® Informix®)
codeset	VARCHAR(128)	Reserved for future use
recdelim	VARCHAR(128)	The record delimiter
flddelim	CHAR(4)	The field delimiter
datefmt	CHAR(8)	Reserved for future use
moneyfmt	CHAR(20)	Reserved for future use
maxerrors	INTEGER	Number of errors to allow
rejectfile	CHAR(464)	Name of the reject file
flags	INTEGER	Optional load flags
ndfiles	INTEGER	Number of data files in sysextdfiles

You can use the **dbschema** utility to write out the description of the external tables. To query these system catalog tables about an external table, use the **tabid** as stored in **systables** with **tabtype** = 'E'.

An index on the **tabid** column allows only unique values.

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SYSFRAGAUTH

The **sysfragauth** system catalog table stores information about the privileges that are granted on table fragments. This table has the following columns.

Table 1. SYSFRAGAUTH table column descriptions

Column	Type	Explanation
grantor	CHAR(32)	Name of the grantor of privilege
grantee	CHAR(32)	Name of the grantee of privilege
tabid	INTEGER	Identifying code of the fragmented table
fragment	VARCHAR(128)	Name of dbspace where fragment is stored
fragauth	CHAR(6)	A 6-byte pattern specifying fragment privileges (including 3 bytes reserved for future use): <ul style="list-style-type: none"> • u or U = Update • i or I = Insert • d or D = Delete

In the **fragauth** column, an uppercase code (such as U for Update) means that the grantee can grant the privilege to other users; a lowercase (for example, u for Update) means the user cannot grant the privilege to others. Hyphen (-) indicates the absence of the privilege for that position within the pattern.

A composite index on the **tabid**, **grantor**, **grantee**, and **fragment** columns allows only unique values. A composite index on the **tabid** and **grantee** columns allows duplicate values.

The following example displays the fragment-level privileges for one base table, as they exist in the **sysfragauth** table. In this example, the grantee **rajesh** can grant the Update, Delete, and Insert privileges to other users.

grantor	grantee	tabid	fragment	fragauth
dba	omar	101	dbsp1	-ui---

grantor	grantee	tabid	fragment	fragauth
dba	jane	101	dbsp3	--i--
dba	maria	101	dbsp4	--id--
dba	rajesh	101	dbsp2	-UID-

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SYSFRAGDIST

The **sysfragdist** system catalog table stores fragment-level column statistics for fragmented tables and indexes. One row exists for each table fragment or index fragment.

Only columns in fragmented tables are described here. (For table-level column statistics, see the **sysdistrib** system catalog table.)

The **sysfragdist** table has the following columns.

Column	Type	Explanation
tabid	INTEGER	Unique identifying code of table (= systables.tabid)
fragid	INTEGER	Unique identifying code of fragment (= sysfragments.partnum)
colno	SMALLINT	Unique identifying code of column (= syscolumns.colno)
seqno	SMALLINT	Sequence number (for distributions that span multiple rows)
mode	CHAR(1)	UPDATE STATISTICS mode (H = high, or M = medium)
resolution	SMALLFLOAT	Average percentage of the sample in each bin
confidence	SMALLFLOAT	Estimated likelihood that a MEDIUM mode sample value is equivalent to an exact HIGH mode result
rowssampled	FLOAT	Number of rows in the sample
ustbuildduration	INTERVAL HOUR TO FRACTION(5)	Time spent to calculate the distribution for this column
constr_time	DATETIME YEAR TO FRACTION(5)	Time when the distribution was recorded
ustnrows	FLOAT	Rows in fragment when distribution was calculated.
minibinsize	FLOAT	For internal use only
nupdates	FLOAT	Number of updates to the table
ndeletes	FLOAT	Number of deletes to the table
ninserts	FLOAT	Number of inserts to the table
version	INTEGER	Reserved for future use
dbsnum	INTEGER	Unique identifying code of sbpace where encdist is stored
encdist	STAT	Encrypted fragment distribution

The set of rows with a given combination of **tabid**, **fragid**, and **colno** values identifies the column statistics for that fragment of a table. These statistics can span multiple rows by using the **seqno** column for sequence numbering.

The *mode*, *resolution* and *confidence* values that are specified in the UPDATE STATISTICS MEDIUM or HIGH statement that calculate the column statistics for the fragment are recorded in the **sysfragdist** columns of the same names. To use existing fragment statistics to build table statistics, these three parameters should not change between UPDATE STATISTICS statements that reference the fragments of the same table. The only exception to this is that “H” mode fragmented statistics can be used to build “M” mode table statistics.

Column distribution statistics for the fragment are stored in the column **encdist**. The **dbsnum** column stores the identifying code of the smart blob space where the **encdist** object describing this fragment is stored. By default, the SBSPACENAME configuration parameter setting is the identifier of the sbpace whose identifying code is in the **dbsnum** column.

The following three columns record counts of how many DML operations modifying data rows were performed on the fragment at the time of generation of column distribution statistics:

- UPDATE operations in **nupdates**
- DELETE operations in **ndeletes**
- and INSERT operations in **ninserts**

These counts can also include rows modified by MERGE statements.

These DML counter columns store the values of the counters from the server partition that existed when distribution statistics were generated. When UPDATE STATISTICS runs in MEDIUM or HIGH mode against the fragmented table with fragment level statistics, the database server compares the stored values in these columns with the current values in the partition.

When the AUTO_STAT_MODE configuration parameter, or the AUTO_STAT_MODE session environment setting, or the AUTO keyword of the UPDATE STATISTICS statement has enabled selective updating of data distribution statistics, the **ninserts**, **ndeletes**, and **ninserts** values can affect whether UPDATE STATISTICS operations refresh existing data distribution statistics for the fragment. Column statistics for the fragment corresponding to the row in the **sysfragdist** table are not

updated if the sum of the stored values differs from the sum of these current DML counter values for the partition page by less than the threshold specified by the setting of the STATCHANGE table attribute or of the STATCHANGE configuration parameter.

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SYSPFRAGMENTS

The **sysfragments** system catalog table stores fragmentation information and LOW mode statistical distributions for individual fragments of tables and indexes. One row exists for each table fragment or index fragment.

The **sysfragments** table has the following columns.

Column	Type	Explanation
fragtype	CHAR(1)	Code indicating the type of fragmented object: <ul style="list-style-type: none">• I = Original index fragment• T = Original table fragment
tabid	INTEGER	Unique identifying code of table
indexname	VARCHAR(128)	Name of index
colno	INTEGER	Identifying code of TEXT or BYTE column, or the upper limit on the number of rolling window fragments
partn	INTEGER	Identifying code of physical storage location
strategy	CHAR(1)	Code for type of fragment distribution strategy: <ul style="list-style-type: none">• R = Round-robin distribution strategy• E = Expression-based distribution strategy• I = IN DBSPACE clause specifies a storage location as part of distribution strategy• N = raNge-iNterval (or rolliNg wiNdow) distribution strategy• L = List distribution strategy• T = Table-based distribution strategy• H = table is a subtable within a table Hierarchy
location	CHAR(1)	Reserved for future use; shows L for local
servername	VARCHAR(128)	Reserved for future use
evalpos	INTEGER	Position of fragment in the fragmentation list. For fragmentation by INTERVAL, one of the following values that indicates the type of information in the exprrtext field: <ul style="list-style-type: none">• -1 = List of dbspaces for interval fragments• -2 = Interval value• -3 = Fragmentation key• -4 = Rolling window fragment Fragmentation by LIST also uses the -3 value.
exprrtext	TEXT	Expression for fragmentation strategy For fragmentation by INTERVAL, LIST, or rolling window, provides the information corresponding to the value of the evalpos field.
exprrbin	BYTE	Binary version of expression
exprrarr	BYTE	Range-partitioning data to optimize expression in range-expression fragmentation strategy
flags	INTEGER	Used internally
dbspace	VARCHAR(128)	Name of dbspace storing this fragment
levels	SMALLINT	Number of B-tree index levels
npused	FLOAT	For table-fragmentation strategies: the number of data pages For index-fragmentation strategies: the number of leaf pages For rolling window tables: the units for the storage size limit in nrows
nrows	FLOAT	For tables: the number of rows in the fragment. For indexes: the number of unique keys. For rolling window tables: the upper limit on storage size in the purge policy.
clust	FLOAT	Degree of index clustering; smaller numbers correspond to greater clustering.
partition	VARCHAR(128)	Fragment name. This can match the name of the dbspace that stores the fragment, or can be an arbitrary name.
version	SMALLINT	Number that increments when fragment statistics is updated

Column	Type	Explanation
nupdates	FLOAT	Number of updates to the fragment
ndeletes	FLOAT	Number of deletes to the fragment
ninserts	FLOAT	Number of inserts to the fragment

Every fragment has a row in this table. The **evalpos** and **evaltext** fields contain information about individual fragments.

Tables and indexes created with fragmentation by INTERVAL or LIST have additional rows containing information about the fragmentation strategy.

The **strategy** type T is used for attached indexes. (This is a fragmented index whose fragmentation strategy is the same as for the table fragmentation.)

For information about the **nupdates**, **ndeletes**, and **ninserts** columns, which in **sysfragments** tabulate DML operations on a table since the most recent recalculation of its distribution statistics, see the description of the three columns that have the same names in the [SYSDISTRIB](#) system catalog table.

In , a composite index on the **fragtype**, **tabid**, **indexname**, and **evalpos** columns allows duplicate values.

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SYSINDEXES

The **sysindexes** table is a view on the **sysindices** table. It contains one row for each index in the database.

The **sysindexes** table has the following columns.

Table 1. SYSINDEXES table column descriptions

Column	Type	Explanation
idxname	VARCHAR(128)	Index name
owner	VARCHAR(32)	Owner of index (user informix for system catalog tables and <i>username</i> for database tables)
tabid	INTEGER	Unique identifying code of table
idxtype	CHAR(1)	Index type: <ul style="list-style-type: none"> • U = Unique • D = Duplicates allowed • G = Nonbitmap generalized-key index • g = Bitmap generalized-key index • u = unique, bitmap • d = nonunique, bitmap
clustered	CHAR(1)	Clustered or nonclustered index (C = Clustered)
part1	SMALLINT	Column number (colno) of a single index or the 1st component of a composite index
part2	SMALLINT	2nd component of a composite index
part3	SMALLINT	3rd component of a composite index
part4	SMALLINT	4th component of a composite index
part5	SMALLINT	5th component of a composite index
part6	SMALLINT	6th component of a composite index
part7	SMALLINT	7th component of a composite index
part8	SMALLINT	8th component of a composite index
part9	SMALLINT	9th component of a composite index
part10	SMALLINT	10th component of a composite index
part11	SMALLINT	11th component of a composite index
part12	SMALLINT	12th component of a composite index
part13	SMALLINT	13th component of a composite index
part14	SMALLINT	14th component of a composite index
part15	SMALLINT	15th component of a composite index
part16	SMALLINT	16th component of a composite index
levels	SMALLINT	Number of B-tree levels
leaves	INTEGER	Number of leaves
nunique	INTEGER	Number of unique keys in the first column
clust	INTEGER	Degree of clustering; smaller numbers correspond to greater clustering
idxflags	INTEGER	Bitmap storing the current locking mode of the index

As with most system catalog tables, changes that affect existing indexes are reflected in this table only after you run the UPDATE STATISTICS statement.

Each **part1** through **part16** column in this table holds the column number (**colno**) of one of the 16 possible parts of a composite index. If the component is ordered in descending order, the **colno** is entered as a negative value. The columns are filled in for B-tree indexes that do not use user-defined data types or functional indexes. For generic B-trees and all other access methods, the **part1** through **part16** columns all contain zeros.

The **clust** column is blank until the UPDATE STATISTICS statement is run on the table. The maximum value is the number of rows in the table, and the minimum value is the number of data pages in the table.

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SYSINDICES

The **sysindices** system catalog table describes the indexes in the database. It stores LOW mode statistics for all indexes, and contains one row for each index that is defined in the database.

Table 1. **sysindices** system catalog table columns

Column	Type	Explanation
idxname	VARCHAR(128)	Name of index
owner	VARCHAR(32)	Name of owner of index (user informix for system catalog tables and <i>username</i> for database tables)
tabid	INTEGER	Unique identifying code of table
idxtype	CHAR(1)	Uniqueness status <ul style="list-style-type: none"> • U = Unique values required • D = Duplicates allowed
clustered	CHAR(1)	Clustered or nonclustered status (C = Clustered)
levels	SMALLINT	Number of tree levels
leaves	FLOAT	Number of leaves
nunique	FLOAT	Number of unique keys in the first column
clust	FLOAT	Degree of clustering; smaller numbers correspond to greater clustering. The maximum value is the number of rows in the table, and the minimum value is the number of data pages in the table. This column is blank until UPDATE STATISTICS is run on the table.
nrows	FLOAT	Estimated number of rows in the table (zero until UPDATE STATISTICS is run on the table)
indexkeys	INDEXKEYARRAY	Internal representation of the index keys. Column can have up to three fields, in the format: procid , (<i>col1,col2, . . . , coln</i>), opclassid where $1 < n < 341$
amid	INTEGER	Unique identifying code of the access method that implements this index. (Value = am_id for that access method in the sysams table.)
amparam	LVARCHAR(2048)	List of parameters used to customize the amid access method behavior
collation	CHAR(32)	Database locale whose collating order was in effect at the time of index creation
pagesize	INTEGER	Size of the page, in bytes, where this index is stored
nhashcols	SMALLINT	Number of hashed columns in a FOT index
nbuckets	SMALLINT	Number of subtrees (buckets) in a forest of trees (FOT) index
ustlows	DATETIME YEAR TO FRACTION	Date and time when index statistics were last recorded
ustbuldduration	INTERVAL HOUR TO FRACTION(5)	Time required to calculate index statistics
nupdates	FLOAT	Number of updates to the table
n deletes	FLOAT	Number of deletes to the table
ninserts	FLOAT	Number of inserts to the table
fextsize	INT	Size (in KB) of the first extent of the index
nextsize	INT	Size (in KB) of the next extent of the index
indexattr	INT	<ul style="list-style-type: none"> • 0x00000001 = The index has a partial column key • 0x00000002 = The index is compressed • 0x00000004 = The index is on a BSON column
jparam	LVARCHAR(2048)	BSON index information

Tip: This system catalog table is changed from Version 7.2 of IBM® Informix®. The earlier schema of this system catalog table is still available as a view that can be accessed under its original name: **sysindexes**. See [SYSINDEXES](#).

Changes that affect existing indexes are reflected in this system catalog table only after you run the UPDATE STATISTICS statement.

The fields within the **indexkeys** columns have the following significance:

- The **procid** (as in **sysprocedures**) exists only for a functional index on return values of a function defined on columns of the table.
- The list of columns (*col1, col2, ... , coln*) in the second field identifies the columns on which the index is defined. The maximum is language-dependent: up to 341 for an SPL or Java™ UDR; up to 102 for a C UDR.
- The **opclassid** identifies the secondary access method that the database server used to build and to search the index. This is the same as the **sysopclasses.opclassid** value for the access method.

For information about the **nupdates**, **n deletes**, and **ninserts** columns, which in **sysindices** tabulate DML operations on an index since the most recent recalculation of its distribution statistics, see the description of the three columns that have the same names in the [SYSDISTRIB](#) system catalog table.

The **textsize** column shows the user-defined first extent size (in kilobytes) that the optional EXTENT SIZE clause specified in the CREATE INDEX statement that defined the index. Similarly, the **nextsize** column shows the user-defined next extent size (in kilobytes) that the optional NEXT SIZE clause specified in the CREATE INDEX statement. Each of these columns displays a value of zero (0) if the corresponding EXTENT SIZE or NEXT SIZE clause was omitted when the index was created.

If the CREATE INDEX statement that defines a new index includes no explicit extent size specifications, the database server automatically calculates the first and next extent sizes, but the **textsize** and **nextsize** column values are set to 0. When the database server is converted from a release earlier than Version 11.70, the **textsize** and **nextsize** values for every migrated index are 0.

The **tabid** column is indexed and allows duplicate values. A composite index on the **idxname**, **owner**, and **tabid** columns allows only unique values.

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SYSDISTRIB

The **sysinherits** system catalog table stores information about table hierarchies and named ROW type inheritance. Every supertype, subtype, supertable, and subtable in the database has a corresponding row in the **sysinherits** table.

Column	Type	Explanation
child	INTEGER	Identifying code of the subtable or subtype
parent	INTEGER	Identifying code of the supertable or supertype
class	CHAR(1)	Inheritance class: t = named ROW type T = table

The **child** and **parent** values are from **sysxdtypes.extended_id** for named ROW types, or from **sys tables.tabid** for tables. Simple indexes on the **child** and **parent** columns allow duplicate values.

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SYSLANGAUTH

The **syslangauth** system catalog table contains the authorization information about computer languages that are used to write user-defined routines (UDRs).

Table 1. SYSLANGAUTH table column descriptions

Column	Type	Explanation
grantor	VARCHAR(32)	Name of the grantor of the language authorization
grantee	VARCHAR(32)	Name of the grantee of the language authorization
langid	INTEGER	Identifying code of language in sysroutinelangs table
langauth	CHAR(1)	The language authorization: <ul style="list-style-type: none">• u = Usage privilege granted• U = Usage privilege granted WITH GRANT OPTION

A composite index on the **langid**, **grantor**, and **grantee** columns allows only unique values. A composite index on the **langid** and **grantee** columns allows duplicate values.

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SYSDISTRIB

The **syslogmap** system catalog table contains fragmentation information.

Table 1. SYSLOGMAP table column descriptions

Column	Type	Explanation
tabloc	INTEGER	Code for the location of a table in another database
tabid	INTEGER	Unique identifying code of the table

Column	Type	Explanation
fragid	INTEGER	Identifying code of the fragment
flags	INTEGER	Bitmap of modifiers from declaration of fragment

A simple index on the **tabloc** column and a composite index on the **tabid** and **fragid** columns do not allow duplicate values.

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SYSOBJSTATE

The **sysobjstate** system catalog table stores information about the state (object mode) of database objects. The types of database objects that are listed in this table are indexes, triggers, and constraints.

Every index, trigger, and constraint in the database has a corresponding row in the **sysobjstate** table if a user creates the object. Indexes that the database server creates on the system catalog tables are not listed in the **sysobjstate** table because their object mode cannot be changed.

The **sysobjstate** table has the following columns.

Table 1. SYSOBJSTATE table column descriptions

Column	Type	Explanation
objtype	CHAR(1)	Code for the type of database object: <ul style="list-style-type: none"> • C = Constraint • I = Index • T = Trigger
owner	VARCHAR(32)	Authorization identifier of the owner of the database object
name	VARCHAR(128)	Name of the database object
tabid	INTEGER	Identifying code of table on which the object is defined
state	CHAR(1)	The current state (object mode) of the database object. This value can be one of the following codes: <ul style="list-style-type: none"> • D = Disabled • E = Enabled • F = Filtering with no integrity-violation errors • G = Filtering with integrity-violation error

A composite index on the **objtype**, **name**, **owner**, and **tabid** columns allows only unique combinations of values. A simple index on the **tabid** column allows duplicate values.

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SYSOPCLASSES

The **sysopclasses** system catalog table contains information about operator classes associated with secondary access methods. It contains one row for each operator class that has been defined in the database. The **sysopclasses** table has the following columns.

Column	Type	Explanation
opclassname	VARCHAR(128)	Name of the operator class
owner	VARCHAR(32)	Name of the owner of the operator class
amid	INTEGER	Identifying code of the secondary access method associated with this operator class
opclassid	SERIAL	Identifying code of the operator class
ops	LVARCHAR(2048)	List of names of the operators that belong to this operator class
support	LVARCHAR(2048)	List of names of support functions defined for this operator class

The **opclassid** value corresponds to the **sysams.am_defopclass** value that specifies the default operator class for the secondary access method that the **amid** column specifies.

The **sysopclasses** table has a composite index on the **opclassname** and **owner** columns and an index on **opclassid** column. Both indexes allow only unique values.

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SYSPROCAUTH

The **sysprocauth** system catalog table describes the privileges granted on a procedure or function. It contains one row for each set of privileges that is granted. The **sysprocauth** table has the following columns.

Table 1. SYSPROCAUTH table column descriptions

Column	Type	Explanation
grantor	VARCHAR(32)	Name of grantor of privileges to access the routine
grantee	VARCHAR(32)	Name of grantee of privileges to access the routine
procid	INTEGER	Unique identifying code of the routine
procauth	CHAR(1)	Type of privilege granted on the routine: <ul style="list-style-type: none">• e = Execute privilege on routine• E = Execute privilege WITH GRANT OPTION

A composite index on the **procid**, **grantor**, and **grantee** columns allows only unique values. A composite index on the **procid** and **grantee** columns allows duplicate values.

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SYSPROCBODY

The **sysprocbody** system catalog table describes the compiled version of each procedure or function in the database. Because the **sysprocbody** table stores the text of the routine, each routine can have multiple rows. The **sysprocbody** table has the following columns.

Table 1. SYSPROCBODY table column descriptions

Column	Type	Explanation
procid	INTEGER	Unique identifying code for the routine
datakey	CHAR(1)	Type of information in the data column: <ul style="list-style-type: none">• A = Routine alter SQL (will not change this value after update statistics)• D = Routine user documentation text• E = Time of creation information• L = Literal value (that is, literal number or quoted string)• P = Interpreter instruction code (p-code)• R = Routine return value type list• S = Routine symbol table• T = Routine text creation SQL
seqno	INTEGER	Line number within the routine
data	CHAR(256)	Actual text of the routine

The A flag indicates the procedure modifiers are altered. ALTER ROUTINE statement updates only modifiers and not the routine body. UPDATE STATISTICS updates the query plan and not the routine modifiers, and the value of datakey will not be changed from A. The A flag marks all the procedures and functions that have altered modifiers, including overloaded procedures and functions. The T flag is used for routine creation text.

The **data** column contains actual data, which can be in one of these formats:

- Encoded return values list
- Encoded symbol table
- Literal data
- P-code for the routine
- Compiled code for the routine
- Text of the routine and its documentation

A composite index on the **procid**, **datakey**, and **seqno** columns allows only unique values.

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SYSPROCCOLUMNS

The **sysproccolumns** system catalog table stores information about return types and parameter names of all UDRs in SYSPROCEDURES.

A composite index on the **procid** and **paramid** columns in this table allows only unique values.

Table 1. SYSPROCCOLUMNS table column descriptions

Column	Type	Explanation
procid	INTEGER	Unique identifying code of the routine
paramid	INTEGER	Unique identifying code of the parameter

Column	Type	Explanation
paramname	VARCHAR (IDENTSIZE)	Name of the parameter
paramtype	SMALLINT	Identifies the type of parameter
paramlen	SMALLINT	Specifies the length of the parameter
paramxid	INTEGER	Specifies the extended type ID for the parameter
paramattr	INTEGER	0 = Parameter is of unknown type 1 = Parameter is INPUT mode 2 = Parameter is INOUT mode 3 = Parameter is multiple return value 4 = Parameter is OUT mode 5 = Parameter is a return value

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SYSPROCEDURES

The **sysprocedures** system catalog table lists the characteristics for each function and procedure that is registered in the database. It contains one row for each routine.

Each function in **sysprocedures** has a unique value, **procid**, called a *routine identifier*. Throughout the system catalog, a function is identified by its routine identifier, not by its name.

The **sysprocedures** table has the following columns.

Table 1. SYSPROCEDURES table column descriptions

Column	Type	Explanation
procname	VARCHAR(128)	Name of routine
owner	VARCHAR(32)	Name of owner
procid	SERIAL	Unique identifying code for the routine
mode	CHAR(1)	Mode type: <ul style="list-style-type: none"> D or d = DBA O or o = Owner P or p = Protected R or r = Restricted T or t = Trigger
retsize	INTEGER	Compiled size (in bytes) of returned values
symsize	INTEGER	Compiled size (in bytes) of symbol table
datasize	INTEGER	Compiled size (in bytes) of constant data
codesize	INTEGER	Compiled size (in bytes) of routine code
numargs	INTEGER	Number of arguments to routine
isproc	CHAR(1)	Specifies if the routine is a procedure or a function: <ul style="list-style-type: none"> t = procedure f = function
specificname	VARCHAR(128)	Specific name for the routine
externalname	VARCHAR(255)	Location of the external routine. This item is language-specific in content and format.
paramstyle	CHAR(1)	Parameter style: I = IBM® Informix®
langid	INTEGER	Language code (in sysroutinelangs table)
paramtypes	RTNPARAMTYPES	Information describing the parameters of the routine
variant	BOOLEAN	Whether the routine is VARIANT or not: <ul style="list-style-type: none"> t = is VARIANT f = is not VARIANT
client	BOOLEAN	Reserved for future use
handlesnulls	BOOLEAN	NULL handling indicator: <ul style="list-style-type: none"> t = handles NULLs f = does not handle NULLs
percallcost	INTEGER	Amount of CPU per call Integer cost to execute UDR: cost/call - 0 -(2^31-1)
commutator	VARCHAR(128)	Name of commutator function

Column	Type	Explanation
negator	VARCHAR(128)	Name of the negator function
selfunc	VARCHAR(128)	Name of function to estimate selectivity of the UDR
internal	BOOLEAN	Specifies if the routine can be called from SQL: <ul style="list-style-type: none"> t = routine is internal, not callable from SQL f = routine is external, callable from SQL
class	CHAR(18)	CPU class by which the routine should be executed
stack	INTEGER	Stack size in bytes required per invocation
parallelizable	BOOLEAN	Parallelization indicator for UDR: <ul style="list-style-type: none"> t = parallelizable f = not parallelizable
costfunc	VARCHAR(128)	Name of the cost function for the UDR
selconst	SMALLFLOAT	Selectivity constant for UDR
proclags	INTEGER	For internal use only
collation	CHAR(32)	Collating order at the time when the routine was created

In the **mode** column, the R mode is a special case of the O mode. A routine is in restricted (R) mode if it was created with a specified owner who is different from the routine creator. If routine statements involving a remote database are executed, the database server uses the access privileges of the user who executes the routine instead of the privileges of the routine owner. In all other scenarios, R-mode routines behave the same as O-mode routines.

The database server can create protected routines for internal use. The **sysprocedures** table identifies these protected routines with the letter P or p in the **mode** column, where p indicates an SPL routine. Protected routines have the following restrictions:

- You cannot use the ALTER FUNCTION, ALTER PROCEDURE, or ALTER ROUTINE statements to modify protected routines.
- You cannot use the DROP FUNCTION, DROP PROCEDURE, or DROP ROUTINE statements to unregister protected routines.
- You cannot use the **dbschema** utility to display protected routines.

In earlier versions, protected SPL routines were indicated by a lowercase p. Starting with version 9.0, protected SPL routines are treated as DBA routines and cannot be Owner routines. Thus D and O indicate DBA routines and Owner routines, while d and o indicate protected DBA routines and protected Owner routines. The trigger mode designates user-defined SPL routines that can be invoked only from the FOR EACH ROW section of a triggered action.

Important: After you issue the SET SESSION AUTHORIZATION statement, the database server assigns a restricted mode to all Owner routines that you created while using the new identity.

A unique index is defined on the **procid** column. A composite index on the **procname**, **isproc**, **numargs**, and **owner** columns allows duplicate values, as does a composite index on the **specificname** and **owner** columns.

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SYSPROCPLAN

The **sysprocplan** system catalog table describes the query-execution plans and dependency lists for data-manipulation statements within each routine. Because different parts of a routine plan can be created on different dates, this table can contain multiple rows for each routine.

Table 1. SYSPROCPLAN table column descriptions

Column	Type	Explanation
procid	INTEGER	Identifying code for the routine
planid	INTEGER	Identifying code for the plan
datakey	CHAR(1)	Type of information stored in data column: <ul style="list-style-type: none"> D = Dependency list I = Information record Q = Execution plan
seqno	INTEGER	Line number within the plan
created	DATE	Date when plan was created
datasize	INTEGER	Size (in bytes) of the list or plan
data	CHAR(256)	Encoded (compiled) list or plan

Before a routine is run, its dependency list in the **data** column is examined. If the major version number of a table accessed by the plan has changed, or if any object that the routine uses has been modified since the plan was optimized (for example, if an index has been dropped), then the plan is optimized again. When **datakey** is I, the **data** column stores information about UPDATE STATISTICS and PDQPRIORITY.

It is possible to delete all the plans for a given routine by using the DELETE statement on **sysprocplan**. When the routine is subsequently executed, new plans are automatically generated and recorded in **sysprocplan**. The UPDATE STATISTICS FOR PROCEDURE statement also updates this table.

A composite index on the **procid**, **planid**, **datakey**, and **seqno** columns allows only unique values.

SYSREFERENCES

The **sysreferences** system catalog table lists all referential constraints on columns. It contains a row for each referential constraint in the database.

Table 1. SYSREFERENCES table column descriptions

Column	Type	Explanation
constrid	INTEGER	Code uniquely identifying the constraint
primary	INTEGER	Identifying code of the corresponding primary key
ptabid	INTEGER	Identifying code of the table that is the primary key
updrule	CHAR(1)	Reserved for future use; displays an R
delrule	CHAR(1)	Whether constraint uses cascading delete or restrict rule: <ul style="list-style-type: none"> • C = Cascading delete • R = Restrict (default)
matchtype	CHAR(1)	Reserved for future use; displays an N
pendant	CHAR(1)	Reserved for future use; displays an N

The **constrid** column is indexed and allows only unique values. The **primary** column is indexed and allows duplicate values.

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SYSROLEAUTH

The **sysroleauth** system catalog table describes the roles that are granted to users. It contains one row for each role that is granted to a user in the database. The **sysroleauth** table has the following columns.

Table 1. SYSROLEAUTH table column descriptions

Column	Type	Explanation
rolename	VARCHAR(32)	Name of the role
grantee	VARCHAR(32)	Name of the grantee of the role
is_grantable	CHAR(1)	Specifies whether the role is grantable: <ul style="list-style-type: none"> • Y = Grantable • N = Not grantable

The **is_grantable** column indicates whether the role was granted with the WITH GRANT OPTION of the GRANT statement.

A composite index on the **rolename** and **grantee** columns allows only unique values.

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SYSROUTINELANGS

The **sysroutinelangs** system catalog table lists the supported programming languages for user-defined routines (UDRs). It has these columns.

Column	Type	Explanation
langid	SERIAL	Code uniquely identifying a supported language
langname	CHAR(30)	Name of the language, such as C or SPL
langinitfunc	VARCHAR(128)	Name of initialization function for the language
langpath	CHAR(255)	Directory path for the UDR language
langclass	CHAR(18)	Name of the class of the UDR language

An index on the **langname** column allows duplicate values.

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SYSSECLABELAUTH

The **sysseclabelauth** system catalog table records the LBAC labels that have been granted to users. It has these columns.

Column	Type	Explanation
GRANTEE	CHAR(32)	The name of the label grantee
secpolicyid	INTEGER	The ID of the security policy to which the security label belongs.
readseclabelid	INTEGER	The security label ID of the security label granted for read access
writeseclabelid	INTEGER	The security label ID of the security label granted for write access

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SYSSECLABELCOMPONENTS

The **sysseclabelcomponents** system catalog table records security label components. It has these columns.

Column	Type	Explanation
compname	VARCHAR(128)	Component name
compid	SERIAL	Component ID
comptype	CHAR(1)	The component type: <ul style="list-style-type: none">• A = array• S = set• T = tree
numelements	INTEGER	Number of elements in the component
coveringinfo	VARCHAR(128)	Internal encoding information
numalters	SMALLINT	Numbers of alter operations that have been performed on the component

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SYSSECLABELCOMPONENTELEMENTS

The **sysseclabelcomponentelements** system catalog table records the values of component elements of security labels. It has these columns.

Column	Type	Explanation
compid	INTEGER	Component ID
element	VARCHAR(32)	Element name
elementencoding	CHAR(8)	Encoded form of the element
parentelement	VARCHAR(32)	The name of the parent elements for tree components. The value is NULL for the following items: Set components Array components Root nodes of a tree component
alterversion	SMALLINT	The number of the alter operation when the element is added. This value is used by the dbexport and dbimport commands.

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SYSSECLABELNAMES

The **sysseclabelnames** system catalog table records the security label names. It has these columns.

Column	Type	Explanation
secpolicyid	INTEGER	The ID of the security policy to which the security label belongs.
seclabelname	VARCHAR(128)	The name of the security label
seclabelid	INTEGER	The ID of the security label

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SYSSECLABELS

The **sysseclabels** system catalog table records the security label encoding. It has these columns.

Column	Type	Explanation
secpolicyid	INTEGER	ID of the security policy to which the security label belongs
seclabelid	INTEGER	Security label ID
sysseclabelnames	VARCHAR(128)	Security label encoding

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SYSSECPOLICIES

The **syssecpolicies** system catalog table records security policies. It has these columns.

Column	Type	Explanation
secpolicyname	VARCHAR(128)	Security policy name
secpolicyid	SERIAL	Security policy ID
numcomps	SMALLINT	Number of security label components in the security policy
comptypelist	CHAR(16)	An ordered list of the type of each component in the policy. <ul style="list-style-type: none">• A = array• S = set• T = tree• – = Beyond NUMCOMPS
overrideylabel	CHAR(1)	Indicates the behavior when a user's security label and exemption credentials do not allow them to insert or update a data row with the security that is label provided on the INSERT or UPDATE SQL statement. <ul style="list-style-type: none">• Y: The security label provided is ignored and replaced by the user's security label for write access.• N: Return an error when not authorized to write a security label.

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SYSSECPOLICYCOMPONENTS

The **syssecpolicycomponents** system catalog table records the components for each security policies. It has these columns.

Column	Type	Explanation
secpolicyid	INTEGER	Security policy ID
compid	INTEGER	ID of a component of the label security policy
compno	SMALLINT	Position of the security label component as it exists in the security policy, starting with position 1.

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SYSSECPOLICYEXEMPTIONS

The **syssecpolicyexemptions** system catalog table records the exemptions that have been given to users. It has these columns.

Column	Type	Explanation
grantee	CHAR(32)	The user who has this exemption
secpolicyid	INTEGER	ID of the policy on which the exemption is granted

Column	Type	Explanation
exemption	CHAR(6)	<p>The exemption given to the user who is identified in the GRANTEE column. The six characters have the following meanings:</p> <ul style="list-style-type: none"> • 1 = Read array • 2 = Read set • 3 = Read tree • 4 = Write array • 5 = Write set • 6 = Write tree <p>Each character has one of the following values:</p> <ul style="list-style-type: none"> • E = Exempt • D = Write down exemption • U = Write up exemption • – = No exemption

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SYSSEQUENCES

The **syssequences** system catalog table lists the sequence objects that exist in the database. The **syssequences** table has the following columns.

Column	Type	Explanation
seqid	SERIAL	Code uniquely identifying the sequence object
tabid	INTEGER	Identifying code of the sequence as a table object
start_val	INT8	Starting value of the sequence
inc_val	INT8	Value of the increment between successive values
max_val	INT8	Largest possible value of the sequence
min_val	INT8	Smallest possible value of the sequence
cycle	CHAR(1)	Zero means NOCYCLE, 1 means CYCLE
restart_val	INT8	Starting value of the sequence after ALTER SEQUENCE RESTART was run
cache	INTEGER	Number of preallocated values in sequence cache
order	CHAR(1)	Zero means NOORDER, 1 means ORDER

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SYSSURROGATEAUTH

The **syssurrogateauth** system catalog table stores trusted user and surrogate user information.

The **syssurrogateauth** system catalog table is populated when the GRANT SETSESSIONAUTH statement is run. Users or roles specified in the TO clause are added to **trusteduser** column. Users specified in the ON clause are added to **surrogateuser** column.

For example, consider the following statement:

```
GRANT SETSESSIONAUTH ON bill, john TO mary, peter;
```

Entries in the **syssurrogateauth** table are created as follows:

trusteduser	surrogateuser
mary	bill
mary	john
peter	bill
peter	john

The **syssurrogateauth** table has the following columns.

Table 1. SYSSURROGATEAUTH table column descriptions

Column	Type	Explanation
trusteduser	CHAR(32)	Trusted user name or role.
surrogateuser	CHAR(32)	Surrogate user name.

SYSSYNONYMS

The **syssynonyms** system catalog table is unused. The **syssynonym** table describes synonyms. The **syssynonyms** system catalog table has the following columns.

Table 1. SYSSYNONYMS table column descriptions

Column	Type	Explanation
owner	VARCHAR(32)	Name of the owner of the synonym
synname	VARCHAR(128)	Name of the synonym
created	DATE	Date when the synonym was created
tabid	INTEGER	Identifying code of a table, sequence, or view

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SYSSYNTABLE

The **syssynntable** system catalog table outlines the mapping between each public or private synonym and the database object (table, sequence, or view) that it represents. It contains one row for each entry in the **systables** table that has a **tabtype** value of P or S. The **syssynntable** table has the following columns.

Column	Type	Explanation
tabid	INTEGER	Identifying code of the public synonym
servername	VARCHAR(128)	Name of an external database server
dbname	VARCHAR(128)	Name of an external database
owner	VARCHAR(32)	Name of the owner of an external object
tabname	VARCHAR(128)	Name of an external table or view
btbid	INTEGER	Identifying code of a base table, sequence, or view

ANSI-compliant databases do not support public synonyms; their **syssynntable** tables can describe only synonyms whose **syssynntable.tabtype** value is P.

If you define a synonym for an object that is in your current database, only the **tabid** and **btbid** columns are used. If you define a synonym for a table that is external to your current database, the **btbid** column is not used, but the **tabid**, **servername**, **dbname**, **owner**, and **tabname** columns are used.

The **tabid** column maps to **systables.tabid**. With the **tabid** information, you can determine additional facts about the synonym from **systables**.

An index on the **tabid** column allows only unique values. The **btbid** column is indexed to allow duplicate values.

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SYSTABAMDATA

The **systabamdata** system catalog table stores the table-specific hashing parameters of tables that were created with a primary access method.

The **systabamdata** table has the following columns.

Table 1. SYSTABAMDATA table column descriptions

Column	Type	Explanation
tabid	INTEGER	Identifying code of the table
am_param	LVARCHAR(8192)	Access method parameter choices
am_space	VARCHAR(128)	Name of the storage space holding the data values

The **am_param** column stores configuration parameters that determine how a primary access method accesses a given table. Each configuration parameter in the **am_param** list has the format *keyword=value* or *keyword*.

The **am_space** column specifies the location of the table. It might be located in a cooked file, a different database, or an sbspace within the database server.

The **tabid** column is the primary key to the **systables** table. This column is indexed and must contain unique values.

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SYSTABAUTH

The **sysabauth** system catalog table describes each set of privileges that are granted on a table, view, sequence, or synonym. It contains one row for each set of table privileges that are granted in the database; the REVOKE statement can modify a row. The **sysabauth** table has the following columns.

Table 1. SYSTABAUTH table column descriptions

Column	Type	Explanation
grantor	VARCHAR(32)	Name of the grantor of privilege
grantee	VARCHAR(32)	Name of the grantee of privilege
tabid	INTEGER	Value from sysables.tabid for database object
tabauth	CHAR(9) CHAR(8)	Pattern that specifies privileges on the table, view, synonym, or sequence: <ul style="list-style-type: none"> • s or S = Select • u or U = Update • * = Column-level privilege • i or I = Insert • d or D = Delete • x or X = Index • a or A = Alter • r or R = References • n or N = Under privilege

If the **tabauth** column shows a privilege code in uppercase (for example, s for Select), this indicates that the user also has the option to grant that privilege to others. Privilege codes listed in lowercase (for example, s for select) indicate that the user has the specified privilege, but cannot grant it to others.

A hyphen (-) indicates the absence of the privilege corresponding to that position within the **tabauth** pattern.

A **tabauth** value with an asterisk (*) means column-level privileges exist; see also **syscolauth** (page [SYSINDEXES](#)). (In DB-Access, the **Privileges** option of the **Info** command for a specified table can display the column-level privileges on that table.)

A composite index on **tabid**, **grantor**, and **grantee** allows only unique values. A composite index on **tabid** and **grantee** allows duplicate values.

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SYSTABLES

The **sysables** system catalog table contains a row for each table object (a table, view, synonym, or in IBM® Informix®, a sequence) that has been defined in the database, including the tables and views of the system catalog.

Table 1. SYSTABLES table column descriptions

Column	Type	Explanation
tabname	VARCHAR(128)	Name of table, view, synonym, or sequence
owner	CHAR(32)	Owner of table (user informix for system catalog tables and <i>username</i> for database tables)
partnum	INTEGER	Physical storage location code
tabid	SERIAL	System-assigned sequential identifying number
rowsize	SMALLINT	Maximum row size in bytes (< 32,768)
ncols	SMALLINT	Number of columns in the table
nindexes	SMALLINT	Number of indexes on the table
nrows	FLOAT	Number of rows in the table
created	DATE	Date when table was created or last modified
version	INTEGER	Number that changes when table is altered
tabtype	CHAR(1)	Code indicating the type of table object: <ul style="list-style-type: none"> • T = Table • E = External Table • V = View • Q = Sequence • P = Private synonym • S = Public synonym (Type S is unavailable in an ANSI-compliant database.)
locklevel	CHAR(1)	Lock mode for the table: <ul style="list-style-type: none"> • B = Page and row level • P = Page level • R = Row level

Column	Type	Explanation
npused	FLOAT	Number of data pages that have ever been initialized in the tablespace by the database server
fextsize	INTEGER	Size of initial extent (in KB)
nextsize	INTEGER	Size of all subsequent extents (in KB)
flags	SMALLINT	Codes for classifying permanent tables: ROWID 1 - Has rowid column defined UNDER 2 - Table created under a supertable VIEWREMOTE 4 - View is based on a remote table CDR 8 - Has CDRCOLS defined RAW 16 - (Informix) RAW table EXTERNAL 32 - External table AUDIT 64 - Audit table attribute - FGA AQT 128 - View is an AQT for DWA offloading VIRTAQT 256 - View is a virtual AQT
site	VARCHAR(128)	Reserved for future use
dbname	VARCHAR(128)	Reserved for future use
type_xid	INTEGER	Code from sysxdtypes.extended_id for typed tables, or 0 for untyped tables
am_id	INTEGER	Access method code (key to sysams table) NULL or 0 indicates built-in storage manager
pagesize	INTEGER	The pagesize, in bytes, of the dbspace (or dbspaces, if the table is fragmented) where the table data resides.
ustlowts	DATETIME YEAR TO FRACTION (5)	When table, row, and page-count statistics were last recorded
secpolicyid	INTEGER	ID of the SECURITY policy attached to the table. NULL for non-protected tables
protgranularity	CHAR(1)	LBAC granularity level: <ul style="list-style-type: none"> • R: Row level granularity • C: Column level granularity • B: Both column and row granularity • Blank for non-protected tables
statlevel	CHAR(1)	Statistics level <ul style="list-style-type: none"> • T = table • F = fragment • A = automatic
statchange	SMALLINT	For internal use only

Each table, view, sequence, and synonym recorded in the **systables** table is assigned a **tabid**, which is a system-assigned SERIAL value that uniquely identifies the object. The first 99 **tabid** values are reserved for the system catalog. The **tabid** of the first user-defined table object in a database is always 100.

The **tabid** column is indexed and contains only unique values. A composite index on the **tablename** and **owner** columns also requires unique values.

The version column contains an encoded number that is stored in **systables** when a new table is created. Portions of this value are incremented when data-definition statements, such as ALTER INDEX, ALTER TABLE, DROP INDEX, and CREATE INDEX, are performed on the table.

In the **flags** column, ST_RAW represents a nonlogging permanent table in a database that supports transaction logging.

The setting of the SQL_LOGICAL_CHAR parameter is encoded into the **systables.flags** column value in the row that describes the ' **VERSION**' table. Note the leading blank space in the identifier of this system-generated table.

To determine whether the database enables the SQL_LOGICAL_CHAR configuration parameter, which can apply logical character semantics to the declarations of character columns, you can execute the following query:

```
SELECT flags INTO $value FROM 'informix'.systables WHERE tablename = ' VERSION';
```

Because the SQL_LOGICAL_CHAR setting is encoded in the two least significant bits of the " **VERSION.flags**" value, you can calculate its setting from the returned **flags** value by the following formula:

```
SQL_LOGICAL_CHAR = (value & 0x03) + 1
```

Here `&` is the bitwise `AND` operator. Any `SQL_LOGICAL_CHAR` setting greater than 1 indicates that `SQL_LOGICAL_CHAR` was enabled when the database was created, and that explicit or default maximum size specifications of character columns are multiplied by that setting.

When a prepared statement that references a database table is executed, the version value is checked to make sure that nothing has changed since the statement was prepared. If the version value has been changed by DDL operations that modified the table schema while automatic recompilation was disabled by the `IFX_AUTO_REPREPARE` setting of the `SET ENVIRONMENT` statement, the prepared statement is not executed, and you must prepare the statement again.

The **npused** column does not reflect the number of pages used for `BYTE` or `TEXT` data, nor the number of pages that are freed in `DELETE` or `TRUNCATE` operations.

The **nrows** column and the **npused** columns might not accurately reflect the number of rows and the number of data pages used by an external table unless the `NUMROWS` clause was specified when the external table was created. See the *IBM Informix Administrator's Guide* for more information.

The **systables** table has two rows that store information about the database locale: `GL_COLLATE` with a **tabid** of 90 and `GL_CTYPE` with a **tabid** of 91. To view these rows, enter the following `SELECT` statement:

```
SELECT * FROM systables WHERE tabid=90 OR tabid=91;
```

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SYSTRACECLASSES

The **systraceclasses** system catalog table contains the names and identifiers of trace classes. The **systraceclasses** table has the following columns.

Table 1. SYSTRACECLASSES table column descriptions

Column	Type	Explanation
name	CHAR(18)	Name of the class of trace messages
classid	SERIAL	Identifying code of the trace class

A *trace class* is a category of trace messages that you can use in the development and testing of new DataBlade modules and user-defined routines. Developers use the tracing facility by calling the appropriate DataBlade API routines within their code.

To create a new trace class, insert a row directly into the **systraceclasses** table. By default, all users can view this table, but only users with the `DBA` privilege can modify it.

The database cannot support tracing unless the `MITRACE_OFF` configuration parameter is undefined.

A unique index on the **name** column requires each trace class to have a unique name. The database server assigns to each class a unique sequential code. The index on this **classid** column also allows only unique values.

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SYSTRACEMSGS

The **systracemsgs** system catalog table stores internationalized trace messages that you can use in debugging user-defined routines.

The **systracemsgs** table has the following columns.

Table 1. SYSTRACEMSGS table column descriptions

Column	Type	Explanation
name	VARCHAR(128)	Name of the message
msgid	SERIAL	Identifying code of the message template
locale	CHAR(36)	Locale with which this version of the message is associated (for example, en_us.8859-1)
seqno	SMALLINT	Reserved for future use
message	VARCHAR(255)	The message text

DataBlade module developers create a trace message by inserting a row directly into the **systracemsgs** table. After a message is created, the development team can specify it either by name or by **msgid** code, using trace statements that the DataBlade API provides.

To create a trace message, you must specify its name, locale, and text. By default, all users can view the **systracemsgs** table, but only users with the `DBA` privilege can modify it.

The database cannot support tracing unless the `MITRACE_OFF` configuration parameter is undefined.

A unique composite index is defined on the **name** and **locale** columns. Another unique index is defined on the **msgid** column.

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SYSTRIGBODY

The **systrigbody** system catalog table contains the ASCII text of the trigger definition and the linearized code for the trigger. *Linearized code* is binary data and code that is represented in ASCII format.

Important: The database server uses the linearized code that is stored in **systrigbody**. You must not alter the content of rows that contain linearized code.

The **systrigbody** table has the following columns.

Table 1. SYSTRIGBODY table column descriptions

Column	Type	Explanation
trigid	INTEGER	Identifying code of the trigger
datakey	CHAR(1)	Code specifying the type of data: <ul style="list-style-type: none">• A = ASCII text for the body, triggered actions• B = Linearized code for the body• D = English text for the header, trigger definition• H = Linearized code for the header• S = Linearized code for the symbol table
seqno	INTEGER	Page number of this data segment
data	CHAR(256)	English text or linearized code

A composite index on the **trigid**, **datakey**, and **seqno** columns allows only unique values.

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SYSTRIGGERS

The **systriggers** system catalog table contains information about the SQL triggers in the database. This information includes the triggering event and the correlated reference specification for the trigger. The **systriggers** table has the following columns.

Table 1. SYSTRIGGERS table column descriptions

Column	Type	Explanation
trigid	SERIAL	Identifying code of the trigger
trigname	VARCHAR(128)	Name of the trigger
owner	VARCHAR(32)	Name of the owner of the trigger
tabid	INTEGER	Identifying code of the triggering table
event	CHAR(1)	Code for the type of triggering event: <ul style="list-style-type: none">• D = Delete trigger• I = Insert trigger• U = Update trigger• S = Select trigger• d = INSTEAD OF Delete trigger• i = INSTEAD OF Insert trigger• u = INSTEAD OF Update trigger
old	VARCHAR(128)	Name of value before update
new	VARCHAR(128)	Name of value after update
mode	CHAR(1)	Reserved for future use
collation	CHAR(32)	Collating order at the time when the routine was created

A composite index on the **trigname** and **owner** columns allows only unique values. An index on the **trigid** column also requires unique values. An index on the **tabid** column allows duplicate values.

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SYSUSERS

The **sysusers** system catalog table lists the authorization identifier of every individual user, or public for the PUBLIC group, who holds database-level access privileges. This table also lists the name of every role that holds access privileges on any object in the database.

This system catalog table has the following columns:

Table 1. SYSUSERS table column descriptions

Column	Type	Explanation
username	VARCHAR(32)	Name of the database user or role. An index on username allows only unique values. The username value can be the login name of a user or the name of a role.

Column	Type	Explanation
usertype	CHAR(1)	Code specifying the highest database-level privilege held by username , where username is an individual user or the PUBLIC group, or a role name. The valid codes are: <ul style="list-style-type: none"> D = DBA (all privileges) R = Resource (create UDRs, UDTs, permanent tables, and indexes) C = Connect (work with existing tables) G = Role U = Default role. When a user is assigned a default role, an implicit connection to the database is granted to the user. This is the role the user has before being granted a C, D, or R role.
priority	SMALLINT	Reserved for future use.
password	CHAR(16)	Reserved for future use.
defrole	VARCHAR(32)	Name of the default role.

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SYSVIEWS

The **sysviews** system catalog table describes each view in the database. Because it stores the SELECT statement that created the view, **sysviews** can contain multiple rows for each view. It has the following columns.

Column	Type	Explanation
tabid	INTEGER	Identifying code of the view
seqno	SMALLINT	Line number of the SELECT statement
viewtext	CHAR(256)	Actual SELECT statement used to create the view

A composite index on **tabid** and **seqno** allows only unique values.

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SYSVIOLATIONS

The **sysviolations** system catalog table stores information about constraint violations for base tables.

This table is updated when the DELETE, INSERT, MERGE, or UPDATE statement detects a violation of an enabled constraint or unique index in a database table for which the START VIOLATIONS TABLE statement of SQL has created an associated violations table (and for Informix®, a diagnostics table). For each base table that has an active violations table, the **sysviolations** table has a corresponding row, with the following columns.

Column	Type	Explanation
targettid	INTEGER	Identifying code of the <i>target table</i> (the base table on which the violations table and the diagnostic table are defined)
viotid	INTEGER	Identifying code of the violations table
diatid	INTEGER	Identifying code of the diagnostics table
maxrows	INTEGER	Maximum number of rows that can be inserted into the diagnostics table by a single insert, update, or delete operation on a target table that has a filtering mode object defined on it.

The **maxrows** column also signifies the maximum number of rows that can be inserted in the diagnostics table during a single operation that enables a disabled object or that sets a disabled object to filtering mode (provided that a diagnostics table exists for the target table). If no maximum is specified for the diagnostics or violations table, then **maxrows** contains a NULL value.

The primary key of this table is the **targettid** column. An additional unique index is also defined on the **viotid** column.

IBM® Informix also has a unique index on the **diatid** column.

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SYSXADATASOURCES

The **sysxadatasources** system catalog table stores XA data sources.

The **sysxadatasources** table has the following columns.

Column	Type	Explanation
--------	------	-------------

Column	Type	Explanation
xa_datasrc_owner	CHAR(32)	The user ID of the XA data source owner
xa_datasrc_name	VARCHAR(128)	The name of the XA data source
xa_datasrc_rmid	SERIAL	Unique RMID of the XA data source
xa_source_typeid	INTEGER	XA data source type ID

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SYSXASOURCETYPES

The **sysxasourcetypes** system catalog table stores XA data source types.

The **sysxasourcetypes** table has the following columns.

Column	Type	Explanation
xa_source_typeid	SERIAL	A unique identifier for the source type
xa_source_owner	CHAR(32)	The user ID of the owner
xa_source_name	VARCHAR(128)	The name of the source type
xa_flags	INTEGER	
xa_version	INTEGER	
xa_open	INTEGER	UDR ID of xa_open_entry
xa_close	INTEGER	UDR ID of xa_close_entry
xa_start	INTEGER	UDR ID of xa_start_entry
xa_end	INTEGER	UDR ID of xa_end_entry
xa_rollback	INTEGER	UDR ID of xa_rollback_entry
xa_prepare	INTEGER	UDR ID of xa_prepare_entry
xa_commit	INTEGER	UDR ID of xa_commit_entry
xa_recover	INTEGER	UDR ID of xa_recover_entry
xa_forget	INTEGER	UDR ID of xa_forget_entry
xa_complete	INTEGER	UDR ID of xa_complete_entry

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SYSXTDESC

The **sysxtddesc** system catalog table provides a text description of each user-defined data type (UDT) defined in the database. The **sysxtddesc** table has the following columns.

Column	Type	Explanation
extended_id	INTEGER	Code uniquely identifying the extended data types
seqno	SMALLINT	Value to order and identify one line of the description of the UDT A new line is created only if the remaining text string is larger than 255 bytes.
description	CHAR(256)	Textual description of the extended data type

A composite index on **extended_id** and **seqno** allows duplicate values.

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SYSXTDTYPEAUTH

The **sysxtdtypeauth** system catalog table identifies the privileges on each UDT (user-defined data type).

The **sysxtdtypeauth** table contains one row for each set of privileges granted and has the following columns:

Column	Type	Explanation
grantor	VARCHAR(32)	Name of grantor of privilege
grantee	VARCHAR(32)	Name of grantee of privilege

Column	Type	Explanation
type	INTEGER	Code identifying the UDT
auth	CHAR(2)	Code identifying privileges on the UDT: <ul style="list-style-type: none"> • n or N = Under privilege • u or U = Usage privilege

If the privilege code in the **auth** column is upper case (for example, 'U' for usage), a user who has this privilege can also grant it to others. If the code is in lower case, a user who has the privilege cannot grant it to others.

A composite index on **type**, **grantor**, and **grantee** allows only unique values. A composite index on the **type** and **grantee** columns allows duplicate values.

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SYSXTDTYPES

The **sysxtdtypes** system catalog table has an entry for each UDT (user-defined data type), including opaque and distinct data types and complex data types (named ROW types, unnamed ROW types, and COLLECTION types), that is defined in the database.

The **sysxtdtypes** table has the following columns.

Table 1. SYSXTDTYPES table column descriptions

Column	Type	Explanation
extended_id	SERIAL	Unique identifying code for extended data type
domain	CHAR(1)	Code for the domain of the UDT
mode	CHAR(1)	Code classifying the UDT: <ul style="list-style-type: none"> • B = Base (opaque) type • C = Collection type or unnamed ROW type • D = Distinct type • R = Named ROW type • S = Reserved for internal use • T = Reserved for internal use • ' ' (blank) = Built-in type
owner	VARCHAR(32)	Name of the owner of the UDT
name	VARCHAR(128)	Name of the UDT
type	SMALLINT	Code classifying the UDT
source	INTEGER	The sysxtdtypes reference (for distinct types only) Zero (0) indicates that a distinct UDT was created from a built-in data type.
maxlen	INTEGER	The maximum length for variable-length data types Zero indicates a fixed-length UDT.
length	INTEGER	The length in bytes for fixed-length data types Zero indicates a variable-length UDT.
byvalue	CHAR(1)	'T' = UDT is passed by value 'F' = UDT is not passed by value
cannothash	CHAR(1)	'T' = UDT is hashable by default hash function 'F' = UDT is not hashable by default function
align	SMALLINT	Alignment (= 1, 2, 4, or 8) for this UDT
locator	INTEGER	Locator key for unnamed ROW type

Each extended data type is characterized by a unique identifier, called an extended identifier (**extended_id**), a data type identifier (**type**), and the length and description of the data type.

For distinct types created from built-in data types, the **type** column codes correspond to the value of the **syscolumns.coltype** column (indicating the source type) as listed on page [SYSCOLUMNS](#), but incremented by the hexadecimal value 0x0000800. The file \$INFORMIXDIR/incl/esql/sqltypes.h contains information about **sysxtdtypes.type** and **syscolumns.coltype** codes.

An index on the **extended_id** column allows only unique values. An index on the **locator** column allows duplicate values, as does a composite index on the **name** and **owner** columns. A composite index on the **type** and **source** columns also allows duplicate values.

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Information Schema

The Information Schema consists of read-only views that provide information about all the tables, views, and columns in the current database server to which you have access. These views also provide information about SQL dialects (such as IBM® Informix®, Oracle, or Sybase) and SQL standards. Note that unlike a system catalog, whose tables describes an individual database, these views describe the IBM Informix instance, rather than a single database.

This version of the Information Schema views is an X/Open CAE standard. These standards are provided so that applications developed on other database systems can obtain IBM Informix system catalog information without accessing the IBM Informix system catalog tables directly.

Important: Because the X/Open CAE standard for Information Schema views differs from ANSI-compliant Information Schema views, it is recommended that you do not install the X/Open CAE Information Schema views on ANSI-compliant databases.

The following Information Schema views are available:

- **tables**
- **columns**
- **sql_languages**
- **server_info**

Sections that follow contain information about how to generate and access Information Schema views and information about their structure.

- [Generating the Information Schema Views](#)
- [Accessing the Information Schema Views](#)
- [Structure of the Information Schema Views](#)

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Generating the Information Schema Views

The Information Schema views are generated automatically when you, as DBA, run the following DB-Access command:

```
dbaccess database-name $INFORMIXDIR/etc/xpg4_is.sql
```

The views display data from the system catalog tables. If tables, views, or routines exist with any of the same names as the Information Schema views, you must either rename those database objects or rename the views in the script before you can install the views. You can drop the views with the DROP VIEW statement on each view. To re-create the views, rerun the script.

Important: In addition to the columns specified for each Information Schema view, individual vendors might include additional columns or change the order of the columns. It is recommended that applications not use the forms SELECT * or SELECT table-name* to access an Information Schema view.

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Accessing the Information Schema Views

All Information Schema views have the Select privilege granted to PUBLIC WITH GRANT OPTION so that all users can query the views. Because no other privileges are granted on the Information Schema views, they cannot be updated.

You can query the Information Schema views as you would query any other table or view in the database.

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Structure of the Information Schema Views

The following Information Schema views are described in this section:

- **tables**
- **columns**
- **sql_languages**
- **server_info**

In order to accept long identifier names, most of the columns in the views are defined as VARCHAR data types with large maximum sizes.

- [The tables Information Schema View](#)
- [The columns Information Schema View](#)
- [The sql_languages Information Schema View](#)
- [The server_info Information Schema View](#)

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The tables Information Schema View

The **tables** Information Schema view contains one row for each table to which you have access. It contains the following columns.

Column	Data Type	Explanation
table_schema	VARCHAR(32)	Name of owner of table
table_name	VARCHAR(128)	Name of table or view
table_type	VARCHAR(128)	BASE TABLE for table or VIEW for view
remarks	VARCHAR(255)	Reserved for future use

The visible rows in the **tables** view depend on your privileges. For example, if you have one or more privileges on a table (such as Insert, Delete, Select, References, Alter, Index, or Update on one or more columns), or if privileges are granted to PUBLIC, you see the row that describes that table.

Related reference:

[The columns Information Schema View](#)

[The sql_languages Information Schema View](#)

[The server_info Information Schema View](#)

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The columns Information Schema View

The **columns** Information Schema view contains one row for each accessible column. It contains the following columns.

Table 1. Description of the columns Information Schema View

Column	Data Type	Explanation
table_schema	VARCHAR(128)	Name of owner of table
table_name	VARCHAR(128)	Name of table or view
column_name	VARCHAR(128)	Name of the column in the table or view
ordinal_position	INTEGER	Position of the column within its table The ordinal_position value is a sequential number that starts at 1 for the first column. This is the IBM® Informix® extension to XPG4.
data_type	VARCHAR(254)	Name of the data type of the column, such as CHARACTER or DECIMAL
char_max_length	INTEGER	Maximum length (in bytes) for character data types; NULL otherwise
numeric_precision	INTEGER	Uses one of the following values: <ul style="list-style-type: none"> Total number of digits for exact numeric data types (DECIMAL, INTEGER, MONEY, SMALLINT) Number of digits of mantissa precision (machine-dependent) for approximate data types (FLOAT, SMALLFLOAT) NULL for all other data types.
numeric_prec_radix	INTEGER	Uses one of the following values: <ul style="list-style-type: none"> 2 = Approximate data types (FLOAT and SMALLFLOAT) 10 = Exact numeric data types (DECIMAL, INTEGER, MONEY, and SMALLINT) NULL for all other data types
numeric_scale	INTEGER	Number of significant digits to the right of the decimal point for DECIMAL and MONEY data types 0 for INTEGER and SMALLINT types NULL for all other data types
datetime_precision	INTEGER	Number of digits in the fractional part of the seconds for DATE and DATETIME columns; NULL otherwise This column is the IBM Informix extension to XPG4.
is_nullable	VARCHAR(3)	Indicates whether a column allows NULL values; either YES or NO
remarks	VARCHAR(254)	Reserved for future use

Related reference:

[The tables Information Schema View](#)

[The sql_languages Information Schema View](#)

[The server_info Information Schema View](#)

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The sql_languages Information Schema View

The **sql_languages** Information Schema view contains a row for each instance of conformance to standards that the current database server supports. The **sql_languages** view contains the following columns.

Column	Data Type	Explanation
--------	-----------	-------------

Column	Data Type	Explanation
source	VARCHAR(254)	Organization defining this SQL version
source_year	VARCHAR(254)	Year the source document was approved
conformance	VARCHAR(254)	Standard to which the server conforms
integrity	VARCHAR(254)	Indication of whether this is an integrity enhancement feature; either YES or NO
implementation	VARCHAR(254)	Identification of the SQL product of the vendor
binding_style	VARCHAR(254)	Direct, module, or other binding style
programming_lang	VARCHAR(254)	Host language for which binding style is adapted

The **sql_languages** view is completely visible to all users.

Related reference:

[The tables Information Schema View](#)

[The columns Information Schema View](#)

[The server_info Information Schema View](#)

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The server_info Information Schema View

The **server_info** Information Schema view describes the database server to which the application is currently connected. It contains two columns.

Column	Data Type	Explanation
server_attribute	VARCHAR(254)	An attribute of the database server
attribute_value	VARCHAR(254)	Value of the server_attribute as it applies to the current database server

Each row in this view provides information about one attribute. X/Open-compliant databases must provide applications with certain required information about the database server.

The **server_info** view includes the following **server_attribute** information.

server_attribute	Explanation
identifier_length	Maximum number of bytes for a user-defined identifier
row_length	Maximum number of bytes in a row
userid_length	Maximum number of bytes in a user name
txn_isolation	Initial transaction isolation level for the database server: Read Uncommitted (= Default isolation level for databases with no transaction logging; also called Dirty Read) Read Committed (= Default isolation level for databases that are not ANSI-compliant, but that support explicit transaction logging) Serializable (= Default isolation level for ANSI-compliant databases; also called Repeatable Read)
collation_seq	Assumed ordering of the character set for the database server The following values are possible: ISO 8859-1 EBCDIC The default IBM® Informix® representation shows ISO 8859-1.

The **server_info** view is completely visible to all users.

Related reference:

[The tables Information Schema View](#)

[The columns Information Schema View](#)

[The sql_languages Information Schema View](#)

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Data types

Every column in a table in a database is assigned a data type. The data type precisely defines the kinds of values that you can store in that column.

These topics describe built-in and extended data types, casting between two data types, and operator precedence.

- [Summary of data types](#)
IBM Informix supports the most common set of built-in data types. Additionally, an extended set of data types are supported on the database server.
- [**** MISSING FILE ****](#)
- [Description of Data Types](#)
- [Built-In Data Types](#)
- [Extended Data Types](#)
- [Data Type Casting and Conversion](#)
- [Operator Precedence](#)

Summary of data types

IBM® Informix® supports the most common set of built-in data types. Additionally, an extended set of data types are supported on the database server.

You can use both *built-in* data types (which are system-defined) and *extended* data types (which you can define) in the following ways:

- Use them to create columns within database tables.
- Declare them as arguments and as returned types of routines.
- Use them as base types from which to create DISTINCT data types.
- Cast them to other data types.
- Declare and access host variables of these types in SPL and ESQL/C.

You assign data types to columns with the CREATE TABLE statement and change them with the ALTER TABLE statement. When you change an existing column data type, all data is converted to the new data type, if possible.

For information about the ALTER TABLE and CREATE TABLE statements, on SQL statements that create specific data types, that create and drop casts, and on other data type topics, see the *IBM Informix Guide to SQL: Syntax*.

For information about how to create and use complex data types supported by IBM Informix, see the *IBM Informix Database Design and Implementation Guide*. For information about how to create user-defined data types, see *IBM Informix User-Defined Routines and Data Types Developer's Guide*.

Some data types can be used in distributed SQL operations, while others can be used only in SQL operations within the same database.

Built-in data types supported in local and distributed SQL operations

The following table lists all of the built-in SQL data types that Informix supports. These built-in SQL data types are valid in all Informix SQL transactions, including data-manipulation language (DML) operations of these types:

- Operations on objects in the local database
- Cross-database operations on objects in databases of the local server instance
- Cross-server operations on objects in databases of two or more database server instances

Table 1. Data types supported in all operations

Data type	Explanation
BIGINT data type	Stores 8-byte integer values from $-(2^{63}-1)$ to $2^{63}-1$
BIGSERIAL data type	Stores sequential, 8-byte integers from 1 to $2^{63}-1$
BSON and JSON built-in opaque data types	The BSON data type is the binary representation of a JSON data type format for serializing JSON documents. The JSON data type is a plain text format for entering and displaying structured data.
BYTE data type	Stores any kind of binary data, up to 2^{31} bytes in length
CHAR(n) data type	Stores character strings; collation is in code-set order
CHARACTER(n) data type	Is a synonym for CHAR
CHARACTER VARYING(m,r) data type	Stores character strings of varying length (ANSI-compliant); collation is in code-set order
DATE data type	Stores calendar dates
DATETIME data type	Stores calendar date combined with time of day
DEC data type	Is a synonym for DECIMAL
DECIMAL	Stores floating-point numbers with definable precision; if database is ANSI-compliant, the scale is zero
DECIMAL(p,s) Fixed Point	Stores fixed-point numbers of defined scale and precision
DOUBLE PRECISION data types	Synonym for FLOAT
FLOAT(n)	Stores double-precision floating-point numbers corresponding to the double data type in C
INT data type	Is a synonym for INTEGER
INT8	Stores 8-byte integer values from $-(2^{63}-1)$ to $2^{63}-1$
INTEGER data type	Stores whole numbers from -2,147,483,647 to +2,147,483,647
INTERVAL data type	Stores a span of time (or level of effort) in units of <i>years</i> and <i>months</i> .
INTERVAL data type	Stores a span of time in a contiguous set of units of <i>days</i> , <i>hours</i> , <i>minutes</i> , <i>seconds</i> , and <i>fractions of a second</i>
MONEY(p,s) data type	Stores currency amounts
NCHAR(n) data type	Same as CHAR, but can support localized collation
NUMERIC(p,s) data type	Synonym for DECIMAL(p,s)
NVARCHAR(m,r) data type	Same as VARCHAR, but can support localized collation
REAL data type	Is a synonym for SMALLFLOAT

Data type	Explanation
SERIAL(n) data type	Stores sequential integers (> 0) in positive range of INT
SERIAL8(n) data type	Stores sequential integers (> 0) in positive range of INT8
SMALLFLOAT	Stores single-precision floating-point numbers corresponding to the float data type of the C language
SMALLINT data type	Stores whole numbers from -32,767 to +32,767
TEXT data type	Stores any kind of text data, up to 2 ³¹ bytes in length
VARCHAR(m,r) data type	Stores character strings of varying length (up to 255 bytes); collation is in code-set order

In cross-server MERGE operations, the source table (but not the target table) can be in a database of a remote Informix server.

For the character data types (CHAR, CHAR VARYING, LVARCHAR, NCHAR, NVARCHAR, and VARCHAR), a data string can include letters, digits, punctuation, whitespace, diacritical marks, ligatures, and other printable symbols from the code set of the database locale. For **UTF-8** and for code sets of some East Asian locales, multibyte characters are supported within data strings.

Built-in data types supported only in local database SQL operations

The following table lists the data types that Informix supports only for use in SQL operations in a local database.

Table 2. Data types supported in a local database

Data type	Explanation
BLOB data type	Stores binary data in random-access chunks
The binary18 data type	Stores 18 byte binary-encoded strings
The binaryvar data type	Stores binary-encoded strings with a maximum length of 255 bytes
BOOLEAN data type	Stores Boolean values true and false
CLOB data type	Stores text data in random-access chunks
DISTINCT data types	Stores data in a user-defined type that has the same format as a source type on which it is based, but its casts and functions can differ from those on the source type
Calendar data type	Stores a calendar for a TimeSeries data type
CalendarPattern data type	Stores the structure of the calendar pattern for a Calendar data type
IDSSECURITYLABEL data type	Stores LBAC security label objects.
LIST(e) data type	Stores a sequentially ordered collection of elements, all of the same data type, e; allows duplicate values
The lld_locator data type	Stores a large object identifier
The lld_lob data type	Stores the location of a smart large object and specifies whether the object contains binary or character data
LVARCHAR(m) data type	Stores variable-length strings of up to 32,739 bytes
MULTISET(e) data type	Stores a non-ordered collection of values, with elements all of the same data type, e; allows duplicate values.
The node data type for querying hierarchical data	Stores a combination of integers and decimal points that represents hierarchical relationships, of variable length up to 256 characters
OPAQUE data types	Stores a user-defined data type whose internal structure is inaccessible to the database server
ROW data type, Named	Stores a named ROW type
ROW data type, Unnamed	Stores an unnamed ROW type
SET(e) data type	Stores a non-ordered collection of elements, all of the same data type, e; does not allow duplicate values
ST_LineString data type	Stores a one-dimensional object as a sequence of points defining a linear interpolated path
ST_MultiLineString data type	Stores a collection of ST_LineString data types
ST_MultiPoint data type	Stores a collection of ST_Point data types
ST_MultiPolygon data type	Stores a collection of ST_Polygon data types
ST_Point data type	Stores a zero-dimensional geometry that occupies a single location in coordinate space
ST_Polygon data type	Stores a two-dimensional surface stored as a sequence of points defining its exterior bounding ring and 0 or more interior rings
TimeSeries data type	Stores a collection of row subtypes

These extended data types of Informix are individually described in other topics. These data types are valid in local operations on databases where the data types are defined.

Extended data types in cross-database distributed SQL transactions

Distributed operations on other databases of the same Informix instance can access BOOLEAN, BLOB, CLOB, and LVARCHAR data types, which are implemented as built-in opaque types. Such operations can also access DISTINCT types whose base types are built-in types, and user-defined types (UDTs), if the UDTs and DISTINCT types are explicitly cast to built-in types, and if all of the UDTs, casts, and DISTINCT types are defined in all the participating databases.

You cannot, however, reference the following extended data types in cross-database transactions that access multiple databases of the local Informix instance:

- UDTs that are not cast to built-in data types
- DISTINCT types that are not cast to built-in data types
- Collection data types
- Named or unnamed ROW data types

Extended data types in cross-server distributed SQL transactions

Distributed SQL transactions and function calls that access databases of other Informix instances cannot return values of complex or smart large object data types, nor of most distinct or built-in opaque data types. Among the extended data types, only the following can be accessed in cross-server SQL operations:

- Any non-opaque built-in data type
- BOOLEAN
- DISTINCT of non-opaque built-in types
- DISTINCT of BOOLEAN
- DISTINCT of LVARCHAR
- DISTINCT of any of the DISTINCT types listed above
- IDSECURITYLABEL
- LVARCHAR

A cross-server distributed SQL transaction can support DISTINCT data types only if they are cast explicitly to built-in types, and all of the DISTINCT types, their data type hierarchies, and their casts are defined exactly the same way in each database that participates in the distributed operation. For queries or other DML operations in cross-server UDRs that use the data types in the preceding list as parameters or as returned data types, the UDR must also have the same definition in every participating database.

The built-in DISTINCT data type IDSECURITYLABEL, which stores security label objects, can be accessed in cross-server and cross-database operations on protected data by users who hold sufficient security credentials. Like local operations on protected data, distributed queries that access remote tables protected by a security policy can return only the qualifying rows that IDSLBACRULES allow, after the database server has compared the security label that secures the data with the security credentials of the user who issues the query.

Related concepts:

[Extended Data Types](#)

Related reference:

[Built-In Data Types](#)

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Description of Data Types

This section describes the data types that IBM® Informix® supports.

- [BIGINT data type](#)
The BIGINT data type stores integers from $-(2^{63} - 1)$ to $2^{63} - 1$, which is $-9,223,372,036,854,775,807$ to $9,223,372,036,854,775,807$, in eight bytes.
- [BIGSERIAL data type](#)
The BIGSERIAL data type stores a sequential integer, of the BIGINT data type, that is assigned automatically by the database server when a new row is inserted. The behavior of the BIGSERIAL data type is similar to the SERIAL data type, but with a larger range.
- [BLOB data type](#)
The BLOB data type stores any kind of binary data in random-access chunks, called sbspaces. Binary data typically consists of saved spreadsheets, program-load modules, digitized voice patterns, and so on. The database server performs no interpretation of the contents of a BLOB column.
- [BOOLEAN data type](#)
The BOOLEAN data type stores TRUE or FALSE data values as a single byte.
- [BYTE data type](#)
The BYTE data type stores any kind of binary data in an undifferentiated byte stream. Binary data typically consists of digitized information, such as spreadsheets, program load modules, digitized voice patterns, and so on.
- [CHAR\(n\) data type](#)
The CHAR data type stores any string of letters, numbers, and symbols. It can store single-byte and multibyte characters, based on the database locale.
- [CHARACTER\(n\) data type](#)
The CHARACTER data type is a synonym for CHAR.
- [CHARACTER VARYING\(m,r\) data type](#)
The CHARACTER VARYING data type stores a string of letters, digits, and symbols of varying length, where m is the maximum size of the column (in bytes) and r is the minimum number of bytes reserved for that column.
- [CLOB data type](#)
The CLOB data type stores any kind of text data in random-access chunks, called sbspaces. Text data can include text-formatting information, if this information is also textual, such as PostScript, Hypertext Markup Language (HTML), Standard Graphic Markup Language (SGML), or Extensible Markup Language (XML) data.
- [DATE data type](#)
The DATE data type stores the calendar date. DATE data types require four bytes. A calendar date is stored internally as an integer value equal to the number

- of days since December 31, 1899.
- [DATETIME data type](#)
The DATETIME data type stores an instant in time expressed as a calendar date and time of day.
- [DEC data type](#)
The DEC data type is a synonym for DECIMAL.
- [DECIMAL](#)
The DECIMAL data type can take two forms: DECIMAL(*p*) floating point and DECIMAL(*p*,*s*) fixed point.
- [DISTINCT data types](#)
A DISTINCT type is a data type that is derived from a source type (called the base type).
- [DOUBLE PRECISION data types](#)
The DOUBLE PRECISION keywords are a synonym for the FLOAT keyword.
- [FLOAT\(*n*\)](#)
- [IDSESECURITYLABEL data type](#)
The IDSESECURITYLABEL type stores a security label in a table that is protected by a label-based access control (LBAC) security policy.
- [INT data type](#)
The INT data type is a synonym for INTEGER.
- [INT8](#)
The INT8 data type stores whole numbers that can range in value from $-9,223,372,036,854,775,807$ to $9,223,372,036,854,775,807$ [or $-(2^{63}-1)$ to $2^{63}-1$], for 18 or 19 digits of precision.
- [INTEGER data type](#)
The INTEGER data type stores whole numbers that range from $-2,147,483,647$ to $2,147,483,647$ for 9 or 10 digits of precision.
- [INTERVAL data type](#)
The INTERVAL data type stores a value that represents a span of time. INTERVAL types are divided into two classes: *year-month intervals* and *day-time intervals*.
- [LIST\(*e*\) data type](#)
The LIST data type is a collection type that can store ordered non-NULL elements of the same SQL data type.
- [LVARCHAR\(*m*\) data type](#)
Use the LVARCHAR data type to create a column for storing variable-length character strings whose upper limit (*m*) can be up to 32,739 bytes.
- [MONEY\(*p*,*s*\) data type](#)
The MONEY data type stores currency amounts.
- [MULTISET\(*e*\) data type](#)
The MULTISET data type is a collection type that stores a non-ordered set that can include duplicate element values.
- [Named ROW](#)
- [NCHAR\(*n*\) data type](#)
The NCHAR data type stores fixed-length character data. The data can be a string of single-byte or multibyte letters, digits, and other symbols that are supported by the code set of the database locale.
- [NUMERIC\(*p*,*s*\) data type](#)
The NUMERIC data type is a synonym for fixed-point DECIMAL.
- [NVARCHAR\(*m*,*r*\) data type](#)
The NVARCHAR data type stores strings of varying lengths. The string can include digits, symbols, and both single-byte and (in some locales) multibyte characters.
- [OPAQUE data types](#)
An OPAQUE type is a data type for which you must provide information to the database server.
- [REAL data type](#)
The REAL data type is a synonym for SMALLFLOAT.
- [ROW data type, Named](#)
A named ROW data type must be declared with a name. This SQL identifier must be unique among data type names within the same database.
- [ROW data type, Unnamed](#)
An unnamed ROW type contains fields but has no user-declared name. An unnamed ROW type is defined by its structure.
- [SERIAL\(*n*\) data type](#)
The SERIAL data type stores a sequential integer, of the INT data type, that is automatically assigned by the database server when a new row is inserted.
- [SERIAL8\(*n*\) data type](#)
The SERIAL8 data type stores a sequential integer, of the INT8 data type, that is assigned automatically by the database server when a new row is inserted.
- [SET\(*e*\) data type](#)
The SET data type is an unordered collection type that stores unique elements
- [SMALLFLOAT](#)
The SMALLFLOAT data type stores single-precision floating-point numbers with approximately nine significant digits.
- [SMALLINT data type](#)
The SMALLINT data type stores small whole numbers that range from $-32,767$ to $32,767$. The maximum negative number, $-32,768$, is a reserved value and cannot be used.
- [TEXT data type](#)
The TEXT data type stores any kind of text data. It can contain both single-byte and multibyte characters that the locale supports. The term *simple large object* refers to an instance of a TEXT or BYTE data type.
- [Unnamed ROW](#)
- [VARCHAR\(*m*,*r*\) data type](#)
The VARCHAR data type stores character strings of varying length that contain single-byte and (if the locale supports them) multibyte characters, where *m* is the maximum size (in bytes) of the column and *r* is the minimum number of bytes reserved for that column.

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BIGINT data type

The BIGINT data type stores integers from $-(2^{63}-1)$ to $2^{63}-1$, which is $-9,223,372,036,854,775,807$ to $9,223,372,036,854,775,807$, in eight bytes.

This data type has storage advantages over INT8 and advantages for some arithmetic operations and sort comparisons over INT8 and DECIMAL data types.

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BIGSERIAL data type

The BIGSERIAL data type stores a sequential integer, of the BIGINT data type, that is assigned automatically by the database server when a new row is inserted. The behavior of the BIGSERIAL data type is similar to the SERIAL data type, but with a larger range.

The default BIGSERIAL starting number is 1, but you can assign an initial value, *n*, when you create or alter the table. The value of *n* must be a positive integer in the range of 1 to 9,223,372,036,854,775,807. If you insert the value zero (0) in a BIGSERIAL column, the value that is used is the maximum positive value that already exists in the BIGSERIAL column + 1. If you insert any value that is not zero, that value will be inserted as it is.

A table can have no more than one SERIAL column, but it can have a SERIAL column and either a SERIAL8 column or a BIGSERIAL column.

For information about:

- The SERIAL data type, see [SERIAL\(n\) data type](#)
- Using the SERIAL8 data type with the INT8 or BIGINT data type, see [Using SERIAL8 and BIGSERIAL with INT8 or BIGINT](#)
- [Using SERIAL8 and BIGSERIAL with INT8 or BIGINT](#)
All the arithmetic operators that are valid for INT8 and BIGINT (such as +, -, *, and /) and all the SQL functions that are valid for INT8 and BIGINT (such as ABS, MOD, POW, and so on) are also valid for SERIAL8 and BIGSERIAL values.

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Using SERIAL8 and BIGSERIAL with INT8 or BIGINT

All the arithmetic operators that are valid for INT8 and BIGINT (such as +, -, *, and /) and all the SQL functions that are valid for INT8 and BIGINT (such as ABS, MOD, POW, and so on) are also valid for SERIAL8 and BIGSERIAL values.

Data conversion rules that apply to INT8 and BIGINT also apply to SERIAL8 and BIGSERIAL, but with a NOT NULL constraint on SERIAL8 or BIGSERIAL.

The value of a SERIAL8 or BIGSERIAL column of one table can be stored in INT8 or BIGINT columns of another table. In the second table, however, the INT8 or BIGINT values are not subject to the constraints on the original SERIAL8 or BIGSERIAL column.

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BLOB data type

The BLOB data type stores any kind of binary data in random-access chunks, called sbspaces. Binary data typically consists of saved spreadsheets, program-load modules, digitized voice patterns, and so on. The database server performs no interpretation of the contents of a BLOB column.

A BLOB column can be up to 4 terabytes (4×2^{40} bytes) in length, though your system resources might impose a lower practical limit. The minimum amount of disk space allocated for smart large object data types is 512 bytes.

The term *smart large object* refers to BLOB and CLOB data types. Use CLOB data types (see page [CLOB data type](#)) for random access to text data. For general information about BLOB and CLOB data types, see [Smart large objects](#).

You can use these SQL functions to perform operations on a BLOB column:

- **FILETOBLOB** copies a file into a BLOB column.
- **LOTOFILE** copies a BLOB (or CLOB) value into an operating-system file.
- **LOCOPY** copies an existing smart large object to a new smart large object.

For more information about these SQL functions, see the *IBM Informix Guide to SQL: Syntax*.

Within SQL, you are limited to the equality (=) comparison operation and the encryption and decryption functions for BLOB data. (The encryption and decryption functions are described in the *IBM Informix Guide to SQL: Syntax*.) To perform additional operations, you must use one of the application programming interfaces (APIs) from within your client application.

You can insert data into BLOB columns in the following ways:

- With the **dbload** or **onload** utilities
- With the LOAD statement (DB-Access)
- With the **FILETOBLOB** function
- From BLOB (**ifx_lo_t**) host variables (IBM® Informix® ESQL/C)

If you select a BLOB column using DB-Access, only the string <SBlob value> is returned; no actual value is displayed.

Related information:

[FILETOBLOB and FILETOCLOB Functions](#)

BOOLEAN data type

The BOOLEAN data type stores TRUE or FALSE data values as a single byte.

The following table shows internal and literal representations of the BOOLEAN data type.

Logical Value	Internal Representation	Literal Representation
TRUE	\0	't'
FALSE	\1	'f'
NULL	Internal Use Only	NULL

You can compare two BOOLEAN values to test for equality or inequality. You can also compare a BOOLEAN value to the Boolean literals 't' and 'f'. BOOLEAN values are not case-sensitive; 't' is equivalent to 'T' and 'f' to 'F'.

You can use a BOOLEAN column to store what a Boolean expression returns. In the following example, the value of **boolean_column** is 't' if **column1** is less than **column2**, 'f' if **column1** is greater than or equal to **column2**, and NULL if the value of either **column1** or **column2** is unknown:

```
UPDATE my_table SET boolean_column = lessthan(column1, column2)
```

BYTE data type

The BYTE data type stores any kind of binary data in an undifferentiated byte stream. Binary data typically consists of digitized information, such as spreadsheets, program load modules, digitized voice patterns, and so on.

The term *simple large object* refers to an instance of a TEXT or BYTE data type. No more than 195 columns of the same table can be declared as BYTE and TEXT data types.

The BYTE data type has no maximum size. A BYTE column has a theoretical limit of 2^{31} bytes and a practical limit that your disk capacity determines.

You cannot use the MEDIUM or HIGH options of the UPDATE STATISTICS statement to calculate distribution statistics on BYTE columns.

BYTE objects in DML operations

You can store, retrieve, update, or delete the contents of a BYTE column. You cannot, however, use BYTE operands in arithmetic or string operations, nor assign literals to BYTE columns with the SET clause of the UPDATE statement. You also cannot use BYTE objects in any of the following contexts in a SELECT statement:

- With aggregate functions
- With the IN clause
- With the MATCHES or LIKE clauses
- With the GROUP BY clause
- With the ORDER BY clause

BYTE operands are valid in Boolean expressions only when you are testing for NULL values with the IS NULL or IS NOT NULL operators.

You can use the following methods, which can load rows or update fields, to insert BYTE data:

- With the **dbload** or **onload** utilities
- With the LOAD statement (DB-Access)
- From BYTE host variables (IBM® Informix® ESQL/C)

You cannot use a quoted text string, number, or any other actual value to insert or update BYTE columns.

When you select a BYTE column, you can receive all or part of it. To retrieve it all, use the regular syntax for selecting a column. You can also select any part of a BYTE column by using subscripts, as the next example, which reads the first 75 bytes of the **cat_picture** column associated with the catalog number 10001:

```
SELECT cat_picture [1,75] FROM catalog WHERE catalog_num = 10001
```

A built-in cast converts BYTE values to BLOB values. For more information, see the *IBM Informix Database Design and Implementation Guide*.

If you select a BYTE column using the DB-Access Interactive Schema Editor, only the string "<BYTE value>" is returned; no data value is displayed.

Important: If you try to return a BYTE column from a subquery, an error results, even if the column is not used in a Boolean expression nor with an aggregate.

CHAR(n) data type

The CHAR data type stores any string of letters, numbers, and symbols. It can store single-byte and multibyte characters, based on the database locale.

A CHAR(*n*) column has a length of *n* bytes, where $1 \leq n \leq 32,767$. If you do not specify *n*, CHAR(1) is the default length. Character columns typically store alphanumeric strings, such as names, addresses, phone numbers, and so on. When a value is retrieved or stored as CHAR(*n*), exactly *n* bytes of data are transferred. If the string is shorter than *n* bytes, the string is extended with blank spaces up to the declared length. If the data value is longer than *n* bytes, a data string of length *n* that has been truncated from the right is inserted or retrieved, without the database server raising an exception.

This does not create partial characters in multibyte locales. In right-to-left locales, such as Arabic, Hebrew, or Farsi, the truncation is from the left.

Size specifications in CHAR data type declarations can be affected by the SQL_LOGICAL_CHAR feature that is described in the section [Logical Character Semantics in Character Type Declarations](#).

For more information about East Asian locales that support multibyte code sets, see [Multibyte Characters with VARCHAR](#).

- [Treating CHAR Values as Numeric Values](#)
- [Sorting and Relational Comparisons](#)
- [Nonprintable Characters with CHAR](#)

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Treating CHAR Values as Numeric Values

If you plan to perform calculations on numbers stored in a column, you should assign a number data type to that column. Although you can store numbers in CHAR columns, you might not be able to use them in some arithmetic operations. For example, if you insert a sum into a CHAR column, you might experience overflow problems if the CHAR column is too small to hold the value. In this case, the insert fails. Numbers that have leading zeros (such as some zip codes) have the zeros stripped if they are stored as number types INTEGER or SMALLINT. Instead, store these numbers in CHAR columns.

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Sorting and Relational Comparisons

In general, the collating order for sorting CHAR values is the order of characters in the code set. (An exception is the MATCHES operator with ranges; see [Collating VARCHAR Values](#).) For more information about collation order, see the *IBM® Informix® GLS User's Guide*.

For multibyte locales, the database supports any multibyte characters in the code set. When storing multibyte characters in a CHAR data type, make sure to calculate the number of bytes needed. For more information about multibyte characters and locales, see the *IBM Informix GLS User's Guide*.

CHAR values are compared to other CHAR values by padding the shorter value on the right with blank spaces until the values have equal length, and then comparing the two values, using the code-set order for collation.

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Nonprintable Characters with CHAR

A CHAR value can include tab, newline, whitespace, and nonprintable characters. You must, however, use an application to insert nonprintable characters into host variables and the host variables into your database. After passing nonprintable characters to the database server, you can store or retrieve them. After you select nonprintable characters, fetch them into host variables and display them with your own display mechanism.

An important exception is the first value in the ASCII code set is used as the end-of-data terminator symbol in columns of the CHAR data type. For this reason, any subsequent characters in the same string cannot be retrieved from a CHAR column, because the database server reads only the characters (if any) that precede this null terminator. For example, you cannot use the following 7-byte string as a CHAR data type value with a length of 7 bytes:

`abc\0def`

If you try to display nonprintable characters with DB-Access your screen returns inconsistent results. (Which characters are nonprintable is locale-dependent. For more information see the discussion of code-set conversion between the client and the database server in the *IBM® Informix® GLS User's Guide*.)

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CHARACTER(n) data type

The CHARACTER data type is a synonym for CHAR.

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CHARACTER VARYING(m,r) data type

The CHARACTER VARYING data type stores a string of letters, digits, and symbols of varying length, where *m* is the maximum size of the column (in bytes) and *r* is the minimum number of bytes reserved for that column.

The CHARACTER VARYING data type complies with ANSI/ISO standard for SQL; the non-ANSI VARCHAR data type supports the same functionality. For more information, see the description of the VARCHAR type in [VARCHAR\(m,r\) data type](#).

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CLOB data type

The CLOB data type stores any kind of text data in random-access chunks, called sbspaces. Text data can include text-formatting information, if this information is also textual, such as PostScript, Hypertext Markup Language (HTML), Standard Graphic Markup Language (SGML), or Extensible Markup Language (XML) data.

The term *smart large object* refers to CLOB and BLOB data types. The CLOB data type supports special operations for character strings that are inappropriate for BLOB values. A CLOB value can be up to 4 terabytes (4×2^{40} bytes) in length. The minimum amount of disk space allocated for smart large object data types is 512 bytes.

Use the BLOB data type (see [BLOB data type](#)) for random access to binary data. For general information about the CLOB and BLOB data types, see [Smart large objects](#).

The following SQL functions can perform operations on a CLOB column:

- **FILETOCLOB** copies a file into a CLOB column.
- **LOTOFILE** copies a CLOB (or BLOB) value into a file.
- **LOCOPY** copies a CLOB (or BLOB) value to a new smart large object.
- **ENCRYPT_DES** or **ENCRYPT_TDES** creates an encrypted BLOB value from a plain-text CLOB argument.
- **DECRYPT_BINAR** or **DECRYPT_CHAR** returns an unencrypted BLOB value from an encrypted BLOB argument (that **ENCRYPT_DES** or **ENCRYPT_TDES** created from a plain-text CLOB value).

For more information about these SQL functions, see the *IBM® Informix® Guide to SQL: Syntax*.

No casts exist for CLOB data. Therefore, the database server cannot convert data of the CLOB type to any other data type, except by using these encryption and decryption functions to return a BLOB. Within SQL, you are limited to the equality (=) comparison operation for CLOB data. To perform additional operations, you must use one of the application programming interfaces from within your client application.

- [Multibyte characters with CLOB](#)

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Multibyte characters with CLOB

You can insert data into CLOB columns in the following ways:

- With the **dbload** or **onload** utilities
- With the LOAD statement (DB-Access)
- From CLOB (**ifx_lo_t**) host variables (ESQL/C)

For examples of CLOB types, see the *IBM® Informix® Guide to SQL: Tutorial* and the *IBM Informix Database Design and Implementation Guide*.

With GLS, the following rules apply:

- Multibyte CLOB characters must be defined in the database locale.
- The CLOB data type is collated in code-set order.
- The database server handles code-set conversions for CLOB data.

For more information about database locales, collation order, and code-set conversion, see the *IBM Informix GLS User's Guide*.

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DATE data type

The DATE data type stores the calendar date. DATE data types require four bytes. A calendar date is stored internally as an integer value equal to the number of days since December 31, 1899.

Because DATE values are stored as integers, you can use them in arithmetic expressions. For example, you can subtract a DATE value from another DATE value. The result, a positive or negative INTEGER value, indicates the number of days that elapsed between the two dates. (You can use a UNITS DAY expression to convert the result to an INTERVAL DAY TO DAY data type.)

The following example shows the default display format of a DATE column:

mm/dd/yyyy

In this example, *mm* is the month (1-12), *dd* is the day of the month (1-31), and *yyyy* is the year (0001-9999). You can specify a different order of time units and a different time-unit separator than / (or no separator) by setting the **DBDATE** environment variable. For more information, see [DBDATE environment variable](#).

In non-default locales, you can display dates in culture-specific formats. The locale and the **GL_DATE** and **DBDATE** environment variables (as described in the next chapter) affect the display formatting of DATE values. They do not, however, affect the internal storage format for DATE columns in the database. For more information, see the *IBM® Informix® GLS User's Guide*.

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DATETIME data type

The DATETIME data type stores an instant in time expressed as a calendar date and time of day.

You select how precisely a DATETIME value is stored; its precision can range from a year to a fraction of a second.

DATETIME stores a data value as a contiguous series of fields that represents each time unit (*year, month, day*, and so forth) in the data type declaration.

Field qualifiers to specify a DATETIME data type have this format:

DATETIME *largest_qualifier* TO *smallest_qualifier*

This resembles an INTERVAL field qualifier, but DATETIME represents a point in time, rather than (like INTERVAL) a span of time. These differences exist between DATETIME and INTERVAL qualifiers:

- The DATETIME keyword replaces the INTERVAL keyword.
- DATETIME field qualifiers cannot specify a nondefault precision for the *largest_qualifier* time unit.
- Field qualifiers of a DATETIME data type can include YEAR, MONTH, and smaller time units, but an INTERVAL data type that includes the DAY field qualifier (or smaller time units) cannot also include the YEAR or MONTH field qualifiers.

The *largest_qualifier* and *smallest_qualifier* of a DATETIME data type can be any of the fields that the following table lists, provided that *smallest_qualifier* does not specify a larger time unit than *largest_qualifier*. (The largest and smallest time units can be the same; for example, DATETIME YEAR TO YEAR.)

Table 1. DATETIME field qualifiers

Qualifier field	Valid entries
YEAR	A year numbered from 1 to 9,999 (A.D.)
MONTH	A month numbered from 1 to 12
DAY	A day numbered from 1 to 31, as appropriate to the month
HOURL	An hour numbered from 0 (midnight) to 23
MINUTE	A minute numbered from 0 to 59
SECOND	A second numbered from 0 - 59
FRACTION	A decimal fraction-of-a-second with up to 5 digits of scale. The default scale is 3 digits (a thousandth of a second). For <i>smallest_qualifier</i> to specify another scale, write FRACTION(<i>n</i>), where <i>n</i> is the number of digits from 1 - 5.

The declaration of a DATETIME column need not include the full YEAR to FRACTION range of time units. It can include any contiguous subset of these time units, or even only a single time unit.

For example, you can enter a MONTH TO HOUR value in a column declared as YEAR TO MINUTE, if each entered value contains information for a contiguous series of time units. You cannot, however, enter a value for only the MONTH and HOUR; the entry must also include a value for DAY.

If you use the DB-Access TABLE menu, and you do not specify the DATETIME qualifiers, a default DATETIME qualifier, YEAR TO YEAR, is assigned.

A valid DATETIME literal must include the DATETIME keyword, the values to be entered, and the field qualifiers. You must include these qualifiers because, as noted earlier, the value that you enter can contain fewer fields than were declared for that column. Acceptable qualifiers for the first and last fields are identical to the list of valid DATETIME fields that are listed in the table [Table 1](#).

Write values for the field qualifiers as integers and separate them with delimiters. The following table lists the delimiters that are used with DATETIME values in the default US English locale. (These are a superset of the delimiters that are used in INTERVAL values.)

Table 2. Delimiters used with DATETIME

Delimiter	Placement in DATETIME Literal
Hyphen (-)	Between the YEAR, MONTH, and DAY time-unit values
Blank space ()	Between the DAY and HOUR time-unit values
Colon (:)	Between the HOUR, MINUTE, and SECOND time-unit values
Decimal point (.)	Between the SECOND and FRACTION time-unit values

The following illustration shows a DATETIME YEAR TO FRACTION(3) value with delimiters.

Figure 1. Example DATETIME Value with Delimiters

2003-09-23 12:42:06.001



When you enter a value with fewer time-unit fields than in the column, the value that you enter is expanded automatically to fill all the declared time-unit fields. If you leave out any more significant fields, that is, time units larger than any that you include, those fields are filled automatically with the current values for those time units from the system clock calendar. If you leave out any less-significant fields, those fields are filled with zeros (or with 1 for MONTH and DAY) in your entry.

You can also enter DATETIME values as character strings. The character string must include information for each field defined in the DATETIME column. The INSERT statement in the following example shows a DATETIME value entered as a character string:

```
INSERT INTO cust_calls (customer_num, call_dtime, user_id,  
    call_code, call_descr)  
VALUES (101, '2001-01-14 08:45', 'maryj', 'D',  
    'Order late - placed 6/1/00');
```

If **call_dtime** is declared as DATETIME YEAR TO MINUTE, the character string must include values for the *year*, *month*, *day*, *hour*, and *minute* fields.

If the character string does not contain information for all the declared fields (or if it adds additional fields), then the database server returns an error.

All fields of a DATETIME column are two-digit numbers except for the *year* and *fraction* fields. The *year* field is stored as four digits. When you enter a two-digit value in the year field, how the abbreviated year is expanded to four digits depends on the setting of the DBCENTURY environment variable.

For example, if you enter 02 as the *year* value, whether the year is interpreted as 1902, 2002, or 2102 depends on the setting of DBCENTURY and on the value of the system clock calendar at execution time. If you do not set DBCENTURY, the leading digits of the current year are appended by default.

The *fraction* field requires n digits where $1 \leq n \leq 5$, rounded up to an even number. You can use the following formula (rounded up to a whole number of bytes) to calculate the number of bytes that a DATETIME value requires:

(total number of digits for all fields) / 2 + 1

For example, a YEAR TO DAY qualifier requires a total of eight digits (four for *year*, two for *month*, and two for *day*). According to the formula, this data value requires 5, or $(8/2) + 1$, bytes of storage.

The USEOSTIME configuration parameter can affect the subsecond granularity when the database server obtains the current time from the operating system in SQL statements. For details, see the *IBM® Informix® Administrator's Reference*.

With an ESQL API, the DBTIME environment variable affects DATETIME formatting. Nondefault locales and settings of the GL_DATE and DBDATE environment variables also affect the display of datetime data. They do not, however, affect the internal storage format of a DATETIME column.

If you specify a locale other than U.S. English, the locale defines the culture-specific display formats for DATETIME values. To change the default display format, change the setting of the GL_DATETIME environment variable. When a database with a nondefault locale uses a nondefault GL_DATETIME setting, the USE_DTENV environment variable must be set to 1 before the database server can correctly process localized DATETIME values in the following operations:

- using the LOAD or UNLOAD feature of DB-Access
- using the **dbexport** or **dbimport** migration utilities
- using DML statements of SQL on database tables or on objects that the CREATE EXTERNAL TABLE statement defined.

For more information about locales and GLS environment variables that can specify end-user DATETIME formats, see the *IBM Informix GLS User's Guide*.

Related concepts:

[Manipulating DATE with DATETIME and INTERVAL Values](#)

[Manipulating DATETIME Values](#)

Related reference:

[INTERVAL data type](#)

[DBCENTURY environment variable](#)

[DBTIME environment variable](#)

Related information:

[The mi_datetime_compare\(\) function](#)

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DEC data type

The DEC data type is a synonym for DECIMAL.

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DECIMAL

The DECIMAL data type can take two forms: DECIMAL(p) floating point and DECIMAL(p,s) fixed point.

In an ANSI-compliant database all DECIMAL numbers are fixed point.

By default, literal numbers that include a decimal (.) point are interpreted by the database server as DECIMAL values.

- [DECIMAL\(p\) Floating Point](#)
The DECIMAL data type stores decimal floating-point numbers up to a maximum of 32 significant digits, where p is the total number of significant digits (the *precision*).
- [DECIMAL\(p,s\) Fixed Point](#)
- [DECIMAL Storage](#)

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DECIMAL(p) Floating Point

The DECIMAL data type stores decimal floating-point numbers up to a maximum of 32 significant digits, where p is the total number of significant digits (the *precision*).

Specifying precision is optional. If you specify no precision (p), DECIMAL is treated as DECIMAL(16), a floating-point decimal with a precision of 16 places. DECIMAL(p) has an absolute exponent range between 10^{-130} and 10^{124} .

If you declare a DECIMAL(p) column in an ANSI-compliant database, the scale defaults to DECIMAL(p , 0), meaning that only integer values can be stored in this data type.

In a database that is not ANSI-compliant, a DECIMAL(p) is a floating-point data type of a scale large enough to store the exponential notation for a value.

For example, the following calculation shows how many bytes of storage a DECIMAL(5) column requires in the default locale (where the decimal point occupies a single byte):

```

1 byte for the sign of the data value
1 byte for the 1st digit
1 byte for the decimal point
4 bytes for the rest of the digits (precision of 5 - 1)
1 byte for the e symbol
1 byte for the sign of the exponent
3 bytes for the exponent
-----
12 bytes total

```

Thus, "12345" in a DECIMAL(5) column is displayed as "12345.00000" (that is, with a scale of 6) in a database that is not ANSI-compliant.

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DECIMAL (p,s) Fixed Point

In fixed-point numbers, DECIMAL(p,s), the decimal point is fixed at a specific place, regardless of the value of the number. When you specify a column of this type, you declare its precision (p) as the total number of digits that it can store, from 1 to 32. You declare its *scale* (s) as the total number of digits in the fractional part (that is, to the right of the decimal point).

All numbers with an absolute value less than $0.5 * 10^{-s}$ have the value zero. The largest absolute value of a DECIMAL(p,s) data type that you can store without an overflow error is $10^{p-s} - 10^{-s}$. A DECIMAL column typically stores numbers with fractional parts that must be stored and displayed exactly (for example, rates or percentages). In an ANSI-compliant database, all DECIMAL numbers must have absolute values in the range 10^{-32} to 10^{+31} .

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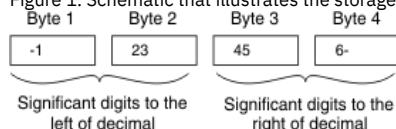
DECIMAL Storage

The database server uses one byte of disk storage to store two digits of a decimal number, plus an additional byte to store the exponent and sign, with the first byte representing a sign bit and a 7-bit exponent in excess-65 format. The rest of the bytes express the mantissa as base-100 digits. The significant digits to the left of the decimal and the significant digits to the right of the decimal are stored in separate groups of bytes. At the maximum *precision* specification, DECIMAL(32,s) data types can store $s-1$ decimal digits to the right of the decimal point, if s is an odd number.

How the database server stores decimal numbers is illustrated in the following example. If you specify DECIMAL(6,3), the data type consists of three significant digits in the integral part and three significant digits in the fractional part (for instance, 123.456). The three digits to the left of the decimal are stored on 2 bytes (where one of the bytes only holds a single digit) and the three digits to the right of the decimal are stored on another 2 bytes, as [Figure 1](#) illustrates.

(The exponent byte is not shown.) With the additional byte required for the exponent and sign, DECIMAL(6,3) requires a total of 5 bytes of storage.

Figure 1. Schematic that illustrates the storage of digits in a decimal (p,s) value



You can use the following formulas (rounded down to a whole number of bytes) to calculate the byte storage (N) for a DECIMAL(p,s) data type (where N includes the byte that is required to store the exponent and the sign):

If the *scale* is odd: $N = (precision + 4) / 2$
If the *scale* is even: $N = (precision + 3) / 2$

For example, the data type DECIMAL(5,3) requires 4 bytes of storage (9/2 rounded down equals 4).

There is one caveat to these formulas. The maximum number of bytes the database server uses to store a decimal value is 17. One byte is used to store the exponent and sign, leaving 16 bytes to store up to 32 digits of precision. If you specify a precision of 32 and an *odd* scale, however, you lose 1 digit of precision. Consider, for example, the data type DECIMAL(32,31). This decimal is defined as 1 digit to the left of the decimal and 31 digits to the right. The 1 digit to the left of the decimal requires 1 byte of storage. This leaves only 15 bytes of storage for the digits to the right of the decimal. The 15 bytes can accommodate only 30 digits, so 1 digit of precision is lost.

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DISTINCT data types

A DISTINCT type is a data type that is derived from a source type (called the base type).

A source type can be:

- A built-in type
- An existing DISTINCT type
- An existing named ROW type
- An existing opaque type

A DISTINCT type inherits from its source type the length and alignment on the disk. A DISTINCT type thus makes efficient use of the preexisting functionality of the database server.

When you create a DISTINCT data type, the database server automatically creates two explicit casts: one cast from the DISTINCT type to its source type and one cast from the source type to the DISTINCT type. A DISTINCT type based on a built-in source type does not inherit the built-in casts that are provided for the built-in type. A DISTINCT type does inherit, however, any user-defined casts that have been defined on the source type.

A DISTINCT type cannot be compared directly to its source type. To compare the two types, you must first explicitly cast one type to the other.

You must define a DISTINCT type in the database. Definitions of DISTINCT types are stored in the **sysxdtypes** system catalog table. The following SQL statements maintain the definitions of DISTINCT types in the database:

- The CREATE DISTINCT TYPE statement adds a DISTINCT type to the database.
- The DROP TYPE statement removes a previously defined DISTINCT type from the database.

For more information about the SQL statements mentioned above, see the *IBM® Informix® Guide to SQL: Syntax*. For information about casting DISTINCT data types, see [Casts for distinct types](#). For examples that show how to create and register cast functions for a DISTINCT type, see the *IBM Informix Database Design and Implementation Guide*.

Size specifications in declarations of DISTINCT types whose base types are built-in character types can be affected by the SQL_LOGICAL_CHAR feature that is described in the section [Logical Character Semantics in Character Type Declarations](#).

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DOUBLE PRECISION data types

The DOUBLE PRECISION keywords are a synonym for the FLOAT keyword.

Related reference:

[FLOAT\(n\)](#)

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FLOAT(n)

The FLOAT data type stores double-precision floating-point numbers with up to 17 significant digits. FLOAT corresponds to IEEE 4-byte floating-point, and to the **double** data type in C. The range of values for the FLOAT data type is the same as the range of the C **double** data type on your computer.

You can use *n* to specify the precision of a FLOAT data type, but SQL ignores the precision. The value *n* must be a whole number between 1 and 14.

A column with the FLOAT data type typically stores scientific numbers that can be calculated only approximately. Because floating-point numbers retain only their most significant digits, the number that you enter in this type of column and the number the database server displays can differ slightly.

The difference between the two values depends on how your computer stores floating-point numbers internally. For example, you might enter a value of 1.1000001 into a FLOAT field and, after processing the SQL statement, the database server might display this value as 1.1. This situation occurs when a value has more digits than the floating-point number can store. In this case, the value is stored in its approximate form with the least significant digits treated as zeros.

FLOAT data types usually require 8 bytes of storage per value. Conversion of a FLOAT value to a DECIMAL value results in 17 digits of precision.

Related reference:

[DOUBLE PRECISION data types](#)

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IDSSECURITYLABEL data type

The IDSSECURITYLABEL type stores a security label in a table that is protected by a label-based access control (LBAC) security policy.

Only a user who holds the **DBSECADM** role can create, alter, or drop a column of this data type. IDSSECURITYLABEL is a built-in DISTINCT OF VARCHAR(128) data type, but because its use is restricted to databases that implement label-based access control, it is not classified as a character data type. A table that is protected by a security policy can have only one IDSSECURITYLABEL column. A table that is not associated with any label-based security policy cannot include an IDSSECURITYLABEL column. You cannot encrypt the security label in a column of type IDSSECURITYLABEL.

For a discussion of security policies, security components, security labels, and other concepts of label-based access control (LBAC), see the IBM® Informix® Security Guide.

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INT data type

The INT data type is a synonym for INTEGER.

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INT8

The INT8 data type stores whole numbers that can range in value from $-9,223,372,036,854,775,807$ to $9,223,372,036,854,775,807$ [or $-(2^{63}-1)$ to $2^{63}-1$], for 18 or 19 digits of precision.

The number $-9,223,372,036,854,775,808$ is a reserved value that cannot be used. The INT8 data type is typically used to store large counts, quantities, and so on.

IBM® Informix® stores INT8 data in internal format that can require up to 10 bytes of storage.

Arithmetic operations and sort comparisons are performed more efficiently on integer data than on floating-point or fixed-point decimal data, but INT8 cannot store data with absolute values beyond $|2^{63}-1|$. If a value exceeds the numeric range of INT8, the database server does not store the value.

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INTEGER data type

The INTEGER data type stores whole numbers that range from $-2,147,483,647$ to $2,147,483,647$ for 9 or 10 digits of precision.

The number $2,147,483,648$ is a reserved value and cannot be used. The INTEGER value is stored as a signed binary integer and is typically used to store counts, quantities, and so on.

Arithmetic operations and sort comparisons are performed more efficiently on integer data than on float or decimal data. INTEGER columns, however, cannot store absolute values beyond $(2^{31}-1)$. If a data value lies outside the numeric range of INTEGER, the database server does not store the value.

INTEGER data types require 4 bytes of storage per value.

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INTERVAL data type

The INTERVAL data type stores a value that represents a span of time. INTERVAL types are divided into two classes: *year-month intervals* and *day-time intervals*.

A year-month interval can represent a span of years and months, and a day-time interval can represent a span of days, hours, minutes, seconds, and fractions of a second.

An INTERVAL value is always composed of one value or a series of values that represents time units. Within a data-definition statement such as CREATE TABLE or ALTER TABLE that defines the precision of an INTERVAL data type, the qualifiers must have the following format:

```
INTERVAL largest_qualifier(n) TO smallest_qualifier
```

Here the *largest_qualifier* and *smallest_qualifier* keywords are taken from one of the two INTERVAL classes, as shown in the table [Table 1](#).

If SECOND (or a larger time unit) is the *largest_qualifier*, the declaration of an INTERVAL data type can optionally specify *n*, the precision of the largest time unit (for *n* ranging from 1 to 9); this is not a feature of DATETIME data types.

If *smallest_qualifier* is FRACTION, you can also specify a scale in the range from 1 to 5. For FRACTION TO FRACTION qualifiers, the upper limit of *n* is 5, rather than 9. There are two incommensurable classes of INTERVAL data types:

- Those with a *smallest_qualifier* larger than DAY
- Those with a *largest_qualifier* smaller than MONTH

Table 1. Interval Classes

Interval Class	Time Units	Valid Entry
YEAR-MONTH INTERVAL	YEAR	A number of years
YEAR-MONTH INTERVAL	MONTH	A number of months
DAY-TIME INTERVAL	DAY	A number of days
DAY-TIME INTERVAL	HOURL	A number of hours
DAY-TIME INTERVAL	MINUTE	A number of minutes
DAY-TIME INTERVAL	SECOND	A number of seconds
DAY-TIME INTERVAL	FRACTION	A decimal fraction of a second, with up to 5 digits. The default scale is 3 digits (thousandth of a second). To specify a non-default scale, write FRACTION(<i>n</i>), where $1 \leq n \leq 5$.

As with DATETIME data types, you can define an INTERVAL to include only the subset of time units that you need. But because the construct of “month” (as used in calendar dates) is not a time unit that has a fixed number of days, a single INTERVAL value cannot combine months and days; arithmetic that involves operands of the two different INTERVAL classes is not supported.

A value entered into an INTERVAL column need not include the full range of time units that were specified in the data-type declaration of the column. For example, you can enter a value of HOUR TO SECOND precision into a column defined as DAY TO SECOND. A value must always consist, however, of contiguous time units. In the previous example, you cannot enter only the HOUR and SECOND values; you must also include MINUTE values.

A valid INTERVAL literal contains the INTERVAL keyword, the values to be entered, and the field qualifiers. (See the discussion of literal intervals in the *IBM® Informix® Guide to SQL: Syntax*.) When a value contains only one field, the largest and smallest fields are the same.

When you enter a value in an INTERVAL column, you must specify the largest and smallest fields in the value, just as you do for DATETIME values. In addition, you can optionally specify the precision of the first field (and the scale of the last field if it is a FRACTION). If the largest and smallest field qualifiers are both FRACTION, you can specify only the scale in the last field.

Acceptable qualifiers for the largest and smallest fields are identical to the list of INTERVAL fields that the tab;e [Table 1](#) displays.

If you use the DB-Access **TABLE** menu, but you specify no INTERVAL field qualifiers, then a default INTERVAL qualifier, YEAR TO YEAR, is assigned.

The *largest_qualifier* in an INTERVAL value can be up to nine digits (except for FRACTION, which cannot be more than five digits), but if the value that you want to enter is greater than the default number of digits allowed for that field, you must explicitly identify the number of significant digits in the value that you enter. For example, to define an INTERVAL of DAY TO HOUR that can store up to 999 days, you can specify it the following way:

INTERVAL DAY (3) TO HOUR

INTERVAL literals use the same delimiters as DATETIME literals (except that MONTH and DAY time units are not valid within the same INTERVAL value). the following table shows the INTERVAL delimiters.

Table 2. INTERVAL Delimiters

Delimiter	Placement in an INTERVAL Literal
Hyphen	Between the YEAR and MONTH portions of the value
Blank space	Between the DAY and HOUR portions of the value
Colon	Between the HOUR, MINUTE, and SECOND portions of the value
Decimal point	Between the SECOND and FRACTION portions of the value

You can also enter INTERVAL values as character strings. The character string must include information for the same time units that were specified in the data-type declaration for the column. The INSERT statement in the following example shows an INTERVAL value entered as a character string:

```
INSERT INTO manufact (manu_code, manu_name, lead_time)
VALUES ('BRO', 'Ball-Racquet Originals', '160')
```

Because the *lead_time* column is defined as INTERVAL DAY(3) TO DAY, this INTERVAL value requires only one field, the span of days required for lead time. If the character string does not contain information for all fields (or adds additional fields), the database server returns an error. For additional information about entering INTERVAL values as character strings, see the *IBM Informix Guide to SQL: Syntax*.

By default, all fields of an INTERVAL column are two-digit numbers, except for the year and fraction fields. The year field is stored as four digits. The fraction field requires *n* digits where $1 \leq n \leq 5$, rounded up to an even number. You can use the following formula (rounded up to a whole number of bytes) to calculate the number of bytes required for an INTERVAL value:

(total number of digits for all fields)/2 + 1

For example, INTERVAL YEAR TO MONTH requires six digits (four for *year* and two for *month*), and requires 4, or (6/2) + 1, bytes of storage.

For information about using INTERVAL as a constant expression, see the description of the INTERVAL Field Qualifier in the *IBM Informix Guide to SQL: Syntax*.

Related concepts:[Manipulating DATE with DATETIME and INTERVAL Values](#)[Manipulating INTERVAL Values](#)**Related reference:**[DATETIME data type](#)**Related information:**[The mi_interval_compare\(\) function](#)

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LIST(e) data type

The LIST data type is a collection type that can store ordered non-NULL elements of the same SQL data type.

The LIST data type supports, but does not require, duplicate element values. The elements of a LIST data type have ordinal positions. The LIST object must have a first element, which can be followed by a second element, and so on.

For unordered collection data types that do not support ordinal positions, see [MULTISET\(e\) data type](#) and [SET\(e\) data type](#). For complex data types that can store a set of values that includes different SQL data types, see [ROW Data Types](#).

No more than 97 columns of the same table can be declared as LIST data types. (The same restriction applies to SET and MULTISET collection types.)

By default, the database server inserts new elements into a LIST object at the end of the set of elements. To support the ordinal position of a LIST, the INSERT statement provides the AT clause. This clause allows you to specify the position at which you want to insert a LIST element value. For more information, see the INSERT statement in the *IBM® Informix® Guide to SQL: Syntax*.

All elements in a LIST object have the same element type. To specify the element type, use the following syntax:

LIST(*element_type* NOT NULL)

The *element_type* of a LIST can be any of the following data types:

- A built-in type, except SERIAL, SERIAL8, BIGSERIAL, BYTE, and TEXT
- A DISTINCT type
- An unnamed or named ROW type
- Another collection type
- An opaque type

You must specify the NOT NULL constraint for LIST elements. No other constraints are valid for LIST columns. For more information about the syntax of the LIST data type, see the *IBM Informix Guide to SQL: Syntax*.

You can use LIST in most contexts where any other data type is valid. For example:

- After the IN predicate in the WHERE clause of a SELECT statement to search for matching LIST values
- As an argument to the CARDINALITY or **mi_collection_card()** function to determine the number of elements in a LIST column

You *cannot* use LIST values as arguments to an aggregate function such as AVG, MAX, MIN, or SUM.

Just as with the other collection data types, you must use parentheses (**()**) in data type declarations to delimit the set of elements of a LIST data type:

```
CREATE FUNCTION update_nums( list1 LIST (ROW (a VARCHAR(10) ,
                                             b VARCHAR(10) ,
                                             c INT) NOT NULL )) ;
```

In SQL expressions that include literal LIST values, however, you must use braces (**{ }**) to delimit the set of elements of a LIST object, as in the examples that follow.

Two LIST values are equal if they have the same elements in the same order. The following are both examples of LIST objects, but their values are not equal. :

```
LIST{"blue", "green", "yellow"}
```

```
LIST{"yellow", "blue", "green"}
```

The above expressions are not equal because the values are not in the same order. To be equal, the second statement must be:

```
LIST{"blue", "green", "yellow"}
```

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LVARCHAR(m) data type

Use the LVARCHAR data type to create a column for storing variable-length character strings whose upper limit (*m*) can be up to 32,739 bytes.

This limit is much greater than the VARCHAR data type, which is used for character strings that are no longer than 255 bytes.

The LVARCHAR data type is implemented as a built-in opaque data type. You can access LVARCHAR columns in remote tables by using distributed queries across databases of the same or different IBM® Informix® instances.

By default, the database server interprets quoted strings as LVARCHAR types. It also uses LVARCHAR for input and output casts for opaque data types.

The LVARCHAR data type stores opaque data types in the string (external) format. Each opaque type has an input support function and cast, which convert it from LVARCHAR to a form that database servers can manipulate. Each opaque type also has an output support function and cast, which convert it from its internal representation to LVARCHAR.

Important: When LVARCHAR is declared (with no size specification) as the data type of a column in a database table, the default maximum size is 2 KB (2048 bytes), but you can specify an explicit maximum length of up to 32,739 bytes. When LVARCHAR is used in I/O operations on an opaque data type, however, the maximum size is limited only by the operating system.

You cannot use the MEDIUM or HIGH options of the UPDATE STATISTICS statement to calculate distribution statistics on LVARCHAR columns.

Size specifications in LVARCHAR data type declarations can be affected by the SQL_LOGICAL_CHAR feature that is described in the section [Logical Character Semantics in Character Type Declarations](#).

For more information about LVARCHAR, see the *IBM Informix User-Defined Routines and Data Types Developer's Guide*.

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MONEY(p,s) data type

The MONEY data type stores currency amounts.

Like the DECIMAL(p,s) data type, MONEY can store fixed-point numbers up to a maximum of 32 significant digits, where *p* is the total number of significant digits (the precision) and *s* is the number of digits to the right of the decimal point (the scale).

Unlike the DECIMAL data type, the MONEY data type is always treated as a fixed-point decimal number. The database server defines the data type MONEY(*p*) as DECIMAL(*p*,2). If the precision and scale are not specified, the database server defines a MONEY column as DECIMAL(16,2).

You can use the following formula (rounded down to a whole number of bytes) to calculate the byte storage for a MONEY data type:

If the scale is odd: $N = (\text{precision} + 4) / 2$
If the scale is even: $N = (\text{precision} + 3) / 2$

For example, a MONEY data type with a precision of 16 and a scale of 2 (MONEY(16,2)) requires 10 or $(16 + 3)/2$, bytes of storage.

In the default locale, client applications format values from MONEY columns with the following currency notation:

- A currency symbol: a dollar sign (\$) at the front of the value
- A thousands separator: a comma (,) that separates every three digits in the integer part of the value
- A decimal point: a period (.) between the integer and fractional parts of the value

To change the format for MONEY values, change the **DBMONEY** environment variable. For valid **DBMONEY** settings, see [DBMONEY environment variable](#).

The default value that the database server uses for scale is locale-dependent. The default locale specifies a default scale of two. For non-default locales, if the scale is omitted from the declaration, the database server creates MONEY values with a locale-specific scale.

The currency notation that client applications use is locale-dependent. If you specify a nondefault locale, the client uses a culture-specific format for MONEY values that might differ from the default U.S. English format in the leading (or trailing) currency symbol, thousands separator, and decimal separator, depending on what the locale files specify. For more information about locale dependency, see the *IBM® Informix® GLS User's Guide*.

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MULTISET(e) data type

The MULTISET data type is a collection type that stores a non-ordered set that can include duplicate element values.

The elements in a MULTISET have no ordinal position. That is, there is no concept of a first, second, or third element in a MULTISET. (For a collection type with ordinal positions for elements, see [LIST\(e\) data type](#).)

All elements in a MULTISET have the same element type. To specify the element type, use the following syntax:

MULTISET(*element_type* NOT NULL)

The *element_type* of a collection can be any of the following types:

- Any built-in type, except SERIAL, SERIAL8, BIGSERIAL, BYTE, and TEXT
- An unnamed or a named ROW type
- Another collection type or opaque type

You can use MULTISET anywhere that you use any other data type, unless otherwise indicated. For example:

- After the IN predicate in the WHERE clause of a SELECT statement to search for matching MULTISET values
- As an argument to the CARDINALITY or **mi_collection_card()** function to determine the number of elements in a MULTISET column

You *cannot* use MULTISET values as arguments to an aggregate function such as AVG, MAX, MIN, or SUM.

You must specify the NOT NULL constraint for MULTISET elements. No other constraints are valid for MULTISET columns. For more information about the MULTISET collection type, see the *IBM® Informix® Guide to SQL: Syntax*.

Two multiset data values are equal if they have the same elements, even if the elements are in different positions within the set. The following examples are both multiset values but are not equal:

```
MULTISET {"blue", "green", "yellow"}  
MULTISET {"blue", "green", "yellow", "blue"}
```

The following multiset values are equal:

```
MULTISET {"blue", "green", "blue", "yellow"}  
MULTISET {"blue", "green", "yellow", "blue"}
```

No more than 97 columns of the same table can be declared as MULTISET data types. (The same restriction applies to SET and LIST collection types.)

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Named ROW

See [ROW data type, Named](#).

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NCHAR(n) data type

The NCHAR data type stores fixed-length character data. The data can be a string of single-byte or multibyte letters, digits, and other symbols that are supported by the code set of the database locale.

The main difference between CHAR and NCHAR data types is the collating order.

The collation order of the CHAR data type follows the code-set order, but the collating order of the NCHAR data type can be a localized order, if DB_LOCALE (or SET COLLATION) specifies a locale that defines a localized order for collation.

Size specifications in NCHAR data type declarations can be affected by the SQL_LOGICAL_CHAR configuration parameter that is described in the section [Logical Character Semantics in Character Type Declarations](#).

In databases that are created with the NLSCASE INSENSITIVE property, operations on NCHAR strings ignore letter case, ordering data values without respect to or preference for letter case. For example, the NCHAR string "IDS" might precede or follow "IdS" or "iDs" in the collated list that a query returns, depending on the order in which these data strings are retrieved, because all of the following NCHAR strings are treated as duplicate values:

```
"ids" "IDS" "iDs" "IDs" "IdS" "iDs" "IDS" "Ids"
```

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NUMERIC(p,s) data type

The NUMERIC data type is a synonym for fixed-point DECIMAL.

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NVARCHAR(m,r) data type

The NVARCHAR data type stores strings of varying lengths. The string can include digits, symbols, and both single-byte and (in some locales) multibyte characters.

The main difference between VARCHAR and NVARCHAR data types is the collation order. Collation of VARCHAR data follows code-set order, but NVARCHAR collation can be locale specific, if **DB_LOCALE** (or SET COLLATION) has specified a locale that defines a localized order for collation. (The section [Collating VARCHAR Values](#) describes an exception.)

A column declared as NVARCHAR, without parentheses or parameters, has a maximum size of one byte, and a reserved size of zero.

The first parameter in NVARCHAR data type declarations can be affected by the SQL_LOGICAL_CHAR configuration parameter that is described in the section [Logical Character Semantics in Character Type Declarations](#).

No more than 195 columns of the same table can be NVARCHAR data types.

In databases that are created with the NLSCASE INSENSITIVE property, operations on NVARCHAR strings ignore letter case, ordering data values without respect to or preference for letter case. For example, the NVARCHAR string "IBM" might precede or follow "IbM" or "iBm" in the collated list that a query returns, depending on the order in which these data strings are retrieved, because all of the following NVARCHAR strings are treated as duplicate values:

```
"ibm" "IBM" "iBm" "IBm" "IbM" "iBM" "iBM" "Ibm"
```

OPAQUE data types

An OPAQUE type is a data type for which you must provide information to the database server.

You must provide this information:

- A data structure for how the data values are stored on disk
- Support functions to determine how to convert between the disk storage format and the user format for data entry and display
- Secondary access methods that determine how the index on this data type is built, used, and manipulated
- User functions that use the data type
- A system catalog entry to register the OPAQUE type in the database

The internal structure of an OPAQUE type is not visible to the database server and can only be accessed through user-defined routines. Definitions for OPAQUE types are stored in the **sysxtotypes** system catalog table. These SQL statements maintain the definitions of OPAQUE types in the database:

- The CREATE OPAQUE TYPE statement registers a new OPAQUE type in the database.
- The DROP TYPE statement removes a previously defined OPAQUE type from the database.

For more information about the above-mentioned SQL statements, see the *IBM® Informix® Guide to SQL: Syntax*. For information about how to create OPAQUE types and an example of an OPAQUE type, see *IBM Informix User-Defined Routines and Data Types Developer's Guide*.

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REAL data type

The REAL data type is a synonym for SMALLFLOAT.

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ROW data type, Named

A named ROW data type must be declared with a name. This SQL identifier must be unique among data type names within the same database.

(An unnamed ROW type is a ROW type that contains fields but has no user-defined name.) Only named ROW types support data type inheritance. For more information, see [ROW Data Types](#).

Defining named ROW types

You must declare and register in the database a new named ROW type by using the CREATE ROW TYPE statement of SQL. Definitions for named ROW types are stored in the **sysxtotypes** system catalog table.

The fields of a ROW data type can be any built-in data type or UDT, but TEXT or BYTE fields of a ROW type are valid in typed tables only. If you want to assign a ROW type to a column in the CREATE TABLE or ALTER TABLE statements, its elements cannot be TEXT or BYTE data types.

In general, the data type of a field of a ROW type can be any of these types:

- A built-in type (except for the TEXT or BYTE data types)
- A collection type (LIST, MULTISET, or SET)
- A distinct type
- Another named or unnamed ROW type
- An opaque type

These SQL statements maintain the definitions of named ROW data types:

- The CREATE ROW TYPE statement adds a named ROW type to the database.
- The DROP ROW TYPE statement removes a previously defined named ROW type from the database.

No more than 195 columns of the same table can be named ROW types.

For details about these SQL syntax statements, see the *IBM® Informix® Guide to SQL: Syntax*. For examples of how to create and use named ROW types, see the *IBM Informix Database Design and Implementation Guide*.

Equivalence and named ROW types

No two named ROW types can be equal, even if they have identical structures, because they have different names. For example, the following named ROW types have the same structure (the same number of fields and the same order of data types of fields within the row) but they are not equal:

```
name_t (lname CHAR(15), initial CHAR(1), fname CHAR(15))
emp_t (lname CHAR(15), initial CHAR(1), fname CHAR(15))
```


A Boolean equality condition like `name_t = emp_t` always evaluates to FALSE if both of the operands are different named ROW types.

Named ROW types and inheritance

Named ROW types can be part of a type-inheritance hierarchy. One named ROW type can be the parent (or supertype) of another named ROW type. A subtype in a hierarchy inherits all the properties of its supertype. Type inheritance is explained in the CREATE ROW TYPE statement in the *IBM Informix Guide to SQL: Syntax* and in the *IBM Informix Database Design and Implementation Guide*.

Typed tables

Tables that are part of an inheritance hierarchy must be typed tables. Typed tables are tables that have been assigned a named ROW type. For the syntax you use to create typed tables, see the CREATE TABLE statement in the *IBM Informix Guide to SQL: Syntax*. Table inheritance and its relation to type inheritance is also explained in that section. For information about how to create and use typed tables, see the *IBM Informix Database Design and Implementation Guide*.

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ROW data type, Unnamed

An unnamed ROW type contains fields but has no user-declared name. An unnamed ROW type is defined by its structure.

Two unnamed ROW types are equal if they have the same structure (meaning the ordered list of the data types of the fields). If two unnamed ROW types have the same number of fields, and if the order of the data type of each field in one ROW type matches the order of data types of the corresponding fields in the other ROW data type, then the two unnamed ROW data types are equal.

For example, the following unnamed ROW types are equal:

```
ROW (lname char(15), initial char(1) fname char(15))
ROW (dept char(15), rating char(1) name char(15))
```

The following ROW types have the same number of fields and the same data types, but are not equal, because their fields are not in the same order:

```
ROW (x integer, y varchar(20), z real)
ROW (x integer, z real, y varchar(20))
```

A field of an unnamed ROW type can be any of the following data types:

- A built-in type
- A collection type
- A distinct type
- Another ROW type
- An opaque type

Unnamed ROW types cannot be used in typed tables or in type inheritance hierarchies. For more information about unnamed ROW types, see the *IBM® Informix® Guide to SQL: Syntax* and the *IBM Informix Database Design and Implementation Guide*.

- [Creating unnamed ROW types](#)
- [Inserting Values into Unnamed ROW Type Columns](#)

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Creating unnamed ROW types

You can create an unnamed ROW type in several ways:

- You can declare an unnamed ROW type using the ROW keyword. Each field in a ROW can have a different field type. To specify the field type, use the following syntax:

```
ROW(field_name field_type, ...)
```

The *field_name* must conform to the rules for SQL identifiers. (See the Identifier section in the *IBM® Informix® Guide to SQL: Syntax*.)

- To generate an unnamed ROW type, use the ROW keyword as a constructor with a series of values. A corresponding unnamed ROW type is created, using the default data types of the specified values. For example, the following declaration:

```
ROW(1, 'abc', 5.30)
```

defines this unnamed ROW data type:

```
ROW (x INTEGER, y VARCHAR, z DECIMAL)
```

- You can create an unnamed ROW type by an implicit or explicit cast from a named ROW type or from another unnamed ROW type.
- The rows of any table (except a table defined on a named ROW type) are unnamed ROW types.

No more than 195 columns of the same table can be unnamed ROW types.

Inserting Values into Unnamed ROW Type Columns

When you specify field values for an unnamed ROW type, list the field values after the constructor and between parentheses. For example, suppose you have an unnamed ROW-type column. The following INSERT statement adds one group of field values to this ROW column:

```
INSERT INTO table1 VALUES (ROW(4, 'abc'))
```

You can specify a ROW column in the IN predicate in the WHERE clause of a SELECT statement to search for matching ROW values. For more information, see the Condition section in the *IBM® Informix® Guide to SQL: Syntax*.

SERIAL(n) data type

The SERIAL data type stores a sequential integer, of the INT data type, that is automatically assigned by the database server when a new row is inserted.

The default serial starting number is 1, but you can assign an initial value, *n*, when you create or alter the table.

- You must specify a positive number for the starting number.
- If you specify zero (0) for the starting number, the value that is used is the maximum positive value that already exists in the SERIAL column + 1.

The maximum value for SERIAL is 2,147,483,647. If you assign a number greater than 2,147,483,647, you receive a syntax error. Use the SERIAL8 or BIGSERIAL data type, rather than SERIAL, if you need a larger range.

A table can have no more than one SERIAL column, but it can have a SERIAL column and either a SERIAL8 column or a BIGSERIAL column.

SERIAL values in a column are not automatically unique. You must apply a unique index or primary key constraint to this column to prevent duplicate serial numbers. If you use the interactive schema editor in DB-Access to define the table, a unique index is applied automatically to a SERIAL column.

SERIAL numbers might not be consecutive, because of concurrent users, rollbacks, and other factors.

The DEFINE *variable* LIKE *column* syntax of SPL for indirect typing declares a variable of the INTEGER data type if *column* is a SERIAL data type.

After a number is assigned, it cannot be changed. You can insert a value into a SERIAL column (using the INSERT statement) or reset a serial column (using the ALTER TABLE statement), if the new value does not duplicate any existing value in the column. To insert into a SERIAL column, your database server increments by one the previous value (or the reset value, if that is larger) and assigns the result as the entered value. If ALTER TABLE has reset the next value of a SERIAL column to a value smaller than values already in that column, however, the next value follows this formula:

```
(maximum existing value in SERIAL column) + 1
```

For example, if you reset the serial value of **customer.customer_num** to 50, when the largest existing value is 128, the next assigned number will be 129. For more details on SERIAL data entry, see the *IBM® Informix® Guide to SQL: Syntax*.

A SERIAL column can store unique codes such as order, invoice, or customer numbers. SERIAL data values require four bytes of storage, and have the same precision as the INTEGER data type. For details of another way to assign unique whole numbers to each row of a database table, see the CREATE SEQUENCE statement in *IBM Informix Guide to SQL: Syntax*.

SERIAL8(n) data type

The SERIAL8 data type stores a sequential integer, of the INT8 data type, that is assigned automatically by the database server when a new row is inserted.

The SERIAL8 data type behaves like the SERIAL data type, but with a larger range. For more information about how to insert values into SERIAL8 columns, see the *IBM® Informix® Guide to SQL: Syntax*.

A SERIAL8 data column is commonly used to store large, unique numeric codes such as order, invoice, or customer numbers. SERIAL8 data values have the same precision and storage requirements as INT8 values (page [INT8](#)).

The default serial starting number is 1, but you can assign an initial value, *n*, when you create or alter the table.

- You must specify a positive number for the starting number.
- If you specify zero (0) for the starting number, the value that is used is the maximum positive value that already exists in the SERIAL8 column + 1.

A table can have no more than one SERIAL column, but it can have a SERIAL column and either a SERIAL8 column or a BIGSERIAL column.

SERIAL8 values in a column are not automatically unique. You must apply a unique index or primary key constraint to this column to prevent duplicate serial numbers. If you use the interactive schema editor in DB-Access to define the table, a unique index is applied automatically to a SERIAL8 column.

SERIAL8 numbers might not be consecutive, because of concurrent users, rollbacks, and other factors.

The DEFINE *variable* LIKE *column* syntax of SPL for indirect typing declares a variable of the INTEGER data type if *column* is a SERIAL8 data type.

For more information, see [Assigning a Starting Value for SERIAL8](#). For information about using the SERIAL8 data type with the INT8 or BIGINT data type, see [Using SERIAL8 and BIGSERIAL with INT8 or BIGINT](#)

- [Assigning a Starting Value for SERIAL8](#)

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Assigning a Starting Value for SERIAL8

The default serial starting number is 1, but you can assign an initial value, *n*, when you create or alter the table. To start the values at 1 in a SERIAL8 column of a table, give the value 0 for the SERIAL8 column when you insert rows into that table. The database server will assign the value 1 to the SERIAL8 column of the first row of the table. The largest SERIAL8 value that you can assign is $2^{63}-1$ (9,223,372,036,854,775,807). If you assign a value greater than this, you receive a syntax error. When the database server generates a SERIAL8 value of this maximum number, it wraps around and starts generating values beginning at 1.

After a nonzero SERIAL8 number is assigned, it cannot be changed. You can, however, insert a value into a SERIAL8 column (using the INSERT statement) or reset the SERIAL8 value *n* (using the ALTER TABLE statement), if that value does not duplicate any existing values in the column.

When you insert a number into a SERIAL8 column or reset the next value of a SERIAL8 column, your database server assigns the next number in sequence to the number entered. If you reset the next value of a SERIAL8 column to a value that is less than the values already in that column, however, the next value is computed using the following formula:

maximum existing value in SERIAL8 column + 1

For example, if you reset the SERIAL8 value of the **customer_num** column in the **customer** table to 50, when the highest-assigned customer number is 128, the next customer number assigned is 129.

For information about using the SERIAL8 data type with the INT8 or BIGINT data type, see [Using SERIAL8 and BIGSERIAL with INT8 or BIGINT](#)

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SET(e) data type

The SET data type is an unordered collection type that stores unique elements

Duplicate element values are not valid as explained in *IBM® Informix® Guide to SQL: Syntax*. (For a collection type that supports duplicate values, see the description of MULTiset in [MULTiset\(e\) data type](#).)

No more than 97 columns of the same table can be declared as SET data types. (The same restriction also applies to MULTiset and LIST collection types.)

The elements in a SET have no ordinal position. That is, no construct of a first, second, or third element in a SET exists. (For a collection type with ordinal positions for elements, see [LIST\(e\) data type](#).) All elements in a SET have the same element type. To specify the element type, use this syntax:

SET (element_type NOT NULL)

The *element_type* of a collection can be any of the following types:

- A built-in type, except SERIAL, SERIAL8, BIGSERIAL, BYTE, and TEXT
- A named or unnamed ROW type
- Another collection type
- An opaque type

You must specify the NOT NULL constraint for SET elements. No other constraints are valid for SET columns. For more information about the syntax of the SET collection type, see the *IBM Informix Guide to SQL: Syntax*.

You can use SET anywhere that you use any other data type, unless otherwise indicated. For example:

- After the IN predicate in the WHERE clause of a SELECT statement to search for matching SET values
- As an argument to the CARDINALITY or **mi_collection_card()** function to determine the number of elements in a SET column

SET values are not valid as arguments to an aggregate function such as AVG, MAX, MIN, or SUM. For more information, see the Condition and Expression sections in the *IBM Informix Guide to SQL: Syntax*.

The following examples declare two sets. The first statement declares a set of integers and the second declares a set of character elements.

```
SET (INTEGER NOT NULL)
SET (CHAR(20) NOT NULL)
```

The following examples construct the same sets from value lists:

```
SET{1, 5, 13}
SET{"Oakland", "Menlo Park", "Portland", "Lenexa"}
```

In the following example, a SET constructor function is part of a CREATE TABLE statement:

```
CREATE TABLE tab
(
  c CHAR(5),
```

```
s SET (INTEGER NOT NULL)
);
```

The following set values are equal:

```
SET{ "blue", "green", "yellow" }
SET{ "yellow", "blue", "green" }
```

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SMALLFLOAT

The SMALLFLOAT data type stores single-precision floating-point numbers with approximately nine significant digits.

SMALLFLOAT corresponds to the **float** data type in C. The range of values for a SMALLFLOAT data type is the same as the range of values for the C **float** data type on your computer.

A SMALLFLOAT data type column typically stores scientific numbers that can be calculated only approximately. Because floating-point numbers retain only their most significant digits, the number that you enter in this type of column and the number the database displays might differ slightly depending on how your computer stores floating-point numbers internally.

For example, you might enter a value of 1.1000001 in a SMALLFLOAT field and, after processing the SQL statement, the application might display this value as 1.1. This difference occurs when a value has more digits than the floating-point number can store. In this case, the value is stored in its approximate form with the least significant digits treated as zeros.

SMALLFLOAT data types usually require four bytes of storage. Conversion of a SMALLFLOAT value to a DECIMAL value results in nine digits of precision.

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SMALLINT data type

The SMALLINT data type stores small whole numbers that range from -32,767 to 32,767. The maximum negative number, -32,768, is a reserved value and cannot be used.

The SMALLINT value is stored as a signed binary integer.

Integer columns typically store counts, quantities, and so on. Because the SMALLINT data type requires only two bytes per value, arithmetic operations are performed efficiently. SMALLINT, however, stores only a limited range of values, compared to other built-in numeric data types. If a number is outside the range of the minimum and maximum SMALLINT values, the database server does not store the data value, but instead issues an error message.

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TEXT data type

The TEXT data type stores any kind of text data. It can contain both single-byte and multibyte characters that the locale supports. The term *simple large object* refers to an instance of a TEXT or BYTE data type.

A TEXT column has a theoretical limit of 2³¹ bytes (two gigabytes) and a practical limit that your available disk storage determines. No more than 195 columns of the same table can be declared as TEXT data types. The same restriction also applies to BYTE data types.

You can store, retrieve, update, or delete the value in a TEXT column.

You can use TEXT operands in Boolean expressions only when you are testing for NULL values with the IS NULL or IS NOT NULL operators.

You can use the following methods, which can load rows or update fields, to insert TEXT data:

- With the **dbload** or **onload** utilities
- With the LOAD statement (DB-Access)
- From TEXT host variables (ESQL)

A built-in cast exists to convert TEXT objects to CLOB objects. For more information, see the *IBM® Informix® Database Design and Implementation Guide*.

Strings of the TEXT data type are collated in code-set order. For more information about collating orders, see the *IBM Informix GLS User's Guide*.

Selecting data in a TEXT column

When you select a TEXT column, you can receive all or part of it. To retrieve it all, use the regular syntax for selecting a column. You can also select any part of a TEXT column by using subscripts, as this example shows:

```
SELECT cat_descr [1,75] FROM catalog WHERE catalog_num = 10001
```

The SELECT statement reads the first 75 bytes of the **cat_descr** column associated with the **catalog_num** value 10001.

Loading data into a TEXT column

You can use the LOAD statement to insert data into a table. For example, the inp.txt file contains the following information:

```
1|aaaaa|
2|bbbbb|
3|ccccc|
```

To load this data into the blobtab table use the following statement:

```
LOAD FROM inp.txt INSERT INTO blobtab;
```

Limitations

You cannot use TEXT operands in arithmetic or string expressions, nor can you assign literals to TEXT columns in the SET clause of the UPDATE statement.

You also cannot use TEXT values in any of the following ways:

- With aggregate functions
- With the IN clause
- With the MATCHES or LIKE clauses
- With the GROUP BY clause
- With the ORDER BY clause

You cannot use a quoted text string, number, or any other actual value to insert or update TEXT columns.

You cannot use the MEDIUM or HIGH options of the UPDATE STATISTICS statement to calculate distribution statistics on TEXT columns.

Important: An error results if you try to return a TEXT column from a subquery, even if no TEXT column is used in a comparison condition or with the IN predicate.

- [Nonprintable Characters in TEXT Values](#)

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Nonprintable Characters in TEXT Values

TEXT columns typically store documents, program source files, and so on. In the default U.S. English locale, data objects of type TEXT can contain a combination of printable ASCII characters and the following control characters:

- Tab (CTRL-I)
- New line (CTRL-J)
- New page (CTRL-L)

Both printable and nonprintable characters can be inserted in text columns. IBM® Informix® products do not do any checking of data values that are inserted in a column of the TEXT data type. (Applications might have difficulty, however, in displaying TEXT values that include non-printable characters.) For detailed information about entering and displaying nonprintable characters, see [Nonprintable Characters with CHAR](#).

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Unnamed ROW

See [ROW data type, Unnamed](#).

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VARCHAR(m,r) data type

The VARCHAR data type stores character strings of varying length that contain single-byte and (if the locale supports them) multibyte characters, where *m* is the maximum size (in bytes) of the column and *r* is the minimum number of bytes reserved for that column.

A column declared as VARCHAR without parentheses or parameters has a maximum size of one byte, and a reserved size of zero.

The VARCHAR data type is the IBM® Informix® implementation of a character varying data type. The ANSI standard data type for varying-length character strings is CHARACTER VARYING.

The size of the maximum size (*m*) parameter of a VARCHAR column can range from 1 to 255 bytes. If you are placing an index on a VARCHAR column, the maximum size is 254 bytes. You can store character strings that are shorter, but not longer, than the *m* value that you specify.

Specifying the minimum reserved space (*r*) parameter is optional. This value can range from 0 to 255 bytes but must be less than the maximum size (*m*) of the VARCHAR column. If you do not specify any minimum value, it defaults to 0. You should specify this parameter when you initially intend to insert rows with short or NULL character strings in the column but later expect the data to be updated with longer values.

For variable-length strings longer than 255 bytes, you can use the LVARCHAR data type, whose upper limit is 32,739 bytes, instead of VARCHAR.

In an index based on a VARCHAR column (or on a NVARCHAR column), each index key has a length that is based on the data values that are actually entered, rather than on the declared maximum size of the column. (See, however, [IFX_PAD_VARCHAR environment variable](#) for information about how you can configure the effective size of VARCHAR and NVARCHAR data strings that IBM Informix sends or receives.)

When you store a string in a VARCHAR column, only the actual data characters are stored. The database server does not strip a VARCHAR string of any user-entered trailing blanks, nor pad a VARCHAR value to the declared length of the column. If you specify a reserved space (*r*), but some data strings are shorter than *r* bytes, some space reserved for rows goes unused.

VARCHAR values are compared to other VARCHAR values (and to other character-string data types) in the same way that CHAR values are compared. The shorter value is padded on the right with blank spaces until the values have equal lengths; then they are compared for the full length.

No more than 195 columns of the same table can be VARCHAR data types.

Nonprintable Characters with VARCHAR

Nonprintable VARCHAR characters are entered, displayed, and treated in the same way that nonprintable characters in CHAR values are treated. For details, see [Nonprintable Characters with CHAR](#).

Storing Numeric Values in a VARCHAR Column

When you insert a numeric value in a VARCHAR column, the stored value does not get padded with trailing blanks to the maximum length of the column. The number of digits in a numeric VARCHAR value is the number of characters that are required to store that value. For example, in the next example, the value stored in table **mytab** is 1.

```
create table mytab (col1 varchar(10));
insert into mytab values (1);
```

Tip: VARCHAR treats C null (binary 0) and string terminators as termination characters for nonprintable characters.

In some East Asian locales, VARCHAR data types can store multibyte characters if the database locale supports a multibyte code set. If you store multibyte characters, make sure to calculate the number of bytes needed. For more information, see the *IBM Informix GLS User's Guide*.

Multibyte Characters with VARCHAR

The first parameter in VARCHAR data type declarations can be affected by the SQL_LOGICAL_CHAR feature that is described in the section [Logical Character Semantics in Character Type Declarations](#).

Collating VARCHAR Values

The main difference between the NVARCHAR and the VARCHAR data types (like the difference between CHAR and NCHAR) is the difference in collating order. In general, collation of VARCHAR (like CHAR and LVARCHAR) values is in the order of the characters as they exist in the code set.

An exception is the MATCHES operator, which applies a localized collation to NVARCHAR and VARCHAR values (and to CHAR, LVARCHAR, and NCHAR values) if you use bracket ([]) symbols to define ranges when **DB_LOCALE** (or SET COLLATION) has specified a localized collating order. For more information, see the *IBM Informix GLS User's Guide*.

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Built-In Data Types

IBM® Informix® supports the following built-in data types.

Category	Data Types
Character	CHAR, CHARACTER VARYING, LVARCHAR, NCHAR, NVARCHAR, VARCHAR, IDSSecurityLabel
Large-object	Simple-large-object types: BYTE, TEXT Smart-large-object types: BLOB, CLOB
Logical	BOOLEAN
Multirepresentational	BSON and JSON built-in opaque data types
Numeric	BIGINT, BIGSERIAL, DECIMAL, FLOAT, INT8, INTEGER, MONEY, SERIAL, SERIAL8, SMALLFLOAT, SMALLINT
Time	DATE, DATETIME, INTERVAL

- [Character Data Types](#)
The character data types store string values.
- [Large-Object Data Types](#)
- [Time Data Types](#)

Related reference:

[Summary of data types](#)

Related information:

[BSON and JSON built-in opaque data types](#)

Character Data Types

The character data types store string values.

Built-in Character Types

Table 1. Attributes of built-in character data types

	Size (in bytes)	Default	Reserved	Collation	Length
CHAR(n)	1 to 32,767	1 byte	None	Code set	Fixed
NCHAR(n)	1 to 32,767	1 byte	None	Localized	Fixed
VARCHAR(m, r)	1 to 255	0 for r	0 to 255 bytes	Code set	Variable
NVARCHAR(m, r)	1 to 255	0 for r	0 to 255 bytes	Localized	Variable
LVARCHAR(m)	1 to 32,739	2048 bytes	None	Code set	Variable

The database server also uses LVARCHAR to represent the external format of opaque data types. In I/O operations of the database server, LVARCHAR data values have no upper limit on their size, apart from file size restrictions or limits of your operating system or hardware resources.

Logical Character Semantics in Character Type Declarations

IBM® Informix® supports a configuration parameter, `SQL_LOGICAL_CHAR`, whose setting can instruct the SQL parser to interpret the maximum size of character columns in data type declarations of the `CREATE TABLE` or `ALTER TABLE` statements as logical characters, rather than in units of bytes.

When a database is created, the current `SQL_LOGICAL_CHAR` setting for the database server is recorded in the **systables** table of the system catalog. The feature has no effect on tables that are subsequently created or altered in the database if the setting is OFF or 1.

In a database where the `SQL_LOGICAL_CHAR` setting is ON or is a digit between 2, 3, or 4, however, the SQL parser interprets explicit and implicit size declarations as logical characters in declarations of SPL variables and declarations of columns in database tables for the following character types:

- CHAR and CHARACTER
- CHARACTER VARYING and VARCHAR
- LVARCHAR
- NCHAR
- NVARCHAR
- DISTINCT types of the data types listed above
- DISTINCT types of those DISTINCT types
- ROW data type fields of the types listed above .
- LIST, MULTISET, and SET elements of the types listed above.

This feature has no effect on the maximum storage size limits for the character types listed in the previous table. For databases that use a multibyte locale, however, it can reduce the risk of data truncation when a string is inserted into a character column or assigned to a character variable.

For example, if 4 is the `SQL_LOGICAL_CHAR` setting for the database, then a `VARCHAR(10, 5)` specification is interpreted as requesting a maximum of 40 bytes of storage, with 5 of these bytes reserved, creating a `VARCHAR(40, 5)` data type in standard SQL notation, rather than what was specified in the declaration.

The reserve size parameters of VARCHAR and NVARCHAR data types are not affected by the `SQL_LOGICAL_CHAR` setting, because the minimum size of a multibyte character is 1 byte. In this example, the minimum size of 5 multibyte characters is 5 bytes, a size that remains unchanged.

See the description of the `SQL_LOGICAL_CHAR` configuration parameter in the *IBM Informix Administrator's Reference* for more information about the effect of the `SQL_LOGICAL_CHAR` setting in databases whose **DB_LOCALE** specifies a multibyte locale. For additional information about multibyte locales and logical characters, see the *IBM Informix GLS User's Guide*.

IDSSECURITYLABEL

IBM Informix also supports the IDSSECURITYLABEL data type for systems that implement label-based access control (LBAC). This built-in data type can be formally classified as a character type, because it is defined as a `DISTINCT OF VARCHAR(128)` data type, but only users who hold the **DBSECADM** role can declare this data type in DDL operations. It supports the LBAC security feature, rather than functioning as a general-purpose character type.

Data Type Promotion

For some string-manipulation operations of IBM Informix, the five built-in character data types listed above support data type promotion, in order to reduce the risk of string operations failing because a returned string is too large to be stored in an NVARCHAR or VARCHAR column or program variable. See the topic "Return Types from CONCAT and String Manipulation Functions" in *IBM Informix Guide to SQL: Syntax* for details of data type promotion among IBM Informix character types.

National Language Support

The NCHAR and NVARCHAR types are sometimes called National Language Support data types because of their support for localized collation. Because columns of type VARCHAR or NVARCHAR have no default size, you must specify a size (no greater than 255) in their declaration. For VARCHAR or NVARCHAR columns on

which an index is defined, the maximum size is 254 bytes.

NLSCASE INSENSITIVE Databases

In databases created with the `NLSCASE INSENSITIVE` keyword option, operations on data strings of the `NCHAR` or `NVARCHAR` types makes no distinction between uppercase and lowercase variants of the same letter. Rows are stored in `NCHAR` or `NVARCHAR` columns in the letter case in which characters were loaded, but data strings that consist of the same letters in the same sequence are evaluated as duplicates, even if the case of some letters is not identical. For example, the three `NCHAR` strings "ABC" and "AbC" and "abC" are treated as duplicates. Other built-in character types, including `CHAR`, `LVARCHAR`, and `VARCHAR`, follow the default case-sensitive rules, so that the same three strings in a `CHAR` column evaluate to distinct values.

Databases with the `NLSCASE INSENSITIVE` property also ignore the letter case of `DISTINCT` data types whose base types are `NCHAR` or `NVARCHAR`, as well as `NCHAR` or `NVARCHAR` fields in named or unnamed `ROW` types, and `NCHAR` or `NVARCHAR` elements of `COLLECTION` data types, including `LIST`, `SET`, or `MULTISET`.

In a database that is insensitive to the letter case of `NCHAR` or `NVARCHAR` values, string manipulation operations might produce unexpected results, if they implicitly cast `CHAR`, `LVARCHAR`, or `VARCHAR` operands or arguments to `NCHAR` or `NVARCHAR` data types. In some contexts, the operation can return a duplicate string, despite letter case variations that the database server would not have treated as duplicates for the original data types.

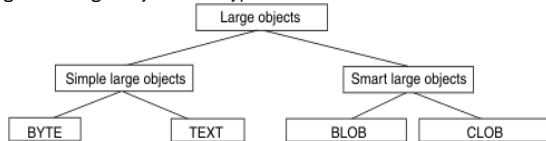
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Large-Object Data Types

A large object is a data object that is logically stored in a table column but physically stored independent of the column. Large objects are stored separate from the table because they typically store a large amount of data. Separation of this data from the table can increase performance.

Figure 1 shows the large-object data types.

Figure 1. Large-Object Data Types



Only IBM® Informix® supports BLOB and CLOB data types.

For the relative advantages and disadvantages of simple and smart large objects, see the *IBM Informix Database Design and Implementation Guide*.

- [Simple Large Objects](#)
- [Smart large objects](#)

Smart large objects are a category of large objects that support random access to the data, and that are generally recoverable.

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Simple Large Objects

Simple large objects are a category of large objects that have a theoretical size limit of 2^{31} bytes and a practical limit that your disk capacity determines. IBM® Informix® supports these simple-large-object data types:

BYTE

Stores binary data. For more detailed information about this data type, see the description on page [BYTE data type](#).

TEXT

Stores text data. For more detailed information about this data type, see the description on page [TEXT data type](#).

No more than 195 columns of the same table can be declared as `BYTE` or `TEXT` data types. Unlike smart large objects, simple large objects do not support random access to the data. When you transfer a simple large object between a client application and the database server, you must transfer the entire `BYTE` or `TEXT` value. If the data cannot fit into memory, you must store the data value in an operating-system file and then retrieve it from that file.

The database server stores simple large objects in *blobspaces*. A *blobspace* is a logical storage area that contains one or more chunks that only store `BYTE` and `TEXT` data. For information about how to define *blobspaces*, see your *IBM Informix Administrator's Guide*.

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Smart large objects

Smart large objects are a category of large objects that support random access to the data, and that are generally recoverable.

The random access feature allows you to seek and read through the smart large object as if it were an operating-system file.

Smart large objects are also useful for opaque data types with large storage requirements. (See the description of opaque data types in [Opaque Data Types](#).) They have a theoretical size limit of 2^{42} bytes and a practical limit that your disk capacity determines.

IBM® Informix® supports the following smart-large-object data types:

BLOB

Stores binary data. For more information about this data type, see the description on page [BLOB data type](#).

CLOB

Stores text data. For more information about this data type, see [CLOB data type](#).

IBM Informix stores smart large objects in *sbspaces*. An *sbspace* is a logical storage area that contains one or more chunks that store only BLOB and CLOB data. For information about how to define sbspaces, see your *IBM Informix Performance Guide*.

When you define a BLOB or CLOB column, you can determine the following large-object characteristics:

- LOG and NOLOG: whether the database server should log the smart large object in accordance with the current database logging mode.
- KEEP ACCESS TIME and NO KEEP ACCESS TIME: whether the database server should keep track of the last time the smart large object was accessed.
- HIGH INTEG and MODERATE INTEG: whether the database server should use sbspace page headers and page footers to detect data corruption (HIGH INTEG), or only use page headers (MODERATE INTEG).

Use of these characteristics can affect performance. For information, see your *IBM Informix Performance Guide*.

When an SQL statement accesses a smart-large-object, the database server does not send the actual BLOB or CLOB data. Instead, it establishes a pointer to the data and returns this pointer. The client application can then use this pointer in open, read, or write operations on the smart large object.

To access a BLOB or CLOB column from within a client application, use one of the following application programming interfaces (APIs):

- From within IBM Informix ESQL/C programs, use the smart-large-object API. (For more information, see the *IBM Informix ESQL/C Programmer's Manual*.)
- From within a DataBlade module, use the Client and Server API. (For more information, see the *IBM Informix DataBlade API Programmer's Guide*.)

For information about smart large objects, see the *IBM Informix Guide to SQL: Syntax* and *IBM Informix Database Design and Implementation Guide*.

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Time Data Types

DATE and DATETIME data values represent zero-dimensional points in time; INTERVAL data values represent 1-dimensional spans of time, with positive or negative values. DATE precision is always an integer count of days, but various field qualifiers can define the DATETIME and INTERVAL precision. You can use DATE, DATETIME, and INTERVAL data in arithmetic and relational expressions. You can manipulate a DATETIME value with another DATETIME value, an INTERVAL value, the current time (specified by the keyword CURRENT), or some unit of time (using the keyword UNITS).

You can use a DATE value in most contexts where a DATETIME value is valid, and vice versa. You also can use an INTERVAL operand in arithmetic operations where a DATETIME value is valid. In addition, you can add two INTERVAL values and multiply or divide an INTERVAL value by a number.

An INTERVAL column can hold a value that represents the difference between two DATETIME values or the difference between (or sum of) two INTERVAL values. In either case, the result is a span of time, which is an INTERVAL value. Conversely, if you add or subtract an INTERVAL from a DATETIME value, another DATETIME value is produced, because the result is a specific time.

[Table 1](#) lists the binary arithmetic operations that you can perform on DATE, DATETIME, and INTERVAL operands, and the data type that is returned by the arithmetic expression.

Table 1. Arithmetic Operations on DATE, DATETIME, and INTERVAL Values

Operand 1	Operator	Operand 2	Result
DATE	-	DATETIME	INTERVAL
DATETIME	-	DATE	INTERVAL
DATE	+ or -	INTERVAL	DATETIME
DATETIME	-	DATETIME	INTERVAL
DATETIME	+ or -	INTERVAL	DATETIME
INTERVAL	+	DATETIME	DATETIME
INTERVAL	+ or -	INTERVAL	INTERVAL
DATETIME	-	CURRENT	INTERVAL
CURRENT	-	DATETIME	INTERVAL
INTERVAL	+	CURRENT	DATETIME
CURRENT	+ or -	INTERVAL	DATETIME
DATETIME	+ or -	UNITS	DATETIME
INTERVAL	+ or -	UNITS	INTERVAL
INTERVAL	* or /	NUMBER	INTERVAL

No other combinations are allowed. You cannot add two DATETIME values because this operation does not produce either a specific time or a span of time. For example, you cannot add December 25 and January 1, but you can subtract one from the other to find the time span between them.

- [Manipulating DATETIME Values](#)
You can subtract most DATETIME values from each other.
- [Manipulating DATETIME with INTERVAL Values](#)

- [Manipulating DATE with DATETIME and INTERVAL Values](#)
 - [Manipulating INTERVAL Values](#)
- You can add or subtract INTERVAL values only if both values are from the same class; that is, if both are year-month or both are day-time.
- [Multiplying or Dividing INTERVAL Values](#)

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Manipulating DATETIME Values

You can subtract most DATETIME values from each other.

Dates can be in any order and the result is either a positive or a negative INTERVAL value. The first DATETIME value determines the precision of the result, which includes the same time units as the first operand.

If the second DATETIME value has fewer fields than the first, the precision of the second operand is increased automatically to match the first.

In the following example, subtracting the DATETIME YEAR TO HOUR value from the DATETIME YEAR TO MINUTE value results in a positive interval value of 60 days, 1 hour, and 30 minutes. Because minutes were not included in the second operand, the database server sets the minutes value for the second operand to 0 before performing the subtraction.

```
DATETIME (2003-9-30 12:30) YEAR TO MINUTE
- DATETIME (2003-8-1 11) YEAR TO HOUR
```

```
Result: INTERVAL (60 01:30) DAY TO MINUTE
```

If the second DATETIME operand has more fields than the first (regardless of whether the precision of the extra fields is larger or smaller than those in the first operand), the additional time unit fields in the second value are ignored in the calculation.

In the next expression (and its result), the year is not included for the second operand. Therefore, the year is set automatically to the current year (from the system clock-calendar), in this example 2005, and the resulting INTERVAL is negative, which indicates that the second date is later than the first.

```
DATETIME (2005-9-30) YEAR TO DAY
- DATETIME (10-1) MONTH TO DAY
```

```
Result: INTERVAL (-1) DAY TO DAY [assuming that the current
                                   year is 2005]
```

You can compare two DATETIME values by using the `mi_datetime_compare()` function.

Related reference:

[DATETIME data type](#)

Related information:

[The mi_datetime_compare\(\) function](#)

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Manipulating DATETIME with INTERVAL Values

INTERVAL values can be added to or subtracted from DATETIME values. In either case, the result is a DATETIME value. If you are adding an INTERVAL value to a DATETIME value, the order of values is unimportant; however, if you are subtracting, the DATETIME value must come first. Adding or subtracting a positive INTERVAL value moves the DATETIME result forward or backward in time. The expression shown in the following example moves the date ahead by three years and five months:

```
DATETIME (2000-8-1) YEAR TO DAY
+ INTERVAL (3-5) YEAR TO MONTH
```

```
Result: DATETIME (2004-01-01) YEAR TO DAY
```

Important: Evaluate the logic of your addition or subtraction. Remember that months can have 28, 29, 30, or 31 days and that years can have 365 or 366 days.

In most situations, the database server automatically adjusts the calculation when the operands do not have the same precision. In certain contexts, however, you must explicitly adjust the precision of one value to perform the calculation. If the INTERVAL value you are adding or subtracting has fields that are not included in the DATETIME value, you must use the EXTEND function to increase the precision of the DATETIME value. (For more information about the EXTEND function, see the Expression segment in the *IBM® Informix® Guide to SQL: Syntax*.)

For example, you cannot subtract an INTERVAL MINUTE TO MINUTE value from the DATETIME value in the previous example that has a YEAR TO DAY field qualifier. You can, however, use the EXTEND function to perform this calculation, as the following example shows:

```
EXTEND (DATETIME (2008-8-1) YEAR TO DAY, YEAR TO MINUTE)
- INTERVAL (720) MINUTE(3) TO MINUTE
```

```
Result: DATETIME (2008-07-31 12:00) YEAR TO MINUTE
```

The EXTEND function allows you to explicitly increase the DATETIME precision from YEAR TO DAY to YEAR TO MINUTE. This allows the database server to perform the calculation, with the resulting extended precision of YEAR TO MINUTE.

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Manipulating DATE with DATETIME and INTERVAL Values

You can use DATE operands in some arithmetic expressions with DATETIME or INTERVAL operands by writing expressions to do the manipulating, as [Table 1](#) shows.

Table 1. Results of Expressions That Manipulate DATE with DATETIME or INTERVAL Values

Expression	Result
DATE – DATETIME	INTERVAL
DATETIME – DATE	INTERVAL
DATE + or – INTERVAL	DATETIME

In the cases that [Table 1](#) shows, DATE values are first converted to their corresponding DATETIME equivalents, and then the expression is evaluated by the rules of arithmetic.

Although you can interchange DATE and DATETIME values in many situations, you must indicate whether a value is a DATE or a DATETIME data type. A DATE value can come from the following sources:

- A column or program variable of type DATE
- The TODAY keyword
- The DATE() function
- The MDY function
- A DATE literal

A DATETIME value can come from the following sources:

- A column or program variable of type DATETIME
- The CURRENT keyword
- The EXTEND function
- A DATETIME literal

The database locale defines the default DATE and DATETIME formats. For the default locale, U.S. English, these formats are 'mm/dd/yy' for DATE values and 'yyyy-mm-dd hh:MM:ss' for DATETIME values.

To represent DATE and DATETIME values as character strings, the fields in the strings must be in the required order. In other words, when a DATE value is expected, the string must be in DATE format and when a DATETIME value is expected, the string must be in DATETIME format. For example, you can use the string 10/30/2008 as a DATE string but not as a DATETIME string. Instead, you must use 2008-10-30 or 08-10-30 as the DATETIME string.

In a nondefault locale, literal DATE and DATETIME strings must match the formats that the locale defines. For more information, see the *IBM® Informix® GLS User's Guide*.

You can customize the DATE format that the database server expects with the **DBDATE** and **GL_DATE** environment variables. You can customize the DATETIME format that the database server expects with the **DBTIME** and **GL_DATETIME** environment variables. For more information, see [DBDATE environment variable](#) and [DBTIME environment variable](#). For more information about all these environment variables, see the *IBM Informix GLS User's Guide*.

You can also subtract one DATE value from another DATE value, but the result is a positive or negative INTEGER count of days, rather than an INTERVAL value. If an INTERVAL value is required, you can either use the UNITS DAY operator to convert the INTEGER value into an INTERVAL DAY TO DAY value, or else use EXTEND to convert one of the DATE values into a DATETIME value before subtracting.

For example, the following expression uses the **DATE()** function to convert character string constants to DATE values, calculates their difference, and then uses the UNITS DAY keywords to convert the INTEGER result into an INTERVAL value:

```
(DATE ('5/2/2007') - DATE ('4/6/1968')) UNITS DAY
```

Result: INTERVAL (12810) DAY(5) TO DAY

Important: Because of the high precedence of UNITS relative to other SQL operators, you should generally enclose any arithmetic expression that is the operand of UNITS within parentheses, as in the preceding example.

If you need YEAR TO MONTH precision, you can use the EXTEND function on the first DATE operand, as the following example shows:

```
EXTEND (DATE ('5/2/2007'), YEAR TO MONTH) - DATE ('4/6/1969')
```

Result: INTERVAL (39-01) YEAR TO MONTH

The resulting INTERVAL precision is YEAR TO MONTH, because the DATETIME value came first. If the DATE value had come first, the resulting INTERVAL precision would have been DAY(5) TO DAY.

Related reference:

[DATETIME data type](#)

[INTERVAL data type](#)

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Manipulating INTERVAL Values

You can add or subtract INTERVAL values only if both values are from the same class; that is, if both are year-month or both are day-time.

In the following example, a SECOND TO FRACTION value is subtracted from a MINUTE TO FRACTION value:

```
INTERVAL (100:30.0005) MINUTE (3) TO FRACTION (4)
- INTERVAL (120.01) SECOND (3) TO FRACTION
```

Result: INTERVAL (98:29.9905) MINUTE TO FRACTION (4)

The use of numeric qualifiers alerts the database server that the MINUTE and FRACTION in the first value and the SECOND in the second value exceed the default number of digits.

When you add or subtract INTERVAL values, the second value cannot have a field with greater precision than the first. The second INTERVAL, however, can have a field of smaller precision than the first. For example, the second INTERVAL can be HOUR TO SECOND when the first is DAY TO HOUR. The additional fields (in this case MINUTE and SECOND) in the second INTERVAL value are ignored in the calculation.

You can compare two INTERVAL values by using the `mi_interval_compare()` function.

Related reference:

[INTERVAL data type](#)

Related information:

[The mi_interval_compare\(\) function](#)

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Multiplying or Dividing INTERVAL Values

You can multiply or divide INTERVAL values by numbers. Any remainder from the calculation is ignored, however, and the result is truncated to the precision of the INTERVAL. The following expression multiplies an INTERVAL value by a literal number that has a fractional part:

```
INTERVAL (15:30.0002) MINUTE TO FRACTION (4) * 2.5
```

Result: INTERVAL (38:45.0005) MINUTE TO FRACTION (4)

In this example, $15 * 2.5 = 37.5$ minutes, $30 * 2.5 = 75$ seconds, and $2 * 2.5 = 5$ FRACTION (4). The 0.5 minute is converted into 30 seconds and 60 seconds are converted into 1 minute, which produces the final result of 38 minutes, 45 seconds, and 0.0005 of a second. The result of any calculation has the same precision as the original INTERVAL operand.

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Extended Data Types

IBM® Informix® enables you to create *extended data types* to characterize data that cannot easily be represented with the built-in data types. (You cannot, however, use extended data types in distributed transactions that query external tables.) You can create these categories of extended data types:

- Complex data types
- Distinct data types
- Opaque data types

Sections that follow provide an overview of each of these data types.

For more information about extended data types, see the *IBM Informix Database Design and Implementation Guide* and *IBM Informix User-Defined Routines and Data Types Developer's Guide*.

- [Complex data types](#)
A *complex data type* can store one or more values of other built-in or extended data types.
- [Distinct Data Types](#)
A distinct data type has the same internal structure as some other source data type in the database. The source type can be a built-in or extended data type. What distinguishes a distinct type from its source type are support functions that are defined on the distinct type.
- [Opaque Data Types](#)
An opaque data type is a user-defined or built-in data type that is fully encapsulated. The internal structure of an opaque data type is unknown to the database server.

Related reference:

[Summary of data types](#)

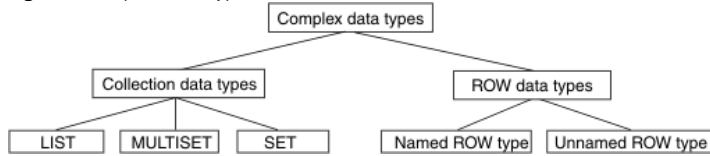
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Complex data types

A *complex data type* can store one or more values of other built-in or extended data types.

[Figure 1](#) shows the complex types that IBM® Informix® supports.

Figure 1. Complex Data Types of IBM Informix



The following table summarizes the structure of the complex data types.

Table 1. Collection types are complex data types that are made up of elements, each of which is of the same data type.

Collection types	Description
LIST	A group of ordered elements, each of which need not be unique within the group.
MULTISET	A group of elements, each of which need not be unique. The order of the elements is ignored.
SET	A group of elements, each of which is unique. The order of the elements is ignored.

Table 2. ROW types are complex data types that are made up of fields.

ROW types	Description
Named ROW type	Row types that are identified by their name.
Unnamed ROW type	Row types that are identified by their structure.

Complex data types can be nested. For example, you can construct a ROW type whose fields include one or more sets, multisets, ROW types, and lists. Likewise, a collection type can have elements whose data type is a ROW type or a collection type.

Complex types that include opaque types inherit the following support functions.

- **input**
- **output**
- **send**
- **recv**
- **import**
- **export**
- **import_binary**
- **export_binary**
- **assign**
- **destroy**
- **LO_handles**
- **hash**
- **lessthan**
- **equal**
- **lessthan** (for ROW types only)

The topics that follow summarize the complex data types. For more information, see the *IBM Informix Database Design and Implementation Guide*.

- [Collection Data Types](#)
- [ROW Data Types](#)

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Collection Data Types

A collection data type is a complex type that is made up of one or more elements, all of the same data type. A collection element can be of any data type (including other complex types) except BYTE, TEXT, SERIAL, SERIAL8, or BIGSERIAL.

Important: An element cannot have a *NULL* value. You must specify the *NOT NULL* constraint for collection elements. No other constraints are valid for collections. IBM® Informix® supports three kinds of built-in collection types: LIST, SET, and MULTISET. The keywords used to declare these collections are the names of the *type constructors* or just *constructors*. For the syntax of collection types, see the *IBM Informix Guide to SQL: Syntax*. No more than 97 columns of the same table can be declared as collection data types.

When you specify element values for a collection, list the element values after the constructor and between braces ({}). For example, suppose you have a collection column with the following MULTISET data type:

```
CREATE TABLE table1
(
  mset_col MULTISET(INTEGER NOT NULL)
)
```

The next INSERT statement adds one group of element values to this column. (The word MULTISET in these two examples is the MULTISET constructor.)

```
INSERT INTO table1 VALUES (MULTISET{5, 9, 7, 5})
```

You can leave the braces empty to indicate an empty set:

```
INSERT INTO table1 VALUE (MULTISET{})
```

An empty collection is not equivalent to a NULL value for the column.

- [Accessing collection data](#)

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Accessing collection data

To access the elements of a collection column, you must fetch the collection into a collection variable and modify the contents of the collection variable. Collection variables can be either of the following types:

- Variables in an SPL routine
For more information, see the *IBM Informix Guide to SQL: Tutorial*.
- Host variables in IBM® Informix® ESQL/C programs
For more information, see the *IBM Informix ESQL/C Programmer's Manual*.

You can also use nested dot notation to access collection data. For more about accessing elements of a collection, see the *IBM Informix Guide to SQL: Tutorial*. Important: Collection data types are not valid as arguments to functions that are used for functional indexes.

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ROW Data Types

A ROW data type is an ordered collection of one or more elements, called *fields*. Each field has a name and a data type. The fields of a ROW are comparable to the columns of a table, but with important differences:

- A field has no default clause.
- You cannot define constraints on a field.
- You can only use fields with row types, not with tables.

Two kinds of ROW data types exist:

- *Named ROW data types* are identified by their names.
- *Unnamed ROW data types* are identified by their structure.

The *structure* of an unnamed ROW data type is the number (and the order of data types) of its fields.

No more than 195 columns of the same table can be declared as ROW data types. For more information about ROW data types, see [ROW data type, Named](#) and [ROW data type, Unnamed](#).

You can cast between named and unnamed ROW data types; this is described in the *IBM® Informix® Database Design and Implementation Guide*.

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Distinct Data Types

A distinct data type has the same internal structure as some other source data type in the database. The source type can be a built-in or extended data type. What distinguishes a distinct type from its source type are support functions that are defined on the distinct type.

No more than approximately 97 columns of the same table can be DISTINCT of collection data types (SET, LIST, and MULTISSET). No more than approximately 195 columns of the same table can be DISTINCT types that are based on BYTE, TEXT, ROW, LVARCHAR, NVARCHAR, or VARCHAR source types. (Here 195 columns is an approximate lower limit that applies to platforms with a 2 Kb base page size. For platforms with a base page size of 4 Kb, such as Windows and AIX® systems, the upper limit is approximately 450 columns of these data types.) For more information, see the section [DISTINCT data types](#). See also *IBM® Informix® User-Defined Routines and Data Types Developer's Guide*.

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Opaque Data Types

An opaque data type is a user-defined or built-in data type that is fully encapsulated. The internal structure of an opaque data type is unknown to the database server.

Except for user-defined types (UDTs) that are DISTINCT of built-in non-opaque types, UDTs whose source types are built-in types are opaque data types. Similarly, UDTs that are DISTINCT of built-in opaque types are opaque types.

Built-in opaque data types

The built-in data types BLOB, BOOLEAN, CLOB, BSON, JSON, and LVARCHAR are implemented as opaque data types. You can access all of these in other databases of the same Informix® instance, but you cannot access the BLOB or CLOB built-in opaque data types in cross-server distributed operations.

UDTs that are DISTINCT of built-in opaque types and that are cast to built-in types are valid in cross-server queries and other DML operations, but all the casts and all the DISTINCT OF definitions for the UDTs must be identical in every participating database.

Several system catalog tables, whose schema are shown in [Structure of the System Catalog](#), have columns of built-in opaque data types. For information on how the system catalog encodes columns of built-in opaque data types, see [SYSCOLUMNS](#).

User-defined opaque data types

You must provide the following information to the database server for an opaque data type:

- A data structure for how the data values are stored on disk
- Support functions to determine how to convert between the disk storage format and the user format for data entry and display
- Secondary access methods that determine how the index on this data type is built, used, and manipulated
- User functions that use the data type
- A system catalog entry to register the opaque type in the database

The internal structure of an opaque type is not visible to the database server and can only be accessed through user-defined routines. Definitions for opaque types are stored in the sysxdtypes system catalog table. These SQL statements maintain the definitions of opaque types in the database:

- The CREATE OPAQUE TYPE statement registers a new opaque type in the database.
- The DROP TYPE statement removes a previously defined opaque type from the database.

For more information, see the section [OPAQUE data types](#). See also *IBM® Informix User-Defined Routines and Data Types Developer's Guide*.

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Data Type Casting and Conversion

Occasionally, the data type that was assigned to a column with the CREATE TABLE statement is inappropriate. You can change the data type of a column when you are required to store larger values than the current data type can accommodate. The database server allows you to change the data type of the column or to cast its values to a different data type with either of the following methods:

- Use the ALTER TABLE statement to modify the data type of a column.
For example, if you create a SMALLINT column and later find that you must store integers larger than 32,767, you must change the data type of that column to store the larger value. You can use ALTER TABLE to change the data type to INTEGER. The conversion changes the data type of all values that currently exist in the column and any new values that might be added.
- Use the CAST AS keywords or the double colon (::) cast operator to cast a value to a different data type.
Casting does not permanently alter the data type of a value; it expresses the value in a more convenient form. Casting user-defined data types into built-in types allows client programs to manipulate data types without knowledge of their internal structure.

If you change data types, the new data type must be able to store all of the old value.

Both data-type conversion and casting depend on casts registered in the **syscasts** system catalog table. For information about **syscasts**, see [SYSCASTS](#).

A cast is either built-in or user defined. Guidelines exist for casting distinct and extended data types. For more information about casting opaque data types, see *IBM® Informix® User-Defined Routines and Data Types Developer's Guide*. For information about casting other extended data types see, the *IBM Informix Database Design and Implementation Guide*.

- [Using Built-in Casts](#)
- [Using User-Defined Casts](#)
- [Determining Which Cast to Apply](#)
- [Casts for distinct types](#)
- [What Extended Data Types Can Be Cast?](#)

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Using Built-in Casts

User **informix** owns built-in casts. They govern conversions from one built-in data type to another. Built-in casts allow the database server to attempt the following data-type conversions:

- A character type to any other character type
- A character type to or from another built-in type
- A numeric type to any other numeric type

The database server automatically invokes appropriate built-in casts when required. For time data types, conversion between DATE and DATETIME data types requires explicit casts with the EXTEND function, and explicit casts with the UNITS operator are required for number-to-INTERVAL conversion. Built-in casts are unavailable for converting large (BYTE, BLOB, CLOB, and TEXT) built-in types to other built-in data types.

When you convert a column from one built-in data type to another, the database server applies the appropriate built-in casts to each value already in the column. If the new data type cannot store any of the resulting values, the ALTER TABLE statement fails.

For example, if you try to convert a column from the INTEGER data type to the SMALLINT data type and the following values exist in the INTEGER column, the database server does not change the data type, because SMALLINT columns cannot accommodate numbers greater than 32,767:

100 400 700 50000 700

The same situation might occur if you attempt to transfer data from FLOAT or SMALLFLOAT columns to INTEGER, SMALLINT, or DECIMAL columns. Errors of overflow, underflow, or truncation can occur during data type conversion.

Sections that follow describe database server behavior during certain types of casts and conversions.

- [Converting from number to number](#)
- [Converting Between Number and Character](#)
- [Converting Between INTEGER and DATE](#)
- [Converting Between DATE and DATETIME](#)

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Converting from number to number

When you convert data from one number data type to another, you occasionally find rounding errors.

The following table indicates which numeric data type conversions are acceptable and what kinds of errors you can encounter when you convert between certain numeric data types. In the table, the following codes are used:

- OK No error
- P An error can occur, depending on the precision of the decimal
- E An error can occur, depending on the data value
- D No error, but less significant digits might be lost

Table 1. Acceptable conversions and possible errors

Target Type	SMALL INT	INTEGER	INT8	SMALL FLOAT	FLOAT	DECIMAL
SMALLINT	OK	OK	OK	OK	OK	OK
INTEGER	E	OK	OK	E	OK	P
INT8	E	E	OK	D	E	P
SMALLFLOAT	E	E	E	OK	OK	P
FLOAT	E	E	E	D	OK	P
DECIMAL	E	E	E	D	D	P

For example, if you convert a FLOAT value to DECIMAL(4,2), your database server rounds off the floating-point number before storing it as DECIMAL.

This conversion can result in an error depending on the precision assigned to the DECIMAL column.

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Converting Between Number and Character

You can convert a character column (of a data type such as CHAR, NCHAR, NVARCHAR, or VARCHAR) to a numeric column. If a data string, however, contains any characters that are not valid in a number column (for example, the letter *l* instead of the number 1), the database server returns an error.

You can also convert a numeric column to a character column. If the character column is not large enough to receive the number, however, the database server generates an error. If the database server generates an error, it cannot complete the ALTER TABLE statement or cast, and leaves the column values as characters. You receive an error message and the statement is rolled back automatically (regardless of whether you are in a transaction).

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Converting Between INTEGER and DATE

You can convert an integer column (SMALLINT, INTEGER, or INT8) to a DATE value. The database server interprets the integer as a value in the internal format of the DATE column. You can also convert a DATE column to an integer column. The database server stores the internal format of the DATE column as an integer representing a Julian date.

Converting Between DATE and DATETIME

You can convert DATE columns to DATETIME columns. If the DATETIME column contains more fields than the DATE column, however, the database server either ignores the fields or fills them with zeros. The illustrations in the following list show how these two data types are converted (assuming that the default date format is *mm/dd/yyyy*):

- If you convert DATE to DATETIME YEAR TO DAY, the database server converts the existing DATE values to DATETIME values. For example, the value 08/15/2002 becomes 2002-08-15.
- If you convert DATETIME YEAR TO DAY to the DATE format, the value 2002-08-15 becomes 08/15/2002.
- If you convert DATE to DATETIME YEAR TO SECOND, the database server converts existing DATE values to DATETIME values and fills in the additional DATETIME fields with zeros. For example, 08/15/2002 becomes 2002-08-15 00:00:00.
- If you convert DATETIME YEAR TO SECOND to DATE, the database server converts existing DATETIME to DATE values but drops fields for time units smaller than DAY. For example, 2002-08-15 12:15:37 becomes 08/15/2002.

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Using User-Defined Casts

Implicit and explicit casts are owned by the users who create them. They govern casts and conversions between user-defined data types and other data types. Developers of user-defined data types must create certain implicit and explicit casts and the functions that are used to implement them. The casts allow user-defined types to be expressed in a form that clients can manipulate.

For information about how to register and use implicit and explicit casts, see the CREATE CAST statement in the *IBM® Informix® Guide to SQL: Syntax* and the *IBM Informix Database Design and Implementation Guide*.

- [Implicit Casts](#)
- [Explicit Casts](#)

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Implicit Casts

Implicit casts allow you to convert a user-defined data type to a built-in type or vice versa. The database server automatically invokes a single implicit cast when it must evaluate and compare expressions or pass arguments. Operations that require more than one implicit cast fail.

Users can explicitly invoke an implicit cast using the CAST AS keywords or the double colon (::) cast operator.

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Explicit Casts

Explicit casts, unlike implicit casts or built-in casts, are *never* invoked automatically by the database server. Users must invoke them explicitly with the CAST AS keywords or with the double colon (::) cast operator.

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Determining Which Cast to Apply

The database server uses the following rules to determine which cast to apply in a particular situation:

- To compare two built-in types, the database server automatically invokes the appropriate built-in casts.
- The database server applies only one implicit cast per operand. If two or more casts are required to convert the operand to the specified type, the user must explicitly invoke the additional casts.

In the following example, the literal value 5.55 is implicitly cast to DECIMAL, and is then explicitly cast to MONEY, and finally to yen:

```
CREATE DISTINCT TYPE yen AS MONEY
...
INSERT INTO currency_tab
VALUES (5.55::MONEY::yen)
```

- To compare a distinct type to its source type, the user must explicitly cast one type to the other.
- To compare a distinct type to a type other than its source, the database server looks for an implicit cast between the source type and the specified type.

If neither cast is registered, the user must invoke an explicit cast between the distinct type and the specified type. If this cast is not registered, the database server automatically invokes a cast from the source type to the specified type.

If none of these casts is defined, the comparison fails.

- To compare an opaque type to a built-in type, the user must explicitly cast the opaque type to a data type that the database server understands (such as LVARCHAR, SENDRECV, IMPEXP, or IMPEXPBIN). The database server then invokes built-in casts to convert the results to the specified built-in type.
- To compare two opaque types, the user must explicitly cast one opaque type to a form that the database server understands (such as LVARCHAR, SENDRECV, IMPEXP, or IMPEXPBIN) and then explicitly cast this type to the second opaque type.

For information about casting and the BOOLEAN, BSON, JSON, IMPEXP, IMPEXPBIN, LVARCHAR, and SENDRECV built-in opaque data types, see *IBM® Informix® User-Defined Routines and Data Types Developer's Guide*.

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Casts for distinct types

You define a distinct type based on a built-in type or an existing opaque type or ROW type. Although data of the distinct type has the same length and alignment and is passed in the same way as data of the source type, the two cannot be compared directly. To compare a distinct type and its source type, you must explicitly cast one type to the other.

When you create a new distinct type, the database server automatically registers two explicit casts:

- A cast from the distinct type to its source type
- A cast from the source type to the distinct type

You can create an implicit cast between a distinct type and its source type. To create an implicit cast, however, you must first drop the default explicit cast between the distinct type and its source type.

You also can use all casts that have been registered for the source type without modification on the distinct type. You can also create and register new casts and support functions that apply only to the distinct type.

For examples that show how to create a cast function for a distinct type and register the function as cast, see the *IBM Informix Database Design and Implementation Guide*.

Important: For releases of IBM® Informix® earlier than Version 9.21, distinct data types inherited the built-in casts that are provided for the source type. The built-in casts of the source type are not inherited by distinct data types in this release.

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What Extended Data Types Can Be Cast?

The next table shows the extended data type combinations that you can cast.

Table 1. Extended data type combinations

Target Type	Opaque Type	Distinct Type	Named ROW Type	Unnamed ROW Type	Collection Type	Built-in Type
Opaque Type	Explicit or implicit	Explicit	Explicit	Not Valid	Not Valid	Explicit or implicit ³
Distinct Type	Explicit ³	Explicit	Explicit	Not Valid	Not Valid	Explicit or implicit
Named ROW Type	Explicit ³	Explicit	Explicit ³	Explicit ¹	Not Valid	Not Valid
Unnamed ROW Type	Not Valid	Not Valid	Explicit ¹	Implicit ¹	Not Valid	Not Valid
Collection Type	Not Valid	Not Valid	Not Valid	Not Valid	Explicit ²	Not Valid
Built-in Type	Explicit or implicit ³	Explicit or implicit	Not Valid	Not Valid	Not Valid	System defined (implicit)

¹ Applies when two ROW types are structurally equivalent or casts exist to handle data conversions where corresponding field types are not the same.

² Applies when a cast exists to convert between the element types of the respective collection types.

³ Applies when a user-defined cast exists to convert between the two data types.

The table shows only whether a cast between a source type and a target type are possible. In some cases, you must first create a user-defined cast before you can perform a conversion between two data types. In other cases, the database server provides either an implicit cast or a built-in cast that you must explicitly invoke.

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Operator Precedence

An *operator* is a symbol or keyword that can be in an SQL expression. Most SQL operators are restricted in the data types of their operands and returned values. Some operators only support operands of built-in data types; others can support built-in and extended data types as operands.

The following table shows the precedence of the operators that IBM® Informix® supports, in descending (highest to lowest) order of precedence. Operators with the same precedence are listed in the same row.

Operator Precedence	Example in Expression
<code>. (membership) [] (substring)</code>	<code>customer.phone [1, 3]</code>
UNITS	<code>x UNITS DAY</code>
<code>+ - (unary)</code>	<code>- y</code>
<code>:: (cast)</code>	<code>NULL::TEXT</code>
<code>* /</code>	<code>x / y</code>
<code>+ - (binary)</code>	<code>x - y</code>
<code>|| (concatenation)</code>	<code>customer.fname || customer.lname</code>
ANY ALL SOME	<code>orders.ship_date > SOME (SELECT paid_date FROM orders)</code>
NOT	<code>NOT y</code>
<code>< <= > >= != <></code>	<code>x >= y</code>
IN BETWEEN ... AND LIKE MATCHES	<code>customer.fname MATCHES y</code>
AND	<code>x AND y</code>
OR	<code>x OR y</code>

See the *IBM Informix Guide to SQL: Syntax* for the syntax and semantics of these SQL operators.

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Environment variables

Various *environment variables* affect the functionality of your IBM® Informix® products. You can set environment variables that identify your terminal, specify the location of your software and define other parameters.

Some environment variables are required; others are optional. You must either set or accept the default setting for required environment variables.

These topics describe how to use the environment variables that apply to one or more IBM Informix products and shows how to set them.

- [Types of environment variables](#)
- [Limitations on environment variables](#)
- [Using environment variables on UNIX](#)

You can set, unset, modify, and view environment variables. If you already use any IBM Informix products, some or all of the appropriate environment variables might be set.

- [Using environment variables on Windows](#)
- [Environment variables in Informix products](#)

The topics that follow discuss (in alphabetic order) environment variables that IBM Informix database server products and their utilities use.

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Types of environment variables

Two types of environment variables are explained in this chapter:

- Environment variables that are specific to IBM® Informix®
Set IBM Informix environment variables when you want to work with IBM Informix products. Each IBM Informix product publication specifies the environment variables that you must set to use that product.
- Environment variables that are used with a specific operating system
IBM Informix products rely on the correct setting of certain standard operating system environment variables. For example, you must always set the PATH environment variable.

In a UNIX environment, you might also be required to set the **TERMCAP** or **TERMINFO** environment variable to use some products effectively.

The GLS environment variables that support nondefault locales are described in the *IBM Informix GLS User's Guide*. The GLS variables are included in the list of environment variables in [Table 1](#).

The database server uses the environment variables that were in effect at the time when the database server was initialized.

The **onstat -g env** command lists the active environment settings.

Tip: Additional environment variables that are specific to your client application or SQL API might be explained in the publication for that product.

Important: Do not set any environment variable in the home directory of user **informix** (or in the file `.informix` in that directory) while initializing the database and creating the **sysmaster** database.

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Limitations on environment variables

Size of a block of environment variables

At the start of a session, the client groups all the environment variables that the server will use and sends the environment variables to the server as single block. The maximum size of this block is 32K. If the block of environment variables is greater than 32K, the error -1832 is returned to the application. The text of this error is "Environment block is greater than 32K."

To resolve this error, you can either unset one or more environment variables or reduce the size of some of the environment variables.

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Using environment variables on UNIX

You can set, unset, modify, and view environment variables. If you already use any IBM® Informix® products, some or all of the appropriate environment variables might be set.

You can set environment variables on UNIX in the following places:

- At the system prompt on the command line
When you set an environment variable at the system prompt, you must reassign it the next time you log in to the system.
- In an environment-configuration file
An environment-configuration file is a common or private file where you can set all the environment variables that IBM Informix products use. The use of such files reduces the number of environment variables that you must set at the command line or in a shell file.
- In a login file
Values of environment variables set in your `.login`, `.cshrc`, or `.profile` file are assigned automatically every time you log in to the system.
- In the SET ENVIRONMENT statement of SQL
Values of some environment variables can reset by the SET ENVIRONMENT statement. The scope of the new settings is generally the routine that executed the SET ENVIRONMENT statement, but it is the current session for the OPTCOMPIND environment variable of , as described in the section [OPTCOMPIND environment variable](#). For more information about these routines and on the SET ENVIRONMENT statement, see the *IBM Informix Guide to SQL: Syntax*.

In IBM Informix ESQL/C, you can set supported environment variables within an application with the **putenv()** system call and retrieve values with the **getenv()** system call, if your UNIX system supports these functions. For more information about **putenv()** and **getenv()**, see the *IBM Informix ESQL/C Programmer's Manual* and your C documentation.

- [Setting environment variables in a configuration file](#)
- [Setting environment variables at login time](#)
- [Syntax for setting environment variables](#)
- [Unsetting environment variables](#)
- [Modifying an environment-variable setting](#)
- [Viewing your environment-variable settings](#)
- [Checking environment variables with the chkenv utility](#)
- [Rules of precedence for environment variables](#)

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Setting environment variables in a configuration file

The common (shared) environment-configuration file that is provided with IBM® Informix® products is located in **\$INFORMIXDIR/etc/informix.rc**. Permissions for this shared file must be set to 644.

A user can override the system or shared environment variables by setting variables in a private environment-configuration file. This file must have all of the following characteristics:

- Stored in the user's home directory
- Named **.informix**
- Permissions set to readable by the user

An environment-configuration file can contain comment lines (preceded by the # comment indicator) and variable definition lines that set values (separated by blank spaces or tabs), as the following example shows:

```
# This is an example of an environment-configuration file
#
```

```
DBDATE DMY4-  
#  
# These are ESQL/C environment variable settings  
#  
INFORMIXC gcc  
CPFIRST TRUE
```

You can use the **ENVIGNORE** environment variable, described in [ENVIGNORE environment variable \(UNIX\)](#), to override one or more entries in an environment-configuration file. Use the IBM Informix **chkenv** utility, described in [Checking environment variables with the chkenv utility](#), to perform a sanity check on the contents of an environment-configuration file. The **chkenv** utility returns an error message if the file contains a bad environment variable or if the file is too large.

The first time you set an environment variable in a shell file or environment-configuration file, you must tell the shell process to read your entry before you work with your IBM Informix product. If you use a C shell, **source** the file; if you use a Bourne or Korn shell, use a period (.) to execute the file.

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Setting environment variables at login time

Add commands that set your environment variables to the appropriate login file:

For C shell

.login or **.cshrc**

For Bourne shell or Korn shell

.profile

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Syntax for setting environment variables

Use standard UNIX commands to set environment variables. The examples in the following table show how to set the ABCD environment variable to *value* for the C shell, Bourne shell, and Korn shell. The Korn shell also supports a shortcut, as the last row indicates. Environment variables are case-sensitive.

Shell	Command
C	setenv ABCD value
Bourne	ABCD=value export ABCD
Korn	ABCD=value export ABCD
Korn	export ABCD=value

The following diagram shows how the syntax for setting an environment variable is represented throughout this chapter. These diagrams indicate the setting for the C shell; for the Bourne or Korn shells, use the syntax illustrated in the preceding table.

```
>>setenv--ABCD--value -----><
```

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Unsetting environment variables

To unset an environment variable, enter the following command.

Shell	Command
C	unsetenv ABCD
Bourne or Korn	unset ABCD

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Modifying an environment-variable setting

Sometimes you must add information to an environment variable that is already set. For example, the **PATH** environment variable is always set on UNIX. When you use IBM® Informix® productd, you must add to the **PATH** setting the name of the directory where the executable files for the IBM Informix products are stored.

In the following example, the **INFORMIXDIR** is **/usr/informix**. (That is, during installation, the IBM Informix products were installed in the **/usr/informix** directory.) The executable files are in the **bin** subdirectory, **/usr/informix/bin**. To add this directory to the front of the C shell **PATH** environment variable, use the following command:

```
setenv PATH /usr/informix/bin:$PATH
```

Rather than entering an explicit pathname, you can use the value of the **INFORMIXDIR** environment variable (represented as **\$INFORMIXDIR**), as the following example shows:

```
setenv INFORMIXDIR /usr/informix
setenv PATH $INFORMIXDIR/bin:$PATH
```

You might prefer to use this version to ensure that your **PATH** entry does not conflict with the search path that was set in **INFORMIXDIR**, and so that you are not required to reset **PATH** whenever you change **INFORMIXDIR**. If you set the **PATH** environment variable on the C shell command line, you might be required to include braces (`{ }`) with the existing **INFORMIXDIR** and **PATH**, as the following command shows:

```
setenv PATH ${INFORMIXDIR}/bin:${PATH}
```

For more information about how to set and modify environment variables, see the publications for your operating system.

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Viewing your environment-variable settings

After you install one or more IBM® Informix® products, enter the following command at the system prompt to view your current environment settings.

UNIX version	Command
BSD UNIX	env
UNIX System V	printenv

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Checking environment variables with the **chkenv** utility

The **chkenv** utility checks the validity of shared or private environment-configuration files. It validates the names of the environment variables in the file, but not their values. Use **chkenv** to provide debugging information when you define, in an environment-configuration file, all the environment variables that your IBM® Informix® products use.

```
>>-chkenv--+-filename-----><
          '-pathname-'
```

filename

is the name of the environment-configuration file to be debugged.

pathname

is the full directory path in which the environment variable file is located.

File **\$INFORMIXDIR/etc/informix.rc** is the shared environment-configuration file. A private environment-configuration file is stored as **.informix** in the home directory of the user. If you specify no *pathname* for **chkenv**, the utility checks both the shared and private environment configuration files. If you provide a *pathname*, **chkenv** checks only the specified file.

Issue the following command to check the contents of the shared environment-configuration file:

```
chkenv informix.rc
```

The **chkenv** utility returns an error message if it finds a bad environment-variable name in the file or if the file is too large. You can modify the file and rerun the utility to check the modified environment-variable names.

IBM Informix products ignore all lines in the environment-configuration file, starting at the point of the error, if the **chkenv** utility returns the following message:

```
-33523      filename: Bad environment variable on line number.
```

If you want the product to ignore specified environment-variables in the file, you can also set the **ENVIGNORE** environment variable. For a discussion of the use and format of environment-configuration files and the **ENVIGNORE** environment variable, see page [ENVIGNORE environment variable \(UNIX\)](#).

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Rules of precedence for environment variables

When IBM® Informix® products accesses an environment variable, normally the following rules of precedence apply:

1. Of highest precedence is the value that is defined in the environment (shell) by explicitly setting the value at the shell prompt.
2. The second highest precedence goes to the value that is defined in the private environment-configuration file in the home directory of the user (**~/.informix**).
3. The next highest precedence goes to the value that is defined in the common environment-configuration file (**\$INFORMIXDIR/etc/informix.rc**).
4. The lowest precedence goes to the default value, if one exists.

For precedence information about GLS environment variables, see the *IBM Informix GLS User's Guide*.

Important: If you set one or more environment variables before you start the database server, and you do not explicitly set the same environment variables for your client products, the clients will adopt the original settings.

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Using environment variables on Windows

The following sections discuss setting, viewing, unsetting, and modifying environment variables for Windows applications.

- [Where to set environment variables on Windows](#)
- [Setting environment variables on Windows](#)
- [Rules of precedence for Windows environment variables](#)

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Where to set environment variables on Windows

You can set environment variables in several places on Windows, depending on which IBM® Informix® application you use.

Environment variables can be set in several ways, as described in [Setting environment variables on Windows](#).

The SET ENVIRONMENT statement of SQL can set certain routine-specific environment options. For more information, see the description of SET ENVIRONMENT in the *IBM Informix Guide to SQL: Syntax*.

To use client applications such as IBM Informix ESQL/C or the Schema Tools on Windows environment, use the **Setnet32** utility to set environment variables. For information about the **Setnet32** utility, see the *Informix Client Products Installation Guide* for your operating system.

In Informix ESQL/C, you can set supported environment variables within an application with the **ifx_putenv()** function and retrieve values with the **ifx_getenv()** function, if your Windows system supports them. For more information about **ifx_putenv()** and **ifx_getenv()**, see the *IBM Informix ESQL/C Programmer's Manual*.

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Setting environment variables on Windows

You can set environment variables for command-prompt utilities in the following ways:

- With the System applet in the Control Panel
- In a command-line session
- [Using the system applet to change environment variables](#)
The System applet provides a graphical interface to create, modify, and delete system-wide and user-specific variables. Environment variables that are set with the System applet are visible to all command-prompt sessions.
- [Using the command prompt to change environment variables](#)
You can change the setting of an environment variable at a command prompt.
- [Using dbservername.cmd to initialize a command-prompt environment](#)
Each time that you open a Windows command prompt, it acts as an independent environment. Therefore, environment variables that you set within it are valid only for that particular command-prompt instance.

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Using the system applet to change environment variables

The System applet provides a graphical interface to create, modify, and delete system-wide and user-specific variables. Environment variables that are set with the System applet are visible to all command-prompt sessions.

To change environment variables with the System applet in the control panel

1. Double-click the System applet icon from the Control Panel window.
2. Click the Environment tab near the top of the window.
Two list boxes display System Environment Variables and User Environment Variables. System Environment Variables apply to an entire system, and User Environment Variables apply only to the sessions of the individual user.
3. To change the value of an existing variable, select that variable. The name of the variable and its current value are in the boxes at the bottom of the window.
4. To add a new variable, highlight an existing variable and type the new variable name in the box at the bottom of the window.
5. Next, enter the value for the new variable at the bottom of the window and click **Set**.
6. To delete a variable, select the variable and click **Delete**.

Using the command prompt to change environment variables

You can change the setting of an environment variable at a command prompt.

The following diagram shows the syntax for setting an environment variable at a command prompt in Windows.

```
>>-set--ABCD---value-----><
```

If no *value* is specified, the environment variable is unset, as if it did not exist.

To view your current settings after one or more IBM® Informix® products are installed, enter the following command at the command prompt.

```
>>-set-----><
```

Sometimes you must add information to an environment variable that is already set. For example, the PATH environment variable is always set in Windows environments. When you use IBM Informix products, you must add the name of the directory where the executable files for the IBM Informix products are stored to the PATH.

In the following example, INFORMIXDIR is d:\informix (that is, during installation, IBM Informix products were installed in the d: \informix directory). The executable files are in the bin subdirectory, d:\informix\bin. To add this directory at the beginning of the **PATH** environment-variable value, use the following command:

```
set PATH=d:\informix\bin;%PATH%
```

Rather than entering an explicit pathname, you can use the value of the INFORMIXDIR environment variable (represented as **%INFORMIXDIR%**), as the following example shows:

```
set INFORMIXDIR=d:\informix
set PATH=%PATH%
```

You might prefer to use this version to ensure that your PATH entry does not contradict the search path that was set in INFORMIXDIR and to avoid the requirement to reset PATH whenever you change INFORMIXDIR.

For more information about setting and modifying environment variables, see your operating-system publications.

Using dbservername.cmd to initialize a command-prompt environment

Each time that you open a Windows command prompt, it acts as an independent environment. Therefore, environment variables that you set within it are valid only for that particular command-prompt instance.

For example, if you open one command window and set the variable, INFORMIXDIR, and then open another command window and type `set` to check your environment, you will find that INFORMIXDIR is not set in the new command-prompt session.

The database server installation program creates a batch file that you can use to configure command-prompt utilities, ensuring that your command-prompt environment is initialized correctly each time that you run a command-prompt session. The batch file, `dbservername.cmd`, is located in `%INFORMIXDIR%`, and is a plain text file that you can modify with any text editor. If you have more than one database server installed in `%INFORMIXDIR%`, there will be more than one batch file with the `.cmd` extension, each bearing the name of the database server with which it is associated.

To run `dbservername.cmd` from a command prompt, type `dbservername` or configure a command prompt so that it runs `dbservername.cmd` automatically at start.

Rules of precedence for Windows environment variables

When IBM® Informix® products access an environment variable, normally the following rules of precedence apply:

1. The setting in Setnet32 with the **Use my settings** box selected.
2. The setting in Setnet32 with the **Use my settings** box cleared.
3. The setting on the command line before running the application.
4. The setting in Windows as a user variable.
5. The setting in Windows as a system variable.
6. The lowest precedence goes to the default value.

Environment variables in Informix products

The topics that follow discuss (in alphabetic order) environment variables that IBM® Informix® database server products and their utilities use.

Important: The descriptions of the following environment variables include the syntax for setting the environment variable on UNIX. For a general description of how to set these environment variables on Windows, see [Setting environment variables on Windows](#).

- [Environment variable portal](#)
This portal is an index of usage categories for IBM Informix and UNIX environment variables. The portal contains links to the topics that describe the environment variables.
- [ANSIOWNER environment variable](#)
In an ANSI-compliant database, you can prevent the default behavior of upshifting lowercase letters in owner names that are not delimited by quotation marks by setting the **ANSIOWNER** environment variable to 1.
- [CPFIRST environment variable](#)
Use the CPFIRST environment variable to specify the default compilation order for all IBM Informix ESQ/C source files in your programming environment.
- [CMCONFIG environment variable](#)
Set the **CMCONFIG** environment variable to specify the location of the Connection Manager configuration file. You use the configuration file to specify service level agreements and other Connection Manager configuration options.
- [CLIENT_LABEL environment variable](#)
Set the **CLIENT_LABEL** environment variable in CSDK 4.10.xC10 or JDBC 4.10.JC10 client to assign a character string to CSDK or JDBC client session and identify that character string on the database server. You use this for environments where same userid runs multiple instances of the same application, and there is a need to distinguish one session from the other.
- [DBACCNOIGN environment variable](#)
Use the **DBACCNOIGN** environment variable to specify the behavior of the DB-Access utility when specified errors occurs.
- [DBANSIWARN environment variable](#)
Use the **DBANSIWARN** environment variable to indicate that you want to check for IBM Informix extensions to ANSI-standard SQL syntax.
- [DBBLOBBUF environment variable](#)
Use the **DBBLOBBUF** environment variable to control whether TEXT or BYTE values are stored temporarily in memory or in a file while being processed by the UNLOAD statement. **DBBLOBBUF** affects only the UNLOAD statement.
- [DBCENTURY environment variable](#)
Use the **DBCENTURY** environment variable to specify how to expand literal DATE and DATETIME values that are entered with abbreviated year values. To avoid problems in expanding abbreviated years, applications should require entry of 4-digit years, and should always display years as four digits.
- [DBDATE environment variable](#)
Use the **DBDATE** environment variable to specify the end-user formats of DATE values.
- [DBDELIMITER environment variable](#)
Set the **DBDELIMITER** environment variable to specify the field delimiter used with the **dbexport** utility and with the LOAD and UNLOAD statements.
- [DBEDIT environment variable](#)
Use the **DBEDIT** environment variable to specify the text editor to use with SQL statements and command files in DB-Access.
- [DBFLTMASK environment variable](#)
- [DBINFO_DBSpace_RETURN_NULL_FOR_INVALID_PARTNUM environment variable](#)
Use the **DBINFO_DBSpace_RETURN_NULL_FOR_INVALID_PARTNUM** environment variable to specify if dbinfo('dbspace', partnum) raises an error -727 or returns NULL when an invalid partition number (partnum) is provided.
- [DBLANG environment variable](#)
Use the **DBLANG** environment variable to specify the subdirectory of **\$INFORMIXDIR** or the full pathname of the directory that contains the compiled message files that IBM Informix products use.
- [DBMONEY environment variable](#)
Use the **DBMONEY** environment variable to specify the display format of values in columns of smallfloat, FLOAT, DECIMAL, or MONEY data types, and of complex data types derived from any of these data types.
- [DBPATH environment variable](#)
Use the **DBPATH** environment variable to identify the database servers that contain databases. DBPATH can also specify a list of directories (in addition to the current directory) in which DB-Access looks for command scripts (**.sql** files).
- [DBPRINT environment variable](#)
Use the **DBPRINT** environment variable to specify the default printing program.
- [DBREMOTECMD environment variable \(UNIX\)](#)
Use the **DBREMOTECMD** environment variable to override the default remote shell to perform remote tape operations with the database server.
- [DBSPACETEMP environment variable](#)
The **DBSPACETEMP** environment variable specifies the dbspaces in which temporary tables are built. The list can include standard dbspaces, temporary dbspaces, or both.
- [DBTEMP environment variable](#)
- [DBTIME environment variable](#)
The **DBTIME** environment variable specifies a formatting mask for the display and data-entry format of DATETIME values.
- [DBUPSPACE environment variable](#)
Use the **DBUPSPACE** environment variable to specify the amount of system disk space and the amount of memory that the UPDATE STATISTICS MEDIUM and UPDATE STATISTICS HIGH statement can use when it reads and sorts column values to construct column distributions. The **DBUPSPACE** setting can also request SET EXPLAIN output to describe the execution path for calculating the statistical distributions.
- [DEFAULT_ATTACH environment variable](#)
- [DELIMIDENT environment variable](#)
The **DELIMIDENT** environment variable specifies that strings enclosed between double quotation (") marks are delimited database identifiers.
- [ENVIGNORE environment variable \(UNIX\)](#)

- [FET_BUF_SIZE environment variable](#)
- [IFMXMONGOAUTH environment variable](#)
Set the IFMXMONGOAUTH environment variable to enable PAM authentication for MongoDB clients through the wire listener.
- [IFX_DEF_TABLE_LOCKMODE environment variable](#)
- [IFX_DIRECTIVES environment variable](#)
- [IFX_EXTDIRECTIVES environment variable](#)
- [IFX_LARGE_PAGES environment variable](#)
The IFX_LARGE_PAGES environment variable specifies whether the database server can use large pages on platforms where the hardware and the operating system support large pages of shared memory. If this is enabled in the server environment, IBM Informix can use the large pages for non-message shared memory segments that are located in physical memory.
- [IFX_LOB_XFERSIZE environment variable](#)
Use the **IFX_LOB_XFERSIZE** environment variable to specify the number of bytes in a CLOB or BLOB data type to transfer from a client application to the database server before checking whether an error has occurred.
- [IFX_LONGID environment variable](#)
- [IFX_NETBUF_PVTPPOOL_SIZE environment variable \(UNIX\)](#)
Use the IFX_NETBUF_PVTPPOOL_SIZE environment variable to specify the maximum size of the free (unused) private network buffer pool for each database server session.
- [IFX_NETBUF_SIZE environment variable](#)
Use the IFX_NETBUF_SIZE environment variable to configure the network buffers to the optimum size. This environment variable specifies the size of all network buffers in the free (unused) global pool and the private network buffer pool for each database server session.
- [IFX_NO_SECURITY_CHECK environment variable \(UNIX\)](#)
- [IFX_NO_TIMELIMIT_WARNING environment variable](#)
- [IFX_NODBPROC environment variable](#)
- [IFX_NOT_STRICT_THOUS_SEP environment variable](#)
- [IFX_ONTAPE_FILE_PREFIX environment variable](#)
- [IFX_PAD_VARCHAR environment variable](#)
- [IFX_UNLOAD_EILSEQ_MODE environment variable](#)
Use the IFX_UNLOAD_EILSEQ_MODE environment variable to help migrate databases from Informix Version 10 to Version 11.50 or 11.70, where character data might be encoded with a codeset that is different than the codeset used to create the Version 10 database.
- [IFX_UPDESC environment variable](#)
- [IFX_XSTDCOMPLIANCE_XAEND environment variable](#)
- [IFX_XFER_SHMBASE environment variable](#)
- [IMCADMIN environment variable](#)
- [IMCCONFIG environment variable](#)
- [IMCSERVER environment variable](#)
- [INFORMIXC environment variable \(UNIX\)](#)
- [INFORMIXCMNAME environment variable](#)
If the Connection Manager raises an event alarm, the **INFORMIXCMNAME** environment variable is used to store the name of the Connection Manager instance that raised the alarm. The environment variable is set automatically by the Connection Manager.
- [INFORMIXCMCONUNITNAME environment variable](#)
If the Connection Manager raises an event alarm, the **INFORMIXCMCONUNITNAME** environment variable is used to store the name of the Connection Manager connection unit that raised the alarm. The environment variable is set automatically by the Connection Manager.
- [INFORMIXCONCSMCFG environment variable](#)
Use the **INFORMIXCONCSMCFG** environment variable to specify the location of the **concsm.cfg** file that describes communications support modules.
- [INFORMIXCONRETRY environment variable](#)
The INFORMIXCONRETRY environment variable sets a limit on the maximum number of connection attempts that can be made to each database server by the client after the initial connection attempt fails. These attempts are made within the time limit that the INFORMIXCONTIME setting specifies.
- [INFORMIXCONTIME environment variable](#)
The INFORMIXCONTIME environment variable specifies the number of seconds the CONNECT statement attempts to establish a connection to a database server before returning an error. If you set no value, the default of 60 seconds can typically support a few hundred concurrent client connections. However, some systems might encounter few connection errors with a value as low as 15. The total distance between nodes, hardware speed, the volume of traffic, and the concurrency level of the network can all affect what value you should set to optimize INFORMIXCONTIME.
- [INFORMIXCPPMAP environment variable](#)
- [INFORMIXDIR environment variable](#)
- [INFORMIXSERVER environment variable](#)
The **INFORMIXSERVER** environment variable specifies the default database server to which an explicit or implicit connection is made by an SQL API client, the DB-Access utility, or other IBM Informix products.
- [INFORMIXSHMBASE environment variable \(UNIX\)](#)
- [INFORMIXSQLHOSTS environment variable](#)
The INFORMIXSQLHOSTS environment variable specifies where the SQL client or the database server can find connectivity information.
- [INFORMIXSTACKSIZE environment variable](#)
- [INFORMIXTERM environment variable \(UNIX\)](#)
The INFORMIXTERM environment variable specifies whether DB-Access should use the information in the terminfo directory or the termcap file.
- [INF_ROLE_SEP environment variable](#)
- [INTERACTIVE_DESKTOP_OFF environment variable \(Windows\)](#)
- [JAR_TEMP_PATH environment variable](#)
- [JAVA_COMPILER environment variable](#)
- [JVM_MAX_HEAP_SIZE environment variable](#)
- [LD_LIBRARY_PATH environment variable \(UNIX\)](#)
- [LIBPATH environment variable \(UNIX\)](#)
- [NODEFDAC environment variable](#)
Enabling NODEFDAC applies the ANSI-compliant restrictions on default access privileges for the PUBLIC group when tables or Owner-mode user-defined routines are created in databases that are not ANSI-compliant.
- [ONCONFIG environment variable](#)
The ONCONFIG environment variable specifies the name of the active file, called the onconfig file, which holds the configuration parameters for the database server.

- [ONINIT_STDOUT environment variable \(Windows\)](#)
The ONINIT_STDOUT environment variable specifies a path and file name in which output from the **oninit** command is stored.
- [OPTCOMPIND environment variable](#)
- [OPTMSG environment variable](#)
- [OPTOFC environment variable](#)
Use the **OPTOFC** environment variable to enable optimize-OPEN-FETCH-CLOSE functionality in IBM Informix ESQL/C applications or other APIs (such as JDBC, ODBC, OLE DB, LIBDMI, and Lib C++) that use DECLARE and OPEN statements to establish a cursor.
- [OPT_GOAL environment variable \(UNIX\)](#)
- [PATH environment variable](#)
- [PDQPRIORITY environment variable](#)
The **PDQPRIORITY** environment variable determines the degree of parallelism that the database server uses and affects how the database server allocates resources, including memory, processors, and disk reads.
- [PLCONFIG environment variable](#)
- [PLOAD_LO_PATH environment variable](#)
- [PLOAD_SHMBASE environment variable](#)
- [PSM_ACT_LOG environment variable](#)
Use the PSM_ACT_LOG environment variable to specify the location of the IBM Informix Primary Storage Manager activity log for your environment, for example, for a single session.
- [PSM_CATALOG_PATH environment variable](#)
Use the PSM_CATALOG_PATH environment variable to specify the location of the IBM Informix Primary Storage Manager catalog tables for your environment, for example, for a single session.
- [PSM_DBS_POOL environment variable](#)
Use the PSM_DBS_POOL environment variable to change the name of the pool in which the IBM Informix Primary Storage Manager places backup and restore dbspace data for your environment, for example, for a single session.
- [PSM_DEBUG environment variable](#)
Use the PSM_DEBUG environment variable to specify the amount of debugging information that prints in the Informix Primary Storage Manager debug log for your environment, for example, for a single session.
- [PSM_DEBUG_LOG environment variable](#)
Use the PSM_DEBUG_LOG environment variable to specify the location of the IBM Informix Primary Storage Manager debug log for your environment, for example, for a single session.
- [PSM_LOG_POOL environment variable](#)
Use the PSM_LOG_POOL environment variable to change the name of the pool in which the IBM Informix Primary Storage Manager places backup and restore log data for your environment, for example, for a single session.
- [PSORT_DBTEMP environment variable](#)
The PSORT_DBTEMP environment variable specifies the location where the database server writes the temporary files that the PSORT_NPROCS environment variable uses to perform a sort.
- [PSORT_NPROCS environment variable](#)
The **PSORT_NPROCS** environment variable enables the database server to improve the performance of the parallel-process sorting package by allocating more threads for sorting.
- [RTREE_COST_ADJUST_VALUE environment variable](#)
- [SHLIB_PATH environment variable \(UNIX\)](#)
- [SRV_FET_BUF_SIZE environment variable](#)
Use the SRV_FET_BUF_SIZE environment variable to specify the size of the fetch buffer that the local database server uses in distributed DML transactions across database servers.
- [STMT_CACHE environment variable](#)
Use the STMT_CACHE environment variable to control the use of the shared-statement cache on a session.
- [TERM environment variable \(UNIX\)](#)
- [TERMCAP environment variable \(UNIX\)](#)
The TERMCAP environment variable is used for terminal handling. It tells DB-Access (and other character-based applications) to communicate with the termcap file instead of the terminfo directory.
- [TERMINFO environment variable \(UNIX\)](#)
The TERMINFO environment variable is used for terminal handling.
- [THREADLIB environment variable \(UNIX\)](#)
- [TZ environment variable](#)
The **TZ** environment variable is used for setting the time zone. It is used by various time functions to compute times relative to Coordinated Universal Time (UTC), formerly known as Greenwich Mean Time (GMT). The format is specified by the operating system.
- [USETABLENAME environment variable](#)

Related information:

[Informix environment variables with the IBM Informix JDBC Driver](#)
[GLS-related environment variables](#)
[Enterprise Replication configuration parameter and environment variable reference](#)
[AC CONFIG file environment variable](#)

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Environment variable portal

This portal is an index of usage categories for IBM® Informix® and UNIX environment variables. The portal contains links to the topics that describe the environment variables.

Because the following table contains a comprehensive list of categories with links to applicable topics. Some environment variables are applicable for more than one category.

Table 1. Uses for environment variables

Functional category	Environment variable
Abbreviated year values	Specify how to expand literal DATE and DATETIME values: DBCENTURY environment variable
ANSI/ISO SQL compliance	<p>Set the case of owner names: ANSIOWNER environment variable</p> <p>Specify if you want to check for IBM Informix extensions to ANSI-standard SQL syntax: DBANSIWARN environment variable</p> <p>No default table or routine access privileges for PUBLIC in databases not created WITH LOG MODE ANSI: NODEFDAC environment variable</p>
archecker utility	Specify the full path name for the archecker configuration file: AC_CONFIG file environment variable
Buffers	<p>Manage the fetch buffer size: FET_BUF_SIZE environment variable</p> <p>Manage the network size: IFX_NETBUF_SIZE environment variable</p> <p>Manage the network pool size: IFX_NETBUF_PVTPPOOL_SIZE environment variable (UNIX)</p> <p>Manage the BYTE or TEXT data buffer: DBBLOBBUF environment variable</p>
Cache	Control the use of the shared-statement cache on a session: STMT_CACHE environment variable
Client/server	<p>Specify the default database server: INFORMIXSERVER environment variable</p> <p>Specify where shared-memory segments are attached to the client process: INFORMIXSHMBASE environment variable (UNIX)</p> <p>Specify the stack size for a client process: INFORMIXSTACKSIZE environment variable</p> <p>Specify locale information, including for the client and server: GLS-related environment variables</p>
Code-set conversion	<p>Specify locale and multibyte information: GLS-related environment variables</p> <p>Specify the location of the concsn.cfg file: INFORMIXCONCSMCFG environment variable</p> <p>Specify the filename or pathname of the C compiler: INFORMIXC environment variable (UNIX)</p> <p>Specify the pathname of the map file for C++ programs: INFORMIXCPPMAP environment variable</p> <p>Specify information for compiling multithreaded IBM Informix ESQL/C applications: THREADLIB environment variable (UNIX)</p>
Configuration	<p>Specify the name of the active that holds configuration parameters: ONCONFIG environment variable</p> <p>Ignore specified environment variable settings: ENVIGNORE environment variable (UNIX)</p> <p>Specify the default database server: INFORMIXSERVER environment variable</p> <p>Specify the dbspaces in which temporary tables are built: DBSPACETEMP environment variable</p> <p>Manage query optimizer directives: IFX_DIRECTIVES environment variable and IFX_EXTDIRECTIVES environment variable</p> <p>Modify the value of the OPTCOMPIND configuration parameter: OPTCOMPIND environment variable</p> <p>Specify the query performance goal for the optimizer: OPT_GOAL environment variable (UNIX)</p> <p>Specify the degree of parallelism that the database server uses: PDQPRIORITY environment variable</p> <p>Specify the stack size that is applied to all client processes: INFORMIXSTACKSIZE environment variable</p>
Connecting	<p>Set the maximum number of <i>additional</i> connection attempts: INFORMIXCONRETRY environment variable</p> <p>Set connect time information: INFORMIXCONTIME environment variable</p> <p>Specify the default database server to for connections: INFORMIXSERVER environment variable</p> <p>Specify the location of connection information: INFORMIXSQLHOSTS environment variable</p>

Functional category	Environment variable
Connection Manager	Specify the location of the Connection Manager configuration file: CMCONFIG environment variable
Data distributions	Manage the amount of system disk space that the UPDATE STATISTICS statement can use: DBUPSPACE environment variable
Database locale	Manage locale information: GLS-related environment variables
Database server	Specify servers for connections: INFORMIXSERVER environment variable Set the locale for file I/O: GLS-related environment variables Specify the name of the active file that holds configuration parameters: ONCONFIG environment variable Manage parallel sorting: PSORT_DBTEMP environment variable and PSORT_NPROCS environment variable Manage parallelism: PDQPRIORITY environment variable Manage role separation: INF_ROLE_SEP environment variable Manage shared memory: INFORMIXSHMBASE environment variable (UNIX) Manage stack size: INFORMIXSTACKSIZE environment variable Manage temporary tables: DBSPACETEMP environment variable , DBTEMP environment variable , and PSORT_DBTEMP environment variable Manage variable-length packets: IFX_PAD_VARCHAR environment variable
Date and time values, formats	Manage date and time information: DBCENTURY environment variable , DBDATE environment variable , DBTIME environment variable , GLS-related environment variables (GL_DATE and GL_DATETIME), The USE_DTENV environment variable , and TZ environment variable
DB-Access utility	Manage the database server and DB-Access: DBANSIWARN environment variable , DBDELIMITER environment variable , DBEDIT environment variable , DBFLTMASK environment variable , DBPATH environment variable , FET_BUF_SIZE environment variable , INFORMIXSERVER environment variable , INFORMIXTERM environment variable (UNIX) , TERM environment variable (UNIX) , TERMCAP environment variable (UNIX) , and TERMINFO environment variable (UNIX)
dbexport utility	Set the field delimiter: DBDELIMITER environment variable
dbinfo	Specify if dbinfo('dbspace', partnum) raises error -727 or returns NULL for an invalid partnum: DBINFO DBSPACE RETURN NULL FOR INVALID PARTNUM environment variable
Delimited identifiers	Set the field delimiter used with the dbexport utility and with the LOAD and UNLOAD statements: DBDELIMITER environment variable
Disk space	Manage the amount of system disk space and memory that the UPDATE STATISTICS MEDIUM or HIGH statement can use: DBUPSPACE environment variable
Editor	Specify the text editor to use with SQL statements and command files in DB-Access: DBEDIT environment variable
Enterprise Replication	Specify information for Enterprise Replication: Enterprise Replication configuration parameter and environment variable reference
ESQL/C	Specify ANSI compliance: DBANSIWARN environment variable Specify the filename or pathname of the C compiler to use with ESQL/C: INFORMIXC environment variable (UNIX) Set delimited identifiers: DELIMIDENT environment variable Specify multibyte characters and locale information GLS-related environment variables (CLIENT_LOCALE, ESQLMF, and GL_USER) Specify information for multithreaded applications: THREADLIB environment variable (UNIX) Specify the default compilation order: CPFIRST environment variable
Executable programs	Specify the directories to search for executable programs: PATH environment variable
Fetch buffer size	Set buffer size information: FET_BUF_SIZE environment variable
Filenames: multibyte	GLS-related environment variables (GLS8BITFSYS)
Files: field delimiter	Set the field delimiter: DBDELIMITER environment variable

Functional category	Environment variable
Files: installation	Specify the directory that contains the subdirectories in which your product files are installed: INFORMIXDIR environment variable
Files: locale	Specify locale information: GLS-related environment variables (CLIENT_LOCALE, DB_LOCALE, and SERVER_LOCALE)
Files: map for C++	Specify the pathname of the map file for C++ programs: INFORMIXCPPMAP environment variable
Files: message	Specify the subdirectory of \$INFORMIXDIR or the pathname of the directory that contains the compiled message files that the database server uses: DBLANG environment variable
Files: temporary	DBSPACETEMP environment variable
Files: temporary	Specify a directory for temporary files: DBTEMP environment variable
Files: temporary sorting	Specify the location of temporary files used for sorting: PSORT_DBTEMP environment variable
Files: termcap, terminfo	Specify terminal information: INFORMIXTERM environment variable (UNIX) , TERM environment variable (UNIX) , TERMCAP environment variable (UNIX) , and TERMINFO environment variable (UNIX) .
Format: date and time	Define the format for date and time information: DBCENTURY environment variable , DBDATE environment variable , DBTIME environment variable , GLS-related environment variables (GL_DATE and GL_DATETIME), The USE_DTENV environment variable , and TZ environment variable
Format: private-use characters	Set the display width for characters in Unicode Private-Use Area (PUA) ranges: GLS-related environment variables (IFX_PUA_DISPLAY_MAPPING)
Format: money	Define the format for money information: DBMONEY environment variable and GLS-related environment variables
Gateways	Set information for Gateways: DBTEMP environment variable
High-Performance Loader	Specify information for the High-Performance Loader: DBONPLOAD environment variable , _PLOAD_LO_PATH environment variable , and PLOAD_SHMBase environment variable
Identifiers	Specify field delimiters: DELIMIDENT environment variable Specify information for identifiers longer than 18 bytes: IFX_LONGID environment variable Specify information for multibyte characters: GLS-related environment variables (CLIENT_LOCALE and ESQLMF)
Installation	Specify the directory that contains the subdirectories in which your product files are installed: INFORMIXDIR environment variable Specify which directories to search for executable programs: PATH environment variable
JDBC	Manage environment variables used with JDBC: Informix environment variables with the IBM Informix JDBC Driver
Language environment	Specify language and locale information: DBLANG environment variable and GLS-related environment variables
Libraries	Specify paths for libraries: LD_LIBRARY_PATH environment variable (UNIX) , LIBPATH environment variable (UNIX) , and SHLIB_PATH environment variable (UNIX)
Locale	Define client, server, and database locale information: GLS-related environment variables (CLIENT_LOCALE, DB_LOCALE, and SERVER_LOCALE)
Lock mode	Set the default lock mode for database tables that are created without specifying the LOCKMODE PAGE or LOCKMODE ROW keywords: IFX_DEF_TABLE_LOCKMODE environment variable
Long Identifiers	Specify information for identifiers longer than 18 bytes: IFX_LONGID environment variable
Map file for C++	Specify the pathname of the map file for C++ programs: INFORMIXCPPMAP environment variable
Message chaining	Enable or disable optimized message transfers (message chaining) for IBM Informix ESQ/C: OPTMSG environment variable
Message files	Specify the directory that contains compiled message files: DBLANG environment variable
Money format	Define the format for money information: DBMONEY environment variable and GLS-related environment variables
Multibyte characters	Specify information for multibyte characters: GLS-related environment variables (CLIENT_LOCALE, DB_LOCALE, SERVER_LOCALE, and GL_USEGLU)

Functional category	Environment variable
Multibyte filter	Specify Informix ESQL/C multibyte filter information: GLS-related environment variables (ESQLMF)
Multithreaded applications	Specify information for compiling multithreaded IBM Informix ESQL/C applications: THREADLIB environment variable (UNIX)
Network	Specify network information: DBPATH environment variable
Nondefault locale	Define client, server, and database locale information: GLS-related environment variables (CLIENT_LOCALE, DB_LOCALE, and SERVER_LOCALE)
ON-Bar utility	Optimize the deduplication capabilities for storage managers: IFX_BAR_USE_DEDUP environment variable Disable the ability to replicate, import, or export backup objects among TSM servers: IFX_TSM_OBJINFO_OFF environment variable
ONCONFIG parameters	Specify the name of the file that holds configuration parameters: ONCONFIG environment variable
oninit output (Windows only)	Specify a path and file for oninit output: ONINIT_STDOUT environment variable (Windows)
Optimization: directives	Manage query optimizer directives: IFX_DIRECTIVES environment variable and IFX_EXTDIRECTIVES environment variable
Optimization: message transfers	Enable or disable optimized message transfers (message chaining) for IBM Informix ESQL/C: OPTMSG environment variable
Optimization: join method	Modify the value of the OPTCOMPIND configuration parameter: OPTCOMPIND environment variable
Optimization: performance goal	Specify the query performance goal for the optimizer: OPT_GOAL environment variable (UNIX)
OPTOFC feature	Enable optimize-OPEN-FETCH-CLOSE functionality: OPTOFC environment variable
PAM authentication for MongoDB clients	Enable PAM authentication for MongoDB clients: IFMXMONGOAUTH environment variable
Path name: archchecker configuration file	Specify the full path name for the archchecker configuration file: AC_CONFIG file environment variable
Path name: C compiler	Specify the filename or pathname of the C compiler: INFORMIXC environment variable (UNIX)
Path name: database files	Specify database server file and path information: DBPATH environment variable
Path name: executable programs	Specify directories to search for executable programs: PATH environment variable
Path name: HPL smart-large-object handles	Specify the pathname for smart-large-object handles: PLOAD_LO_PATH environment variable
Path name: installation	Specify the directory that contains the subdirectories in which your product files are installed: INFORMIXDIR environment variable
Path name: libraries	Specify paths for libraries: LD_LIBRARY_PATH environment variable (UNIX) , LIBPATH environment variable (UNIX) , and SHLIB_PATH environment variable (UNIX)
Path name: message files	Specify the directory that contains compiled message files: DBLANG environment variable and GLS-related environment variables
Path name: parallel sorting	Specify the location of temporary files for sorts: PSORT_DBTEMP environment variable
IBM Informix Primary Storage Manager	Manage the storage manager: PSM_ACT_LOG environment variable , PSM_CATALOG_PATH environment variable , PSM_DBS_POOL environment variable , PSM_DEBUG environment variable , PSM_DEBUG_LOG environment variable , and PSM_LOG_POOL environment variable
Preserve owner name case	Set the case of owner names: ANSIOWNER environment variable
Printing	Specify the default printing program: DBPRINT environment variable
Privileges	Configure role separation: INF_ROLE_SEP environment variable

Functional category	Environment variable
Query: optimization	<p>Manage query optimizer directives: IFX_DIRECTIVES environment variable and IFX_EXTDIRECTIVES environment variable</p> <p>Modify the value of the OPTCOMPIND configuration parameter: OPTCOMPIND environment variable</p> <p>Specify the query performance goal for the optimizer: OPT_GOAL environment variable (UNIX)</p> <p>Specify user-defined data types can use to estimate the cost of an R-tree index for queries on UDT columns: RTREE_COST_ADJUST_VALUE environment variable</p>
Query: prioritization	Specify the degree of parallelism that the database server uses: PDQPRIORITY environment variable
Remote shell	Specify information that overrides the default remote shell for performing remote tape operations: DBREMOTECMD environment variable (UNIX)
Role separation	Configure role separation: INF_ROLE_SEP environment variable
Rolled-back transactions	<p>Manage what the DB-Access utility does when an error occurs: DBACCNOIGN environment variable</p> <p>Specify whether an internal rollback of a global transaction frees the transaction: IFX_XASTDCOMPLIANCE_XAEND environment variable</p>
Server locale	Define the locale of your database server: GLS-related environment variables SERVER_LOCALE
Shared memory	<p>Specify where shared-memory segments are attached to the client process: INFORMIXSHMBASE environment variable (UNIX)</p> <p>Specify the shared-memory address for High Performance Loader (HPL) processes: PLOAD_SHMBASE environment variable</p>
Shell: remote	Specify information that overrides the default remote shell for performing remote tape operations: DBREMOTECMD environment variable (UNIX)
Shell: search path	Specify which directories to search for executable programs: PATH environment variable
Sorting	<p>Specify the location of temporary files for sorts: PSORT_DBTEMP environment variable</p> <p>Allocate more threads for sorting: PSORT_NPROCS environment variable</p>
SQL statements	<p>Specify information for caching: STMT_CACHE environment variable</p> <p>Specify connection information: INFORMIXCONRETRY environment variable, INFORMIXCONTIME environment variable, and INFORMIXSERVER environment variable</p> <p>Specify information for CREATE TEMP TABLE operations: DBSPACETEMP environment variable</p> <p>Specify information for DESCRIBE FOR UPDATE operations: IFX_UPDESC environment variable</p> <p>Specify information for LOAD and UNLOAD operations: DBDELIMITER environment variable and DBBLOBBUF environment variable</p> <p>Specify information for SELECT INTO TEMP operations: DBSPACETEMP environment variable</p> <p>Specify information for SET PDQPRIORITY operations: PDQPRIORITY environment variable</p> <p>Specify information for SET STMT_CACHE operations</p> <p>Specify information for UPDATE STATISTICS operations: DBUPSPACE environment variable</p>
Stack size	Define the stack size that is applied to client processes: INFORMIXSTACKSIZE environment variable
Temporary tables	Define information for temporary tables: DBSPACETEMP environment variable , DBTEMP environment variable , and PSORT_DBTEMP environment variable
Terminal handling	Specify terminal information: INFORMIXTERM environment variable (UNIX) , TERM environment variable (UNIX) , TERMCAP environment variable (UNIX) , and TERMINFO environment variable (UNIX)
Time-limited software license	Set information for trial or evaluation software warning messages: IFX_NO_TIMELIMIT_WARNING environment variable
Variables: overriding	Deactivate some specified environment variable settings: ENVIGNORE environment variable (UNIX)

Functional category	Environment variable
Virtual memory segments on large pages	Specify whether the database server can use large pages on platforms where the hardware and the operating system support large pages of shared memory: IFX_LARGE_PAGES environment variable
Year values (abbreviated)	Specify how to expand DATE and DATETIME values that are entered as abbreviated year values: DBCENTURY environment variable

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ANSIOWNER environment variable

In an ANSI-compliant database, you can prevent the default behavior of upshifting lowercase letters in owner names that are not delimited by quotation marks by setting the **ANSIOWNER** environment variable to 1.

```
>>-setenv--ANSIOWNER-- 1-----><
```

To prevent upshifting of lowercase letters in owner names in an ANSI-compliant database, you must set **ANSIOWNER** before you initialize IBM® Informix®.

The following table shows how an ANSI-compliant database of IBM Informix stores or reads the specified name of a database object called **oblong** if you were the owner of **oblong** and your **userid** (in all lowercase letters) were **owen**:

Table 1. Lettercase of implicit, unquoted, and quoted owner names, with and without ANSIOWNER

Owner Format	Specification	ANSIOWNER = 1	ANSIOWNER Not Set
Implicit:	oblong	owen.oblong	OWEN.oblong
Unquoted:	owen.oblong	owen.oblong	OWEN.oblong
Quoted:	'owen'.oblong	owen.oblong	owen.oblong

Because they do not match the lettercase of your **userid**, any SQL statements that specified the formats that are stored as **OWEN.oblong** would fail with errors.

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CPFIRST environment variable

Use the CPFIRST environment variable to specify the default compilation order for all IBM® Informix® ESQL/C source files in your programming environment.

```
>>-setenv--CPFIRST--+-TRUE--+-----><
'-FALSE-'
```

When you compile Informix ESQL/C programs with CPFIRST not set, the Informix ESQL/C preprocessor runs first, by default, on the program source file and then passes the resulting file to the C language preprocessor and compiler. You can, however, compile the Informix ESQL/C program source file in the following order:

1. Run the C preprocessor
2. Run the Informix ESQL/C preprocessor
3. Run the C compiler and linker

To use a nondefault compilation order for a specific program, you can either give the program source file a .ecp extension, run the -cp option with the **esql** command on a program source file with a .ec extension, or set CPFIRST.

Set CPFIRST to **TRUE** (uppercase only) to run the C preprocessor before the Informix ESQL/C preprocessor on all Informix ESQL/C source files in your environment, irrespective of whether the -cp option is passed to the **esql** command or the source files have the .ec or the .ecp extension.

To restore the default order on a system where the CPFIRST environment variable has been set to **TRUE**, you can set CPFIRST to **FALSE**. On UNIX systems that support the C shell, the following command has the same effect:

```
unsetenv CPFIRST
```

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CMCONFIG environment variable

Set the **CMCONFIG** environment variable to specify the location of the Connection Manager configuration file. You use the configuration file to specify service level agreements and other Connection Manager configuration options.

```
>>-setenv--CMCONFIG--path/file_name-----><
```

path/file_name

is the full path and file name of a Connection Manager configuration file.

If the CMCONFIG environment variable is not set and the configuration file name is not specified on the **oncmsm** utility command line, the Connection Manager attempts to load the file from the following path and file name:

```
$INFORMIXDIR/etc/cmsm.cfg
```

Examples

Suppose the CMCONFIG environment variable points to a valid path and file name of a Connection Manager configuration file. To reload a Connection Manager instance using the configuration file specified in the shell environment enter the following command:

```
./oncmsm -r
```

To shut down a Connection Manager instance using the configuration file specified in the shell environment:

```
./oncmsm -k
```

Related information:

[The oncmsm utility](#)

[Example of configuring connection management for a high-availability cluster](#)

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CLIENT_LABEL environment variable

Set the **CLIENT_LABEL** environment variable in CSDK 4.10.xC10 or JDBC 4.10.JC10 client to assign a character string to CSDK or JDBC client session and identify that character string on the database server. You use this for environments where same userid runs multiple instances of the same application, and there is a need to distinguish one session from the other.

```
>>-onstat -g env--sesID-----><
```

```
>>-select * from sysenvses where envses_name = CLIENT_LABEL----><
```

CSDK Example

Suppose the CLIENT_LABEL is set to two different strings and the same esqlc program is executed with the session ids being 43 and 201:

```
bash-3.2$ export CLIENT_LABEL='csdk_client1'
bash-3.2$ ./myesqlc
```

```
bash-3.2$ export CLIENT_LABEL='csdk_client2'
bash-3.2$ ./myesqlc
```

```
onstat
```

```
onstat -g env 43
```

```
IBM Informix Dynamic Server Version 14.10 -- On-Line -- Up 5 days 23:01:39 -- 210712
Kbytes
```

```
Environment for session 43:
```

Variable	Value [values-list]
CLIENT_LABEL	cdsk_client2
CLIENT_LOCALE	en_US.8859-1
CLNT_PAM_CAPABLE	1
snip	

```
onstat -g env 201
```

```
IBM Informix Dynamic Server Version 14.10 -- On-Line -- Up 5 days 23:02:41 -- 210712
Kbytes
```

```
Environment for session 201:
```

Variable	Value [values-list]
CLIENT_LABEL	cdsk_client1
CLIENT_LOCALE	en_US.8859-1
CLNT_PAM_CAPABLE	1

```
sysmaster
```

```
select * from sysenvses where envses_name = 'CLIENT_LABEL'
```

envses_sid	201
envses_id	9
envses_name	CLIENT_LABEL
envses_value	cdsk_client1

```

envses_sid      43
envses_id       9
envses_name     CLIENT_LABEL
envses_value    cdsk_client2

```

```
2 row(s) retrieved.
```

```
Database closed.
```

JDBC Example

Suppose the CLIENT_LABEL is set to two different strings in the JDBC connection URL and the same JDBC program is executed with the session ids being 232 and 234:

```
java myjdbc "jdbc:informix-sqli://myhost:52220:user=myuser;password=mypasswd;CLIENT_LABEL=jdbc_client1"
```

```
java myjdbc "jdbc:informix-sqli://myhost:52220:user=myuser;password=mypasswd;CLIENT_LABEL=jdbc_client2"
```

```
onstat
```

```
onstat -g env 232
```

```
IBM Informix Dynamic Server Version 12.10.FC10 -- On-Line -- Up 6 days 00:56:26 -- 210712
Kbytes
```

```
Environment for session 232:
```

```

Variable      Value [values-list]
CLIENT_LABEL  jdbc_client1
CLIENT_LOCALE en_US.8859-1
CLNT_PAM_CAPABLE 1

```

```
onstat -g env 234
```

```
IBM Informix Dynamic Server Version 12.10.FC10 -- On-Line -- Up 6 days 00:56:59 -- 210712
Kbytes
```

```
Environment for session 234:
```

```

Variable      Value [values-list]
CLIENT_LABEL  jdbc_client2
CLIENT_LOCALE en_US.8859-1
CLNT_PAM_CAPABLE 1

```

```
sysmaster
```

```
Database selected.
```

```
select * from sysenvses where envses_name = 'CLIENT_LABEL'
```

```

envses_sid      234
envses_id       9
envses_name     CLIENT_LABEL
envses_value    jdbc_client2

```

```

envses_sid      232
envses_id       9
envses_name     CLIENT_LABEL
envses_value    jdbc_client1

```

```
2 row(s) retrieved.
```

```
Database closed.
```

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DBACCNOIGN environment variable

Use the **DBACCNOIGN** environment variable to specify the behavior of the DB-Access utility when specified errors occurs.

The **DBACCNOIGN** environment variable affects the behavior of the DB-Access utility if an error occurs under one of the following circumstances:

- You run DB-Access in non-menu mode.
- In IBM® Informix® only, you execute the LOAD command with DB-Access in menu mode.

Set the DBACCNOIGN environment variable to 1 to roll back an incomplete transaction if an error occurs while you run the DB-Access utility under either of the preceding conditions.

```
>>-setenv--DBACCNOIGN--1-----><
```

For example, assume DB-Access runs the following SQL commands:

```

DATABASE mystore
BEGIN WORK

INSERT INTO receipts VALUES (cust1, 10)
INSERT INTO receipt VALUES (cust1, 20)
INSERT INTO receipts VALUES (cust1, 30)

UPDATE customer
  SET balance =
    (SELECT (balance-60)
     FROM customer WHERE custid = 'cust1')
  WHERE custid = 'cust1'
COMMIT WORK

```

Here, one statement has a misspelled table name: the **receipt** table does not exist. If DBACCNOIGN is not set in your environment, DB-Access inserts two records into the **receipts** table and updates the **customer** table. Now, the decrease in the **customer** balance exceeds the sum of the inserted receipts.

But if DBACCNOIGN is set to 1, messages open that indicate that DB-Access rolled back all the INSERT and UPDATE statements. The messages also identify the cause of the error so that you can resolve the problem.

- [LOAD statement example when DBACCNOIGN is set](#)

You can set the DBACCNOIGN environment variable to protect data integrity during a LOAD statement, even if DB-Access runs the LOAD statement in menu mode.

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LOAD statement example when DBACCNOIGN is set

You can set the DBACCNOIGN environment variable to protect data integrity during a LOAD statement, even if DB-Access runs the LOAD statement in menu mode.

Assume you execute the LOAD statement from the DB-Access SQL menu. Forty-nine rows of data load correctly, but the 50th row contains an invalid value that causes an error. If you set DBACCNOIGN to 1, the database server does not insert the forty-nine previous rows into the database. If DBACCNOIGN is not set, the database server inserts the first 49 rows.

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DBANSIWARN environment variable

Use the DBANSIWARN environment variable to indicate that you want to check for IBM® Informix® extensions to ANSI-standard SQL syntax.

Unlike most environment variables, you are not required to set

DBANSIWARN

to a value. You can set it to any value or to no value.

```
>>-setenv--DBANSIWARN-----><
```

Running DB-Access with DBANSIWARN set is functionally equivalent to including the **-ansi** flag when you invoke DB-Access (or any IBM Informix product that recognizes the **-ansi** flag) from the command line. If you set DBANSIWARN before you run DB-Access, any syntax-extension warnings are displayed on the screen within the SQL menu.

At runtime, the DBANSIWARN environment variable causes the sixth character of the **sqlwarn** array in the SQL Communication Area (SQLCA) to be set to **w** when a statement is executed that is recognized as including any IBM Informix extension to the ANSI/ISO standard for SQL syntax.

For details on SQLCA, see the *IBM Informix ESQL/C Programmer's Manual*.

After you set DBANSIWARN, IBM Informix extension checking is automatic until you log out or unset DBANSIWARN. To turn off IBM Informix extension checking, you can disable DBANSIWARN with this command:

```
unsetenv DBANSIWARN
```

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DBBLOBBUF environment variable

Use the **DBBLOBBUF** environment variable to control whether TEXT or BYTE values are stored temporarily in memory or in a file while being processed by the UNLOAD statement. **DBBLOBBUF** affects only the UNLOAD statement.

```
>>-setenv--DBBLOBBUF--size-----><
```

size

represents the maximum size of TEXT or BYTE data in KB.

If the TEXT or BYTE data size is smaller than the default of 10 KB (or the setting of **DBBLOBBUF**), the TEXT or BYTE value is temporarily stored in memory. If the data size is larger than the default or the **DBBLOBBUF** setting, the data value is written to a temporary file. For instance, to set a buffer size of 15 KB, set **DBBLOBBUF** as in the following example:

```
setenv DBBLOBBUF 15
```

Here any TEXT or BYTE value smaller than 15 KB is stored temporarily in memory. Values larger than 15 KB are stored temporarily in a file.

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DBCENTURY environment variable

Use the **DBCENTURY** environment variable to specify how to expand literal DATE and DATETIME values that are entered with abbreviated year values. To avoid problems in expanding abbreviated years, applications should require entry of 4-digit years, and should always display years as four digits.

```
.-R-----.  
>>-setenv--DBCENTURY--+-F-----+-----><  
'+-C-+-'  
'-P-'
```

When **DBCENTURY** is not set (or is set to **R**), the first two digits of the current year are used to expand 2-digit year values. For example, if today's date is 09/30/2003, then the abbreviated date 12/31/99 expands to 12/31/2099, and the abbreviated date 12/31/00 expands to 12/31/2000.

The **R**, **P**, **F**, and **C** settings determine algorithms for expanding two-digit years.

Setting	Algorithm
R = Current®	Use the first two digits of the current year to expand the year value.
P = Past	Expanded dates are created by prefixing the abbreviated year value with 19 and 20. Both dates are compared to the current date, and the most recent date that is earlier than the current date is used.
F = Future	Expanded dates are created by prefixing the abbreviated year value with 20 and 21. Both dates are compared to the current date, and the earliest date that is later than the current date is used.
C = Closest	Expanded dates are created by prefixing the abbreviated year value with 19, 20, and 21. These three dates are compared to the current date, and the date that is closest to the current date is used.

Settings are case sensitive, and no error is issued for invalid settings. If you enter **f** (for example), then the default (**R**) setting takes effect. The **P** and **F** settings cannot return the current date, which is not in the past or future.

Years entered as a single digit are prefixed with 0 and then expanded. Three-digit years are not expanded. Pad years earlier than 100 with leading zeros.

- [Examples of expanding year values](#)

The examples in this topic illustrate how various settings of **DBCENTURY** cause abbreviated years to be expanded in DATE and DATETIME values.

- [Abbreviated years and expressions in database objects](#)

When an expression in a database object (including a check constraint, fragmentation expression, SPL routine, trigger, or UDR) contains a literal date or DATETIME value in which the year has one or two digits, the database server evaluates the expression using the setting that **DBCENTURY** (and other relevant environment variables) had when the database object was created (or was last modified).

Related reference:

[DATETIME data type](#)

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Examples of expanding year values

The examples in this topic illustrate how various settings of **DBCENTURY** cause abbreviated years to be expanded in DATE and DATETIME values.

DBCENTURY = P

```
Example data type: DATE  
Current date: 4/6/2003  
User enters: 1/1/1  
Prefix with "19" expansion : 1/1/1901  
Prefix with "20" expansion: 1/1/2001  
Analysis: Both are prior to current date, but 1/1/2001 is closer to  
current date.
```

Important: The effect of **DBCENTURY** depends on the current date from the system clock-calendar. Thus, 1/1/1, the abbreviated date in this example, would instead be expanded to 1/1/1901 if the current date were 1/1/2001 and **DBCENTURY** = **P**.

DBCENTURY = F

```
Example data type: DATETIME year to month
Current date: 5/7/2005
User enters: 1-1
Prefix with "20" expansion: 2001-1
Prefix with "21" expansion: 2101-1
Analysis: Only date 2101-1 is after the current date, so it is chosen.
```

DBCENTURY = C

```
Example data type: DATE
Current date: 4/6/2000
User enters: 1/1/1
Prefix with "19" expansion : 1/1/1901
Prefix with "20" expansion: 1/1/2001
Prefix with "21" expansion: 1/1/2101
Analysis: Here 1/1/2001 is closest to the current date, so it is chosen.
```

DBCENTURY = R or DBCENTURY Not Set

```
Example data type: DATETIME year to month
Current date: 4/6/2000
User enters: 1-1
Prefix with "20" expansion: 2001-1
```

```
Example data type: DATE
Current date: 4/6/2003
User enters: 0/1/1
Prefix with "20" expansion: 2000/1
Analysis: In both examples, the Prefix with "20" algorithm is used.
```

Setting **DBCENTURY** does not affect IBM® Informix® products when the locale specifies a non-Gregorian calendar, such as Hebrew or Islamic calendars. The leading digits of the current year are used for alternative calendar systems when the year is abbreviated.

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Abbreviated years and expressions in database objects

When an expression in a database object (including a check constraint, fragmentation expression, SPL routine, trigger, or UDR) contains a literal date or DATETIME value in which the year has one or two digits, the database server evaluates the expression using the setting that DBCENTURY (and other relevant environment variables) had when the database object was created (or was last modified).

If DBCENTURY has been reset to a new value, the new value is ignored when the abbreviated year is expanded.

For example, suppose a user creates a table and defines the following check constraint on a column named **birthdate**:

```
birthdate < '09/25/50'
```

The expression is interpreted according to the value of DBCENTURY when the constraint was defined. If the table that contains the **birthdate** column is created on 09/23/2000 and DBCENTURY =C, the check constraint expression is consistently interpreted as **birthdate** < '09/25/1950' when inserts or updates are performed on the **birthdate** column. Even if different values of DBCENTURY are set when users perform inserts or updates on the **birthdate** column, the constraint expression is interpreted according to the setting at the time when the check constraint was defined (or was last modified).

Database objects created on some earlier versions of IBM® Informix® do not support the priority of creation-time settings.

For legacy objects to acquire this feature

1. Drop the objects.
2. Recreate them (or for fragmentation expressions, detach them and then reattach them).

After the objects are redefined, date literals within expressions of the objects will be interpreted according to the environment at the time when the object was created or was last modified. Otherwise, their behavior will depend on the runtime environment and might become inconsistent if this changes.

Administration of a database that includes a mix of legacy objects and new objects might become difficult because of differences between the new and the old behavior for evaluating date expressions. To avoid this, it is recommended that you redefine any legacy objects.

The value of DBCENTURY and the current date are not the only factors that determine how the database server interprets date and DATETIME values. The DBDATE, DBTIME, GL_DATE, and GL_DATETIME environment variables can also influence how dates are interpreted. For information about GL_DATE and GL_DATETIME, see the *IBM Informix GLS User's Guide*.

Important: The behavior of DBCENTURY for IBM Informix is not compatible with earlier versions.

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DBDATE environment variable

Use the **DBDATE** environment variable to specify the end-user formats of DATE values.

On UNIX systems that use the C shell, set **DBDATE** with this syntax.

```
.-MD-. .-Y4-. .-/-.
>>-setenv--DBDATE--+-DM-+-+--Y2-+-+--+-+----->>
+-Y4-+-+ -MD-+-+ +-.-+-+
'-Y2-' '-DM-' +-.-+-+
'-0--'
```

The following formatting symbols are valid in the **DBDATE** setting:

- ./ are characters that can exist as separators in a date format.
- 0 indicates that no separator is displayed between time units.
- D, M are characters that represent the day and the month.
- Y2, Y4 are characters that represent the year and the precision of the year.

Some East Asian locales support additional syntax for era-based dates.

DBDATE can specify the following attributes of the display format:

- The order of time units (the month, day, and year) in a date
- Whether the year is shown as two digits (Y2) or four digits (Y4)
- The separator between the month, day, and year time units

For the U.S. English locale, the default for **DBDATE** is **MDY4/**, where **M** represents the month, **D** represents the day, **Y4** represents a four-digit year, and slash (/) is the time-units separator (for example, 01/08/2011). Other valid characters for the separator are a hyphen (-), a period (.), or a zero (0). To indicate no separator, use the zero. The slash (/) is used by default if you attempt to specify a character other than a hyphen, period, or zero as a separator, or if you do not include any separator in the **DBDATE** specification.

If **DBDATE** is not set on the client, any **DBDATE** setting on the database server overrides the **MDY4/** default on the client. If **DBDATE** is set on the client, that value (rather than the setting on the database server) is used by the client.

The following table shows some examples of valid **DBDATE** settings and their corresponding displays for the date 8 January, 2011:

DBDATE Setting	Representation of January 8, 2011:		DBDATE Setting	Representation of January 8, 2011:
MDY4/	01/08/2011		Y2DM.	11.08.01
DMY2-	08-01-11		MDY20	010811
MDY4	01/08/2011		Y4MD*	2011/01/08

Formats **Y4MD*** (because asterisk is not a valid separator) and **MDY4** (with no separator defined) both display the default symbol (slash) as the separator.

Important: If you use the Y2 format, the setting of the **DBCENTURY** environment variable can also affect how literal DATE values are evaluated in data entry. Also, certain routines that *IBM® Informix® ESQL/C* calls can use the **DBTIME** variable, rather than **DBDATE**, to set DATETIME formats to international specifications. For more information, see the discussion of the **DBTIME** environment variable in [DBTIME environment variable](#) and in the *IBM Informix ESQL/C Programmer's Manual*.

The setting of the **DBDATE** variable takes precedence over that of the **GL_DATE** environment variable, and over any default DATE format that **CLIENT_LOCALE** specifies. For information about **GL_DATE** and **CLIENT_LOCALE**, see the *IBM Informix GLS User's Guide*.

End-user formats affect the following contexts:

- When you display DATE values, IBM Informix products use the **DBDATE** environment variable to format the output.
- During data entry of DATE values, IBM Informix products use the **DBDATE** environment variable to interpret the input.

For example, if you specify a literal DATE value in an INSERT statement, the database server expects this literal value to be compatible with the format that **DBDATE** specifies. Similarly, the database server interprets the date that you specify as the argument to the **DATE()** function to be in **DBDATE** format.

- [DATE expressions in database objects](#)
When an expression in a database object (including a check constraint, fragmentation expression, SPL routine, trigger, or UDR) contains a literal date value, the database server evaluates the expression using the setting that **DBDATE** (or other relevant environment variables) had when the database object was created (or was last modified). If **DBDATE** has been reset to a new value, the new value is ignored when the literal DATE is evaluated.

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DATE expressions in database objects

When an expression in a database object (including a check constraint, fragmentation expression, SPL routine, trigger, or UDR) contains a literal date value, the database server evaluates the expression using the setting that **DBDATE** (or other relevant environment variables) had when the database object was created (or was last modified). If **DBDATE** has been reset to a new value, the new value is ignored when the literal DATE is evaluated.

For example, suppose **DBDATE** is set to **MDY2/** and a user creates a table with the following check constraint on the column **orderdate**:

```
orderdate < '06/25/98'
```

The date of the preceding expression is formatted according to the value of **DBDATE** when the constraint is defined. The check constraint expression is interpreted as `orderdate < '06/25/98'` regardless of the value of **DBDATE** during inserts or updates on the **orderdate** column. Suppose **DBDATE** is reset to `DMY2/` when a user inserts the value `'30/01/98'` into the **orderdate** column. The date value inserted uses the date format `DMY2/`, whereas the check constraint expression uses the date format `MDY2/`.

See [Abbreviated years and expressions in database objects](#) for a discussion of legacy objects from earlier versions of IBM® Informix® that are always evaluated according to the runtime environment. That section describes how to redefine objects so that dates are interpreted according to environment variable settings that were in effect when the object was defined (or when the object was last modified).

Important: The behavior of **DBDATE** for IBM Informix is not compatible with earlier versions.

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DBDELIMITER environment variable

Set the **DBDELIMITER** environment variable to specify the field delimiter used with the **dbexport** utility and with the LOAD and UNLOAD statements.

```
>>-setenv--DBDELIMITER--'delimiter'-----><
```

delimiter

is the field delimiter for unloaded data files.

The *delimiter* can be any single character, except those in the following list:

- Hexadecimal digits (0 through 9, a through f, A through F)
- Newline or CTRL-J
- The backslash (\) symbol

The vertical bar (| = ASCII 124) is the default. To change the field delimiter to a plus (+) symbol, for example, you can set **DBDELIMITER** as follows:

```
setenv DBDELIMITER '+'
```

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DBEDIT environment variable

Use the **DBEDIT** environment variable to specify the text editor to use with SQL statements and command files in DB-Access.

If **DBEDIT** is set, the specified text editor is invoked automatically. If **DBEDIT** is not, set you are prompted to specify a text editor as the default for the rest of the session.

```
>>-setenv--DBEDIT--editor-----><
```

editor

is the name of the text editor you want to use.

For most UNIX systems, the default text editor is **vi**. If you use another text editor, be sure that it creates flat ASCII files. Some word processors in *document mode* introduce printer control characters that can interfere with the operation of your IBM® Informix® product.

To specify the EMACS text editor, set **DBEDIT** with the following command:

```
setenv DBEDIT emacs
```

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DBFLTMASK environment variable

The DB-Access utility displays the floating-point values of data types **FLOAT**, **SMALLFLOAT**, and **DECIMAL(p)** within a 14-character buffer. By default, DB-Access displays as many digits to the right of the decimal point as will fit into this character buffer. Therefore, the actual number of decimal digits that DB-Access displays depends on the size of the floating-point value.

To reduce the number of digits displayed to the right of the decimal point in floating-point values, set **DBFLTMASK** to the specified number of digits.

```
>>-setenv--DBFLTMASK--scale-----><
```

scale

is the number of decimal digits that you want the IBM® Informix® client application to display in the floating-point values. Here *scale* must be smaller than 16, the default number of digits displayed.

If the floating-point value contains more digits to the right of the decimal than **DBFLTMASK** specifies, DB-Access rounds the value to the specified number of digits. If the floating-point value contains fewer digits to the right of the decimal, DB-Access pads the value with zeros. If you set **DBFLTMASK** to a value greater than can fit into the 14-character buffer, however, DB-Access rounds the value to the number of digits that can fit.

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DBINFO_DBSPACE_RETURN_NULL_FOR_INVALID_PARTNUM environment variable

Use the **DBINFO_DBSPACE_RETURN_NULL_FOR_INVALID_PARTNUM** environment variable to specify if `dbinfo('dbspace', partnum)` raises an error -727 or returns NULL when an invalid partition number (partnum) is provided.

```
+--DBINFO_DBSPACE_RETURN_NULL_FOR_INVALID_PARTNUM--+-'0'--+-----+
                                                    '-1'-'
```

A partition number is considered invalid if it resolves to a dbspace number which is not a valid dbspace in the instance. This includes the pseudo tables which are having partition numbers that would be associated with dbspace 0 which is not a (real) dbspace in an Informix instance. This reflects that pseudo tables do not directly have an on-disk representation but rather are state information from (shared) memory which are exposed via SQL.

In case of an invalid partnum the `dbinfo('dbspace', partnum)` function would result in an error '727: Invalid or NULL TBLspace number given to dbinfo(dbpace)'. When the environment variable **DBINFO_DBSPACE_RETURN_NULL_FOR_INVALID_PARTNUM** is set to 1, `dbinfo()` will not result in an error in this case, but rather does return NULL as dbspace name. When setting a value of '0' or not setting the environment variable, the default behavior returns an error -727 for an invalid partnum. In any case a NULL provided as partnum will result in error -727 being raised.

With SET ENVIRONMENT DBINFO_DBSPACE_RETURN_NULL_FOR_INVALID_PARTNUM the variable can be set dynamically at runtime. This overrides the current DBINFO_DBSPACE_RETURN_NULL_FOR_INVALID_PARTNUM value for the current user session only. For more information about the SET ENVIRONMENT DBINFO_DBSPACE_RETURN_NULL_FOR_INVALID_PARTNUM statement of SQL, see the [Guide to SQL: Syntax](#).

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DBLANG environment variable

Use the **DBLANG** environment variable to specify the subdirectory of **\$INFORMIXDIR** or the full pathname of the directory that contains the compiled message files that IBM® Informix® products use.

```
>>-setenv--DBLANG--+-relative_path+-----><
                    '-full_path-----'
```

relative_path

is a subdirectory of **\$INFORMIXDIR**.

full_path

is the pathname to the compiled message files.

By default, IBM Informix products put compiled messages in a locale-specific subdirectory of the **\$INFORMIXDIR/msg** directory. These compiled message files have the file extension **.iem**. If you want to use a message directory other than **\$INFORMIXDIR/msg**, where, for example, you can store message files that you create, you must perform the following steps:

To use a message directory other than \$INFORMIXDIR/msg

1. Use the **mkdir** command to create the appropriate directory for the message files.
You can make this directory under the directory **\$INFORMIXDIR** or **\$INFORMIXDIR/msg**, or you can make it under any other directory.
2. Set the owner and group of the new directory to **informix** and the access permission for this directory to **755**.
3. Set the **DBLANG** environment variable to the new directory. If this is a subdirectory of **\$INFORMIXDIR** or **\$INFORMIXDIR/msg**, then you need only list the relative path to the new directory. Otherwise, you must specify the full pathname of the directory.
4. Copy the **.iem** files or the message files that you created to the new message directory that **\$DBLANG** specifies.
All the files in the message directory should have the owner and group **informix** and access permission **644**.

IBM Informix products that use the default U.S. English locale search for message files in the following order:

1. In **\$DBLANG**, if **DBLANG** is set to a full pathname
2. In **\$INFORMIXDIR/msg/\$DBLANG**, if **DBLANG** is set to a relative pathname
3. In **\$INFORMIXDIR/\$DBLANG**, if **DBLANG** is set to a relative pathname
4. In **\$INFORMIXDIR/msg/en_us/0333**
5. In **\$INFORMIXDIR/msg/en_us.8859-1**
6. In **\$INFORMIXDIR/msg**
7. In **\$INFORMIXDIR/msg/english**

For more information about search paths for messages, see the description of **DBLANG** in the *IBM Informix GLS User's Guide*.

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DBMONEY environment variable

Use the **DBMONEY** environment variable to specify the display format of values in columns of smallfloat, FLOAT, DECIMAL, or MONEY data types, and of complex data types derived from any of these data types.

```

      .-'$'----- .-.-.
>>-setenv--DBMONEY--+--front-----+--+-----+-----><
      '- 'front' '- '      +-back---+
                          '- 'back' '- '

```

\$

is a currency symbol that precedes MONEY values in the default locale if no other *front* symbol is specified, or if **DBMONEY** is not set.

, or .

is a comma or period (the default) that separates the integral part from the fractional part of the FLOAT, DECIMAL, or MONEY value. Whichever symbol you do not specify becomes the thousands separator.

back

is a currency symbol that follows the MONEY value.

front

is a currency symbol that precedes the MONEY value.

The *back* symbol can be up to seven characters and can contain any character that the locale supports, except a digit, a comma (,), or a period (.) symbol. The *front* symbol can be up to seven characters and can contain any character that the locale supports except a digit, a comma (,), or a period (.) symbol. If you specify any character that is not a letter of the alphabet for *front* or *back*, you must enclose the *front* or *back* setting between single quotation (') marks.

When you display MONEY values, IBM® Informix® products use the **DBMONEY** setting to format the output. **DBMONEY** has no effect, however, on the internal format of data values that are stored in columns of the database.

If you do not set **DBMONEY**, then MONEY values for the default locale, U.S. English, are formatted with a dollar sign (\$) that precedes the MONEY value, a period (.) that separates the integral from the fractional part of the MONEY value, and no *back* symbol. For example, 100.50 is formatted as \$100.50.

Suppose you want to represent MONEY values as DM (deutsche mark) units, using the currency symbol DM and comma (,) as the decimal separator. Enter the following command to set the **DBMONEY** environment variable:

```
setenv DBMONEY DM,
```

Here DM is the *front* currency symbol that precedes the MONEY value, and a comma separates the integral from the fractional part of the MONEY value. As a result, the value 100.50 is displayed as DM100,50.

For more information about how **DBMONEY** formats MONEY values in nondefault locales, see the *IBM Informix GLS User's Guide*.

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DBPATH environment variable

Use the **DBPATH** environment variable to identify the database servers that contain databases. DBPATH can also specify a list of directories (in addition to the current directory) in which DB-Access looks for command scripts (.sql files).

The CONNECT DATABASE, START DATABASE, and DROP DATABASE statements use **DBPATH** to locate the database under two conditions:

- If the location of a database is not explicitly stated
- If the database cannot be located in the default server

The CREATE DATABASE statement does not use **DBPATH**.

To add a new **DBPATH** entry to existing entries, see [Modifying an environment-variable setting](#).

```

      .-: [16]-----
      v                                     |
>>-setenv--DBPATH-----+pathname-----+-----+-----><
      +-/ /--servername--/--full_pathname-+
      '-/ /--servername-----'

```

full_pathname

is the full path, from **root**, of a directory where .sql files are stored.

pathname

is the valid relative path of a directory where .sql files are stored.

servername

is the name of a database server where databases are stored. You cannot reference database files with a *servername*.

DBPATH can contain up to 16 entries. Each entry must be less than 128 characters. In addition, the maximum length of **DBPATH** depends on the hardware platform on which you set **DBPATH**.

When you access a database with the CONNECT, DATABASE, START DATABASE, or DROP DATABASE statement, the search for the database is done first in the directory or database server specified in the statement. If no database server is specified, the default database server that was specified by the **INFORMIXSERVER**

environment variable is used.

If the database is not located during the initial search, and if **DBPATH** is set, the database servers and directories in **DBPATH** are searched for in the specified database. These entries are searched in the same order in which they are listed in the **DBPATH** setting.

- [Using DBPATH with DB-Access](#)
- [Searching local directories](#)
- [Searching networked computers for databases](#)
- [Specifying a servername](#)

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Using DBPATH with DB-Access

If you use DB-Access and select the **Choose** option from the **SQL** menu without having already selected a database, you see a list of all the **.sql** files in the directories listed in your **DBPATH**. After you select a database, the **DBPATH** is not used to find the **.sql** files. Only the **.sql** files in the current working directory are displayed.

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Searching local directories

Use a pathname without a database server name to search for **.sql** scripts on your local computer. In the following example, the **DBPATH** setting causes DB-Access to search for the database files in your current directory and then in the Joachim and Sonja directories on the local computer:

```
setenv DBPATH /usr/joachim:/usr/sonja
```

As the previous example shows, if the pathname specifies a directory name but not a database server name, the directory is sought on the computer that runs the default database server that the **INFORMIXSERVER** specifies; see [INFORMIXSERVER environment variable](#). For instance, with the previous example, if **INFORMIXSERVER** is set to **quality**, the **DBPATH** value is *interpreted*, as the following example shows, where the double slash precedes the database server name:

```
setenv DBPATH //quality/usr/joachim://quality/usr/sonja
```

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Searching networked computers for databases

If you use more than one database server, you can set **DBPATH** explicitly to contain the database server and directory names that you want to search for databases. For example, if **INFORMIXSERVER** is set to **quality**, but you also want to search the **marketing** database server for **/usr/joachim**, set **DBPATH** as the following example shows:

```
setenv DBPATH //marketing/usr/joachim:/usr/sonja
```

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Specifying a servername

You can set **DBPATH** to contain only database server names. This feature allows you to locate only databases; you cannot use it to locate command files.

The database administrator must include each database server mentioned by **DBPATH** in the **\$INFORMIXDIR/etc/sqlhosts** file. For information about communication-configuration files and dbservernames, see your *IBM® Informix® Administrator's Guide* and the *IBM Informix Administrator's Reference*.

For example, if **INFORMIXSERVER** is set to **quality**, you can search for a database first on the **quality** database server and then on the **marketing** database server by setting **DBPATH**, as the following example shows:

```
setenv DBPATH //marketing
```

If you use DB-Access in this example, the names of all the databases on the **quality** and **marketing** database servers are displayed with the **Select** option of the **DATABASE** menu.

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DBPRINT environment variable

Use the DBPRINT environment variable to specify the default printing program.

```
>>-setenv--DBPRINT--program-----><
```

program

Any command, shell script, or UNIX utility that produces standard ASCII output.

If you do not set DBPRINT, the default *program* is found in one of two places:

- For most BSD UNIX systems, the default program is **lpr**.
- For UNIX System V, the default program is usually **lp**.

Enter the following command to set the DBPRINT environment variable to specify **myprint** as the print program:

```
setenv DBPRINT myprint
```

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DBREMOTECMD environment variable (UNIX)

Use the DBREMOTECMD environment variable to override the default remote shell to perform remote tape operations with the database server.

You can set DBREMOTECMD to a simple command or to a full path name.

```
>>-setenv--DBREMOTECMD--+command--+-----><
                        '-pathname-'
```

command

A command to override the default remote shell.

pathname

A path name to override the default remote shell.

If you do not specify the full path name, the database server searches your PATH for the specified *command*. You should use the full path name syntax on interactive UNIX platforms to avoid problems with similarly named programs in other directories and possible confusion with the *restricted shell* (/usr/bin/rsh).

The following command sets DBREMOTECMD for a simple command name:

```
setenv DBREMOTECMD rcmd
```

The next command to set DBREMOTECMD specifies a full path name:

```
setenv DBREMOTECMD /usr/bin/remsh
```

For more information about using remote tape devices for backups, see [Specify a remote device](#).

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DBSPACETEMP environment variable

The **DBSPACETEMP** environment variable specifies the dbspaces in which temporary tables are built. The list can include standard dbspaces, temporary dbspaces, or both.

```
      .-,-,-----
      V      |
>>-setenv--DBSPACETEMP---dbspace+-----><
```

dbspace

is the name of an existing standard or temporary dbspace.

You can list dbspaces, separated by colon (:) or comma (,) symbols, to designate space for temporary tables across physical storage devices. For example, the following command to set the **DBSPACETEMP** environment variable specifies three dbspaces for temporary tables:

```
setenv DBSPACETEMP sorttmp1:sorttmp2:sorttmp3
```

DBSPACETEMP overrides any default dbspaces that the DBSPACETEMP parameter specifies in the configuration file of the database server. For UPDATE STATISTICS operations, DBSPACETEMP is used only when you specify the HIGH keyword option.

On UNIX platforms, you might have better performance if the list of dbspaces in **DBSPACETEMP** is composed of chunks that are allocated as raw devices.

The number of dbspaces is limited by the maximum size of the environment variable, as defined by your operating system. Your database server does not create a dbspace specified by the environment variable if the dbspace does not exist.

precision

is the number of digits for the value of any time unit, or the maximum number of characters in the name of a month.

special

is one of the placeholder characters that are listed following.

These terms and symbols are described in the pages that follow.

This quoted string can include literal characters and placeholders for the values of individual time units and other elements of a DATETIME value. DBTIME takes effect only when you call certain IBM® Informix® ESQL/C DATETIME routines. (For details, see the *IBM Informix ESQL/C Programmer's Manual*.) If DBTIME is not set, the behavior of these routines is undefined, and "YYYY-MM-DD hh:mm:ss.ffffff" is the default display and input format for DATETIME YEAR TO FRACTION(5) literal values in the default locale.

The percentage (%) symbol gives special significance to the *special* placeholder symbol that follows. Without a preceding % symbol, any character within the formatting mask is interpreted as a literal character, even if it is the same character as one of the placeholder characters in the following list. Note also that the *special* placeholder symbols are case sensitive.

The following characters within a DBTIME format string are placeholders for time units (or for other features) within a DATETIME value.

%b

is replaced by the abbreviated month name.

%B

is replaced by the full month name.

%d

is replaced by the day of the month as a decimal number [01,31].

%Fn

is replaced by a fraction of a second with a scale that the integer *n* specifies. The default value of *n* is 2; the range of *n* is $0 \leq n \leq 5$.

%H

is replaced by the hour (24-hour clock).

%I

is replaced by the hour (12-hour clock).

%M

is replaced by the minute as a decimal number [00,59].

%m

is replaced by the month as a decimal number [01,12].

%p

is replaced by A.M. or P.M. (or the equivalent in the locale file).

%S

is replaced by the second as a decimal number [00,59].

%y

is replaced by the year as a four-digit decimal number.

%Y

is replaced by the year as a four-digit decimal number. User must enter a four-digit value.

%%

is replaced by % (to allow a literal % character in the format string).

For example, consider this display format for DATETIME YEAR TO SECOND:

Mar 21, 2013 at 16 h 30 m 28 s

If the user enters a two-digit year value, this value is expanded to 4 digits according to the DBCENTURY environment variable setting. If DBCENTURY is not set, then the string 19 is used by default for the first two digits.

Set DBTIME as the following command line (for the C shell) shows:

setenv DBTIME '%b %d, %Y at %H h %M m %S s'

The default DBTIME produces the following ANSI SQL string format:

2001-03-21 16:30:28

You can set the default DBTIME as the following example shows:

setenv DBTIME '%Y-%m-%d %H:%M:%S'

An optional field width and precision specification (*w.p*) can immediately follow the percent (%) character. It is interpreted as follows:

w

Specifies the minimum field width. The value is right-justified with blank spaces on the left.

-w

Specifies the minimum field width. The value is left-justified with blank spaces on the right.

0w

Specifies the minimum field width. The value is right-justified and padded with zeros on the left.

p

Specifies the precision of d, H, I, m, M, S, y, and Y time unit values, or the maximum number of characters in b and B month names.

The following limitations apply to field-width and precision specifications:

- If the data value supplies fewer digits than *precision* specifies, the value is padded with leading zeros.
- If a data value supplies more characters than *precision* specifies, excess characters are truncated from the right.
- If no field width or precision is specified for d, H, I, m, M, S, or y placeholders, 0.2 is the default, or 0.4 for the Y placeholder.
- A *precision* specification is significant only when converting a DATETIME value to an ASCII string, but not vice versa.

Important: Any separator character between the `%S` and `%F` directives for DATETIME user formats must be explicitly defined. Specifying `%S%F` concatenates the digits that represent the integer and fractional parts of the seconds value.

Like DBDATE, GL_DATE, or GL_DATETIME, or USE_DTEENV, the DBTIME setting controls only the character-string representation of data values. It cannot change the internal storage format of the DATETIME column. (For additional information about formatting DATE values, see the discussion of DBDATE in the topic [DBDATE environment variable](#).)

If you specify a locale other than U.S. English, the locale defines the culture-specific display formats for DATETIME values. To change the default display format, change the setting of DBTIME, or of the GL_DATETIME and USE_DTEENV environment variables.

Related reference:
[DATETIME data type](#)

DBUPSPACE environment variable

```
>>-setenv--DBUPSPACE--+.1024---.  .- : -15-----+.
                        '- disk -' '- : - memory -' '- : - directive -'
```

is an unsigned integer, encoding one of the following directives for the UPDATE STATISTICS execution plan:

- For example, to set **DBUPSPACE** to 2,500 KiB of disk space and 1 megabyte of memory, enter this command:

After you set this value, the database server will attempt to use no more than 2,500 KiB of disk space during the execution of an `UPDATE STATISTICS MEDIUM` or `HIGH` statement. If a table requires 5 megabytes of disk space for sorting, then `UPDATE STATISTICS` accomplishes the task in two passes; the distributions for one half of the columns are constructed with each pass. For a table of a given storage size, this parameter determines the number of passes, but no pass can write less than a full column.

[Default name and location of the explain output file on UNIX](#)
[Default name and location of the output file on Windows](#)

DEFAULT ATTACH environment variable

```
>>-setenv--DEFAULT ATTACH--1-----<<
```

If the **DEFAULT_ATTACH** environment variable is set to 1, then by default, the pages of nonfragmented B-tree indexes on nonfragmented tables are stored in the same partition (and in the same dbspace) that stores data pages of the table. The IN TABLE keywords of the CREATE INDEX statement are not required (but do not return an error).

Setting **DEFAULT_ATTACH** to 1 has no effect, however, on any other types of indexes, whose pages are always stored in separate partitions from the data pages of the indexed table. These index types whose storage distribution is always different from that of their table include

- R-tree indexes,
- functional indexes,
- forest of trees indexes,
- fragmented indexes,
- and indexes on fragmented tables.

Index storage in the same partition as the data pages is supported only for nonfragmented B-tree indexes on nonfragmented tables.

If **DEFAULT_ATTACH** is not set, then by default, any CREATE INDEX statement that does not specify IN TABLE as its Storage Options clause creates an index whose pages are stored in partitions separate from the data pages. This release of IBM Informix can support existing indexes that were created by Version 7.x of IBM Informix.

Important: Future releases of IBM Informix might not continue to support **DEFAULT_ATTACH**. Developing new applications that depend on this deprecated feature is not recommended.

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DELIMIDENT environment variable

The DELIMIDENT environment variable specifies that strings enclosed between double quotation (") marks are delimited database identifiers.

The DELIMIDENT environment variable is also supported on client systems, where it can be set to y, to n, or to no setting.

- **y** specifies that client applications must use single quotation (') symbols to delimit character strings, and must use double quotation (") symbols only around delimited SQL identifiers, which can support a larger character set than is valid in undelimited identifiers. Letters within delimited strings or delimited identifiers are case-sensitive. This is the default value for OLE DB and .NET.
- **n** specifies that client applications can use double quotation (") or single quotation (') symbols to delimit character strings, but not to delimit SQL identifiers. If the database server encounters a string delimited by double or single quotation symbols in a context where an SQL identifier is required, it issues an error. An owner name that qualifies an SQL identifier can be delimited by single quotation (') symbols. You must use a pair of the same quotation symbols to delimit a character string.
This is the default value for ESQL/C, JDBC, and ODBC. APIs that have ESQL/C as an underlying layer, such as IBM® Informix® 4GL, the DataBlade API (LIBDMI), and the C++ API, behave as ESQL/C, and use 'n' as the default if no value for DELIMIDENT is specified on the client system.
- Specifying the DELIMIDENT environment variable with no value on the client system requires client applications to use the DELIMIDENT setting that is the default for their application programming interface (API).

```
>>--setenv--DELIMIDENT-----><
```

No value is required; DELIMIDENT takes effect if it exists, and it remains in effect while it is on the list of environment variables. Removing DELIMIDENT when it is set at the server level requires restarting the server.

Delimited identifiers can include white space (such as the phrase "**Vitamin E**") or can be identical to SQL keywords, (such as "**TABLE**" or "**USAGE**"). You can also use them to declare database identifiers that contain characters outside the default character set for SQL identifiers (such as "**Column #6**"). In the default locale, this set consists of letters, digits, and the underscore (_) symbol.

Even if DELIMIDENT is set, you can use single quotation (') symbols to delimit authorization identifiers as the owner name component of a database object name, as in the following example:

```
RENAME COLUMN 'Owner'.table2.collum3 TO column3;
```

This example is an exception to the general rule that when DELIMIDENT is set, the SQL parser interprets character strings delimited by single quotation symbols as string literals, and interprets character strings delimited by double quotation symbols (") as SQL identifiers.

Database identifiers (also called *SQL identifiers*) are names for database objects, such as tables and columns. *Storage identifiers* are names for storage objects, such as dbspaces, blobspaces, and sbspaces. You cannot use DELIMIDENT to declare storage identifiers that contain characters outside the default SQL character set.

Delimited identifiers are case sensitive. To use delimited identifiers, applications in Informix ESQL/C must set DELIMIDENT at compile time and at run time. Important: If DELIMIDENT is not already set, you should be aware that setting it can cause the failure of existing .sql scripts or client applications that use double (") quotation marks in contexts other than delimiting SQL identifiers, such as delimiters of string literals. You must use single (') rather than double quotation marks for delimited constructs that are not SQL identifiers if DELIMIDENT is set.

On UNIX systems that use the C shell and on which DELIMIDENT has been set, you can disable this feature (which causes anything between double quotation symbols to be interpreted as an SQL identifier) by the command:

```
unsetenv DELIMIDENT
```

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ENVIGNORE environment variable (UNIX)

The ENVIGNORE environment variable can deactivate specified environment variable settings in the common (shared) configuration file, `informix.rc`, and private environment-configuration file, `.informix`.

```

      .-:-----
      |
V-----|
>>-setenv--ENVIGNORE---variable-+-----><

```

variable

The name of an environment variable to be deactivated.

Use colon (:) symbols between consecutive *variable* names. For example, to ignore the `DBPATH` and `DBMONEY` entries in the environment-configuration files, enter the following command:

```
setenv ENVIGNORE DBPATH:DBMONEY
```

The common environment-configuration file is stored in `$INFORMIXDIR/etc/informix.rc`.

The private environment-configuration file is stored in the home directory of the user as `.informix`.

For information about creating or modifying an environment-configuration file, see [Setting environment variables in a configuration file](#).

ENVIGNORE itself cannot be set in an environment-configuration file.

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FET_BUF_SIZE environment variable

The `FET_BUF_SIZE` environment variable can override the default setting for the size of the fetch buffer for all data types except `BYTE` and `TEXT` values. For ANSI databases, you must set transactions to `READ ONLY` for the `FET_BUF_SIZE` environment variable to improve performance, otherwise rows are returned one by one.

```
>>-setenv--FET_BUF_SIZE--size-----><
```

size

is a positive integer that is larger than the default buffer size, but no greater than 2147483648 (2GB), specifying the size (in bytes) of the fetch buffer that holds data retrieved by a query.

For example, to set a buffer size to 5,000 bytes on a UNIX system that uses the C shell, set `FET_BUF_SIZE` by entering the following command:

```
setenv FET_BUF_SIZE 5000
```

When `FET_BUF_SIZE` is set to a valid value, the new value overrides the default value (or any previously set value of `FET_BUF_SIZE`). The default setting for the fetch buffer is dependent on row size.

The processing of `BYTE` and `TEXT` values is not affected by `FET_BUF_SIZE`.

No error is raised if `FET_BUF_SIZE` is set to a value that is less than the default size or is larger than 2147483648 (2GB). In these cases, however, the invalid fetch buffer size is ignored, and the default size is in effect.

A valid `FET_BUF_SIZE` setting is in effect for the local database server and for any remote database server from which you retrieve rows through a distributed query in which the local server is the coordinator and the remote database is subordinate. The greater the size of the buffer, the more rows can be returned, and the less frequently the client application must wait while the database server returns rows. A large buffer can improve performance by reducing the overhead of filling the client-side buffer.

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IFXMONGOAUTH environment variable

Set the `IFXMONGOAUTH` environment variable to enable PAM authentication for MongoDB clients through the wire listener.

You can set the `IFXMONGOAUTH` environment variable to any value or to no value.

```
>>-setenv--IFXMONGOAUTH--1-----><
```

Setting the `IFXMONGOAUTH` environment variable is a prerequisite to configuring PAM authentication for MongoDB clients.

You can disable the `IFXMONGOAUTH` environment variable with this command:

```
unsetenv IFXMONGOAUTH
```

Related information:

[Configuring PAM authentication](#)

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IFX_DEF_TABLE_LOCKMODE environment variable

The **IFX_DEF_TABLE_LOCKMODE** environment variable can specify the default lock mode for database tables that are subsequently created without explicitly specifying the LOCKMODE PAGE or LOCKMODE ROW keywords. This feature is convenient if you must create several tables of the same lock mode. UNIX systems that use the C shell support the following syntax:

```
>>-setenv--IFX_DEF_TABLE_LOCKMODE--+-PAGE-+-----><
                                     '-ROW--'
```

PAGE

The default lock mode is page-level granularity. This value disables the LAST COMMITTED feature of COMMITTED READ.

ROW

The default lock mode is row-level granularity.

Similar functionality is available by setting the DEF_TABLE_LOCKMODE parameter of the ONCONFIG file to PAGE or ROW. When a table is created or modified, any conflicting lock mode specifications are resolved according to the following descending (highest to lowest) order of precedence:

1. Explicit LOCKMODE specification of CREATE TABLE or ALTER TABLE
2. **IFX_DEF_TABLE_LOCKMODE** environment variable setting
3. DEF_TABLE_LOCKMODE parameter setting in the ONCONFIG file
4. The system default lock mode (= page mode)

To make the DEF_TABLE_LOCKMODE setting the default mode (or to restore the system default if DEF_TABLE_LOCKMODE is not set) use the command:

```
unsetenv IFX_DEF_TABLE_LOCKMODE
```

If **IFX_DEF_TABLE_LOCKMODE** is set in the environment of the database server before running **oninit**, then its scope is all sessions of the database server (just as if DEF_TABLE_LOCKMODE were set in the ONCONFIG file). If **IFX_DEF_TABLE_LOCKMODE** is set in the shell, or in the **\$HOME/.informix** or **\$INFORMIXDIR/etc/informix.rc** files, then the scope is restricted to the current session (if you set it in the shell) or to the individual user.

Important: This has no effect on existing tables. If you specify *ROW* as the lock mode, the database will use this to restore, recover, or copy data. For tables that were created in *PAGE* mode, this might cause lock-table overflow or performance degradation.

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IFX_DIRECTIVES environment variable

The **IFX_DIRECTIVES** environment variable setting determines whether the optimizer allows query optimization directives from within a query. The **IFX_DIRECTIVES** environment variable is set on the client.

You can specify either **ON** and **OFF** or **1** and **0** to set the environment variable.

```
>>-setenv--IFX_DIRECTIVES--+-1-+-----><
                                     '-0-'
```

1

Optimizer directives accepted

0

Optimizer directives not accepted

The setting of the **IFX_DIRECTIVES** environment variable overrides the value of the DIRECTIVES configuration parameter that is set for the database server. If the **IFX_DIRECTIVES** environment variable is not set, however, then all client sessions will inherit the database server configuration for directives that the ONCONFIG parameter DIRECTIVES determines. The default setting for the **IFX_DIRECTIVES** environment variable is **ON**.

For more information about the DIRECTIVES parameter, see the *IBM Informix Administrator's Reference*. For more information about the performance impact of directives, see your *IBM Informix Performance Guide*.

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IFX_EXTDIRECTIVES environment variable

The IFX_EXTDIRECTIVES environment variable specifies whether the query optimizer allows external query optimization directives from the **sysdirectives** system catalog table to be applied to queries in existing applications.

You have two options for setting the IFX_EXTDIRECTIVES environment variable:

- Global, for all users:
On the server, set IFX_EXTDIRECTIVES in the environment as user informix and then run the **oninit** command.
- Client specific:
On the client, set IFX_EXTDIRECTIVES in the environment. When IFX_EXTDIRECTIVES is set in the client environment, the client setting are used regardless of the server (global) setting.

You can determine the server setting using the **onstat -g env** command.

You can specify either ON and OFF or 1 and 0 to set the environment variable.

```
>>-setenv--IFX_DIRECTIVES--+1-+-----><
                        '-0-'
```

- 1
External optimizer directives accepted
- 0
External optimizer directives not accepted

Queries within a given client application can use external directives if both the EXT_DIRECTIVES parameter in the configuration file of the database server and the **IFX_EXTDIRECTIVES** environment variable setting on the client system are both set to 1 or ON. If **IFX_EXTDIRECTIVES** is not set, external directives are supported only if the ONCONFIG parameter EXT_DIRECTIVES is set to 2. The following table summarizes the effect of valid IFX_EXTDIRECTIVES and EXT_DIRECTIVES settings on support for external optimizer directives.

Table 1. Effect of IFX_EXTDIRECTIVES and EXT_DIRECTIVES settings on external directives

	EXT_DIRECTIVES = 0	EXT_DIRECTIVES = 1	EXT_DIRECTIVES = 2
IFX_EXTDIRECTIVES No setting	OFF	OFF	ON
IFX_EXTDIRECTIVES0 = OFF	OFF	OFF	OFF
IFX_EXTDIRECTIVES1 = ON	OFF	ON	ON

The database server interprets any EXT_DIRECTIVES setting besides 1 or 2 (or no setting) as equivalent to OFF, disabling support for external directives. Any value of **IFX_EXTDIRECTIVES** other than 1 has the same effect for the client.

For information about how to define external optimizer directives, see the description of the SAVE EXTERNAL DIRECTIVES statement of SQL in the *IBM Informix Guide to SQL: Syntax*. For more information about the EXT_DIRECTIVES configuration parameter, see the *IBM Informix Administrator's Reference*. For more information about the performance impact of directives, see your *IBM Informix Performance Guide*.

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IFX_LARGE_PAGES environment variable

The IFX_LARGE_PAGES environment variable specifies whether the database server can use large pages on platforms where the hardware and the operating system support large pages of shared memory. If this is enabled in the server environment, IBM® Informix® can use the large pages for non-message shared memory segments that are located in physical memory.

The IFX_LARGE_PAGES environment variable is supported only on AIX®, Solaris, and Linux operating systems. The setting of IFX_LARGE_PAGES has no effect on if the operating system does not support large pages, or if large pages are not configured on the system.

You can specify either 1 or 0 to set this environment variable.

```
>>-setenv--IFX_LARGE_PAGES--+1-+-----><
                        '-0-'
```

- 0
The use of large pages is disabled. This is the default on AIX systems.
- 1
The use of large pages is enabled. This is the default on Solaris and Linux systems.

The DBSA must use operating system commands to configure the large pages. See the operating system documentation for the configuration procedures.

can use large pages for non-message shared memory segments that are locked in physical memory, if sufficient large pages are configured and available. The RESIDENT configuration parameter controls whether a shared memory segment is locked in physical memory, so that the segment cannot be swapped. If there are insufficient large pages to hold a segment, the segment might contain a mixture of large pages and regular pages.

On AIX the large pages used by are 16 MB in size.

On Linux x86_64 the large pages used by are defined by the `Hugepagesize` entry in the `/proc/meminfo` file.

aligns the segment address and rounds up to the segment size automatically. In addition to messages regarding rounding, the server prints an informational message to the server log file whenever it attempts to use large pages to store a segment.

When IFX_LARGE_PAGES is enabled, the use of large pages can offer significant performance benefits in large memory configurations.

Related information:

[RESIDENT configuration parameter](#)

IFX_LOB_XFERSIZE environment variable

Use the **IFX_LOB_XFERSIZE** environment variable to specify the number of bytes in a CLOB or BLOB data type to transfer from a client application to the database server before checking whether an error has occurred.

The error check occurs each time the specified number of bytes is transferred. If an error occurs, the remaining data is not sent and an error is reported. If no error occurs, the file transfer will continue until it finishes.

For example, if the value of **IFX_LOB_XFERSIZE** is set to 10485760 (10 MB), then error checking will occur after every 10485760 bytes of the CLOB or BLOB data is sent. If **IFX_LOB_XFERSIZE** is not set, the error check occurs after the entire BLOB or CLOB data is transferred.

The valid range for **IFX_LOB_XFERSIZE** is from 1 to 9223372036854775808 bytes. The **IFX_LOB_XFERSIZE** environment variable is set on the client.

```
>>-setenv--IFX_LOB_XFERSIZE--value-----><
```

value

the number of bytes in a CLOB or BLOB to transfer from a client application to the database server before checking whether an error has occurred

You should adjust the value of **IFX_LOB_XFERSIZE** to suit your environment. Set **IFX_LOB_XFERSIZE** low enough so that transmission errors of large BLOB or CLOB data types are detected early, but not so low that excessive network resources are used.

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IFX_LONGID environment variable

The **IFX_LONGID** environment variable setting and the version number of the client application determine whether a given client application is capable of handling long identifiers. (Older versions of IBM® Informix® restricted SQL identifiers to 18 or fewer bytes; *long identifiers* can have up to 128 bytes when **IFX_LONGID** is set.) Valid **IFX_LONGID** values are 1 and 0.

```
>>-setenv--IFX_LONGID--+-1-+-----><
                        '-0-'
```

1

Client supports long identifiers.

0

Client cannot support long identifiers.

When **IFX_LONGID** is set to zero, applications display only the first 18 bytes of long identifiers, without indicating (by +) that truncation has occurred.

If **IFX_LONGID** is unset or is set to a value other than 1 or 0, the determination is based on the internal version of the client application. If the (server-based) version is not less than 9.0304, or is in the (CSDK-based) range $2.90 \leq \text{version} < 4.0$, the client is considered capable of handling long identifiers. Otherwise, the client application is considered incapable.

The **IFX_LONGID** setting overrides the internal version of the client application. If the client cannot handle long identifiers despite a newer version number, set **IFX_LONGID** to 0. If the client version can handle long identifiers despite an older version number, set **IFX_LONGID** to 1.

If you set **IFX_LONGID** on the client, the setting affects only that client. If you start the database server with **IFX_LONGID** set, all client applications use that setting by default. If **IFX_LONGID** is set to different values on the client and on the database server, however, the client setting takes precedence. Important: ESQL executables that have been built with the -static option using the libos.a library version that does not support long identifiers cannot use the **IFX_LONGID** environment variable. You must recompile such applications with the new libos.a library that includes support for long identifiers. Executables that use shared libraries (no -static option) can use **IFX_LONGID** without recompilation provided that they use the new libifos.so that provides support for long identifiers. For details, see your ESQL product publication.

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IFX_NETBUF_PVTPPOOL_SIZE environment variable (UNIX)

Use the **IFX_NETBUF_PVTPPOOL_SIZE** environment variable to specify the maximum size of the free (unused) private network buffer pool for each database server session.

```
>>-setenv--IFX_NETBUF_PVTPPOOL_SIZE--count-----><
```

count

an integer specifying the number of units (buffers) in the pool.

The default size is 1 buffer. If `IFX_NETBUF_PVTPPOOL_SIZE` is set to 0, then each session obtains buffers from the free global network buffer pool. You must specify the value in decimal form.

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IFX_NETBUF_SIZE environment variable

Use the `IFX_NETBUF_SIZE` environment variable to configure the network buffers to the optimum size. This environment variable specifies the size of all network buffers in the free (unused) global pool and the private network buffer pool for each database server session.

```
>>-setenv--IFX_NETBUF_SIZE--size-----><
```

size

is the integer size (in bytes) for one network buffer.

The default size is 4 KB (4,096 bytes). The maximum size is 64 KB (65,536 bytes) and the minimum size is 512 bytes. You can specify the value in hexadecimal or decimal form.

Tip: You cannot set a different size for each session.

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IFX_NO_SECURITY_CHECK environment variable (UNIX)

The `IFX_NO_SECURITY_CHECK` environment variable allows user **informix** or **root** to complete operations with a database server instance even when the IBM® Informix® utilities detect that the `$INFORMIXDIR` path is not secure. Do not use this environment variable unless your system setup makes it absolutely necessary to do so.

The purpose of `IFX_NO_SECURITY_CHECK` is for environments where the database server started but while running it detects that the runtime path is not secure anymore. In this case, a superuser might be required to stop the database server in order to remedy the security flaw. With this environment variable, either user **informix** or **root** can use the **onmode** utility to shut down a nonsecure instance, which would otherwise not be possible because key programs do not run when the `$INFORMIXDIR` path is not secure.

There is some risk in using this environment variable, but in some circumstances it might be necessary to remedy a bigger security problem. The requirement that only user **informix** or **root** can invoke `IFX_NO_SECURITY_CHECK` makes it unlikely that an illegitimate user would be able to run it.

To use this environment variable, set it to any non-empty string.

```
>>-setenv--IFX_NO_SECURITY_CHECK--1-----><
```

1

Any value entered here when running this environment variable disables the **onsecurity** utility.

Important: Turn off this environment variable after you have finished troubleshooting the security problem.

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IFX_NO_TIMELIMIT_WARNING environment variable

Trial or evaluation versions of IBM® Informix® software products, which cease to function when some time limit has elapsed since the software was installed, by default issue warning messages that tell users when the license will expire. If you set the **IFX_NO_TIMELIMIT_WARNING** environment variable, however, the time-limited software does not issue these warning messages.

```
>>-setenv--IFX_NO_TIMELIMIT_WARNING-----><
```

For users who dislike viewing warning messages, this feature is an alternative to redirecting the error output. Setting **IFX_NO_TIMELIMIT_WARNING** has no effect, however, on when a time-limited license expires; the software ceases to function at the same point in time when it would if this environment variable had not been set. If you do set **IFX_NO_TIMELIMIT_WARNING**, users will not see potentially annoying warnings about the impending license expiration, but some users might be annoyed at you when the database server (or whatever software has a time-limited license) ceases to function without any warning.

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IFX_NODBPROC environment variable

The **IFX_NODBPROC** environment variable lets you prevent the database server from running the `sysdbopen()` or `sysdbclose()` procedure. These procedures cannot be run if this environment variable is set to any value.

```
>>-setenv--IFX_NODBPROC--string-----><
```

string

Any value prevents the database server from running `sysdbopen()` or `sysdbclose()`.

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IFX_NOT_STRICT_THOUS_SEP environment variable

IBM® Informix® requires the thousands separator to have 3 digits following it. For example, 1,000 is considered correct, and 1,00 is considered wrong. In previous releases, both formats were considered correct.

```
>>-setenv--IFX_NOT_STRICT_THOUS_SEP--n-----><
```

n

Set *n* to 1 for the behavior in previous releases, which is that the thousands separator can have fewer than three digits following it.

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IFX_ONTAPE_FILE_PREFIX environment variable

When `TAPEDEV` and `LTAPEDEV` specify directories, use the **IFX_ONTAPE_FILE_PREFIX** environment variable to specify a prefix for backup file names that replaces the `hostname_servnum` format. If no value is set, file names are `hostname_servnum_Ln` for levels and `hostname_servnum_Lognnnnnnnnnn` for log files.

If you set the value of `IFX_ONTAPE_FILE_PREFIX` to `My_Backup`, the backup file names have the following names:

- `My_Backup_L0`
- `My_Backup_L1`
- `My_Backup_L2`
- `My_Backup_Log0000000001`
- `My_Backup_Log0000000002`

```
>>-setenv--IFX_ONTAPE_FILE_PREFIX--string-----><
```

string

The prefix to use for the names of backup files.

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IFX_PAD_VARCHAR environment variable

The **IFX_PAD_VARCHAR** environment variable setting controls how the database server sends and receives `VARCHAR` and `NVARCHAR` data values. Valid **IFX_PAD_VARCHAR** values are 1 and 0.

```
>>-setenv--IFX_PAD_VARCHAR--+-1-+-----><
      '_0-'
```

1

Transmit the entire structure, up to the declared *max* size.

0

Transmit only the portion of the structure containing data.

For example, to send the string "ABC" from a column declared as `NVARCHAR(255)` when **IFX_PAD_VARCHAR** is set to 0 would send 3 bytes.

If the setting were 1 in the previous example, however, the number of bytes sent would be 255 bytes.

The effect **IFX_PAD_VARCHAR** is context-sensitive. In a low-bandwidth network, a setting of 0 might improve performance by reducing the total volume of transmitted data. But in a high-bandwidth network, a setting of 1 might improve performance, if the CPU time required to process variable-length packets were greater than the time required to send the entire character stream. In cross-server distributed operations, this setting has no effect, and padding characters are dropped from `VARCHAR` or `NVARCHAR` values that are passed between database servers.

IFX_UNLOAD_EILSEQ_MODE environment variable

Use the IFX_UNLOAD_EILSEQ_MODE environment variable to help migrate databases from Informix® Version 10 to Version 11.50 or 11.70, where character data might be encoded with a codeset that is different than the codeset used to create the Version 10 database.

In earlier versions of Informix, it was possible to load character data into a database that did not match the locale and codeset of the database. For example you could load Chinese data into a database created with the DB_LOCALE=en_US.8859-1 codeset. In newer versions of Informix, to insert Chinese data you would need a database created with the Chinese (DB_LOCALE=zh_tw.big5 locale and codeset).

Important: For databases created with Version 10 and Client SDK 2.4, when you attempt to unload the invalid character data an error occurs unless you have set this environment variable. The IFX_UNLOAD_EILSEQ_MODE environment variable enables DB-Access, dbexport, and High Performance Loader (HPL) to unload character and bypass the GLS validation that normally occurs when you unload data by using the Version 11.50 and 11.70 tools.

To use this environment variable, set it to any non-empty string.

```
>>-setenv--IFX_UNLOAD_EILSEQ_MODE--value-----><
```

value

Any alpha or numeric value. For example: yes, true, or 1.

This environment variable takes effect when character data is being fetched or retrieved from the database.

```
setenv IFX_UNLOAD_EILSEQ_MODE 1
setenv IFX_UNLOAD_EILSEQ_MODE yes
setenv IFX_UNLOAD_EILSEQ_MODE on
```

This environment variable is similar to setting the EILSEQ_COMPAT_MODE configuration parameter in the ONCONFIG file. The configuration parameter affects character data that is inserted into the database, whereas the IFX_UNLOAD_EILSEQ_MODE environment variable affects character data that is unloaded from the database.

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IFX_UPDESC environment variable

You must set the **IFX_UPDESC** environment variable at execution time before you can do a DESCRIBE of an UPDATE statement.

```
>>-setenv--IFX_UPDESC--value-----><
```

value

is any non-NULL value.

A NULL value (here meaning that **IFX_UPDESC** is not set) disables the describe-for-update feature. Any non-NULL value enables the feature.

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IFX_XASTDCOMPLIANCE_XAEND environment variable

In earlier releases of IBM® Informix®, an internal rollback of a global transaction freed the transaction. In releases later than Version 9.40, however, the default behavior after an internal rollback is not to free the global transaction until an explicit rollback, as required by the X/Open XA standard. By setting the DISABLE_B162428_XA_FIX configuration parameter to 1, you can restore the legacy behavior as the default for all sessions.

The **IFX_XASTDCOMPLIANCE_XAEND** environment variable can override the configuration parameter for the current session, using the following syntax. Valid **IFX_XASTDCOMPLIANCE_XAEND** values are 1 and 0.

```
>>-setenv--IFX_XASTDCOMPLIANCE_XAEND--+-1-+-----><
                                     '-0-'
```

0

Frees global transactions only after an explicit rollback

1

Frees global transactions after any rollback

This environment variable can be particularly useful when the server instance is disabled for new behavior by the DISABLE_B162428_XA_FIX configuration parameter, but one client requires the new behavior. Setting this environment variable to zero supports the new behavior in the current session.

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IFX_XFER_SHMBASE environment variable

An alternative base address for a utility to attach the server shared memory segments.

```
>>-setenv--IFX_XFER_SHMBASE---address-----><
```

address

Valid address in hexadecimal

After the database server allocates shared memory, the database server might allocate multiple contiguous OS shared memory segments. The client utility that connects to shared memory must attach all those OS segments contiguously also. The utility might have some other shared objects (for example, the xbsa library in onbar) loaded at the address where the server has shared memory segment attached. To workaround this situation, you can specify a different base address in the environment variable IFX_XFER_SHMBASE for the utility to attach the shared memory segments. The onstat, onmode, and oncheck utilities must attach to exact same shared memory base as oninit. Setting IFX_XFER_SHMBASE is not an option for these utilities.

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IMCADMIN environment variable

The **IMCADMIN** environment variable supports the **imcadmin** administrative tool by specifying the name of a database server through which **imcadmin** can connect to MaxConnect. For **imcadmin** to operate correctly, you must set IMCADMIN before you use any IBM® Informix® products.

```
>>-setenv--IMCADMIN--dbservername-----><
```

dbservername

is the name of a database server.

Here *dbservername* must be listed in the **sqlhosts** file on the computer where the MaxConnect runs. MaxConnect uses this setting to obtain the following connectivity information from the **sqlhosts** file:

- Where the administrative listener port must be established
- The network protocol that the specified database server uses
- The host name of the system where the specified database server is located

You cannot use the **imcadmin** tool unless **IMCADMIN** is set to a valid database server name.

For more information about using **IMCADMIN**, see *IBM Informix MaxConnect User's Guide*.

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IMCCONFIG environment variable

The **IMCCONFIG** environment variable specifies a nondefault filename, and optionally a pathname, for the MaxConnect configuration file. On UNIX systems that support the C shell, this variable can be set by the following command.

```
>>-setenv--IMCCONFIG--pathname-----><
```

pathname

is a full pathname or a simple filename.

When the setting is a filename that is not qualified by a full pathname, MaxConnect searches for the specified file in the **\$INFORMIXDIR/etc/** directory. Thus, if you set **IMCCONFIG** to **IMCconfig.imc2**, MaxConnect searches for **\$INFORMIXDIR/etc/IMCconfig.imc2** as its configuration file.

If the **IMCCONFIG** environment variable is not set, MaxConnect searches by default for **\$INFORMIXDIR/etc/IMCconfig** as its configuration file.

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IMCSERVER environment variable

The **IMCSERVER** environment variable specifies the name of a database server entry in the **sqlhosts** file that contains information about connectivity.

The database server can be either local or remote. On UNIX systems that support the C shell, the **IMCSERVER** environment variable can be set by the command.

```
>>-setenv--IMCSERVER--dbservername-----><
```


dbservername

is the valid name of a database server.

Here *dbservername* must be the name of a database server in the **sqlhosts** file. For more information about **sqlhosts** settings with MaxConnect, see your *IBM Informix Administrator's Guide*. You cannot use MaxConnect unless **IMCSERVER** is set to a valid database server name.

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INFORMIXC environment variable (UNIX)

The INFORMIXC environment variable specifies the filename or pathname of the C compiler to be used to compile files that IBM® Informix® ESQL/C generates. The setting takes effect only during the C compilation stage.

If INFORMIXC is not set, the default compiler on most systems is **cc**.

Tip: On Windows, you pass either -mcc or -bcc options to the *esql* preprocessor to use either the Microsoft or Borland C compilers.

```
>>-setenv--INFORMIXC--+-compiler-+-----><
                        '-pathname-'
```

compiler

The file name of the C compiler.

pathname

The full path name of the C compiler.

For example, to specify the GNU C compiler, enter the following command:

```
setenv INFORMIXC gcc
```

Important: If you use **gcc**, be aware that the database server assumes that strings are writable, so you must compile by using the -fwritable-strings option. Failure to do so can produce unpredictable results, possibly including core dumps.

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INFORMIXCMNAME environment variable

If the Connection Manager raises an event alarm, the **INFORMIXCMNAME** environment variable is used to store the name of the Connection Manager instance that raised the alarm. The environment variable is set automatically by the Connection Manager.

The **INFORMIXCMNAME** environment variable corresponds to the NAME parameter in the Connection Manager configuration file. The environment variable is used by the **CMALARMPROGRAM** program to determine the Connection Manager instance responsible for the event alarm. You can also use the environment variable in your own Connection Manager event alarm handler.

The environment variable is set automatically by the Connection Manager and should not be modified.

Related reference:

[INFORMIXCMCONUNITNAME environment variable](#)

Related information:

[The oncmsm utility](#)

[Connection Manager event alarm IDs](#)

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INFORMIXCMCONUNITNAME environment variable

If the Connection Manager raises an event alarm, the **INFORMIXCMCONUNITNAME** environment variable is used to store the name of the Connection Manager connection unit that raised the alarm. The environment variable is set automatically by the Connection Manager.

The **INFORMIXCMCONUNITNAME** environment variable corresponds to the connection unit name parameter in the Connection Manager configuration file. The environment variable is used by the **CMALARMPROGRAM** program to determine the Connection Manager instance responsible for the event alarm. You can also use the environment variable in your own Connection Manager event alarm handler.

The environment variable is set automatically by the Connection Manager and should not be modified.

Related reference:

[INFORMIXCMNAME environment variable](#)

Related information:

[The oncmsm utility](#)

[Connection Manager event alarm IDs](#)

INFORMIXCONCSMCFG environment variable

Use the **INFORMIXCONCSMCFG** environment variable to specify the location of the **concsbm.cfg** file that describes communications support modules.

```
>>-setenv--INFORMIXCONCSMCFG--pathname-----><
```

pathname

specifies the full pathname of the **concsbm.cfg** file.

The following command specifies that the **concsbm.cfg** file is in **/usr/myfiles**:

```
setenv INFORMIXCONCSMCFG /usr/myfiles
```

You can also specify a different name for the file. The following example specifies a filename of **csbmconfig** in the same directory:

```
setenv INFORMIXCONCSMCFG /usr/myfiles/csbmconfig
```

The default location of the **concsbm.cfg** file is in **\$INFORMIXDIR/etc**. For more information about communications support modules and the contents of the **concsbm.cfg** file, see the *IBM Informix Administrator's Reference*.

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INFORMIXCONRETRY environment variable

The **INFORMIXCONRETRY** environment variable sets a limit on the maximum number of connection attempts that can be made to each database server by the client after the initial connection attempt fails. These attempts are made within the time limit that the **INFORMIXCONTIME** setting specifies.

```
>>-setenv--INFORMIXCONRETRY--count-----><
```

count

The number of additional attempts to connect to each database server after the initial connection attempt fails.

For example, the following command sets **INFORMIXCONRETRY** to specify three connection attempts after the initial attempt:

```
setenv INFORMIXCONRETRY 3
```

The default value for **INFORMIXCONRETRY** is one attempt after the initial connection attempt.

Order of precedence among INFORMIXCONRETRY settings

When you specify a setting for the **INFORMIXCONRETRY** client environment variable, it overrides any **INFORMIXCONRETRY** configuration parameter setting in the **onconfig** file.

If the **SET ENVIRONMENT** statement specifies a setting for the **INFORMIXCONRETRY** session environment option, however, the SQL statement setting overrides the **INFORMIXCONRETRY** client environment variable setting for subsequent connection attempts during the current session. The **SET ENVIRONMENT** **INFORMIXCONRETRY** setting has no effect on other sessions.

In summary, this is the ascending order (lowest to highest) of the methods for setting a limit on attempts for a connection to a database server:

- **INFORMIXCONRETRY** configuration parameter
- **INFORMIXCONRETRY** client environment variable
- **SET ENVIRONMENT** **INFORMIXCONRETRY** statement of SQL

The **INFORMIXCONTIME** setting takes precedence over the **INFORMIXCONRETRY** setting. Connection attempts can end after the **INFORMIXCONTIME** value is exceeded, but before the **INFORMIXCONRETRY** value is reached. For more information about restricting the time available to establish a connection to a database server, see [INFORMIXCONTIME environment variable](#)

Related reference:

[INFORMIXCONRETRY configuration parameter](#)

Related information:

[INFORMIXCONRETRY session environment option](#)

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INFORMIXCONTIME environment variable

The **INFORMIXCONTIME** environment variable specifies the number of seconds the **CONNECT** statement attempts to establish a connection to a database server before returning an error. If you set no value, the default of 60 seconds can typically support a few hundred concurrent client connections. However, some systems

might encounter few connection errors with a value as low as 15. The total distance between nodes, hardware speed, the volume of traffic, and the concurrency level of the network can all affect what value you should set to optimize INFORMIXCONTIME.

The INFORMIXCONTIME and INFORMIXCONRETRY environment variables let you configure your client-side connection capability to retry the connection instead of returning a **-908** error.

```
>>--setenv--INFORMIXCONTIME--seconds-----><
```

seconds

Represents the minimum number of seconds spent in attempts to establish a connection to a database server.

For example, enter this command to set INFORMIXCONTIME to 60 seconds:

```
setenv INFORMIXCONTIME 60
```

If INFORMIXCONTIME is set to 60 and INFORMIXCONRETRY is set to 3, attempts to connect to the database server (after the initial attempt at 0 seconds) are made at 20, 40, and 60 seconds, if necessary, before aborting. This 20-second interval is the result of INFORMIXCONTIME divided by INFORMIXCONRETRY. If you set the INFORMIXCONTIME value to zero, the database server automatically uses the default value of 60 seconds.

If the CONNECT statement must search DBPATH, the INFORMIXCONRETRY setting specifies the number of additional connection attempts that can be made for each database server entry in DBPATH.

- All appropriate servers in the DBPATH setting are accessed at least once, even if the INFORMIXCONTIME value is exceeded. Thus, the CONNECT statement might take longer than the INFORMIXCONTIME time limit to return an error that indicates connection failure or that the database was not found.
- The INFORMIXCONTIME value is divided among the number of database server entries that are specified in DBPATH. Thus, if DBPATH contains numerous servers, increase the INFORMIXCONTIME value accordingly. For example, if DBPATH contains three entries, to spend at least 30 seconds attempting each connection, set INFORMIXCONTIME to 90.

The INFORMIXCONTIME and INFORMIXCONRETRY environment variables can be modified with the **onutil** SET command, as in the following example:

```
% onutil
1> SET INFORMIXCONTIME 120;
Dynamic Configuration completed successfully
2> SET INFORMIXCONRETRY 10;
Dynamic Configuration completed successfully
```

Order of precedence among INFORMIXCONTIME settings

When you specify a setting for the INFORMIXCONTIME client environment variable, it overrides the INFORMIXCONTIME configuration parameter settings in the onconfig file for the current session.

If the SET ENVIRONMENT statement specifies a setting for the INFORMIXCONRETRY session environment option, however, the SQL statement setting overrides the INFORMIXCONRETRY client environment variable setting for subsequent connection attempts during the current session. The SET ENVIRONMENT INFORMIXCONRETRY setting has no effect on other sessions.

In summary, this is the ascending order (lowest to highest) of the methods for setting an upper limit on the amount of time that a CONNECT statement can spend attempting to connect to a database server:

- INFORMIXCONTIME configuration parameter
- INFORMIXCONTIME client environment variable
- SET ENVIRONMENT INFORMIXCONTIME statement of SQL.

INFORMIXCONTIME takes precedence over the INFORMIXCONRETRY setting. Connection attempts can end after the INFORMIXCONTIME value is exceeded, but before the INFORMIXCONRETRY value is reached.

Related information:

[INFORMIXCONTIME session environment option](#)

[INFORMIXCONTIME configuration parameter](#)

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INFORMIXCPPMAP environment variable

Set the INFORMIXCPPMAP environment variable to specify the fully qualified pathname of the map file for C++ programs. Information in the map file includes the database server type, the name of the shared library that supports the database object or value object type, the library entry point for the object, and the C++ library for which an object was built.

```
>>--setenv--INFORMIXCPPMAP--pathname-----><
```

pathname

The directory path where the C++ map file is stored.

The map file is a text file that can have any filename. You can specify several map files, separated by colons (:) on UNIX or semicolons (;) on Windows.

On UNIX, the default map file is \$INFORMIXDIR/etc/c++map. On Windows, the default map file is %INFORMIXDIR%\etc\c++map.

INFORMIXDIR environment variable

The **INFORMIXDIR** environment variable specifies the directory that contains the subdirectories in which your product files are installed. You must always set **INFORMIXDIR**. Verify that **INFORMIXDIR** is set to the full pathname of the directory in which you installed your database server. If you have multiple versions of a database server, set **INFORMIXDIR** to the appropriate directory name for the version that you want to access. For information about when to set **INFORMIXDIR**, see your *IBM Informix Installation Guide*.

```
>>-setenv--INFORMIXDIR--pathname-----><
```

pathname

is the directory path where the product files are installed.

To set **INFORMIXDIR** to **usr/informix/**, for example, as the installation directory, enter the following command:

```
setenv INFORMIXDIR /usr/informix
```

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INFORMIXSERVER environment variable

The **INFORMIXSERVER** environment variable specifies the default database server to which an explicit or implicit connection is made by an SQL API client, the DB-Access utility, or other IBM® Informix® products.

This environment variable must be set before you can use IBM Informix client products. It has the following syntax.

```
>>-setenv--INFORMIXSERVER--dbservername-----><
```

dbservername

is the name of the default database server.

The value of **INFORMIXSERVER** can be a local or remote server, but must correspond to a valid *dbservername* entry in the **\$INFORMIXDIR/etc/sqlhosts** file on the computer running the application. The *dbservername* must begin with a lower-case letter and cannot exceed 128 bytes. It can include any printable characters except uppercase characters, field delimiters (blank space or tab), the newline character, and the hyphen (or minus) symbol.

For example, this command specifies the **coral** database server as the default:

```
setenv INFORMIXSERVER coral
```

INFORMIXSERVER specifies the database server to which an application connects if the CONNECT DEFAULT statement is executed. It also defines the database server to which an initial implicit connection is established if the first statement in an application is not a CONNECT statement.

Important: You must set **INFORMIXSERVER** even if the application or DB-Access does not use implicit or explicit default connections.

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INFORMIXSHMBASE environment variable (UNIX)

The **INFORMIXSHMBASE** environment variable affects only client applications connected to IBM® Informix® databases that use the interprocess communications (IPC) shared-memory (**ipcshm**) protocol.

Important: Resetting **INFORMIXSHMBASE** requires a thorough understanding of how the application uses memory. Normally you do not reset **INFORMIXSHMBASE**. **INFORMIXSHMBASE** specifies where shared-memory communication segments are attached to the client process so that client applications can avoid collisions with other memory segments that it uses. If you do not set **INFORMIXSHMBASE**, the memory address of the communication segments defaults to an implementation-specific value such as 0x800000.

```
>>-setenv--INFORMIXSHMBASE--value-----><
```

value

is an integer (in KB) used to calculate the memory address.

The database server calculates the memory address where segments are attached by multiplying the value of **INFORMIXSHMBASE** by 1,024. For example, on a system that uses the C shell, you can set the memory address to the value 0x800000 by entering the following command:

```
setenv INFORMIXSHMBASE 8192
```

For more information, see your *IBM Informix Administrator's Guide* and the *IBM Informix Administrator's Reference*.

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INFORMIXSQLHOSTS environment variable

The INFORMIXSQLHOSTS environment variable specifies where the SQL client or the database server can find connectivity information.

```
>>-setenv--INFORMIXSQLHOSTS--pathname-----><
```

pathname

The full path name of the connectivity information file.

UNIX: Default = \$INFORMIXDIR/etc/sqlhosts

Windows server: Default = %INFORMIXDIR%\etc\sqlhosts.%INFORMIXSERVER%

For example, the following command overrides the default location and specifies that the mysqlhosts file is in the /work/envt directory:

```
setenv INFORMIXSQLHOSTS /work/envt/mysqlhosts
```

Windows client: The INFORMIXSQLHOSTS environment variable points to the computer whose registry contains the SQLHOSTS subkey. For example, the following command instructs the Windows client to look for connectivity information in the registry of a computer named **arizona**:

```
set INFORMIXSQLHOSTS = \\arizona
```

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INFORMIXSTACKSIZE environment variable

The **INFORMIXSTACKSIZE** environment variable specifies the stack size (in KB) that is applied to all client processes. Any value that you set for INFORMIXSTACKSIZE in the client environment is ignored by the database server.

```
>>-setenv--INFORMIXSTACKSIZE--size-----><
```

size

is an integer, setting the stack size (in KB) for SQL client threads.

For example, to decrease the **INFORMIXSTACKSIZE** to 20 KB, enter the following command:

```
setenv INFORMIXSTACKSIZE 20
```

If **INFORMIXSTACKSIZE** is not set, the stack size is taken from the database server configuration parameter STACKSIZE or else defaults to a platform-specific value. The default stack size value for the primary thread of an SQL client is 32 KB for nonrecursive database activity.

Warning: For instructions on setting this value, see the *IBM Informix Administrator's Reference*. If you incorrectly set the value of **INFORMIXSTACKSIZE**, it can cause the database server to fail.

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INFORMIXTERM environment variable (UNIX)

The INFORMIXTERM environment variable specifies whether DB-Access should use the information in the terminfo directory or the termcap file.

On character-based systems, the terminfo directory and termcap file determine terminal-dependent keyboard and screen capabilities, such as the operation of function keys, color and intensity attributes in screen displays, and the definition of window borders and graphic characters.

```
>>-setenv--INFORMIXTERM--+-terminfo-+-----><
                        '-termcap--'
```

If INFORMIXTERM is not set, the default setting is terminfo.

The terminfo directory contains a file for each terminal name that has been defined. The terminfo setting for INFORMIXTERM is supported only on computers that provide full support for the UNIX System V terminfo library. For details, see the machine notes file for your product.

When DB-Access is installed on your system, a termcap file is placed in the **etc** subdirectory of \$INFORMIXDIR. This file is a superset of an operating-system **termcap** file. You can use the **termcap** file that the database server supplies, the system termcap file, or a termcap file that you create. You must set the TERMCAP environment variable if you do not use the default termcap file. For information about setting the TERMCAP environment variable, see [TERMCAP environment variable \(UNIX\)](#).

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INF_ROLE_SEP environment variable

The `INF_ROLE_SEP` environment variable configures the security feature of role separation when the database server is installed or reinstalled on UNIX systems. Role separation enforces separating administrative tasks by people who run and audit the database server. After the installation is complete, `INF_ROLE_SEP` has no effect. If `INF_ROLE_SEP` is not set, then user **informix** (the default) can perform all administrative tasks.

```
>>-setenv--INF_ROLE_SEP--n-----><
```

n
is any positive integer.

On Windows, the install process asks whether you want to enable role separation regardless of the setting of `INF_ROLE_SEP`. To enable role separation for database servers on Windows, select the role-separation option during installation.

If `INF_ROLE_SEP` is set when IBM® Informix® is installed on a UNIX platform, role separation is implemented and a separate group is specified to serve each of the following responsibilities:

- The Database Server Administrator (DBSA)
- The Audit Analysis Officer (AAO)
- The standard user

On UNIX, you can establish role separation by changing the group that owns the `aadir`, `dbsadir`, or etc directories at any time after the installation is complete. You can disable role separation by resetting the group that owns these directories to **informix**. You can have role separation enabled, for example, for the Audit Analysis Officer (AAO) without having role separation enabled for the Database Server Administrator (DBSA).

For more information about the security feature of role separation, see the *IBM Informix Security Guide*. To learn how to configure role separation when you install your database server, see your *IBM Informix Installation Guide*.

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INTERACTIVE_DESKTOP_OFF environment variable (Windows)

This environment variable lets you prevent interaction with the Windows desktop when an SPL routine executes a `SYSTEM` command.

```
>>-setenv--INTERACTIVE_DESKTOP_OFF--1+-----><
                                     '-0-'
```

If **INTERACTIVE_DESKTOP_OFF** is 1 and an SPL routine attempts to interact with the desktop (for example, with the `notepad.exe` or `cmd.exe` program), the routine fails unless the user is a member of the **Administrators** group.

The valid settings (1 or 0) have the following effects:

- 1
Prevents the database server from acquiring desktop resources for the user executing the stored procedure
- 0
SYSTEM commands in a stored procedure can interact with the desktop. This is the default value.

Setting **INTERACTIVE_DESKTOP_OFF** to 1 allows an SPL routine that does not interact with the desktop to execute more quickly. This setting also allows the database server to simultaneously call a greater number of `SYSTEM` commands because the command no longer depends on a limited operating- system resource (Desktop and WindowStation handles).

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JAR_TEMP_PATH environment variable

Set the **JAR_TEMP_PATH** variable to specify a non-default local file system location where jar management procedures such as `install_jar()` and `replace_jar()` can store temporary **.jar** files of the Java™ virtual machine.

```
>>-setenv--JAR_TEMP_PATH--pathname-----><
```

pathname
specifies a local directory for temporary **.jar** files.

This directory must have read and write permissions for the user who starts the database server. If the **JAR_TEMP_PATH** environment variable is not set, temporary copies of **.jar** files are stored in the **/tmp** directory of the local file system for the database server.

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JAVA_COMPILER environment variable

You can set the `JAVA_COMPILER` environment variable in the Java™ virtual machine environment to disable JIT compilation.

```
>>-setenv--JAVA_COMPILER--+-none-+-----><
                               '-NONE-'
```

The `NONE` and `none` settings are equivalent. On UNIX systems that support the C shell and on which `JAVA_COMPILER` has been set to `NONE` or `none`, you can enable the JIT compiler for the JVM environment by the following command:

```
unset JAVA_COMPILER
```

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JVM_MAX_HEAP_SIZE environment variable

The `JVM_MAX_HEAP_SIZE` environment variable can set a non-default upper limit on the size of the heap for the Java™ virtual machine.

```
>>-setenv--JVM_MAX_HEAP_SIZE -size-----><
```

size

is a positive integer that specifies the maximum size (in megabytes).

For example, the following command sets the maximum heap size at 12 MB:

```
set JVM_MAX_HEAP_SIZE 12
```

If you do not set `JVM_MAX_HEAP_SIZE`, 16 MB is the default maximum size.

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LD_LIBRARY_PATH environment variable (UNIX)

The `LD_LIBRARY_PATH` environment variable tells the shell on Solaris systems which directories to search for client or shared IBM® Informix® general libraries. You must specify the directory that contains your client libraries before you can use the product.

```

               .-:-----
               v      |
>>-setenv--LD_LIBRARY_PATH--$PATH:---pathname-+-----><
```

pathname

Specifies the search path for the library.

For INTERSOLV DataDirect ODBC Driver on AIX®, set `LIBPATH`. For INTERSOLV DataDirect ODBC Driver on HP-UX, set `SHLIB_PATH`.

The following example sets the `LD_LIBRARY_PATH` environment variable to the directory:

```
setenv LD_LIBRARY_PATH
${INFORMIXDIR}/lib:${INFORMIXDIR}/lib/esql:$LD_LIBRARY_PATH
```

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LIBPATH environment variable (UNIX)

The `LIBPATH` environment variable tells the shell on AIX® systems which directories to search for dynamic-link libraries for the INTERSOLV DataDirect ODBC Driver. You must specify the full path name for the directory where you installed the product.

```

               .-:-----
               v      |
>>-setenv--LIBPATH---pathname-+-----><
```

pathname

Specifies the search path for the libraries.

On Solaris, set `LD_LIBRARY_PATH`. On HP-UX, set `SHLIB_PATH`.

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NODEFDAC environment variable

Enabling NODEFDAC applies the ANSI-compliant restrictions on default access privileges for the PUBLIC group when tables or Owner-mode user-defined routines are created in databases that are not ANSI-compliant.

In a database that is not ANSI-compliant, when the **NODEFDAC** environment variable enabled by setting it to *yes*,

- the database server withholds default table access privileges from PUBLIC when a new table is created,
- and also withholds the default Execute privilege from PUBLIC when an owner-privileged UDR is created.

```
>>-setenv--NODEFDAC---yes-----><
```

yes

prevents default table privileges (Select, Insert, Update, and Delete) from being granted to PUBLIC on new tables in a database that is not ANSI-compliant. This setting also prevents the Execute privilege from being granted to PUBLIC by default when a new user-defined routine is created in Owner mode.

The *yes* setting is case sensitive, and is also sensitive to leading and trailing blank spaces. Including uppercase letters or blank spaces in the setting is equivalent to leaving **NODEFDAC** unset. When **NODEFDAC** is not set, or if it is set to any value besides *yes*, default privileges on tables and Owner-mode UDRs are granted to PUBLIC by default when the table or UDR is created in a database that is not ANSI-compliant. The setting *YES*, for example, disables **NODEFDAC**.

Enabling **NODEFDAC** has no effect in an ANSI-compliant databases.

Important: Enabling **NODEFDAC** withholds default table or routine privileges from PUBLIC when the object is created, but the **NODEFDAC** setting cannot prevent the PUBLIC group from being granted the same privileges by a user who holds the necessary access privileges on the new table or on the new UDR.

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ONCONFIG environment variable

The ONCONFIG environment variable specifies the name of the active file, called the onconfig file, which holds the configuration parameters for the database server.

This file is read as input during the initialization procedure. After you prepare your onconfig configuration file, set the ONCONFIG environment variable to the name of this file.

```
>>-setenv--ONCONFIG--filename-----><
```

filename

is the name of your onconfig file in the %INFORMIXDIR%\etc\%ONCONFIG% or \$INFORMIXDIR/etc/\$ONCONFIG directory
This file contains the configuration parameters for your database.

To prepare the onconfig file, make a copy of the onconfig.std file and modify the copy. Name the onconfig file so that it can easily be related to a specific database server. If you have multiple instances of a database server, each instance *must* have its own uniquely named onconfig file.

If the ONCONFIG environment variable is not set, the database server reads the configuration values from the onconfig file during initialization.

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ONINIT_STDOUT environment variable (Windows)

The ONINIT_STDOUT environment variable specifies a path and file name in which output from the **oninit** command is stored.

While it is not generally necessary to view output from the **oninit** command, it might be necessary in certain situations, such as when using the -v (verbose) option or when you want to see output from an unhandled exception in a process launched within a virtual processor. When the value of ONINIT_STDOUT is set to the name of a file, output from the **oninit** command is written to the file.

```
>>-set--ONINIT_STDOUT\--path\filename-----><
```

You can set the ONINIT_STDOUT environment variable as a system variable in Control Panel > System > Advanced > Environment Variables. If the IBM® Informix® service is configured to log on as user **informix**, start the service using the **starts** command after setting the environment variable. Note, however, that because environment variables are read from the system when the service is started, if the service is set to log on as the local system user, you must restart your computer for the environment variable to take effect. Because the local system user is effectively logged on at all times, environment variables are refreshed only when the operating system is restarted.

For example, if the environment variable set to C:\temp\oninit_out.txt, you can start the server with the verbose option with the following command:

```
starts %INFORMIXSERVER% -v
```

The **oninit** messages are saved to the C:\temp\oninit_out.txt file.

OPTCOMPIND environment variable

You can set the **OPTCOMPIND** environment variable so that the optimizer can select the appropriate join method.

```
>>-setenv--OPTCOMPIND--+-2-+-----><
                        '-0-'
```

- 0 A nested-loop join is preferred, where possible, over a sort-merge join or a hash join.
- 1 When the isolation level is *not* Repeatable Read, the optimizer behaves as in setting 2; otherwise, the optimizer behaves as in setting 0.
- 2 Nested-loop joins are not necessarily preferred. The optimizer bases its decision purely on costs, regardless of transaction isolation mode.

When **OPTCOMPIND** is not set, the database server uses the OPTCOMPIND value from the ONCONFIG configuration file. When neither the environment variable nor the configuration parameter is set, the default value is 2.

On IBM® Informix®, the SET ENVIRONMENT OPTCOMPIND statement can set or reset **OPTCOMPIND** dynamically at runtime. This overrides the current **OPTCOMPIND** value (or the ONCONFIG configuration parameter OPTCOMPIND) for the current user session only. For more information about the SET ENVIRONMENT OPTCOMPIND statement of SQL see the *IBM Informix Guide to SQL: Syntax*.

For more information about the ONCONFIG configuration parameter OPTCOMPIND, see the *IBM Informix Administrator's Reference*. For more information about the different join methods that the optimizer uses, see your *IBM Informix Performance Guide*.

OPTMSG environment variable

Set the OPTMSG environment variable at runtime before you start the IBM® Informix® ESQL/C application to enable (or disable) optimized message transfers (message chaining) for all SQL statements in the application.

```
>>-setenv--OPTMSG--+-0-+-----><
```

- 0 disables optimized message transfers.
- 1 enables optimized message transfers and implements the feature for any subsequent connection.

The default value is 0 (zero), which explicitly disables message chaining. You might want, for example, to disable optimized message transfers for statements that require immediate replies, for debugging, or to ensure that the database server processes all messages before the application terminates.

When you set OPTMSG within an application, you can activate or deactivate optimized message transfers for each connection or within each thread. To enable optimized message transfers, you must set OPTMSG before you establish a connection.

For more information about setting OPTMSG and defining related global variables, see the *IBM Informix ESQL/C Programmer's Manual*.

OPTOFC environment variable

Use the **OPTOFC** environment variable to enable optimize-OPEN-FETCH-CLOSE functionality in IBM® Informix® ESQL/C applications or other APIs (such as JDBC, ODBC, OLE DB, LIBDMI, and Lib C++) that use DECLARE and OPEN statements to establish a cursor.

```
>>-setenv--OPTOFC--+-0-+-----><
```

- 0 disables **OPTOFC** for all threads of the application.
- 1 enables **OPTOFC** for every cursor in every thread of the application.

The default value is 0 (zero).

You can set the **OPTOFC** environment variable on the client or server. If this environment variable is set on the server, then any application that does not explicitly set this environment variable uses the value that is set on the server.

The **OPTOFC** environment variable reduces the number of message requests between the application and the database server.

If you set **OPTOFC** from the shell, you must set it before you start the Informix ESQL/C application. For more information about enabling **OPTOFC** and related features, see the *IBM Informix ESQL/C Programmer's Manual*.

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OPT_GOAL environment variable (UNIX)

Set the OPT_GOAL environment variable in the user environment, before you start an application, to specify the query performance goal for the optimizer.

```
.- -1-.
>>-setenv--OPT_GOAL--+-0---+-----><
```

- 0
Specifies user-response-time optimization.
- 1
Specifies total-query-time optimization.

The default behavior is for the optimizer to use query plans that optimize the total query time.

You can also specify the optimization goal for individual queries with optimizer directives or for a session with the SET OPTIMIZATION statement.

Both methods take precedence over the OPT_GOAL environment variable setting. You can also set the OPT_GOAL configuration parameter for the IBM® Informix® system; this method has the lowest level of precedence.

For more information about optimizing queries for your database server, see your *IBM Informix Performance Guide*. For information about the SET OPTIMIZATION statement, see the *IBM Informix Guide to SQL: Syntax*.

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PATH environment variable

The UNIX PATH environment variable tells the shell which directories to search for executable programs. You must add the directory containing your IBM® Informix® product to your PATH setting before you can use the product.

```
.-:-----
v      |
>>-setenv--PATH--$PATH:----pathname-+-----><
```

pathname
Specifies the search path for the executable files.

Include a colon (:) separator between the path names on UNIX systems. (Use the semicolon (;) separator between path names on Windows systems.)

You can specify the search path in various ways. The PATH environment variable tells the operating system where to search for executable programs. You must include the directory that contains your IBM Informix product in your **path** setting before you can use the product. This directory should be located before \$INFORMIXDIR/bin, which you must also include.

For additional information about how to modify your path, see [Modifying an environment-variable setting](#).

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PDQPRIORITY environment variable

The **PDQPRIORITY** environment variable determines the degree of parallelism that the database server uses and affects how the database server allocates resources, including memory, processors, and disk reads.

```
>>-setenv--PDQPRIORITY--+-HIGH-----+-----><
                        +-LOW-----+
                        +-OFF-----+
                        '-resources-'
```

resources

Is an integer in the range 0 to 100. The value 1 is the same as LOW, and 100 is the same as HIGH. Values lower than 0 are set to 0 (OFF), and values greater than 100 are set to 100 (HIGH).
Value 0 is the same as OFF (for IBM® Informix® only).

Here the HIGH, LOW, and OFF keywords have the following effects:

HIGH

When the database server allocates resources among all users, it gives as many resources as possible to the query.

LOW

Data values are fetched from fragmented tables in parallel.

OFF

PDQ processing is turned off (for IBM Informix only).

Usually, the more resources a database server uses, the better its performance for a given query. If the server uses too many resources, however, contention for the resources can take resources away from other queries, resulting in degraded performance. For more information about performance considerations for **PDQPRIORITY**, see the *IBM Informix Performance Guide*.

An application can override the setting of this environment variable when it issues the SQL statement SET PDQPRIORITY, as the *IBM Informix Guide to SQL: Syntax* describes.

- [Using PDQPRIORITY with Informix](#)

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Using PDQPRIORITY with Informix

The *resources* value specifies the query priority level and the amount of resources that the database server uses to process the query.

When PDQPRIORITY is not set, the default value is OFF.

When PDQPRIORITY is set to HIGH, IBM® Informix® determines an appropriate value to use for PDQPRIORITY based on several criteria. These include the number of available processors, the fragmentation of tables queried, the complexity of the query, and additional factors.

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PLCONFIG environment variable

The PLCONFIG environment variable specifies the name of the configuration file that the High Performance Loader (HPL) uses. This file must be located in the \$INFORMIXDIR/etc directory. If the PLCONFIG environment variable is not set, then \$INFORMIXDIR/etc/plconfig is the default configuration file.

```
>>-setenv--PLCONFIG--filename-----><
```

filename

Specifies the simple file name of the configuration file that the High-Performance Loader uses.

For example, to specify the \$INFORMIXDIR/etc/custom.cfg file as the configuration file for the High-Performance Loader, enter the following command:

```
setenv PLCONFIG custom.cfg
```

For more information, see the *IBM Informix High-Performance Loader User's Guide*.

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PLOAD_LO_PATH environment variable

The **PLOAD_LO_PATH** environment variable lets you specify the pathname for smart-large-object handles (which identify the location of smart large objects such as BLOB and CLOB data types).

```
>>-setenv--PLOAD_LO_PATH--pathname-----><
```

pathname

specifies the directory for the smart-large-object handles.

If **PLOAD_LO_PATH** is not set, the default directory is /tmp.

For more information, see the *IBM Informix High-Performance Loader User's Guide*.

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PLOAD_SHMBASE environment variable

The PLOAD_SHMBASE environment variable lets you specify the shared-memory address at which the High Performance Loader (HPL) **onpload** processes will attach. If PLOAD_SHMBASE is not set, the HPL determines which shared-memory address to use.

```
>>-setenv--PLOAD_SHMBASE--value-----><
```

value

Used to calculate the shared-memory address.

If the **onpload** utility cannot attach, an error is issued, and you must specify a new value.

The **onpload** utility tries to determine at which address to attach, as follows in the following (descending) order:

1. Attach at the same address (SHMBASE) as the database server.
2. Attach beyond the database server segments.
3. Attach at the address specified in PLOAD_SHMBASE.

Tip: It is recommended that you let the HPL decide where to attach and that you set PLOAD_SHMBASE only if necessary to avoid shared-memory collisions between **onpload** and the database server.

For more information, see the *IBM Informix High-Performance Loader User's Guide*.

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PSM_ACT_LOG environment variable

Use the PSM_ACT_LOG environment variable to specify the location of the IBM® Informix® Primary Storage Manager activity log for your environment, for example, for a single session.

```
>>-setenv--PSM_ACT_LOG -pathname-----><
```

pathname

The full path name for the location of the \$INFORMIXDIR/psm_act.log. If you specify a file name only, the storage manager creates the activity log in the working directory in which you started the storage manager.

The PSM_ACT_LOG environment variable overrides the value of the PSM_ACT_LOG configuration parameter.

Related information:

[PSM_ACT_LOG configuration parameter](#)

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PSM_CATALOG_PATH environment variable

Use the PSM_CATALOG_PATH environment variable to specify the location of the IBM® Informix® Primary Storage Manager catalog tables for your environment, for example, for a single session.

```
>>-setenv--PSM_CATALOG_PATH -pathname-----><
```

pathname

The full path name for the location of the catalog table, which contain information about the pools, devices, and objects managed by the storage manager.

The PSM_CATALOG_PATH environment variable overrides the value of the PSM_CATALOG_PATH configuration parameter.

Related information:

[PSM_CATALOG_PATH configuration parameter](#)

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PSM_DBS_POOL environment variable

Use the PSM_DBS_POOL environment variable to change the name of the pool in which the IBM® Informix® Primary Storage Manager places backup and restore dbspace data for your environment, for example, for a single session.

```
>>-setenv--PSM_DBS_POOL -pool_name-----><
```

pool_name

The name of the storage manager pool.

The PSM_DBS_POOL environment variable overrides the value of the PSM_DBS_POOL configuration parameter.

Related information:

[PSM_DBS_POOL configuration parameter](#)

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PSM_DEBUG environment variable

Use the PSM_DEBUG environment variable to specify the amount of debugging information that prints in the Informix® Primary Storage Manager debug log for your environment, for example, for a single session.

```
>>-setenv--PSM_DEBUG -value-----><
```

value

- 0 = No debugging messages.
- 1 = Prints only internal errors.
- 2 = Prints information about the entry and exit of functions and prints internal errors.
- 3 = Prints the information specified by 1-2 with additional details.
- 4 = Prints information about parallel operations and the information specified by 1-3.
- 5 = Prints information about internal states in the Informix Primary Storage Manager.
- 6 = Prints the information specified by 1-5 with additional details.
- 7 = Prints information specified by 1-6 with additional details.
- 8 = Prints information specified by 1-7 with additional details.
- 9 = Prints all debugging information.

The PSM_DEBUG environment variable overrides the value of the PSM_DEBUG configuration parameter.

Related information:

[PSM_DEBUG configuration parameter](#)

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PSM_DEBUG_LOG environment variable

Use the PSM_DEBUG_LOG environment variable to specify the location of the IBM® Informix® Primary Storage Manager debug log for your environment, for example, for a single session.

```
>>-setenv--PSM_DEBUG_LOG -pathname-----><
```

pathname

The full path name for the location of the \$INFORMIXDIR/psm_debug.log. If you specify a file name only, the storage manager creates the debug log in the working directory in which you started the storage manager.

The PSM_DEBUG_LOG environment variable overrides the value of the PSM_DEBUG_LOG configuration parameter.

Related information:

[PSM_DEBUG_LOG configuration parameter](#)

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PSM_LOG_POOL environment variable

Use the PSM_LOG_POOL environment variable to change the name of the pool in which the IBM® Informix® Primary Storage Manager places backup and restore log data for your environment, for example, for a single session.

```
>>-setenv--PSM_LOG_POOL -pool_name-----><
```

pool_name

The name of the storage manager log pool.

The PSM_LOG_POOL environment variable overrides the value of the PSM_LOG_POOL configuration parameter.

Related information:

[PSM_LOG_POOL configuration parameter](#)

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PSORT_DBTEMP environment variable

The PSORT_DBTEMP environment variable specifies the location where the database server writes the temporary files that the PSORT_NPROCS environment variable uses to perform a sort.

```
      .-:-----  
      v      |  
>>-setenv--PSORT_DBTEMP---pathname-+-----><
```

pathname

The name of the UNIX directory used for intermediate writes during a sort.

To set the PSORT_DBTEMP environment variable to specify the directory (for example, /usr/leif/tempSORT), enter the following command:

```
setenv PSORT_DBTEMP /usr/leif/tempSORT
```

For maximum performance, specify directories that are located in file systems on different disks.

You might also want to consider setting the environment variable DBSPACETEMP to place temporary files used in sorting in dbspaces rather than operating-system files. See the discussion of the DBSPACETEMP environment variable in [DBSPACETEMP environment variable](#).

The database server uses the directory that PSORT_DBTEMP specifies, even if the environment variable PSORT_NPROCS is not set. For additional information about the PSORT_DBTEMP environment variable, see your *IBM Informix Administrator's Guide* and your *IBM Informix Performance Guide*.

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PSORT_NPROCS environment variable

The **PSORT_NPROCS** environment variable enables the database server to improve the performance of the parallel-process sorting package by allocating more threads for sorting.

Before the sorting package performs a parallel sort, make sure that the database server has enough memory for the sort.

```
>>-setenv--PSORT_NPROCS--threads-----><
```

threads

is an integer, specifying the maximum number of threads to be used to sort a query. This value cannot be greater than 10.

The following command sets **PSORT_NPROCS** to 4:

```
setenv PSORT_NPROCS 4
```

To disable parallel sorting, enter the following command:

```
unsetenv PSORT_NPROCS
```

It is recommended that you initially set **PSORT_NPROCS** to 2 when your computer has multiple CPUs. If subsequent CPU activity is lower than I/O activity, you can increase the value of **PSORT_NPROCS**.

Tip: If the **PDQPRIORITY** environment variable is not set, the database server allocates the minimum amount of memory to sorting. This minimum memory is insufficient to start even two sort threads. If you have not set **PDQPRIORITY**, check the available memory before you perform a large-scale sort (such as an index build) to make sure that you have enough memory.

- [Default PSORT_NPROCS values for detached indexes](#)
- [Default PSORT_NPROCS values for attached indexes](#)

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Default PSORT_NPROCS values for detached indexes

If the **PSORT_NPROCS** environment variable is set, the database server uses the specified number of sort threads as an upper limit for ordinary sorts. If **PSORT_NPROCS** is not set, parallel sorting does not take place. If you have a single-CPU virtual processor, the database server uses one thread for the sort. If **PSORT_NPROCS** is set to 0, the database server uses three threads for the sort.

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Default PSORT_NPROCS values for attached indexes

The default number of threads is different for attached indexes.

If the **PSORT_NPROCS** environment variable is set, you get the specified number of sort threads for each fragment of the index that is being built.

If **PSORT_NPROCS** is not set, or if it is set to 0, you get two sort threads for each fragment of the index unless you have a single-CPU virtual processor. If you have a single-CPU virtual processor, you get one sort thread for each fragment of the index.

For additional information about the **PSORT_NPROCS** environment variable, see your *IBM® Informix® Administrator's Guide* and your *IBM Informix Performance Guide*.

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RTREE_COST_ADJUST_VALUE environment variable

The **RTREE_COST_ADJUST_VALUE** environment variable specifies a coefficient that support functions of user-defined data types can use to estimate the cost of an R-tree index for queries on UDT columns.

```
>>-setenv--RTREE_COST_ADJUST_VALUE--value-----><
```

value

is a floating-point number, where $1 \leq \text{value} \leq 1000$, specifying a multiplier for estimating the cost of using an index on a UDT column.

For spatial queries, the I/O overhead tends to exceed by far the CPU cost, so by multiplying the uncorrected estimated cost by an appropriate *value* from this setting, the database server can make better cost-based decisions on how to implement queries on UDT columns for which an R-tree index exists.

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SHLIB_PATH environment variable (UNIX)

The **SHLIB_PATH** environment variable tells the shell on HP-UX systems which directories to search for dynamic-link libraries. This is used, for example, with the INTERSOLV DataDirect ODBC Driver. You must specify the full pathname for the directory where you installed the product.

```
          .-:-----  
          v |  
>>-setenv--SHLIB_PATH--$PATH:---pathname-+-----><
```

pathname

Specifies the search path for the libraries.

On Solaris systems, set **LD_LIBRARY_PATH**. On AIX® systems, set **LIBPATH**.

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SRV_FET_BUF_SIZE environment variable

Use the **SRV_FET_BUF_SIZE** environment variable to specify the size of the fetch buffer that the local database server uses in distributed DML transactions across database servers.

```
>>-setenv--SRV_FET_BUF_SIZE--size-----><
```

size

is a positive integer that is no greater than 1048576 (1 MiB), specifying the size (in bytes) of the fetch buffer that holds data retrieved by a cross-server distributed query.

For example, to set a buffer size to 5,000 bytes on a UNIX system that uses the C shell, set **SRV_FET_BUF_SIZE** by entering the following command:

```
setenv SRV_FET_BUF_SIZE 5000
```

When **SRV_FET_BUF_SIZE** is set to a valid value, the new value overrides the default value (or any previously set value) of **SRV_FET_BUF_SIZE**. The setting takes effect only when it is set in the starting environment of the database server.

When **SRV_FET_BUF_SIZE** is not set, the default setting for the fetch buffer is dependent on row size.

No error is raised if `SRV_FET_BUF_SIZE` is set to a value that is less than the default size, or that is greater than 1048576 (1MiB). If you specify a size for `SRV_FET_BUF_SIZE` that is greater than 1048576, the value is set to 1048576. In older 11.70 releases, up to and including 11.70.xC4, the upper limit is 32767.

A valid `SRV_FET_BUF_SIZE` setting is in effect only in cross-server DML transactions in which the local database server participates as the coordinator or as a subordinate database server.

- It has no effect, however, on queries that access only databases of the local server instance, and it does not affect the size of the fetch buffer in client-to-local-server communication.
- The processing of `BYTE` and `TEXT` objects is not affected by the `SRV_FET_BUF_SIZE` setting.
- Setting `SRV_FET_BUF_SIZE` for the environment of the local database server does not reset the fetch buffer size of remote server instances that coordinate or participate in cross-server DML transactions with the local server instance.

The greater the size of the buffer, the more rows can be returned, and the less frequently the local server must wait while the database server returns rows. A large buffer can improve performance when transferring a large amount of data between servers.

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STMT_CACHE environment variable

Use the `STMT_CACHE` environment variable to control the use of the shared-statement cache on a session.

This feature can reduce memory consumption and can speed query processing among different user sessions. Valid `STMT_CACHE` values are 1 and 0.

```
>>-setenv--STMT_CACHE--+-1-+-----><
                        '-0-'
```

- 1
 enables the SQL statement cache.
- 0
 disables the SQL statement cache.

Set the `STMT_CACHE` environment variable for applications that do not use the `SET STMT_CACHE` statement to control the use of the SQL statement cache. By default, a statement cache is disabled, but can be enabled through the `STMT_CACHE` parameter of the `onconfig.std` file or by the `SET STMT_CACHE` statement.

This environment variable has no effect if the SQL statement cache is disabled through the configuration file setting. Values set by the `SET STMT_CACHE` statement in the application override the `STMT_CACHE` setting.

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TERM environment variable (UNIX)

The `TERM` environment variable is used for terminal handling. It lets DB-Access (and other character-based applications) recognize and communicate with the terminal that you are using.

```
>>-setenv--TERM--type-----><
```

type
 Specifies the terminal type.

The terminal type specified in the `TERM` setting must correspond to an entry in the `termcap` file or `terminfo` directory.

Before you can set the `TERM` environment variable, you must obtain the code for your terminal from the database administrator.

For example, to specify the `vt100` terminal, set the `TERM` environment variable by entering the following command:

```
setenv TERM vt100
```

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TERMCAP environment variable (UNIX)

The `TERMCAP` environment variable is used for terminal handling. It tells DB-Access (and other character-based applications) to communicate with the `termcap` file instead of the `terminfo` directory.

```
>>-setenv--TERMCAP--pathname-----><
```

pathname
 Specifies the location of the `termcap` file.

The termcap file contains a list of various types of terminals and their characteristics. For example, to provide DB-Access terminal-handling information, which is specified in the /usr/informix/etc/termcap file, enter the following command:

```
setenv TERMCAP /usr/informix/etc/termcap
```

You can use set TERMCAP in any of the following ways. If several termcap files exist, they have the following (descending) order of precedence:

1. The termcap file that you create
2. The termcap file that the database server supplies (that is, \$INFORMIXDIR/etc/termcap)
3. The operating-system termcap file (that is, /etc/termcap)

If you set the TERMCAP environment variable, be sure that the INFORMIXTERM environment variable is set to termcap.

If you do not set the TERMCAP environment variable, the terminfo directory is used by default.

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TERMINFO environment variable (UNIX)

The TERMINFO environment variable is used for terminal handling.

The environment variable is supported only on platforms that provide full support for the terminfo libraries that System V and Solaris UNIX systems provide.

```
>>-setenv--TERMINFO--/usr/lib/terminfo-----><
```

TERMINFO tells DB-Access to communicate with the terminfo directory instead of the termcap file. The terminfo directory has subdirectories that contain files that pertain to terminals and their characteristics.

To set TERMINFO, enter the following command:

```
setenv TERMINFO /usr/lib/terminfo
```

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THREADLIB environment variable (UNIX)

Use the THREADLIB environment variable to compile multithreaded IBM® Informix® ESQL/C applications. A multithreaded Informix ESQL/C application lets you establish as many connections to one or more databases as there are threads. These connections can remain active while the application program executes.

The THREADLIB environment variable indicates which thread package to use when you compile an application. Currently only the Distributed Computing Environment (DCE) is supported.

```
>>-setenv--THREADLIB--DCE-----><
```

The THREADLIB environment variable is checked when the -thread option is passed to the Informix ESQL/C script when you compile a multithreaded Informix ESQL/C application. When you use the -thread option while compiling, the Informix ESQL/C script generates an error if THREADLIB is not set, or if THREADLIB is set to an unsupported thread package.

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TZ environment variable

The **TZ** environment variable is used for setting the time zone. It is used by various time functions to compute times relative to Coordinated Universal Time (UTC), formerly known as Greenwich Mean Time (GMT). The format is specified by the operating system.

```
>>-setenv--TZ--tzn-+-----+--hh-+-----+-----+-----+-----><
      +-  +-  ':-mm-+-----+-' '-dzn-'
      '-  -'      ':-ss-'
```

tzn

Three-letter time zone name, such as PST. You must specify the correct offset from local time to UTC (Universal Time Coordinated).

hh

A one- or two-digit difference in hours between UTC and local time. Optionally signed.

mm

Two-digit difference in minutes between UTC and local time.

ss

Two-digit difference in seconds between UTC and local time.

dzn

Three-letter daylight-saving-time zone, such as PDT. If daylight saving time is never in effect in the locality, set **TZ** without a value for *dzn*.

For example, if you use Pacific Standard Time with Pacific daylight savings time, set the **TZ** environment variable to `PST8PDT`. For more information on setting the **TZ** environment variable, see your operating system documentation.

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USETABLENAME environment variable

The **USETABLENAME** environment variable can prevent users from using a synonym to specify the *table* in ALTER TABLE or DROP TABLE statements. Unlike most environment variables, **USETABLENAME** is not required to be set to a value. It takes effect if you set it to any value, or to no value.

```
>>-setenv--USETABLENAME-----><
```

By default, ALTER TABLE or DROP TABLE statements accept a valid synonym for the name of the *table* to be altered or dropped. (In contrast, RENAME TABLE issues an error if you specify a synonym, as do the ALTER SEQUENCE, DROP SEQUENCE, and RENAME SEQUENCE statements, if you attempt to substitute a synonym for the *sequence* name in those statements.)

If you set **USETABLENAME**, an error results if a synonym is in ALTER TABLE or DROP TABLE statements. Setting **USETABLENAME** has no effect on the DROP VIEW statement, which accepts a valid synonym for the view.

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Appendixes

- [The stores_demo Database](#)
The **stores_demo** database contains a set of tables that describe an imaginary business and many of the examples in the IBM Informix documentation are based on this database.
- [The superstores_demo database](#)
The **superstores_demo** database illustrates an object-relational schema.

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The stores_demo Database

The **stores_demo** database contains a set of tables that describe an imaginary business and many of the examples in the IBM® Informix® documentation are based on this database.

The **stores_demo** database uses the default (U.S. English) locale and is not ANSI-compliant.

For information about how to create and populate the **stores_demo** database, see the *IBM Informix DB-Access User's Guide*. For information about how to design and implement a relational database, see the *IBM Informix Database Design and Implementation Guide*.

- [The stores_demo Database Map](#)
Some of the tables in the **stores_demo** database have relationships between them.

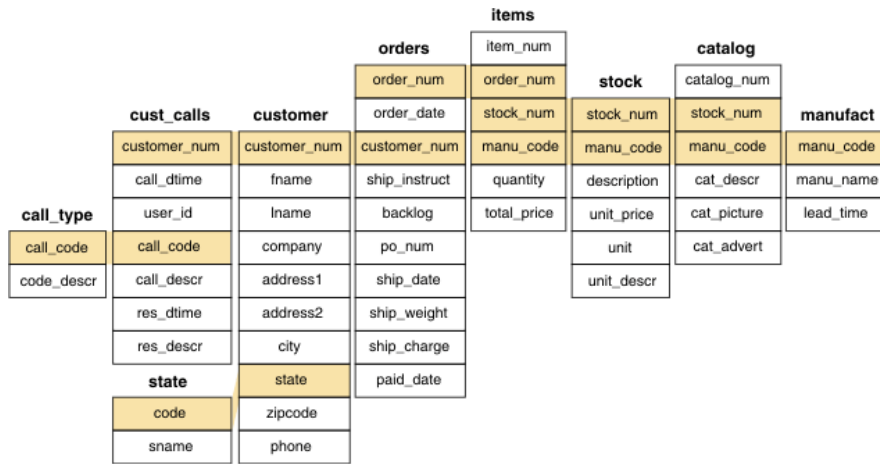
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The stores_demo Database Map

Some of the tables in the **stores_demo** database have relationships between them.

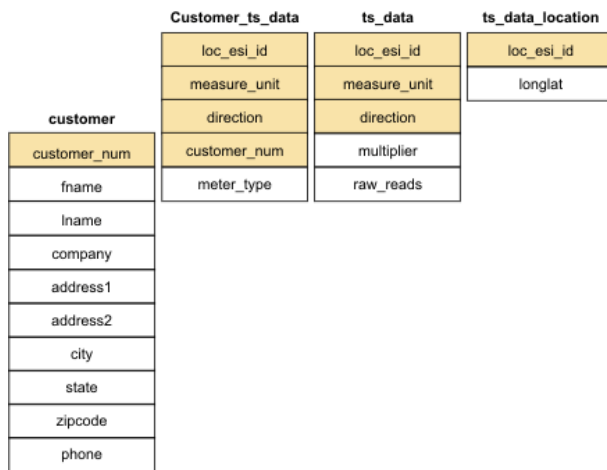
The following illustration displays the joins in the **stores_demo** database between customers, catalog orders, and customer calls. The shading that connects a column in one table to a column with the same name in another table indicates the relationships, or *joins*, between tables.

Figure 1. Joins between customers and catalog orders



The following illustration displays the joins in the **stores_demo** database between customers, electricity meter data, and location. The **Customer_ts_data**, **ts_data**, and **ts_data_location** tables contain time series data. You can prevent the creation of these time series tables when you create the demonstration database.

Figure 2. Joins between customers, electricity usage data, and location



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The superstores_demo database

The **superstores_demo** database illustrates an object-relational schema.

SQL files and user-defined routines (UDRs) that are provided with DB-Access let you derive the **superstores_demo** object-relational database.

The **superstores_demo** database uses the default locale and is not ANSI-compliant.

For information about how to create and populate the demonstration databases, including relevant SQL files, see the *IBM® Informix® DB-Access User's Guide*. For conceptual information about demonstration databases, see the *IBM Informix Database Design and Implementation Guide*.

- [Structure of the superstores_demo Tables](#)
Although many of the tables in the **superstores_demo** database have the same name as **stores_demo** tables, they are different.
- [User-defined routines and extended data types](#)
The **superstores_demo** database uses user-defined routines (UDRs) and extended data types.
- [Table Hierarchies](#)

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Structure of the superstores_demo Tables

Although many of the tables in the **superstores_demo** database have the same name as **stores_demo** tables, they are different.

The **superstores_demo** database includes the following tables. The tables are listed alphabetically, not in the order in which they are created.

- **call_type**
- **catalog**
- **cust_calls**

- customer
 - retail_customer
 - whlsale_customer
- items
- location
 - location_non_us
 - location_us
- manufact
- orders
- region
- sales_rep
- state
- stock
- stock_discount
- units

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User-defined routines and extended data types

The **superstores_demo** database uses user-defined routines (UDRs) and extended data types.

A UDR is a routine that you define that can be invoked within an SQL statement or another UDR. A UDR can either return values or not.

The data type system of IBM® Informix® is an extensible and flexible system that supports the creation of following kinds of data types:

- Extensions of existing data types by, redefining some of the behavior for data types that the database server provides
- Definitions of customized data types by a user

For information about creating and using UDRs and extended data types, see *IBM Informix User-Defined Routines and Data Types Developer's Guide*.

The **superstores_demo** database creates the *distinct* data type, percent, in a UDR, as follows:

```
CREATE DISTINCT TYPE percent AS DECIMAL(5,5);
DROP CAST (DECIMAL(5,5) AS percent);
CREATE IMPLICIT CAST (DECIMAL(5,5) AS percent);
The superstores_demo database creates the following named row types:
```

- location hierarchy:
 - location_t
 - loc_us_t
 - loc_non_us_t
- customer hierarchy:
 - name_t
 - customer_t
 - retail_t
 - whlsale_t
- orders table
 - ship_t

location_t definition

location_id	SERIAL
loc_type	CHAR(2)
company	VARCHAR(20)
street_addr	LIST (VARCHAR(25) NOT NULL)
city	VARCHAR(25)
country	VARCHAR(25)

loc_us_t definition

state_code	CHAR(2)
zip	ROW (code INTEGER, suffix SMALLINT)
phone	CHAR(18)

loc_non_us_t definition

province_code	CHAR(2)
zipcode	CHAR(9)
phone	CHAR(15)

name_t definition

first	VARCHAR(15)
last	VARCHAR(15)

customer_t definition

customer_num	SERIAL
customer_type	CHAR(1)
customer_name	name_t
customer_loc	INTEGER
contact_dates	LIST(DATETIME YEAR TO DAY NOT NULL)
cust_discount	percent
credit_status	CHAR(1)

retail_t definition

credit_num	CHAR(19)
expiration	DATE

whlsale_t definition

resale_license	CHAR(15)
terms_net	SMALLINT

ship_t definition

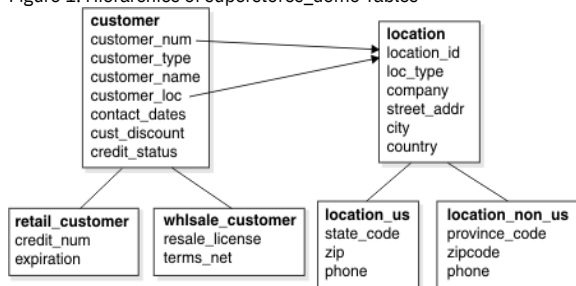
date	DATE
weight	DECIMAL(8,2)
charge	MONEY(6,2)
instruct	VARCHAR(40)

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Table Hierarchies

The following illustration shows how the hierarchical tables of the **superstores_demo** database are related. The foreign key and primary relationships between the two tables are indicated by shaded arrows that point from the **customer.custnum** and **customer.loc** columns to the **location.location_id** columns.

Figure 1. Hierarchies of superstores_demo Tables



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Guide to SQL: Tutorial

This publication shows how to use basic and advanced structured query language (SQL) to access and manipulate the data in your databases. It discusses the data manipulation language (DML) statements as well as triggers and stored procedure language (SPL) routines, which DML statements often use.

This publication is written for the following users:

- Database users
- Database administrators
- Database-application programmers

This publication assumes that you have the following background:

- A working knowledge of your computer, your operating system, and the utilities that your operating system provides
- Some experience working with relational databases or exposure to database concepts
- Some experience with computer programming

This publication is one of a series of publications that discusses the IBM® Informix® implementation of SQL. The *IBM Informix Guide to SQL: Syntax* contains all the syntax descriptions for SQL and SPL. The *IBM Informix Guide to SQL: Reference* provides reference information for aspects of SQL other than the language statements. The *IBM Informix Database Design and Implementation Guide* shows how to use SQL to implement and manage your databases.

- [Database concepts](#)
- [Compose SELECT statements](#)
- [Select data from complex types](#)

- [Functions in SELECT statements](#)
- [Compose advanced SELECT statements](#)
- [Modify data](#)
- [Access and modify data in an external database](#)
- [SQL programming](#)
- [Modify data through SQL programs](#)
- [Programming for a multiuser environment](#)
- [Create and use SPL routines](#)
- [Create and use triggers](#)

Database concepts

This chapter describes fundamental database concepts and focuses on the following topics:

- Data models
- Multiple users
- Database terminology
- SQL (Structured Query Language)

Your real use of a database begins with the SELECT statement, which [Compose SELECT statements](#), describes.

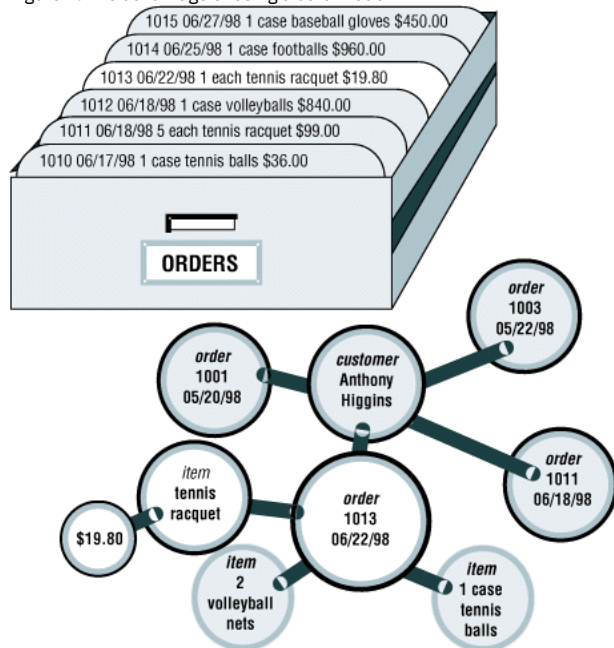
- [Illustration of a data model](#)
- [Concurrent use and security](#)
- [Important database terms](#)
- [Structured Query Language](#)
- [Summary](#)

Illustration of a data model

The principal difference between information collected in a database versus information collected in a file is the way the data is organized. A flat file is organized physically; certain items precede or follow other items. But the contents of a database are organized according to a *data model*. A data model is a plan, or map, that defines the units of data and specifies how each unit relates to the others.

For example, a number can appear in either a file or a database. In a file, it is simply a number that occurs at a certain point in the file. A number in a database, however, has a role that the data model assigns to it. The role might be a *price* that is associated with a *product* that was sold as one *item* of an *order* that a *customer* placed. Each of these components, price, product, item, order, and customer, also has a role that the data model specifies. For an illustration of a data model, see the following figure.

Figure 1. The advantage of using a data model



You design the data model when you create the database. You then insert units of data according to the plan that the model lays out. Some books use the term *schema* instead of *data model*.

- [Store data](#)
- [Query data](#)
- [Modify data](#)

Store data

Another difference between a database and a file is that the organization of the database is stored with the database.

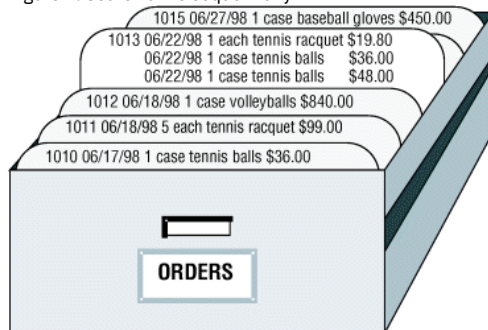
A file can have a complex inner structure, but the definition of that structure is not within the file; it is in the programs that create or use the file. For example, a document file that a word-processing program stores might contain detailed structures that describe the format of the document. However, only the word-processing program can decipher the contents of the file, because the structure is defined within the program, not within the file.

A data model, however, is contained in the database it describes. It travels with the database and is available to any program that uses the database. The model defines not only the names of the data items but also their data types, so a program can adapt itself to the database. For example, a program can find out that, in the current database, a price item is a decimal number with eight digits, two to the right of the decimal point; then it can allocate storage for a number of that type. How programs work with databases is the subject of [SQL programming](#), and [Modify data through SQL programs](#).

Query data

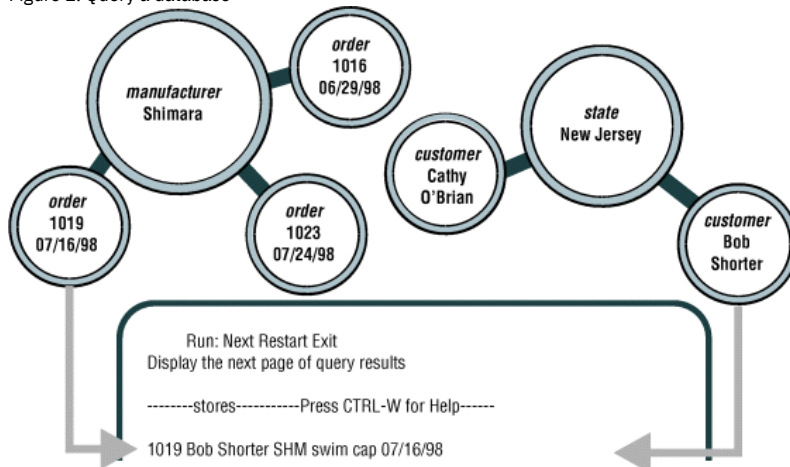
Another difference between a database and a file is the way you can access them. You can search a file sequentially, looking for particular values at particular physical locations in each line or record. That is, you might ask, "What records have the number 1013 in the first field?" The following figure shows this type of search.

Figure 1. Search a file sequentially



In contrast, when you query a database, you use the terms that the model defines. You can query the database with questions such as, "What *orders* have been placed for *products* made by the Shimara Corporation, by *customers* in New Jersey, with *ship dates* in the third quarter?" The following figure shows this type of query.

Figure 2. Query a database



In other words, when you access data that is stored in a file, you must state your question in terms of the physical layout of the file. When you query a database, you can ignore the arcane details of computer storage and state your query in terms that reflect the real world, at least to the extent that the data model reflects the real world.

[Compose SELECT statements](#), and [Compose advanced SELECT statements](#), discuss the language you use to make queries.

For information about how to build and implement your data model, see the *IBM® Informix® Database Design and Implementation Guide*.

Modify data

The data model also makes it possible to modify the contents of the database with less chance for error. You can query the database with statements such as, "Find every *stock item* with a *manufacturer* of Presta or Schraeder, and increase its *price* by 13 percent." You state changes in terms that reflect the meaning of the data. You do not have to waste time and effort thinking about details of fields within records in a file, so the chances for error are fewer.

The statements you use to modify stored data are covered in [Modify data](#).

Concurrent use and security

A database can be a common resource for many users. Multiple users can query and modify a database simultaneously. The database server (the program that manages the contents of all databases) ensures that the queries and modifications are done in sequence and without conflict.

Having concurrent users on a database provides great advantages but also introduces new problems of security and privacy. Some databases are private; individuals set them up for their own use. Other databases contain confidential material that must be shared, but only among a restricted group; still other databases provide public access.

- [Control database use](#)
- [Centralized management](#)

Control database use

IBM® Informix® database software provides the means to control database use. When you design a database, you can perform any of the following functions:

- Keep the database completely private
 - Open its entire contents to all users or to selected users
 - Restrict the selection of data that some users can view (different selections of data to different groups of users)
 - Allow specified users to view certain items, but not modify them
 - Allow specified users to add new data, but not modify old data
 - Allow specified users to modify all, or specified items of, existing data
 - Ensure that added or modified data conforms to the data model
- [Access-management strategies](#)

Access-management strategies

IBM® Informix® supports two access-management systems:

Label-Based Access Control (LBAC)

Label-Based Access Control is an implementation of Mandatory Access Control, which is typically used in databases that store highly sensitive data, such as systems maintained by armed forces or security services. The primary documentation of IBM Informix features relating to LBAC is the *IBM Informix Security Guide*. *IBM Informix Guide to SQL: Syntax* describes how LBAC security objects are created and maintained by the Database Security Administrator (DBSECADM). Only the Database Server Administrator (DBSA) can grant the DBSECADM role.

Discretionary Access Control (DAC)

Discretionary Access Control is a simpler system that involves less overhead than LBAC. Based on access privileges and roles, DAC is enabled in all databases, including those that implement LBAC.

- [Creating and granting a role](#)
- [Defining and granting privileges for a default role](#)
- [Built-in roles](#)

Creating and granting a role

To support DAC, the database administrator (DBA) can define *roles* and assign them to users to standardize the access privileges of groups of users who need access to the same database objects. When the DBA assigns privileges to that role, every user who is granted role holds those privileges when that role is activated. In order to activate a specific role, a user must issue the SET ROLE statement. The SQL statements used for defining and manipulating roles include: CREATE ROLE, DROP ROLE, GRANT, REVOKE, and SET ROLE.

For more information on the SQL syntax statements for defining and manipulating roles, see the *IBM® Informix® Guide to SQL: Syntax*.

To create and grant a role:

1. Use the CREATE ROLE statement to create a new role in the current database.
2. Use the GRANT statement to grant access privileges to that role
3. Use the GRANT statement to grant the role to a user or to PUBLIC (all users).
4. The user must issue the SET ROLE statement to enable that role.

Defining and granting privileges for a default role

The DBA can also define a *default role* to assign to individual users or to the PUBLIC group for a specific database. The role is automatically activated when the user establishes a connection with that database, without the requiring the user to issue a SET ROLE statement. At connection time, each user who holds a default role has whatever access privileges are granted to the user individually, as well as the privileges of the default role.

Only one role that the CREATE ROLE statement defines can be in effect for a given user at a given time. If a user who holds both a default role and one or more other roles uses the SET ROLE statement to make a nondefault role the active role, then any access privileges that were granted only to the default role (and not to the user individually, nor to PUBLIC, nor to the new active role) are no longer in effect for that user. The same user can issue the SET ROLE DEFAULT statement to reactivate the default role, but this action disables any privileges that the user held only through the previously enabled nondefault role.

If different default roles are assigned to the user and to PUBLIC, the default role of the user takes precedence.

To define and grant privileges for a default role:

1. Use the CREATE ROLE statement to create a new role in the current database.
2. Use the GRANT statement to grant privileges to the role.
3. Grant the role to a user and set the role as the default user or PUBLIC role using the one of the following syntax:
 - GRANT DEFAULT ROLE *rolename* TO *username*;
 - GRANT DEFAULT ROLE *rolename* TO PUBLIC;
4. Use the REVOKE DEFAULT ROLE statement to disassociate a default role from a user.
Restriction: Only the DBA or the database owner can remove the default role.
5. Use the SET ROLE DEFAULT statement to reset the current role back to the default role.

Built-in roles

For security reasons, IBM® Informix® supports certain built-in roles that are in effect for any user who is granted the role and is connected to the database, regardless of whether any other role is also active.

For example, in a database in which the IFX_EXTEND_ROLE configuration parameter is set to ON, only the Database Server Administrator (DBSA) or users to whom the DBSA has granted the built-in EXTEND role can create or drop UDRs that are defined with the EXTERNAL keyword.

Similarly, in a database that implements LBAC security policies, the DBSA can grant the built-in DBSECADM role. The grantee of this role becomes the Database Security Administrator, who can define and implement LBAC security policies and can assign security labels to data and to users.

Unlike user-defined roles, built-in roles cannot be destroyed by the DROP ROLE statement. The SET ROLE statement has no effect on a built-in role, because it is always active while users are connected to a database in which they have been granted the built-in role.

For more information on the External Routine Reference segment or SQL statements for defining and manipulating roles, see the *IBM Informix Guide to SQL: Syntax*.

For more information on the DBSECADM role or SQL statements for defining and manipulating LBAC security objects, see the *IBM Informix Security Guide*.

For more information on default roles, see the *IBM Informix Administrator's Guide*.

For more information about how to grant and limit access to your database, see the *IBM Informix Database Design and Implementation Guide*.

Centralized management

Databases that many people use are valuable and must be protected as important business assets. You create a significant problem when you compile a store of valuable data and simultaneously allow many employees to access it. You handle this problem by protecting data while maintaining performance. The database server lets you centralize these tasks.

Databases must be guarded against loss or damage. The hazards are many: failures in software and hardware, and the risks of fire, flood, and other natural disasters. Losing an important database creates a huge potential for damage. The damage could include not only the expense and difficulty of re-creating the lost data, but also the loss of productive time by the database users as well as the loss of business and goodwill while users cannot work. A plan for regular backups helps avoid or mitigate these potential disasters.

A large database that many people use must be maintained and tuned. Someone must monitor its use of system resources, chart its growth, anticipate bottlenecks, and plan for expansion. Users will report problems in the application programs; someone must diagnose these problems and correct them. If rapid response is important, someone must analyze the performance of the system and find the causes of slow responses.

Important database terms

You should know a number of terms before you begin the next chapter. Depending on the database server you use, a different set of terms can describe the database and the data model that apply.

- [The relational database model](#)
- [Tables](#)
- [Columns](#)
- [Rows](#)
- [Views](#)
- [Sequences](#)
- [Operations on tables](#)
- [The object-relational model](#)

The relational database model

The databases you create with the IBM® Informix® database server are *object-relational* databases. In practical terms this means that all data is presented in the form of *tables* with *rows* and *columns* where the following simple corresponding relationships apply.

Relationship

Description

table = entity

A table represents all that the database knows about one subject or kind of thing.

column = attribute

A column represents one feature, characteristic, or fact that is true of the table subject.

row = instance

A row represents one individual instance of the table subject.

Some rules apply about how you choose entities and attributes, but they are important only when you are designing a new database. (For more information about database design, see the *IBM Informix Database Design and Implementation Guide*.) The data model in an existing database is already set. To use the database, you need to know only the names of the tables and columns and how they correspond to the real world.

Tables

A *database* is a collection of information that is grouped into one or more tables. A table is an array of data *items* organized into rows and columns. A demonstration database is distributed with every IBM® Informix® database server product. A partial table from the demonstration database follows.

stock_num	manu_code	description	unit_price	unit	unit_descr
...
1	HRO	baseball gloves	250.00	case	10 gloves/case
1	HSK	baseball gloves	800.00	case	10 gloves/case
1	SMT	baseball gloves	450.00	case	10 gloves/case
2	HRO	baseball	126.00	case	24/case
3	HSK	baseball bat	240.00	case	12/case
4	HSK	football	960.00	case	24/case
4	HRO	football	480.00	case	24/case
5	NRG	tennis racquet	28.00	each	each
...
313	ANZ	swim cap	60.00	case	12/box

A table represents all that the database administrator (DBA) wants to store about one *entity*, one type of thing that the database describes. The example table, **stock**, represents all that the DBA wants to store about the merchandise that a sporting goods store stocks. Other tables in the demonstration database represent such entities as **customer** and **orders**.

Columns

Each column of a table contains one *attribute*, which is one characteristic, feature, or fact that describes the subject of the table. The **stock** table has columns for the following facts about items of merchandise: stock numbers, manufacturer codes, descriptions, prices, and units of measure.

Rows

Each row of a table is one *instance* of the subject of the table, which is one particular example of that entity. Each row of the **stock** table stands for one item of merchandise that the sporting goods store sells.

Views

A *view* is a virtual table based on a specified SELECT statement. A view is a dynamically controlled picture of the contents in a database and allows a programmer to determine what information the user sees and manipulates. Different users can be given different views of the contents of a database, and their access to those contents can be restricted in several ways.

Sequences

A *sequence* is a database object that generates a sequence of whole numbers within a defined range. The sequence of numbers can run in either ascending or descending order, and is monotonic. For more information about sequences, see the *IBM® Informix® Guide to SQL: Syntax*.

Operations on tables

Because a database is really a collection of tables, database operations are operations on tables. The object-relational model supports three fundamental operations: selection, projection, and joining. The following figure shows the selection and projection operations. (All three operations are defined in detail, with many examples, in the following topics.)

Figure 1. Illustration of selection and projection
stock table

stock_num	manu_code	description	unit_price	unit	unit_descr
1	HRO	baseball gloves	250.00	case	10 gloves/case
1	HSK	baseball gloves	800.00	case	10 gloves/case
1	SMT	baseball gloves	450.00	case	10 gloves/case
2	HRO	baseball	126.00	case	24/case
3	HSK	baseball bat	240.00	case	12/case
4	HSK	football	960.00	case	24/case
4	HRO	football	480.00	case	24/case
5	NRG	tennis racquet	28.00	each	each
313	ANZ	swim cap	60.00	case	12/box

P R O J E C T I O N

When you *select* data from a table, you are choosing certain rows and ignoring others. For example, you can query the **stock** table by asking the database management system to, "Select all rows in which the manufacturer code is HSK and the unit price is between 200.00 and 300.00."

When you *project* from a table, you are choosing certain columns and ignoring others. For example, you can query the **stock** table by asking the database management system to "project the **stock_num**, **unit_descr**, and **unit_price** columns."

A table contains information about only one entity; when you want information about multiple entities, you must *join* their tables. You can join tables in many ways. For more information about join operations, refer to [Compose advanced SELECT statements](#).

The object-relational model

IBM® Informix® () allows you to build *object-relational* databases. In addition to supporting alphanumeric data such as character strings, integers, date, and decimal, an object-relational database extends the features of a relational model with the following object-oriented capabilities:

Extensibility

You can extend the capability of the database server by defining new data types (and the access methods and functions to support them) and user-defined routines (UDRs) that allow you to store and manage images, audio, video, large text documents, and so forth.

IBM, as well as third-party vendors, packages some data types and access methods into DataBlade modules or shared class libraries, that you can add on to the database server, if it suits your needs. A DataBlade module enables you to store non-traditional data types such as two-dimensional spatial objects (lines, polygons, ellipses, and circles) and to access them through R-tree indexes. A DataBlade module might also provide new types of access to large text documents, including phrase matching, fuzzy searches, and synonym matching.

You can also extend the database server on your own by using the features of IBM Informix that enable you to add data types and access methods. For more information, see *IBM Informix User-Defined Routines and Data Types Developer's Guide*.

You can create UDRs in SPL and the C programming language to encapsulate application logic or to enhance the functionality of the . For more information, see [Create and use SPL routines](#).

Complex types

You can define new data types that combine one or more existing data types. Complex types enable greater flexibility in organizing data at the level of columns and tables. For example, with complex types, you can define columns that contain collections of values of a single type and columns that contain multiple component types.

Inheritance

You can define objects (types and tables) that acquire the properties of other objects and add new properties that are specific to the object that you define.

provides object-oriented capabilities beyond those of the relational model but represents all data in the form of tables with rows and columns. Although the object-relational model extends the capabilities of the relational model, you can implement your data model as a traditional relational database if you choose.

Some rules apply about how you choose entities and attributes, but they are important only when you are designing a new database. For more information about object-relational database design, see the *IBM Informix Database Design and Implementation Guide*.

Structured Query Language

Most computer software has not yet reached a point where you can literally ask a database, "What orders have been placed by customers in New Jersey with ship dates in the third quarter?" You must still phrase questions in a restricted syntax that the software can easily parse. You can pose the same question to the demonstration database in the following terms:

```
SELECT * FROM customer, orders
WHERE customer.customer_num = orders.customer_num
AND customer.state = 'NJ'
```

```
AND orders.ship_date  
BETWEEN DATE('7/1/98') AND DATE('9/30/98');
```

This question is a sample of Structured Query Language (SQL). It is the language that you use to direct all operations on the database. SQL is composed of statements, each of which begins with one or two keywords that specify a function. The IBM® Informix® implementation of SQL includes a large number of SQL statements, from ALLOCATE DESCRIPTOR to WHENEVER.

You will use most of the statements only when you set up or tune your database. You will use three or four statements regularly to query or update your database. For details on SQL statements, see the *IBM Informix Guide to SQL: Syntax*.

One statement, SELECT, is in almost constant use. SELECT is the only statement that you can use to retrieve data from the database. It is also the most complicated statement, and the next two chapters of this book explore its many uses.

- [Standard SQL](#)
- [Informix SQL and ANSI SQL](#)
- [Interactive SQL](#)
- [General programming](#)
- [ANSI-compliant databases](#)
- [Global Language Support](#)

Standard SQL

The relational model and SQL were invented and developed at IBM® in the early and middle 1970s. Once IBM proved that it was possible to implement practical relational databases and that SQL was a usable language for manipulating them, other implementations of SQL were developed.

For reasons of performance or competitive advantage, or to take advantage of local hardware or software features, each SQL implementation differed in small ways from the others and from the IBM version of the language. To ensure that the differences remained small, a standards committee was formed in the early 1980s.

Committee X3H2, sponsored by the American National Standards Institute (ANSI), issued the SQL1 standard in 1986. This standard defines a core set of SQL features and the syntax of statements such as SELECT.

Informix SQL and ANSI SQL

The IBM® Informix® implementation of SQL is compatible with standard SQL. SQL is also compatible with the IBM version of the language. However, SQL contains *extensions* to the standard; that is, extra options or features for certain statements, and looser rules for others. Most of the differences occur in the statements that are not in everyday use. For example, few differences occur in the SELECT statement, which accounts for 90 percent of SQL use.

When a difference exists between SQL and ANSI standard, the *IBM Informix Guide to SQL: Syntax* identifies the Informix syntax as an extension to the ANSI standard for SQL.

Interactive SQL

To carry out the examples in this book and to experiment with SQL and database design, you need a program that lets you execute SQL statements interactively. DB-Access is such a program. It helps you compose SQL statements and then passes your SQL statements to the database server for execution and displays the results to you.

General programming

You can write programs that incorporate SQL statements and exchange data with the database server. That is, you can write a program to retrieve data from the database and format it however you choose. You can also write programs that take data from any source in any format, prepare it, and insert it into the database.

You can also write programs called stored routines to work with database data and objects. The stored routines that you write are stored directly in a database in tables. You can then execute a stored routine from DB-Access or an SQL Application Programming Interface (API) such as IBM® Informix® ESQL/C.

[SQL programming](#), and [Modify data through SQL programs](#), present an overview of how SQL is used in programs.

ANSI-compliant databases

Use the MODE ANSI keywords when you create a database to designate it as ANSI compliant. Within such a database, certain characteristics of the ANSI/ISO standard apply. For example, all actions that modify data take place within a transaction automatically, which means that the changes are made in their entirety or not at all. Differences in the behavior of ANSI-compliant databases are noted, where appropriate, in the statement descriptions in the *IBM® Informix® Guide to SQL: Syntax*. For a detailed discussion of ANSI-compliant databases, see the *IBM Informix Database Design and Implementation Guide*.

Global Language Support

IBM® Informix® database server products provide the Global Language Support (GLS) feature. In addition to U.S. ASCII English, GLS allows you to work in other locales and use non-ASCII characters in SQL data and identifiers. You can use the GLS feature to conform to the customs of a specific locale. The locale files contain culture-specific information, such as money and date formats and collation orders. For more GLS information, see the *IBM Informix GLS User's Guide*.

Summary

A database contains a collection of related information but differs in a fundamental way from other methods of storing data. The database contains not only the data, but also a data model that defines each data item and specifies its meaning with respect to the other items and to the real world.

More than one user can access and modify a database at the same time. Each user has a different view of the contents of a database, and each user's access to those contents can be restricted in several ways.

A relational database consists of tables, and the tables consist of columns and rows. The relational model supports three fundamental operations on tables: selections, projections, and joins.

An object-relational database extends the features of a relational database. You can define new data types to store and manage audio, video, large text documents, and so forth. You can define complex types that combine one or more existing data types to provide greater flexibility in how you organize your data in columns and tables. You can define types and tables that inherit the properties of other database objects and add new properties that are specific to the object that you define.

To manipulate and query a database, use SQL. IBM® pioneered SQL and ANSI standardized it. IBM Informix® extensions that you can use to your advantage add to the ANSI-defined language. IBM Informix tools also make it possible to maintain strict compliance with ANSI standards.

Two layers of software mediate all your work with databases. The bottom layer is always a database server that executes SQL statements and manages the data on disk and in computer memory. The top layer is one of many applications, some from IBM and some written by you, by other vendors, or your colleagues.

Middleware is the component that links the database server to the application, and is provided by the database vendor to bind the client programs with the database server. IBM Informix Stored Procedure Language (SPL) is an example of such a tool.

Compose SELECT statements

The SELECT statement is the most important and the most complex SQL statement. You can use it and the SQL statements INSERT, UPDATE, and DELETE to manipulate data. You can use the SELECT statement to retrieve data from a database, as part of an INSERT statement to produce new rows, or as part of an UPDATE statement to update information.

The SELECT statement is the primary way to query information in a database. It is your key to retrieving data in a program, report, form, or spreadsheet. You can use SELECT statements with a query tool such as DB-Access or embed SELECT statements in an application.

This chapter introduces the basic methods for using the SELECT statement to query and retrieve data from relational databases. It discusses how to tailor your statements to select columns or rows of information from one or more tables, how to include expressions and functions in SELECT statements, and how to create various join conditions between database tables. The syntax and usage for the SELECT statement are described in detail in the *IBM® Informix® Guide to SQL: Syntax*.

Most examples in this publication come from the tables in the **stores_demo** database, which is included with the software for your SQL API or database utility. In the interest of brevity, the examples show only part of the data that is retrieved for each SELECT statement. For information on the structure and contents of the demonstration database, see the *IBM Informix Guide to SQL: Reference*. For emphasis, keywords are shown in uppercase letters in the examples, although SQL is not case sensitive.

- [SELECT statement overview](#)
- [Single-table SELECT statements](#)
- [Multiple-table SELECT statements](#)
- [Summary](#)

SELECT statement overview

The SELECT statement is constructed of clauses that let you look at data in a relational database. These clauses let you select columns and rows from one or more database tables or views, specify one or more conditions, order and summarize the data, and put the selected data in a temporary table.

This chapter shows how to use five SELECT statement clauses. If you include all five of these clauses, they must appear in the SELECT statement in the following order:

1. Projection clause
2. FROM clause
3. WHERE clause
4. ORDER BY clause
5. INTO TEMP clause

Only the Projection clause and FROM clause are required. These two clauses form the basis for every database query, because they specify the column values to be retrieved, and the tables that contain those columns. Use one or more of the other clauses from the following list:

- Add a WHERE clause to select specific rows or create a *join* condition.
- Add an ORDER BY clause to change the order in which data is produced.
- Add an INTO TEMP clause to save the results as a table for further queries.

Two additional SELECT statement clauses, GROUP BY and HAVING, let you perform more complex data retrieval. They are introduced in [Compose advanced SELECT statements](#). Another clause, INTO, specifies the program or host variable to receive data from a SELECT statement in an application program. Complete syntax and rules for using the SELECT statement are in the *IBM® Informix® Guide to SQL: Syntax*.

- [Output from SELECT statements](#)
- [Some basic concepts](#)

Output from SELECT statements

Although the syntax remains the same across all IBM® Informix® products, the formatting and display of the resulting output depends on the application. The examples in this chapter and in [Compose advanced SELECT statements](#) display the SELECT statements and their output as they appear when you use the interactive Query-language option in DB-Access.

- [Output from large object data types](#)
- [Output from user-defined data types](#)
- [Output in non-default code sets](#)

Output from large object data types

When you issue a SELECT statement that includes a large object, DB-Access displays the results as follows:

- For a TEXT column or CLOB column, the contents of the column are displayed.
- For a BYTE column, the words <BYTE value> are displayed instead of the actual value.
- For a BLOB column, the words <SBlob data> are displayed instead of the actual value.

Output from user-defined data types

DB-Access uses special conventions to display output from columns that contain complex or opaque data types. For more information about these data types, refer to the *IBM® Informix® Database Design and Implementation Guide*.

Output in non-default code sets

You can issue a SELECT statement that queries NCHAR columns instead of CHAR columns or NVARCHAR columns instead of VARCHAR columns.

For more Global Language Support (GLS) information, see the *IBM® Informix® GLS User's Guide*. For additional information on using NCHAR and NVARCHAR data types with non-default code sets, see the *IBM Informix Database Design and Implementation Guide* and the *IBM Informix Guide to SQL: Reference*.

Some basic concepts

The SELECT statement, unlike INSERT, UPDATE, and DELETE statements, does not modify the data in a database. It simply queries the data. Whereas only one user at a time can modify data, multiple users can query or select the data concurrently. For more information about statements that modify data, see [Modify data](#). The syntax descriptions of the INSERT, UPDATE, and DELETE statements appear in the *IBM® Informix® Guide to SQL: Syntax*.

In a relational database, a *column* is a data element that contains a particular type of information that occurs in every row in the table. A *row* is a group of related items of information about a single entity across all columns in a database table.

You can select columns and rows from a database table; from a *system catalog table*, a special table that contains information on the database; or from a *view*, a virtual table created to contain a customized set of data. System catalog tables are described in the *IBM Informix Guide to SQL: Reference*. Views are discussed in the *IBM Informix Database Design and Implementation Guide*.

- [Privileges](#)
- [Relational operations](#)
- [Selection and projection](#)
- [Join](#)

Privileges

Before you make a query against data, make sure you have the Connect privilege on the database and the Select privilege on the table. These privileges are normally granted to all users. Database access privileges are discussed in the *IBM® Informix® Database Design and Implementation Guide* and in the GRANT and REVOKE statements in the *IBM Informix Guide to SQL: Syntax*.

Relational operations

A *relational operation* involves manipulating one or more tables, or *relations*, to result in another table. The three kinds of relational operations are selection, projection, and join. This chapter includes examples of selection, projection, and simple joining.

Selection and projection

In relational terminology, *selection* is defined as taking the horizontal subset of rows of a single table that satisfies a particular condition. This kind of SELECT statement returns some of the rows and all the columns in a table. Selection is implemented through the WHERE clause of a SELECT statement, as the following figure shows.

Figure 1. Query

```
SELECT * FROM customer WHERE state = 'NJ';
```

The result contains the same number of columns as the **customer** table, but only a subset of its rows. In this example, DB-Access displays the data from each column on a separate line.

Figure 2. Query result

customer_num	119
fname	Bob
lname	Shorter
company	The Triathletes Club
address1	2405 Kings Highway
address2	
city	Cherry Hill
state	NJ
zipcode	08002
phone	609-663-6079

customer_num	122
fname	Cathy
lname	O'Brian
company	The Sporting Life
address1	543d Nassau
address2	
city	Princeton
state	NJ
zipcode	08540
phone	609-342-0054

In relational terminology, *projection* is defined as taking a vertical subset from the columns of a single table that retains the unique rows. This kind of SELECT statement returns some of the columns and all the rows in a table.

Projection is implemented through the *projection list* in the Projection clause of a SELECT statement, as the following figure shows.

Figure 3. Query

```
SELECT city, state, zipcode FROM customer;
```

The result contains the same number of rows as the **customer** table, but it *projects* only a subset of the columns in the table. Because only a small amount of data is selected from each row, DB-Access is able to display all of the data from the row on one line.

Figure 4. Query result

city	state	zipcode
Sunnyvale	CA	94086
San Francisco	CA	94117
Palo Alto	CA	94303
Redwood City	CA	94026
Los Altos	CA	94022
Mountain View	CA	94063
Palo Alto	CA	94304
Redwood City	CA	94063
Sunnyvale	CA	94086
Redwood City	CA	94062
Sunnyvale	CA	94085
:		
Oakland	CA	94609
Cherry Hill	NJ	08002
Phoenix	AZ	85016
Wilmington	DE	19898
Princeton	NJ	08540
Jacksonville	FL	32256
Bartlesville	OK	74006

The most common kind of SELECT statement uses both selection and projection. A query of this kind returns some of the rows and some of the columns in a table, as the following figure shows.

Figure 5. Query

```
SELECT UNIQUE city, state, zipcode
FROM customer
WHERE state = 'NJ';
```

Figure 6 contains a subset of the rows and a subset of the columns in the **customer** table.

Figure 6. Query result

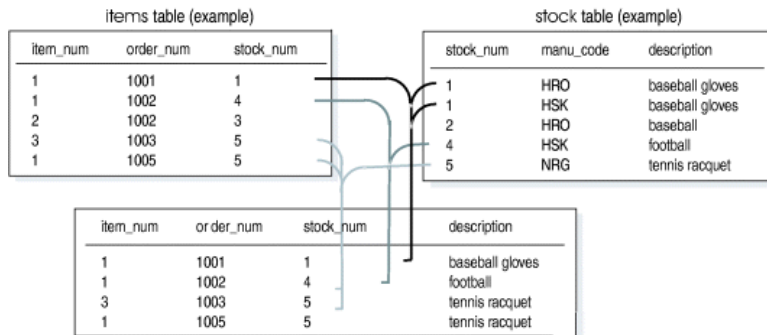
city	state	zipcode
Cherry Hill	NJ	08002
Princeton	NJ	08540

Join

A join occurs when two or more tables are connected by one or more columns in common, which creates a new table of results. The following figure shows a query that uses a subset of the **items** and **stock** tables to illustrate the concept of a join.

Figure 1. A join between two tables

```
SELECT UNIQUE item_num, order_num,
       stock.stock_num, description
FROM items, stock
WHERE items.stock_num = stock.stock_num
```



The following query joins the **customer** and **state** tables.

Figure 2. Query

```
SELECT UNIQUE city, state, zipcode, sname
FROM customer, state
WHERE customer.state = state.code;
```

The result consists of specified rows and columns from both the **customer** and **state** tables.

Figure 3. Query result

city	state	zipcode	sname
Bartlesville	OK	74006	Oklahoma
Blue Island	NY	60406	New York
Brighton	MA	02135	Massachusetts
Cherry Hill	NJ	08002	New Jersey
Denver	CO	80219	Colorado
Jacksonville	FL	32256	Florida
Los Altos	CA	94022	California
Menlo Park	CA	94025	California
Mountain View	CA	94040	California
Mountain View	CA	94063	California
Oakland	CA	94609	California
Palo Alto	CA	94303	California
Palo Alto	CA	94304	California
Phoenix	AZ	85008	Arizona
Phoenix	AZ	85016	Arizona
Princeton	NJ	08540	New Jersey
Redwood City	CA	94026	California
Redwood City	CA	94062	California
Redwood City	CA	94063	California
San Francisco	CA	94117	California
Sunnyvale	CA	94085	California
Sunnyvale	CA	94086	California
Wilmington	DE	19898	Delaware

Single-table SELECT statements

You can query a single table in a database in many ways. You can tailor a SELECT statement to perform the following actions:

- Retrieve all or specific columns
- Retrieve all or specific rows
- Perform computations or other functions on the retrieved data
- Order the data in various ways

The most basic SELECT statement contains only the two required clauses, the Projection clause and FROM.

- [The asterisk symbol \(*\)](#)

- [The ORDER BY clause to sort the rows](#)
- [Select specific columns](#)
- [The WHERE clause](#)
- [Create a comparison condition](#)
- [FIRST clause to select specific rows](#)
- [Expressions and derived values](#)
- [Rowid values in SELECT statements](#)

The asterisk symbol (*)

The following query specifies all the columns in the **manufact** table in a projection list. An *explicit* projection list is a list of the column names or expressions that you want to project from a table.

Figure 1. Query

```
SELECT manu_code, manu_name, lead_time FROM manufact;
```

The following query uses the *wildcard* asterisk symbol (*) as shorthand in the projection list to represent the names of all the columns in the table. You can use the asterisk symbol (*) when you want all the columns in their defined order. An *implicit* select list uses the asterisk symbol.

Figure 2. Query

```
SELECT * FROM manufact;
```

Because the **manufact** table has only three columns, [Figure 1](#) and [Figure 2](#) are equivalent and display the same results; that is, a list of every column and row in the **manufact** table. The following figure shows the results.

Figure 3. Query result

manu_code	manu_name	lead_time
SMT	Smith	3
ANZ	Anza	5
NRG	Norge	7
HSK	Husky	5
HRO	Hero	4
SHM	Shimara	30
KAR	Karsten	21
NKL	Nikolus	8
PRC	ProCycle	9

- [Reorder the columns](#)

Reorder the columns

The following query shows how you can change the order in which the columns are listed by changing their order in your projection list.

Figure 1. Query

```
SELECT manu_name, manu_code, lead_time FROM manufact;
```

The query result includes the same columns as the previous query result, but because the columns are specified in a different order, the display is also different.

Figure 2. Query result

manu_name	manu_code	lead_time
Smith	SMT	3
Anza	ANZ	5
Norge	NRG	7
Husky	HSK	5
Hero	HRO	4
Shimara	SHM	30
Karsten	KAR	21
Nikolus	NKL	8
ProCycle	PRC	9

The ORDER BY clause to sort the rows

The results from a query are not arranged in any particular order. For example, [Figure 4](#) and [Figure 2](#) appear to be in random order.

You can add an ORDER BY clause to your SELECT statement to direct the system to sort the data in a specific order. The ORDER BY clause is a list of column names from any remote or local table or view. Any expressions that are allowed in the projection list are allowed in the ORDER BY list. If a column used in the ORDER BY list has a Select trigger on it, the trigger will not be activated.

The following query returns every row from the **manu_code**, **manu_name**, and **lead_time** columns in the **manufact** table, sorted according to **lead_time**.

Figure 1. Query

```
SELECT manu_code, manu_name, lead_time
FROM manufact
ORDER BY lead_time;
```

For IBM® Informix®, you do not need to include the columns that you want to use in the ORDER BY clause in the projection list. That is, you can sort the data according to a column that is not retrieved in the projection list. The following query returns every row from the **manu_code** and **manu_name** columns in the **manufact** table, sorted according to **lead_time**. The **lead_time** column is in the ORDER BY clause although it is not included in the projection list.

Figure 2. Query

```
SELECT manu_code, manu_name
FROM manufact
ORDER BY lead_time;
```

- [Ascending order](#)
- [Descending order](#)
- [Sorting on multiple columns](#)

Ascending order

The retrieved data is sorted and displayed, by default, in *ascending* order. In the ASCII character set, ascending order is uppercase A to lowercase z for character data types, and lowest to highest value for numeric data types. DATE and DATETIME data is sorted from earliest to latest, and INTERVAL data is ordered from shortest to longest span of time.

Descending order

Descending order is the opposite of ascending order, from lowercase z to uppercase A for character types, and from highest to lowest for numeric data types. DATE and DATETIME data is sorted from latest to earliest, and INTERVAL data is ordered from longest to shortest span of time. The following query shows an example of descending order.

Figure 1. Query

```
SELECT * FROM manufact ORDER BY lead_time DESC;
```

The keyword DESC following a column name causes the retrieved data to be sorted in descending order, as the result shows.

Figure 2. Query result

manu_code	manu_name	lead_time
SHM	Shimara	30
KAR	Karsten	21
PRC	ProCycle	9
NKL	Nikolus	8
NRG	Norge	7
HSK	Husky	5
ANZ	Anza	5
HRO	Hero	4
SMT	Smith	3

You can specify any column of a built-in data type (except TEXT, BYTE, BLOB, or CLOB) in the ORDER BY clause, and the database server sorts the data based on the values in that column.

Sorting on multiple columns

You can also ORDER BY two or more columns, which creates a *nested sort*. The default is still ascending, and the column that is listed first in the ORDER BY clause takes precedence.

The following query and [Figure 3](#) and the corresponding query results show nested sorts. To modify the order in which selected data is displayed, change the order of the two columns that are named in the ORDER BY clause.

Figure 1. Query

```
SELECT stock_num, manu_code, description, unit_price
FROM stock
ORDER BY manu_code, unit_price;
```

In the query result, the **manu_code** column data appears in alphabetical order and, within each set of rows with the same **manu_code** (for example, ANZ, HRO), the **unit_price** is listed in ascending order.

Figure 2. Query result

stock_num	manu_code	description	unit_price
5	ANZ	tennis racquet	\$19.80
9	ANZ	volleyball net	\$20.00
6	ANZ	tennis ball	\$48.00
313	ANZ	swim cap	\$60.00
201	ANZ	golf shoes	\$75.00
310	ANZ	kick board	\$84.00
:			
111	SHM	10-spd, assmbld	\$499.99
112	SHM	12-spd, assmbld	\$549.00
113	SHM	18-spd, assmbld	\$685.90
5	SMT	tennis racquet	\$25.00

6 SMT	tennis ball	\$36.00
1 SMT	baseball gloves	\$450.00

The following query shows the reverse order of the columns in the ORDER BY clause.

Figure 3. Query

```
SELECT stock_num, manu_code, description, unit_price
FROM stock
ORDER BY unit_price, manu_code;
```

In the query result, the data appears in ascending order of **unit_price** and, where two or more rows have the same **unit_price** (for example, \$20.00, \$48.00, \$312.00), the **manu_code** is in alphabetical order.

Figure 4. Query result

stock_num	manu_code	description	unit_price
302	HRO	ice pack	\$4.50
302	KAR	ice pack	\$5.00
5	ANZ	tennis racquet	\$19.80
9	ANZ	volleyball net	\$20.00
103	PRC	frnt derailleur	\$20.00
:			
108	SHM	crankset	\$45.00
6	ANZ	tennis ball	\$48.00
305	HRO	first-aid kit	\$48.00
303	PRC	socks	\$48.00
311	SHM	water gloves	\$48.00
:			
113	SHM	18-spd, assmbld	\$685.90
1	HSK	baseball gloves	\$800.00
8	ANZ	volleyball	\$840.00
4	HSK	football	\$960.00

The order of the columns in the ORDER BY clause is important, and so is the position of the DESC keyword. Although the statements in the following query contain the same components in the ORDER BY clause, each produces a different result (not shown).

Figure 5. Query

```
SELECT * FROM stock ORDER BY manu_code, unit_price DESC;

SELECT * FROM stock ORDER BY unit_price, manu_code DESC;

SELECT * FROM stock ORDER BY manu_code DESC, unit_price;

SELECT * FROM stock ORDER BY unit_price DESC, manu_code;
```

Select specific columns

The previous section shows how to select and order all data from a table. However, often all you want to see is the data in one or more specific columns. Again, the formula is to use the Projection and FROM clauses, specify the columns and table, and perhaps order the data in ascending or descending order with an ORDER BY clause.

If you want to find all the customer numbers in the **orders** table, use a statement such as the one in the following query.

Figure 1. Query

```
SELECT customer_num FROM orders;
```

The result shows how the statement simply selects all data in the **customer_num** column in the **orders** table and lists the customer numbers on all the orders, including duplicates.

Figure 2. Query result

customer_num
104
101
104
:
122
123
124
126
127

The output includes several duplicates because some customers have placed more than one order. Sometimes you want to see duplicate rows in a projection. At other times, you want to see only the distinct values, not how often each value appears.

To suppress duplicate rows, you can include the keyword DISTINCT or its synonym UNIQUE at the start of the select list, once in each level of a query, as the following query shows.

Figure 3. Query

```
SELECT DISTINCT customer_num FROM orders;

SELECT UNIQUE customer_num FROM orders;
```

To produce a more readable list, [Figure 3](#) limits the display to show each customer number in the **orders** table only once, as the result shows.

Figure 4. Query result

customer_num

101
104
106
110
111
112
115
116
117
119
120
121
122
123
124
126
127

Suppose you are handling a customer call, and you want to locate purchase order number DM354331. To list all the purchase order numbers in the **orders** table, use a statement such as the following query shows.

Figure 5. Query

```
SELECT po_num FROM orders;
```

The result shows how the statement retrieves data in the **po_num** column in the **orders** table.

Figure 6. Query result

po_num

B77836
9270
B77890
8006
2865
Q13557
278693
:
:

However, the list is not in a useful order. You can add an ORDER BY clause to sort the column data in ascending order and make it easier to find that particular **po_num**, as shown in the following query.

Figure 7. Query

```
SELECT po_num FROM orders ORDER BY po_num;
```

Figure 8. Query result

po_num

278693
278701
2865
429Q
4745
8006
8052
9270
B77836
B77890
:
:

To select multiple columns from a table, list them in the projection list in the Projection clause. The following query shows that the order in which the columns are selected is the order in which they are retrieved, from left to right.

Figure 9. Query

```
SELECT ship_date, order_date, customer_num,  
       order_num, po_num  
FROM orders  
ORDER BY order_date, ship_date;
```

As [Sorting on multiple columns](#) shows, you can use the ORDER BY clause to sort the data in ascending or descending order and perform nested sorts. The result shows ascending order.

Figure 10. Query result

ship_date	order_date	customer_num	order_num	po_num
06/01/1998	05/20/1998	104	1001	B77836
05/26/1998	05/21/1998	101	1002	9270
05/23/1998	05/22/1998	104	1003	B77890
05/30/1998	05/22/1998	106	1004	8006
06/09/1998	05/24/1998	116	1005	2865
	05/30/1998	112	1006	Q13557
06/05/1998	05/31/1998	117	1007	278693
07/06/1998	06/07/1998	110	1008	LZ230
06/21/1998	06/14/1998	111	1009	4745
06/29/1998	06/17/1998	115	1010	429Q
06/29/1998	06/18/1998	117	1012	278701
07/03/1998	06/18/1998	104	1011	B77897
07/10/1998	06/22/1998	104	1013	B77930

07/03/1998	06/25/1998	106	1014	8052
07/16/1998	06/27/1998	110	1015	MA003
07/12/1998	06/29/1998	119	1016	PC6782
07/13/1998	07/09/1998	120	1017	DM354331
07/13/1998	07/10/1998	121	1018	S22942
07/16/1998	07/11/1998	122	1019	Z55709
07/16/1998	07/11/1998	123	1020	W2286
07/25/1998	07/23/1998	124	1021	C3288
07/30/1998	07/24/1998	126	1022	W9925
07/30/1998	07/24/1998	127	1023	KF2961

When you use SELECT and ORDER BY on several columns in a table, you might find it helpful to use integers to refer to the position of the columns in the ORDER BY clause. When an integer is an element in the ORDER BY list, the database server treats it as the position in the projection list. For example, using 3 in the ORDER BY list (ORDER BY 3) refers to the third item in the projection list. The statements in the following query retrieve and display the same data, as [Figure 12](#) shows.

Figure 11. Query

```
SELECT customer_num, order_num, po_num, order_date
FROM orders
ORDER BY 4, 1;

SELECT customer_num, order_num, po_num, order_date
FROM orders
ORDER BY order_date, customer_num;
```

Figure 12. Query result

customer_num	order_num	po_num	order_date
104	1001	B77836	05/20/1998
101	1002	9270	05/21/1998
104	1003	B77890	05/22/1998
106	1004	8006	05/22/1998
116	1005	2865	05/24/1998
112	1006	Q13557	05/30/1998
117	1007	278693	05/31/1998
110	1008	LZ230	06/07/1998
111	1009	4745	06/14/1998
115	1010	429Q	06/17/1998
104	1011	B77897	06/18/1998
117	1012	278701	06/18/1998
104	1013	B77930	06/22/1998
106	1014	8052	06/25/1998
110	1015	MA003	06/27/1998
119	1016	PC6782	06/29/1998
120	1017	DM354331	07/09/1998
121	1018	S22942	07/10/1998
122	1019	Z55709	07/11/1998
123	1020	W2286	07/11/1998
124	1021	C3288	07/23/1998
126	1022	W9925	07/24/1998
127	1023	KF2961	07/24/1998

You can include the DESC keyword in the ORDER BY clause when you assign integers to column names, as the following query shows.

Figure 13. Query

```
SELECT customer_num, order_num, po_num, order_date
FROM orders
ORDER BY 4 DESC, 1;
```

In this case, data is first sorted in descending order by **order_date** and in ascending order by **customer_num**.

- [Select substrings](#)
- [ORDER BY and non-English data](#)

Select substrings

To select part of the value of a character column, include a *substring* in the projection list. Suppose your marketing department is planning a mailing to your customers and wants their geographical distribution based on zip codes. You could write a query similar to the following.

Figure 1. Query

```
SELECT zipcode[1,3], customer_num
FROM customer
ORDER BY zipcode;
```

The query uses a substring to select the first three characters of the **zipcode** column (which identify the state) and the full **customer_num**, and lists them in ascending order by zip code, as the result shows.

Figure 2. Query result

zipcode	customer_num
021	125
080	119
085	122
198	121
322	123
:	

943	103
943	107
946	118

ORDER BY and non-English data

By default, IBM® Informix® database servers use the U.S. English language environment, called a locale, for database data. The U.S. English locale specifies data sorted in code-set order. This default locale uses the ISO 8859-1 code set.

If your database contains non-English data, you should store non-English data in NCHAR (or NVARCHAR) columns to obtain results sorted by the language. The ORDER BY clause should return data in the order appropriate to that language.

The following query uses a SELECT statement with an ORDER BY clause to search the table, **abonnés**, and to order the selected information by the data in the **nom** column.

Figure 1. Query

```
SELECT numéro,nom,prénom
FROM abonnés
ORDER BY nom;
```

The collation order for the results of this query can vary, depending on the following system variations:

- Whether the **nom** column is CHAR or NCHAR data type. The database server sorts data in CHAR columns by the order the characters appear in the code set. The database server sorts data in NCHAR columns by the order the characters are listed in the collation portion of the locale.
- Whether the database server is using the correct non-English locale when it accesses the database. To use a non-English locale, you must set the **CLIENT_LOCALE** and **DB_LOCALE** environment variables to the appropriate locale name.

For the query to return expected results, the **nom** column should be NCHAR data type in a database that uses a French locale. Other operations, such as less than, greater than, or equal to, are also affected by the user-specified locale. For more information on non-English data and locales, see the *IBM Informix GLS User's Guide*.

The following result and [Figure 3](#) show two sample sets of output.

Figure 2. Query result

numéro	nom	prénom
13612	Azevedo	Edouardo Freire
13606	Dupré	Michèle Françoise
13607	Hammer	Gerhard
13602	Hämmer	le Greta
13604	LaForêt	Jean-Noël
13610	LeMatre	Héloïse
13613	Llanero	Gloria Dolores
13603	Montaña	José Antonio
13611	Oatfield	Emily
13609	Tiramisù	Paolo Alfredo
13600	da Sousa	João Lourenço Antunes
13615	di Girolamo	Giuseppe
13601	Ålesund	Sverre
13608	Étaix	Émile
13605	Ötker	Hans-Jürgen
13614	Øverst	Per-Anders

The following query result follows the ISO 8859-1 code-set order, which ranks uppercase letters before lowercase letters and moves names that contain an accented character (Ålesund, Étaix, Ötker, and Øverst) to the end of the list.

Figure 3. Query result

numéro	nom	prénom
13601	Ålesund	Sverre
13612	Azevedo	Edouardo Freire
13600	da Sousa	João Lourenço Antunes
13615	di Girolamo	Giuseppe
13606	Dupré	Michèle Françoise
13608	Étaix	Émile
13607	Hammer	Gerhard
13602	Hämmer	le Greta
13604	LaForêt	Jean-Noël
13610	LeMatre	Héloïse
13613	Llanero	Gloria Dolores
13603	Montaña	José Antonio
13611	Oatfield	Emily
13605	Ötker	Hans-Jürgen
13614	Øverst	Per-Anders
13609	Tiramisù	Paolo Alfredo

The result shows that when the appropriate locale file is referenced by the database server, names including non-English characters (Ålesund, Étaix, Ötker, and Øverst) are collated differently than they are in the ISO 8859-1 code set. They are sorted correctly for the locale. It does not distinguish between uppercase and lowercase letters.

The WHERE clause

The set of rows that a SELECT statement returns is its *active set*. A *singleton* SELECT statement returns a single row. You can add a WHERE clause to a SELECT statement if you want to see only specific rows. For example, you use a WHERE clause to restrict the rows that the database server returns to only the orders that a particular customer placed or the calls that a particular customer service representative entered.

You can use the WHERE clause to set up a comparison condition or a join condition. This section demonstrates only the first use. Join conditions are described in a later section and in the next chapter.

Create a comparison condition

The WHERE clause of a SELECT statement specifies the rows that you want to see. A comparison condition employs specific *keywords* and *operators* to define the search criteria.

For example, you might use one of the keywords BETWEEN, IN, LIKE, or MATCHES to test for equality, or the keywords IS NULL to test for null values. You can combine the keyword NOT with any of these keywords to specify the opposite condition.

The following table lists the relational operators that you can use in a WHERE clause in place of a keyword to test for equality.

Operator	Operation
=	equals
!= or <>	does not equal
>	greater than
>=	greater than or equal to
<	less than
<=	less than or equal to

For CHAR expressions, greater than means *after* in ASCII collating order, where lowercase letters are after uppercase letters, and both are after numerals. See the ASCII Character Set chart in the *IBM Informix Guide to SQL: Syntax*. For DATE and DATETIME expressions, greater than means *later in time*, and for INTERVAL expressions, it means *of longer duration*.

You cannot use TEXT or BYTE columns to create a comparison condition, except when you use the IS NULL or IS NOT NULL keywords to test for NULL values.

You cannot specify BLOB or CLOB columns to create a comparison condition on IBM® Informix®, except when you use the IS NULL or IS NOT NULL keywords to test for NULL values.

You can use the preceding keywords and operators in a WHERE clause to create comparison-condition queries that perform the following actions:

- Include values
- Exclude values
- Find a range of values
- Find a subset of values
- Identify NULL values

To perform variable text searches using the following criteria, use the preceding keywords and operators in a WHERE clause to create comparison-condition queries:

- Exact-text comparison
- Single-character wildcards
- Restricted single-character wildcards
- Variable-length wildcards
- Subscripting

The following section contains examples that illustrate these types of queries.

- [Include rows](#)
- [Exclude rows](#)
- [Specify a range of rows](#)
- [Exclude a range of rows](#)
- [Use a WHERE clause to find a subset of values](#)
- [Identify NULL values](#)
- [Form compound conditions](#)
- [Exact-text comparisons](#)
- [Variable-text searches](#)

You can use the keywords LIKE and MATCHES for variable-text queries that are based on substring searches of fields. Include the keyword NOT to indicate the opposite condition.

- [A single-character wildcard](#)
- [MATCHES clause and non-default locales](#)
- [Protect special characters](#)
- [Subscripting in a WHERE clause](#)

Include rows

Use the equal sign (=) relational operator to include rows in a WHERE clause, as the following query shows.

Figure 1. Query

```
SELECT customer_num, call_code, call_dtime, res_dtime
FROM cust_calls
WHERE user_id = 'maryj';
```

The query returns the set of rows that is shown.

Figure 2. Query result

customer_num	call_code	call_dtime	res_dtime
106	D	1998-06-12 08:20	1998-06-12 08:25
121	O	1998-07-10 14:05	1998-07-10 14:06
127	I	1998-07-31 14:30	

Exclude rows

Use the relational operators != or <> to exclude rows in a WHERE clause.

The following query assumes that you are selecting from an ANSI-compliant database; the statements specify the owner or login name of the creator of the **customer** table. This qualifier is not required when the creator of the table is the current user, or when the database is not ANSI compliant. However, you can include the qualifier in either case. For a detailed discussion of owner naming, see the *IBM® Informix® Guide to SQL: Syntax*.

Figure 1. Query

```
SELECT customer_num, company, city, state
FROM odin.customer
WHERE state != 'CA';

SELECT customer_num, company, city, state
FROM odin.customer
WHERE state <> 'CA';
```

Both statements in the query exclude values by specifying that, in the **customer** table that the user **odin** owns, the value in the **state** column should not be equal to CA, as the result shows.

Figure 2. Query result

customer_num	company	city	state
119	The Triathletes Club	Cherry Hill	NJ
120	Century Pro Shop	Phoenix	AZ
121	City Sports	Wilmington	DE
122	The Sporting Life	Princeton	NJ
123	Bay Sports	Jacksonville	FL
124	Putnum's Putters	Bartlesville	OK
125	Total Fitness Sports	Brighton	MA
126	Neelie's Discount Sp	Denver	CO
127	Big Blue Bike Shop	Blue Island	NY
128	Phoenix College	Phoenix	AZ

Specify a range of rows

The following query shows two ways to specify a range of rows in a WHERE clause.

Figure 1. Query

```
SELECT catalog_num, stock_num, manu_code, cat_advert
FROM catalog
WHERE catalog_num BETWEEN 10005 AND 10008;

SELECT catalog_num, stock_num, manu_code, cat_advert
FROM catalog
WHERE catalog_num >= 10005 AND catalog_num <= 10008;
```

Each statement in the query specifies a range for **catalog_num** from 10005 through 10008, inclusive. The first statement uses keywords, and the second statement uses relational operators to retrieve the rows, as the result shows.

Figure 2. Query result

catalog_num	10005
stock_num	3
manu_code	HSK
cat_advert	High-Technology Design Expands the Sweet Spot
catalog_num	10006
stock_num	3
manu_code	SHM
cat_advert	Durable Aluminum for High School and Collegiate Athletes


```
catalog_num 10007
stock_num   4
manu_code   HSK
cat_advert  Quality Pigskin with Joe Namath Signature
```

```
catalog_num 10008
stock_num   4
manu_code   HRO
cat_advert  Highest Quality Football for High School
            and Collegiate Competitions
```

Although the **catalog** table includes a column with the BYTE data type, that column is not included in this SELECT statement because the output would show only the words <BYTE value> by the column name. You can write an SQL API application to display TEXT and BYTE values.

Exclude a range of rows

The following query uses the keywords NOT BETWEEN to exclude rows that have the character range 94000 through 94999 in the **zipcode** column, as the result shows.

Figure 1. Query

```
SELECT fname, lname, city, state
FROM customer
WHERE zipcode NOT BETWEEN '94000' AND '94999'
ORDER BY state;
```

Figure 2. Query result

fname	lname	city	state
Frank	Lessor	Phoenix	AZ
Fred	Jewell	Phoenix	AZ
Eileen	Neelie	Denver	CO
Jason	Wallack	Wilmington	DE
Marvin	Hanlon	Jacksonville	FL
James	Henry	Brighton	MA
Bob	Shorter	Cherry Hill	NJ
Cathy	O'Brian	Princeton	NJ
Kim	Satifer	Blue Island	NY
Chris	Putnum	Bartlesville	OK

Use a WHERE clause to find a subset of values

Like [Exclude rows](#), the following query assumes the use of an ANSI-compliant database. The owner qualifier is in quotation marks to preserve the case sensitivity of the literal string.

Figure 1. Query

```
SELECT lname, city, state, phone
FROM 'Aleta'.customer
WHERE state = 'AZ' OR state = 'NJ'
ORDER BY lname;
```

```
SELECT lname, city, state, phone
FROM 'Aleta'.customer
WHERE state IN ('AZ', 'NJ')
ORDER BY lname;
```

Each statement in the query retrieves rows that include the subset of AZ or NJ in the **state** column of the **Aleta.customer** table.

Figure 2. Query result

lname	city	state	phone
Jewell	Phoenix	AZ	602-265-8754
Lessor	Phoenix	AZ	602-533-1817
O'Brian	Princeton	NJ	609-342-0054
Shorter	Cherry Hill	NJ	609-663-6079

You cannot test TEXT or BYTE columns with the IN keyword.

Also, when you use IBM® Informix®, you cannot test BLOB or CLOB columns with the IN keyword.

In the example of a query on an ANSI-compliant database, no quotation marks exist around the table owner name. Whereas the two statements in [Figure 1](#) searched the **Aleta.customer** table, the following query searches the table **ALETA.customer**, which is a different table, because of the way ANSI-compliant databases look at owner names.

Figure 3. Query

```
SELECT lname, city, state, phone
FROM Aleta.customer
WHERE state NOT IN ('AZ', 'NJ')
ORDER BY state;
```

The previous query adds the keywords NOT IN, so the subset changes to exclude the subsets AZ and NJ in the **state** column. The following figure shows the results in order of the **state** column.

Figure 4. Query result

lname	city	state	phone
Pauli	Sunnyvale	CA	408-789-8075
Sadler	San Francisco	CA	415-822-1289
Currie	Palo Alto	CA	415-328-4543
Higgins	Redwood City	CA	415-368-1100
Vector	Los Altos	CA	415-776-3249
Watson	Mountain View	CA	415-389-8789
Ream	Palo Alto	CA	415-356-9876
Quinn	Redwood City	CA	415-544-8729
Miller	Sunnyvale	CA	408-723-8789
Jaeger	Redwood City	CA	415-743-3611
Keyes	Sunnyvale	CA	408-277-7245
Lawson	Los Altos	CA	415-887-7235
Beatty	Menlo Park	CA	415-356-9982
Albertson	Redwood City	CA	415-886-6677
Grant	Menlo Park	CA	415-356-1123
Parmelee	Mountain View	CA	415-534-8822
Sipes	Redwood City	CA	415-245-4578
Baxter	Oakland	CA	415-655-0011
Neelie	Denver	CO	303-936-7731
Wallack	Wilmington	DE	302-366-7511
Hanlon	Jacksonville	FL	904-823-4239
Henry	Brighton	MA	617-232-4159
Satifer	Blue Island	NY	312-944-5691
Putnum	Bartlesville	OK	918-355-2074

Identify NULL values

Use the IS NULL or IS NOT NULL option to check for NULL values. A NULL value represents either the absence of data or an unknown value. A NULL value is not the same as a zero or a blank.

The following query returns all rows that have a null **paid_date**, as the result shows.

Figure 1. Query

```
SELECT order_num, customer_num, po_num, ship_date
FROM orders
WHERE paid_date IS NULL
ORDER BY customer_num;
```

Figure 2. Query result

order_num	customer_num	po_num	ship_date
1004	106	8006	05/30/1998
1006	112	Q13557	
1007	117	278693	06/05/1998
1012	117	278701	06/29/1998
1016	119	PC6782	07/12/1998
1017	120	DM354331	07/13/1998

Form compound conditions

To connect two or more comparison conditions, or *Boolean expressions*, use the logical operators AND, OR, and NOT. A Boolean expression evaluates as true or false or, if NULL values are involved, as unknown.

In the following query, the operator AND combines two comparison expressions in the WHERE clause.

Figure 1. Query

```
SELECT order_num, customer_num, po_num, ship_date
FROM orders
WHERE paid_date IS NULL
AND ship_date IS NOT NULL
ORDER BY customer_num;
```

The query returns all rows that have NULL paid_date or a NOT NULL ship_date.

Figure 2. Query result

order_num	customer_num	po_num	ship_date
1004	106	8006	05/30/1998
1007	117	278693	06/05/1998
1012	117	278701	06/29/1998
1017	120	DM354331	07/13/1998

Exact-text comparisons

The following examples include a WHERE clause that searches for exact-text comparisons by using the keyword LIKE or MATCHES or the equal sign (=) relational operator. Unlike earlier examples, these examples illustrate how to query a table that is not in the current database. You can access a table that is not in the current database only if the database that contains the table has the same ANSI compliance status as the current database. If the current database is an ANSI-compliant database, the table you want to access must also reside in an ANSI-compliant database. If the current database is not an ANSI-compliant database, the table you want to access must also reside in a database that is not an ANSI-compliant database.

Although the database used previously in this chapter is the demonstration database, the FROM clause in the following examples specifies the **manatee** table, created by the owner **bubba**, which resides in an ANSI-compliant database named **syzygy**. For more information on how to access tables that are not in the current database, see the *IBM® Informix® Guide to SQL: Syntax*.

Each statement in the following query retrieves all the rows that have the single word *helmet* in the **description** column, as the result shows.

Figure 1. Query

```
SELECT stock_no, mfg_code, description, unit_price
FROM syzygy:bubba.manatee
WHERE description = 'helmet'
ORDER BY mfg_code;
```

```
SELECT stock_no, mfg_code, description, unit_price
FROM syzygy:bubba.manatee
WHERE description LIKE 'helmet'
ORDER BY mfg_code;
```

```
SELECT stock_no, mfg_code, description, unit_price
FROM syzygy:bubba.manatee
WHERE description MATCHES 'helmet'
ORDER BY mfg_code;
```

The results might look like the following figure.

Figure 2. Query result

stock_no	mfg_code	description	unit_price
991	ABC	helmet	\$222.00
991	BKE	helmet	\$269.00
991	HSK	helmet	\$311.00
991	PRC	helmet	\$234.00
991	SPR	helmet	\$245.00

Variable-text searches

You can use the keywords LIKE and MATCHES for variable-text queries that are based on substring searches of fields. Include the keyword NOT to indicate the opposite condition.

The keyword LIKE complies with the ISO/ANSI standard for SQL, whereas MATCHES is the IBM® Informix® extension.

Variable-text search strings can include the wildcard symbols that are listed with the keywords LIKE or MATCHES in the following table.

Keyword	Symbol	Explanation
LIKE	%	Evaluates to zero or more characters
LIKE	_	Evaluates to a single character
LIKE	\	Escapes special significance of next character
MATCHES	*	Evaluates to zero or more characters
MATCHES	?	Evaluates to a single character (except null)
MATCHES	[]	Evaluates to a single character or range of values
MATCHES	\	Escapes special significance of next character

You cannot test BLOB, CLOB, TEXT, or BYTE columns with the LIKE or MATCHES operators.

A single-character wildcard

The statements in the following query illustrate the use of a single-character wildcard in a WHERE clause. Further, they demonstrate a query on a table that is not in the current database. The **stock** table is in the database **sloth**. Besides being outside the current demonstration database, **sloth** is on a separate database server called **meerkat**.

For more information, see [Access and modify data in an external database](#) and the *IBM® Informix® Guide to SQL: Syntax*.

Figure 1. Query

```
SELECT stock_num, manu_code, description, unit_price
FROM sloth@meerkat:stock
WHERE manu_code LIKE '_R_'
AND unit_price >= 100
ORDER BY description, unit_price;
```

```
SELECT stock_num, manu_code, description, unit_price
FROM sloth@meerkat:stock
```

```
WHERE manu_code MATCHES '?R?'
AND unit_price >= 100
ORDER BY description, unit_price;
```

Each statement in the query retrieves only those rows for which the middle letter of the **manu_code** is R, as the result shows. The comparison 'R' (for LIKE) or '?R?' (for MATCHES) specifies, from left to right, the following items:

- Any single character
- The letter R
- Any single character

Figure 2. Query result

stock_num	manu_code	description	unit_price
205	HRO	3 golf balls	\$312.00
2	HRO	baseball	\$126.00
1	HRO	baseball gloves	\$250.00
7	HRO	basketball	\$600.00
102	PRC	bicycle brakes	\$480.00
114	PRC	bicycle gloves	\$120.00
4	HRO	football	\$480.00
110	PRC	helmet	\$236.00
110	HRO	helmet	\$260.00
307	PRC	infant jogger	\$250.00
306	PRC	tandem adapter	\$160.00
308	PRC	twin jogger	\$280.00
304	HRO	watch	\$280.00

- [WHERE clause to specify a range of initial characters](#)
- [WHERE clause with variable-length wildcard](#)

WHERE clause to specify a range of initial characters

The following query selects only those rows where the **manu_code** begins with A through H and returns the rows that the result shows. The test '[A-H]' specifies any single letter from A through H, inclusive. No equivalent wildcard symbol exists for the LIKE keyword.

Figure 1. Query

```
SELECT stock_num, manu_code, description, unit_price
FROM stock
WHERE manu_code MATCHES '[A-H]*'
ORDER BY description, manu_code;
```

Figure 2. Query result

stock_num	manu_code	description	unit_price
205	ANZ	3 golf balls	\$312.00
205	HRO	3 golf balls	\$312.00
2	HRO	baseball	\$126.00
3	HSK	baseball bat	\$240.00
1	HRO	baseball gloves	\$250.00
1	HSK	baseball gloves	\$800.00
7	HRO	basketball	\$600.00
:			
313	ANZ	swim cap	\$60.00
6	ANZ	tennis ball	\$48.00
5	ANZ	tennis racquet	\$19.80
8	ANZ	volleyball	\$840.00
9	ANZ	volleyball net	\$20.00
304	ANZ	watch	\$170.00

WHERE clause with variable-length wildcard

The statements in the following query use a wildcard at the end of a string to retrieve all the rows where the **description** begins with the characters **bicycle**.

Figure 1. Query

```
SELECT stock_num, manu_code, description, unit_price
FROM stock
WHERE description LIKE 'bicycle%'
ORDER BY description, manu_code;

SELECT stock_num, manu_code, description, unit_price
FROM stock
WHERE description MATCHES 'bicycle*'
ORDER BY description, manu_code;
```

Either statement returns the following rows.

Figure 2. Query result

stock_num	manu_code	description	unit_price
-----------	-----------	-------------	------------

102	PRC	bicycle brakes	\$480.00
102	SHM	bicycle brakes	\$220.00
114	PRC	bicycle gloves	\$120.00
107	PRC	bicycle saddle	\$70.00
106	PRC	bicycle stem	\$23.00
101	PRC	bicycle tires	\$88.00
101	SHM	bicycle tires	\$68.00
105	PRC	bicycle wheels	\$53.00
105	SHM	bicycle wheels	\$80.00

The comparison 'bicycle%' or 'bicycle*' specifies the characters `bicycle` followed by any sequence of zero or more characters. It matches `bicycle stem` with `stem` matched by the wildcard. It matches to the characters `bicycle` alone, if a row exists with that description.

The following query narrows the search by adding another comparison condition that excludes a `manu_code` of `PRC`.

Figure 3. Query

```
SELECT stock_num, manu_code, description, unit_price
FROM stock
WHERE description LIKE 'bicycle%'
AND manu_code NOT LIKE 'PRC'
ORDER BY description, manu_code;
```

The statement retrieves only the following rows.

Figure 4. Query result

stock_num	manu_code	description	unit_price
102	SHM	bicycle brakes	\$220.00
101	SHM	bicycle tires	\$68.00
105	SHM	bicycle wheels	\$80.00

When you select from a large table and use an initial wildcard in the comparison string (such as '%cycle'), the query often takes longer to execute. Because indexes cannot be used, every row is searched.

MATCHES clause and non-default locales

By default, IBM® Informix® database servers use the U.S. English language environment, called a locale, for database data. This default locale uses the ISO 8859-1 code set. The U.S. English locale specifies that `MATCHES` will use code-set order.

If your database uses a non-default locale, a `MATCHES` clause that specifies a range uses the collation order of that locale for character data types (including `CHAR`, `NCHAR`, `VARCHAR`, `NVARCHAR`, and `LVARCHAR`). This feature of `MATCHES` ranges is an exception to the general rule that only `NCHAR` and `NVARCHAR` columns can use locale-specific collation. If the locale does not specify any special collation order, however, then `MATCHES` uses the code-set order.

With IBM Informix, you can use the `SET COLLATION` statement to specify a database locale for your session that is different from the `DB_LOCALE` setting. See the *IBM Informix Guide to SQL: Syntax* for a description of `SET COLLATION`.

Figure 1. Query

```
SELECT numéro,nom,prénom
FROM abonnés
WHERE nom MATCHES '[E-P]*'
ORDER BY nom;
```

In the result, the rows for `Étaix`, `Ötker`, and `Øverst` are not selected and listed because, with ISO 8859-1 code-set order, the accented first letter of each name is not in the `E` through `P` `MATCHES` range for the `nom` column.

Figure 2. Query result

numéro	nom	prénom
13607	Hammer	Gerhard
13602	Hämmer	Greta
13604	LaForêt	Jean-Noël
13610	LeMatre	Héloïse
13613	Llanero	Gloria Dolores
13603	Montaña	José Antonio
13611	Oatfield	Emily

For more information on non-English data and locales, see the *IBM Informix GLS User's Guide*.

Protect special characters

The following query uses the keyword `ESCAPE` with `LIKE` or `MATCHES` so you can protect a special character from misinterpretation as a wildcard symbol.

Figure 1. Query

```
SELECT * FROM cust_calls
WHERE res_descr LIKE '%!%%' ESCAPE '!';
```

The `ESCAPE` keyword designates an escape character (! in this example) that protects the next character so that it is interpreted as data and not as a wildcard. In the example, the escape character causes the middle percent sign (%) to be treated as data. By using the `ESCAPE` keyword, you can search for occurrences of a percent sign (%) in the `res_descr` column by using the `LIKE` wildcard percent sign (%). The query retrieves the following row.

Figure 2. Query result

```
customer_num 116
call_dtime 1997-12-21 11:24
user_id mannyn
call_code I
call_descr Second complaint from this customer!
Received two cases righthanded outfielder
glove (1 HRO) instead of one case lefties.
res_dtime 1997-12-27 08:19
res_descr Memo to shipping (Ava Brown) to send case
of lefthanded gloves, pick up wrong case;
memo to billing requesting 5% discount to
placate customer due to second offense
and lateness of resolution because of
holiday.
```

Subscripting in a WHERE clause

You can use *subscripting* in the WHERE clause of a SELECT statement to specify a range of characters or numbers in a column, as the following query shows. Figure 1. Query

```
SELECT catalog_num, stock_num, manu_code, cat_advert,
       cat_descr
FROM catalog
WHERE cat_advert[1,4] = 'High';
```

The subscript [1,4] causes the query to retrieve all rows in which the first four letters of the **cat_advert** column are *High*, as result shows. Figure 2. Query result

```
catalog_num 10004
stock_num 2
manu_code HRO
cat_advert Highest Quality Ball Available, from Hand-Sti
cat_descr tching to the Robinson Signature
Jackie Robinson signature ball. Highest professional quality,
used by National League.

catalog_num 10005
stock_num 3
manu_code HSK
cat_advert High-Technology Design Expands the Sweet Spot
cat_descr Pro-style wood. Available in sizes: 31, 32, 33, 34, 35.
:
catalog_num 10045
stock_num 204
manu_code KAR
cat_advert High-Quality Beginning Set of Irons. Appropriate
cat_descr for High School Competitions
Ideally balanced for optimum control. Nylon covered shaft.

catalog_num 10068
stock_num 310
manu_code ANZ
cat_advert High-Quality Kickboard
cat_descr White. Standard size.
```

FIRST clause to select specific rows

You can include a *FIRST max* specification in the Projection clause of a SELECT statement, where *max* has an integer value, to instruct the query to return no more than the first *max* rows that match the conditions of the SELECT statement. You can also use the keyword *LIMIT* as a synonym for *FIRST* in this context (and only in this context). The rows that a SELECT statement with a *FIRST* clause returns might depend on whether the statement also includes an *ORDER BY* clause.

The keyword *SKIP*, followed by an unsigned integer, can precede the *FIRST* or *LIMIT* keyword in the Projection clause. The *SKIP offset* clause instructs the database server to exclude the first *offset* qualifying rows from the result set of the query before returning the number of rows that the *FIRST* clause specifies. In SPL routines, the parameter of *SKIP*, *FIRST*, or *LIMIT* can be a literal integer or a local SPL variable. If the Projection clause includes *SKIP offset* but no *FIRST* or *LIMIT* specification, then the query returns all of the qualifying rows except for the first *offset* rows.

The Projection clause cannot include the *SKIP*, *FIRST*, or *LIMIT* keywords in these contexts:

- when the SELECT statement is part of a view definition
- in a subquery, except in the FROM clause of the outer query
- in a cross-server distributed query in which a participating database server does not support the *SKIP*, *FIRST*, or *LIMIT* keywords.

For information about restrictions on use of the *FIRST* clause, see the description of the Projection clause of the SELECT statement in the *IBM® Informix® Guide to SQL: Syntax*.

- [FIRST clause without an ORDER BY clause](#)
- [FIRST clause with an ORDER BY clause](#)

FIRST clause without an ORDER BY clause

If you do not include an ORDER BY clause in a SELECT statement with a FIRST clause, any rows that match the conditions of the SELECT statement might be returned. In other words, the database server determines which of the qualifying rows to return, and the query result can vary depending on the query plan that the optimizer chooses.

The following query uses the FIRST clause to return the first five rows from the **state** table.

Figure 1. Query

```
SELECT FIRST 5 * FROM state;
```

Figure 2. Query result

code	sname
AK	Alaska
HI	Hawaii
CA	California
OR	Oregon
WA	Washington

You can use a FIRST clause when you simply want to know the names of all the columns and the type of data that a table contains, or to test a query that otherwise would return many rows. The following query shows how to use the FIRST clause to return column values for the first row of a table.

Figure 3. Query

```
SELECT FIRST 1 * FROM orders;
```

Figure 4. Query result

order_num	1001
order_date	05/20/1998
customer_num	104
ship_instruct	express
backlog	n
po_num	B77836
ship_date	06/01/1998
ship_weight	20.40
ship_charge	\$10.00
paid_date	07/22/1998

FIRST clause with an ORDER BY clause

You can include an ORDER BY clause in a SELECT statement with a FIRST clause to return rows that contain the highest or lowest values for a specified column. The following query shows a query that includes an ORDER BY clause to return (by alphabetical order) the first five states contained in the **state** table. The query, which is the same as [Figure 1](#) except for the ORDER BY clause, returns a different set of rows than [Figure 1](#).

Figure 1. Query

```
SELECT FIRST 5 * FROM state ORDER BY sname;
```

Figure 2. Query result

code	sname
AL	Alabama
AK	Alaska
AZ	Arizona
AR	Arkansas
CA	California

The following query shows how to use a FIRST clause in a query with an ORDER BY clause to find the 10 most expensive items listed in the **stock** table.

Figure 3. Query

```
SELECT FIRST 10 description, unit_price  
FROM stock ORDER BY unit_price DESC;
```

Figure 4. Query result

description	unit_price
football	\$960.00
volleyball	\$840.00
baseball gloves	\$800.00
18-spd, assmbld	\$685.90
irons/wedge	\$670.00
basketball	\$600.00
12-spd, assmbld	\$549.00
10-spd, assmbld	\$499.99
football	\$480.00
bicycle brakes	\$480.00

Applications can use the SKIP and FIRST keywords of the Projection clause, in conjunction with the ORDER BY clause, to perform successive queries that incrementally retrieve all of the qualifying rows in subsets of some fixed size (for example, the maximum number of rows that are visible without scrolling a screen

display). You can accomplish this by incrementing the *offset* parameter of the SKIP clause by the *max* parameter of the FIRST clause after each query. By imposing a unique order on the qualifying rows, the ORDER BY clause ensures that each query returns a disjunct subset of the qualifying rows.

The following query shows a query that includes SKIP, FIRST, and ORDER BY specifications to return (by alphabetical order) the sixth through tenth states in the **state** table, but not the first five states. This query resembles [Figure 1](#), except that the SKIP 5 specification instructs the database server to return a different set of rows than [Figure 1](#).

Figure 5. Query

```
SELECT SKIP 5 FIRST 5 * FROM state ORDER BY sname;
```

Figure 6. Query result

code	sname
CO	Colorado
CT	Connecticut
DE	Delaware
FL	Florida
GA	Georgia

If you use the SKIP, FIRST, or LIMIT keywords, you must take care to specify parameters that correspond to the design goals of your application. If the *offset* parameter of skip is larger than the number of qualifying rows, then any FIRST or LIMIT specification has no effect, and the query returns nothing.

Expressions and derived values

You are not limited to selecting columns by name. You can list an *expression* in the Projection clause of a SELECT statement to perform computations on column data and to display information *derived* from the contents of one or more columns.

An expression consists of a column name, a constant, a quoted string, a keyword, or any combination of these items connected by operators. It can also include host variables (program data) when the SELECT statement is embedded in a program.

- [Arithmetic expressions](#)
- [CASE expressions](#)
- [Sorting on derived columns](#)

Arithmetic expressions

An arithmetic expression contains at least one of the arithmetic operators listed in the following table and produces a number.

Operator	Operation
+	addition
-	subtraction
*	multiplication
/	division

You cannot use TEXT or BYTE columns in arithmetic expressions.

With IBM® Informix®, you cannot specify BLOB or CLOB in arithmetic expressions.

Arithmetic operations enable you to see the results of proposed computations without actually altering the data in the database. You can add an INTO TEMP clause to save the altered data in a temporary table for further reference, computations, or impromptu reports. The following query calculates a 7 percent sales tax on the **unit_price** column when the **unit_price** is \$400 or more (but does not update it in the database).

Figure 1. Query

```
SELECT stock_num, description, unit_price, unit_price * 1.07
FROM stock
WHERE unit_price >= 400;
```

The result appears in the **expression** column.

Figure 2. Query result

stock_num	description	unit_price	(expression)
1	baseball gloves	\$800.00	\$856.00
1	baseball gloves	\$450.00	\$481.50
4	football	\$960.00	\$1027.20
4	football	\$480.00	\$513.60
7	basketball	\$600.00	\$642.00
8	volleyball	\$840.00	\$898.80
102	bicycle brakes	\$480.00	\$513.60
111	10-spd, assmbld	\$499.99	\$534.99
112	12-spd, assmbld	\$549.00	\$587.43
113	18-spd, assmbld	\$685.90	\$733.91
203	irons/wedge	\$670.00	\$716.90

The following query calculates a surcharge of \$6.50 on orders when the quantity ordered is less than 5.
Figure 3. Query

```
SELECT item_num, order_num, quantity,
       total_price, total_price + 6.50
FROM items
WHERE quantity < 5;
```

The result appears in the **expression** column.
Figure 4. Query result

item_num	order_num	quantity	total_price	(expression)
1	1001	1	\$250.00	\$256.50
1	1002	1	\$960.00	\$966.50
2	1002	1	\$240.00	\$246.50
1	1003	1	\$20.00	\$26.50
2	1003	1	\$840.00	\$846.50
1	1004	1	\$250.00	\$256.50
2	1004	1	\$126.00	\$132.50
3	1004	1	\$240.00	\$246.50
4	1004	1	\$800.00	\$806.50
⋮				
1	1023	2	\$40.00	\$46.50
2	1023	2	\$116.00	\$122.50
3	1023	1	\$80.00	\$86.50
4	1023	1	\$228.00	\$234.50
5	1023	1	\$170.00	\$176.50
6	1023	1	\$190.00	\$196.50

The following query calculates and displays in the **expression** column the interval between when the customer call was received (**call_dtime**) and when the call was resolved (**res_dtime**), in days, hours, and minutes.
Figure 5. Query

```
SELECT customer_num, call_code, call_dtime,
       res_dtime - call_dtime
FROM cust_calls
ORDER BY customer_num;
```

Figure 6. Query result

customer_num	call_code	call_dtime	(expression)
106	D	1998-06-12 08:20	0 00:05
110	L	1998-07-07 10:24	0 00:06
116	I	1997-11-28 13:34	0 03:13
116	I	1997-12-21 11:24	5 20:55
119	B	1998-07-01 15:00	0 17:21
121	O	1998-07-10 14:05	0 00:01
127	I	1998-07-31 14:30	

- [Display labels](#)

Display labels

You can assign a *display label* to a computed or derived data column to replace the default column header **expression**. In [Figure 1](#), [Figure 3](#), and [Figure 1](#), the derived data appears in the **expression** column. The following query also presents derived values, but the column that displays the derived values has the descriptive header **taxed**.

Figure 1. Query

```
SELECT stock_num, description, unit_price,
       unit_price * 1.07 taxed
FROM stock
WHERE unit_price >= 400;
```

The result shows that the label **taxed** is assigned to the expression in the projection list that displays the results of the operation `unit_price * 1.07`.
Figure 2. Query result

stock_num	description	unit_price	taxed
1	baseball gloves	\$800.00	\$856.00
1	baseball gloves	\$450.00	\$481.50
4	football	\$960.00	\$1027.20
4	football	\$480.00	\$513.60
7	basketball	\$600.00	\$642.00
8	volleyball	\$840.00	\$898.80
102	bicycle brakes	\$480.00	\$513.60
111	10-spd, assmbld	\$499.99	\$534.99
112	12-spd, assmbld	\$549.00	\$587.43
113	18-spd, assmbld	\$685.90	\$733.91
203	irons/wedge	\$670.00	\$716.90

In the following query, the label **surcharge** is defined for the column that displays the results of the operation `total_price + 6.50`.
Figure 3. Query

```
SELECT item_num, order_num, quantity,
       total_price, total_price + 6.50 surcharge
FROM items
WHERE quantity < 5;
```

The **surcharge** column is labeled in the output.

Figure 4. Query result

item_num	order_num	quantity	total_price	surcharge
1	1001	1	\$250.00	\$256.50
1	1002	1	\$960.00	\$966.50
2	1002	1	\$240.00	\$246.50
1	1003	1	\$20.00	\$26.50
2	1003	1	\$840.00	\$846.50
⋮				
1	1023	2	\$40.00	\$46.50
2	1023	2	\$116.00	\$122.50
3	1023	1	\$80.00	\$86.50
4	1023	1	\$228.00	\$234.50
5	1023	1	\$170.00	\$176.50
6	1023	1	\$190.00	\$196.50

The following query assigns the label **span** to the column that displays the results of subtracting the DATETIME column **call_dtime** from the DATETIME column **res_dtime**.

Figure 5. Query

```
SELECT customer_num, call_code, call_dtime,
       res_dtime - call_dtime span
FROM cust_calls
ORDER BY customer_num;
```

The **span** column is labeled in the output.

Figure 6. Query result

customer_num	call_code	call_dtime	span
106	D	1998-06-12 08:20	0 00:05
110	L	1998-07-07 10:24	0 00:06
116	I	1997-11-28 13:34	0 03:13
116	I	1997-12-21 11:24	5 20:55
119	B	1998-07-01 15:00	0 17:21
121	O	1998-07-10 14:05	0 00:01
127	I	1998-07-31 14:30	

CASE expressions

A CASE expression is a conditional expression, which is similar to the concept of the CASE statement in programming languages. You can use a CASE expression when you want to change the way data is represented. The CASE expression allows a statement to return one of several possible results, depending on which of several condition tests evaluates to TRUE.

TEXT or BYTE values are not allowed in a CASE expression.

Consider a column that represents marital status numerically as 1, 2, 3, 4 with the corresponding values meaning single, married, divorced, widowed. In some cases, you might prefer to store the short values (1, 2, 3, 4) for database efficiency, but employees in human resources might prefer the more descriptive values (single, married, divorced, widowed). The CASE expression makes such conversions between different sets of values easy.

In IBM® Informix®, the CASE expression also supports extended data types and cast expressions.

The following example shows a CASE expression with multiple WHEN clauses that returns more descriptive values for the **manu_code** column of the **stock** table. If none of the WHEN conditions is true, NULL is the default result. (You can omit the ELSE NULL clause.)

```
SELECT
CASE
  WHEN manu_code = "HRO" THEN "Hero"
  WHEN manu_code = "SHM" THEN "Shimara"
  WHEN manu_code = "PRC" THEN "ProCycle"
  WHEN manu_code = "ANZ" THEN "Anza"
  ELSE NULL
END
FROM stock;
```

You must include at least one WHEN clause within the CASE expression; subsequent WHEN clauses and the ELSE clause are optional. If no WHEN condition evaluates to true, the resulting value is NULL. You can use the IS NULL expression to handle NULL results. For information on handling NULL values, see the *IBM Informix Guide to SQL: Syntax*.

The following query shows a simple CASE expression that returns a character string value to flag any orders from the **orders** table that have not been shipped to the customer.

Figure 1. Query

```
SELECT order_num, order_date,
CASE
  WHEN ship_date IS NULL
  THEN "order not shipped"
```

```
END
FROM orders;
```

Figure 2. Query result

```
order_num order_date (expression)
1001 05/20/1998
1002 05/21/1998
1003 05/22/1998
1004 05/22/1998
1005 05/24/1998
1006 05/30/1998 order not shipped
1007 05/31/1998
:
1019 07/11/1998
1020 07/11/1998
1021 07/23/1998
1022 07/24/1998
1023 07/24/1998
```

For information about how to use the CASE expression to update a column, see [CASE expression to update a column](#).

Sorting on derived columns

When you want to use ORDER BY on an expression, you can use either the display label assigned to the expression or an integer, as [Figure 1](#) and [Figure 3](#) show.

Figure 1. Query

```
SELECT customer_num, call_code, call_dtime,
       res_dtime - call_dtime span
FROM cust_calls
ORDER BY span;
```

The query retrieves the same data from the **cust_calls** table as [Figure 5](#). In the query, the ORDER BY clause causes the data to be displayed in ascending order of the derived values in the **span** column, as the result shows.

Figure 2. Query result

customer_num	call_code	call_dtime	span
127	I	1998-07-31 14:30	
121	O	1998-07-10 14:05	0 00:01
106	D	1998-06-12 08:20	0 00:05
110	L	1998-07-07 10:24	0 00:06
116	I	1997-11-28 13:34	0 03:13
119	B	1998-07-01 15:00	0 17:21
116	I	1997-12-21 11:24	5 20:55

The following query uses an integer to represent the result of the operation `res_dtime - call_dtime` and retrieves the same rows that appear in the above result.

Figure 3. Query

```
SELECT customer_num, call_code, call_dtime,
       res_dtime - call_dtime span
FROM cust_calls
ORDER BY 4;
```

Rowid values in SELECT statements

The database server assigns a unique *rowid* to rows in nonfragmented tables. The rowid is, in effect, a hidden column in every table. The sequential values of rowid have no special significance and can vary depending on the location of the physical data in the chunk. You can use a rowid to locate the internal record number that is associated with a row in a table. Rows in fragmented tables do not automatically contain the rowid column.

It is recommended that you use primary keys as a method of access in your applications rather than rowids. Because primary keys are defined in the ANSI specification of SQL, using them to access data makes your applications more portable. In addition, the database server requires less time to access data in a fragmented table when it uses a primary key than it requires to access the same data when it uses rowid.

For more information about rowids, see the *IBM® Informix® Database Design and Implementation Guide* and your *IBM Informix Administrator's Guide*.

The following query uses the rowid and the wildcard asterisk symbol (*) in the Projection clause to retrieve each row in the **manufact** table and its corresponding rowid.

Figure 1. Query

```
SELECT rowid, * FROM manufact;
```

Figure 2. Query result

rowid	manu_code	manu_name	lead_time
257	SMT	Smith	3
258	ANZ	Anza	5
259	NRG	Norge	7

260	HSK	Husky	5
261	HRO	Hero	4
262	SHM	Shimara	30
263	KAR	Karsten	21
264	NKL	Nikolus	8
265	PRC	ProCycle	9

Never store a rowid in a permanent table or attempt to use it as a foreign key. If a table is dropped and then reloaded from external data, all the rowids will be different.

Multiple-table SELECT statements

To select data from two or more tables, specify the table names in the FROM clause. Add a WHERE clause to create a join condition between at least one related column in each table. This WHERE clause creates a temporary composite table in which each pair of rows that satisfies the join condition is linked to form a single row.

A *simple join* combines information from two or more tables based on the relationship between one column in each table. A *composite join* is a join between two or more tables based on the relationship between two or more columns in each table.

To create a join, you must specify a relationship, called a *join condition*, between at least one column from each table. Because the columns are being compared, they must have compatible data types. When you join large tables, performance improves when you index the columns in the join condition.

Data types are described in the *IBM® Informix® Guide to SQL: Reference* and the *IBM Informix Database Design and Implementation Guide*. Indexing is discussed in detail in the *IBM Informix Administrator's Guide*.

- [Create a Cartesian product](#)
- [Create a join](#)
- [Some query shortcuts](#)

Create a Cartesian product

When you perform a multiple-table query that does not explicitly state a join condition among the tables, you create a *Cartesian product*. A Cartesian product consists of every possible combination of rows from the tables. This result is usually large and unwieldy.

The following query selects from two tables and produces a Cartesian product.

Figure 1. Query

```
SELECT * FROM customer, state;
```

Although only 52 rows exist in the **state** table and 28 rows in the **customer** table, the effect of the query is to multiply the rows of one table by the rows of the other and retrieve an impractical 1,456 rows, as the result shows.

Figure 2. Query result

```
customer_num  101
fname         Ludwig
lname        Pauli
company       All Sports Supplies
address1      213 Erstwild Court
address2
city          Sunnyvale
state         CA
zipcode       94086
phone         408-789-8075
code          AK
sname         Alaska

customer_num  101
fname         Ludwig
lname        Pauli
company       All Sports Supplies
address1      213 Erstwild Court
address2
city          Sunnyvale
state         CA
zipcode       94086
phone         408-789-8075
code          HI
sname         Hawaii

customer_num  101
fname         Ludwig
lname        Pauli
company       All Sports Supplies
address1      213 Erstwild Court
address2
city          Sunnyvale
state         CA
zipcode       94086
phone         408-789-8075
code          CA
```

```
sname      California
:
```

In addition, some of the data that is displayed in the concatenated rows is contradictory. For example, although the **city** and **state** from the **customer** table indicate an address in California, the **code** and **sname** from the **state** table might be for a different state.

Create a join

Conceptually, the first stage of any join is the creation of a Cartesian product. To refine or constrain this Cartesian product and eliminate meaningless combinations of rows of data, include a WHERE clause with a valid join condition in your SELECT statement.

This section illustrates *cross joins*, *equi-joins*, *natural joins*, and *multiple-table joins*. Additional complex forms, such as *self-joins* and *outer joins*, are discussed in [Compose advanced SELECT statements](#).

- [Cross join](#)
- [Equi-join](#)
- [Natural join](#)
- [Multiple-table join](#)

Cross join

A *cross join* combines all rows in all tables selected and creates a Cartesian product. The results of a cross join can be very large and difficult to manage.

The following query uses ANSI join syntax to create a cross join.

Figure 1. Query

```
SELECT * FROM customer CROSS JOIN state;
```

The results of the query are identical to the results of [Figure 1](#). In addition, you can filter a cross join by specifying a WHERE clause.

For more information about Cartesian products, see [Create a Cartesian product](#). For more information about ANSI syntax, see [ANSI join syntax](#).

Equi-join

An *equi-join* is a join based on equality or matching column values. This equality is indicated with an equal sign (=) as the comparison operator in the WHERE clause, as the following query shows.

Figure 1. Query

```
SELECT * FROM manufact, stock
WHERE manufact.manu_code = stock.manu_code;
```

The query joins the **manufact** and **stock** tables on the **manu_code** column. It retrieves only those rows for which the values of the two columns are equal, some of which the result shows.

Figure 2. Query result

```
manu_code      SMT
manu_name      Smith
lead_time      3
stock_num      1
manu_code      SMT
description     baseball gloves
unit_price     $450.00
unit           case
unit_descr     10 gloves/case
```

```
manu_code      SMT
manu_name      Smith
lead_time      3
stock_num      5
manu_code      SMT
description     tennis racquet
unit_price     $25.00
unit           each
unit_descr     each
```

```
manu_code      SMT
manu_name      Smith
lead_time      3
stock_num      6
manu_code      SMT
description     tennis ball
unit_price     $36.00
unit           case
unit_descr     24 cans/case
```

```
manu_code      ANZ
manu_name      Anza
```

```

lead_time      5
stock_num      5
manu_code      ANZ
description    tennis racquet
unit_price     $19.80
unit           each
unit_descr     each
:

```

In this equi-join, the result includes the **manu_code** column from both the **manufact** and **stock** tables because the select list requested every column.

You can also create an equi-join with additional constraints, where the comparison condition is based on the inequality of values in the joined columns. These joins use a relational operator in addition to the equal sign (=) in the comparison condition that is specified in the WHERE clause.

To join tables that contain columns with the same name, qualify each column name with the name of its table and a period symbol (.), as the following query shows. Figure 3. Query

```

SELECT order_num, order_date, ship_date, cust_calls.*
FROM orders, cust_calls
WHERE call_dtime >= ship_date
AND cust_calls.customer_num = orders.customer_num
ORDER BY orders.customer_num;

```

The query joins the **customer_num** column and then selects only those rows where the **call_dtime** in the **cust_calls** table is greater than or equal to the **ship_date** in the **orders** table. The result shows the combined rows that it returns.

Figure 4. Query result

```

order_num      1004
order_date     05/22/1998
ship_date      05/30/1998
customer_num    106
call_dtime     1998-06-12 08:20
user_id        maryj
call_code      D
call_descr     Order received okay, but two of the cans of
               ANZ tennis balls within the case were empty
res_dtime      1998-06-12 08:25
res_descr      Authorized credit for two cans to customer,
               issued apology. Called ANZ buyer to report
               the qa problem.

order_num      1008
order_date     06/07/1998
ship_date      07/06/1998
customer_num    110
call_dtime     1998-07-07 10:24
user_id        richc
call_code      L
call_descr     Order placed one month ago (6/7) not received.
res_dtime      1998-07-07 10:30
res_descr      Checked with shipping (Ed Smith). Order out
               yesterday-was waiting for goods from ANZ.
               Next time will call with delay if necessary.

order_num      1023
order_date     07/24/1998
ship_date      07/30/1998
customer_num    127
call_dtime     1998-07-31 14:30
user_id        maryj
call_code      I
call_descr     Received Hero watches (item # 304) instead
               of ANZ watches
res_dtime
res_descr      Sent memo to shipping to send ANZ item 304
               to customer and pickup HRO watches. Should
               be done tomorrow, 8/1

```

Natural join

A *natural join* is a type of equi-join and is structured so that the join column does not display data redundantly, as the following query shows.

Figure 1. Query

```

SELECT manu_name, lead_time, stock.*
FROM manufact, stock
WHERE manufact.manu_code = stock.manu_code;

```

Like the example for equi-join, the query joins the **manufact** and **stock** tables on the **manu_code** column. Because the Projection list is more closely defined, the **manu_code** is listed only once for each row retrieved, as the result shows.

Figure 2. Query result

```

manu_name      Smith
lead_time      3
stock_num      1
manu_code      SMT
description     baseball gloves

```

```

unit_price    $450.00
unit          case
unit_descr    10 gloves/case

```

```

manu_name     Smith
lead_time     3
stock_num     5
manu_code     SMT
description   tennis racquet
unit_price    $25.00
unit          each
unit_descr    each

```

```

manu_name     Smith
lead_time     3
stock_num     6
manu_code     SMT
description   tennis ball
unit_price    $36.00
unit          case
unit_descr    24 cans/case

```

```

manu_name     Anza
lead_time     5
stock_num     5
manu_code     ANZ
description   tennis racquet
unit_price    $19.80
unit          each
unit_descr    each
:

```

All joins are *associative*; that is, the order of the joining terms in the WHERE clause does not affect the meaning of the join.

Both statements in the following query create the same natural join.

Figure 3. Query

```

SELECT catalog.*, description, unit_price, unit, unit_descr
FROM catalog, stock
WHERE catalog.stock_num = stock.stock_num
AND catalog.manu_code = stock.manu_code
AND catalog_num = 10017;

```

```

SELECT catalog.*, description, unit_price, unit, unit_descr
FROM catalog, stock
WHERE catalog_num = 10017
AND catalog.manu_code = stock.manu_code
AND catalog.stock_num = stock.stock_num;

```

Each statement retrieves the following row.

Figure 4. Query result

```

catalog_num    10017
stock_num      101
manu_code      PRC
cat_descr      Reinforced, hand-finished tubular. Polyurethane belted.
Effective against punctures. Mixed tread for super wear
and road grip.
cat_picture    <BYTE value>

cat_advert     Ultimate in Puncture Protection, Tires
               Designed for In-City Riding
description    bicycle tires
unit_price     $88.00
unit           box
unit_descr     4/box

```

Figure 3 includes a TEXT column, **cat_descr**; a BYTE column, **cat_picture**; and a VARCHAR column, **cat_advert**.

Multiple-table join

A *multiple-table join* connects more than two tables on one or more associated columns; it can be an equi-join or a natural join.

The following query creates an equi-join on the **catalog**, **stock**, and **manufact** tables.

Figure 1. Query

```

SELECT * FROM catalog, stock, manufact
WHERE catalog.stock_num = stock.stock_num
AND stock.manu_code = manufact.manu_code
AND catalog_num = 10025;

```

The query retrieves the following rows.

Figure 2. Query result

```

catalog_num    10025
stock_num      106

```

```
manu_code      PRC
cat_descr
Hard anodized alloy with pearl finish; 6mm hex bolt hard ware.
Available in lengths of 90-140mm in 10mm increments.
cat_picture    <BYTE value>
```

```
cat_advert     ProCycle Stem with Pearl Finish
stock_num      106
manu_code      PRC
description     bicycle stem
unit_price      $23.00
unit           each
unit_descr     each
manu_code      PRC
manu_name       ProCycle
lead_time       9
```

The **manu_code** is repeated three times, once for each table, and **stock_num** is repeated twice.

To avoid the considerable duplication of a multiple-table query such as [Figure 1](#), include specific columns in the projection list to define the SELECT statement more closely, as the following query shows.

Figure 3. Query

```
SELECT catalog.*, description, unit_price, unit,
       unit_descr, manu_name, lead_time
FROM catalog, stock, manufact
WHERE catalog.stock_num = stock.stock_num
      AND stock.manu_code = manufact.manu_code
      AND catalog_num = 10025;
```

The query uses a wildcard to select all columns from the table with the most columns and then specifies columns from the other two tables. The result shows the natural join that the query produces. It displays the same information as the previous example, but without duplication.

Figure 4. Query result

```
catalog_num    10025
stock_num      106
manu_code      PRC
cat_descr
Hard anodized alloy with pearl finish. 6mm hex bolt
hardware. Available in lengths of 90-140mm in 10mm increments.
cat_picture    <BYTE value>

cat_advert     ProCycle Stem with Pearl Finish
description     bicycle stem
unit_price      $23.00
unit           each
unit_descr     each
manu_name       ProCycle
lead_time       9
```

Some query shortcuts

You can use aliases, the INTO TEMP clause, and display labels to speed your way through joins and multiple-table queries and to produce output for other uses.

- [Aliases](#)
- [The INTO TEMP clause](#)

Aliases

You can assign aliases to the tables in the FROM clause of a SELECT statement to make multiple-table queries shorter and more readable. You can use an alias wherever the table name would be used, for instance, as a prefix to the column names in the other clauses.

Figure 1. Query

```
SELECT s.stock_num, s.manu_code, s.description,
       s.unit_price, c.catalog_num,
       c.cat_advert, m.lead_time
FROM stock s, catalog c, manufact m
WHERE s.stock_num = c.stock_num
      AND s.manu_code = c.manu_code
      AND s.manu_code = m.manu_code
      AND s.manu_code IN ('HRO', 'HSK')
      AND s.stock_num BETWEEN 100 AND 301
ORDER BY catalog_num;
```

The associative nature of the SELECT statement allows you to use an alias before you define it. In the query above, the aliases **s** for the **stock** table, **c** for the **catalog** table, and **m** for the **manufact** table are specified in the FROM clause and used throughout the SELECT and WHERE clauses as column prefixes.

Compare the length of [Figure 1](#) with the following query, which does not use aliases.

Figure 2. Query

```
SELECT stock.stock_num, stock.manu_code, stock.description,
       stock.unit_price, catalog.catalog_num,
```



```

        catalog.cat_advert,
        manufact.lead_time
FROM stock, catalog, manufact
WHERE stock.stock_num = catalog.stock_num
      AND stock.manu_code = catalog.manu_code
      AND stock.manu_code = manufact.manu_code
      AND stock.manu_code IN ('HRO', 'HSK')
      AND stock.stock_num BETWEEN 100 AND 301
ORDER BY catalog_num;

```

Figure 1 and Figure 2 are equivalent and retrieve the data that the following query shows.
Figure 3. Query result

```

stock_num      110
manu_code      HRO
description     helmet
unit_price     $260.00
catalog_num    10033
cat_advert     Lightweight Plastic with Vents Assures Cool
               Comfort Without Sacrificing Protection
lead_time      4

stock_num      110
manu_code      HSK
description     helmet
unit_price     $308.00
catalog_num    10034
cat_advert     Teardrop Design Used by Yellow Jerseys; You
               Can Time the Difference
lead_time      5
:

```

You cannot use the ORDER BY clause for the TEXT column **cat_descr** or the BYTE column **cat_picture**.

You can use aliases to shorten your queries on tables that are not in the current database.

The following query joins columns from two tables that reside in different databases and systems, neither of which is the current database or system.
Figure 4. Query

```

SELECT order_num, lname, fname, phone
FROM masterdb@central:customer c, sales@western:orders o
WHERE c.customer_num = o.customer_num
      AND order_num <= 1010;

```

By assigning the aliases c and o to the long *database@system:table* names, **masterdb@central:customer** and **sales@western:orders**, respectively, you can use the aliases to shorten the expression in the WHERE clause and retrieve the data, as the result shows.

Figure 5. Query result

order_num	lname	fname	phone
1001	Higgins	Anthony	415-368-1100
1002	Pauli	Ludwig	408-789-8075
1003	Higgins	Anthony	415-368-1100
1004	Watson	George	415-389-8789
1005	Parmelee	Jean	415-534-8822
1006	Lawson	Margaret	415-887-7235
1007	Sipes	Arnold	415-245-4578
1008	Jaeger	Roy	415-743-3611
1009	Keyes	Frances	408-277-7245
1010	Grant	Alfred	415-356-1123

For more information on how to access tables that are not in the current database, see [Access other database servers](#) and the *IBM® Informix® Guide to SQL: Syntax*.

You can also use synonyms as shorthand references to the long names of tables that are not in the current database as well as current tables and views. For details on how to create and use synonyms, see the *IBM Informix Database Design and Implementation Guide*.

The INTO TEMP clause

By adding an INTO TEMP clause to your SELECT statement, you can temporarily save the results of a multiple-table query in a separate table that you can query or manipulate without modifying the database. Temporary tables are dropped when you end your SQL session or when your program or report terminates.

The following query creates a temporary table called **stockman** and stores the results of the query in it. Because all columns in a temporary table must have names, the alias **adj_price** is required.

Figure 1. Query

```

SELECT DISTINCT stock_num, manu_name, description,
               unit_price, unit_price * 1.05 adj_price
FROM stock, manufact
WHERE manufact.manu_code = stock.manu_code
INTO TEMP stockman;
SELECT * from stockman;

```

Figure 2. Query result

stock_num	manu_name	description	unit_price	adj_price
-----------	-----------	-------------	------------	-----------

1	Hero	baseball gloves	\$250.00	\$262.5000
1	Husky	baseball gloves	\$800.00	\$840.0000
1	Smith	baseball gloves	\$450.00	\$472.5000
2	Hero	baseball	\$126.00	\$132.3000
3	Husky	baseball bat	\$240.00	\$252.0000
4	Hero	football	\$480.00	\$504.0000
4	Husky	football	\$960.00	\$1008.0000
⋮				
306	Shimara	tandem adapter	\$190.00	\$199.5000
307	ProCycle	infant jogger	\$250.00	\$262.5000
308	ProCycle	twin jogger	\$280.00	\$294.0000
309	Hero	ear drops	\$40.00	\$42.0000
309	Shimara	ear drops	\$40.00	\$42.0000
310	Anza	kick board	\$84.00	\$88.2000
310	Shimara	kick board	\$80.00	\$84.0000
311	Shimara	water gloves	\$48.00	\$50.4000
312	Hero	racer goggles	\$72.00	\$75.6000
312	Shimara	racer goggles	\$96.00	\$100.8000
313	Anza	swim cap	\$60.00	\$63.0000
313	Shimara	swim cap	\$72.00	\$75.6000

You can query this table and join it with other tables, which avoids a multiple sort and lets you move more quickly through the database. For more information on temporary tables, see the *IBM® Informix® Guide to SQL: Syntax* and the *IBM Informix Administrator's Guide*.

Summary

This chapter presented syntax examples and results for basic kinds of SELECT statements that are used to query a relational database. The section [Single-table SELECT statements](#) shows how to perform the following actions:

- Select columns and rows from a table with the Projection and FROM clauses
- Select rows from a table with the Projection, FROM, and WHERE clauses
- Use the DISTINCT or UNIQUE keyword in the Projection clause to eliminate duplicate rows from query results
- Sort retrieved data with the ORDER BY clause and the DESC keyword
- Select and order data values that contain non-English characters
- Use the BETWEEN, IN, MATCHES, and LIKE keywords and various relational operators in the WHERE clause to create comparison conditions
- Create comparison conditions that include values, exclude values, find a range of values (with keywords, relational operators, and subscripting), and find a subset of values
- Use exact-text comparisons, variable-length wildcards, and restricted and unrestricted wildcards to perform variable text searches
- Use the logical operators AND, OR, and NOT to connect search conditions or Boolean expressions in a WHERE clause
- Use the ESCAPE keyword to protect special characters in a query
- Search for NULL values with the IS NULL and IS NOT NULL keywords in the WHERE clause
- Use the FIRST clause to specify that a query returns only a specified number of the rows that match the conditions of the SELECT statement
- Use arithmetic operators in the Projection clause to perform computations on number fields and display derived data
- Assign display labels to computed columns as a formatting tool for reports

This chapter also introduced simple join conditions that enable you to select and display data from two or more tables. The section [Multiple-table SELECT statements](#) describes how to perform the following actions:

- Create a Cartesian product
- Create a CROSS JOIN, which creates a Cartesian product
- Include a WHERE clause with a valid join condition in your query to constrain a Cartesian product
- Define and create a natural join and an equi-join
- Join two or more tables on one or more columns
- Use aliases as a shortcut in multiple-table queries
- Retrieve selected data into a separate, temporary table with the INTO TEMP clause to perform computations outside the database

Select data from complex types

This chapter describes how to query *complex data types*. A complex data type is built from a combination of other data types with an SQL type constructor. An SQL statement can access individual components within the complex type. Complex data types are *row types* or *collection types*.

ROW types have instances that combine one or more related data fields. The two kinds of ROW types are *named* and *unnamed*.

Collection types have instances where each collection value contains a group of elements of the same data type, which can be any fundamental or complex data type. A collection can consist of a LIST, SET, or MULTISSET datatype.

Important: There is no cross-database support for complex data types. They can only be manipulated in local databases.

For a more complete description of the data types that the database server supports, see the chapter on data types in the *IBM® Informix® Guide to SQL: Reference*.

For information about how to create and use complex types, see the *IBM Informix Database Design and Implementation Guide*, *IBM Informix Guide to SQL: Reference*, and *IBM Informix Guide to SQL: Syntax*.

- [Select row-type data](#)
- [Select from a collection](#)
- [Select rows within a table hierarchy](#)
- [Summary](#)

Select row-type data

This section describes how to query data that is defined as row-type data. A ROW type is a complex type that combines one or more related data fields.

The two kinds of ROW types are as follows:

Named ROW type

A named ROW type can define tables, columns, fields of another row-type column, program variables, statement local variables, and routine return values.

Unnamed ROW type

An unnamed ROW type can define columns, fields of another row-type column, program variables, statement local variables, routine return values, and constants.

The examples used throughout this section use the named ROW types **zip_t**, **address_t**, and **employee_t**, which define the **employee** table. The following figure shows the SQL syntax that creates the ROW types and table.

Figure 1. SQL syntax that creates the ROW types and table.

```
CREATE ROW TYPE zip_t
(
  z_code    CHAR(5),
  z_suffix  CHAR(4)
)

CREATE ROW TYPE address_t
(
  street    VARCHAR(20),
  city      VARCHAR(20),
  state     CHAR(2),
  zip       zip_t
)

CREATE ROW TYPE employee_t
(
  name      VARCHAR(30),
  address   address_t,
  salary    INTEGER
)

CREATE TABLE employee OF TYPE employee_t
```

The named ROW types **zip_t**, **address_t** and **employee_t** serve as templates for the fields and columns of the typed table, **employee**. A *typed table* is a table that is defined on a named ROW type. The **employee_t** type that serves as the template for the **employee** table uses the **address_t** type as the data type of the **address** field. The **address_t** type uses the **zip_t** type as the data type of the **zip** field.

The following figure shows the SQL syntax that creates the **student** table. The **s_address** column of the **student** table is defined on an unnamed ROW type. (The **s_address** column could also have been defined as a named ROW type.)

Figure 2. SQL syntax that creates the student table.

```
CREATE TABLE student
(
  s_name      VARCHAR(30),
  s_address   ROW(street VARCHAR(20), city VARCHAR(20),
                  state CHAR(2), zip VARCHAR(9)),
  grade_point_avg DECIMAL(3,2)
)
```

- [Select columns of a typed table](#)
- [Select columns that contain row-type data](#)

Select columns of a typed table

A query on a typed table is no different from a query on any other table. For example, the following query uses the asterisk symbol (*) to specify a SELECT statement that returns all columns of the **employee** table.

Figure 1. Query

```
SELECT * FROM employee
```

The SELECT statement on the **employee** table returns all rows for all columns.

Figure 2. Query result

name	Paul, J.
address	ROW(102 Ruby, Belmont, CA, 49932, 1000)
salary	78000
name	Davis, J.
address	ROW(133 First, San Jose, CA, 85744, 4900)
salary	75000
:	:

The following query shows how to construct a query that returns rows for the **name** and **address** columns of the **employee** table.

Figure 3. Query

```
SELECT name, address FROM employee
```

Figure 4. Query result

name	Paul, J.
address	ROW(102 Ruby, Belmont, CA, 49932, 1000)
name	Davis, J.
address	ROW(133 First, San Jose, CA, 85744, 4900)
:	:

Select columns that contain row-type data

A *row-type column* is a column that is defined on a named ROW type or unnamed ROW type. You use the same SQL syntax to query a named ROW type and an unnamed row-type column.

A query on a row-type column returns data from all the fields of the ROW type. A *field* is a component data type within a ROW type. For example, the **address** column of the **employee** table contains the **street**, **city**, **state**, and **zip** fields. The following query shows how to construct a query that returns all fields of the **address** column.

Figure 1. Query

```
SELECT address FROM employee
```

Figure 2. Query result

address	ROW(102 Ruby, Belmont, CA, 49932, 1000)
address	ROW(133 First, San Jose, CA, 85744, 4900)
address	ROW(152 Topaz, Willits, CA, 69445, 1000)
:	:

To access individual fields that a column contains, use single-dot notation to project the individual fields of the column. For example, suppose you want to access specific fields from the **address** column of the **employee** table. The following SELECT statement projects the **city** and **state** fields from the **address** column.

Figure 3. Query

```
SELECT address.city, address.state FROM employee
```

Figure 4. Query result

city	state
Belmont	CA
San Jose	CA
Willits	CA
:	:

You construct a query on an unnamed row-type column in the same way you construct a query on a named row-type column. For example, suppose you want to access data from the **s_address** column of the **student** table in [Figure 2](#). You can use *dot notation* to query the individual fields of a column that are defined on an unnamed row type. The following query shows how to construct a SELECT statement on the **student** table that returns rows for the **city** and **state** fields of the **s_address** column.

Figure 5. Query

```
SELECT s_address.city, s_address.state FROM student
```

Figure 6. Query result

city	state
Belmont	CA
Mount Prospect	IL
Greeley	CO
:	:

- [Field projections](#)
- [Field projections to select nested fields](#)
- [Asterisk notation to access all fields of a row type](#)

Field projections

Do not confuse fields with columns. Columns are only associated with tables, and column projections use conventional dot notation of the form `name_1.name_2` for a table and column, respectively. A *field* is a component data type within a ROW type. With ROW types (and the capability to assign a ROW type to a single column), you can project individual fields of a column with single dot notation of the form: `name_a.name_b.name_c.name_d`. IBM® Informix® database servers use the following precedence rules to interpret dot notation:

1. `table_name_a.column_name_b.field_name_c.field_name_d`
2. `column_name_a.field_name_b.field_name_c.field_name_d`

When the meaning of a particular identifier is ambiguous, the database server uses precedence rules to determine which database object the identifier specifies. Consider the following two statements:

```
CREATE TABLE b (c ROW(d INTEGER, e CHAR(2)))
CREATE TABLE c (d INTEGER)
```

In the following SELECT statement, the expression `c.d` references column **d** of table **c** (rather than field **d** of column **c** in table **b**) because a table identifier has a higher precedence than a column identifier:

```
SELECT * FROM b,c WHERE c.d = 10
```

To avoid referencing the wrong database object, you can specify the full notation for a field projection. Suppose, for example, you want to reference field **d** of column **c** in table **b** (not column **d** of table **c**). The following statement specifies the table, column, and field identifiers of the object you want to reference:

```
SELECT * FROM b,c WHERE b.c.d = 10
```

Important: Although precedence rules reduce the chance of the database server misinterpreting field projections, it is recommended that you use unique names for all table, column, and field identifiers.

Field projections to select nested fields

Typically the row type is a column, but you can use any row-type expression for field projection. When the row-type expression itself contains other row types, the expression contains nested fields. To access nested fields within an expression or individual fields, use dot notation. To access all the fields of the row type, use an asterisk (*). This section describes both methods of row-type access.

For a discussion of how to use dot notation and asterisk notation with row-type expressions, see the Expression segment in the *IBM® Informix® Guide to SQL: Syntax*.

- [Select individual fields of a row type](#)

Select individual fields of a row type

Consider the **address** column of the **employee** table, which contains the fields **street**, **city**, **state**, and **zip**. In addition, the **zip** field contains the nested fields: **z_code** and **z_suffix**. (You might want to review the row type and table definitions of [Figure 1](#).) A query on the **zip** field returns rows for the **z_code** and **z_suffix** fields. However, you can specify that a query returns only specific nested fields. The following query shows how to use dot notation to construct a SELECT statement that returns rows for the **z_code** field of the **address** column only.

Figure 1. Query

```
SELECT address.zip.z_code FROM employee
```

Figure 2. Query result

```
z_code
39444
6500
76055
19004
⋮
```

Asterisk notation to access all fields of a row type

Asterisk notation is supported only within the select list of a SELECT statement. When you specify the column name for a row-type column in a projection list, the database server returns values for all fields of the column. You can also use asterisk notation when you want to project all the fields within a ROW type.

The following query uses asterisk notation to return all fields of the **address** column in the **employee** table.

Figure 1. Query

```
SELECT address.* FROM employee;
```

Figure 2. Query result

```
address  ROW(102 Ruby, Belmont, CA, 49932, 1000)
address  ROW(133 First, San Jose, CA, 85744, 4900)
address  ROW(152 Topaz, Willits, CA, 69445, 1000)
⋮
```

The asterisk notation makes it easier to perform some SQL tasks. Suppose you create a function **new_row()** that returns a row-type value and you want to call this function and insert the row that is returned into a table. The database server provides no easy way to handle such operations. However, the following query shows how to use asterisk notation to return all fields of **new_row()** and insert the returned fields into the **tab_2** table.

Figure 3. Query

```
INSERT INTO tab_2 SELECT new_row(exp).* FROM tab_1
```

For information about how to use the INSERT statement, see [Modify data](#).

Important: An expression that uses the `. *` notation is evaluated only once.

Select from a collection

This section describes how to query columns that are defined on collection types. A *collection type* is a complex data type in which each collection value contains a group of elements of the same data type. For a detailed description of collection data types, see the *IBM® Informix® Database Design and Implementation Guide*. For information about how to access the individual elements that a collection contains, see [Handle collections in SELECT statements](#).

The following figure shows the **manager** table, which is used in examples throughout this section. The **manager** table contains both simple and nested collection types. A *simple collection* is a collection type that does not contain any fields that are themselves collection types. The **direct_reports** column of the **manager** table is a simple collection. A *nested collection* is a collection type that contains another collection type. The **projects** column of the **manager** table is a nested collection. Figure 1. The manager table

```
CREATE TABLE manager
(
  mgr_name      VARCHAR(30),
  department    VARCHAR(12),
  direct_reports SET(VARCHAR(30) NOT NULL),
  projects      LIST(ROW(pro_name VARCHAR(15),
                        pro_members SET(VARCHAR(20) NOT NULL)
                        ) NOT NULL)
)
```

A query on a column that is a collection type returns, for each row in the table, all the elements that the particular collection contains. For example, the following query shows a query that returns data in the **department** column and all elements in the **direct_reports** column for each row of the **manager** table.

Figure 2. Query

```
SELECT department, direct_reports FROM manager
```

Figure 3. Query result

department	marketing
direct_reports	SET {Smith, Waters, Adams, Davis, Kurasawa}
department	engineering
direct_reports	SET {Joshi, Davis, Smith, Waters, Fosmire, Evans, Jones}
department	publications
direct_reports	SET {Walker, Fremont, Porat, Johnson}
department	accounting
direct_reports	SET {Baker, Freeman, Jacobs}
:	:

The output of a query on a collection type always includes the type constructor that specifies whether the collection is a SET, MULTISET, or LIST. For example, in the result, the SET constructor precedes the elements of each collection. Braces ({}) demarcate the elements of a collection; commas separate individual elements of a collection.

- [Select nested collections](#)
- [The IN keyword to search for elements in a collection](#)

Select nested collections

The **projects** column of the **manager** table (see [Figure 1](#)) is a nested collection. A query on a nested collection type returns all the elements that the particular collection contains. The following query shows a query that returns all elements from the **projects** column for a specified row. The WHERE clause limits the query to a single row in which the value in the **mgr_name** column is *Sayles*.

Figure 1. Query

```
SELECT projects
FROM manager
WHERE mgr_name = 'Sayles'
```

The query result shows a **project** column collection for a single row of the **manager** table. The query returns the names of those projects that the manager *Sayles* oversees. The collection contains, for each element in the LIST, the project name (**pro_name**) and the SET of individuals (**pro_members**) who are assigned to each project.

Figure 2. Query result

```
projects LIST {ROW(voyager_project, SET{Simonian, Waters, Adams, Davis})}
projects LIST {ROW(horizon_project, SET{Freeman, Jacobs, Walker, Cannan})}
projects LIST {ROW(sapphire_project, SET{Villers, Reeves, Doyle, Strongin})}
:
```

The IN keyword to search for elements in a collection

You can use the IN keyword in the WHERE clause of an SQL statement to determine whether a collection contains a certain element. For example, the following query shows how to construct a query that returns values for **mgr_name** and **department** where *Adams* is an element of a collection in the **direct_reports** column.

Figure 1. Query

```
SELECT mgr_name, department
FROM manager
WHERE 'Adams' IN direct_reports
```

Figure 2. Query result

```
mgr_name    Sayles
department  marketing
```

Although you can use a WHERE clause with the IN keyword to search for a particular element in a simple collection, the query always returns the complete collection. For example, the following query returns all the elements of the collection where `Adams` is an element of a collection in the `direct_reports` column.

```
SELECT mgr_name, direct_reports
FROM manager
WHERE 'Adams' IN direct_reports
```

Figure 4. Query result

```
mgr_name    Sayles
direct_reports SET {Smith, Waters, Adams, Davis, Kurasawa}
```

As the result shows, a query on a collection column returns the entire collection, not a particular element within the collection.

You can use the IN keyword in a WHERE clause to reference a simple collection only. You cannot use the IN keyword to reference a collection that contains fields that are themselves collections. For example, you cannot use the IN keyword to reference the `projects` column in the `manager` table because `projects` is a nested collection.

You can combine the NOT and IN keywords in the WHERE clause of a SELECT statement to search for collections that do not contain a certain element. For example, the following query shows a query that returns values for `mgr_name` and `department` where `Adams` is not an element of a collection in the `direct_reports` column.

Figure 5. Query

```
SELECT mgr_name, department
FROM manager
WHERE 'Adams' NOT IN direct_reports
```

Figure 6. Query result

```
mgr_name    Williams
department  engineering

mgr_name    Lyman
department  publications

mgr_name    Cole
department  accounting
```

For information about how to count the elements in a collection column, see [Cardinality function](#).

Select rows within a table hierarchy

This section describes how to query rows from tables within a table hierarchy. For more information about how to create and use a table hierarchy, see the *IBM® Database Design and Implementation Guide*.

The following figure shows the statements that create the type and table hierarchies that the examples in this section use.

Figure 1. Statements that create the type and table hierarchies.

```
CREATE ROW TYPE address_t
(
  street  VARCHAR (20) ,
  city    VARCHAR (20) ,
  state   CHAR (2) ,
  zip     VARCHAR (9)
)

CREATE ROW TYPE person_t
(
  name     VARCHAR (30) ,
  address  address_t ,
  soc_sec  CHAR (9)
)

CREATE ROW TYPE employee_t
(
  salary   INTEGER
)
UNDER person_t

CREATE ROW TYPE sales_rep_t
(
  rep_num  SERIAL8 ,
  region_num INTEGER
)
UNDER employee_t
```

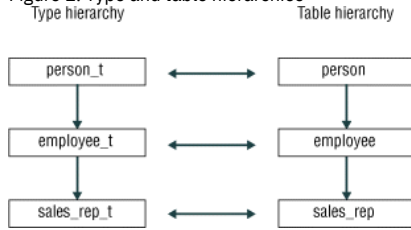
```
CREATE TABLE person OF TYPE person_t

CREATE TABLE employee OF TYPE employee_t
UNDER person

CREATE TABLE sales_rep OF TYPE sales_rep_t
UNDER employee
```

The following figure shows the hierarchical relationships of the row types and tables in the previous figure.

Figure 2. Type and table hierarchies



- [Select rows of the supertable without the ONLY keyword](#)
- [Select rows from a supertable with the ONLY keyword](#)
- [An alias for a supertable](#)

Select rows of the supertable without the ONLY keyword

A table hierarchy allows you to construct, in a single SQL statement, a query whose scope is a supertable and its subtables. A query on a supertable returns rows from both the supertable and its subtables. The following query shows a query on the **person** table, which is the root supertable in the table hierarchy.

Figure 1. Query

```
SELECT * FROM person
```

[Figure 8](#) returns all columns in the supertable and those columns in subtables (**employee** and **sales_rep**) that are inherited from the supertable. A query on a supertable does not return columns from subtables that are not in the supertable. The query result shows the **name**, **address**, and **soc_sec** columns in the **person**, **employee**, and **sales_rep** tables.

Figure 2. Query result

name	Rogers, J.
address	ROW(102 Ruby Ave, Belmont, CA, 69055)
soc_sec	454849344
name	Sallie, A.
address	ROW(134 Rose St, San Carlos, CA, 69025)
soc_sec	348441214
:	:

Select rows from a supertable with the ONLY keyword

Although a SELECT statement on a supertable returns rows from both the supertable and its subtables, you cannot tell which rows come from the supertable and which rows come from the subtables. To limit the results of a query to the supertable only, you must include the ONLY keyword in the SELECT statement. For example, the following query returns rows in the **person** table only.

Figure 1. Query

```
SELECT * FROM ONLY(person);
```

Figure 2. Query result

name	Rogers, J.
address	ROW(102 Ruby Ave, Belmont, CA, 69055)
soc_sec	454849344
:	:

An alias for a supertable

An *alias* is a word that immediately follows the name of a table in the FROM clause. You can specify an alias for a typed table in a SELECT or UPDATE statement and then use the alias (in the same SELECT or UPDATE statement) as an expression by itself. If you create an alias for a supertable, the alias can represent values from the supertable or the subtables that inherit from the supertable. In DB-Access, the following query returns row values for all instances of the **person**, **employee**, and **sales_rep** tables.

Figure 1. Query

```
SELECT p FROM person p;
```

Informix® ESQL/C does not recognize this construct. In Informix ESQL/C programs, the query returns an error.

Summary

This chapter introduced sample syntax and results for selecting data from complex types using SELECT statements to query a relational database. The section [Select row-type data](#) shows how to perform the following actions:

- Select row-type data from typed tables and columns
- Use row-type expressions for field projections

The section [Select from a collection](#) shows how to perform the following actions:

- Query columns that are defined on collection types
- Search for elements in a collection
- Query columns that are defined on nested collection types

The section [Select rows within a table hierarchy](#) shows how to perform the following actions:

- Query a supertable with or without the ONLY keyword
- Specify an alias for a supertable

Functions in SELECT statements

In addition to column names and operators, an expression can also include one or more functions. This chapter shows how to use functions in SELECT statements to perform more complex database queries and data manipulation.

For information about the syntax of the following SQL functions and other SQL functions, see the Expressions segment in the *IBM® Informix® Guide to SQL: Syntax*. Tip: You can also use functions that you create yourself. For information about user-defined functions, see [Create and use SPL routines](#), and *IBM Informix User-Defined Routines and Data Types Developer's Guide*.

- [Functions in SELECT statements](#)
- [SPL routines in SELECT statements](#)
- [Data encryption functions](#)
- [Summary](#)

Functions in SELECT statements

You can use any basic type of expression (column, constant, function, aggregate function, and procedure), or combination thereof, in the select list.

A function expression uses a function that is evaluated for each row in the query. All function expressions require arguments. This set of expressions contains the time function and the length function when they are used with a column name as an argument.

- [Aggregate functions](#)
- [Time functions](#)
- [Date-conversion functions](#)
- [Cardinality function](#)
- [Smart large object functions](#)
- [String-manipulation functions](#)
- [Other functions](#)

Aggregate functions

An aggregate function returns one value for a set of queried rows. The aggregate functions take on values that depend on the set of rows that the WHERE clause of the SELECT statement returns. In the absence of a WHERE clause, the aggregate functions take on values that depend on all the rows that the FROM clause forms.

You cannot use aggregate functions for expressions that contain the following data types:

- TEXT
- BYTE
- CLOB
- BLOB
- Collection data types (LIST, MULTISSET, and SET)
- ROW types
- Opaque data types (except with user-defined aggregate functions that support opaque types)

Aggregates are often used to summarize information about groups of rows in a table. This use is discussed in [Compose advanced SELECT statements](#). When you apply an aggregate function to an entire table, the result contains a single row that summarizes all the selected rows.

All IBM® Informix® database servers support the following aggregate functions.

- [The AVG function](#)
- [The COUNT function](#)

- [The MAX and MIN functions](#)
- [The RANGE function](#)
- [The STDEV function](#)
- [The SUM function](#)
- [The VARIANCE function](#)
- [Apply aggregate functions to expressions](#)

The AVG function

The following query computes the average **unit_price** of all rows in the **stock** table.

Figure 1. Query

```
SELECT AVG (unit_price) FROM stock;
```

Figure 2. Query result

```
(avg)
$197.14
```

The following query computes the average **unit_price** of just those rows in the **stock** table that have a **manu_code** of **SHM**.

Figure 3. Query

```
SELECT AVG (unit_price) FROM stock WHERE manu_code = 'SHM';
```

Figure 4. Query result

```
(avg)
$204.93
```

The COUNT function

The following query counts and displays the total number of rows in the **stock** table.

Figure 1. Query

```
SELECT COUNT (*) FROM stock;
```

Figure 2. Query result

```
(count(*))
73
```

The following query includes a WHERE clause to count specific rows in the **stock** table, in this case, only those rows that have a **manu_code** of **SHM**.

Figure 3. Query

```
SELECT COUNT (*) FROM stock WHERE manu_code = 'SHM';
```

Figure 4. Query result

```
(count(*))
17
```

By including the keyword **DISTINCT** (or its synonym **UNIQUE**) and a column name in the following query, you can tally the number of different manufacturer codes in the **stock** table.

Figure 5. Query

```
SELECT COUNT (DISTINCT manu_code) FROM stock;
```

Figure 6. Query result

```
(count)
9
```

The MAX and MIN functions

You can combine aggregate functions in the same SELECT statement. For example, you can include both the **MAX** and the **MIN** functions in the select list, as the following query shows.

Figure 1. Query

```
SELECT MAX (ship_charge), MIN (ship_charge) FROM orders;
```

The query finds and displays both the highest and lowest **ship_charge** in the **orders** table.

Figure 2. Query result

(max)	(min)
\$25.20	\$5.00

The RANGE function

The **RANGE** function computes the difference between the maximum and the minimum values for the selected rows.

You can apply the **RANGE** function only to numeric columns. The following query finds the range of prices for items in the **stock** table.

Figure 1. Query

```
SELECT RANGE(unit_price) FROM stock;
```

Figure 2. Query result

(range)
955.50

As with other aggregates, the **RANGE** function applies to the rows of a group when the query includes a GROUP BY clause, which the following query shows.

Figure 3. Query

```
SELECT RANGE(unit_price) FROM stock
GROUP BY manu_code;
```

Figure 4. Query result

(range)
820.20
595.50
720.00
225.00
632.50
0.00
460.00
645.90
425.00

The STDEV function

The **STDEV** function computes the standard deviation for the selected rows. It is the square root of the **VARIANCE** function.

You can apply the **STDEV** function only to numeric columns. The following query finds the standard deviation on a population:

```
SELECT STDEV(age) FROM u_pop WHERE age > 21;
```

As with the other aggregates, the **STDEV** function applies to the rows of a group when the query includes a GROUP BY clause, as the following example shows:

```
SELECT STDEV(age) FROM u_pop
GROUP BY state
WHERE STDEV(age) > 21;
```

Nulls are ignored unless every value in the specified column is null. If every column value is null, the **STDEV** function returns a null for that column. For more information about the **STDEV** function, see the Expression segment in the *IBM® Informix® Guide to SQL: Syntax*.

The SUM function

The following query calculates the total **ship_weight** of orders that were shipped on July 13, 1998.

Figure 1. Query

```
SELECT SUM(ship_weight) FROM orders
WHERE ship_date = '07/13/1998';
```

Figure 2. Query result

(sum)
130.5

The VARIANCE function

The **VARIANCE** function returns the variance for a sample of values as an unbiased estimate of the variance for all rows selected. It computes the following value:

$$(\text{SUM}(X_i^2) - (\text{SUM}(X_i))^2 / N) / (N - 1)$$

In this example, x_i is each value in the column and N is the total number of values in the column. You can apply the **VARIANCE** function only to numeric columns. The following query finds the variance on a population:

```
SELECT VARIANCE(age) FROM u_pop WHERE age > 21;
```

As with the other aggregates, the **VARIANCE** function applies to the rows of a group when the query includes a **GROUP BY** clause, which the following example shows:

```
SELECT VARIANCE(age) FROM u_pop
GROUP BY birth
WHERE VARIANCE(age) > 21;
```

Nulls are ignored unless every value in the specified column is null. If every column value is null, the **VARIANCE** function returns a null for that column. For more information about the **VARIANCE** function, see the Expression segment in the *IBM® Informix® Guide to SQL: Syntax*.

Apply aggregate functions to expressions

The following query shows how you can apply aggregate functions to arithmetic expressions, and declare display labels for their results:

Figure 1. Query

```
SELECT MAX (res_dtime - call_dtime) maximum,
MIN (res_dtime - call_dtime) minimum,
AVG (res_dtime - call_dtime) average
FROM cust_calls;
```

The query finds and displays the maximum, minimum, and average amounts of time (in days, hours, and minutes) between the reception and resolution of a customer call, and labels the derived values appropriately. The query result shows these aggregate time-interval values that the query calculates:

Figure 2. Query result

maximum	minimum	average
5 20:55	0 00:01	1 02:56

Time functions

You can use the time functions **DAY**, **MONTH**, **WEEKDAY**, and **YEAR** in either the Projection clause or the **WHERE** clause of a query. These functions return a value that corresponds to the expressions or arguments that you use to call the function. You can also use the **CURRENT** or **SYSDATE** function to return a value with the current date and time, or use the **EXTEND** function to adjust the precision of a **DATE** or **DATETIME** value.

- [The DAY and CURRENT functions](#)
- [The MONTH function](#)
- [The WEEKDAY function](#)
- [The YEAR function](#)
- [Format DATETIME values](#)

The DAY and CURRENT functions

The following query returns the day of the month for the **call_dtime** and **res_dtime** columns in two *expression* columns.

Figure 1. Query

```
SELECT customer_num, DAY (call_dtime), DAY (res_dtime)
FROM cust_calls;
```

Figure 2. Query result

customer_num	(expression)	(expression)
106	12	12
110	7	7
119	1	2
121	10	10
127	31	
116	28	28
116	21	27

The following query uses the **DAY** and **CURRENT** functions to compare column values to the current day of the month. It selects only those rows where the value is earlier than the current day. In this example, the **CURRENT** day is 15.

Figure 3. Query

```
SELECT customer_num, DAY (call_dtime), DAY (res_dtime)
FROM cust_calls
WHERE DAY (call_dtime) < DAY (CURRENT);
```

Figure 4. Query result

customer_num	(expression)	(expression)
106	12	12

110	7	7
119	1	2
121	10	10

The following query uses the **CURRENT** function to select all calls except those that came in today.

Figure 5. Query

```
SELECT customer_num, call_code, call_descr
FROM cust_calls
WHERE call_dtime < CURRENT YEAR TO DAY;
```

Figure 6. Query result

```
customer_num 106
call_code    D
call_descr    Order was received, but two of the cans of ANZ tennis balls
              within the case were empty

customer_num 110
call_code    L
call_descr    Order placed one month ago (6/7) not received.
:
customer_num 116
call_code    I
call_descr    Second complaint from this customer! Received two cases
              right-handed outfielder gloves (1 HRO) instead of one case
              lefties.
```

The **SYSDATE** function closely resembles the **CURRENT** function, but the default precision of its returned value is DATETIME YEAR TO FRACTION(5), rather than the default DATETIME YEAR TO FRACTION(3) precision of **CURRENT** when no DATETIME qualifier is specified.

The MONTH function

The following query uses the **MONTH** function to extract and show what month the customer call was received and resolved, and it uses display labels for the resulting columns. However, it does not make a distinction between years.

Figure 1. Query

```
SELECT customer_num,
       MONTH (call_dtime) call_month,
       MONTH (res_dtime) res_month
FROM cust_calls;
```

Figure 2. Query result

customer_num	call_month	res_month
106	6	6
110	7	7
119	7	7
121	7	7
127	7	7
116	11	11
116	12	12

The following query uses the **MONTH** function plus **DAY** and **CURRENT** to show what month the customer call was received and resolved if **DAY** is earlier than the current day.

Figure 3. Query

```
SELECT customer_num,
       MONTH (call_dtime) called,
       MONTH (res_dtime) resolved
FROM cust_calls
WHERE DAY (res_dtime) < DAY (CURRENT);
```

Figure 4. Query result

customer_num	called	resolved
106	6	6
119	7	7
121	7	7

The WEEKDAY function

The following query uses the **WEEKDAY** function to indicate which day of the week calls are received and resolved (0 represents Sunday, 1 is Monday, and so on), and the expression columns are labeled.

Figure 1. Query

```
SELECT customer_num,
       WEEKDAY (call_dtime) called,
       WEEKDAY (res_dtime) resolved
```

```
FROM cust_calls
ORDER BY resolved;
```

Figure 2. Query result

customer_num	called	resolved
127	3	
110	0	0
119	1	2
121	3	3
116	3	3
106	3	3
116	5	4

The following query uses the **COUNT** and **WEEKDAY** functions to count how many calls were received on a weekend. This kind of statement can give you an idea of customer-call patterns or indicate whether overtime pay might be required.

Figure 3. Query

```
SELECT COUNT(*)
FROM cust_calls
WHERE WEEKDAY (call_dtime) IN (0,6);
```

Figure 4. Query result

```
(count(*))
4
```

The YEAR function

The following query retrieves rows where the **call_dtime** is earlier than the beginning of the current year.

Figure 1. Query

```
SELECT customer_num, call_code,
YEAR (call_dtime) call_year,
YEAR (res_dtime) res_year
FROM cust_calls
WHERE YEAR (call_dtime) < YEAR (TODAY);
```

Figure 2. Query result

customer_num	call_code	call_year	res_year
116 I		1997	1997
116 I		1997	1997

Format DATETIME values

In the following query, the **EXTEND** function displays only the specified subfields to restrict the two DATETIME values.

Figure 1. Query

```
SELECT customer_num,
EXTEND (call_dtime, month to minute) call_time,
EXTEND (res_dtime, month to minute) res_time
FROM cust_calls
ORDER BY res_time;
```

The query returns the month-to-minute range for the columns labeled **call_time** and **res_time** and gives an indication of the work load.

Figure 2. Query result

customer_num	call_time	res_time
127	07-31 14:30	
106	06-12 08:20	06-12 08:25
119	07-01 15:00	07-02 08:21
110	07-07 10:24	07-07 10:30
121	07-10 14:05	07-10 14:06
116	11-28 13:34	11-28 16:47
116	12-21 11:24	12-27 08:19

The **TO_CHAR** function can also format DATETIME values. See [The TO_CHAR function](#) for information about this built-in function, which can also accept DATE values or numeric values as an argument, and returns a formatted character string.

Besides the built-in time functions that these examples illustrate, IBM® Informix® also supports the **ADD_MONTHS**, **LAST_DAY**, **MDY**, **MONTHS_BETWEEN**, **NEXT_DAY**, and **QUARTER** functions. In addition to these functions, the **TRUNC** and **ROUND** functions can return values that change the precision of DATE or DATETIME arguments. These additional time functions are described in the *IBM Informix Guide to SQL: Syntax*.

Date-conversion functions

You can use a date-conversion function anywhere you use an expression.

The following conversion functions convert between date and character values:

- [The DATE function](#)
- [The TO_CHAR function](#)
- [The TO_DATE function](#)

The DATE function

The **DATE** function converts a character string to a DATE value. In the following query, the **DATE** function converts a character string to a DATE value to allow for comparisons with DATETIME values. The query retrieves DATETIME values only when **call_dtime** is later than the specified **DATE**.

Figure 1. Query

```
SELECT customer_num, call_dtime, res_dtime
FROM cust_calls
WHERE call_dtime > DATE ('12/31/97');
```

Figure 2. Query result

customer_num	call_dtime	res_dtime
106	1998-06-12 08:20	1998-06-12 08:25
110	1998-07-07 10:24	1998-07-07 10:30
119	1998-07-01 15:00	1998-07-02 08:21
121	1998-07-10 14:05	1998-07-10 14:06
127	1998-07-31 14:30	

The following query converts DATETIME values to DATE format and displays the values, with labels, only when **call_dtime** is greater than or equal to the specified date.

Figure 3. Query

```
SELECT customer_num,
       DATE (call_dtime) called,
       DATE (res_dtime) resolved
FROM cust_calls
WHERE call_dtime >= DATE ('1/1/98');
```

Figure 4. Query result

customer_num	called	resolved
106	06/12/1998	06/12/1998
110	07/07/1998	07/07/1998
119	07/01/1998	07/02/1998
121	07/10/1998	07/10/1998
127	07/31/1998	

The TO_CHAR function

The **TO_CHAR** function converts DATETIME or DATE values to character string values. The **TO_CHAR** function evaluates a DATETIME value according to the date-formatting directive that you specify and returns an NVARCHAR value. For a complete list of the supported date-formatting directives, see the description of the GL_DATETIME environment variable in the *IBM® Informix® GLS User's Guide*.

You can also use the **TO_CHAR** function to convert a DATETIME or DATE value to an LVARCHAR value.

The following query uses the **TO_CHAR** function to convert a DATETIME value to a more readable character string.

Figure 1. Query

```
SELECT customer_num,
       TO_CHAR(call_dtime, "%A %B %d %Y") call_date
FROM cust_calls
WHERE call_code = "B";
```

Figure 2. Query result

customer_num	call_date
119	Friday July 01 1998

The following query uses the **TO_CHAR** function to convert DATE values to more readable character strings.

Figure 3. Query

```
SELECT order_num,
       TO_CHAR(ship_date, "%A %B %d %Y") date_shipped
FROM orders
WHERE paid_date IS NULL;
```

Figure 4. Query result

order_num	date_shipped
1004	Monday May 30 1998

order_num	1006
date_shipped	
order_num	1007
date_shipped	Sunday June 05 1998
order_num	1012
date_shipped	Wednesday June 29 1998
order_num	1016
date_shipped	Tuesday July 12 1998
order_num	1017
date_shipped	Wednesday July 13 1998

The **TO_CHAR** function can also format numeric values. For more information about the built-in **TO_CHAR** function, see the *IBM Informix Guide to SQL: Syntax*.

The TO_DATE function

The **TO_DATE** function accepts an argument of a character data type and converts this value to a DATETIME value. The **TO_DATE** function evaluates a character string according to the date-formatting directive that you specify and returns a DATETIME value. For a complete list of the supported date-formatting directives, see the description of the GL_DATETIME environment variable in the *IBM® Informix® GLS User's Guide*.

You can also use the **TO_DATE** function to convert an LVARCHAR value to a DATETIME value.

The following query uses the **TO_DATE** function to convert character string values to DATETIME values whose format you specify.

Figure 1. Query

```
SELECT customer_num, call_descr
FROM cust_calls
WHERE call_dtime = TO_DATE("2008-07-07 10:24",
"%Y-%m-%d %H:%M");
```

Figure 2. Query result

customer_num	110
call_descr	Order placed one month ago (6/7) not received.

You can use the **DATE** or **TO_DATE** function to convert a character string to a DATE value. One advantage of the **TO_DATE** function is that it allows you to specify a format for the value returned. (You can use the **TO_DATE** function, which always returns a DATETIME value, to convert a character string to a DATE value because the database server implicitly handles conversions between DATE and DATETIME values.)

Cardinality function

The **CARDINALITY** function counts the number of elements that a collection contains. You can use the **CARDINALITY** function with simple or nested collections. Any duplicates in a collection are counted as individual elements. The following query shows a query that returns, for every row in the **manager** table, **department** values and the number of elements in each **direct_reports** collection.

Figure 1. Query

```
SELECT department, CARDINALITY(direct_reports) FROM manager;
```

Figure 2. Query result

department	marketing	5
department	engineering	7
department	publications	4
department	accounting	3

You can also evaluate the number of elements in a collection from within a predicate expression, as the following query shows.

Figure 3. Query

```
SELECT department, CARDINALITY(direct_reports) FROM manager
WHERE CARDINALITY(direct_reports) < 6
GROUP BY department;
```

Figure 4. Query result

department	accounting	3
department	marketing	5
department	publications	4

Smart large object functions

The database server provides four SQL functions that you can call from within an SQL statement to import and export smart large objects. The following table shows the smart-large-object functions.

Table 1. SQL functions for smart large objects

Function name	Purpose
FILETOBLOB()	Copies a file into a BLOB column
FILETOCLOB()	Copies a file into a CLOB column
LOCOPY()	Copies BLOB or CLOB data into another BLOB or CLOB column
LOTOFILE()	Copies a BLOB or CLOB into a file

For detailed information and the syntax of smart-large-object functions, see the Expression segment in the *IBM® Informix® Guide to SQL: Syntax*.

You can use any of the functions that the table shows in SELECT, UPDATE, and INSERT statements. For examples of how to use the preceding functions in INSERT and UPDATE statements, see [Modify data](#).

Suppose you create the **inmate** and **fbi_list** tables, as the following figure shows.

Figure 1. Create the inmate and fbi_list tables.

```
CREATE TABLE inmate
(
  id_num    INT,
  picture   BLOB,
  felony    CLOB
);

CREATE TABLE fbi_list
(
  id        INTEGER,
  mugshot   BLOB
) PUT mugshot IN (sbspace1);
```

The following SELECT statement uses the **LOTOFILE()** function to copy data from the **felony** column into the felon_322.txt file that is located on the client computer:

```
SELECT id_num, LOTOFILE(felony, 'felon_322.txt', 'client')
FROM inmate
WHERE id = 322;
```

The first argument for **LOTOFILE()** specifies the name of the column from which data is to be exported. The second argument specifies the name of the file into which data is to be copied. The third argument specifies whether the target file is located on the client computer ('client') or server computer ('server').

The following rules apply for specifying the path of a file name in a function argument, depending on whether the file resides on the client or server computer:

- If the source file resides on the server computer, you must specify the full path name to the file (not the path name relative to the current working directory).
- If the source file resides on the client computer, you can specify either the full or relative path name to the file.

String-manipulation functions

String-manipulation functions accept arguments of type CHAR, NCHAR, VARCHAR, NVARCHAR, or LVARCHAR. You can use a string-manipulation function anywhere you use an expression.

The following functions convert between upper and lowercase letters in a character string:

- **LOWER**
- **UPPER**
- **INITCAP**

The following functions manipulate character strings in various ways:

- **REPLACE**
- **SUBSTR**
- **SUBSTRING**
- **LPAD**
- **RPAD**

Restriction: You cannot overload any of the string-manipulation functions to handle extended data types.

- [The LOWER function](#)
- [The UPPER function](#)
- [The INITCAP function](#)
- [The REPLACE function](#)
- [The SUBSTRING and SUBSTR functions](#)
- [The SUBSTRING function](#)
- [The SUBSTR function](#)
- [The LPAD function](#)
- [The RPAD function](#)

The LOWER function

Use the **LOWER** function to replace every uppercase letter in a character string with a lowercase letter. The **LOWER** function accepts an argument of a character data type and returns a value of the same data type as the argument you specify.

The following query uses the **LOWER** function to convert any uppercase letters in a character string to lowercase letters.

Figure 1. Query

```
SELECT manu_code, LOWER(manu_code)
  FROM items
 WHERE order_num = 1018
```

Figure 2. Query result

manu_code	(expression)
PRC	prc
KAR	kar
PRC	prc
SMT	smt
HRO	hro

The UPPER function

Use the **UPPER** function to replace every lowercase letter in a character string with an uppercase letter. The **UPPER** function accepts an argument of a character data type and returns a value of the same data type as the argument you specify.

The following query uses the **UPPER** function to convert any lowercase letters in a character string to uppercase letters.

Figure 1. Query

```
SELECT call_code, UPPER(code_descr) FROM call_type
```

Figure 2. Query result

call_code	(expression)
B	BILLING ERROR
D	DAMAGED GOODS
I	INCORRECT MERCHANDISE SENT
L	LATE SHIPMENT
O	OTHER

The INITCAP function

Use the **INITCAP** function to replace the first letter of every word in a character string with an uppercase letter. The **INITCAP** function assumes a new word whenever the function encounters a letter that is preceded by any character other than a letter. The **INITCAP** function accepts an argument of a character data type and returns a value of the same data type as the argument you specify.

The following query uses the **INITCAP** function to convert the first letter of every word in a character string to an uppercase letter.

Figure 1. Query

```
SELECT INITCAP(description) FROM stock
 WHERE manu_code = "ANZ";
```

Figure 2. Query result

(expression)
Tennis Racquet
Tennis Ball
Volleyball
Volleyball Net
Helmet
Golf Shoes
3 Golf Balls
Running Shoes
Watch
Kick Board
Swim Cap

The REPLACE function

Use the **REPLACE** function to replace a certain set of characters in a character string with other characters.

In the following query, the **REPLACE** function replaces the unit column value *each* with *item* for every row that the query returns. The first argument of the **REPLACE** function is the expression to be evaluated. The second argument specifies the characters that you want to replace. The third argument specifies a new character string to replace the characters removed.

Figure 1. Query

```
SELECT stock_num, REPLACE(unit, "each", "item") cost_per, unit_price
FROM stock
WHERE manu_code = "HRO";
```

Figure 2. Query result

stock_num	cost_per	unit_price
1	case	\$250.00
2	case	\$126.00
4	case	\$480.00
7	case	\$600.00
110	case	\$260.00
205	case	\$312.00
301	item	\$42.50
302	item	\$4.50
304	box	\$280.00
305	case	\$48.00
309	case	\$40.00
312	box	\$72.00

The SUBSTRING and SUBSTR functions

You can use the **SUBSTRING** and **SUBSTR** functions to return a portion of a character string. You specify the *start position* and *length* (optional) to determine which portion of the character string the function returns.

Restriction: The units of measurement in the arguments to these two functions are bytes, rather than logical characters. This is of no importance in the default locale, nor in other single-byte locales, but you should not invoke **SUBSTRING** or **SUBSTR** in locales in which the logical characters of the code set can differ in their storage lengths.

The SUBSTRING function

You can use the **SUBSTRING** function to return some portion of a character string. You specify the *start position* and *length* (optional) to determine which portion of the character string the function returns. You can specify a positive or negative number for the start position. A start position of 1 specifies that the **SUBSTRING** function begins from the first position in the string. When the start position is zero (0) or a negative number, the **SUBSTRING** function counts backward from the beginning of the string.

The following query shows an example of the **SUBSTRING** function, which returns the first four characters for any **sname** column values that the query returns. In this example, the **SUBSTRING** function starts at the beginning of the string and returns four characters counting forward from the start position.

Figure 1. Query

```
SELECT sname, SUBSTRING(sname FROM 1 FOR 4) FROM state
WHERE code = "AZ";
```

Figure 2. Query result

sname	(expression)
Arizona	Ariz

In the following query, the **SUBSTRING** function specifies a start position of 6 but does not specify the length. The function returns a character string that extends from the sixth position to the end of the string.

Figure 3. Query

```
SELECT sname, SUBSTRING(sname FROM 6) FROM state
WHERE code = "WV";
```

Figure 4. Query result

sname	(expression)
West Virginia	Virginia

In the following query, the **SUBSTRING** function returns only the first character for any **sname** column value that the query returns. For the **SUBSTRING** function, a start position of -2 counts backward three positions (0, -1, -2) from the start position of the string (for a start position of 0, the function counts backward one position from the beginning of the string).

Figure 5. Query

```
SELECT sname, SUBSTRING(sname FROM -2 FOR 4) FROM state
WHERE code = "AZ";
```

Figure 6. Query result

sname	(expression)
Arizona	A

The SUBSTR function

The **SUBSTR** function serves the same purpose as the **SUBSTRING** function, but the syntax of the two functions differs.

To return a portion of a character string, specify the *start position* and *length* (optional) to determine which portion of the character string the **SUBSTR** function returns. The start position that you specify for the **SUBSTR** function can be a positive or a negative number. However, the **SUBSTR** function treats a negative number in the start position differently than does the **SUBSTRING** function. When the start position is a negative number, the **SUBSTR** function counts backward from the end of the character string, which depends on the length of the string, not the character length of a word or visible characters that the string contains. The **SUBSTR** function recognizes zero (0) or 1 in the start position as the first position in the string.

The following query shows an example of the **SUBSTR** function that includes a negative number for the start position. Given a start position of -15, the **SUBSTR** function counts backward 15 positions from the end of the string to find the start position and then returns the next five characters.

Figure 1. Query

```
SELECT sname, SUBSTR(sname, -15, 5) FROM state
WHERE code = "CA";
```

Figure 2. Query result

sname	(expression)
California	Calif

To use a negative number for the start position, you need to know the length of the value that is evaluated. The **sname** column is defined as CHAR(15), so a **SUBSTR** function that accepts an argument of type **sname** can use a start position of 0, 1, or -15 for the function to return a character string that begins from the first position in the string.

The following query returns the same result as [Figure 1](#).

Figure 3. Query

```
SELECT sname, SUBSTR(sname, 1, 5) FROM state
WHERE code = "CA";
```

The LPAD function

Use the **LPAD** function to return a copy of a string that has been left padded with a sequence of characters that are repeated as many times as necessary or truncated, depending on the specified length of the padded portion of the string. Specify the source string, the length of the string to be returned, and the character string to serve as padding.

The data type of the source string and the character string that serves as padding can be any data type that converts to VARCHAR or NVARCHAR.

The following query shows an example of the **LPAD** function with a specified length of 21 characters. Because the source string has a length of 15 characters (**sname** is defined as CHAR(15)), the **LPAD** function pads the first six positions to the left of the source string.

Figure 1. Query

```
SELECT sname, LPAD(sname, 21, "-")
FROM state
WHERE code = "CA" OR code = "AZ";
```

Figure 2. Query result

sname	(expression)
California	-----California
Arizona	-----Arizona

The RPAD function

Use the **RPAD** function to return a copy of a string that has been right padded with a sequence of characters that are repeated as many times as necessary or truncated, depending on the specified length of the padded portion of the string. Specify the source string, the length of the string to be returned, and the character string to serve as padding.

The data type of the source string and the character string that serves as padding can be any data type that converts to VARCHAR or NVARCHAR.

The following query shows an example of the **RPAD** function with a specified length of 21 characters. Because the source string has a length of 15 characters (**sname** is defined as CHAR(15)), the **RPAD** function pads the first six positions to the right of the source string.

Figure 1. Query

```
SELECT sname, RPAD(sname, 21, "-")
FROM state
WHERE code = "WV" OR code = "AZ";
```

Figure 2. Query result

sname	(expression)
West Virginia	West Virginia -----
Arizona	Arizona -----

In addition to these functions, the **LTRIM** and **RTRIM** functions can return a value that drops specified leading or trailing padding characters from their string argument, and the **ASCII** function can return the numeric value of the codepoint within the ASCII character set of the first character in its string argument. These built-in functions for operations on string values are described in the *IBM® Informix® Guide to SQL: Syntax*.

Other functions

You can also use the **LENGTH**, **USER**, **CURRENT**, **SYSDATE**, and **TODAY** functions anywhere in an SQL expression that you would use a constant. In addition, you can include the **DBSERVERNAME** function in a SELECT statement to display the name of the database server where the current database resides.

You can use these functions to select an expression that consists entirely of constant values or an expression that includes column data. In the first instance, the result is the same for all rows of output.

In addition, you can use the **HEX** function to return the hexadecimal encoding of an expression, the **ROUND** function to return the rounded value of an expression, and the **TRUNC** function to return the truncated value of an expression. For more information on the preceding functions, see the *IBM® Informix® Guide to SQL: Syntax*.

- [The LENGTH function](#)
- [The USER function](#)
- [The TODAY function](#)
- [The DBSERVERNAME and SITENAME functions](#)
- [The HEX function](#)
- [The DBINFO function](#)
- [The DECODE function](#)
- [The NVL function](#)

The LENGTH function

In the following query, the **LENGTH** function calculates the number of bytes in the combined **fname** and **lname** columns for each row where the length of **company** is greater than 15.

Figure 1. Query

```
SELECT customer_num,  
       LENGTH (fname) + LENGTH (lname) namelength  
FROM customer  
WHERE LENGTH (company) > 15;
```

Figure 2. Query result

customer_num	namelength
101	11
105	13
107	11
112	14
115	11
118	10
119	10
120	10
122	12
124	11
125	10
126	12
127	10
128	11

Although the **LENGTH** function might not be useful when you work with DB-Access, it can be important to determine the string length for programs and reports. The **LENGTH** function returns the clipped length of a CHARACTER or VARCHAR string and the full number of bytes in a TEXT or BYTE string.

IBM® Informix® also supports the **CHAR_LENGTH** function, which returns the number of logical characters in its string argument, rather than the number of bytes. This function is useful in locales where a single logical character might require more than a single byte of storage. For more information about the **CHAR_LENGTH** function, see the *IBM Informix Guide to SQL: Syntax* and the *IBM Informix GLS User's Guide*.

The USER function

Use the **USER** function when you want to define a restricted view of a table that contains only rows that include your user ID. For information about how to create views, see the *IBM® Informix® Database Design and Implementation Guide* and the **GRANT** and **CREATE VIEW** statements in the *IBM Informix Guide to SQL: Syntax*.

The following query returns the user name (login account name) of the user who executes the query. It is repeated once for each row in the table.

Figure 1. Query

```
SELECT * FROM cust_calls  
WHERE user_id = USER;
```

If the user name of the current user is **richc**, the query retrieves only those rows in the **cust_calls** table where **user_id** = **richc**.

Figure 2. Query result

```
customer_num 110
call_dtime 1998-07-07 10:24
user_id richc
call_code L
call_descr Order placed one month ago (6/7) not received.
res_dtime 1998-07-07 10:30
res_descr Checked with shipping (Ed Smith). Order sent yesterday-we
were waiting for goods from ANZ. Next time will call with
delay if necessary

customer_num 119
call_dtime 1998-07-01 15:00
user_id richc
call_code B
call_descr Bill does not reflect credit from previous order
res_dtime 1998-07-02 08:21
res_descr Spoke with Jane Akant in Finance. She found the error and is
sending new bill to customer
```

The TODAY function

The **TODAY** function returns the current system date. If the following query is issued when the current system date is July 10, 1998, it returns this one row.
Figure 1. Query

```
SELECT * FROM orders WHERE order_date = TODAY;
```

Figure 2. Query result

```
order_num 1018
order_date 07/10/1998
customer_num 121
ship_instruct SW corner of Biltmore Mall
backlog n
po_num S22942
ship_date 07/13/1998
ship_weight 70.50
ship_charge $20.00
paid_date 08/06/1998
```

The DBSERVERNAME and SITENAME functions

You can include the function **DBSERVERNAME** (or its synonym, **SITENAME**) in a SELECT statement to find the name of the database server. You can query the **DBSERVERNAME** for any table that has rows, including system catalog tables.

In the following query, you assign the label **server** to the **DBSERVERNAME** expression and also select the **tabid** column from the **systables** system catalog table. This table describes database tables, and **tabid** is the table identifier.

Figure 1. Query

```
SELECT DBSERVERNAME server, tabid
FROM systables
WHERE tabid <= 4;
```

Figure 2. Query result

server	tabid
montague	1
montague	2
montague	3
montague	4

The WHERE clause restricts the numbers of rows displayed. Otherwise, the database server name would be displayed once for each row of the **systables** table.

The HEX function

In the following query, the **HEX** function returns the hexadecimal format of two columns in the **customer** table, as the result shows.

Figure 1. Query

```
SELECT HEX (customer_num) hexnum, HEX (zipcode) hexzip
FROM customer;
```

Figure 2. Query result

hexnum	hexzip
0x00000065	0x00016F86
0x00000066	0x00016FA5
0x00000067	0x0001705F
0x00000068	0x00016F4A

```
0x00000069 0x00016F46
0x0000006A 0x00016F6F
:
```

The DBINFO function

You can call the **DBINFO** function in a SELECT statement to find any of the following information:

- The name of a dbspace corresponding to a tblspace number or expression
- The last SERIAL, SERIAL8 or BIGSERIAL value inserted into a table
- The number of rows processed by the SELECT, INSERT, DELETE, UPDATE, MERGE, EXECUTE FUNCTION, EXECUTE PROCEDURE, or EXECUTE ROUTINE statement
- The session ID of the current session
- The name of the current database to which the session is connected
- Whether an INSERT, UPDATE, or DELETE statement is being performed as part of a replicated transaction.
- The name of the host computer on which the database server runs
- The type of operating system and the word length of the host computer
- The local time zone and the current date and time in Coordinated Universal Time (UTC) format
- The DATETIME value corresponding to a specified integer column or to a specified UTC time value (as an integer number of seconds since 1970-01-01 00:00:00+00:00)
- The exact version of the database server to which a client application is connected, or a specified component of the full version string.

You can use the **DBINFO** function anywhere within SQL statements and within SPL routines.

The following query shows how you might use the **DBINFO** function to find out the name of the host computer on which the database server runs.

Figure 1. Query

```
SELECT FIRST 1 DBINFO('dbhostname') FROM systables;
```

Figure 2. Query result

```
(constant)
lyceum
```

Without the **FIRST 1** clause to restrict the values in the **tabid**, the host name of the computer on which the database server runs would be repeated for each row of the **systables** table. The following query shows how you might use the **DBINFO** function to find out the complete version number and the type of the current database server.

Figure 3. Query

```
SELECT FIRST 1 DBINFO('version','full') FROM systables;
```

For more information about how to use the **DBINFO** function to find information about your current database server, database session, or database, see the *IBM® Informix® Guide to SQL: Syntax*.

The DECODE function

You can use the **DECODE** function to convert an expression of one value to another value. The **DECODE** function has the following form:

```
DECODE(test, a, a_value, b, b_value, ..., n, n_value, exp_m )
```

The **DECODE** function returns *a_value* when *a* equals *test*, and returns *b_value* when *b* equals *test*, and, in general, returns *n_value* when *n* equals *test*.

If several expressions match *test*, **DECODE** returns *n_value* for the first expression found. If no expression matches *test*, **DECODE** returns *exp_m*; if no expression matches *test* and there is no *exp_m*, **DECODE** returns NULL.

Restriction: The **DECODE** function does not support arguments of type TEXT or BYTE.

Suppose an **employee** table exists that includes **emp_id** and **evaluation** columns. Suppose also that execution of the following query on the **employee** table returns the rows that the result shows.

Figure 1. Query

```
SELECT emp_id, evaluation FROM employee;
```

Figure 2. Query result

emp_id	evaluation
012233	great
012344	poor
012677	NULL
012288	good
012555	very good

In some cases, you might want to convert a set of values. For example, suppose you want to convert the descriptive values of the **evaluation** column in the preceding example to corresponding numeric values. The following query shows how you might use the **DECODE** function to convert values from the **evaluation** column to numeric values for each row in the **employee** table.

Figure 3. Query

```
SELECT emp_id, DECODE(evaluation, "poor", 0, "fair", 25, "good",
50, "very good", 75, "great", 100, -1) AS evaluation
FROM employee;
```

Figure 4. Query result

emp_id	evaluation
012233	100
012344	0
012677	-1
012288	50
012555	75
⋮	

You can specify any data type for the arguments of the **DECODE** function provided that the arguments meet the following requirements:

- The arguments *test*, *a*, *b*, ..., *n* all have the same data type or evaluate to a common compatible data type.
- The arguments *a_value*, *b_value*, ..., *n_value* all have the same data type or evaluate to a common compatible data type.

The NVL function

You can use the **NVL** function to convert an expression that evaluates to NULL to a value that you specify. The **NVL** function accepts two arguments: the first argument takes the name of the expression to be evaluated; the second argument specifies the value that the function returns when the first argument evaluates to NULL. If the first argument does not evaluate to NULL, the function returns the value of the first argument. Suppose a **student** table exists that includes **name** and **address** columns. Suppose also that execution of the following query on the **student** table returns the rows that the result shows.

Figure 1. Query

```
SELECT name, address FROM student;
```

Figure 2. Query result

name	address
John Smith	333 Vista Drive
Lauren Collier	1129 Greenridge Street
Fred Frith	NULL
Susan Jordan	NULL

The following query includes the **NVL** function, which returns a new value for each row in the table where the **address** column contains a NULL value.

Figure 3. Query

```
SELECT name, NVL(address, "address is unknown") AS address
FROM student;
```

Figure 4. Query result

name	address
John Smith	333 Vista Drive
Lauren Collier	1129 Greenridge Street
Fred Frith	address is unknown
Susan Jordan	address is unknown

You can specify any data type for the arguments of the **NVL** function provided that the two arguments evaluate to a common compatible data type.

If both arguments of the **NVL** function evaluate to NULL, the function returns NULL.

IBM® Informix® also supports the **NULLIF** function, which resembles the **NVL** function, but has different semantics. **NULLIF** returns NULL if its two arguments are equal, or returns its first argument if its arguments are not equal. For more information about the **NULLIF** function, see the *IBM Informix Guide to SQL: Syntax*.

SPL routines in SELECT statements

Previous examples in this chapter show SELECT statement expressions that consist of column names, operators, and SQL functions. This section shows expressions that contain an SPL routine call.

SPL routines contain special Stored Procedure Language (SPL) statements as well as SQL statements. For more information on SPL routines, see [Create and use SPL routines](#).

IBM® Informix® allows you to write external routines in C and in Java™. For more information, see *IBM Informix User-Defined Routines and Data Types Developer's Guide*.

When you include an SPL routine expression in a projection list, the SPL routine must be one that returns a single value (one column of one row). For example, the following statement is valid only if **test_func()** returns a single value:

```
SELECT col_a, test_func(col_b) FROM tab1
WHERE col_c = "Davis";
```

SPL routines that return more than a single value are not supported in the Projection clause of SELECT statements. In the preceding example, if **test_func()** returns more than one value, the database server returns an error message.

SPL routines provide a way to extend the range of functions available by allowing you to perform a subquery on each row you select.

For example, suppose you want a listing of the customer number, the customer's last name, and the number of orders the customer has made. The following query shows one way to retrieve this information. The **customer** table has **customer_num** and **lname** columns but no record of the number of orders each customer has made. You could write a **get_orders** routine, which queries the **orders** table for each **customer_num** and returns the number of corresponding orders (labeled **n_orders**).

Figure 1. Query

```
SELECT customer_num, lname, get_orders(customer_num) n_orders
FROM customer;
```

The result shows the output from this SPL routine.

Figure 2. Query result

customer_num	lname	n_orders
101	Pauli	1
102	Sadler	9
103	Currie	9
104	Higgins	4
⋮		
123	Hanlon	1
124	Putnum	1
125	Henry	0
126	Neelie	1
127	Satifer	1
128	Lessor	0

Use SPL routines to encapsulate operations that you frequently perform in your queries. For example, the condition in the following query contains a routine, **conv_price**, that converts the unit price of a stock item to a different currency and adds any import tariffs.

Figure 3. Query

```
SELECT stock_num, manu_code, description FROM stock
WHERE conv_price(unit_price, ex_rate = 1.50,
tariff = 50.00) < 1000;
```

Data encryption functions

You can use the SET ENCRYPTION PASSWORD statement with built-in SQL encryption functions that use Advanced Encryption Standard (AES) and Triple DES (3DES) encryption to secure your sensitive data. When you use encryption, only those users who have the correct password will be able to read, copy, or modify the data.

Use the SET ENCRYPTION PASSWORD statement with the following built-in encryption and decryption functions:

- **ENCRYPT_AES**

```
ENCRYPT_AES (data-string-expression
[, password-string-expression [, hint-string-expression ]])
```

- **ENCRYPT_TDES**

```
ENCRYPT_TDES (data-string-expression
[, password-string-expression [, hint-string-expression ]])
```

- **DECRYPT_CHAR**

```
DECRYPT_CHAR (EncryptedData [, PasswordOrPhrase])
```

- **DECRYPT_BINARY**

```
DECRYPT_BINARY (EncryptedData [, PasswordOrPhrase])
```

- **GETHINT**

```
GETHINT (EncryptedData)
```

If you have used the SET ENCRYPTION PASSWORD statement to specify a default password, then the database server applies that password in subsequent calls to encryption and decryption functions that you invoke in the same session.

Use **ENCRYPT_AES** and **ENCRYPT_TDES** to define encrypted data and use **DECRYPT_CHAR** and **DECRYPT_BINARY** to query encrypted data. Use **GETHINT** to display the password hint string, if set, on the server.

You can use these SQL built-in functions to implement column-level or cell-level encryption.

- Use column-level encryption to encrypt all values in a given column with the same password.
- Use cell-level encryption to encrypt data within the column with different passwords.

Tip: If you intend to select encrypted data from a large table, specify an unencrypted column on which to select the rows. You can create indexes or foreign-key constraints on columns that contain encrypted data, but to do so is an inefficient use of resources, because such indexes and foreign-key constraints are not used by the query optimizer.

- [Using column-level data encryption to secure credit card data](#)

Using column-level data encryption to secure credit card data

The following example uses column-level encryption to secure credit card data.

To use column-level data encryption to secure credit card data:

1. Create the table: `create table customer (id char(30), creditcard lvarchar(67));`
2. Insert the encryption data:
 - a. Set session password: `SET ENCRYPTION PASSWORD "credit card number is encrypted";`
 - b. Encrypt data.

```
INSERT INTO customer VALUES
("Alice", encrypt_aes("1234567890123456"));
INSERT INTO customer VALUES
("Bob", encrypt_aes("2345678901234567"));
```

3. Query encryption data with decryption function.

```
SET ENCRYPTION PASSWORD "credit card number is encrypted";
SELECT id FROM customer
WHERE DECRYPT_CHAR(creditcard) = "2345678901234567";
```

Important: Encrypted data values occupy more storage space than the corresponding unencrypted data. A column whose width is sufficient to store plain text might need to be increased before it can support column-level encryption or cell-level encryption. If you attempt to insert an encrypted value into a column whose declared width is shorter than the encrypted string, the column stores a truncated value that cannot be decrypted.

For more information on encryption security, see *IBM® Informix® Administrator's Guide*.

For more information on the syntax and storage requirements of built-in encryption and decryption functions, see *IBM Informix Guide to SQL: Syntax*.

Summary

This chapter introduced sample syntax and results for functions in basic SELECT statements to query a relational database and to manipulate the returned data. [Functions in SELECT statements](#) shows how to perform the following actions:

- Use the aggregate functions in the Projection clause to calculate and retrieve specific data.
- Include the time functions **DATE**, **DAY**, **MDY**, **MONTH**, **WEEKDAY**, **YEAR**, **CURRENT**, and **EXTEND** plus the **TODAY**, **LENGTH**, and **USER** functions in your SELECT statements.
- Use conversion functions in the SELECT clause to convert between date and character values.
- Use string-manipulation functions in the SELECT clause to convert between upper and lower case letters or to manipulate character strings in various ways.

[SPL routines in SELECT statements](#) shows how to include SPL routines in your SELECT statements.

[Data encryption functions](#) shows how the use of the SET ENCRYPTION statement and built-in encryption and decryption functions can prevent users who cannot provide a password from viewing or modifying sensitive data.

Compose advanced SELECT statements

This section increases the scope of what you can do with the SELECT statement and enables you to perform more complex database queries and data manipulation. [Compose SELECT statements](#), focused on five of the clauses in the SELECT statement syntax. This section adds the GROUP BY clause and the HAVING clause. You can use the GROUP BY clause with aggregate functions to organize rows returned by the FROM clause. You can include a HAVING clause to place conditions on the values that the GROUP BY clause returns.

This section also extends the earlier discussion of joins. It illustrates *self-joins*, which enable you to join a table to itself, and four kinds of *outer joins*, in which you apply the keyword OUTER to treat two or more joined tables unequally. It also introduces correlated and uncorrelated subqueries and their operational keywords, shows how to combine queries with the UNION operator, and defines the set operations known as union, intersection, and difference.

Examples in this section show how to use some or all of the SELECT statement clauses in your queries. The clauses must appear in the following order:

1. Projection
2. FROM
3. WHERE
4. GROUP BY
5. HAVING
6. ORDER BY
7. INTO TEMP

For an example of a SELECT statement that uses all these clauses in the correct order, see [Figure 5](#).

An additional SELECT statement clause, INTO, which you can use to specify program and host variables in SQL APIs, is described in [SQL programming](#), as well as in the publications that come with the product.

This section also describes nested SELECT statements, in which subqueries are specified within the Projection, FROM, or WHERE clauses of the main query. Other sections show how SELECT statements can define and manipulate collections, and how to perform set operations on query results.

- [The GROUP BY and HAVING clauses](#)
- [Create advanced joins](#)
- [Subqueries in SELECT statements](#)
- [Handle collections in SELECT statements](#)
- [Set operations](#)
- [Summary](#)

The GROUP BY and HAVING clauses

The optional GROUP BY and HAVING clauses add functionality to your SELECT statement. You can include one or both in a basic SELECT statement to increase your ability to manipulate aggregates.

The GROUP BY clause combines similar rows, producing a single result row for each group of rows that have the same values, for each column listed in the Projection clause. The HAVING clause sets conditions on those groups after you form them. You can use a GROUP BY clause without a HAVING clause, or a HAVING clause without a GROUP BY clause.

- [The GROUP BY clause](#)
- [The HAVING clause](#)

The GROUP BY clause

The GROUP BY clause divides a table into sets. This clause is most often combined with aggregate functions that produce summary values for each of those sets. Some examples in [Compose SELECT statements](#) show the use of aggregate functions applied to a whole table. This section illustrates aggregate functions applied to groups of rows.

Using the GROUP BY clause without aggregates is much like using the DISTINCT (or UNIQUE) keyword in the SELECT clause. The following query is described in [Select specific columns](#).

Figure 1. Query

```
SELECT DISTINCT customer_num FROM orders;
```

You could also write the statement as the following query shows.

Figure 2. Query

```
SELECT customer_num FROM orders
GROUP BY customer_num;
```

[Figure 1](#) and [Figure 2](#) return the following rows.

Figure 3. Query result

customer_num
101
104
106
110
⋮
124
126
127

The GROUP BY clause collects the rows into sets so that each row in each set has the same customer numbers. With no other columns selected, the result is a list of the unique **customer_num** values.

The power of the GROUP BY clause is more apparent when you use it with aggregate functions.

The following query retrieves the number of items and the total price of all items for each order.

Figure 4. Query

```
SELECT order_num, COUNT (*) number, SUM (total_price) price
FROM items
GROUP BY order_num;
```

The GROUP BY clause causes the rows of the **items** table to be collected into groups, each group composed of rows that have identical **order_num** values (that is, the items of each order are grouped together). After the database server forms the groups, the aggregate functions COUNT and SUM are applied within each group.

[Figure 4](#) returns one row for each group. It uses labels to give names to the results of the COUNT and SUM expressions, as the result shows.

Figure 5. Query result

order_num	number	price
1001	1	\$250.00
1002	2	\$1200.00
1003	3	\$959.00
1004	4	\$1416.00
⋮		
1021	4	\$1614.00
1022	3	\$232.00
1023	6	\$824.00

The result collects the rows of the **items** table into groups that have identical order numbers and computes the COUNT of rows in each group and the SUM of the prices.

You cannot include a TEXT, BYTE, CLOB, or BLOB column in a GROUP BY clause. To *group*, you must be able to *sort*, and no natural sort order exists for these data types.

Unlike the ORDER BY clause, the GROUP BY clause does not order data. Include an ORDER BY clause *after* your GROUP BY clause if you want to sort data in a particular order or sort on an aggregate in the projection list.

The following query is the same as [Figure 4](#) but includes an ORDER BY clause to sort the retrieved rows in ascending order of **price**, as the result shows.

Figure 6. Query

```
SELECT order_num, COUNT(*) number, SUM (total_price) price
FROM items
GROUP BY order_num
ORDER BY price;
```

Figure 7. Query result

order_num	number	price
1010	2	\$84.00
1011	1	\$99.00
1013	4	\$143.80
1022	3	\$232.00
1001	1	\$250.00
1020	2	\$438.00
1006	5	\$448.00
:		
1002	2	\$1200.00
1004	4	\$1416.00
1014	2	\$1440.00
1019	1	\$1499.97
1021	4	\$1614.00
1007	5	\$1696.00

The topic [Select specific columns](#) describes how to use an integer in an ORDER BY clause to indicate the position of a column in the projection list. You can also use an integer in a GROUP BY clause to indicate the position of column names or display labels in the GROUP BY list.

The following query returns the same rows as [Figure 6](#) shows.

Figure 8. Query

```
SELECT order_num, COUNT(*) number, SUM (total_price) price
FROM items
GROUP BY 1
ORDER BY 3;
```

When you build a query, all non-aggregate columns that are in the projection list in the Projection clause must also be included in the GROUP BY clause. A SELECT statement with a GROUP BY clause must return only one row per group. Columns that are listed after GROUP BY are certain to reflect only one distinct value within a group, and that value can be returned. However, a column not listed after GROUP BY might contain different values in the rows that are contained in the group.

The following query shows how to use the GROUP BY clause in a SELECT statement that joins tables.

Figure 9. Query

```
SELECT o.order_num, SUM (i.total_price)
FROM orders o, items i
WHERE o.order_date > '01/01/98'
AND o.customer_num = 110
AND o.order_num = i.order_num
GROUP BY o.order_num;
```

The query joins the **orders** and **items** tables, assigns table aliases to them, and returns the rows.

Figure 10. Query result

order_num	(sum)
1008	\$940.00
1015	\$450.00

The HAVING clause

To complement a GROUP BY clause, use a HAVING clause to apply one or more qualifying conditions to groups after they are formed. The effect of the HAVING clause on groups is similar to the way the WHERE clause qualifies individual rows. One advantage of using a HAVING clause is that you can include aggregates in the search condition, whereas you cannot include aggregates in the search condition of a WHERE clause.

Each HAVING condition compares one column or aggregate expression of the group with another aggregate expression of the group or with a constant. You can use HAVING to place conditions on both column values and aggregate values in the group list.

The following query returns the average total price per item on all orders that have more than two items. The HAVING clause tests each group as it is formed and selects those that are composed of more than two rows.

Figure 1. Query

```
SELECT order_num, COUNT(*) number, AVG (total_price) average
FROM items
```

```
GROUP BY order_num
HAVING COUNT(*) > 2;
```

Figure 2. Query result

order_num	number	average
1003	3	\$319.67
1004	4	\$354.00
1005	4	\$140.50
1006	5	\$89.60
1007	5	\$339.20
1013	4	\$35.95
1016	4	\$163.50
1017	3	\$194.67
1018	5	\$226.20
1021	4	\$403.50
1022	3	\$77.33
1023	6	\$137.33

If you use a HAVING clause without a GROUP BY clause, the HAVING condition applies to all rows that satisfy the search condition. In other words, all rows that satisfy the search condition make up a single group.

The following query, a modified version of [Figure 1](#), returns just one row, the average of all **total_price** values in the table, as the result shows.

Figure 3. Query

```
SELECT AVG (total_price) average
FROM items
HAVING count(*) > 2;
```

Figure 4. Query result

average
\$270.97

If [Figure 3](#), like [Figure 1](#), had included the non-aggregate column **order_num** in the Projection clause, you would have to include a GROUP BY clause with that column in the group list. In addition, if the condition in the HAVING clause was not satisfied, the output would show the column heading and a message would indicate that no rows were found.

The following query contains all the SELECT statement clauses that you can use in the IBM® Informix® version of interactive SQL (the INTO clause that names host variables is available only in an SQL API).

Figure 5. Query

```
SELECT o.order_num, SUM (i.total_price) price,
       paid_date - order_date span
FROM orders o, items i
WHERE o.order_date > '01/01/98'
      AND o.customer_num > 110
      AND o.order_num = i.order_num
GROUP BY 1, 3
HAVING COUNT (*) < 5
ORDER BY 3
INTO TEMP temptabl;
```

The query joins the **orders** and **items** tables; employs display labels, table aliases, and integers that are used as column indicators; groups and orders the data; and puts the results in a temporary table, as the result shows.

Figure 6. Query result

order_num	price	span
1017	\$584.00	
1016	\$654.00	
1012	\$1040.00	
1019	\$1499.97	26
1005	\$562.00	28
1021	\$1614.00	30
1022	\$232.00	40
1010	\$84.00	66
1009	\$450.00	68
1020	\$438.00	71

Create advanced joins

The topic [Create a join](#) shows how to include a WHERE clause in a SELECT statement to join two or more tables on one or more columns. It illustrates natural joins and equi-joins.

This section discusses how to use two more complex kinds of joins, self-joins and outer joins. As described for simple joins, you can define aliases for tables and assign display labels to expressions to shorten your multiple-table queries. You can also issue a SELECT statement with an ORDER BY clause that sorts data into a temporary table.

- [Self-joins](#)
- [Outer joins](#)

Self-joins

A join does not always have to involve two different tables. You can join a table to itself, creating a *self-join*. Joining a table to itself can be useful when you want to compare values in a column to other values in the same column.

To create a self-join, list a table twice in the FROM clause, and assign it a different alias each time. Use the aliases to refer to the table in the Projection and WHERE clauses as if it were two separate tables. (Aliases in SELECT statements are discussed in [Aliases](#) and in the *IBM® Informix® Guide to SQL: Syntax*.)

Just as in joins between tables, you can use arithmetic expressions in self-joins. You can test for null values, and you can use an ORDER BY clause to sort the values in a specified column in ascending or descending order.

The following query finds pairs of orders where the **ship_weight** differs by a factor of five or more and the **ship_date** is not null. The query then orders the data by **ship_date**.

Figure 1. Query

```
SELECT x.order_num, x.ship_weight, x.ship_date,
       y.order_num, y.ship_weight, y.ship_date
FROM orders x, orders y
WHERE x.ship_weight >= 5 * y.ship_weight
      AND x.ship_date IS NOT NULL
      AND y.ship_date IS NOT NULL
ORDER BY x.ship_date;
```

Table 1. Query result

order_num	ship_weight	ship_date	order_num	ship_weight	ship_date
1004	95.80	05/30/1998	1011	10.40	07/03/1998
1004	95.80	05/30/1998	1020	14.00	07/16/1998
1004	95.80	05/30/1998	1022	15.00	07/30/1998
1007	125.90	06/05/1998	1015	20.60	07/16/1998
1007	125.90	06/05/1998	1020	14.00	07/16/1998

If you want to store the results of a self-join into a temporary table, append an INTO TEMP clause to the SELECT statement and assign display labels to at least one set of columns to rename them. Otherwise, the duplicate column names cause an error and the temporary table is not created.

The following query, which is similar to [Figure 1](#), labels all columns selected from the **orders** table and puts them in a temporary table called **shipping**.

Figure 2. Query

```
SELECT x.order_num orders1, x.po_num purch1,
       x.ship_date ship1, y.order_num orders2,
       y.po_num purch2, y.ship_date ship2
FROM orders x, orders y
WHERE x.ship_weight >= 5 * y.ship_weight
      AND x.ship_date IS NOT NULL
      AND y.ship_date IS NOT NULL
ORDER BY orders1, orders2
INTO TEMP shipping;
```

If you query with **SELECT * from table shipping**, you see the following rows.

Figure 3. Query result

orders1	purch1	ship1	orders2	purch2	ship2
1004	8006	05/30/1998	1011	B77897	07/03/1998
1004	8006	05/30/1998	1020	W2286	07/16/1998
1004	8006	05/30/1998	1022	W9925	07/30/1998
1005	2865	06/09/1998	1011	B77897	07/03/1998
:					
1019	Z55709	07/16/1998	1020	W2286	07/16/1998
1019	Z55709	07/16/1998	1022	W9925	07/30/1998
1023	KF2961	07/30/1998	1011	B77897	07/03/1998

You can join a table to itself more than once. The maximum number of self-joins depends on the resources available to you.

The self-join in the following query creates a list of those items in the **stock** table that are supplied by three manufacturers. The self-join includes the last two conditions in the WHERE clause to eliminate duplicate manufacturer codes in rows that are retrieved.

Figure 4. Query

```
SELECT s1.manu_code, s2.manu_code, s3.manu_code,
       s1.stock_num, s1.description
FROM stock s1, stock s2, stock s3
WHERE s1.stock_num = s2.stock_num
      AND s2.stock_num = s3.stock_num
      AND s1.manu_code < s2.manu_code
      AND s2.manu_code < s3.manu_code
ORDER BY stock_num;
```

Figure 5. Query result

manu_code	manu_code	manu_code	stock_num	description
HRO	HSK	SMT	1	baseball gloves
ANZ	NRG	SMT	5	tennis racquet

ANZ	HRO	HSK	110	helmet
ANZ	HRO	PRC	110	helmet
ANZ	HRO	SHM	110	helmet
ANZ	HSK	PRC	110	helmet
ANZ	HSK	SHM	110	helmet
ANZ	PRC	SHM	110	helmet
HRO	HSK	PRC	110	helmet
HRO	HSK	SHM	110	helmet
HRO	PRC	SHM	110	helmet
:	:	:	:	:
KAR	NKL	PRC	301	running shoes
KAR	NKL	SHM	301	running shoes
KAR	PRC	SHM	301	running shoes
NKL	PRC	SHM	301	running shoes

If you want to select rows from a payroll table to determine which employees earn more than their manager, you might construct the self-join as the following SELECT statement shows:

```
SELECT emp.employee_num, emp.gross_pay, emp.level,
       emp.dept_num, mgr.employee_num, mgr.gross_pay,
       mgr.dept_num, mgr.level
FROM payroll emp, payroll mgr
WHERE emp.gross_pay > mgr.gross_pay
      AND emp.level < mgr.level
      AND emp.dept_num = mgr.dept_num
ORDER BY 4;
```

The following query uses a *correlated subquery* to retrieve and list the 10 highest-priced items ordered.
Figure 6. Query

```
SELECT order_num, total_price
FROM items a
WHERE 10 >
      (SELECT COUNT (*)
       FROM items b
        WHERE b.total_price < a.total_price)
ORDER BY total_price;
```

The query returns the 10 rows.
Figure 7. Query result

order_num	total_price
1018	\$15.00
1013	\$19.80
1003	\$20.00
1005	\$36.00
1006	\$36.00
1013	\$36.00
1010	\$36.00
1013	\$40.00
1022	\$40.00
1023	\$40.00

You can create a similar query to find and list the 10 employees in the company who have the most seniority.

For more information about correlated subqueries, refer to [Subqueries in SELECT statements](#).

Outer joins

This section shows how to create and use outer joins in a SELECT statement. The topic [Create a join](#) discusses inner joins. Whereas an inner join treats two or more joined tables equally, an outer join treats two or more joined tables asymmetrically. An outer join makes one of the tables dominant (also called the *outer table*) over the other subordinate tables (also called *inner tables*).

In an inner join or in a *simple join*, the result contains only the combinations of rows that satisfy the join conditions. Rows that do not satisfy the join conditions are discarded.

In an outer join, the result contains the combinations of rows that satisfy the join conditions and the rows from the dominant table that would otherwise be discarded because no matching row was found in the subordinate table. The rows from the dominant table that do not have matching rows in the subordinate table contain NULL values in the columns selected from the subordinate table.

An outer join allows you to apply *join filters* to the inner table before the join condition is applied.

The database server supports syntax for outer joins that is an extension to the ANSI standard for the SQL language. Besides outer join syntax based on this IBM® Informix® extension, the database server also supports the ANSI standard syntax, which provides more flexibility for creating queries that join a dominant table with one or more subordinate tables. With the exception of joins in view definitions, it is recommended that you use the ANSI standard syntax for creating new outer-join queries.

In view definitions, however, the Informix-extension syntax does not require materialized views, and so it might offer performance advantages over ISO/ANSI join syntax in those contexts, including business-analytic operations that query complex views joining multiple tables.

Whichever form of outer-join syntax you use, however, a single query cannot mix both syntax modes. All of the outer join operations in the same query block must either use SQL syntax that complies with the ISO/ANSI standard, or else use the IBM Informix extension syntax.

Important: Before you rely on outer joins, determine whether one or more inner joins can work. You can often use an inner join when you do not need supplemental information from other tables.

Restriction: You cannot combine IBM Informix and ANSI outer-join syntax in the same query block.

For information on the syntax of outer joins, see the *IBM Informix Guide to SQL: Syntax*.

- [IBM Informix extension to outer join syntax](#)
- [ANSI join syntax](#)
- [Left outer join](#)

In the syntax of a left outer join, the dominant table of the outer join appears to the left of the keyword that begins the outer join. A left outer join returns all of the rows for which the join condition is true and, in addition, returns all other rows from the dominant table and displays the corresponding values from the subservient table as NULL.

- [Right outer join](#)

In the syntax of a right outer join, the dominant table of the outer join appears to the right of the keyword that begins the outer join. A right outer join returns all of the rows for which the join condition is true and, in addition, returns all other rows from the dominant table and displays the corresponding values from the subservient table as NULL.

- [Simple join](#)
- [Simple outer join on two tables](#)
- [Outer join for a simple join to a third table](#)
- [Outer join of two tables to a third table](#)
- [Joins that combine outer joins](#)

IBM Informix extension to outer join syntax

The IBM® Informix® extension to outer-join syntax begins an outer join with the OUTER keyword. When you use the syntax, you must include the join condition in the WHERE clause. When you use the syntax for an outer join, the database server supports the following three basic types of outer joins:

- A simple outer join on two tables
- An outer join for a simple join to a third table
- An outer join of two tables to a third table

An outer join must have a Projection clause, a FROM clause, and a WHERE clause. The join conditions are expressed in a WHERE clause. To transform a simple join into an outer join, insert the keyword OUTER directly before the name of the subordinate tables in the FROM clause. As shown later in this section, you can include the OUTER keyword more than once in your query.

No extension to outer-join syntax is equivalent to the ANSI right outer join.

ANSI join syntax

The following ANSI joins are supported:

- Left outer join
- Right outer join

The ANSI outer-join syntax begins an outer join with the LEFT JOIN, LEFT OUTER JOIN, RIGHT JOIN, or RIGHT OUTER JOIN keywords. The OUTER keyword is optional. Queries can specify a join condition and optional join filters in the ON clause. The WHERE clause specifies a post-join filter. In addition, you can explicitly specify the type of join using the LEFT or right clause. ANSI join syntax also allows the dominant or subordinate part of an outer join to be the result set of another join, when you begin the join with a left parenthesis.

If you use ANSI syntax for an outer join, you must use the ANSI syntax for all outer joins in a single query block.

Tip: The examples in this section use table aliases for brevity. [Aliases](#) discusses table aliases.

Left outer join

In the syntax of a left outer join, the dominant table of the outer join appears to the left of the keyword that begins the outer join. A left outer join returns all of the rows for which the join condition is true and, in addition, returns all other rows from the dominant table and displays the corresponding values from the subservient table as NULL.

The following query uses ANSI syntax for a LEFT OUTER JOIN to join the **customer** and **cust_calls** tables, with **customer** the dominant table:

Figure 1. Query 1

```
SELECT c.customer_num, c.lname, c.company, c.phone,
       u.call_dtime, u.call_descr
FROM customer c LEFT OUTER JOIN cust_calls u
ON c.customer_num = u.customer_num;
```

The next query similarly uses the ON clause to specify the join condition, and adds an additional filter in the WHERE clause to limit your result set; such a filter is a post-join filter.

The query returns only rows in which customers have not made any calls to customer service. In this query, the database server applies the filter in the WHERE clause after it performs the outer join on the **customer_num** column of the **customer** and **cust_calls** tables.

Figure 2. Query 2


```
SELECT c.customer_num, c.lname, c.company, c.phone,
       u.call_dtime, u.call_descr
FROM customer c LEFT OUTER JOIN cust_calls u
ON c.customer_num = u.customer_num
WHERE u.customer_num IS NULL;
```

The next example shows the IBM® Informix®-extension syntax that is equivalent to the previous ANSI-compliant left outer join:
Figure 3. Query 3

```
SELECT c.customer_num, c.lname, c.company, c.phone,
       u.call_dtime, u.call_descr
FROM customer c OUTER JOIN cust_calls u
WHERE c.customer_num = u.customer_num
AND u.customer_num IS NULL;
```

Here the WHERE clause defines the join condition, and excludes rows with non-NULL **cust_calls** values.

Examples of ISO/ANSI LEFT OUTER JOIN queries

The following examples illustrate various query constructions that ANSI join syntax can support:

```
SELECT *
FROM (t1 LEFT OUTER JOIN (t2 LEFT OUTER JOIN t3 ON t2.c1=t3.c1)
ON t1.c1=t3.c1) JOIN (t4 LEFT OUTER JOIN t5 ON t4.c1=t5.c1)
ON t1.c1=t4.c1;
```

```
SELECT *
FROM (t1 LEFT OUTER JOIN (t2 LEFT OUTER JOIN t3 ON t2.c1=t3.c1)
ON t1.c1=t3.c1),
(t4 LEFT OUTER JOIN t5 ON t4.c1=t5.c1)
WHERE t1.c1 = t4.c1;
```

```
SELECT *
FROM (t1 LEFT OUTER JOIN (t2 LEFT OUTER JOIN t3 ON t2.c1=t3.c1)
ON t1.c1=t3.c1) LEFT OUTER JOIN (t4 JOIN t5 ON t4.c1=t5.c1)
ON t1.c1=t4.c1;
```

```
SELECT *
FROM t1 LEFT OUTER JOIN (t2 LEFT OUTER JOIN t3 ON t2.c1=t3.c1)
ON t1.c1=t2.c1;
```

```
SELECT *
FROM t1 LEFT OUTER JOIN (t2 LEFT OUTER JOIN t3 ON t2.c1=t3.c1)
ON t1.c1=t3.c1;
```

```
SELECT *
FROM (t1 LEFT OUTER JOIN t2 ON t1.c1=t2.c1)
LEFT OUTER JOIN t3 ON t2.c1=t3.c1;
```

```
SELECT *
FROM (t1 LEFT OUTER JOIN t2 ON t1.c1=t2.c1)
LEFT OUTER JOIN t3 ON t1.c1=t3.c1;
```

```
SELECT *
FROM t9, (t1 LEFT JOIN t2 ON t1.c1=t2.c1),
(t3 LEFT JOIN t4 ON t3.c1=10), t10, t11,
(t12 LEFT JOIN t14 ON t12.c1=100);
```

```
SELECT * FROM
((SELECT c1,c2 FROM t3) AS vt3(v31,v32)
LEFT OUTER JOIN
((SELECT c1,c2 FROM t1) AS vt1(vc1,vc2)
LEFT OUTER JOIN
(SELECT c1,c2 FROM t2) AS vt2(vc3,vc4)
ON vt1.vc1 = vt2.vc3)
ON vt3.v31 = vt2.vc3);
```

The last example above includes ANSI-compliant joins on derived tables. It specifies a left outer join on the results of a subquery in the FROM clause of the outer query with the results of another left outer join on two other subquery results. See the section [Subqueries in the FROM clause](#) for less complex examples of the ANSI-compliant syntax for subqueries.

Right outer join

In the syntax of a right outer join, the dominant table of the outer join appears to the right of the keyword that begins the outer join. A right outer join returns all of the rows for which the join condition is true and, in addition, returns all other rows from the dominant table and displays the corresponding values from the subservient table as NULL.

The following query is an example of a right outer join on the **customer** and **orders** tables.
Figure 1. Query

```
SELECT c.customer_num, c.fname, c.lname, o.order_num,
       o.order_date, o.customer_num
FROM customer c RIGHT OUTER JOIN orders o
ON (c.customer_num = o.customer_num);
```

The query returns all rows from the dominant table **orders** and, as necessary, displays the corresponding values from the subservient table **customer** as NULL.

Figure 2. Query result

customer_num	fname	lname	order_num	order date	customer_num
104	Anthony	Wiggins	1001	05/30/1998	104
101	Ludwig	Pauli	1002	05/30/1998	101
104	Anthony	Wiggins	1003	05/30/1998	104
<NULL>	<NULL>	<NULL>	1004	06/05/1998	106

Simple join

The following query is an example of a simple join on the **customer** and **cust_calls** tables.

Figure 1. Query

```
SELECT c.customer_num, c.lname, c.company,
       c.phone, u.call_dtime, u.call_descr
FROM customer c, cust_calls u
WHERE c.customer_num = u.customer_num;
```

The query returns only those rows in which the customer has made a call to customer service, as the result shows.

Figure 2. Query result

```
customer_num  106
lname         Watson
company       Watson & Son
phone         415-389-8789
call_dtime    1998-06-12 08:20
call_descr    Order was received, but two of the cans of
               ANZ tennis balls within the case were empty
:
customer_num  116
lname         Parmelee
company       Olympic City
phone         415-534-8822
call_dtime    1997-12-21 11:24
call_descr    Second complaint from this customer! Received
               two cases right-handed outfielder gloves (1 HRO)
               instead of one case lefties.
```

Simple outer join on two tables

The following query uses the same Projection clause, tables, and comparison condition as the preceding example, but this time it creates a simple outer join in IBM® Informix® extension syntax.

Figure 1. Query

```
SELECT c.customer_num, c.lname, c.company,
       c.phone, u.call_dtime, u.call_descr
FROM customer c, OUTER cust_calls u
WHERE c.customer_num = u.customer_num;
```

The addition of the keyword **OUTER** before the **cust_calls** table makes it the subservient table. An outer join causes the query to return information on all customers, whether or not they have made calls to customer service. All rows from the dominant **customer** table are retrieved, and NULL values are assigned to columns of the subservient **cust_calls** table, as the result shows.

Figure 2. Query result

```
customer_num  101
lname         Pauli
company       All Sports Supplies
phone         408-789-8075
call_dtime
call_descr

customer_num  102
lname         Sadler
company       Sports Spot
phone         415-822-1289
call_dtime
call_descr
:
customer_num  107
lname         Ream
company       Athletic Supplies
phone         415-356-9876
call_dtime
call_descr

customer_num  108
lname         Quinn
company       Quinn's Sports
phone         415-544-8729
call_dtime
call_descr
```

Outer join for a simple join to a third table

Using the IBM® Informix® syntax, the following query shows an outer join that is the result of a simple join to a third table. This second type of outer join is known as a *nested simple join*.

Figure 1. Query

```
SELECT c.customer_num, c.lname, o.order_num,
       i.stock_num, i.manu_code, i.quantity
FROM customer c, OUTER (orders o, items i)
WHERE c.customer_num = o.customer_num
      AND o.order_num = i.order_num
      AND manu_code IN ('KAR', 'SHM')
ORDER BY lname;
```

The query first performs a simple join on the **orders** and **items** tables, retrieving information on all orders for items with a **manu_code** of KAR or SHM. It then performs an outer join to combine this information with data from the dominant **customer** table. An optional ORDER BY clause reorganizes the data into the following form.

Figure 2. Query result

customer_num	lname	order_num	stock_num	manu_code	quantity
114	Albertson				
118	Baxter				
113	Beatty				
:					
105	Vector				
121	Wallack	1018	302	KAR	3
106	Watson				

Outer join of two tables to a third table

Using the IBM® Informix® extension syntax, the following query shows an outer join that is the result of an outer join of each of two tables to a third table. In this third type of outer join, join relationships are possible only between the dominant table and the subservient tables.

Figure 1. Query

```
SELECT c.customer_num, c.lname, o.order_num,
       order_date, call_dtime
FROM customer c, OUTER orders o, OUTER cust_calls x
WHERE c.customer_num = o.customer_num
      AND c.customer_num = x.customer_num
ORDER BY lname
INTO TEMP service;
```

The query individually joins the subservient tables **orders** and **cust_calls** to the dominant **customer** table; it does not join the two subservient tables. An INTO TEMP clause selects the results into a temporary table for further manipulation or queries, as the result shows.

Figure 2. Query result

customer_num	lname	order_num	order_date	call_dtime
114	Albertson			
118	Baxter			
113	Beatty			
103	Currie			
115	Grant	1010	06/17/1998	
:				
117	Sipes	1012	06/18/1998	
105	Vector			
121	Wallack	1018	07/10/1998	1998-07-10 14:05
106	Watson	1004	05/22/1998	1998-06-12 08:20
106	Watson	1014	06/25/1998	1998-06-12 08:20

If [Figure 1](#) had tried to create a join condition between the two subservient tables **o** and **x**, as the following query shows, an error message would indicate the creation of a two-sided outer join.

Figure 3. Query

```
WHERE o.customer_num = x.customer_num
```

Joins that combine outer joins

To achieve multiple levels of nesting, you can create a join that employs any combination of the three types of outer joins. Using the ANSI syntax, the following query creates a join that is the result of a combination of a simple outer join on two tables and a second outer join.

Figure 1. Query

```
SELECT c.customer_num, c.lname, o.order_num,
       stock_num, manu_code, quantity
FROM customer c, OUTER (orders o, OUTER items i)
WHERE c.customer_num = o.customer_num
      AND o.order_num = i.order_num
```

```
AND manu_code IN ('KAR', 'SHM')
ORDER BY lname;
```

The query first performs an outer join on the **orders** and **items** tables, retrieving information on all orders for items with a **manu_code** of KAR or SHM. It then performs a second outer join that combines this information with data from the dominant **customer** table.

Figure 2. Query result

customer_num	lname	order_num	stock_num	manu_code	quantity
114	Albertson				
118	Baxter				
113	Beatty				
103	Currie				
115	Grant	1010			
⋮					
117	Sipes	1012			
117	Sipes	1007			
105	Vector				
121	Wallack	1018	302	KAR	3
106	Watson	1014			
106	Watson	1004			

You can specify the join conditions in two ways when you apply an outer join to the result of an outer join to a third table. The two subservient tables are joined, but you can join the dominant table to either subservient table without affecting the results if the dominant table and the subservient table share a common column.

Subqueries in SELECT statements

A *subquery* (the inner SELECT statement, where one SELECT statement is nested within another) can return zero or more rows or expressions. Each subquery must be delimited by parentheses, and must contain a Projection clause and a FROM clause. A subquery can itself contain other subqueries.

The database server supports subqueries in the following contexts:

- A SELECT statement nested in the Projection clause of another SELECT statement
- a SELECT statement nested in the WHERE clause of another SELECT statement
- a SELECT statement nested in the FROM clause of another SELECT statement.

You can also specify a subquery in various clauses of the INSERT, DELETE, MERGE, or UPDATE statements where a subquery is valid.

Subqueries in the Projection clause or in the WHERE clause can be *correlated* or *uncorrelated*. A subquery is correlated when the value that it produces depends on a value produced by the outer SELECT statement that contains it. For more information, see [Correlated subqueries](#).

Any other kind of subquery is considered uncorrelated. Only uncorrelated subqueries are valid in the FROM clause of the SELECT statement.

- [Correlated subqueries](#)
- [Using subqueries to combine SELECT statements](#)
- [Subqueries in a Projection clause](#)
- [Subqueries in the FROM clause](#)
- [Subqueries in WHERE clauses](#)
- [Subqueries in DELETE and UPDATE statements](#)

Correlated subqueries

A *correlated subquery* is a subquery that refers to a column of a table that is not listed in its FROM clause. The column can be in the Projection clause or in the WHERE clause. To find the table to which the correlated subquery refers, search the columns until a correlation is found.

In general, correlated subqueries diminish performance. Use the table name or alias in the subquery so that there is no doubt as to which table the column is in.

The database server will use the outer query to get values. For example, if the table **taba** has the column **col1** and table **tabb** has the column **col2** and they contain the following:

```
taba.col1    aa,bb,null
tabb.col2    bb, null
```

And the query is:

```
select * from taba where col1 in (select col1 from tabb);
```

Then the results might be meaningless. The database server will provide all values in **taba.col1** and then compare them to **taba.col1** (outer query WHERE clause). This will return all rows. You usually use the subquery to return column values from the inner table. Had the query been written as:

```
select * from taba where col1 in (select tabb.col1 from tabb);
```

Then the error `-217 column not found` would have resulted.

The important feature of a correlated subquery is that, because it depends on a value from the outer SELECT, it must be executed repeatedly, once for every value that the outer SELECT produces. An uncorrelated subquery is executed only once.

Using subqueries to combine SELECT statements

You can construct a SELECT statement with a subquery to replace two separate SELECT statements.

Subqueries in SELECT statements allow you to perform various tasks, including the following actions:

- Compare an expression to the result of another SELECT statement
- Determine whether the results of another SELECT statement include a specific expression
- Determine whether another SELECT statement returns any rows

An optional WHERE clause in a subquery is often used to narrow the search condition.

A subquery selects and returns values to the first or outer SELECT statement. A subquery can return no value, a single value, or a set of values, as follows:

- If a subquery returns no value, the query does not return any rows. Such a subquery is equivalent to a NULL value.
- If a subquery returns one value, the value is in the form of either one aggregate expression or exactly one row and one column. Such a subquery is equivalent to a single number or character value.
- If a subquery returns a list or set of values, the values can represent one row or one column.
- In the FROM clause of the outer query, a subquery can represent a set of rows (sometimes called a *derived table* or a *table expression*).

Subqueries in a Projection clause

A subquery can occur in the Projection clause of another SELECT statement. The following query shows how you might use a subquery in a Projection clause to return the total shipping charges (from the **orders** table) for each customer in the **customer** table. You could also write this query as a join between two tables. Figure 1. Query

```
SELECT customer.customer_num,  
       (SELECT SUM(ship_charge)  
        FROM orders  
        WHERE customer.customer_num = orders.customer_num)  
       AS total_ship_chg  
FROM customer;
```

Figure 2. Query result

customer_num	total_ship_chg
101	\$15.30
102	
103	
104	\$38.00
105	
⋮	
123	\$8.50
124	\$12.00
125	
126	\$13.00
127	\$18.00
128	

Subqueries in the FROM clause

This topic describes subqueries that occur as nested SELECT statements in the FROM clause of an outer SELECT statement. Such subqueries are sometimes called *derived tables* or *table expressions* because the outer query uses the results of the subquery as a data source.

The following query uses asterisk notation in the outer query to return the results of a subquery that retrieves all fields of the **address** column in the **employee** table.

Figure 1. Query

```
SELECT * FROM (SELECT address.* FROM employee);
```

Figure 2. Query result

```
address ROW(102 Ruby, Belmont, CA, 49932, 1000)  
address ROW(133 First, San Jose, CA, 85744, 4900)  
address ROW(152 Topaz, Willits, CA, 69445, 1000))  
⋮
```

This illustrates how to specify a derived table, but it is a trivial example of this syntax, because the outer query does not manipulate any values in the table expression that the subquery in the FROM clause returns. (See [Figure 1](#) for a simple query that returns the same results.)

The following query is a more complex example in which the outer query selects only the first qualifying row of a derived table that a subquery in the FROM clause specifies as a simple join on the **customer** and **cust_calls** tables.

Figure 3. Query

```
SELECT LIMIT 1 * FROM  
(SELECT c.customer_num, c.lname, c.company,
```

```

        c.phone, u.call_dtime, u.call_descr
      FROM customer c, cust_calls u
      WHERE c.customer_num = u.customer_num
      ORDER BY u.call_dtime DESC);

```

The query returns only those rows in which the customer has made a call to customer service, as the result shows.

Figure 4. Query result

```

customer_num  106
lname         Watson
company       Watson & Son
phone         415-389-8789
call_dtime    1998-06-12 08:20
call_descr    Order was received, but two of the cans of
              ANZ tennis balls within the case were empty

```

In the preceding example, the subquery includes an ORDER BY clause that specifies a column that appears in Projection list of the subquery, but the query would also be valid if the Projection list had omitted the **u.call_dtime** column. The FROM clause is the only context in which a subquery can specify the ORDER BY clause.

Subqueries in WHERE clauses

This section describes subqueries that occur as a SELECT statement that is nested in the WHERE clause of another SELECT statement.

You can use any relational operator with ALL and ANY to compare something to every one of (ALL) or to any one of (ANY) the values that the subquery produces. You can use the keyword SOME in place of ANY. The operator IN is equivalent to = ANY. To create the opposite search condition, use the keyword NOT or a different relational operator.

The EXISTS operator tests a subquery to see if it found any values; that is, it asks if the result of the subquery is not null. You cannot use the EXISTS keyword in a subquery that contains a column with a TEXT or BYTE data type.

For the syntax that you use to create a condition with a subquery, see the *IBM® Informix® Guide to SQL: Syntax*.

The following keywords introduce a subquery in the WHERE clause of a SELECT statement.

- [The ALL keyword](#)
- [The ANY keyword](#)
- [Single-valued subqueries](#)
- [Correlated subqueries](#)
- [The EXISTS keyword](#)

The ALL keyword

Use the keyword ALL preceding a subquery to determine whether a comparison is true for every value returned. If the subquery returns no values, the search condition is *true*. (If it returns no values, the condition is true of all the zero values.)

The following query lists the following information for all orders that contain an item for which the total price is less than the total price on every item in order number 1023.

Figure 1. Query

```

SELECT order_num, stock_num, manu_code, total_price
  FROM items
 WHERE total_price < ALL
    (SELECT total_price FROM items
     WHERE order_num = 1023);

```

Figure 2. Query result

order_num	stock_num	manu_code	total_price
1003	9	ANZ	\$20.00
1005	6	SMT	\$36.00
1006	6	SMT	\$36.00
1010	6	SMT	\$36.00
1013	5	ANZ	\$19.80
1013	6	SMT	\$36.00
1018	302	KAR	\$15.00

The ANY keyword

Use the keyword ANY (or its synonym SOME) before a subquery to determine whether a comparison is true for at least one of the values returned. If the subquery returns no values, the search condition is *false*. (Because no values exist, the condition cannot be true for one of them.)

The following query finds the order number of all orders that contain an item for which the total price is greater than the total price of any one of the items in order number 1005.

Figure 1. Query

```
SELECT DISTINCT order_num
FROM items
WHERE total_price > ANY
  (SELECT total_price
   FROM items
   WHERE order_num = 1005);
```

Figure 2. Query result

```
order_num
1001
1002
1003
1004
:
1020
1021
1022
1023
```

Single-valued subqueries

You do not need to include the keyword **ALL** or **ANY** if you know the subquery can return exactly one value to the outer-level query. A subquery that returns exactly one value can be treated like a function. This kind of subquery often uses an aggregate function because aggregate functions always return single values.

The following query uses the aggregate function **MAX** in a subquery to find the **order_num** for orders that include the maximum number of volleyball nets.

Figure 1. Query

```
SELECT order_num FROM items
WHERE stock_num = 9
AND quantity =
  (SELECT MAX (quantity)
   FROM items
   WHERE stock_num = 9);
```

Figure 2. Query result

```
order_num
1012
```

The following query uses the aggregate function **MIN** in the subquery to select items for which the total price is higher than 10 times the minimum price.

Figure 3. Query

```
SELECT order_num, stock_num, manu_code, total_price
FROM items x
WHERE total_price >
  (SELECT 10 * MIN (total_price)
   FROM items
   WHERE order_num = x.order_num);
```

Figure 4. Query result

order_num	stock_num	manu_code	total_price
1003	8	ANZ	\$840.00
1018	307	PRC	\$500.00
1018	110	PRC	\$236.00
1018	304	HRO	\$280.00

Correlated subqueries

A *correlated subquery* is a subquery that refers to a column of a table that is not in its **FROM** clause. The column can be in the **Projection** clause or in the **WHERE** clause.

In general, correlated subqueries diminish performance. It is recommended that you qualify the column name in subqueries with the name or alias of the table, in order to remove any doubt regarding in which table the column resides.

The following query is an example of a correlated subquery that returns a list of the 10 latest shipping dates in the **orders** table. It includes an **ORDER BY** clause after the subquery to order the results because (except in the **FROM** clause) you cannot include **ORDER BY** within a subquery.

Figure 1. Query

```
SELECT po_num, ship_date FROM orders main
WHERE 10 >
  (SELECT COUNT (DISTINCT ship_date)
   FROM orders sub
   WHERE sub.ship_date < main.ship_date)
AND ship_date IS NOT NULL
ORDER BY ship_date, po_num;
```

The subquery is correlated because the number that it produces depends on **main.ship_date**, a value that the outer SELECT produces. Thus, the subquery must be re-executed for every row that the outer query considers.

The query uses the **COUNT** function to return a value to the main query. The ORDER BY clause then orders the data. The query locates and returns the 16 rows that have the 10 latest shipping dates, as the result shows.

Figure 2. Query result

po_num	ship_date
4745	06/21/1998
278701	06/29/1998
429Q	06/29/1998
8052	07/03/1998
B77897	07/03/1998
LZ230	07/06/1998
B77930	07/10/1998
PC6782	07/12/1998
DM354331	07/13/1998
S22942	07/13/1998
MA003	07/16/1998
W2286	07/16/1998
Z55709	07/16/1998
C3288	07/25/1998
KF2961	07/30/1998
W9925	07/30/1998

If you use a correlated subquery, such as [Figure 1](#), on a large table, you should index the **ship_date** column to improve performance. Otherwise, this SELECT statement is inefficient, because it executes the subquery once for every row of the table. For information about indexing and performance issues, see the *IBM® Informix® Administrator's Guide* and your *IBM Informix Performance Guide*.

You cannot use a correlated subquery in the FROM clause, however, as the following invalid example illustrates:

```
SELECT item_num, stock_num FROM items,
  (SELECT stock_num FROM catalog
   WHERE stock_num = items.item_num) AS vtab;
```

The subquery in this example fails with error -24138:

```
ALL COLUMN REFERENCES IN A TABLE EXPRESSION MUST REFER
TO TABLES IN THE FROM CLAUSE OF THE TABLE EXPRESSION.
```

The database server issues this error because the **items.item_num** column in the subquery also appears in the Projection clause of the outer query, but the FROM clause of the inner query specifies only the **catalog** table. The term *table expression* in the error message text refers to the set of column values or expressions that are returned by a subquery in the FROM clause, where only uncorrelated subqueries are valid.

The EXISTS keyword

The keyword EXISTS is known as an *existential qualifier* because the subquery is true only if the outer SELECT, as the following query shows, finds at least one row. Figure 1. Query

```
SELECT UNIQUE manu_name, lead_time
  FROM manufact
 WHERE EXISTS
   (SELECT * FROM stock
    WHERE description MATCHES '*shoe*'
     AND manufact.manu_code = stock.manu_code);
```

You can often construct a query with EXISTS that is equivalent to one that uses IN. The following query uses an IN predicate to construct a query that returns the same result as the query above.

Figure 2. Query

```
SELECT UNIQUE manu_name, lead_time
  FROM stock, manufact
 WHERE manufact.manu_code IN
   (SELECT manu_code FROM stock
    WHERE description MATCHES '*shoe*')
   AND stock.manu_code = manufact.manu_code;
```

[Figure 1](#) and [Figure 2](#) return rows for the manufacturers that produce a kind of shoe, as well as the lead time for ordering the product. The result shows the return values.

Figure 3. Query result

manu_name	lead_time
Anza	5
Hero	4
Karsten	21
Nikolus	8
ProCycle	9
Shimara	30

Add the keyword NOT to IN or to EXISTS to create a search condition that is the opposite of the condition in the preceding queries. You can also substitute !=ALL for NOT IN.

The following query shows two ways to do the same thing. One way might allow the database server to do less work than the other, depending on the design of the database and the size of the tables. To find out which query might be better, use the SET EXPLAIN command to get a listing of the query plan. SET EXPLAIN is discussed in your *IBM® Informix® Performance Guide* and *IBM Informix Guide to SQL: Syntax*.

Figure 4. Query

```
SELECT customer_num, company FROM customer
WHERE customer_num NOT IN
  (SELECT customer_num FROM orders
   WHERE customer.customer_num = orders.customer_num);

SELECT customer_num, company FROM customer
WHERE NOT EXISTS
  (SELECT * FROM orders
   WHERE customer.customer_num = orders.customer_num);
```

Each statement in the query above returns the following rows, which identify customers who have not placed orders.

Figure 5. Query result

customer_num	company
102	Sports Spot
103	Phil's Sports
105	Los Altos Sports
107	Athletic Supplies
108	Quinn's Sports
109	Sport Stuff
113	Sportstown
114	Sporting Place
118	Blue Ribbon Sports
125	Total Fitness Sports
128	Phoenix University

The keywords EXISTS and IN are used for the set operation known as *intersection*, and the keywords NOT EXISTS and NOT IN are used for the set operation known as *difference*. These concepts are discussed in [Set operations](#).

The following query performs a subquery on the **items** table to identify all the items in the **stock** table that have not yet been ordered.

Figure 6. Query

```
SELECT * FROM stock
WHERE NOT EXISTS
  (SELECT * FROM items
   WHERE stock.stock_num = items.stock_num
   AND stock.manu_code = items.manu_code);
```

The query returns the following rows.

Figure 7. Query result

stock_num	manu_code	description	unit_price	unit	unit_descr
101	PRC	bicycle tires	\$88.00	box	4/box
102	SHM	bicycle brakes	\$220.00	case	4 sets/case
102	PRC	bicycle brakes	\$480.00	case	4 sets/case
105	PRC	bicycle wheels	\$53.00	pair	pair
⋮					
312	HRO	racer goggles	\$72.00	box	12/box
313	SHM	swim cap	\$72.00	box	12/box
313	ANZ	swim cap	\$60.00	box	12/box

No logical limit exists to the number of subqueries a SELECT statement can have.

Perhaps you want to check whether information has been entered correctly in the database. One way to find errors in a database is to write a query that returns output only when errors exist. A subquery of this type serves as a kind of *audit query*, as the following query shows.

Figure 8. Query

```
SELECT * FROM items
WHERE total_price != quantity *
  (SELECT unit_price FROM stock
   WHERE stock.stock_num = items.stock_num
   AND stock.manu_code = items.manu_code);
```

The query returns only those rows for which the total price of an item on an order is not equal to the stock unit price times the order quantity. If no discount has been applied, such rows were probably entered incorrectly in the database. The query returns rows only when errors occur. If information is correctly inserted into the database, no rows are returned.

Figure 9. Query result

item_num	order_num	stock_num	manu_code	quantity	total_price
1	1004	1	HRO	1	\$960.00
2	1006	5	NRG	5	\$190.00

Subqueries in DELETE and UPDATE statements

Besides subqueries within the WHERE clause of a SELECT statement, you can use subqueries within other data manipulation language (DML) statements, including the WHERE clause of DELETE and UPDATE statements.

Certain restrictions apply. If the FROM clause of a subquery returns more than one row, and the clause specifies the same table or view that the outer DML statement is modifying, the DML operation will succeed under these circumstances:

- The DML statement is not an INSERT statement.
- No SPL routine within the subquery references the table that is being modified.
- The subquery does not include a correlated column name.
- The subquery is specified using the Condition with Subquery syntax in the WHERE clause of the DELETE or UPDATE statement.

If any of these conditions are not met, the DML operation fails with error -360.

The following example updates the **stock** table by increasing the **unit_price** value by 10% for a subset of prices. The WHERE clause specifies which prices to increase by applying the IN operator to the rows returned by a subquery that selects only the rows of the **stock** table where the **unit_price** value is less than 75.

```
UPDATE stock SET unit_price = unit_price * 1.1
WHERE unit_price IN
  (SELECT unit_price FROM stock WHERE unit_price < 75);
```

Handle collections in SELECT statements

The database server provides the following SQL features to handle collection expressions:

Collection subquery

A collection subquery takes a virtual table (the result of a subquery) and converts it into a collection.

A collection subquery always returns a collection of type MULTISSET. You can use a collection subquery to convert a Query result of relational data into a MULTISSET collection. For information about the collection data types, see the *IBM® Informix® Database Design and Implementation Guide*.

Collection-derived table

A collection-derived table takes a collection and converts it into a virtual table.

Each element of the collection is constructed as a row in the collection-derived table. You can use a collection-derived table to access the individual elements of a collection.

The collection subquery and collection-derived table features represent inverse operations: the collection subquery converts row values from a relational table into a collection whereas the collection-derived table converts the elements of a collection into rows of a relational table.

- [Collection subqueries](#)
- [Collection-derived tables](#)
- [ISO-compliant syntax for collection derived tables](#)

Collection subqueries

A collection subquery enables users to construct a collection expression from a subquery expression. A collection subquery uses the MULTISSET keyword immediately before the subquery to convert the values returned into a MULTISSET collection. When you use the MULTISSET keyword before a subquery expression, however, the database server does not change the rows of the underlying table but only modifies a copy of those rows. For example, if a collection subquery is passed to a user-defined routine that modifies the collection, then a copy of the collection is modified but not the underlying table.

A collection subquery is an expression that can take either of the following forms:

- `MULTISSET(SELECT expression1, expression2... FROM tab_name...)`
- `MULTISSET(SELECT ITEM expression FROM tab_name...)`
- [Omit the ITEM keyword in a collection subquery](#)
- [Specify the ITEM keyword in a collection subquery](#)
- [Collection subqueries in the FROM clause](#)

Omit the ITEM keyword in a collection subquery

If you omit the ITEM keyword in the collection subquery expression, the collection subquery is a MULTISSET whose element type is always an unnamed ROW type. The fields of the unnamed ROW type match the data types of the expressions specified in the Projection clause of the subquery.

Suppose you create the following table that contains a column of type MULTISSET:

```
CREATE TABLE tab2
(
  id_num INT,
  ms_col MULTISSET(ROW(a INT) NOT NULL)
);
```

The following query shows how you might use a collection subquery in a WHERE clause to convert the rows of INT values that the subquery returns to a collection of type MULTISSET. In this example, the database server returns rows when the **ms_col** column of **tab2** is equal to the result of the collection subquery expression Figure 1. Query

```
SELECT id_num FROM tab2
WHERE ms_col = (MULTISSET(SELECT int_col FROM tab1));
```

The query omits the **ITEM** keyword in the collection subquery, so the **INT** values the subquery returns are of type **MULTISET (ROW(a INT) NOT NULL)** that matches the data type of the **ms_col** column of **tab2**.

Specify the **ITEM** keyword in a collection subquery

When the projection list of the subquery contains a single expression, you can preface the projection list of the subquery with the **ITEM** keyword to specify that the element type of the **MULTISET** matches the data type of the subquery result. In other words, when you include the **ITEM** keyword, the database server does not put a row wrapper around the projection list. For example, if the subquery (that immediately follows the **MULTISET** keyword) returns **INT** values, the collection subquery is of type **MULTISET(INT NOT NULL)**.

Suppose you create a function **int_func()** that accepts an argument of type **MULTISET(INT NOT NULL)**. The following query shows a collection subquery that converts rows of **INT** values to a **MULTISET** and uses the collection subquery as an argument in the function **int_func()**.

Figure 1. Query

```
EXECUTE FUNCTION int_func(MULTISET(SELECT ITEM int_col
FROM tab1
WHERE int_col BETWEEN 1 AND 10));
```

The query includes the **ITEM** keyword in the subquery, so the **int_col** values that the query returns are converted to a collection of type **MULTISET (INT NOT NULL)**. Without the **ITEM** keyword, the collection subquery would return a collection of type **MULTISET (ROW(a INT) NOT NULL)**.

Collection subqueries in the **FROM** clause

Collection subqueries are valid in the **FROM** clause of **SELECT** statements, where the outer query can use the values returned by the subquery as a source of data.

The query examples in the section [Collection subqueries](#) specify collection subqueries by using the **TABLE** keyword followed (within parentheses) by the **MULTISET** keyword, followed by a subquery. This syntax is the IBM® Informix® extension to the ANSI/ISO standard for the SQL language.

In the **FROM** clause of the **SELECT** statement, and only in that context, you can substitute syntax that complies with the ANSI/ISO standard for SQL by specifying a subquery, omitting the **TABLE** and **MULTISET** keywords and the nested parentheses, to specify a collection subquery.

The following query uses the IBM Informix extension syntax to join two collection subqueries in the **FROM** clause of the outer query:

Figure 1. Query

```
SELECT * FROM TABLE(MULTISET(SELECT SUM(C1) FROM T1 GROUP BY C1)),
TABLE(MULTISET(SELECT SUM(C1) FROM T2 GROUP BY C2));
```

The following logically equivalent query returns the same results as the query above by using ANSI/ISO-compliant syntax to join two derived tables in the **FROM** clause of the outer query:

Figure 2. Query

```
SELECT * FROM (SELECT SUM(C1) FROM T1 GROUP BY C1),
(SELECT SUM(C1) FROM T2 GROUP BY C2);
```

An advantage of this query over the **TABLE(MULTISET(SELECT ...))** IBM Informix extension version is that it can also be executed by any database server that supports the ANSI/ISO-compliant syntax in the **FROM** clause. For more information about syntax and restrictions for collection subqueries, see the *IBM Informix Guide to SQL: Syntax*.

Collection-derived tables

A *collection-derived table* enables you to handle the elements of a collection expression as rows in a virtual table. Use the **TABLE** keyword in the **FROM** clause of a **SELECT** statement to create a collection-derived table. The database server supports collection-derived tables in **SELECT**, **INSERT**, **UPDATE**, and **DELETE** statements.

The following query uses a collection-derived table named **c_table** to access elements from the **sales** column of the **sales_rep** table in the **superstores_demo** database. The **sales** column is a collection of an unnamed row type whose two fields, **month** and **amount**, store sales data. The query returns an element for **sales.amount** when **sales.month** equals 98-03. Because the inner select is itself an expression, it cannot return more than one column value per iteration of the outer query. The outer query specifies how many rows of the **sales_rep** table are evaluated.

Figure 1. Query

```
SELECT (SELECT c_table.amount FROM TABLE (sales_rep.sales) c_table
WHERE c_table.month = '98-03')
FROM sales_rep;
```

Figure 2. Query result

```
(expression)
```

```
$47.22
$53.22
```

The following query uses a collection-derived table to access elements from the **sales** collection column where the **rep_num** column equals 102. With a collection-derived table, you can specify aliases for the table and columns. If no table name is specified for a collection-derived table, the database server creates one automatically. This example specifies the derived column list **s_month** and **s_amount** for the collection-derived table **c_table**.

Figure 3. Query

```
SELECT * FROM TABLE((SELECT sales FROM sales_rep
WHERE sales_rep.rep_num = 102)) c_table(s_month, s_amount);
```

Figure 4. Query result

s_month	s_amount
1998-03	\$53.22
1998-04	\$18.22

The following query creates a collection-derived table but does not specify a derived table or derived column names. The query returns the same result as [Figure 3](#) except the derived columns assume the default field names of the **sales** column in the **sales_rep** table.

Figure 5. Query

```
SELECT * FROM TABLE((SELECT sales FROM sales_rep
WHERE sales_rep.rep_num = 102));
```

Figure 6. Query result

month	amount
1998-03	\$53.22
1998-04	\$18.22

Restriction: A collection-derived table is read-only, so it cannot be the target table of INSERT, UPDATE, or DELETE statements or the underlying table of an updatable cursor or view.

For a complete description of the syntax and restrictions on collection-derived tables, see the *IBM® Informix® Guide to SQL: Syntax*.

ISO-compliant syntax for collection derived tables

The query examples in the topic [Collection-derived tables](#) specify collection-derived tables by using the TABLE keyword followed by a SELECT statement enclosed within double parentheses. This syntax is the IBM® Informix® extension to the ANSI/ISO standard for the SQL language.

In the FROM clause of the SELECT statement, however, and only in that context, you can instead use syntax that complies with the ANSI/ISO standard for SQL by specifying a subquery, without the TABLE keyword or the nested parentheses, to define a collection-derived table.

The following example is logically equivalent to [Figure 3](#), and specifies the derived column list **s_month** and **s_amount** for the collection-derived table **c_table**.

Figure 1. Query

```
SELECT * FROM (SELECT sales FROM sales_rep
WHERE sales_rep.rep_num = 102) c_table(s_month, s_amount);
```

Figure 2. Query result

s_month	s_amount
1998-03	\$53.22
1998-04	\$18.22

As in the IBM Informix extension syntax, declaring names for the derived table or for its columns is optional, rather than required. The following query uses ANSI/ISO-compliant syntax for a derived table in the FROM clause of the outer query, and produces the same results as [Figure 5](#):

Figure 3. Query

```
SELECT * FROM (SELECT sales FROM sales_rep
WHERE sales_rep.rep_num = 102);
```

Figure 4. Query result

month	amount
1998-03	\$53.22
1998-04	\$18.22

Set operations

The standard set operations *union*, *intersection*, and *difference* let you manipulate database information. These three operations let you use SELECT statements to check the integrity of your database after you perform an update, insert, or delete. They can be useful when you transfer data to a history table, for example, and want to verify that the correct data is in the history table before you delete the data from the original table.

- [Union](#)
- [Intersection](#)
- [Difference](#)

Union

A union operation uses the UNION operator to combine two queries into a single *compound query*. You can use the UNION operator between two or more SELECT statements to produce a temporary table that contains rows that exist in any or all of the original tables. You can also use the UNION operator in the definition of a

view.

You cannot use the UNION operator inside a subquery in the following contexts

- in the Projection clause of the SELECT statement
- in the WHERE clause of the SELECT, INSERT, DELETE, or UPDATE statement.

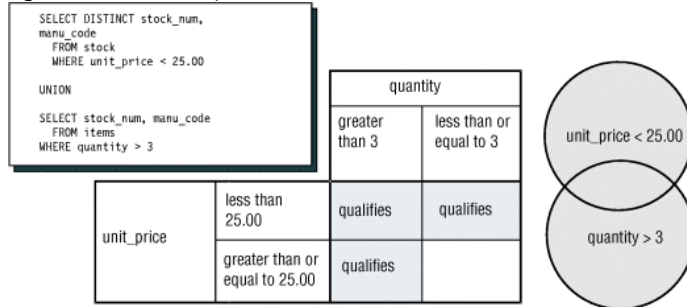
The UNION operator is valid, however, in a subquery in the FROM clause of the SELECT statement, as in the following example:

```
SELECT * FROM (SELECT col1 FROM tab1 WHERE col1 = 100) AS vtab1(c1),
              (SELECT col1 FROM tab2 WHERE col1 = 10
               UNION ALL
               SELECT col1 FROM tab1 WHERE col1 < 50 ) AS vtab2(vc1);
```

IBM® Informix® does not support ordering on ROW types. Because a UNION operation requires a sort to remove duplicate values, you cannot use a UNION operator when either query in the union operation includes ROW type data. However, the database server does support UNION ALL with ROW type data, because this type of operation does not require a sort.

The following figure illustrates the UNION set operation.

Figure 1. The Union set operation



The UNION keyword selects all rows from the two queries, removes duplicates, and returns what is left. Because the results of the queries are combined into a single result, the projection list in each query must have the same number of columns. Also, the corresponding columns that are selected from each table must contain compatible data types (CHARACTER data type columns must be the same length), and these corresponding columns must all allow or all disallow NULL values.

For the complete syntax of the SELECT statement and the UNION operator, see the *IBM Informix Guide to SQL: Syntax*. For information specific to the IBM Informix ESQL/C product and any limitations that involve the INTO clause and compound queries, see the *IBM Informix ESQL/C Programmer's Manual*.

The following query performs a union on the **stock_num** and **manu_code** columns in the **stock** and **items** tables.

Figure 2. Query

```
SELECT DISTINCT stock_num, manu_code FROM stock
WHERE unit_price < 25.00
UNION
SELECT stock_num, manu_code FROM items
WHERE quantity > 3;
```

The query selects those items that have a unit price of less than \$25.00 or that have been ordered in quantities greater than three and lists their **stock_num** and **manu_code**, as the result shows.

Figure 3. Query result

stock_num manu_code

```
5 ANZ
5 NRG
5 SMT
9 ANZ
103 PRC
106 PRC
201 NKL
301 KAR
302 HRO
302 KAR
```

- [ORDER BY clause with UNION](#)
- [The UNION ALL keywords](#)
- [Different column names](#)
- [UNION with multiple tables](#)
- [A literal in the Projection clause](#)
- [A FIRST clause](#)

ORDER BY clause with UNION

As the following query shows, when you include an ORDER BY clause, it must follow the final SELECT statement and use an integer, not an identifier, to refer to the ordering column. Ordering takes place after the set operation is complete.

Figure 1. Query

```
SELECT DISTINCT stock_num, manu_code FROM stock
WHERE unit_price < 25.00
```

```

UNION
SELECT stock_num, manu_code FROM items
  WHERE quantity > 3
  ORDER BY 2;

```

The compound query above selects the same rows as [Figure 2](#) but displays them in order of the manufacturer code, as the result shows.

Figure 2. Query result

```

stock_num manu_code
5 ANZ
9 ANZ
302 HRO
301 KAR
302 KAR
201 NKL
5 NRG
103 PRC
106 PRC
5 SMT

```

The UNION ALL keywords

By default, the UNION keyword excludes duplicate rows. To retain the duplicate values, add the optional keyword ALL, as the following query shows.

Figure 1. Query

```

SELECT stock_num, manu_code FROM stock
  WHERE unit_price < 25.00
UNION ALL
SELECT stock_num, manu_code FROM items
  WHERE quantity > 3
  ORDER BY 2
  INTO TEMP stock_item;

```

The query uses the UNION ALL keywords to unite two SELECT statements and adds an INTO TEMP clause after the final SELECT to put the results into a temporary table. It returns the same rows as [Figure 1](#) but also includes duplicate values.

Figure 2. Query result

```

stock_num manu_code
9 ANZ
5 ANZ
9 ANZ
5 ANZ
9 ANZ
:
5 NRG
5 NRG
103 PRC
106 PRC
5 SMT
5 SMT

```

Different column names

Corresponding columns in the Projection clauses for the combined queries must have compatible data types, but the columns do not need to use the same column names.

The following query selects the **state** column from the **customer** table and the corresponding **code** column from the **state** table.

Figure 1. Query

```

SELECT DISTINCT state FROM customer
  WHERE customer_num BETWEEN 120 AND 125
UNION
SELECT DISTINCT code FROM state
  WHERE sname MATCHES '*a';

```

The query returns state code abbreviations for customer numbers 120 through 125 and for states whose **sname** ends in a.

Figure 2. Query result

```

state
AK
AL
AZ
CA
DE
:
SD
VA
WV

```

In compound queries, the column names or display labels in the first SELECT statement are the ones that appear in the results. Thus, in the query, the column name **state** from the first SELECT statement is used instead of the column name **code** from the second.

UNION with multiple tables

The following query performs a union on three tables. The maximum number of unions depends on the practicality of the application and any memory limitations. Figure 1. Query

```
SELECT stock_num, manu_code FROM stock
  WHERE unit_price > 600.00
UNION ALL
SELECT stock_num, manu_code FROM catalog
  WHERE catalog_num = 10025
UNION ALL
SELECT stock_num, manu_code FROM items
  WHERE quantity = 10
  ORDER BY 2;
```

The query selects items where the **unit_price** in the **stock** table is greater than \$600, the **catalog_num** in the **catalog** table is 10025, or the **quantity** in the **items** table is 10; and the query orders the data by **manu_code**. The result shows the return values.

Figure 2. Query result

stock_num	manu_code
5	ANZ
9	ANZ
8	ANZ
4	HSK
1	HSK
203	NKL
5	NRG
106	PRC
113	SHM

A literal in the Projection clause

The following query uses a literal in the projection list to tag the output of part of a union so it can be distinguished later. The tag is given the label **sortkey**. The query uses **sortkey** to order the retrieved rows.

Figure 1. Query

```
SELECT '1' sortkey, lname, fname, company,
  city, state, phone
  FROM customer x
  WHERE state = 'CA'
UNION
SELECT '2' sortkey, lname, fname, company,
  city, state, phone
  FROM customer y
  WHERE state <> 'CA'
  INTO TEMP calcust;
SELECT * FROM calcust
  ORDER BY 1;
```

The query creates a list in which the customers from California appear first.

Figure 2. Query result

sortkey	1
lname	Baxter
fname	Dick
company	Blue Ribbon Sports
city	Oakland
state	CA
phone	415-655-0011
sortkey	1
lname	Beatty
fname	Lana
company	Sportstown
city	Menlo Park
state	CA
phone	415-356-9982
:	:
sortkey	2
lname	Wallack
fname	Jason
company	City Sports
city	Wilmington
state	DE
phone	302-366-7511

A FIRST clause

You can use the FIRST clause to select the first rows that result from a union query. The following query uses a FIRST clause to return the first five rows of a union between the **stock** and **items** tables.

Figure 1. Query

```
SELECT FIRST 5 DISTINCT stock_num, manu_code
FROM stock
WHERE unit_price < 55.00
UNION
SELECT stock_num, manu_code
FROM items
WHERE quantity > 3;
```

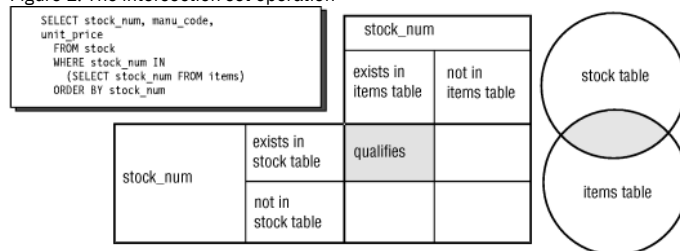
Figure 2. Query result

stock_num	manu_code
5	NRG
5	ANZ
6	SMT
6	ANZ
9	ANZ

Intersection

The *intersection* of two sets of rows produces a table that contains rows that exist in both the original tables. Use the keyword EXISTS or IN to introduce subqueries that show the intersection of two sets. The following figure illustrates the intersection set operation.

Figure 1. The intersection set operation



The following query is an example of a nested SELECT statement that shows the intersection of the **stock** and **items** tables. The result contains all the elements that appear in both sets and returns the following rows.

Figure 2. Query

```
SELECT stock_num, manu_code, unit_price FROM stock
WHERE stock_num IN
(SELECT stock_num FROM items)
ORDER BY stock_num;
```

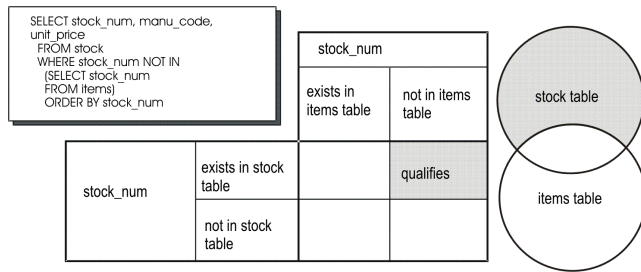
Figure 3. Query result

stock_num	manu_code	unit_price
1	HRO	\$250.00
1	HSK	\$800.00
1	SMT	\$450.00
2	HRO	\$126.00
3	HSK	\$240.00
3	SHM	\$280.00
⋮		
306	SHM	\$190.00
307	PRC	\$250.00
309	HRO	\$40.00
309	SHM	\$40.00

Difference

The *difference* between two sets of rows produces a table that contains rows in the first set that are not also in the second set. Use the keywords NOT EXISTS or NOT IN to introduce subqueries that show the difference between two sets. The following figure illustrates the difference set operation.

Figure 1. The difference set operation



The following query is an example of a nested SELECT statement that shows the difference between the **stock** and **items** tables.
Figure 2. Query

```
SELECT stock_num, manu_code, unit_price FROM stock
WHERE stock_num NOT IN
(SELECT stock_num FROM items)
ORDER BY stock_num;
```

The result contains all the elements from only the first set, which returns 17 rows.
Figure 3. Query result

stock_num	manu_code	unit_price
102	PRC	\$480.00
102	SHM	\$220.00
106	PRC	\$23.00
⋮		
312	HRO	\$72.00
312	SHM	\$96.00
313	ANZ	\$60.00
313	SHM	\$72.00

Summary

This chapter builds on concepts introduced in [Compose SELECT statements](#). It provides sample syntax and results for more advanced kinds of SELECT statements, which are used to query a relational database. This chapter presents the following material:

- Introduces the GROUP BY and HAVING clauses, which you can use with aggregates to return groups of rows and apply conditions to those groups
- Shows how to join a table to itself with a self-join to compare values in a column with other values in the same column and to identify duplicates
- Explains how an outer join treats two or more tables asymmetrically, and provides examples of the four kinds of outer join using both the IBM® Informix® extension and ANSI join syntax.
- Describes how to nest a SELECT statement in the WHERE clause of another SELECT statement to create correlated and uncorrelated subqueries and shows how to use aggregate functions in subqueries
- Describes how to nest SELECT statements in the FROM clause of another SELECT statement to specify uncorrelated subqueries whose results are a data source for the outer SELECT statement
- Demonstrates how to use the keywords ALL, ANY, EXISTS, IN, and SOME to create subqueries, and the effect of adding the keyword NOT or a relational operator
- Describes how to use collection subqueries to convert relational data to a collection of type MULTISSET and how to use collection-derived tables to access elements within a collection
- Discusses the union, intersection, and difference set operations
- Shows how to use the UNION and UNION ALL keywords to create compound queries that consist of two or more SELECT statements

Modify data

This section describes how to modify the data in your databases. Modifying data is fundamentally different from querying data. Querying data involves examining the contents of tables. To modify data involves changing the contents of tables.

- [Modify data in your database](#)
- [Delete rows](#)
- [Insert rows](#)
- [Update rows](#)
- [Privileges on a database and on its objects](#)
- [Data integrity](#)
- [Interrupted modifications](#)
- [Backups and logs with IBM Informix database servers](#)
- [Concurrency and locks](#)
- [IBM Informix data replication](#)
- [Summary](#)

Modify data in your database

The following statements modify data:

- DELETE
- INSERT
- MERGE
- UPDATE

Although these SQL statements are relatively simple when compared with the more advanced SELECT statements, use them carefully because they change the contents of the database.

Think about what happens if the system hardware or software fails during a query. Even if the effect on the application is severe, the database itself is unharmed. However, if the system fails while a modification is under way, the state of the database is in doubt. Obviously, a database in an uncertain state has far-reaching implications. Before you delete, insert, or update rows in a database, ask yourself the following questions:

- Is user access to the database and its tables secure; that is, are specific users given limited database and table-level privileges?
- Does the modified data preserve the existing integrity of the database?
- Are systems in place that make the database relatively immune to external events that might cause system or hardware failures?

If you cannot answer yes to each of these questions, do not panic. Solutions to all these problems are built into the IBM® Informix® database servers. After a description of the statements that modify data, this section discusses these solutions. The *IBM Informix Database Design and Implementation Guide* covers these topics in greater detail.

Delete rows

The DELETE statement removes any row or combination of rows from a table. You cannot recover a deleted row after the transaction is committed. (Transactions are discussed under [Interrupted modifications](#). For now, think of a transaction and a statement as the same thing.)

When you delete a row, you must also be careful to delete any rows of other tables whose values depend on the deleted row. If your database enforces referential constraints, you can use the ON DELETE CASCADE option of the CREATE TABLE or ALTER TABLE statements to allow deletes to cascade from one table in a relationship to another. For more information on referential constraints and the ON DELETE CASCADE option, refer to [Referential integrity](#).

- [Delete all rows of a table](#)
- [Delete all rows using TRUNCATE](#)
- [Delete specified rows](#)
- [Delete selected rows](#)
- [Delete rows that contain row types](#)
- [Delete rows that contain collection types](#)
- [Delete rows from a supertable](#)
- [Complicated delete conditions](#)
- [The Delete clause of MERGE](#)

Delete all rows of a table

The DELETE statement specifies a table and usually contains a WHERE clause that designates the row or rows that are to be removed from the table. If the WHERE clause is left out, all rows are deleted.

Important: Do not execute the following statement.

```
DELETE FROM customer;
```

You can write DELETE statements with or without the FROM keyword.

```
DELETE customer;
```

Because these DELETE statements do not contain a WHERE clause, all rows from the **customer** table are deleted. If you attempt an unconditional delete using the DB-Access menu options, the program warns you and asks for confirmation. However, an unconditional DELETE from within a program can occur without warning.

If you want to delete rows from a table named **from**, you must first set the DELIMIDENT environment variable, or qualify the name of the table with the name of its owner:

```
DELETE legree.from;
```

For more information about delimited identifiers and DELIMIDENT environment variable, see the descriptions of the Quoted String expression and of the Identifier segment in the *IBM® Informix® Guide to SQL: Syntax*.

Delete all rows using TRUNCATE

You can use the TRUNCATE statement to quickly remove all rows from a table and also remove all corresponding index data. You cannot recover deleted rows after the transaction is committed. You can use the TRUNCATE statement on tables that contain any type of columns, including smart large objects.

Removing rows with the TRUNCATE statement is faster than removing them with the DELETE statement. It is not necessary to run the UPDATE STATISTICS statement immediately after the TRUNCATE statement. After TRUNCATE executes successfully, IBM® Informix® automatically updates the statistics and distributions for the table and for its indexes in the system catalog to show no rows in the table or in its dbspace partitions.

For a description of logging, see [Transaction logging](#).

TRUNCATE is a data-definition language statement that does not activate DELETE triggers, if any are defined on the table. For an explanation on using triggers, see [Create and use triggers](#).

If the table that the TRUNCATE statement specifies is a typed table, a successful TRUNCATE operation removes all the rows and B-tree structures from that table and from all its subtables within the table hierarchy. TRUNCATE has no equivalent to the ONLY keyword of the DELETE statement to restricts the operation to a single table within the typed table hierarchy.

IBM Informix always logs the TRUNCATE operation, even for a non-logging table. In databases that support transaction logging, only the COMMIT WORK or ROLLBACK WORK statement of SQL is valid after TRUNCATE within the same transaction. For information on the performance impact of using the TRUNCATE statement, see your *IBM Informix Performance Guide*. For the complete syntax, see the *IBM Informix Guide to SQL: Syntax*.

Delete specified rows

The WHERE clause in a DELETE statement has the same form as the WHERE clause in a SELECT statement. You can use it to designate exactly which row or rows should be deleted. You can delete a customer with a specific customer number, as the following example shows:

```
DELETE FROM customer WHERE customer_num = 175;
```

In this example, because the **customer_num** column has a unique constraint, you can ensure that no more than one row is deleted.

Delete selected rows

You can also choose rows that are based on nonindexed columns, as the following example shows:

```
DELETE FROM customer WHERE company = 'Druid Cyclery';
```

Because the column that is tested does not have a unique constraint, this statement might delete more than one row. (Druid Cyclery might have two stores, both with the same name but different customer numbers.)

To find out how many rows a DELETE statement affects, select the count of qualifying rows from the **customer** table for Druid Cyclery.

```
SELECT COUNT(*) FROM customer WHERE company = 'Druid Cyclery';
```

You can also select the rows and display them to ensure that they are the ones you want to delete.

Using a SELECT statement as a test is only an approximation, however, when the database is available to multiple users concurrently. Between the time you execute the SELECT statement and the subsequent DELETE statement, other users could have modified the table and changed the result. In this example, another user might perform the following actions:

- Insert a new row for another customer named Druid Cyclery
- Delete one or more of the Druid Cyclery rows before you insert the new row
- Update a Druid Cyclery row to have a new company name, or update some other customer to have the name Druid Cyclery.

Although it is not likely that other users would do these things in that brief interval, the possibility does exist. This same problem affects the UPDATE statement. Ways of addressing this problem are discussed under [Concurrency and locks](#), and in greater detail in [Programming for a multiuser environment](#).

Another problem you might encounter is a hardware or software failure before the statement finishes. In this case, the database might have deleted no rows, some rows, or all specified rows. The state of the database is unknown, which is undesirable. To prevent this situation, use transaction logging, as [Interrupted modifications](#) discusses.

Delete rows that contain row types

When a row contains a column that is defined on a ROW type, you can use dot notation to specify that the only rows deleted are those that contain a specific field value. For example, the following statement deletes only those rows from the **employee** table in which the value of the **city** field in the **address** column is *San Jose*:

```
DELETE FROM employee
WHERE address.city = 'San Jose';
```

In the preceding statement, the **address** column might be a named ROW type or an unnamed ROW type. The syntax you use to specify field values of a ROW type is the same.

Delete rows that contain collection types

When a row contains a column that is defined on a collection type, you can search for a particular element in a collection and delete the row or rows in which that element is found. For example, the following statement deletes rows in which the **direct_reports** column contains a collection with the element *Baker*:

```
DELETE FROM manager
WHERE 'Baker' IN direct_reports;
```

Delete rows from a supertable

When you delete the rows of a supertable, the scope of the delete is a supertable and its subtables. Suppose you create a supertable **person** that has two subtables **employee** and **sales_rep** defined under it. The following DELETE statement on the **person** table can delete rows from all the tables **person**, **employee**, and **sales_rep**:

```
DELETE FROM person
WHERE name = 'Walker';
```

To limit a delete to rows of the supertable only, you must use the ONLY keyword in the DELETE statement. For example, the following statement deletes rows of the **person** table only:

```
DELETE FROM ONLY(person)
WHERE name = 'Walker';
```

Important: Use caution when you delete rows from a supertable because the scope of a delete on a supertable includes the supertable and all its subtables.

Complicated delete conditions

The WHERE clause in a DELETE statement can be almost as complicated as the one in a SELECT statement. It can contain multiple conditions that are connected by AND and OR, and it might contain subqueries.

Suppose you discover that some rows of the **stock** table contain incorrect manufacturer codes. Rather than update them, you want to delete them so that they can be re-entered. You know that these rows, unlike the correct ones, have no matching rows in the **manufact** table. The fact that these incorrect rows have no matching rows in the **manufact** table allows you to write a DELETE statement such as the one in the following example:

```
DELETE FROM stock
WHERE 0 = (SELECT COUNT(*) FROM manufact
WHERE manufact.manu_code = stock.manu_code);
```

The subquery counts the number of rows of **manufact** that match; the count is 1 for a correct row of **stock** and 0 for an incorrect one. The latter rows are chosen for deletion.

Tip: One way to develop a DELETE statement with a complicated condition is to first develop a SELECT statement that returns precisely the rows to be deleted.

Write it as **SELECT ***; when it returns the desired set of rows, change **SELECT *** to read **DELETE** and execute it once more.

The WHERE clause of a DELETE statement cannot use a subquery that tests the same table. That is, when you delete from **stock**, you cannot use a subquery in the WHERE clause that also selects from **stock**.

The key to this rule is in the FROM clause. If a table is named in the FROM clause of a DELETE statement, it cannot also appear in the FROM clause of a subquery of the DELETE statement.

The Delete clause of MERGE

Instead of writing a subquery in the WHERE clause, you can use the MERGE statement to join rows from a source tables and a target table, and then delete from the target the rows that match the join condition. (The source table in a Delete MERGE can also be a collection-derived table whose rows are the result of a query that joins other tables and views, but in the example that follows, the source is a single table.)

As in the previous example, suppose you discover that some rows of the **stock** table contain incorrect manufacturer codes. Rather than update them, you want to delete them so that they can be re-entered. You can use the MERGE statement that specifies **stock** as the target table, **manufact** as the source table, a join condition in the ON clause, and with the Delete clause for the **stock** rows with incorrect manufacturer codes, as in the following example:

```
MERGE INTO stock USING manufact
ON stock.manu_code != manufact.manu_code
WHEN MATCHED THEN DELETE;
```

In this example, all the rows of the **stock** table for which the join condition in the ON clause is satisfied will be deleted. Here the inequality predicate in the join condition (**stock.manu_code != manufact.manu_code**) evaluates to true for the rows of **stock** in which the **manu_code** column value is not equal to any **manu_code** value in the **manufact** table.

The **source** table that is being joined to the **target** table must be listed in the USING clause.

The MERGE statement can also update rows of the target table, or insert data from the source table into the target table, according to whether or not the row satisfies the condition that the ON clause specifies for joining the target and source tables. A single MERGE statement can also combine both DELETE and INSERT operations, or can combine both UPDATE and INSERT operations without deleting any rows. The source table is unchanged by the MERGE statement. For more information on the syntax and restrictions for Delete merges, Insert merges, and Update merges, see the description of the MERGE statement in the *IBM® Informix® Guide to SQL: Syntax*.

Insert rows

The INSERT statement adds a new row, or rows, to a table. The statement has two basic functions. It can create a single new row using column values you supply, or it can create a group of new rows using data selected from other tables.

- [Single rows](#)
- [Insert rows into typed tables](#)
- [Syntax rules for inserts on columns](#)
- [Insert rows into supertables](#)
- [Insert collection values into columns](#)
- [Insert smart large objects](#)
- [Multiple rows and expressions](#)
- [Restrictions on the insert selection](#)

Single rows

In its simplest form, the INSERT statement creates one new row from a list of column values and puts that row in the table. The following statement shows how to add a row to the **stock** table:

```
INSERT INTO stock
VALUES (115, 'PRC', 'tire pump', 108, 'box', '6/box');
```

The **stock** table has the following columns:

stock_num
A number that identifies the type of merchandise.

manu_code
A foreign key to the **manufact** table.

description
A description of the merchandise.

unit_price
The unit price of the merchandise.

unit
The unit of measure

unit_descr
Characterizes the unit of measure.

The values that are listed in the VALUES clause in the preceding example have a one-to-one correspondence with the columns of the **stock** table. To write a VALUES clause, you must know the columns of the tables as well as their sequence from first to last.

- [Possible column values](#)
- [Restrictions on column values](#)
- [Serial data types](#)
- [List specific column names](#)

Possible column values

The VALUES clause accepts only constant values, not general SQL expressions. You can supply the following values:

- Literal numbers
- Literal DATETIME values
- Literal INTERVAL values
- Quoted strings of characters
- The word NULL for a NULL value
- The word TODAY for the current date
- The word CURRENT (or SYSDATE) for the current date and time
- The word USER for your authorization identifier
- The word DBSERVERNAME (or SITENAME) for the name of the computer where the database server is running

Note: An alternative to the INSERT statement is the MERGE statement, which can use the same VALUES clause syntax as the INSERT statement to insert rows into a table. The MERGE statement performs an outer join of a source table and a target table, and then inserts into the target table any rows in the result set of the join for which the join predicate evaluates to FALSE. The source table is unchanged by the MERGE statement. Besides inserting rows, the MERGE statement can optionally combine both DELETE and INSERT operations, or combine both UPDATE and INSERT operations. For more information about the syntax and the restrictions on Insert merges, Delete merges, and Update merges, see the description of the MERGE statement in the *IBM® Informix® Guide to SQL: Syntax*.

Restrictions on column values

Some columns of a table might not allow null values. If you attempt to insert NULL in such a column, the statement is rejected. Other columns in the table might not permit duplicate values. If you specify a value that is a duplicate of one that is already in such a column, the statement is rejected. Some columns might even restrict the possible column values allowed. Use data integrity constraints to restrict columns. For more information, see [Data integrity](#).

Restriction: Do not specify the currency symbols for columns that contain money values. Just specify the numeric value of the amount. The database server can convert between numeric and character data types. You can give a string of numeric characters (for example, '-0075.6') as the value of a numeric column. The database server converts the numeric string to a number. An error occurs only if the string does not represent a number.

You can specify a number or a date as the value for a character column. The database server converts that value to a character string. For example, if you specify TODAY as the value for a character column, a character string that represents the current date is used. (The DBDATE environment variable specifies the format that is used.)

Serial data types

A table can have only one column of the SERIAL data type. It can also have either a SERIAL8 column or a BIGSERIAL column.

When you insert values, specify the value zero for the serial column. The database server generates the next actual value in sequence. Serial columns do not allow NULL values.

You can specify a nonzero value for a serial column (as long as it does not duplicate any existing value in that column), and the database server uses the value. That nonzero value might set a new starting point for values that the database server generates. (The next value the database server generates for you is one greater than the maximum value in the column.)

List specific column names

You do not have to specify values for every column. Instead, you can list the column names after the table name and then supply values for only those columns that you named. The following example shows a statement that inserts a new row into the **stock** table:

```
INSERT INTO stock (stock_num, description, unit_price, manu_code)
VALUES (115, 'tyre pump ', 114, 'SHM');
```

Only the data for the stock number, description, unit price, and manufacturer code is provided. The database server supplies the following values for the remaining columns:

- It generates a serial number for an unlisted serial column.
- It generates a default value for a column with a specific default associated with it.
- It generates a NULL value for any column that allows nulls but it does not specify a default value for any column that specifies NULL as the default value. You must list and supply values for all columns that do not specify a default value or do not permit NULL values.

You can list the columns in any order, as long as the values for those columns are listed in the same order. For information about how to designate null or default values for a column, see the *IBM® Informix® Database Design and Implementation Guide*.

After the INSERT statement in the preceding example is executed, the following new row is inserted into the **stock** table:

stock_num	manu_code	description	unit_price	unit	unit_descr
115	SHM	tyre pump	114		

Both **unit** and **unit_descr** are blank, which indicates that NULL values exist in those two columns. Because the **unit** column permits NULL values, the number of tire pumps that can be purchased for \$114 is not known. Of course, if a default value of **box** were specified for this column, then **box** would be the unit of measure. In any case, when you insert values into specific columns of a table, pay attention to what data is needed for that row.

Insert rows into typed tables

You can insert rows into a typed table in the same way you insert rows into a table not based on a ROW type.

When a typed table contains a row-type column (the named ROW type that defines the typed table contains a nested ROW type), you insert into the row-type column in the same way you insert into a row-type column for a table not based on a ROW type. The following section, [Syntax rules for inserts on columns](#), describes how to perform inserts into row-type columns.

This section uses row types **zip_t**, **address_t**, and **employee_t** and typed table **employee** for examples. The following figure shows the SQL syntax that creates the row types and table.

Figure 1. SQL syntax that creates the row types and table.

```
CREATE ROW TYPE zip_t
(
  z_code   CHAR(5),
  z_suffix CHAR(4)
);

CREATE ROW TYPE address_t
(
  street   VARCHAR(20),
  city     VARCHAR(20),
  state    CHAR(2),
  zip      zip_t
);

CREATE ROW TYPE employee_t
(
  name     VARCHAR(30),
  address  address_t,
  salary   INTEGER
);
```

```
CREATE TABLE employee OF TYPE employee_t;
```

Syntax rules for inserts on columns

The following syntax rules apply for inserts on columns that are defined on named ROW types or unnamed ROW types:

- Specify the ROW constructor before the field values to be inserted.
- Enclose the field values of the ROW type in parentheses.
- Cast the ROW expression to the appropriate named ROW type (for named ROW types).
- [Rows that contain named row types](#)
- [Rows that contain unnamed row types](#)
- [Specify NULL values for row types](#)

Rows that contain named row types

The following statement shows you how to insert a row into the **employee** table in [Figure 1](#):

```
INSERT INTO employee
VALUES ('Poole, John',
ROW('402 High St', 'Willits', 'CA',
ROW(69055,1450))::address_t, 35000 );
```

Because the **address** column of the **employee** table is a named ROW type, you must use a cast operator and the name of the ROW type (**address_t**) to insert a value of type **address_t**.

Rows that contain unnamed row types

Suppose you create the table that the following figure shows. The **student** table defines the **s_address** column as an unnamed row type. Figure 1. Create the student table.

```
CREATE TABLE student
(
s_name    VARCHAR(30),
s_address ROW(street VARCHAR (20), city VARCHAR(20),
state CHAR(2), zip VARCHAR(9)),
grade_point_avg DECIMAL(3,2)
);
```

The following statement shows you how to add a row to the **student** table. To insert into the unnamed row-type column **s_address**, use the ROW constructor but do not cast the row-type value.

```
INSERT INTO student
VALUES ('Keene, Terry',
ROW('53 Terra Villa', 'Wheeling', 'IL', '45052'),
3.75);
```

Specify NULL values for row types

The fields of a row-type column can contain NULL values. You can specify NULL values either at the level of the column or the field.

The following statement specifies a NULL value at the column level to insert NULL values for all fields of the **s_address** column. When you insert a NULL value at the column level, do not include the ROW constructor.

```
INSERT INTO student VALUES ('Brauer, Howie', NULL, 3.75);
```

When you insert a NULL value for particular fields of a ROW type, you must include the ROW constructor. The following INSERT statement shows how you might insert NULL values into particular fields of the **address** column of the **employee** table. (The **address** column is defined as a named ROW type.)

```
INSERT INTO employee
VALUES (
'Singer, John',
ROW(NULL, 'Davis', 'CA',
ROW(97000, 2000))::address_t, 67000
);
```

When you specify a NULL value for the field of a ROW type, you do not need to explicitly cast the NULL value when the ROW type occurs in an INSERT statement, an UPDATE statement, or a program variable assignment.

The following INSERT statement shows how you insert NULL values for the **street** and **zip** fields of the **s_address** column for the **student** table:

```
INSERT INTO student
VALUES (
```

```
'Henry, John',
ROW(NULL, 'Seattle', 'WA', NULL), 3.82
);
```

Insert rows into supertables

No special considerations exist when you insert a row into a supertable. An INSERT statement applies only to the table that is specified in the statement. For example, the following statement inserts values into the supertable but does not insert values into any subtables:

```
INSERT INTO person
VALUES (
  'Poole, John',
  ROW('402 Sapphire St.', 'Elmondo', 'CA', '69055'),
  345605900
);
```

Insert collection values into columns

This section describes how to insert a collection value into a column with DB-Access. It does not discuss how to insert individual elements into a collection column. To access or modify the individual elements of a collection, use an SPL routine or Informix® ESQL/C program. For information about how to create Informix ESQL/C programs to insert into a collection, see the *IBM® Informix ESQL/C Programmer's Manual*. For information about how to create an SPL routine to insert into a collection, see [Create and use SPL routines](#).

The examples that this section provides are based on the **manager** table in the following figure. The **manager** table contains both simple and nested collection types.

Figure 1. Create the manager table.

```
CREATE TABLE manager
(
  mgr_name      VARCHAR(30),
  department    VARCHAR(12),
  direct_reports SET(VARCHAR(30) NOT NULL),
  projects      LIST(ROW(pro_name VARCHAR(15),
    pro_members SET(VARCHAR(20) NOT NULL)
    NOT NULL)
);
```

- [Insert values into simple collections and nested collections](#)
- [Insert NULL values into a collection that contains a row type](#)

Insert values into simple collections and nested collections

When you insert values into a row that contains a collection column, you insert the values of all the elements that the collection contains as well as values for the other columns. For example, the following statement inserts a single row into the **manager** table, which includes columns for both simple collections and nested collections:

```
INSERT INTO manager(mgr_name, department,
  direct_reports, projects)
VALUES
(
  'Sayles', 'marketing',
  "SET{'Simonian', 'Waters', 'Adams', 'Davis', 'Jones'}",
  LIST(
    ROW('voyager_project', SET{'Simonian', 'Waters',
      'Adams', 'Davis'}),
    ROW('horizon_project', SET{'Freeman', 'Jacobs',
      'Walker', 'Smith', 'Cannan'}),
    ROW('sapphire_project', SET{'Villers', 'Reeves',
      'Doyle', 'Strongin'})
  )
);
```

Insert NULL values into a collection that contains a row type

To insert values into a collection that is a ROW type, you must specify a value for each field in the ROW type.

In general, NULL values are not allowed in a collection. However, if the element type of the collection is a ROW type, you can insert NULL values into individual fields of the row type.

You can also specify an *empty collection*. An empty collection is a collection that contains no elements. To specify an empty collection, use the braces ({}). For example, the following statement inserts data into a row in the **manager** table but specifies that the **direct_reports** and **projects** columns are empty collections:

```
INSERT INTO manager
VALUES ('Sayles', 'marketing', "SET{}",
```



```
"LIST{ROW(NULL, SET{ }) }"
);
```

A collection column cannot contain NULL elements. The following statement returns an error because NULL values are specified as elements of collections:

```
INSERT INTO manager
VALUES ('Cole', 'accounting', "SET{NULL}",
"LIST{ROW(NULL, "SET{NULL}"" )}");
```

The following syntax rules apply for performing inserts and updates on collection types:

- Use braces ({}) to demarcate the elements that each collection contains.
- If the collection is a nested collection, use braces ({}) to demarcate the elements of both the inner and outer collections.

Insert smart large objects

When you use the INSERT statement to insert an object into a **BLOB** or **CLOB** column, the database server stores the object in an sbspace, rather than the table. The database server provides SQL functions that you can call from within an INSERT statement to import and export BLOB or CLOB data, otherwise known as smart large objects. For a description of these functions, see [Smart large object functions](#).

The following INSERT statement uses the **filetoblob()** and **filetoclob()** functions to insert a row of the **inmate** table. ([Figure 1](#) defines the **inmate** table.)

```
INSERT INTO inmate
VALUES (437, FILETOBLOB('datafile', 'client'),
FILETOCLOB('tmp/text', 'server'));
```

In the preceding example, the first argument for the **FILETOBLOB()** and **FILETOCLOB()** functions specifies the path of the source file to be copied into the **BLOB** and **CLOB** columns of the **inmate** table, respectively. The second argument for each function specifies whether the source file is located on the client computer ('client') or server computer ('server'). To specify the path of a file name in the function argument, apply the following rules:

- If the source file resides on the server computer, you must specify the full path name to the file (not the path name relative to the current working directory).
- If the source file resides on the client computer, you can specify either the full or relative path name to the file.

Note: For CLOB columns, direct strings can also be used in place of **FILETOCLOB()** function.

Multiple rows and expressions

The other major form of the INSERT statement replaces the VALUES clause with a SELECT statement. This feature allows you to insert the following data:

- Multiple rows with only one statement (each time the SELECT statement returns a row, a row is inserted)
- Calculated values (the VALUES clause permits only constants) because the projection list can contain expressions

For example, suppose a follow-up call is required for every order that has been paid for but not shipped. The INSERT statement in the following example finds those orders and inserts a row in **cust_calls** for each order:

```
INSERT INTO cust_calls (customer_num, call_descr)
SELECT customer_num, order_num FROM orders
WHERE paid_date IS NOT NULL
AND ship_date IS NULL;
```

This SELECT statement returns two columns. The data from these columns (in each selected row) is inserted into the named columns of the **cust_calls** table. Then an order number (from **order_num**, a SERIAL column) is inserted into the call description, which is a character column. Remember that the database server allows you to insert integer values into a character column. It automatically converts the serial number to a character string of decimal digits.

Restrictions on the insert selection

The following list contains the restrictions on the SELECT statement for inserting rows:

- It cannot contain an INTO clause.
- It cannot contain an INTO TEMP clause.
- It cannot contain an ORDER BY clause.
- It cannot refer to the table into which you are inserting rows.

The INTO, INTO TEMP, and ORDER BY clause restrictions are minor. The INTO clause is not useful in this context. (For more information, see [SQL programming](#).) To work around the INTO TEMP clause restriction, first select the data you want to insert into a temporary table and then insert the data from the temporary table with the INSERT statement. Likewise, the lack of an ORDER BY clause is not important. If you need to ensure that the new rows are physically ordered in the table, you can first select them into a temporary table and order it, and then insert from the temporary table. You can also apply a physical order to the table using a clustered index after all insertions are done.

Important: The last restriction is more serious because it prevents you from naming the same table in both the INTO clause of the INSERT statement and the FROM clause of the SELECT statement. Naming the same table in both the INTO clause of the INSERT statement and the FROM clause of the SELECT statement causes the database server to enter an endless loop in which each inserted row is reselected and reinserted.

In some cases, however, you might want to select from the same table into which you must insert data. For example, suppose that you have learned that the Nikolus company supplies the same products as the Anza company, but at half the price. You want to add rows to the **stock** table to reflect the difference between

the two companies. Optimally, you want to select data from all the Anza stock rows and reinsert it with the Nikolus manufacturer code. However, you cannot select from the same table into which you are inserting.

To get around this restriction, select the data you want to insert into a temporary table. Then select from that temporary table in the INSERT statement, as the following example shows:

```
SELECT stock_num, 'NIK' temp_manu, description, unit_price/2
      half_price, unit, unit_descr FROM stock
WHERE manu_code = 'ANZ'
      AND stock_num < 110
INTO TEMP anzrows;
```

```
INSERT INTO stock SELECT * FROM anzrows;
```

```
DROP TABLE anzrows;
```

This SELECT statement takes existing rows from **stock** and substitutes a literal value for the manufacturer code and a computed value for the unit price. These rows are then saved in a temporary table, **anzrows**, which is immediately inserted into the **stock** table.

When you insert multiple rows, a risk exists that one of the rows contains invalid data that might cause the database server to report an error. When such an error occurs, the statement terminates early. Even if no error occurs, a small risk exists that a hardware or software failure might occur while the statement is executing (for example, the disk might fill up).

In either event, you cannot easily tell how many new rows were inserted. If you repeat the statement in its entirety, you might create duplicate rows, or you might not. Because the database is in an unknown state, you cannot know what to do. The solution lies in using transactions, as [Interrupted modifications](#) discusses.

Update rows

Use the UPDATE statement to change the contents of one or more existing rows of a table, according to the specifications of the SET clause. This statement takes two fundamentally different forms. One lets you assign specific values to columns by name; the other lets you assign a list of values (that might be returned by a SELECT statement) to a list of columns. In either case, if you are updating rows, and some of the columns have data integrity constraints, the data that you change must conform to the constraints placed on those columns. For more information, refer to [Data integrity](#).

Note: An alternative to the UPDATE statement is the MERGE statement, which can use the same SET clause syntax as the UPDATE statement to modify one or more values in existing rows of a table. The MERGE statement performs an outer join of a source table and a target table, and then updates rows in the target table with values from the result set of the join for which the join predicate evaluates to TRUE. Values in the source table are unchanged by the MERGE statement. Besides updating rows, the MERGE statement can optionally combine both UPDATE and INSERT operations, or can combine both DELETE and INSERT operations without updating any rows. For more information about the syntax and the restrictions on Update merges, Delete merges, and Insert merges, see the description of the MERGE statement in the *IBM® Informix® Guide to SQL: Syntax*.

- [Select rows to update](#)
- [Update with uniform values](#)
- [Restrictions on updates](#)
- [Update with selected values](#)
- [Update row types](#)
- [Update collection types](#)
- [Update rows of a supertable](#)
- [CASE expression to update a column](#)
- [SQL functions to update smart large objects](#)
- [The MERGE statement to update a table](#)

Select rows to update

Either form of the UPDATE statement can end with a WHERE clause that determines which rows are modified. If you omit the WHERE clause, all rows are modified. To select the precise set of rows that need changing in the WHERE clause can be quite complicated. The only restriction on the WHERE clause is that the table that you update cannot be named in the FROM clause of a subquery.

The first form of an UPDATE statement uses a series of assignment clauses to specify new column values, as the following example shows:

```
UPDATE customer
SET fname = 'Barnaby', lname = 'Dorfler'
WHERE customer_num = 103;
```

The WHERE clause selects the row you want to update. In the demonstration database, the **customer.customer_num** column is the primary key for that table, so this statement can update no more than one row.

You can also use subqueries in the WHERE clause. Suppose that the Anza Corporation issues a safety recall of their tennis balls. As a result, any unshipped orders that include stock number 6 from manufacturer ANZ must be put on back order, as the following example shows:

```
UPDATE orders
SET backlog = 'y'
WHERE ship_date IS NULL
      AND order_num IN
      (SELECT DISTINCT items.order_num FROM items
       WHERE items.stock_num = 6
          AND items.manu_code = 'ANZ');
```

This subquery returns a column of order numbers (zero or more). The UPDATE operation then tests each row of **orders** against the list and performs the update if that row matches.

Update with uniform values

Each assignment after the keyword SET specifies a new value for a column. That value is applied uniformly to every row that you update. In the examples in the previous section, the new values were constants, but you can assign any expression, including one based on the column value itself. Suppose the manufacturer code HRO has raised all prices by five percent, and you must update the **stock** table to reflect this increase. Use the following statement:

```
UPDATE stock
  SET unit_price = unit_price * 1.05
  WHERE manu_code = 'HRO';
```

You can also use a subquery as part of the assigned value. When a subquery is used as an element of an expression, it must return exactly one value (one column and one row). Perhaps you decide that for any stock number, you must charge a higher price than any manufacturer of that product. You need to update the prices of all unshipped orders. The SELECT statements in the following example specify the criteria:

```
UPDATE items
  SET total_price = quantity *
    (SELECT MAX (unit_price) FROM stock
     WHERE stock.stock_num = items.stock_num)
  WHERE items.order_num IN
    (SELECT order_num FROM orders
     WHERE ship_date IS NULL);
```

The first SELECT statement returns a single value: the highest price in the **stock** table for a particular product. The first SELECT statement is a correlated subquery because, when a value from **items** appears in the WHERE clause for the first SELECT statement, you must execute the query for every row that you update.

The second SELECT statement produces a list of the order numbers of unshipped orders. It is an uncorrelated subquery that is executed once.

Restrictions on updates

Restrictions exist on the use of subqueries when you modify data. In particular, you cannot query the table that is being modified. You can refer to the present value of a column in an expression, as in the example that increments the **unit_price** column by 5 percent. You can also refer to a value of a column in a WHERE clause in a subquery, as in the example that updated the **stock** table, in which the **items** table is updated and **items.stock_num** is used in a join expression.

The need to update and query a table at the same time does not occur often in a well-designed database. (For more information about database design, see the *IBM® Informix® Database Design and Implementation Guide*.) However, you might want to update and query at the same time when a database is first being developed, before its design has been carefully thought through. A typical problem arises when a table inadvertently and incorrectly contains a few rows with duplicate values in a column that should be unique. You might want to delete the duplicate rows or update only the duplicate rows. Either way, a test for duplicate rows inevitably requires a subquery on the same table that you want to modify, which is not allowed in an UPDATE statement or DELETE statement. [Modify data through SQL programs](#) discusses how to use an *update cursor* to perform this kind of modification.

Update with selected values

The second form of UPDATE statement replaces the list of assignments with a single bulk assignment, in which a list of columns is set equal to a list of values. When the values are simple constants, this form is nothing more than the form of the previous example with its parts rearranged, as the following example shows:

```
UPDATE customer
  SET (fname, lname) = ('Barnaby', 'Dorfler')
  WHERE customer_num = 103;
```

No advantage exists to writing the statement this way. In fact, it is harder to read because it is not obvious which values are assigned to which columns.

However, when the values to be assigned come from a single SELECT statement, this form makes sense. Suppose that changes of address are to be applied to several customers. Instead of updating the **customer** table each time a change is reported, the new addresses are collected in a single temporary table named **newaddr**. It contains columns for the customer number and the address-related fields of the **customer** table. Now the time comes to apply all the new addresses at once.

```
UPDATE customer
  SET (address1, address2, city, state, zipcode) =
    ((SELECT address1, address2, city, state, zipcode
      FROM newaddr
      WHERE newaddr.customer_num=customer.customer_num)
  WHERE customer_num IN (SELECT customer_num FROM newaddr);
```

A single SELECT statement produces the values for multiple columns. If you rewrite this example in the other form, with an assignment for each updated column, you must write five SELECT statements, one for each column to be updated. Not only is such a statement harder to write, but it also takes much longer to execute. Tip: In SQL API programs, you can use record or host variables to update values. For more information, refer to [SQL programming](#).

Update row types

The syntax you use to update a row-type value differs somewhat depending on whether the column is a named ROW type or unnamed ROW type. This section describes those differences and also describes how to specify NULL values for the fields of a ROW type.

- [Update rows that contain named row types](#)
- [Update rows that contain unnamed row types](#)
- [Specify Null values for the fields of a row type](#)

Update rows that contain named row types

To update a column that is defined on a named ROW type, you must specify all fields of the ROW type. For example, the following statement updates only the **street** and **city** fields of the **address** column in the **employee** table, but each field of the ROW type must contain a value (NULL values are allowed):

```
UPDATE employee
SET address = ROW('103 California St',
  San Francisco', address.state, address.zip)::address_t
WHERE name = 'zawinul, joe';
```

In this example, the values of the **state** and **zip** fields are read from and then immediately reinserted into the row. Only the **street** and **city** fields of the **address** column are updated.

When you update the fields of a column that are defined on a named ROW type, you must use a ROW constructor and cast the row value to the appropriate named ROW type.

Update rows that contain unnamed row types

To update a column that is defined on an unnamed ROW type, you must specify all fields of the ROW type. For example, the following statement updates only the **street** and **city** fields of the **address** column in the **student** table, but each field of the ROW type must contain a value (NULL values are allowed):

```
UPDATE student
SET s_address = ROW('13 Sunset', 'Fresno',
  s_address.state, s_address.zip)
WHERE s_name = 'henry, john';
```

To update the fields of a column that are defined on an unnamed ROW type, always specify the ROW constructor before the field values to be inserted.

Specify Null values for the fields of a row type

The fields of a row-type column can contain NULL values. When you insert into or update a row-type field with a NULL value, you must cast the value to the data type of that field.

The following UPDATE statement shows how you might specify NULL values for particular fields of a named row-type column:

```
UPDATE employee
SET address = ROW(NULL::VARCHAR(20), 'Davis', 'CA',
  ROW(NULL::CHAR(5), NULL::CHAR(4))::address_t)
WHERE name = 'henry, john';
```

The following UPDATE statement shows how you specify NULL values for the **street** and **zip** fields of the **address** column for the **student** table.

```
UPDATE student
SET address = ROW(NULL::VARCHAR(20), address.city,
  address.state, NULL::VARCHAR(9))
WHERE s_name = 'henry, john';
```

Important: You cannot specify NULL values for a row-type column. You can only specify NULL values for the individual fields of the row type.

Update collection types

When you use DB-Access to update a collection type, you must update the entire collection. The following statement shows how to update the **projects** column. To locate the row that needs to be updated, use the IN keyword to perform a search on the **direct_reports** column.

```
UPDATE manager
SET projects = "LIST
{
  ROW('brazil_project', SET{'Pryor', 'Murphy', 'Kinsley',
    'Bryant'}),
  ROW ('cuba_project', SET{'Forester', 'Barth', 'Lewis',
    'Leonard'})
}"
WHERE 'Williams' IN direct_reports;
```

The first occurrence of the SET keyword in the preceding statement is part of the UPDATE statement syntax.

Important: Do not confuse the SET keyword of an UPDATE statement with the SET constructor that indicates that a collection is a SET data type.

Although you can use the IN keyword to locate specific elements of a simple collection, you cannot update individual elements of a collection column from DB-Access. However, you can create Informix® ESQL/C programs and SPL routines to update elements within a collection. For information about how to create Informix ESQL/C programs to update a collection, see the [IBM® Informix ESQL/C Programmer's Manual](#). For information about how to create SPL routines to update a collection, see the section [Handle collections](#).

Update rows of a supertable

When you update the rows of a supertable, the scope of the update is a supertable and its subtables.

When you construct an UPDATE statement on a supertable, you can update all columns in the supertable and columns of subtables that are inherited from the supertable. For example, the following statement updates rows from the **employee** and **sales_rep** tables, which are subtables of the supertable **person**:

```
UPDATE person
SET salary=65000
WHERE address.state = 'CA';
```

However, an update on a supertable does not allow you to update columns from subtables that are not in the supertable. For example, in the previous update statement, you cannot update the **region_num** column of the **sales_rep** table because the **region_num** column does not occur in the **employee** table.

When you perform updates on supertables, be aware of the scope of the update. For example, an UPDATE statement on the **person** table that does not include a WHERE clause to restrict which rows to update, modifies all rows of the **person**, **employee**, and **sales_rep** table.

To limit an update to rows of the supertable only, you must use the ONLY keyword in the UPDATE statement. For example, the following statement updates rows of the **person** table only:

```
UPDATE ONLY(person)
SET address = ROW('14 Jackson St', 'Berkeley',
address.state, address.zip)
WHERE name = 'Sallie, A.';
```

Important: Use caution when you update rows of a supertable because the scope of an update on a supertable includes the supertable and all its subtables.

CASE expression to update a column

The CASE expression allows a statement to return one of several possible results, depending on which of several condition tests evaluates to TRUE.

The following example shows how to use a CASE expression in an UPDATE statement to increase the unit price of certain items in the **stock** table:

```
UPDATE stock
SET unit_price = CASE
  WHEN stock_num = 1
  AND manu_code = "HRO"
  THEN unit_price * 1.2
  WHEN stock_num = 1
  AND manu_code = "SMT"
  THEN unit_price * 1.1
  ELSE 0
END
```

You must include at least one WHEN clause within the CASE expression; subsequent WHEN clauses and the ELSE clause are optional. If no WHEN condition evaluates to true, the resulting value is null.

SQL functions to update smart large objects

You can use an SQL function that you can call from within an UPDATE statement to import and export smart large objects. For a description of these functions, see page [Smart large object functions](#).

The following UPDATE statement uses the **LOCOPY()** function to copy BLOB data from the **mugshot** column of the **fbi_list** table into the **picture** column of the **inmate** table. ([Figure 1](#) defines the **inmate** and **fbi_list** tables.)

```
UPDATE inmate (picture)
SET picture = (SELECT LOCOPY(mugshot, 'inmate', 'picture')
FROM fbi_list WHERE fbi_list.id = 669)
WHERE inmate.id_num = 437;
```

The first argument for **LOCOPY()** specifies the column (**mugshot**) from which the object is exported. The second and third arguments specify the name of the table (**inmate**) and column (**picture**) whose storage characteristics the newly created object will use. After execution of the UPDATE statement, the **picture** column contains data from the **mugshot** column.

When you specify the path of a file name in the function argument, apply the following rules:

- If the source file resides on the server computer, you must specify the full path name to the file (not the path name relative to the current working directory).
- If the source file resides on the client computer, you can specify either the full or relative path name to the file.

The MERGE statement to update a table

The MERGE statement allows you to apply a Boolean condition to the result of an outer join of a source table and a target table. If the MERGE statement includes the Update clause, rows that satisfy the join condition that you specify after the ON keyword are used in UPDATE operations on the target. The SET clause of the MERGE statement supports the same syntax as the SET clause of the UPDATE statement, and specifies which columns of the target table to update.

The following example illustrates how you can use the Update clause of the MERGE statement to update a target table:

```
MERGE INTO t_target AS t USING t_source AS s ON t.col_a = s.col_a
  WHEN MATCHED THEN UPDATE
    SET t.col_b = t.col_b + s.col_b ;
```

In the preceding example, the name of the target table is **t_target** and the name of the source table is **t_source**. For rows of the join result where **col_a** has the same value in both the source and the target tables, the MERGE statement updates the **t_target** table by adding the value of column **col_b** in the source table to the current value of the **col_b** column in the **t_target** table.

An UPDATE operation of the MERGE statement does not modify the source table, and cannot update any row in the target table more than once.

A single MERGE statement can combine both UPDATE and INSERT operations, or can combine both DELETE and INSERT operations but the delete clause is not required. For a different example of MERGE that includes no Update clause, see the topic [The Delete clause of MERGE](#)

Privileges on a database and on its objects

You can use the following database privileges to control who accesses a database:

- Database-level privileges
- Table-level privileges
- Routine-level privileges
- Language-level privileges
- Type-level privileges
- Sequence-level privileges
- Fragment-level privileges

This section briefly describes database- and table-level privileges. For more information about database privileges, see the *IBM® Informix® Database Design and Implementation Guide*. For a list of privileges and a description of the GRANT and REVOKE statements, see the *IBM Informix Guide to SQL: Syntax*.

- [Database-level privileges](#)
- [Table-level privileges](#)
- [Display table privileges](#)
- [Grant privileges to roles](#)

Database-level privileges

When you create a database, you are the only one who can access it until you, as the owner or database administrator (DBA) of the database, grant database-level privileges to others. The following table shows database-level privileges.

Privilege	Effect
Connect	Allows you to open a database, issue queries, and create and place indexes on temporary tables.
Resource	Allows you to create permanent tables.
DBA	Allows you to perform several additional functions as the DBA.

Table-level privileges

When you create a table in a database that is not ANSI compliant, all users have access privileges to the table until you, as the owner of the table, revoke table-level privileges from specific users. The following table introduces the four privileges that govern how users can access a table.

Privilege	Purpose
Select	Granted on a table-by-table basis and allows you to select rows from a table. (This privilege can be limited to specific columns in a table.)
Delete	Allows you to delete rows.
Insert	Allows you to insert rows.
Update	Allows you to update existing rows (that is, to change their content).

The people who create databases and tables often grant the Connect and Select privileges to **public** so that all users have them. If you can query a table, you have at least the Connect and Select privileges for that database and table.

You need the other table-level privileges to modify data. The owners of tables often withhold these privileges or grant them only to specific users. As a result, you might not be able to modify some tables that you can query freely.

Because these privileges are granted on a table-by-table basis, you can have only Insert privileges on one table and only Update privileges on another, for example. The Update privileges can be restricted even further to specific columns in a table.

For more information on these and other table-level privileges, see the *IBM® Informix® Database Design and Implementation Guide*.

Display table privileges

If you are the owner of a table (that is, if you created it), you have all privileges on that table. Otherwise, you can determine the privileges you have for a certain table by querying the system catalog. The system catalog consists of system tables that describe the database structure. The privileges granted on each table are recorded in the **systabauth** system table. To display these privileges, you must also know the unique identifier number of the table. This number is specified in the **systables** system table. To display privileges granted on the **orders** table, you might enter the following SELECT statement:

```
SELECT * FROM systabauth
WHERE tabid = (SELECT tabid FROM systables
               WHERE tablename = 'orders');
```

The output of the query resembles the following example:

grantor	grantee	tabid	tabauth
tfecitmutator	101	su-i-x--	
tfecitprocrustes	101	s--idx--	
tfecitpublic	101	s--i-x--	

The grantor is the user who grants the privilege. The grantor is usually the owner of the table but the owner can be another user that the grantor empowered. The grantee is the user to whom the privilege is granted, and the grantee **public** means any user with Connect privilege. If your user name does not appear, you have only those privileges granted to **public**.

The **tabauth** column specifies the privileges granted. The letters in each row of this column are the initial letters of the privilege names, except that **i** means Insert and **x** means Index. In this example, **public** has Select, Insert, and Index privileges. Only the user **mutator** has Update privileges, and only the user **procrustes** has Delete privileges.

Before the database server performs any action for you (for example, execution of a DELETE statement), it performs a query similar to the preceding one. If you are not the owner of the table, and if the database server cannot find the necessary privilege on the table for your user name or for **public**, it refuses to perform the operation.

Grant privileges to roles

As DBA, you can create roles to standardize the privileges given to a class of users. When you assign privileges to that role, every user of that role has those access privileges. The SQL statements used for defining and manipulating roles include: CREATE ROLE, DROP ROLE, GRANT, REVOKE, and SET ROLE. For more information on the SQL syntax statements for defining and manipulating roles, see the *IBM® Informix® Guide to SQL: Syntax*.

Default roles automatically apply upon connection to the database for particular users and groups, without requiring the user to issue a SET ROLE statement. For example:

```
GRANT DEFAULT ROLE manager TO larry;
```

For more information on roles and default roles, see [Control database use](#) or see the *IBM Informix Administrator's Guide*.

For more information on granting and revoking privileges, see [Grant and revoke privileges in applications](#). Also see *IBM Informix Database Design and Implementation Guide*.

Data integrity

The INSERT, UPDATE, and DELETE statements modify data in an existing database. Whenever you modify existing data, the *integrity* of the data can be affected. For example, an order for a nonexistent product could be entered into the **orders** table, a customer with outstanding orders could be deleted from the **customer** table, or the order number could be updated in the **orders** table and not in the **items** table. In each of these cases, the integrity of the stored data is lost.

Data integrity is actually made up of the following parts:

Entity integrity

Each row of a table has a unique identifier.

Semantic integrity

The data in the columns properly reflects the types of information the column was designed to hold.

Referential integrity

The relationships between tables are enforced.

Well-designed databases incorporate these principles so that when you modify data, the database itself prevents you from doing anything that might harm the integrity of the data.

- [Entity integrity](#)
- [Semantic integrity](#)
- [Referential integrity](#)
- [Object modes and violation detection](#)

Entity integrity

An entity is any person, place, or thing to be recorded in a database. Each table represents an entity, and each row of a table represents an instance of that entity. For example, if *order* is an entity, the **orders** table represents the idea of an order and each row in the table represents a specific order.

To identify each row in a table, the table must have a primary key. The primary key is a unique value that identifies each row. This requirement is called the *entity integrity constraint*.

For example, the **orders** table primary key is **order_num**. The **order_num** column holds a unique system-generated order number for each row in the table. To access a row of data in the **orders** table, use the following SELECT statement:

```
SELECT * FROM orders WHERE order_num = 1001;
```

Using the order number in the WHERE clause of this statement enables you to access a row easily because the order number uniquely identifies that row. If the table allowed duplicate order numbers, it would be almost impossible to access one single row because all other columns of this table allow duplicate values.

For more information on primary keys and entity integrity, see the *IBM® Informix® Database Design and Implementation Guide*.

Semantic integrity

Semantic integrity ensures that data entered into a row reflects an allowable value for that row. The value must be within the *domain*, or allowable set of values, for that column. For example, the **quantity** column of the **items** table permits only numbers. If a value outside the domain can be entered into a column, the semantic integrity of the data is violated.

The following constraints enforce semantic integrity:

Data type

The data type defines the types of values that you can store in a column. For example, the data type SMALLINT allows you to enter values from -32,767 to 32,767 into a column.

Default value

The default value is the value inserted into the column when an explicit value is not specified. For example, the **user_id** column of the **cust_calls** table defaults to the login name of the user if no name is entered.

Check constraint

The check constraint specifies conditions on data inserted into a column. Each row inserted into a table must meet these conditions. For example, the **quantity** column of the **items** table might check for quantities greater than or equal to one.

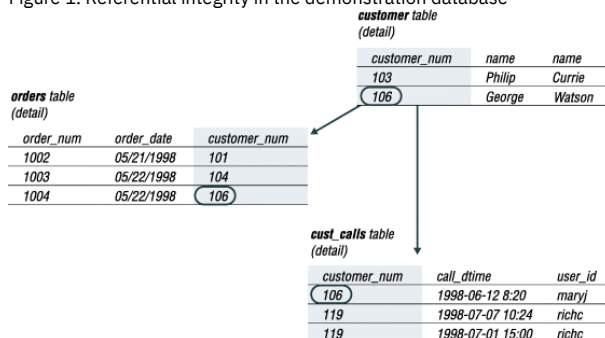
For more information on how to use semantic integrity constraints in database design, see the *IBM® Informix® Database Design and Implementation Guide*.

Referential integrity

Referential integrity refers to the relationship between tables. Because each table in a database must have a primary key, this primary key can appear in other tables because of its relationship to data within those tables. When a primary key from one table appears in another table, it is called a *foreign key*.

Foreign keys join tables and establish dependencies between tables. Tables can form a hierarchy of dependencies in such a way that if you change or delete a row in one table, you destroy the meaning of rows in other tables. For example, the following figure shows that the **customer_num** column of the **customer** table is a primary key for that table and a foreign key in the **orders** and **cust_calls** tables. Customer number 106, George Watson™, is *referenced* in both the **orders** and **cust_calls** tables. If customer 106 is deleted from the **customer** table, the link between the three tables and this particular customer is destroyed.

Figure 1. Referential integrity in the demonstration database



When you delete a row that contains a primary key or update it with a different primary key, you destroy the meaning of any rows that contain that value as a foreign key. Referential integrity is the logical dependency of a foreign key on a primary key. The integrity of a row that contains a foreign key depends on the integrity of the row that it references—the row that contains the matching primary key.

By default, the database server does not allow you to violate referential integrity and gives you an error message if you attempt to delete rows from the parent table before you delete rows from the child table. You can, however, use the ON DELETE CASCADE option to cause deletes from a parent table to trip deletes on child tables. See [The ON DELETE CASCADE option](#).

To define primary and foreign keys, and the relationship between them, use the CREATE TABLE and ALTER TABLE statements. For more information on these statements, see the *IBM® Informix® Guide to SQL: Syntax*. For information about how to build a data model with primary and foreign keys, see the *IBM Informix*

- [The ON DELETE CASCADE option](#)
- [Example of cascading deletes](#)
- [Restrictions on cascading deletes](#)

The ON DELETE CASCADE option

To maintain referential integrity when you delete rows from a primary key for a table, use the ON DELETE CASCADE option in the REFERENCES clause of the CREATE TABLE and ALTER TABLE statements. This option allows you to delete a row from a parent table and its corresponding rows in matching child tables with a single delete command.

Lock during cascading deletes

During deletes, locks are held on all qualifying rows of the parent and child tables. When you specify a delete, the delete that is requested from the parent table occurs before any referential actions are performed.

What happens to multiple children tables

If you have a parent table with two child constraints, one child with cascading deletes specified and one child without cascading deletes, and you attempt to delete a row from the parent table that applies to both child tables, the DELETE statement fails, and no rows are deleted from either the parent or child tables.

Logging must be turned on

You must turn on logging in your current database for cascading deletes to work. Logging and cascading deletes are discussed in [Transaction logging](#).

Example of cascading deletes

Suppose you have two tables with referential integrity rules applied, a parent table, **accounts**, and a child table, **sub_accounts**. The following CREATE TABLE statements define the referential constraints:

```
CREATE TABLE accounts (
  acc_num SERIAL primary key,
  acc_type INT,
  acc_descr CHAR(20));

CREATE TABLE sub_accounts (
  sub_acc INTEGER primary key,
  ref_num INTEGER REFERENCES accounts (acc_num)
    ON DELETE CASCADE,
  sub_descr CHAR(20));
```

The primary key of the accounts table, the **acc_num** column, uses a SERIAL data type, and the foreign key of the **sub_accounts** table, the **ref_num** column, uses an INTEGER data type. Combining the SERIAL data type on the primary key and the INTEGER data type on the foreign key is allowed. Only in this condition can you mix and match data types. The SERIAL data type is an INTEGER, and the database automatically generates the values for the column. All other primary and foreign key combinations must match explicitly. For example, a primary key that is defined as CHAR must match a foreign key that is defined as CHAR.

The definition of the foreign key of the **sub_accounts** table, the **ref_num** column, includes the ON DELETE CASCADE option. This option specifies that a delete of any row in the parent table **accounts** will automatically cause the corresponding rows of the child table **sub_accounts** to be deleted.

To delete a row from the accounts table that will cascade a delete to the **sub_accounts** table, you must turn on logging. After logging is turned on, you can delete the account number 2 from both tables, as the following example shows:

```
DELETE FROM accounts WHERE acc_num = 2;
```

Restrictions on cascading deletes

You can use cascading deletes for most deletes, including deletes on self-referencing and cyclic queries. The only exception is correlated subqueries, which are nested SELECT statements in which the value that the subquery (or inner SELECT) produces depends on a value produced by the outer SELECT statement that contains it. If you have implemented cascading deletes, you cannot write deletes that use a child table in the correlated subquery. You receive an error when you attempt to delete from a correlated subquery.

Restriction: You cannot define a DELETE trigger event on a table if the table defines a referential constraint with ON DELETE CASCADE.

Object modes and violation detection

The object modes and violation detection features of the database can help you monitor data integrity. These features are particularly powerful when they are combined during schema changes or when insert, delete, and update operations are performed on large volumes of data over short periods.

Database objects, within the context of a discussion of the object modes feature, are constraints, indexes, and triggers, and each of them have different modes. Do not confuse database objects that are relevant to the object modes feature with generic database objects. Generic database objects are things like tables and synonyms.

- [Definitions of object modes](#)
- [Example of modes with data manipulation statements](#)
- [Violations and diagnostics tables](#)

Definitions of object modes

You can set disabled, enabled, or filtering modes for a constraint or a unique index. You can set disabled or enabled modes for a trigger or a duplicate index. You can use database object modes to control the effects of INSERT, DELETE, and UPDATE statements.

- [Enabled mode](#)
- [Disabled mode](#)
- [Filtering mode](#)

Enabled mode

Constraints, indexes, and triggers are enabled by default.

When a database object is enabled, the database server recognizes the existence of the database object and takes the database object into consideration while it executes an INSERT, DELETE, or UPDATE statement. Thus, an enabled constraint is enforced, an enabled index updated, and an enabled trigger is executed when the trigger event takes place.

When you enable constraints and unique indexes, if a violating row exists, the data manipulation statement fails (that is no rows change) and the database server returns an error message.

You can identify the reason for the failure when you analyze the information in the violations and diagnostic tables. You can then take corrective action or roll back the operation.

Disabled mode

When a database object is disabled, the database server does not take it into consideration during the execution of an INSERT, DELETE, or UPDATE statement. A disabled constraint is not enforced, a disabled index is not updated, and a disabled trigger is not executed when the trigger event takes place. When you disable constraints and unique indexes, any data manipulation statement that violates the restriction of the constraint or unique index succeed, (that is, the target row is changed), and the database server does not return an error message.

Filtering mode

When a constraint or unique index is in filtering mode, the statement succeeds and the database server enforces the constraint or the unique index requirement during an INSERT, DELETE, or UPDATE statement by writing the failed rows to the violations table associated with the target table. Diagnostic information about the constraint violation is written to the diagnostics table associated with the target table.

Example of modes with data manipulation statements

An example with the INSERT statement can illustrate the differences between the enabled, disabled, and filtering modes. Consider an INSERT statement in which a user tries to add a row that does not satisfy an integrity constraint on a table. For example, assume that user **joe** created a table named **cust_subset**, and this table consists of the following columns: **ssn** (customer's social security number), **fname** (customer's first name), **lname** (customer's last name), and **city** (city in which the customer lives). The **ssn** column has the INT data type. The other three columns have the CHAR data type.

Assume that user **joe** defined the **lname** column as not null but has not assigned a name to the not null constraint, so the database server has implicitly assigned the name **n104_7** to this constraint. Finally, assume that user **joe** created a unique index named **unq_ssn** on the **ssn** column.

Now user **linda** who has the Insert privilege on the **cust_subset** table enters the following INSERT statement on this table:

```
INSERT INTO cust_subset (ssn, fname, city)
VALUES (973824499, "jane", "los altos");
```

To better understand the distinctions among enabled, disabled, and filtering modes, you can view the results of the preceding INSERT statement in the following three sections.

- [Results of the insert operation when the constraint is enabled](#)
- [Results of the insert operation when the constraint is disabled](#)
- [Results of the insert when constraint is in filtering mode](#)
- [Multiple diagnostic rows for one violations row](#)

Results of the insert operation when the constraint is enabled

If the NOT NULL constraint on the **cust_subset** table is enabled, the INSERT statement fails to insert the new row in this table. Instead user **linda** receives the following error message when she enters the INSERT statement:

```
-292 An implied insert column lname does not accept NULLs.
```

Results of the insert operation when the constraint is disabled

If the NOT NULL constraint on the **cust_subset** table is disabled, the INSERT statement that user **linda** issues successfully inserts the new row in this table. The new row of the **cust_subset** table has the following column values.

ssn	fname	lname	city
973824499	jane	NULL	los altos

Results of the insert when constraint is in filtering mode

If the NOT NULL constraint on the **cust_subset** table is set to the filtering mode, the INSERT statement that user **linda** issues fails to insert the new row in this table. Instead the new row is inserted into the violations table, and a diagnostic row that describes the integrity violation is added to the diagnostics table.

Assume that user **joe** has started a violations and diagnostics table for the **cust_subset** table. The violations table is named **cust_subset_vio**, and the diagnostics table is named **cust_subset_dia**. The new row added to the **cust_subset_vio** violations table when user **linda** issues the INSERT statement on the **cust_subset** target table has the following column values.

ssn	fname	lname	city	informix_tupleid	informix_optype	informix_reowner
973824499	jane	NULL	los altos	1	I	linda

This new row in the **cust_subset_vio** violations table has the following characteristics:

- The first four columns of the violations table exactly match the columns of the target table. These four columns have the same names and the same data types as the corresponding columns of the target table, and they have the column values that were supplied by the INSERT statement that user **linda** entered.
- The value 1 in the **informix_tupleid** column is a unique serial identifier that is assigned to the nonconforming row.
- The value I in the **informix_optype** column is a code that identifies the type of operation that has caused this nonconforming row to be created. Specifically, I stands for an INSERT operation.
- The value linda in the **informix_reowner** column identifies the user who issued the statement that caused this nonconforming row to be created.

The INSERT statement that user **linda** issued on the **cust_subset** target table also causes a diagnostic row to be added to the **cust_subset_dia** diagnostics table. The new diagnostic row added to the diagnostics table has the following column values.

informix_tupleid	objtype	objowner	objname
1	C	joe	n104_7

This new diagnostic row in the **cust_subset_dia** diagnostics table has the following characteristics:

- This row of the diagnostics table is linked to the corresponding row of the violations table by means of the **informix_tupleid** column that appears in both tables. The value 1 appears in this column in both tables.
- The value C in the **objtype** column identifies the type of integrity violation that the corresponding row in the violations table caused. Specifically, the value C stands for a constraint violation.
- The value joe in the **objowner** column identifies the owner of the constraint for which an integrity violation was detected.
- The value n104_7 in the **objname** column gives the name of the constraint for which an integrity violation was detected.

By joining the violations and diagnostics tables, user **joe** (who owns the **cust_subset** target table and its associated special tables) or the DBA can find out that the row in the violations table whose **informix_tupleid** value is 1 was created after an INSERT statement and that this row is violating a constraint. The table owner or DBA can query the **sysconstraints** system catalog table to determine that this constraint is a NOT NULL constraint. Now that the reason for the failure of the INSERT statement is known, user **joe** or the DBA can take corrective action.

Multiple diagnostic rows for one violations row

In the preceding example, only one row in the diagnostics table corresponds to the new row in the violations table. However, more than one diagnostic row can be added to the diagnostics table when a single new row is added to the violations table. For example, if the **ssn** value (973824499) that user **linda** entered in the INSERT statement had been the same as an existing value in the **ssn** column of the **cust_subset** target table, only one new row would appear in the violations table, but the following two diagnostic rows would be present in the **cust_subset_dia** diagnostics table.

informix_tupleid	objtype	objowner	objname
1	C	joe	n104_7
1	I	joe	unq_ssn

Both rows in the diagnostics table correspond to the same row of the violations table because both of these rows have the value 1 in the **informix_tupleid** column. The first diagnostic row, however, identifies the constraint violation caused by the INSERT statement that user **linda** issued, while the second diagnostic row

identifies the unique-index violation that the same INSERT statement caused. In this second diagnostic row, the value `I` in the **objtype** column stands for a unique-index violation, and the value `unq_ssn` in the **objname** column gives the name of the index for which the integrity violation was detected.

For more information about how to set database object modes, see the SET Database Object Mode statement in the *IBM® Informix® Guide to SQL: Syntax*.

Violations and diagnostics tables

When you start a violations table for a target table, any rows that violate constraints and unique indexes during INSERT, UPDATE, and DELETE operations on the target table do not cause the entire operation to fail, but are filtered out to the violations table. The diagnostics table contains information about the integrity violations caused by each row in the violations table. By examining these tables, you can identify the cause of failure and take corrective action by either fixing the violation or rolling back the operation.

After you create a violations table for a target table, you cannot alter the columns or the fragmentation of the base table or the violations table. If you alter the constraints on a target table after you have started the violations table, nonconforming rows will be filtered to the violations table.

For information about how to start and stop the violations tables, see the START VIOLATIONS TABLE and STOP VIOLATIONS TABLE statements in the *IBM® Informix® Guide to SQL: Syntax*.

- [Relationship of violations tables and database object modes](#)
- [Examples of START VIOLATIONS TABLE statements](#)
- [Example of privileges on the violations table](#)
- [Example of privileges on the diagnostics table](#)

Relationship of violations tables and database object modes

If you set the constraints or unique indexes defined on a table to the filtering mode, but you do not create the violations and diagnostics tables for this target table, any rows that violate a constraint or unique-index requirement during an insert, update, or delete operation are not filtered to a violations table. Instead, you receive an error message that indicates that you must start a violations table for the target table.

Similarly, if you set a disabled constraint or disabled unique index to the enabled or filtering mode and you want the ability to identify existing rows that do not satisfy the constraint or unique-index requirement, you must create the violations tables before you issue the SET Database Object Mode statement.

Examples of START VIOLATIONS TABLE statements

The examples that follow show different ways to execute the START VIOLATIONS TABLE statement.

Start violations and diagnostics tables without specifying their names

To start a violations and diagnostics table for the target table named **customer** in the demonstration database, enter the following statement:

```
START VIOLATIONS TABLE FOR customer;
```

Because your START VIOLATIONS TABLE statement does not include a USING clause, the violations table is named **customer_vio** by default, and the diagnostics table is named **customer_dia** by default. The **customer_vio** table includes the following columns:

```
customer_num  
fname  
lname  
company  
address1  
address2  
city  
state  
zipcode  
phone  
informix_tupleid  
informix_optype  
informix_reowner
```

The **customer_vio** table has the same table definition as the **customer** table except that the **customer_vio** table has three additional columns that contain information about the operation that caused the bad row.

The **customer_dia** table includes the following columns:

```
informix_tupleid  
objtype  
objowner  
objname
```

This list of columns shows an important difference between the diagnostics table and violations table for a target table. Whereas the violations table has a matching column for every column in the target table, the columns of the diagnostics table are independent of the schema of the target table. The diagnostics table created by any START VIOLATIONS TABLE statement always has the four columns in the list above, with the same column names and data types.

Start violations and diagnostics tables and specify their names

The following statement starts a violations and diagnostics table for the target table named **items**. The USING clause declares explicit names for the violations and diagnostics tables. The violations table is to be named **exceptions**, and the diagnostics table is to be named **reasons**.

```
START VIOLATIONS TABLE FOR items
  USING exceptions, reasons;
```

Specify the maximum number of rows in the diagnostics table

The following statement starts violations and diagnostics tables for the target table named **orders**. The MAX ROWS clause specifies the maximum number of rows that can be inserted into the **orders_di** diagnostics table when a single statement, such as an INSERT, MERGE, or SET Database Object Mode, is executed on the target table.

```
START VIOLATIONS TABLE FOR orders MAX ROWS 50000;
```

If you do not specify a value for MAX ROWS in the START VIOLATIONS TABLE statement, there is no default limit on the number of rows in the diagnostics table, apart from the available disk space.

The MAX ROWS clause limits the number of rows only for operations in which the table functions as a diagnostics table.

Example of privileges on the violations table

The following example illustrates how the initial set of privileges on a violations table is derived from the current set of privileges on the target table.

For example, assume that we created a table named **cust_subset** and that this table consists of the following columns: **ssn** (customer's social security number), **fname** (customer's first name), **lname** (customer's last name), and **city** (city in which the customer lives).

The following set of privileges exists on the **cust_subset** table:

- User **alvin** is the owner of the table.
- User **barbara** has the Insert and Index privileges on the table. She also has the Select privilege on the **ssn** and **lname** columns.
- User **carrie** has the Update privilege on the **city** column. She also has the Select privilege on the **ssn** column.
- User **danny** has the Alter privilege on the table.

Now user **alvin** starts a violations table named **cust_subset_viols** and a diagnostics table named **cust_subset_diags** for the **cust_subset** table, as follows:

```
START VIOLATIONS TABLE FOR cust_subset
  USING cust_subset_viols, cust_subset_diags;
```

The database server grants the following set of initial privileges on the **cust_subset_viols** violations table:

- User **alvin** is the owner of the violations table, so he has all table-level privileges on the table.
- User **barbara** has the Insert, Delete, and Index privileges on the violations table. She also has the Select privilege on the following columns of the violations table: the **ssn** column, the **lname** column, the **informix_tupleid** column, the **informix_optype** column, and the **informix_reowner** column.
- User **carrie** has the Insert and Delete privileges on the violations table. She has the Update privilege on the following columns of the violations table: the **city** column, the **informix_tupleid** column, the **informix_optype** column, and the **informix_reowner** column. She has the Select privilege on the following columns of the violations table: the **ssn** column, the **informix_tupleid** column, the **informix_optype** column, and the **informix_reowner** column.
- User **danny** has no privileges on the violations table.

Example of privileges on the diagnostics table

The following example illustrates how the initial set of privileges on a diagnostics table is derived from the current set of privileges on the target table.

For example, assume that a table called **cust_subset** consists of the following columns: **ssn** (customer's social security number), **fname** (customer's first name), **lname** (customer's last name), and **city** (city in which the customer lives).

The following set of privileges exists on the **cust_subset** table:

- User **alvin** is the owner of the table.
- User **barbara** has the Insert and Index privileges on the table. She also has the Select privilege on the **ssn** and **lname** columns.
- User **carrie** has the Update privilege on the **city** column. She also has the Select privilege on the **ssn** column.
- User **danny** has the Alter privilege on the table.

Now user **alvin** starts a violations table named **cust_subset_viols** and a diagnostics table named **cust_subset_diags** for the **cust_subset** table, as follows:

```
START VIOLATIONS TABLE FOR cust_subset
  USING cust_subset_viols, cust_subset_diags;
```

The database server grants the following set of initial privileges on the **cust_subset_diags** diagnostics table:

- User **alvin** is the owner of the diagnostics table, so he has all table-level privileges on the table.
- User **barbara** has the Insert, Delete, Select, and Index privileges on the diagnostics table.
- User **carrie** has the Insert, Delete, Select, and Update privileges on the diagnostics table.
- User **danny** has no privileges on the diagnostics table.

Interrupted modifications

Even if all the software is error-free and all the hardware is utterly reliable, the world outside the computer can interfere. Lightning might strike the building, interrupting the electrical supply and stopping the computer in the middle of your UPDATE statement. A more likely scenario occurs when a disk fills up or a user supplies incorrect data, causing your multirow insert to stop early with an error. In any case, whenever you modify data, you must assume that some unforeseen event can interrupt the modification.

When an external cause interrupts a modification, you cannot be sure how much of the operation was completed. Even in a single-row operation, you cannot know whether the data reached the disk or the indexes were properly updated.

If multirow modifications are a problem, multistatement modifications are worse. They are usually embedded in programs so you do not see the individual SQL statements being executed. For example, to enter a new order in the demonstration database, perform the following steps:

1. Insert a row in the **orders** table. (This insert generates an order number.)
2. For each item ordered, insert a row in the **items** table.

Two ways to program an order-entry application exist. One way is to make it completely interactive so that the program inserts the first row immediately and then inserts each item as the user enters data. But this approach exposes the operation to the possibility of many more unforeseen events: the customer's telephone disconnecting, the user pressing the wrong key, the user's terminal or computer losing power, and so on.

The following list describes the correct way to build an order-entry application:

- Accept all the data interactively.
- Validate the data, and expand it (look up codes in **stock** and **manufact**, for example).
- Display the information on the screen for inspection.
- Wait for the operator to make a final commitment.
- Perform the insertions quickly.

Even with these steps, an unforeseen circumstance can halt the program after it inserts the order but before it finishes inserting the items. If that happens, the database is in an unpredictable condition: its data integrity is compromised.

- [Transactions](#)
- [Transaction logging](#)
- [Specify transactions](#)

Transactions

The solution to all these potential problems is called the *transaction*. A transaction is a sequence of modifications that must be accomplished either completely or not at all. The database server guarantees that operations performed within the bounds of a transaction are either completely and perfectly committed to disk, or the database is restored to the same state as before the transaction started.

The transaction is not merely protection against unforeseen failures; it also offers a program a way to escape when the program detects a logical error.

Transaction logging

The database server can keep a record of each change that it makes to the database during a transaction. If something happens to cancel the transaction, the database server automatically uses the records to reverse the changes. Many things can make a transaction fail. For example, the program that issues the SQL statements can fail or be terminated. As soon as the database server discovers that the transaction failed, which might be only after the computer and the database server are restarted, it uses the records from the transaction to return the database to the same state as before.

The process of keeping records of transactions is called *transaction logging* or simply *logging*. The records of the transactions, called *log records*, are stored in a portion of disk space separate from the database. This space is called the *logical log* because the log records represent logical units of the transactions.

IBM® Informix® provides support to:

- Create nonlogging (raw) or logging (standard) tables in a logging database.
- Alter a table from nonlogging to logging and vice-versa using the ALTER TABLE statement.

IBM Informix supports nonlogging tables for fast loads of very large tables. It is recommended that you do not use nonlogging tables within a transaction. To avoid concurrency problems, use the ALTER TABLE statement to make the table standard (that is, logging) before you use the table in a transaction.

For more information about nonlogging tables for IBM Informix, see the *IBM Informix Administrator's Guide*. For the performance advantages of nonlogging tables, see the *IBM Informix Performance Guide*. For information about the ALTER TABLE statement, see the *IBM Informix Guide to SQL: Syntax*.

Most IBM Informix databases do not generate transaction records automatically. The DBA decides whether to make a database use transaction logging. Without transaction logging, you cannot roll back transactions.

- [Logging and cascading deletes](#)

Logging and cascading deletes

Logging must be turned on in your database for cascading deletes to work because, when you specify a cascading delete, the delete is first performed on the primary key of the parent table. If the system fails after the rows of the primary key of the parent table are performed but before the rows of the foreign key of the child table are deleted, referential integrity is violated. If logging is turned off, even temporarily, deletes do not cascade. After logging is turned back on, however, deletes can cascade again.

IBM® Informix® allows you to turn on logging with the WITH LOG clause in the CREATE DATABASE statement.

Specify transactions

You can use two methods to specify the boundaries of transactions with SQL statements. In the most common method, you specify the start of a multistatement transaction by executing the BEGIN WORK statement. In databases that are created with the MODE ANSI option, no need exists to mark the beginning of a transaction. One is always in effect; you indicate only the end of each transaction.

In both methods, to specify the end of a successful transaction, execute the COMMIT WORK statement. This statement tells the database server that you reached the end of a series of statements that must succeed together. The database server does whatever is necessary to make sure that all modifications are properly completed and committed to disk.

A program can also cancel a transaction deliberately by executing the ROLLBACK WORK statement. This statement asks the database server to cancel the current transaction and undo any changes.

An order-entry application can use a transaction in the following ways when it creates a new order:

- Accept all data interactively
- Validate and expand it
- Wait for the operator to make a final commitment
- Execute BEGIN WORK
- Insert rows in the **orders** and **items** tables, checking the error code that the database server returns
- If no errors occurred, execute COMMIT WORK; otherwise execute ROLLBACK WORK

If any external failure prevents the transaction from being completed, the partial transaction rolls back when the system restarts. In all cases, the database is in a predictable state. Either the new order is completely entered, or it is not entered at all.

Backups and logs with IBM Informix database servers

By using transactions, you can ensure that the database is always in a consistent state and that your modifications are properly recorded on disk. But the disk itself is not perfectly safe. It is vulnerable to mechanical failures and to flood, fire, and earthquake. The only safeguard is to keep multiple copies of the data. These redundant copies are called *backup copies*.

The *transaction log* (also called the *logical log*) complements the backup copy of a database. Its contents are a history of all modifications that occurred since the last time the database was backed up. If you ever need to restore the database from the backup copy, you can use the transaction log to roll the database forward to its most recent state.

The database server contains elaborate features to support backups and logging. Your database server archive and backup guide describes these features.

The database server has stringent requirements for performance and reliability (for example, it supports making backup copies while databases are in use).

The database server manages its own disk space, which is devoted to logging.

The database server performs logging concurrently for all databases using a limited set of log files. The log files can be copied to another medium (backed up) while transactions are active.

Database users never have to be concerned with these facilities because the DBA usually manages them from a central location.

IBM® Informix® supports the **onload** and **onunload** utilities. Use the **onunload** utility to make a personal backup copy of a single database or table. This program copies a table or a database to tape. Its output consists of binary images of the disk pages as they were stored in the database server. As a result, the copy can be made quickly, and the corresponding **onload** program can restore the file quickly. However, the data format is not meaningful to any other programs. For information about how to use the **onload** and **onunload** utilities, see the *IBM Informix Migration Guide*.

If your DBA uses ON-Bar to create backups and back up logical logs, you might also be able to create your own backup copies using ON-Bar. For more information, see your *IBM Informix Backup and Restore Guide*.

Concurrency and locks

If your database is contained in a single-user workstation, without a network connecting it to other computers, concurrency is unimportant. In all other cases, you must allow for the possibility that, while your program is modifying data, another program is also reading or modifying the same data. *Concurrency* involves two or more independent uses of the same data at the same time.

A high level of concurrency is crucial to good performance in a multiuser database system. Unless controls exist on the use of data, however, concurrency can lead to a variety of negative effects. Programs could read obsolete data; modifications could be lost even though it seems they were entered successfully.

To prevent errors of this kind, the database server imposes a system of *locks*. A lock is a claim, or reservation, that a program can place on a piece of data. The database server guarantees that, as long as the data is locked, no other program can modify it. When another program requests the data, the database server

either makes the program wait or turns it back with an error.

To control the effect that locks have on your data access, use a combination of SQL statements: SET LOCK MODE and either SET ISOLATION or SET TRANSACTION. You can understand the details of these statements after reading a discussion on the use of *cursors* from within programs. Cursors are covered in [SQL programming](#), and [Modify data through SQL programs](#). For more information about locking and concurrency, see [Programming for a multiuser environment](#).

IBM Informix data replication

Data replication, in the broadest sense of the term, means that database objects have more than one representation at more than one distinct site. For example, one way to replicate data, so that reports can be run against the data without disturbing client applications that are using the original database, is to copy the database to a database server on a different computer.

The following list describes the advantages of data replication:

- Clients who access replicated data locally, as opposed to remote data that is not replicated, experience improved performance because they do not have to use network services.
- Clients at all sites experience improved availability with replicated data, because if local replicated data is unavailable, a copy of the data is still available, albeit remotely.

These advantages do not come without a cost. Data replication obviously requires more storage for replicated data than for unreplicated data, and updating replicated data can take more processing time than updating a single object.

Data replication can actually be implemented in the logic of client applications, by explicitly specifying where data should be found or updated. However, this method of achieving data replication is costly, error-prone, and difficult to maintain. Instead, the concept of data replication is often coupled with *replication transparency*. Replication transparency is functionality built into a database server (instead of client applications) to handle the details of locating and maintaining data replicas automatically.

Within the broad framework of data replication, a database server implements nearly transparent data replication of entire database servers. All the data that one database server manages is replicated and dynamically updated on another database server, usually at a remote site. Data replication of the IBM® Informix® database server is sometimes called *hot-site backup*, because it provides a means of maintaining a backup copy of the entire database server that can be used quickly in the event of a catastrophic failure.

Because the database server provides replication transparency, you generally do not need to be concerned with or aware of data replication; the DBA takes care of it. However, if your organization decides to use data replication, you should be aware that special connectivity considerations exist for client applications in a data replication environment. These considerations are described in the *IBM Informix Administrator's Guide*.

The IBM Informix Enterprise Replication feature provides a different method of data replication. For information on this feature, see the .

Summary

Database access is regulated by the privileges that the database owner grants to you. The privileges that let you query data are often granted automatically, but the ability to modify data is regulated by specific Insert, Delete, and Update privileges that are granted on a table-by-table basis.

If data integrity constraints are imposed on the database, your ability to modify data is restricted by those constraints. Your database- and table-level privileges and any data constraints control how and when you can modify data. In addition, the object modes and violation detection features of the database affect how you can modify data and help to preserve the integrity of your data.

You can delete one or more rows from a table with the DELETE statement. Its WHERE clause selects the rows; use a SELECT statement with the same clause to preview the deletes.

The TRUNCATE statement deletes all the rows of a table.

Rows are added to a table with the INSERT statement. You can insert a single row that contains specified column values, or you can insert a block of rows that a SELECT statement generates.

Use the UPDATE statement to modify the contents of existing rows. You specify the new contents with expressions that can include subqueries, so that you can use data that is based on other tables or the updated table itself. The statement has two forms. In the first form, you specify new values column by column. In the second form, a SELECT statement or a record variable generates a set of new values.

Use the REFERENCES clause of the CREATE TABLE and ALTER TABLE statements to create relationships between tables. The ON DELETE CASCADE option of the REFERENCES clause allows you to delete rows from parent and associated child tables with one DELETE statement.

Use transactions to prevent unforeseen interruptions in a modification from leaving the database in an indeterminate state. When modifications are performed within a transaction, they are rolled back after an error occurs. The transaction log also extends the periodically made backup copy of the database. If the database must be restored, it can be brought back to its most recent state.

Data replication, which is transparent to users, offers another type of protection from catastrophic failures.

Access and modify data in an external database

This section summarizes accessing tables and routines that are not in the current database.

- [Access other database servers](#)

- [Restrictions for remote database access](#)

Access other database servers

You can access any table or routine in an *external* database by qualifying the name of the database object (table, view, synonym, or routine).

When the external database is on the same database server as the current database, you must qualify the object name with the database name and a colon. For example, to refer to a table in a database other than the local database, the following SELECT statement accesses information from an external database:

```
SELECT name, number FROM salesdb:contacts
```

In this example, the query returns data from the table, **contacts**, that is in the database, **salesdb**.

A *remote* database server is any database server that is not the current database server. When the external database is on a remote database server, you must qualify the name of the database object with the database server name and the database name, as the following example illustrates:

```
SELECT name, number FROM salesdb@distantserver:contacts
```

In this example, the query returns data from the table, **contacts**, that is in the database, **salesdb** on the remote database server, **distantserver**.

For the syntax and rules on how to specify database object names in an external database, see the *IBM® Informix® Guide to SQL: Syntax*.

- [Access ANSI databases](#)
- [Create joins between external database servers](#)
- [Access external routines](#)

Access ANSI databases

In ANSI databases, the owner of the object is part of the object name: **ownername.objectname**. When both the current and external databases are ANSI databases, unless you are the owner of the object, you must include the owner name. The following SELECT statement shows a fully-qualified table name:

```
SELECT name, number FROM salesdb@aserver:ownername.contacts
```

Tip: You can always over-qualify an object name. That is, you can specify the full object name, database@servername:ownername.objectname, even in situations that do not require the full object name.

For more information about ANSI-compliant databases, refer to the *IBM® Informix® Database Design and Implementation Guide*.

Create joins between external database servers

You can use the same notation in a join. When you specify the database name explicitly, the long table names can become cumbersome unless you use aliases to shorten them, as the following example shows:

```
SELECT O.order_num, C.fname, C.lname
FROM masterdb@central:customer C, sales@boston:orders O
WHERE C.customer_num = O.Customer_num
```

Access external routines

To refer to a routine on a database server other than the current database server, qualify the routine name with the database server name and database name (and the owner name if the remote database is ANSI compliant), as the following SELECT statement illustrates:

```
SELECT name, salesdb@boston:how_long()
FROM salesdb@boston:contacts
```

Restrictions for remote database access

This section summarizes the restrictions for remote database access.

- [SQL statements that access more than one database](#)
Only the data manipulation language (DML) statements of SQL, and a subset of the data definition language (DDL) statements of SQL can reference database objects outside the local database from which the statement is issued, or in databases of server instances that are not the local IBM® Informix® server instance.
- [Access external database objects](#)

SQL statements that access more than one database

Only the data manipulation language (DML) statements of SQL, and a subset of the data definition language (DDL) statements of SQL can reference database objects outside the local database from which the statement is issued, or in databases of server instances that are not the local IBM® Informix® server instance.

You can run the following SQL statements across databases and across database server instances:

- CREATE DATABASE
- CREATE SYNONYM
- CREATE VIEW
- DATABASE
- DELETE
- DROP DATABASE
- EXECUTE FUNCTION
- EXECUTE PROCEDURE
- INFO
- INSERT
- LOAD
- LOCK TABLE
- MERGE
- SELECT
- UNLOAD
- UNLOCK TABLE
- UPDATE

Restriction:

To run each of these SQL statements successfully across databases or across database servers, the local database and the external databases must all have the same logging mode. For example, if the local database from which you issue a distributed query was created as MODE ANSI, any other database that the query accesses cannot be unlogged, and cannot use explicit transactions.

Return data types in cross-database operations

Distributed operations that use SQL statements or UDRs to access other databases of the local IBM Informix database server instance can return values of these data types:

- Any built-in atomic data type that is not opaque
- The built-in opaque types BLOB, BOOLEAN, BSON, CLOB, JSON, and LVARCHAR
- DISTINCT types based on a non-opaque built-in atomic type, or on a built-in opaque type listed above
- User-defined data types (UDTs) that can be cast to built-in types.

The DISTINCT or UDT values above must all be explicitly cast to built-in data types, and all the DISTINCT types, UDTs, and casts must be defined identically in each of the participating databases.

These data types can be returned by SPL, C, and Java-language UDRs as parameters or as return values, if the UDRs are defined in all of the participating databases. The DISTINCT data types must have exactly the same data type hierarchy defined in all databases that participate in the distributed query.

A cross-database distributed query or other cross-database DML operation that accesses another database of the local Informix database server will fail with an error if it references a table, view, or synonym that includes a column of any of the following data types:

- IMPEXP
- IMPEXPBIN
- LOLIST
- SENDRECV
- DISTINCT of any of the built-in opaque data types in this list
- Complex types, including COLLECTION, LIST, MULTISSET, or SET, and named or unnamed ROW types.

This restriction against cross-database distributed operations that access tables with these built-in opaque or complex data types also applies to operations that access databases of two or more database server instances, which the next section describes.

Return data types in cross-server operations

A distributed query (or any other distributed DML operation or function call) across databases of two or more instances cannot return complex or large-object data types, nor most UDTs or opaque data types. Cross-server distributed queries, DML operations, and function calls can return only the following data types:

- Any non-opaque built-in data type
- BOOLEAN
- BSON
- JSON
- LVARCHAR
- DISTINCT of non-opaque built-in types
- DISTINCT of BOOLEAN or LVARCHAR
- DISTINCT of BSON or JSON
- DISTINCT of any of the DISTINCT types in this list.

The same cross-database DDL requirements, that all UDRs, casts, and DISTINCT data types have identical definitions in every participating database, also apply to distributed SQL operations across the databases of two or more database-server instances.

A cross-server DML operation that accesses a database of another Informix instance will fail with an error. however, if it references a table object that includes a column of any of the following data types:

- BLOB
- BYTE

- CLIENTBINVAL
- CLOB
- IFX_LO_SPEC
- IFX_LO_STAT
- IMPEXP
- IMPEXPBIN
- INDEXKEYARRAY
- LOLIST
- POINTER
- RTNPARAMTYPES
- SELFUNCARGS
- SENDRECV
- STAT
- TEXT
- XID
- User-defined OPAQUE type
- Complex types, including COLLECTION, LIST, MULTISSET, or SET, and named or unnamed ROW types.
- DISTINCT of any of the opaque or complex data types in this list.

Access external database objects

To access external database objects:

- You must hold appropriate access permissions on these objects.
- Both databases must be set to the same locale.

Important: Distributed transactions cannot access objects in a database of another Informix® server instance unless both server instances support either a TCP/IP or an IPCSTR connection, as defined in their DBSERVERNAME or DBSERVERALIASES configuration parameters and in the sqlhosts information. This connection-type requirement applies to any communication between Informix database server instances, even if both database servers reside on the same computer.

SQL programming

The previous examples treat SQL as if it were an interactive computer language; that is, as if you could type a SELECT statement directly into the database server and see rows of data rolling back to you.

Of course, that is not the case. Many layers of software stand between you and the database server. The database server retains data in a binary form that must be formatted before it can be displayed. It does not return a mass of data at once; it returns one row at a time, as a program requests it.

You can access information in your database through interactive access with DB-Access, through application programs written with an SQL API such as Informix® ESQL/C, or through an application language such as SPL.

Almost any program can contain SQL statements, execute them, and retrieve data from a database server. This chapter explains how these activities are performed and indicates how you can write programs that perform them.

This chapter introduces concepts that are common to SQL programming in any language. Before you can write a successful program in a particular programming language, you must first become fluent in that language. Then, because the details of the process are different in every language, you must become familiar with the publication for the SQL API specific to that language.

- [SQL in programs](#)
- [Call the database server](#)
- [Retrieve single rows](#)
- [Retrieve multiple rows](#)
- [Dynamic SQL](#)
- [Embed data-definition statements](#)
- [Grant and revoke privileges in applications](#)
- [Summary](#)

SQL in programs

You can write a program in any of several languages and mix SQL statements among the other statements of the program, just as if they were ordinary statements of that programming language. These SQL statements are embedded in the program, and the program contains *embedded SQL*, which is often abbreviated as ESQL.

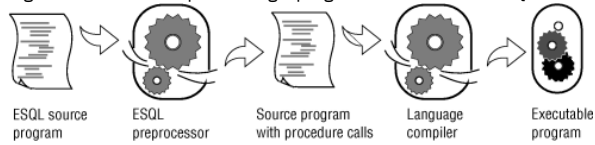
- [SQL in SQL APIs](#)
- [SQL in application languages](#)
- [Static embedding](#)
- [Dynamic statements](#)
- [Program variables and host variables](#)

SQL in SQL APIs

ESQL products are SQL APIs (application programming interfaces). IBM® produces an SQL API for the C programming language.

The following figure shows how an SQL API product works. You write a source program in which you treat SQL statements as executable code. Your source program is processed by an embedded SQL *preprocessor*, a program that locates the embedded SQL statements and converts them into a series of procedure calls and special data structures.

Figure 1. Overview of processing a program with embedded SQL statements



The converted source program then passes through the programming language compiler. The compiler output becomes an executable program after it is linked with a static or *dynamic* library of SQL API procedures. When the program runs, the SQL API library procedures are called; they set up communication with the database server to carry out the SQL operations.

If you link your executable program to a threading library package, you can develop Informix® ESQL/C *multithreaded applications*. A multithreaded application can have many threads of control. It separates a process into multiple execution threads, each of which runs independently. The major advantage of a multithreaded Informix ESQL/C application is that each thread can have many active connections to a database server simultaneously. While a nonthreaded Informix ESQL/C application can establish many connections to one or more databases, it can have only one connection active at a time. A multithreaded Informix ESQL/C application can have one active connection per thread and many threads per application.

For more information on multithreaded applications, see the *IBM Informix ESQL/C Programmer's Manual*.

SQL in application languages

Whereas SQL API products allow you to embed SQL in the host language, some languages include SQL as a natural part of their statement set. Stored Procedure Language (SPL) uses SQL as a natural part of its statement set. You use an SQL API product to write application programs. You use SPL to write routines that are stored with a database and called from an application program.

Static embedding

You can introduce SQL statements into a program through *static embedding* or *dynamic statements*. The simpler and more common way is by static embedding, which means that the SQL statements are written as part of the code. The statements are *static* because they are a fixed part of the source text. For more information on static embedding, see [Retrieve single rows](#) and [Retrieve multiple rows](#).

Dynamic statements

Some applications require the ability to compose SQL statements *dynamically*, in response to user input. For example, a program might have to select different columns or apply different criteria to rows, depending on what the user wants.

With dynamic SQL, the program composes an SQL statement as a string of characters in memory and passes it to the database server to be executed. Dynamic statements are not part of the code; they are constructed in memory during execution. For more information, see [Dynamic SQL](#).

Program variables and host variables

Application programs can use program variables within SQL statements. In SPL, you put the program variable in the SQL statement as syntax allows. For example, a DELETE statement can use a program variable in its WHERE clause.

The following code example shows a program variable in SPL.

```
CREATE PROCEDURE delete_item (drop_number INT)
:
DELETE FROM items WHERE order_num = drop_number
:
```

In applications that use embedded SQL statements, the SQL statements can refer to the contents of program variables. A program variable that is named in an embedded SQL statement is called a *host variable* because the SQL statement is thought of as a guest in the program.

The following example shows a DELETE statement as it might appear when it is embedded in the IBM® Informix® ESQL/C source program:

```
EXEC SQL delete FROM items
WHERE order_num = :onum;
```

In this program, you see an ordinary DELETE statement, as [Modify data](#) describes. When the Informix ESQL/C program is executed, a row of the **items** table is deleted; multiple rows can also be deleted.

The statement contains one new feature. It compares the **order_num** column to an item written as **:onum**, which is the name of a host variable.

An SQL API product provides a way to delimit the names of host variables when they appear in the context of an SQL statement. In Informix ESQL/C, a host variable can be introduced with either a dollar sign (\$) or a colon (:). The colon is the ANSI-compatible format. The example statement asks the database server to delete rows in which the order number equals the current contents of the host variable named **:onum**. This numeric variable was declared and assigned a value earlier in the program.

In IBM Informix ESQL/C, an SQL statement can be introduced with either a leading dollar sign (\$) or the words EXEC SQL.

The differences of syntax as illustrated in the preceding examples are trivial; the essential point is that the SQL API and SPL languages let you perform the following tasks:

- Embed SQL statements in a source program as if they were executable statements of the host language.
- Use program variables in SQL expressions the way literal values are used.

If you have programming experience, you can immediately see the possibilities. In the example, the order number to be deleted is passed in the variable **onum**. That value comes from any source that a program can use. It can be read from a file, the program can prompt a user to enter it, or it can be read from the database. The DELETE statement itself can be part of a subroutine (in which case **onum** can be a parameter of the subroutine); the subroutine can be called once or repetitively.

In short, when you embed SQL statements in a program, you can apply to them all the power of the host language. You can hide the SQL statements under many interfaces, and you can embellish the SQL functions in many ways.

Call the database server

Executing an SQL statement is essentially calling the database server as a subroutine. Information must pass from the program to the database server, and information must be returned from the database server to the program.

Some of this communication is done through host variables. You can think of the host variables named in an SQL statement as the parameters of the procedure call to the database server. In the preceding example, a host variable acts as a parameter of the WHERE clause. Host variables receive data that the database server returns, as [Retrieve multiple rows](#) describes.

- [SQL Communications Area](#)
- [SQLCODE field](#)
- [SQLERRD array](#)
- [SQLWARN array](#)
- [SQLERRM character string](#)
- [SQLSTATE value](#)

SQL Communications Area

The database server always returns a result code, and possibly other information about the effect of an operation, in a data structure known as the SQL Communications Area (SQLCA). If the database server executes an SQL statement in a user-defined routine, the SQLCA of the calling application contains the values that the SQL statement triggers in the routine.

The principal fields of the SQLCA are listed in [Table 1](#) through [Table 1](#). The syntax that you use to describe a data structure such as the SQLCA, as well as the syntax that you use to refer to a field in it, differs among programming languages. For details, see your SQL API publication.

In particular, the subscript by which you name one element of the SQLERRD and SQLWARN arrays differs. Array elements are numbered starting with zero in IBM® Informix® ESQL/C, but starting with one in other languages. In this discussion, the fields are named with specific words such as *third*, and you must translate these words into the syntax of your programming language.

You can also use the SQLSTATE variable of the GET DIAGNOSTICS statement to detect, handle, and diagnose errors. See [SQLSTATE value](#).

SQLCODE field

The SQLCODE field is the primary return code of the database server. After every SQL statement, SQLCODE is set to an integer value as the following table shows. When that value is zero, the statement is performed without error. In particular, when a statement is supposed to return data into a host variable, a code of zero means that the data has been returned and can be used. Any nonzero code means the opposite. No useful data was returned to host variables.

Table 1. Values of SQLCODE

Return value	Interpretation
<i>value</i> < 0	Specifies an error code.
<i>value</i> = 0	Indicates success.
0 < <i>value</i> < 100	After a DESCRIBE statement, an integer value that represents the type of SQL statement that is described.
100	After a successful query that returns no rows, indicates the NOT FOUND condition. NOT FOUND can also occur in an ANSI-compliant database after an INSERT INTO/SELECT, UPDATE, DELETE, or SELECT... INTO TEMP statement fails to access any rows.

- [End of data](#)
- [Negative Codes](#)

End of data

The database server sets SQLCODE to 100 when the statement is performed correctly but no rows are found. This condition can occur in two situations.

The first situation involves a query that uses a cursor. ([Retrieve multiple rows](#) describes queries that use cursors.) In these queries, the FETCH statement retrieves each value from the active set into memory. After the last row is retrieved, a subsequent FETCH statement cannot return any data. When this condition occurs, the database server sets SQLCODE to 100, which indicates `end of data, no rows found`.

The second situation involves a query that does not use a cursor. In this case, the database server sets SQLCODE to 100 when no rows satisfy the query condition. In databases that are not ANSI compliant, only a SELECT statement that returns no rows causes SQLCODE to be set to 100.

In ANSI-compliant databases, SELECT, DELETE, UPDATE, and INSERT statements all set SQLCODE to 100 if no rows are returned.

Negative Codes

When something unexpected goes wrong during a statement, the database server returns a negative number in SQLCODE to explain the problem. The meanings of these codes are documented in the online error message file.

SQLERRD array

Some error codes that can be reported in SQLCODE reflect general problems. The database server can set a more detailed code in the second field of SQLERRD that reveals the error that the database server I/O routines or the operating system encountered.

The integers in the SQLERRD array are set to different values following different statements. The first and fourth elements of the array are used only in IBM® Informix® ESQL/C. The following table shows how the fields are used.

Table 1. Fields of SQLERRD

Field	Interpretation
First	After a successful PREPARE statement for a SELECT, UPDATE, INSERT, or DELETE statement, or after a Select cursor is opened, this field contains the estimated number of rows affected.
Second	When SQLCODE contains an error code, this field contains either zero or an additional error code, called the ISAM error code, that explains the cause of the main error. After a successful insert operation of a single row, this field contains the value of any SERIAL, BIGSERIAL, or SERIAL8 value generated for that row. (This field is not updated, however, when a serial column is directly inserted as a triggered action by a trigger on a table, or by an INSTEAD OF trigger on a view.)
Third	After a successful multirow insert, update, or delete operation, this field contains the number of rows that were processed. After a multirow insert, update, or delete operation that ends with an error, this field contains the number of rows that were successfully processed before the error was detected.
Fourth	After a successful PREPARE statement for a SELECT, UPDATE, INSERT, or DELETE statement, or after a select cursor has been opened, this field contains the estimated weighted sum of disk accesses and total rows processed.
Fifth	After a syntax error in a PREPARE, EXECUTE IMMEDIATE, DECLARE, or static SQL statement, this field contains the offset in the statement text where the error was detected.
Sixth	After a successful fetch of a selected row, or a successful insert, update, or delete operation, this field contains the rowid (physical address) of the last row that was processed. Whether this rowid value corresponds to a row that the database server returns to the user depends on how the database server processes a query, particularly for SELECT statements.
Seventh	Reserved.

These additional details can be useful. For example, you can use the value in the third field to report how many rows were deleted or updated. When your program prepares an SQL statement that the user enters and an error is found, the value in the fifth field enables you to display the exact point of error to the user. (DB-Access uses this feature to position the cursor when you ask to modify a statement after an error.)

SQLWARN array

The eight character fields in the SQLWARN array are set to either a blank or to W to indicate a variety of special conditions. Their meanings depend on the statement just executed.

A set of warning flags appears when a database opens, that is, following a CONNECT, DATABASE, or CREATE DATABASE statement. These flags tell you some characteristics of the database as a whole.

A second set of flags appears following any other statement. These flags reflect unusual events that occur during the statement, which are usually not serious enough to be reflected by SQLCODE.

Both sets of SQLWARN values are summarized in the following table.

Table 1. Fields of SQLWARN

Field	When opening or connecting to a database	All other SQL operations
-------	--	--------------------------

Field	When opening or connecting to a database	All other SQL operations
First	Set to W when any other warning field is set to W. If blank, others need not be checked.	Set to W when any other warning field is set to W.
Second	Set to W when the database now open uses a transaction log.	Set to W if a column value is truncated when it is fetched into a host variable using a FETCH or a SELECT...INTO statement. On a REVOKE ALL statement, set to W when not all seven table-level privileges are revoked.
Third	Set to W when the database now open is ANSI compliant.	Set to W when a FETCH or SELECT statement returns an aggregate function (SUM, AVG, MIN, MAX) value that is NULL.
Fourth	Set to W when the database server is IBM® Informix®.	On a SELECT ... INTO, FETCH ... INTO, or EXECUTE ... INTO statement, set to W when the number of projection list items is not the same as the number of host variables given in the INTO clause to receive them. On a GRANT ALL statement, set to W when not all seven table-level access privileges are granted.
Fifth	Set to W when the database server stores the FLOAT data type in DECIMAL form (done when the host system lacks support for FLOAT types).	Set to W after a DESCRIBE statement if the prepared object contains a DELETE statement or an UPDATE statement without a WHERE clause.
Sixth	Reserved.	Set to W following execution of a statement that does not use ANSI-standard SQL syntax (provided the DBANSIWARN environment variable is set).
Seventh	Set to W when the application is connected to a database server that is the secondary server in a data-replication pair. That is, the server is available only for read operations.	Set to W when a data fragment (a dbspace) has been skipped during query processing (when the DATASKIP feature is on).
Eighth	Set to W when client DB_LOCALE does not match the database locale. For more information, see the <i>IBM Informix GLS User's Guide</i> .	Set to W when SET EXPLAIN ON AVOID_EXECUTE statement prevents query execution.

SQLERRM character string

SQLERRM can store a character string of up to 72 bytes. The SQLERRM character string contains identifiers, such as a table names, that are placed in the error message. For some networked applications, it contains an error message that the networking software generates.

If an INSERT operation fails because a constraint is violated, the name of the constraint that failed is written to SQLERRM.

Tip: If an error string is longer than 72 bytes, the overflow is silently discarded. In some contexts, this can result in the loss of information about runtime errors.

SQLSTATE value

Certain IBM® Informix® products, such as IBM Informix ESQL/C, support the SQLSTATE value in compliance with X/Open and ANSI SQL standards. The GET DIAGNOSTICS statement reads the SQLSTATE value to diagnose errors after you run an SQL statement. The database server returns a result code in a five-character string that is stored in a variable called SQLSTATE. The SQLSTATE error code, or value, tells you the following information about the most recently executed SQL statement:

- If the statement was successful
- If the statement was successful but generated warnings
- If the statement was successful but generated no data
- If the statement failed

For more information on the GET DIAGNOSTICS statement, the SQLSTATE variable, and the meaning of the SQLSTATE return codes, see the GET DIAGNOSTICS statement in the *IBM Informix Guide to SQL: Syntax*.

Tip: If your IBM Informix product supports GET DIAGNOSTICS and SQLSTATE, it is recommended that you use them as the primary structure to detect, handle, and diagnose errors. Using SQLSTATE allows you to detect multiple errors, and it is ANSI compliant.

Retrieve single rows

The set of rows that a SELECT statement returns is its *active set*. A *singleton* SELECT statement returns a single row. You can use embedded SELECT statements to retrieve single rows from the database into host variables. When a SELECT statement returns more than one row of data, however, a program must use a *cursor* to retrieve rows one at a time. Multiple-row select operations are discussed in [Retrieve multiple rows](#).

To retrieve a single row of data, simply embed a SELECT statement in your program. The following example shows how you can write the embedded SELECT statement using IBM® Informix® ESQL/C:

```
EXEC SQL SELECT avg (total_price)
  INTO :avg_price
  FROM items
  WHERE order_num in
    (SELECT order_num from orders
     WHERE order_date < date('6/1/98') );
```

The INTO clause is the only detail that distinguishes this statement from any example in [Compose SELECT statements](#) or [Compose advanced SELECT statements](#). This clause specifies the host variables that are to receive the data that is produced.

When the program executes an embedded SELECT statement, the database server performs the query. The example statement selects an aggregate value so that it produces exactly one row of data. The row has only a single column, and its value is deposited in the host variable named **avg_price**. Subsequent lines of the program can use that variable.

You can use statements of this kind to retrieve single rows of data into host variables. The single row can have as many columns as desired. If a query produces more than one row of data, the database server cannot return any data. It returns an error code instead.

You should list as many host variables in the INTO clause as there are items in the select list. If, by accident, these lists are of different lengths, the database server returns as many values as it can and sets the warning flag in the fourth field of SQLWARN.

- [Data type conversion](#)
- [What if the program retrieves a NULL value?](#)
- [Dealing with errors](#)

Data type conversion

The following Informix® ESQL/C example retrieves the average of a DECIMAL column, which is itself a DECIMAL value. However, the host variable into which the average of the DECIMAL column is placed is not required to have that data type.

```
EXEC SQL SELECT avg (total_price) into :avg_price
FROM items;
```

The declaration of the receiving variable **avg_price** in the previous example of Informix ESQL/C code is not shown. The declaration could be any one of the following definitions:

```
int avg_price;
double avg_price;
char avg_price[16];
dec_t avg_price; /* typedef of decimal number structure */
```

The data type of each host variable that is used in a statement is noted and passed to the database server with the statement. The database server does its best to convert column data into the form that the receiving variables use. Almost any conversion is allowed, although some conversions cause a precision loss. The results of the preceding example differ, depending on the data type of the receiving host variable, as the following table shows.

Data type	Result
FLOAT	The database server converts the decimal result to FLOAT, possibly truncating some fractional digits. If the magnitude of a decimal exceeds the maximum magnitude of the FLOAT format, an error is returned.
INTEGER	The database server converts the result to INTEGER, truncating fractional digits if necessary. If the integer part of the converted number does not fit the receiving variable, an error occurs.
CHARACTER	The database server converts the decimal value to a CHARACTER string. If the string is too long for the receiving variable, it is truncated. The second field of SQLWARN is set to W and the value in the SQLSTATE variable is 01004.

What if the program retrieves a NULL value?

NULL values can be stored in the database, but the data types that programming languages support do not recognize a NULL state. A program must have some way to recognize a NULL item to avoid processing it as data.

Indicator variables meet this need in SQL APIs. An indicator variable is an additional variable that is associated with a host variable that might receive a NULL item. When the database server puts data in the main variable, it also puts a special value in the indicator variable to show whether the data is NULL. In the following IBM® Informix® ESQL/C example, a single row is selected, and a single value is retrieved into the host variable **op_date**:

```
EXEC SQL SELECT paid_date
      INTO :op_date:op_d_ind
      FROM orders
      WHERE order_num = $the_order;
if (op_d_ind < 0) /* data was null */
    rstrdate ('01/01/1900', :op_date);
```

Because the value might be NULL, an indicator variable named **op_d_ind** is associated with the host variable. (It must be declared as a short integer elsewhere in the program.)

Following execution of the SELECT statement, the program tests the indicator variable for a negative value. A negative number (usually -1) means that the value retrieved into the main variable is NULL. If the variable is NULL, this program uses the Informix ESQL/C library function to assign a default value to the host variable. (The function **rstrdate** is part of the IBM Informix ESQL/C product.)

The syntax that you use to associate an indicator variable with a host variable differs with the language you are using, but the principle is the same in all languages.

Dealing with errors

Although the database server automatically handles conversion between data types, several things still can go wrong with a SELECT statement. In SQL programming, as in any kind of programming, you must anticipate errors and provide for them at every point.

- [End of data](#)
- [End of data with databases that are not ANSI compliant](#)
- [Serious errors](#)
- [Interpret end of data with aggregate functions](#)
- [Default values](#)

End of data

One common event is that no rows satisfy a query. This event is signalled by an SQLSTATE code of 02000 and by a code of 100 in SQLCODE after a SELECT statement. This code indicates an error or a normal event, depending entirely on your application. If you are sure a row or rows should satisfy the query (for example, if you are reading a row using a key value that you just read from a row of another table), then the end-of-data code represents a serious failure in the logic of the program. On the other hand, if you select a row based on a key that a user supplies or some other source supplies that is less reliable than a program, a lack of data can be a normal event.

End of data with databases that are not ANSI compliant

If your database is not ANSI compliant, the end-of-data return code, 100, is set in SQLCODE following SELECT statements only. In addition, the SQLSTATE value is set to 02000. (Other statements, such as INSERT, UPDATE, and DELETE, set the third element of SQLERRD to show how many rows they affected; [Modify data through SQL programs](#) covers this topic.)

Serious errors

Errors that set SQLCODE to a negative value or SQLSTATE to a value that begins with anything other than 00, 01, or 02 are usually serious. Programs that you have developed and that are in production should rarely report these errors. Nevertheless, it is difficult to anticipate every problematic situation, so your program must be able to deal with these errors.

For example, a query can return error -206, which means that a table specified in the query is not in the database. This condition occurs if someone dropped the table after the program was written, or if the program opened the wrong database through some error of logic or mistake in input.

Interpret end of data with aggregate functions

A SELECT statement that uses an aggregate function such as **SUM**, **MIN**, or **AVG** always succeeds in returning at least one row of data, even when no rows satisfy the WHERE clause. An aggregate value based on an empty set of rows is null, but it exists nonetheless.

However, an aggregate value is also null if it is based on one or more rows that all contain null values. If you must be able to detect the difference between an aggregate value that is based on no rows and one that is based on some rows that are all null, you must include a COUNT function in the statement and an indicator variable on the aggregate value. You can then work out the following cases.

Count Value	Indicator	Case
0	-1	Zero rows selected
>0	-1	Some rows selected; all were null
>0	0	Some non-null rows selected

Default values

You can handle these inevitable errors in many ways. In some applications, more lines of code are used to handle errors than to execute functionality. In the examples in this section, however, one of the simplest solutions, the default value, should work, as the following example shows:

```
avg_price = 0; /* set default for errors */
EXEC SQL SELECT avg (total_price)
      INTO :avg_price:null_flag
      FROM items;
if (null_flag < 0) /* probably no rows */
  avg_price = 0; /* set default for 0 rows */
```

The previous example deals with the following considerations:

- If the query selects some non-null rows, the correct value is returned and used. This result is the expected and most frequent one.
- If the query selects no rows, or in the much less likely event, selects only rows that have null values in the **total_price** column (a column that should never be null), the indicator variable is set, and the default value is assigned.

- If any serious error occurs, the host variable is left unchanged; it contains the default value initially set. At this point in the program, the programmer sees no need to trap such errors and report them.

Retrieve multiple rows

When any chance exists that a query could return more than one row, the program must execute the query differently. Multirow queries are handled in two stages. First, the program starts the query. (No data is returned immediately.) Then the program requests the rows of data one at a time.

These operations are performed using a special data object called a *cursor*. A cursor is a data structure that represents the current state of a query. The following list shows the general sequence of program operations:

1. The program *declares* the cursor and its associated SELECT statement, which merely allocates storage to hold the cursor.
2. The program *opens* the cursor, which starts the execution of the associated SELECT statement and detects any errors in it.
3. The program *fetches* a row of data into host variables and processes it.
4. The program *closes* the cursor after the last row is fetched.
5. When the cursor is no longer needed, the program *frees* the cursor to deallocate the resources it uses.

These operations are performed with SQL statements named DECLARE, OPEN, FETCH, CLOSE, and FREE.

- [Declare a cursor](#)
- [Open a cursor](#)
- [Fetch rows](#)
- [Cursor input modes](#)
- [Active set of a cursor](#)
- [Parts-explosion problem](#)

Declare a cursor

You use the DECLARE statement to declare a cursor. This statement gives the cursor a name, specifies its use, and associates it with a statement. The following example is written in IBM® Informix® ESQL/C:

```
EXEC SQL DECLARE the_item CURSOR FOR
SELECT order_num, item_num, stock_num
  INTO :o_num, :i_num, :s_num
  FROM items
  FOR READ ONLY;
```

The declaration gives the cursor a name (**the_item** in this case) and associates it with a SELECT statement. ([Modify data through SQL programs](#) discusses how a cursor can also be associated with an INSERT statement.)

The SELECT statement in this example contains an INTO clause. The INTO clause specifies which variables receive data. You can also use the FETCH statement to specify which variables receive data, as [Locate the INTO clause](#) discusses.

The DECLARE statement is not an active statement; it merely establishes the features of the cursor and allocates storage for it. You can use the cursor declared in the preceding example to read through the **items** table once. Cursors can be declared to read backward and forward (see [Cursor input modes](#)). This cursor, because it lacks a FOR UPDATE clause and because it is designated FOR READ ONLY, is used only to read data, not to modify it. [Modify data through SQL programs](#) covers the use of cursors to modify data.

Open a cursor

The program opens the cursor when it is ready to use it. The OPEN statement activates the cursor. It passes the associated SELECT statement to the database server, which begins the search for matching rows. The database server processes the query to the point of locating or constructing the first row of output. It does not actually return that row of data, but it does set a return code in SQLSTATE and in SQLCODE for SQL APIs. The following example shows the OPEN statement in Informix® ESQL/C:

```
EXEC SQL OPEN the_item;
```

Because the database server is seeing the query for the first time, it might detect a number of errors. After the program opens the cursor, it should test SQLSTATE or SQLCODE. If the SQLSTATE value is greater than 02000 or the SQLCODE contains a negative number, the cursor is not usable. An error might be present in the SELECT statement, or some other problem might prevent the database server from executing the statement.

If SQLSTATE is equal to 00000, or SQLCODE contains a zero, the SELECT statement is syntactically valid, and the cursor is ready to use. At this point, however, the program does not know if the cursor can produce any rows.

Fetch rows

The program uses the FETCH statement to retrieve each row of output. This statement names a cursor and can also name the host variables that receive the data. The following example shows the completed IBM® Informix® ESQL/C code:

```
EXEC SQL DECLARE the_item CURSOR FOR
  SELECT order_num, item_num, stock_num
  INTO :o_num, :i_num, :s_num
  FROM items;
EXEC SQL OPEN the_item;
while(SQLCODE == 0)
{
  EXEC SQL FETCH the_item;
  if(SQLCODE == 0)
    printf("%d, %d, %d", o_num, i_num, s_num);
}
```

- [Detect end of data](#)
- [Locate the INTO clause](#)

Detect end of data

In the previous example, the WHILE condition prevents execution of the loop in case the OPEN statement returns an error. The same condition terminates the loop when SQLCODE is set to 100 to signal the end of data. However, the loop contains a test of SQLCODE. This test is necessary because, if the SELECT statement is valid yet finds no matching rows, the OPEN statement returns a zero, but the first fetch returns 100 (end of data) and no data. The following example shows another way to write the same loop:

```
EXEC SQL DECLARE the_item CURSOR FOR
  SELECT order_num, item_num, stock_num
  INTO :o_num, :i_num, :s_num
  FROM items;
EXEC SQL OPEN the_item;
if(SQLCODE == 0)
  EXEC SQL FETCH the_item; /* fetch 1st row*/
while(SQLCODE == 0)
{
  printf("%d, %d, %d", o_num, i_num, s_num);
  EXEC SQL FETCH the_item;
}
```

In this version, the case of no returned rows is handled early, so no second test of SQLCODE exists within the loop. These versions have no measurable difference in performance because the time cost of a test of SQLCODE is a tiny fraction of the cost of a fetch.

Locate the INTO clause

The INTO clause names the host variables that are to receive the data that the database server returns. The INTO clause must appear in either the SELECT or the FETCH statement. However it cannot appear in both statements. The following example specifies host variables in the FETCH statement:

```
EXEC SQL DECLARE the_item CURSOR FOR
  SELECT order_num, item_num, stock_num
  FROM items;
EXEC SQL OPEN the_item;
while(SQLCODE == 0)
{
  EXEC SQL FETCH the_item INTO :o_num, :i_num, :s_num;
  if(SQLCODE == 0)
    printf("%d, %d, %d", o_num, i_num, s_num);
}
```

This form lets you fetch different rows into different locations. For example, you could use this form to fetch successive rows into successive elements of an array.

Cursor input modes

For purposes of input, a cursor operates in one of two modes, *sequential* or *scrolling*. A sequential cursor can fetch only the next row in sequence, so a sequential cursor can read through a table only once each time the cursor is opened. A scroll cursor can fetch the next row or any of the output rows, so a scroll cursor can read the same rows multiple times. The following example shows a sequential cursor declared in IBM® Informix® ESQL/C.

```
EXEC SQL DECLARE pcurs cursor for
  SELECT customer_num, lname, city
  FROM customer;
```

After the cursor is opened, it can be used only with a sequential fetch that retrieves the next row of data, as the following example shows:

```
EXEC SQL FETCH p_curs into:cnum, :clname, :ccity;
```

Each sequential fetch returns a new row.

A scroll cursor is declared with the keywords SCROLL CURSOR, as the following example from IBM Informix ESQL/C shows:

```
EXEC SQL DECLARE s_curs SCROLL CURSOR FOR
  SELECT order_num, order_date FROM orders
  WHERE customer_num > 104
```

Use the scroll cursor with a variety of fetch options. For example, the ABSOLUTE option specifies the absolute row position of the row to fetch.

```
EXEC SQL FETCH ABSOLUTE :numrow s_curs
      INTO :nordr, :nodat
```

This statement fetches the row whose position is given in the host variable **numrow**. You can also fetch the current row again, or you can fetch the first row and then scan through all the rows again. However, these features can cause the application to run more slowly, as the next section describes. For additional options that apply to scroll cursors, see the FETCH statement in the *IBM Informix Guide to SQL: Syntax*.

Active set of a cursor

Once a cursor is opened, it stands for some selection of rows. The set of all rows that the query produces is called the *active set* of the cursor. It is easy to think of the active set as a well-defined collection of rows and to think of the cursor as pointing to one row of the collection. This situation is true as long as no other programs are modifying the same data concurrently.

- [Create the active set](#)
- [Active set for a sequential cursor](#)
- [Active set for a SCROLL cursor](#)
- [Active set and concurrency](#)

Create the active set

When a cursor is opened, the database server does whatever is necessary to locate the first row of selected data. Depending on how the query is phrased, this action can be easy, or it can require a great deal of work and time. Consider the following declaration of a cursor:

```
EXEC SQL DECLARE easy CURSOR FOR
      SELECT fname, lname FROM customer
      WHERE state = 'NJ'
```

Because this cursor queries only a single table in a simple way, the database server quickly determines whether any rows satisfy the query and identifies the first one. The first row is the only row the cursor finds at this time. The rest of the rows in the active set remain unknown. As a contrast, consider the following declaration of a cursor:

```
EXEC SQL DECLARE hard SCROLL CURSOR FOR
      SELECT C.customer_num, O.order_num, sum (items.total_price)
      FROM customer C, orders O, items I
      WHERE C.customer_num = O.customer_num
            AND O.order_num = I.order_num
            AND O.paid_date is null
      GROUP BY C.customer_num, O.order_num
```

The active set of this cursor is generated by joining three tables and grouping the output rows. The optimizer might be able to use indexes to produce the rows in the correct order, but generally the use of ORDER BY or GROUP BY clauses requires the database server to generate all the rows, copy them to a temporary table, and sort the table, before it can determine which row to present first.

In cases where the active set is entirely generated and saved in a temporary table, the database server can take quite some time to open the cursor. Afterwards, the database server could tell the program exactly how many rows the active set contains. However, this information is not made available. One reason is that you can never be sure which method the optimizer uses. If the optimizer can avoid sorts and temporary tables, it does so; but small changes in the query, in the sizes of the tables, or in the available indexes can change the methods of the optimizer.

Active set for a sequential cursor

The database server attempts to use as few resources as possible to maintain the active set of a cursor. If it can do so, the database server never retains more than the single row that is fetched next. It can do this for most sequential cursors. On each fetch, it returns the contents of the current row and locates the next one.

Active set for a SCROLL cursor

All the rows in the active set for a SCROLL cursor must be retained until the cursor closes because the database server cannot be sure which row the program will ask for next.

Most frequently, the database server implements the active set of a scroll cursor as a temporary table. The database server might not fill this table immediately, however (unless it created a temporary table to process the query). Usually it creates the temporary table when the cursor is opened. Then, the first time a row is fetched, the database server copies it into the temporary table and returns it to the program. When a row is fetched for a second time, it can be taken from the temporary table. This scheme uses the fewest resources, in the event that the program abandons the query before it fetches all the rows. Rows that are never fetched are not created or saved.

Active set and concurrency

When only one program is using a database, the members of the active set cannot change. This situation describes most personal computers, and it is the easiest situation to think about. But some programs must be designed for use in a multiprogramming system, where two, three, or dozens of different programs can work on the same tables simultaneously.

When other programs can update the tables while your cursor is open, the idea of the active set becomes less useful. Your program can see only one row of data at a time, but all other rows in the table can be changing.

In the case of a simple query, when the database server holds only one row of the active set, any other row can change. The instant after your program fetches a row, another program can delete the same row, or update it so that if it is examined again, it is no longer part of the active set.

When the active set, or part of it, is saved in a temporary table, *stale data* can present a problem. That is, the rows in the actual tables from which the active-set rows are derived can change. If they do, some of the active-set rows no longer reflect the current table contents.

These ideas seem unsettling at first, but as long as your program only reads the data, stale data does not exist, or rather, all data is equally stale. The active set is a snapshot of the data as it is at one moment. A row is different the next day; it does not matter if it is also different in the next millisecond. To put it another way, no practical difference exists between changes that occur while the program is running and changes that are saved and applied the instant that the program terminates.

The only time that stale data can cause a problem is when the program intends to use the input data to modify the same database; for example, when a banking application must read an account balance, change it, and write it back. [Modify data through SQL programs](#) discusses programs that modify data.

Parts-explosion problem

When you use a cursor supplemented by program logic, you can solve problems that plain SQL cannot solve. One of these problems is the parts-explosion problem, sometimes called bill-of-materials processing. At the heart of this problem is a recursive relationship among objects; one object contains other objects, which contain yet others.

The problem is usually stated in terms of a manufacturing inventory. A company makes a variety of parts, for example. Some parts are discrete, but some are assemblages of other parts.

These relationships are documented in a single table, which might be called **contains**. The column **contains.parent** holds the part numbers of parts that are assemblages. The column **contains.child** has the part number of a part that is a component of the parent. If part number 123400 is an assembly of nine parts, nine rows exist with 123400 in the first column and other part numbers in the second. The following figure shows one of the rows that describe part number 123400.

Figure 1. Parts-explosion problem

CONTAINS	
PARENT	CHILD
FKNN	FKNN
123400	432100
432100	765899

Here is the parts-explosion problem: given a part number, produce a list of all parts that are components of that part. The following example is a sketch of one solution, as implemented in IBM® Informix® ESQL/C:

```
int part_list[200];

boom(top_part)
int top_part;
{
    long this_part, child_part;
    int next_to_do = 0, next_free = 1;
    part_list[next_to_do] = top_part;

    EXEC SQL DECLARE part_scan CURSOR FOR
        SELECT child INTO child_part FROM contains
        WHERE parent = this_part;
    while(next_to_do < next_free)
    {
        this_part = part_list[next_to_do];
        EXEC SQL OPEN part_scan;
        while(SQLCODE == 0)
        {
            EXEC SQL FETCH part_scan;
            if(SQLCODE == 0)
            {
                part_list[next_free] = child_part;
                next_free += 1;
            }
        }
        EXEC SQL CLOSE part_scan;
        next_to_do += 1;
    }
    return (next_free - 1);
}
```

Technically speaking, each row of the **contains** table is the head node of a directed acyclic graph, or *tree*. The function performs a breadth-first search of the tree whose root is the part number passed as its parameter. The function uses a cursor named **part_scan** to return all the rows with a particular value in the **parent** column. The innermost **while** loop opens the **part_scan** cursor, fetches each row in the selection set, and closes the cursor when the part number of each component has been retrieved.

This function addresses the heart of the parts-explosion problem, but the function is not a complete solution. For example, it does not allow for components that appear at more than one level in the tree. Furthermore, a practical **contains** table would also have a column **count**, giving the count of **child** parts used in each **parent**. A program that returns a total count of each component part is much more complicated.

The iterative approach described previously is not the only way to approach the parts-explosion problem. If the number of generations has a fixed limit, you can solve the problem with a single SELECT statement using nested, outer self-joins.

If up to four generations of parts can be contained within one top-level part, the following SELECT statement returns all of them:

```
SELECT a.parent, a.child, b.child, c.child, d.child
FROM contains a
     OUTER (contains b,
           OUTER (contains c, outer contains d) )
WHERE a.parent = top_part_number
     AND a.child = b.parent
     AND b.child = c.parent
     AND c.child = d.parent
```

This SELECT statement returns one row for each line of descent rooted in the part given as **top_part_number**. Null values are returned for levels that do not exist. (Use indicator variables to detect them.) To extend this solution to more levels, select additional nested outer joins of the **contains** table. You can also revise this solution to return counts of the number of parts at each level.

Dynamic SQL

Although static SQL is useful, it requires that you know the exact content of every SQL statement at the time you write the program. For example, you must state exactly which columns are tested in any WHERE clause and exactly which columns are named in any select list.

No problem exists when you write a program to perform a well-defined task. But the database tasks of some programs cannot be perfectly defined in advance. In particular, a program that must respond to an interactive user might need to compose SQL statements in response to what the user enters.

Dynamic SQL allows a program to form an SQL statement during execution, so that user input determines the contents of the statement. This action is performed in the following steps:

1. The program assembles the text of an SQL statement as a character string, which is stored in a program variable.
2. It executes a PREPARE statement, which asks the database server to examine the statement text and prepare it for execution.
3. It uses the EXECUTE statement to execute the prepared statement.

In this way, a program can construct and then use any SQL statement, based on user input of any kind. For example, it can read a file of SQL statements and prepare and execute each one.

DB-Access, a utility that you can use to explore SQL interactively, is the IBM® Informix® ESQL/C program that constructs, prepares, and executes SQL statements dynamically. For example, DB-Access lets you use simple, interactive menus to specify the columns of a table. When you are finished, DB-Access builds the necessary CREATE TABLE or ALTER TABLE statement dynamically and prepares and executes it.

- [Prepare a statement](#)
- [Execute prepared SQL](#)
- [Dynamic host variables](#)
- [Free prepared statements](#)
- [Quick execution](#)

Prepare a statement

In form, a dynamic SQL statement is like any other SQL statement that is written into a program, except that it cannot contain the names of any host variables.

A prepared SQL statement has two restrictions. First, if it is a SELECT statement, it cannot include the INTO *variable* clause. The INTO *variable* clause specifies host variables into which column data is placed, and host variables are not allowed in the text of a prepared object. Second, wherever the name of a host variable normally appears in an expression, a question mark (?) is written as a placeholder in the PREPARE statement. Only the PREPARE statement can specify question mark (?) placeholders.

You can prepare a statement in this form for execution with the PREPARE statement. The following example is written in IBM® Informix® ESQL/C:

```
EXEC SQL prepare query_2 from
'SELECT * from orders
  WHERE customer_num = ? and order_date > ?';
```

The two question marks in this example indicate that when the statement is executed, the values of host variables are used at those two points.

You can prepare almost any SQL statement dynamically. The only statements that you cannot prepare are the ones directly concerned with dynamic SQL and cursor management, such as the PREPARE and OPEN statements. After you prepare an UPDATE or DELETE statement, it is a good idea to test the fifth field of SQLWARN to see if you used a WHERE clause (see [SQLWARN array](#)).

The result of preparing a statement is a data structure that represents the statement. This data structure is not the same as the string of characters that produced it. In the PREPARE statement, you give a name to the data structure; it is **query_2** in the preceding example. This name is used to execute the prepared SQL statement.

The PREPARE statement does not limit the character string to one statement. It can contain multiple SQL statements, separated by semicolons. The following example shows a fairly complex transaction in IBM Informix ESQL/C:

```
strcpy(big_query, "UPDATE account SET balance = balance + ?
WHERE customer_id = ?; \ UPDATE teller SET balance =
balance + ? WHERE teller_id = ?;");
EXEC SQL PREPARE big1 FROM :big_query;
```

When this list of statements is executed, host variables must provide values for six place-holding question marks. Although it is more complicated to set up a multistatement list, performance is often better because fewer exchanges take place between the program and the database server.

Execute prepared SQL

After you prepare a statement, you can execute it multiple times. statements other than SELECT statements, and SELECT statements that return only a single row, are executed with the EXECUTE statement.

The following IBM® Informix® ESQL/C code prepares and executes a multistatement update of a bank account:

```
EXEC SQL BEGIN DECLARE SECTION;
char bigquery[270] = "begin work;";
EXEC SQL END DECLARE SECTION;
stcat ("update account set balance = balance + ? where ", bigquery);
stcat ("acct_number = ?;', bigquery);
stcat ("update teller set balance = balance + ? where ", bigquery);
stcat ("teller_number = ?;', bigquery);
stcat ("update branch set balance = balance + ? where ", bigquery);
stcat ("branch number = ?;', bigquery);
stcat ("insert into history values(timestamp, values);", bigquery);

EXEC SQL prepare bigq from :bigquery;

EXEC SQL execute bigq using :delta, :acct_number, :delta,
:teller_number, :delta, :branch_number;

EXEC SQL commit work;
```

The USING clause of the EXECUTE statement supplies a list of host variables whose values are to take the place of the question marks in the prepared statement. If a SELECT (or EXECUTE FUNCTION) returns only one row, you can use the INTO clause of EXECUTE to specify the host variables that receive the values.

Dynamic host variables

SQL APIs, which support dynamically allocated data objects, take dynamic statements one step further. They let you dynamically allocate the host variables that receive column data.

Dynamic allocation of variables makes it possible to take an arbitrary SELECT statement from program input, determine how many values it produces and their data types, and allocate the host variables of the appropriate types to hold them.

The key to this ability is the DESCRIBE statement. It takes the name of a prepared SQL statement and returns information about the statement and its contents. It sets SQLCODE to specify the type of statement; that is, the verb with which it begins. If the prepared statement is a SELECT statement, the DESCRIBE statement also returns information about the selected output data. If the prepared statement is an INSERT statement, the DESCRIBE statement returns information about the input parameters. The data structure to which a DESCRIBE statement returns information is a predefined data structure that is allocated for this purpose and is known as a system-descriptor area. If you are using IBM® Informix® ESQL/C, you can use a system-descriptor area or, as an alternative, an **sqllda** structure.

The data structure that a DESCRIBE statement returns or references for a SELECT statement includes an array of structures. Each structure describes the data that is returned for one item in the select list. The program can examine the array and discover that a row of data includes a decimal value, a character value of a certain length, and an integer.

With this information, the program can allocate memory to hold the retrieved values and put the necessary pointers in the data structure for the database server to use.

Free prepared statements

A prepared SQL statement occupies space in memory. With some database servers, it can consume space that the database server owns as well as space that belongs to the program. This space is released when the program terminates, but in general, you should free this space when you finish with it.

You can use the FREE statement to release this space. The FREE statement takes either the name of a statement or the name of a cursor that was declared for a statement name, and releases the space allocated to the prepared statement. If more than one cursor is defined on the statement, freeing the statement does not free the cursor.

Quick execution

For simple statements that do not require a cursor or host variables, you can combine the actions of the PREPARE, EXECUTE, and FREE statements into a single operation. The following example shows how the EXECUTE IMMEDIATE statement takes a character string, prepares it, executes it, and frees the storage in one operation:

```
EXEC SQL execute immediate 'drop index my_temp_index';
```

This capability makes it easy to write simple SQL operations. However, because no USING clause is allowed, the EXECUTE IMMEDIATE statement cannot be used for SELECT statements.

Embed data-definition statements

Data-definition statements, the SQL statements that create databases and modify the definitions of tables, are not usually put into programs. The reason is that they are rarely performed. A database is created once, but it is queried and updated many times.

The creation of a database and its tables is generally done interactively, using DB-Access. These tools can also be run from a file of statements, so that the creation of a database can be done with one operating-system command. The data-definition statements are documented in the *IBM® Informix® Guide to SQL: Syntax* and the *IBM Informix Database Design and Implementation Guide*.

Grant and revoke privileges in applications

One task related to data definition is performed repeatedly: granting and revoking privileges. Because privileges must be granted and revoked frequently, possibly by users who are not skilled in SQL, one strategy is to package the GRANT and REVOKE statements in programs to give them a simpler, more convenient user interface.

The GRANT and REVOKE statements are especially good candidates for dynamic SQL. Each statement takes the following parameters:

- A list of one or more privileges
- A table name
- The name of a user

You probably need to supply at least some of these values based on program input (from the user, command-line parameters, or a file) but none can be supplied in the form of a host variable. The syntax of these statements does not allow host variables at any point.

An alternative is to assemble the parts of a statement into a character string and to prepare and execute the assembled statement. Program input can be incorporated into the prepared statement as characters.

The following IBM® Informix® ESQL/C function assembles a GRANT statement from parameters, and then prepares and executes it:

```
char priv_to_grant[100];
char table_name[20];
char user_id[20];

table_grant(priv_to_grant, table_name, user_id)
char *priv_to_grant;
char *table_name;
char *user_id;
{
    EXEC SQL BEGIN DECLARE SECTION;
    char grant_stmt[200];
    EXEC SQL END DECLARE SECTION;

    sprintf(grant_stmt, " GRANT %s ON %s TO %s",
        priv_to_grant, table_name, user_id);
    PREPARE the_grant FROM :grant_stmt;
    if(SQLCODE == 0)
        EXEC SQL EXECUTE the_grant;
    else
        printf("Sorry, got error # %d attempting %s",
            SQLCODE, grant_stmt);

    EXEC SQL FREE the_grant;
}
```

The opening statement of the function that the following example shows specifies its name and its three parameters. The three parameters specify the privileges to grant, the name of the table on which to grant privileges, and the ID of the user to receive them.

```
table_grant(priv_to_grant, table_name, user_id)
char *priv_to_grant;
char *table_name;
char *user_id;
```

The function uses the statements in the following example to define a local variable, **grant_stmt**, which is used to assemble and hold the GRANT statement:

```
EXEC SQL BEGIN DECLARE SECTION;
    char grant_stmt[200];
EXEC SQL END DECLARE SECTION;
```

As the following example illustrates, the GRANT statement is created by concatenating the constant parts of the statement and the function parameters:

```
sprintf(grant_stmt, " GRANT %s ON %s TO %s",priv_to_grant,
    table_name, user_id);
```

This statement concatenates the following six character strings:

- 'GRANT'

- The parameter that specifies the privileges to be granted
- 'ON'
- The parameter that specifies the table name
- 'TO'
- The parameter that specifies the user

The result is a complete GRANT statement composed partly of program input. The PREPARE statement passes the assembled statement text to the database server for parsing.

If the database server returns an error code in SQLCODE following the PREPARE statement, the function displays an error message. If the database server approves the form of the statement, it sets a zero return code. This action does not guarantee that the statement is executed properly; it means only that the statement has correct syntax. It might refer to a nonexistent table or contain many other kinds of errors that can be detected only during execution. The following portion of the example checks that **the_grant** was prepared successfully before executing it:

```
if (SQLCODE == 0)
    EXEC SQL EXECUTE the_grant;
else
    printf("Sorry, got error # %d attempting %s", SQLCODE, grant_stmt);
```

If the preparation is successful, `SQLCODE = 0`, the next step executes the prepared statement.

- [Assign roles](#)

Assign roles

Alternatively, the DBA can define a role with the CREATE ROLE statement, and use the GRANT and REVOKE statements to cancel or assign roles to users, and to grant and revoke privileges of roles. For example:

```
GRANT engineer TO nmartin;
```

The SET ROLE statement is needed to activate a non-default role. For more information on roles and privileges, see [Access-management strategies](#) and [Privileges on a database and on its objects](#). For more information on the GRANT and REVOKE statements, see the *IBM® Informix® Database Design and Implementation Guide*. For more information about the syntax of these statements, see *IBM Informix Guide to SQL: Syntax*.

Summary

SQL statements can be written into programs as if they were normal statements of the programming language. Program variables can be used in WHERE clauses, and data from the database can be fetched into them. A preprocessor translates the SQL code into procedure calls and data structures.

Statements that do not return data, or queries that return only one row of data, are written like ordinary imperative statements of the language. Queries that can return more than one row are associated with a cursor that represents the current row of data. Through the cursor, the program can fetch each row of data as it is needed.

Static SQL statements are written into the text of the program. However, the program can form new SQL statements dynamically, as it runs, and execute them also. In the most advanced cases, the program can obtain information about the number and types of columns that a query returns and dynamically allocate the memory space to hold them.

Modify data through SQL programs

The previous chapter describes how to insert or embed SQL statements, especially the SELECT statement, into programs written in other languages. Embedded SQL enables a program to retrieve rows of data from a database.

This chapter discusses the issues that arise when a program needs to delete, insert, or update rows to modify the database. As in [SQL programming](#), this chapter prepares you for reading your IBM® Informix® embedded language publication.

The general use of the INSERT, UPDATE, and DELETE statements is discussed in [Modify data](#). This chapter examines their use from within a program. You can easily embed the statements in a program, but it can be difficult to handle errors and to deal with concurrent modifications from multiple programs.

- [The DELETE statement](#)
- [The INSERT statement](#)
- [The UPDATE statement](#)
- [Summary](#)

The DELETE statement

To delete rows from a table, a program executes a DELETE statement. The DELETE statement can specify rows in the usual way, with a WHERE clause, or it can refer to a single row, the last one fetched through a specified cursor.

Whenever you delete rows, you must consider whether rows in other tables depend on the deleted rows. This problem of coordinated deletions is covered in [Modify data](#). The problem is the same when deletions are made from within a program.

- [Direct deletions](#)
- [Delete with a cursor](#)

Direct deletions

You can embed a DELETE statement in a program. The following example uses IBM® Informix® ESQL/C:

```
EXEC SQL delete from items
WHERE order_num = :onum;
```

You can also prepare and execute a statement of the same form dynamically. In either case, the statement works directly on the database to affect one or more rows.

The WHERE clause in the example uses the value of a host variable named **onum**. Following the operation, results are posted in SQLSTATE and in the **sqlca** structure, as usual. The third element of the SQLERRD array contains the count of rows deleted even if an error occurs. The value in SQLCODE shows the overall success of the operation. If the value is not negative, no errors occurred and the third element of SQLERRD is the count of all rows that satisfied the WHERE clause and were deleted.

- [Errors during direct deletions](#)
- [Transaction logging](#)
- [Coordinated deletions](#)

Errors during direct deletions

When an error occurs, the statement ends prematurely. The values in SQLSTATE and in SQLCODE and the second element of SQLERRD explain its cause, and the count of rows reveals how many rows were deleted. For many errors, that count is zero because the errors prevented the database server from beginning the operation. For example, if the named table does not exist, or if a column tested in the WHERE clause is renamed, no deletions are attempted.

However, certain errors can be discovered after the operation begins and some rows are processed. The most common of these errors is a lock conflict. The database server must obtain an exclusive lock on a row before it can delete that row. Other programs might be using the rows from the table, preventing the database server from locking a row. Because the issue of locking affects all types of modifications, [Programming for a multiuser environment](#), discusses it.

Other, rarer types of errors can strike after deletions begin. For example, hardware errors that occur while the database is being updated.

Transaction logging

The best way to prepare for any kind of error during a modification is to use transaction logging. In the event of an error, you can tell the database server to put the database back the way it was. The following example is based on the example in the section [Direct deletions](#), which is extended to use transactions:

```
EXEC SQL begin work;                /* start the transaction*/
EXEC SQL delete from items
  where order_num = :onum;
del_result = sqlca.sqlcode;          /* save two error */
del_isamno = sqlca.sqlerrd[1];       /* code numbers */
del_rowcnt = sqlca.sqlerrd[2];       /* and count of rows */
if (del_result < 0)                  /* problem found: */
  EXEC SQL rollback work;            /* put everything back */
else                                 /* everything worked OK:*/
  EXEC SQL commit work;              /* finish transaction */
```

A key point in this example is that the program saves the important return values in the **sqlca** structure before it ends the transaction. Both the ROLLBACK WORK and COMMIT WORK statements, like other SQL statements, set return codes in the **sqlca** structure. However, if you want to report the codes that the error generated, you must save them before executing ROLLBACK WORK. The ROLLBACK WORK statement removes all of the pending transaction, including its error codes.

The advantage of using transactions is that the database is left in a known, predictable state no matter what goes wrong. No question remains about how much of the modification is completed; either all of it or none of it is completed.

In a database with logging, if a user does not start an explicit transaction, the database server initiates an internal transaction prior to execution of the statement and terminates the transaction after execution completes or fails. If the statement execution succeeds, the internal transaction is committed. If the statement fails, the internal transaction is rolled back.

Coordinated deletions

The usefulness of transaction logging is particularly clear when you must modify more than one table. For example, consider the problem of deleting an order from the demonstration database. In the simplest form of the problem, you must delete rows from two tables, **orders** and **items**, as the following example of IBM® Informix® ESQL/C shows:

```
EXEC SQL BEGIN WORK;
EXEC SQL DELETE FROM items
WHERE order_num = :o_num;
```

```

if (SQLCODE >= 0)
{
    EXEC SQL DELETE FROM orders
        WHERE order_num == :o_num;

    {
        if (SQLCODE >= 0)
            EXEC SQL COMMIT WORK;

    }

    {
        else
        {
            printf("Error %d on DELETE", SQLCODE);
            EXEC SQL ROLLBACK WORK;
        }
    }
}

```

The logic of this program is much the same whether or not transactions are used. If they are not used, the person who sees the error message has a much more difficult set of decisions to make. Depending on when the error occurred, one of the following situations applies:

- No deletions were performed; all rows with this order number remain in the database.
- Some, but not all, item rows were deleted; an order record with only some items remains.
- All item rows were deleted, but the order row remains.
- All rows were deleted.

In the second and third cases, the database is corrupted to some extent; it contains partial information that can cause some queries to produce wrong answers. You must take careful action to restore consistency to the information. When transactions are used, all these uncertainties are prevented.

Delete with a cursor

You can also write a DELETE statement with a cursor to delete the row that was last fetched. Deleting rows in this manner lets you program deletions based on conditions that cannot be tested in a WHERE clause, as the following example shows. The following example applies only to databases that are not ANSI compliant because of the way that the beginning and ending of the transaction are set up.

Warning: The design of the Informix® ESQL/C function in this example is unsafe. It depends on the current isolation level for correct operation. Isolation levels are discussed later in the chapter. For more information on isolation levels, see [Programming for a multiuser environment](#). Even when the function works as intended, its effects depend on the physical order of rows in the table, which is not generally a good idea.

```

int delDupOrder()
{
    int ord_num;
    int dup_cnt, ret_code;

    EXEC SQL declare scan_ord cursor for
        select order_num, order_date
            into :ord_num, :ord_date
            from orders for update;
    EXEC SQL open scan_ord;
    if (sqlca.sqlcode != 0)
        return (sqlca.sqlcode);
    EXEC SQL begin work;
    for(;;)
    {
        EXEC SQL fetch next scan_ord;
        if (sqlca.sqlcode != 0) break;
        dup_cnt = 0; /* default in case of error */
        EXEC SQL select count(*) into dup_cnt from orders
            where order_num = :ord_num;
        if (dup_cnt > 1)
        {
            EXEC SQL delete from orders
                where current of scan_ord;
            if (sqlca.sqlcode != 0)
                break;
        }
    }
    ret_code = sqlca.sqlcode;
    if (ret_code == 100) /* merely end of data */
        EXEC SQL commit work;
    else /* error on fetch or on delete */
        EXEC SQL rollback work;
    return (ret_code);
}

```

The purpose of the function is to delete rows that contain duplicate order numbers. In fact, in the demonstration database, the **orders.order_num** column has a unique index, so duplicate rows cannot occur in it. However, a similar function can be written for another database; this one uses familiar column names.

The function declares **scan_ord**, a cursor to scan all rows in the **orders** table. It is declared with the FOR UPDATE clause, which states that the cursor can modify data. If the cursor opens properly, the function begins a transaction and then loops over rows of the table. For each row, it uses an embedded SELECT statement to determine how many rows of the table have the order number of the current row. (This step fails without the correct isolation level, as [Programming for a multiuser environment](#) describes.)

In the demonstration database, with its unique index on this table, the count returned to **dup_cnt** is always one. However, if it is greater, the function deletes the current row of the table, reducing the count of duplicates by one.

Cleanup functions of this sort are sometimes needed, but they generally need more sophisticated design. This function deletes all duplicate rows except the last one that the database server returns. That order has nothing to do with the content of the rows or their meanings. You can improve the function in the previous example by adding, perhaps, an ORDER BY clause to the cursor declaration. However, you cannot use ORDER BY and FOR UPDATE together. [An insert example](#) presents a better approach.

The INSERT statement

You can embed the INSERT statement in programs. Its form and use in a program are the same as described in [Modify data](#) with the additional feature that you can use host variables in expressions, both in the VALUES and WHERE clauses. Moreover, in a program you have the additional ability to insert rows with a cursor.

- [An insert cursor](#)
- [Rows of constants](#)
- [An insert example](#)

An insert cursor

The DECLARE CURSOR statement has many variations. Most are used to create cursors for different kinds of scans over data, but one variation creates a special kind of cursor, called an *insert cursor*. You use an insert cursor with the PUT and FLUSH statements to efficiently insert rows into a table in bulk.

- [Declare an insert cursor](#)
- [Insert with a cursor](#)
- [Status codes after PUT and FLUSH](#)

Declare an insert cursor

To create an insert cursor, declare a cursor to be for an INSERT statement instead of a SELECT statement. You cannot use such a cursor to fetch rows of data; you can use it only to insert them.

The following 4GL code fragment shows the declaration of an insert cursor:

```
DEFINE the_company LIKE customer.company,  
       the_fname LIKE customer.fname,  
       the_lname LIKE customer.lname  
DECLARE new_custs CURSOR FOR  
       INSERT INTO customer (company, fname, lname)  
       VALUES (the_company, the_fname, the_lname)
```

When you open an insert cursor, a buffer is created in memory to hold a block of rows. The buffer receives rows of data as the program produces them; then they are passed to the database server in a block when the buffer is full. The buffer reduces the amount of communication between the program and the database server, and it lets the database server insert the rows with less difficulty. As a result, the insertions go faster.

The buffer is always made large enough to hold at least two rows of inserted values. It is large enough to hold more than two rows when the rows are shorter than the minimum buffer size.

Insert with a cursor

The code in the previous example ([Declare an insert cursor](#)) prepares an insert cursor for use. The continuation, as the following example shows, demonstrates how the cursor can be used. For simplicity, this example assumes that a function named **next_cust** returns either information about a new customer or null data to signal the end of input.

```
EXEC SQL BEGIN WORK;  
EXEC SQL OPEN new_custs;  
while(SQLCODE == 0)  
{  
    next_cust();  
    if(the_company == NULL)  
        break;  
    EXEC SQL PUT new_custs;  
}  
if(SQLCODE == 0) /* if no problem with PUT */  
{  
    EXEC SQL FLUSH new_custs; /* write any rows left */  
    if(SQLCODE == 0) /* if no problem with FLUSH */  
        EXEC SQL COMMIT WORK; /* commit changes */  
}  
else  
    EXEC SQL ROLLBACK WORK; /* else undo changes */
```

The code in this example calls **next_cust** repeatedly. When it returns non-null data, the PUT statement sends the returned data to the row buffer. When the buffer fills, the rows it contains are automatically sent to the database server. The loop normally ends when **next_cust** has no more data to return. Then the FLUSH statement writes any rows that remain in the buffer, after which the transaction terminates.

Re-examine the information about the INSERT statement. See [The INSERT statement](#). The statement by itself, not part of a cursor definition, inserts a single row into the **customer** table. In fact, the whole apparatus of the insert cursor can be dropped from the example code, and the INSERT statement can be written into the code where the PUT statement now stands. The difference is that an insert cursor causes a program to run somewhat faster.

Status codes after PUT and FLUSH

When a program executes a PUT statement, the program should test whether the row is placed in the buffer successfully. If the new row fits in the buffer, the only action of PUT is to copy the row to the buffer. No errors can occur in this case. However, if the row does not fit, the entire buffer load is passed to the database server for insertion, and an error can occur.

The values returned into the SQL Communications Area (SQLCA) give the program the information it needs to sort out each case. SQLCODE and SQLSTATE are set to zero after every PUT statement if no error occurs and to a negative error code if an error occurs.

The database server sets the third element of SQLERRD to the number of rows actually inserted into the table, as follows

- Zero, if the new row is merely moved to the buffer
- The number of rows that are in the buffer, if the buffer load is inserted without error
- The number of rows inserted before an error occurs, if one did occur

Read the code once again to see how SQLCODE is used (see the previous example). First, if the OPEN statement yields an error, the loop is not executed because the WHILE condition fails, the FLUSH operation is not performed, and the transaction rolls back. Second, if the PUT statement returns an error, the loop ends because of the WHILE condition, the FLUSH operation is not performed, and the transaction rolls back. This condition can occur only if the loop generates enough rows to fill the buffer at least once; otherwise, the PUT statement cannot generate an error.

The program might end the loop with rows still in the buffer, possibly without inserting any rows. At this point, the SQL status is zero, and the FLUSH operation occurs. If the FLUSH operation produces an error code, the transaction rolls back. Only when all inserts are successfully performed is the transaction committed.

Rows of constants

The insert cursor mechanism supports one special case where high performance is easy to obtain. In this case, all the values listed in the INSERT statement are constants: no expressions and no host variables are listed, just literal numbers and strings of characters. No matter how many times such an INSERT operation occurs, the rows it produces are identical. When the rows are identical, copying, buffering, and transmitting each identical row is pointless.

Instead, for this kind of INSERT operation, the PUT statement does nothing except to increment a counter. When a FLUSH operation is finally performed, a single copy of the row and the count of inserts are passed to the database server. The database server creates and inserts that many rows in one operation.

You do not usually insert a quantity of identical rows. You can insert identical rows when you first establish a database to populate a large table with null data.

An insert example

[Delete with a cursor](#) contains an example of the DELETE statement whose purpose is to look for and delete duplicate rows of a table. A better way to perform this task is to select the desired rows instead of deleting the undesired ones. The code in the following IBM® Informix® ESQL/C example shows one way to do this task:

```
EXEC SQL BEGIN DECLARE SECTION;
    long last_ord = 1;
    struct {
        long int o_num;
        date    o_date;
        long    c_num;
        char    o_shipinst[40];
        char    o_backlog;
        char    o_po[10];
        date    o_shipdate;
        decimal o_shipwt;
        decimal o_shipchg;
        date    o_paidddate;
    } ord_row;
EXEC SQL END DECLARE SECTION;

EXEC SQL BEGIN WORK;
EXEC SQL INSERT INTO new_orders
    SELECT * FROM orders main
        WHERE 1 = (SELECT COUNT(*) FROM orders minor
            WHERE main.order_num = minor.order_num);
EXEC SQL COMMIT WORK;

EXEC SQL DECLARE dup_row CURSOR FOR
    SELECT * FROM orders main INTO :ord_row
        WHERE 1 < (SELECT COUNT(*) FROM orders minor
            WHERE main.order_num = minor.order_num)
        ORDER BY order_date;
EXEC SQL DECLARE ins_row CURSOR FOR
    INSERT INTO new_orders VALUES (:ord_row);

EXEC SQL BEGIN WORK;
EXEC SQL OPEN ins_row;
```

```
EXEC SQL OPEN dup_row;
while(SQLCODE == 0)
{
    EXEC SQL FETCH dup_row;
    if(SQLCODE == 0)
    {
        if(ord_row.o_num != last_ord)
            EXEC SQL PUT ins_row;
        last_ord = ord_row.o_num;
        continue;
    }
    break;
}
if(SQLCODE != 0 && SQLCODE != 100)
    EXEC SQL ROLLBACK WORK;
else
    EXEC SQL COMMIT WORK;
EXEC SQL CLOSE ins_row;
EXEC SQL CLOSE dup_row;
```

This example begins with an ordinary INSERT statement, which finds all the nonduplicated rows of the table and inserts them into another table, presumably created before the program started. That action leaves only the duplicate rows. (In the demonstration database, the **orders** table has a unique index and cannot have duplicate rows. Assume that this example deals with some other database.)

The code in the previous example then declares two cursors. The first, called **dup_row**, returns the duplicate rows in the table. Because **dup_row** is for input only, it can use the ORDER BY clause to impose some order on the duplicates other than the physical record order used in the example on page [Delete with a cursor](#). In this example, the duplicate rows are ordered by their dates (the oldest one remains), but you can use any other order based on the data.

The second cursor, **ins_row**, is an insert cursor. This cursor takes advantage of the ability to use a C structure, **ord_row**, to supply values for all columns in the row.

The remainder of the code examines the rows that are returned through **dup_row**. It inserts the first one from each group of duplicates into the new table and disregards the rest.

For the sake of brevity, the preceding example uses the simplest kind of error handling. If an error occurs before all rows have been processed, the sample code rolls back the active transaction.

- [How many rows were affected?](#)

How many rows were affected?

When your program uses a cursor to select rows, it can test SQLCODE for 100 (or SQLSTATE for 02000), the end-of-data return code. This code is set to indicate that no rows, or no more rows, satisfy the query conditions. For databases that are not ANSI compliant, the end-of-data return code is set in SQLCODE or SQLSTATE only following SELECT statements; it is not used following DELETE, INSERT, or UPDATE statements. For ANSI-compliant databases, SQLCODE is also set to 100 for updates, deletes, and inserts that affect zero rows.

A query that finds no data is not a success. However, an UPDATE or DELETE statement that happens to update or delete no rows is still considered a success. It updated or deleted the set of rows that its WHERE clause said it should; however, the set was empty.

In the same way, the INSERT statement does not set the end-of-data return code even when the source of the inserted rows is a SELECT statement, and the SELECT statement selected no rows. The INSERT statement is a success because it inserted as many rows as it was asked to (that is, zero).

To find out how many rows are inserted, updated, or deleted, a program can test the third element of SQLERRD. The count of rows is there, regardless of the value (zero or negative) in SQLCODE.

The UPDATE statement

You can embed the UPDATE statement in a program in any of the forms that [Modify data](#) describes with the additional feature that you can name host variables in expressions, both in the SET and WHERE clauses. Moreover, a program can update the row that a cursor addresses.

- [An update cursor](#)
- [Cleanup a table](#)

An update cursor

An *update cursor* permits you to delete or update the current row; that is, the most recently fetched row. The following example in IBM® Informix® ESQL/C shows the declaration of an update cursor:

```
EXEC SQL
    DECLARE names CURSOR FOR
        SELECT fname, lname, company
        FROM customer
    FOR UPDATE;
```

The program that uses this cursor can fetch rows in the usual way.

```
EXEC SQL
  FETCH names INTO :FNAME, :LNAME, :COMPANY;
```

If the program then decides that the row needs to be changed, it can do so.

```
if (strcmp(COMPANY, "SONY") ==0)
{
  EXEC SQL
    UPDATE customer
      SET fname = 'Midori', lname = 'Tokugawa'
      WHERE CURRENT OF names;
}
```

The words `CURRENT OF names` take the place of the usual test expressions in the `WHERE` clause. In other respects, the `UPDATE` statement is the same as usual, even including the specification of the table name, which is implicit in the cursor name but still required.

- [The purpose of the keyword UPDATE](#)
- [Update specific columns](#)
- [UPDATE keyword not always needed](#)

The purpose of the keyword UPDATE

The purpose of the keyword `UPDATE` in a cursor is to let the database server know that the program can update (or delete) any row that it fetches. The database server places a more demanding lock on rows that are fetched through an update cursor and a less demanding lock when it fetches a row for a cursor that is not declared with that keyword. This action results in better performance for ordinary cursors and a higher level of concurrent use in a multiprocessing system. ([Programming for a multiuser environment](#) discusses levels of locks and concurrent use.)

Important: A normal update inside the `FETCH` loop of a cursor cannot guarantee that the updated rows are not fetched again after the `UPDATE`. The `WHERE CURRENT OF` specification relates the `UPDATE` to the Update cursor, and guarantees that each row is updated no more than once, by internally keeping a list of the rows that have already been updated. These rows will not be fetched again by the Update cursor. See the [FOR UPDATE clause](#).

Update specific columns

The following example has updated specific columns of the preceding example of an update cursor:

```
EXEC SQL
  DECLARE names CURSOR FOR
    SELECT fname, lname, company, phone
      INTO :FNAME, :LNAME, :COMPANY, :PHONE FROM customer
    FOR UPDATE OF fname, lname
  END-EXEC.
```

Only the `fname` and `lname` columns can be updated through this cursor. A statement such as the following one is rejected as an error:

```
EXEC SQL
  UPDATE customer
    SET company = 'Siemens'
    WHERE CURRENT OF names
  END-EXEC.
```

If the program attempts such an update, an error code is returned and no update occurs. An attempt to delete with `WHERE CURRENT OF` is also rejected, because deletion affects all columns.

UPDATE keyword not always needed

The ANSI standard for SQL does not provide for the `FOR UPDATE` clause in a cursor definition. When a program uses an ANSI-compliant database, it can update or delete with any cursor.

Cleanup a table

A final, hypothetical example of how to use an update cursor presents a problem that should never arise with an established database but could arise in the initial design phases of an application.

In the example, a large table named **target** is created and populated. A character column, **dactyl**, inadvertently acquires some null values. These rows should be deleted. Furthermore, a new column, **serials**, is added to the table with the `ALTER TABLE` statement. This column is to have unique integer values installed. The following example shows the IBM® Informix® ESQL/C code you use to accomplish these tasks:

```
EXEC SQL BEGIN DECLARE SECTION;
char dcol[80];
short dcolint;
int sequence;
EXEC SQL END DECLARE SECTION;
```

```
EXEC SQL DECLARE target_row CURSOR FOR
SELECT datcol
  INTO :dcol:dcolint
  FROM target
  FOR UPDATE OF serials;
EXEC SQL BEGIN WORK;
EXEC SQL OPEN target_row;
if (sqlca.sqlcode == 0) EXEC SQL FETCH NEXT target_row;
for(sequence = 1; sqlca.sqlcode == 0; ++sequence)
{
  if (dcolint < 0) /* null datcol */
    EXEC SQL DELETE WHERE CURRENT OF target_row;
  else
    EXEC SQL UPDATE target SET serials = :sequence
      WHERE CURRENT OF target_row;
}
if (sqlca.sqlcode >= 0)
  EXEC SQL COMMIT WORK;
else EXEC SQL ROLLBACK WORK;
```

Summary

A program can execute the INSERT, DELETE, and UPDATE statements, as [Modify data](#) describes. A program can also scan through a table with a cursor, updating or deleting selected rows. It can also use a cursor to insert rows, with the benefit that the rows are buffered and sent to the database server in blocks.

In all these activities, you must make sure that the program detects errors and returns the database to a known state when an error occurs. The most important tool for doing this is transaction logging. Without transaction logging, it is more difficult to write programs that can recover from errors.

Programming for a multiuser environment

This section describes several programming issues you need to be aware of when you work in a multiuser environment.

If your database is contained in a single-user workstation and does not access data from another computer, your programs can modify data freely. In all other cases, you must allow for the possibility that, while your program is modifying data, another program is reading or modifying the same data. This situation is described as *concurrency*: two or more independent uses of the same data at the same time. This section addresses concurrency, locking, and isolation levels.

This section also describes the statement cache feature, which can reduce per-session memory allocation and speed up query processing. The statement cache stores statements that can then be shared among different user sessions that use identical SQL statements.

- [Concurrency and performance](#)
- [Locks and integrity](#)
- [Locks and performance](#)
- [Concurrency issues](#)
- [How locks work](#)
- IBM® Informix® database servers support a complex, flexible set of locking features that the topics in this section describe.
- [Lock with the SELECT statement](#)
- The type and duration of locks that the database server places depend on the isolation set in the application and whether the SELECT statement is within an update cursor.
- [Retain update locks](#)
- [Exclusive locks that occur with some SQL statements](#)
- When you execute an INSERT, UPDATE, or DELETE statement, the database server uses *exclusive locks*. An exclusive lock means that no other users can update or delete the item until the database server removes the lock. In addition, no other users can view the row unless they are using the Dirty Read isolation level.
- [The behavior of the lock types](#)
- [Control data modification with access modes](#)
- [Set the lock mode](#)
- [Simple concurrency](#)
- [Hold cursors](#)
- [The SQL statement cache](#)
- [Summary](#)

Concurrency and performance

Concurrency is crucial to good performance in a multiprogramming system. When access to the data is *serialized* so that only one program at a time can use it, processing slows dramatically.

Locks and integrity

Unless controls are placed on the use of data, concurrency can lead to a variety of negative effects. Programs can read obsolete data, or modifications can be lost even though they were apparently completed.

To prevent errors of this kind, the database server imposes a system of *locks*. A lock is a claim, or reservation, that a program can place on a piece of data. The database server guarantees that, as long as the data is locked, no other program can modify it. When another program requests the data, the database server either makes the program wait or turns it back with an error.

Locks and performance

Because a lock serializes access to one piece of data, it reduces concurrency; any other programs that want access to that data must wait. The database server can place a lock on a single row, a disk page, a whole table, or an entire database. (A disk page might hold multiple rows and a row might require multiple disk pages.) The more locks it places and the larger the objects it locks, the more concurrency is reduced. The fewer the locks and the smaller the locked objects, the greater concurrency and performance can be.

The following sections discuss how you can achieve the following goals with your program:

- Place all the locks necessary to ensure data integrity.
- Lock the fewest, smallest pieces of data possible consistent with the preceding goal.

Concurrency issues

To understand the hazards of concurrency, you must think in terms of multiple programs, each executing at its own speed. Suppose that your program is fetching rows through the following cursor:

```
EXEC SQL DECLARE sto_cursor CURSOR FOR
SELECT * FROM stock
WHERE manu_code = 'ANZ';
```

The transfer of each row from the database server to the program takes time. During and between transfers, other programs can perform other database operations. At about the same time that your program fetches the rows produced by that query, another user's program might execute the following update:

```
EXEC SQL UPDATE stock
SET unit_price = 1.15 * unit_price
WHERE manu_code = 'ANZ';
```

In other words, both programs are reading through the same table, one fetching certain rows and the other changing the same rows. The following scenarios are possible:

1. The other program finishes its update before your program fetches its first row.
Your program shows you only updated rows.
2. Your program fetches every row before the other program has a chance to update it.
Your program shows you only original rows.
3. After your program fetches some original rows, the other program catches up and goes on to update some rows that your program has yet to read; then it executes the COMMIT WORK statement.
Your program might return a mixture of original rows and updated rows.
4. Same as number 3, except that after updating the table, the other program issues a ROLLBACK WORK statement.
Your program can show you a mixture of original rows and updated rows that no longer exist in the database.

The first two possibilities are harmless. In possibility number 1, the update is complete before your query begins. It makes no difference whether the update finished a microsecond ago or a week ago.

In possibility number 2, your query is, in effect, complete before the update begins. The other program might have been working just one row behind yours, or it might not start until tomorrow night; it does not matter.

The last two possibilities, however, can be important to the design of some applications. In possibility number 3, the query returns a mix of updated and original data. That result can be detrimental in some applications. In others, such as one that is taking an average of all prices, it might not matter at all.

Possibility number 4 can be disastrous if a program returns some rows of data that, because their transaction was cancelled, can no longer be found in the table.

Another concern arises when your program uses a cursor to update or delete the last-fetched row. Erroneous results occur with the following sequence of events:

- Your program fetches the row.
- Another program updates or deletes the row.
- Your program updates or deletes WHERE CURRENT OF *cursor_name*.

To control concurrent events such as these, use the locking and *isolation level* features of the database server.

How locks work

IBM® Informix® database servers support a complex, flexible set of locking features that the topics in this section describe.

- [Kinds of locks](#)
- [Lock scope](#)
- [Duration of a lock](#)

- [Locks while modifying](#)

Kinds of locks

The following table shows the types of locks that IBM® Informix® database servers support for different situations.

Lock type	Use
Shared	A shared lock reserves its object for reading only. It prevents the object from changing while the lock remains. More than one program can place a shared lock on the same object. More than one object can read the record while it is locked in shared mode.
Exclusive	An exclusive lock reserves its object for the use of a single program. This lock is used when the program intends to change the object. You cannot place an exclusive lock where any other kind of lock exists. After you place an exclusive lock, you cannot place another lock on the same object.
Promotable (or Update)	A promotable (or update) lock establishes the intent to update. You can only place it where no other promotable or exclusive lock exists. You can place promotable locks on records that already have shared locks. When the program is about to change the locked object, you can promote the promotable lock to an exclusive lock, but only if no other locks, including shared locks, are on the record at the time the lock would change from promotable to exclusive. If a shared lock was on the record when the promotable lock was set, you must drop the shared lock before the promotable lock can be promoted to an exclusive lock.

Lock scope

You can apply locks to entire databases, entire tables, disk pages, single rows, or index-key values. The size of the object that is being locked is referred to as the *scope* of the lock (also called the *lock granularity*). In general, the larger the scope of a lock, the more concurrency is reduced, but the simpler programming becomes.

- [Database locks](#)
- [Table locks](#)
- [Row and key locks](#)
- [Page locks](#)
- [Coarse index locks](#)
- [Smart-large-object locks](#)

Database locks

You can lock an entire database. The act of opening a database places a shared lock on the name of the database. A database is opened with the CONNECT, DATABASE, or CREATE DATABASE statements. As long as a program has a database open, the shared lock on the name prevents any other program from dropping the database or putting an exclusive lock on it.

The following statement shows how you might lock an entire database exclusively:

```
DATABASE database_one EXCLUSIVE
```

This statement succeeds if no other program has opened that database. After the lock is placed, no other program can open the database, even for reading, because its attempt to place a shared lock on the database name fails.

A database lock is released only when the database closes. That action can be performed explicitly with the DISCONNECT or CLOSE DATABASE statements or implicitly by executing another DATABASE statement.

Because locking a database reduces concurrency in that database to zero, it makes programming simple; concurrent effects cannot happen. However, you should lock a database only when no other programs need access. Database locking is often used before applying massive changes to data during off-peak hours.

Table locks

You can lock entire tables. In some cases, the database server performs this action automatically. You can also use the LOCK TABLE statement to lock an entire table explicitly.

The LOCK TABLE statement or the database server can place the following types of table locks:

Shared lock

No users can write to the table. In shared mode, the database server places one shared lock on the table, which informs other users that no updates can be performed. In addition, the database server adds locks for every row updated, deleted, or inserted.

Exclusive lock

No other users can read from or write to the table. In exclusive mode, the database server places only one exclusive lock on the table, no matter how many rows it updates. An exclusive table lock prevents any concurrent use of the table and, therefore, can have a serious effect on performance if many other programs are contending for the use of the table. However, when you need to update most of the rows in a table, place an exclusive lock on the table.

- [Lock a table with the LOCK TABLE statement](#)
- [When the database server automatically locks a table](#)

- [Avoid table locking with the ONLINE keyword](#)

For indexes that are not defined with the IN TABLE keyword option, you can minimize the duration of an exclusive lock on the indexed table when you CREATE or DROP an index using the ONLINE keyword.

Lock a table with the LOCK TABLE statement

A transaction tells the database server to use table-level locking for a table with the LOCK TABLE statement. The following example shows how to place an exclusive lock on a table:

```
LOCK TABLE tab1 IN EXCLUSIVE MODE
```

The following example shows how to place a shared lock on a table:

```
LOCK TABLE tab2 IN SHARE MODE
```

Tip: You can set the isolation level for your database server to achieve the same degree of protection as the shared table lock while providing greater concurrency.

When the database server automatically locks a table

The database server always locks an entire table while it performs operations for any of the following statements:

- ALTER FRAGMENT
- ALTER INDEX
- ALTER TABLE
- CREATE INDEX
- DROP INDEX
- RENAME COLUMN
- RENAME TABLE

Completion of the statement (or end of the transaction) releases the lock. An entire table can also be locked automatically during certain queries.

Avoid table locking with the ONLINE keyword

For indexes that are not defined with the IN TABLE keyword option, you can minimize the duration of an exclusive lock on the indexed table when you CREATE or DROP an index using the ONLINE keyword.

While the index is being created or dropped online, no DDL operations on the table are supported, but operations that were concurrent when the CREATE INDEX or DROP INDEX statement was issued can be completed. The specified index is not created or dropped until no other processes are concurrently accessing the table. Then locks are held briefly to write the system catalog data associated with the index. This increases the availability of the system, because the table is still readable by ongoing and new sessions. The following statement shows how to use the ONLINE keyword to avoid automatic table locking with a CREATE INDEX statement:

```
CREATE INDEX idx_1 ON customer (lname) ONLINE;
```

For in-table indexes, however, that are defined with the IN TABLE keyword option, the indexed table remains locked for the duration of the CREATE INDEX or DROP INDEX operation that includes the ONLINE keyword. Attempted access by other sessions to the locked table would fail with at least one of these errors:

```
107: ISAM error: record is locked.
211: Cannot read system catalog (systables).
710: Table (table.tix) has been dropped, altered or renamed.
```

Row and key locks

You can lock one row of a table. A program can lock one row or a selection of rows while other programs continue to work on other rows of the same table.

Row and key locking are not the default behaviors. You must specify row-level locking when you create the table. The following example creates a table with row-level locking:

```
CREATE TABLE tab1
(
  col1...
) LOCK MODE ROW;
```

If you specify a LOCK MODE clause when you create a table, you can later change the lock mode with the ALTER TABLE statement. The following statement changes the lock mode on the reservations table to page-level locking:

```
ALTER TABLE tab1 LOCK MODE PAGE
```

In certain cases, the database server has to lock a row that does not exist. To do this, the database server places a lock on an index-key value. Key locks are used identically to row locks. When the table uses row locking, key locks are implemented as locks on imaginary rows. When the table uses page locking, a key lock is placed on the index page that contains the key or that would contain the key if it existed.

When you insert, update, or delete a key (performed automatically when you insert, update, or delete a row), the database server creates a lock on the key in the index.

Row and key locks generally provide the best performance overall when you update a relatively small number of rows because they increase concurrency. However, the database server incurs some overhead in obtaining a lock.

When one or more rows in a table are locked by an exclusive lock, the effect on other users partly depends on their transaction isolation level. Other users whose isolation levels is not Dirty Read might encounter transactions that fail because the exclusive lock was not released within a specified time limit.

For Committed Read or Dirty Read isolation level operations that attempt to access tables on which a concurrent session has set exclusive row-level locks, the risk of locking conflicts can be reduced by enabling transactions to read the most recently committed version of the data in the locked rows, rather than waiting for the transaction that set the lock to be committed or rolled back. Enabling access to the last committed version of exclusively locked rows can be accomplished in several ways:

- For an individual session, issue this SQL statement

```
SET ISOLATION TO COMMITTED READ LAST COMMITTED;
```

- For all sessions using the Committed Read or Read Committed isolation level, the DBA can set the USELASTCOMMITTED configuration parameter to 'ALL' or to 'COMMITTED READ'.
- For an individual session using the Committed Read or Read Committed isolation level, any user can issue the SET ENVIRONMENT USELASTCOMMITTED statement with 'ALL' or 'COMMITTED READ' as the value of this session environment option.
- For all sessions using Dirty Read or Read Uncommitted isolation levels, the DBA can set the USELASTCOMMITTED configuration parameter to 'ALL' or to 'DIRTY READ'.
- For an individual session using the Dirty Read or Read Uncommitted isolation levels, any user can issue the SET ENVIRONMENT USELASTCOMMITTED statement with 'ALL' or 'DIRTY READ' as the value of this session environment option.

This LAST COMMITTED feature is useful only when row-level locking is in effect, rather than when another session holds an exclusive lock on the entire table. This feature is disabled for any table on which the LOCK TABLE statement applies a table-level lock. See the description of the SET ENVIRONMENT statement in the *IBM® Informix® Guide to SQL: Syntax* and the description of the USELASTCOMMITTED configuration parameter in *IBM Informix Administrator's Reference* for more information about this feature for concurrent access to tables in which some rows are locked by exclusive locks, and for restrictions on the kinds of tables that can support this feature.

Page locks

The database server stores data in units called *disk pages*. A disk page contains one or more rows. In some cases, it is better to lock a disk page than to lock individual rows on it. For example, with operations that require changing a large number of rows, you might choose page-level locking because row-level locking (one lock per row) might not be cost effective.

If you do not specify a LOCK MODE clause when you create a table, the default behavior for the database server is page-level locking. With page locking, the database server locks the entire page that contains the row. If you update several rows that are stored on the same page, the database server uses only one lock for the page.

- [Set the row or page lock mode for all CREATE TABLE statements](#)

Set the row or page lock mode for all CREATE TABLE statements

IBM® Informix® allows you to set the lock mode to page-level locking or row-level locking for all newly created tables for a single user (per session) or for multiple users (per server). You no longer need to specify the lock mode every time that you create a new table with the CREATE TABLE statement.

If you want every new table created within your session to be created with a particular lock mode, you have to set the IFX_DEF_TABLE_LOCKMODE environment variable. For example, for every new table created within your session to be created with lock mode row, set IFX_DEF_TABLE_LOCKMODE to ROW. To override this behavior, use the CREATE TABLE or ALTER TABLE statements and redefine the LOCK MODE clause.

- [Single-user lock mode](#)
- [Multiple-user lock mode](#)
- [Rules of precedence](#)

Single-user lock mode

Set the single-user lock mode if all of the new tables that you create in your session require the same lock mode. Set the single-user lock mode with the IFX_DEF_TABLE_LOCKMODE environment variable. For example, for every new table created within your session to be created with row-level locking, set IFX_DEF_TABLE_LOCKMODE to ROW. To override this behavior, use the CREATE TABLE or ALTER TABLE statements and redefine the LOCK MODE clause. For more information on setting environment variables, see the *IBM® Informix® Guide to SQL: Reference*.

Multiple-user lock mode

Database administrators can use the multiple-user lock mode to create greater concurrency by designating the lock mode for all users on the same server. All tables that any user creates on that server will then have the same lock mode. To enable multiple-user lock mode, set the IFX_DEF_TABLE_LOCKMODE

environment variable before starting the database server or set the DEF_TABLES_LOCKMODE configuration parameter.

Rules of precedence

Locking mode for CREATE TABLE or ALTER TABLE has the following rules of precedence, listed in order of highest precedence to lowest:

1. CREATE TABLE or ALTER TABLE SQL statements that use the LOCK MODE clause
2. Single-user environment variable setting
3. Multi-user environment variable setting in the server environment
4. Configuration parameters in the configuration file
5. Default behavior (page-level locking)

Coarse index locks

When you change the lock mode of an index from normal to coarse lock mode, index-level locks are acquired on the index instead of item-level or page-level locks, which are the normal locks. This mode reduces the number of lock calls on an index.

Use the coarse lock mode when you know the index is not going to change; that is, when read-only operations are performed on the index.

Use the normal lock mode to have the database server place item-level or page-level locks on the index as necessary. Use this mode when the index gets updated frequently.

When the database server executes the command to change the lock mode to coarse, it acquires an exclusive lock on the table for the duration of the command. Any transactions that are currently using a lock of finer granularity must complete before the database server switches to the coarse lock mode.

Smart-large-object locks

Locks on a CLOB or BLOB column are separate from the lock on the row. Smart large objects are locked only when they are accessed. When you lock a table that contains a CLOB or BLOB column, no smart large objects are locked. If accessed for writing, the smart large object is locked in update mode, and the lock is promoted to exclusive when the actual write occurs. If accessed for reading, the smart large object is locked in shared mode. The database server recognizes the transaction isolation mode, so if Repeatable Read isolation level is set, the database server does not release smart-large-object read locks before end of transaction.

When the database server retrieves a row and updates a smart large object that the row points to, only the smart large object is exclusively locked during the time it is being updated.

- [Byte-range locks](#)

Byte-range locks

You can lock a range of bytes for a smart large object. Byte-range locks allow a transaction to selectively lock only those bytes that are accessed so that writers and readers simultaneously can access different byte ranges in the same smart large object.

For information about how to use byte-range locks, see your *IBM® Informix® Performance Guide*.

Byte-range locks support deadlock detection. For information about deadlock detection, see [Handle a deadlock](#).

Duration of a lock

The program controls the duration of a database lock. A database lock is released when the database closes.

Depending on whether the database uses transactions, table lock durations vary. If the database does not use transactions (that is, if no transaction log exists and you do not use a COMMIT WORK statement), a table lock remains until it is removed by the execution of the UNLOCK TABLE statement.

The duration of table, row, and index locks depends on what SQL statements you use and on whether transactions are in use.

When you use transactions, the end of a transaction releases all table, row, page, and index locks. When a transaction ends, all locks are released.

Locks while modifying

When the database server fetches a row through an update cursor, it places a promotable lock on the fetched row. If this action succeeds, the database server knows that no other program can alter that row. Because a promotable lock is not exclusive, other programs can continue to read the row. A promotable lock can improve performance because the program that fetched the row can take some time before it issues the UPDATE or DELETE statement, or it can simply fetch the

next row. When it is time to modify a row, the database server obtains an exclusive lock on the row. If it already has a promotable lock, it changes that lock to exclusive status.

The duration of an exclusive row lock depends on whether transactions are in use. If they are not in use, the lock is released as soon as the modified row is written to disk. When transactions are in use, all such locks are held until the end of the transaction. This action prevents other programs from using rows that might be rolled back to their original state.

When transactions are in use, a key lock is used whenever a row is deleted. Using a key lock prevents the following error from occurring:

- Program A deletes a row.
- Program B inserts a row that has the same key.
- Program A rolls back its transaction, forcing the database server to restore its deleted row.
What is to be done with the row inserted by Program B?

By locking the index, the database server prevents a second program from inserting a row until the first program commits its transaction.

The locks placed while the database server reads various rows are controlled by the current isolation level, as discussed in the next section.

Lock with the SELECT statement

The type and duration of locks that the database server places depend on the isolation set in the application and whether the SELECT statement is within an update cursor.

This section describes the different isolation levels and update cursors.

- [Set the isolation level](#)
- [Update cursors](#)

Set the isolation level

The *isolation level* is the degree to which your program is isolated from the concurrent actions of other programs. The database server offers a choice of isolation levels that reflect a different set of rules for how a program uses locks when it reads data.

To set the isolation level, use either the SET ISOLATION or SET TRANSACTION statement. The SET TRANSACTION statement also lets you set access modes. For more information about access modes, see [Control data modification with access modes](#).

- [SET TRANSACTION versus SET ISOLATION](#)
- [ANSI Read Uncommitted and IBM Informix Dirty Read isolation](#)
- [ANSI Read Committed and IBM Informix Committed Read isolation](#)
- [IBM Informix Cursor Stability isolation](#)
- [ANSI Serializable, ANSI Repeatable Read, and IBM Informix Repeatable Read isolation](#)

SET TRANSACTION versus SET ISOLATION

The SET TRANSACTION statement complies with ANSI SQL-92. This statement is similar to the IBM® Informix® SET ISOLATION statement; however, the SET ISOLATION statement is not ANSI compliant and does not provide access modes.

The following table shows the relationships between the isolation levels that you set with the SET TRANSACTION and SET ISOLATION statements.

SET TRANSACTION correlates with	SET ISOLATION
Read Uncommitted	Dirty Read
Read Committed	Committed Read
Not Supported	Cursor Stability
(ANSI) Repeatable Read Serializable	(IBM Informix) Repeatable Read (IBM Informix) Repeatable Read

The major difference between the SET TRANSACTION and SET ISOLATION statements is the behavior of the isolation levels within transactions. The SET TRANSACTION statement can be issued only once for a transaction. Any cursors opened during that transaction are guaranteed to have that isolation level (or access mode if you are defining an access mode). With the SET ISOLATION statement, after a transaction is started, you can change the isolation level more than once within the transaction. The following examples illustrate the difference between the use of SET ISOLATION and the use of SET TRANSACTION.

- [SET ISOLATION](#)
- [SET TRANSACTION](#)

SET ISOLATION

```
EXEC SQL BEGIN WORK;
EXEC SQL SET ISOLATION TO DIRTY READ;
EXEC SQL SELECT ... ;
EXEC SQL SET ISOLATION TO REPEATABLE READ;
EXEC SQL INSERT ... ;
EXEC SQL COMMIT WORK;
-- Executes without error
```

SET TRANSACTION

```
EXEC SQL BEGIN WORK;
EXEC SQL SET TRANSACTION ISOLATION LEVEL TO SERIALIZABLE;
EXEC SQL SELECT ... ;
EXEC SQL SET TRANSACTION ISOLATION LEVEL TO READ COMMITTED;
Error -876: Cannot issue SET TRANSACTION once a transaction has started.
```

ANSI Read Uncommitted and IBM Informix Dirty Read isolation

The simplest isolation level, ANSI Read Uncommitted and IBM® Informix® Dirty Read, amounts to virtually no isolation. When a program fetches a row, it places no locks, and it respects none; it simply copies rows from the database without regard to what other programs are doing.

A program always receives complete rows of data. Even under ANSI Read Uncommitted or IBM Informix Dirty Read isolation, a program never sees a row in which some columns are updated and some are not. However, a program that uses ANSI Read Uncommitted or IBM Informix Dirty Read isolation sometimes reads updated rows before the updating program ends its transaction. If the updating program later rolls back its transaction, the reading program processes data that never really existed (possibility number 4 in the list of concurrency issues).

ANSI Read Uncommitted or IBM Informix Dirty Read is the most efficient isolation level. The reading program never waits and never makes another program wait. It is the preferred level in any of the following cases:

- All tables are static; that is, concurrent programs only read and never modify data.
- The table is held in an exclusive lock.
- Only one program is using the table.

ANSI Read Committed and IBM Informix Committed Read isolation

When a program requests the ANSI Read Committed or IBM® Informix® Committed Read isolation level, the database server guarantees that it never returns a row that is not committed to the database. This action prevents reading data that is not committed and that is subsequently rolled back.

ANSI Read Committed or IBM Informix Committed Read is implemented simply. Before it fetches a row, the database server tests to determine whether an updating process placed a lock on the row; if not, it returns the row. Because rows that have been updated (but that are not yet committed) have locks on them, this test ensures that the program does not read uncommitted data.

ANSI Read Committed or IBM Informix Committed Read does not actually place a lock on the fetched row, so this isolation level is almost as efficient as ANSI Read Uncommitted or IBM Informix Dirty Read. This isolation level is appropriate to use when each row of data is processed as an independent unit, without reference to other rows in the same or other tables.

Locking conflicts can occur in ANSI Read Committed or IBM Informix Committed Read sessions, however, if the attempt to place the test lock is not successful because a concurrent session holds a shared lock on the row. To avoid waiting for concurrent transactions to release shared locks (by committing or rolling back), supports the Last Committed option to the Committed Read isolation level. When this Last Committed option is in effect, a shared lock by another session causes the query to return the most recently committed version of the row.

The Last Committed feature can also be activated by setting the USELASTCOMMITTED configuration parameter to 'COMMITTED READ' or to 'ALL', or by setting USELASTCOMMITTED session environment option in the SET ENVIRONMENT statement in the **sysdbopen()** procedure when the user connects to the database. For more information about the Last Committed option to the ANSI Read Committed or IBM Informix Committed Read isolation levels, see the description of the SET ISOLATION statement in the *IBM Informix Guide to SQL: Syntax*. For information about the USELASTCOMMITTED configuration parameter, see the *IBM Informix Administrator's Reference*.

IBM® Informix® Cursor Stability isolation

The next level, Cursor Stability, is available only with the SQL statement SET ISOLATION.

When Cursor Stability is in effect, places a lock on the latest row fetched. It places a shared lock for an ordinary cursor or a promotable lock for an update cursor. Only one row is locked at a time; that is, each time a row is fetched, the lock on the previous row is released (unless that row is updated, in which case the lock holds until the end of the transaction). Because Cursor Stability locks only one row at a time, it restricts concurrency less than a table lock or database lock.

Cursor Stability ensures that a row does not change while the program examines it. Such row stability is important when the program updates some other table based on the data it reads from the row. Because of Cursor Stability, the program is assured that the update is based on current information. It prevents the use of *stale data*.

The following example illustrates effective use of Cursor Stability isolation. In terms of the demonstration database, Program A wants to insert a new stock item for manufacturer Hero (HRO). Concurrently, Program B wants to delete manufacturer HRO and all stock associated with it. The following sequence of events can occur:

1. Program A, operating under Cursor Stability, fetches the HRO row from the **manufact** table to learn the manufacturer code. This action places a shared lock on the row.
2. Program B issues a DELETE statement for that row. Because of the lock, the database server makes the program wait.
3. Program A inserts a new row in the **stock** table using the manufacturer code it obtained from the **manufact** table.
4. Program A closes its cursor on the **manufact** table or reads a different row of it, releasing its lock.
5. Program B, released from its wait, completes the deletion of the row and goes on to delete the rows of **stock** that use manufacturer code HRO, including the row that Program A just inserted.

If Program A used a lesser level of isolation, the following sequence could occur:

1. Program A reads the HRO row of the **manufact** table to learn the manufacturer code. No lock is placed.
2. Program B issues a DELETE statement for that row. It succeeds.
3. Program B deletes all rows of **stock** that use manufacturer code HRO.
4. Program B ends.
5. Program A, not aware that its copy of the HRO row is now invalid, inserts a new row of **stock** using the manufacturer code HRO.
6. Program A ends.

At the end, a row occurs in **stock** that has no matching manufacturer code in **manufact**. Furthermore, Program B apparently has a bug; it did not delete the rows that it was supposed to delete. Use of the Cursor Stability isolation level prevents these effects.

The preceding scenario could be rearranged to fail even with Cursor Stability. All that is required is for Program B to operate on tables in the reverse sequence to Program A. If Program B deletes from **stock** before it removes the row of **manufact**, no degree of isolation can prevent an error. Whenever this kind of error is possible, all programs that are involved must use the same sequence of access.

ANSI Serializable, ANSI Repeatable Read, and IBM Informix Repeatable Read isolation

Where ANSI Serializable or ANSI Repeatable Read are required, a single isolation level is provided, called IBM® Informix® Repeatable Read. This is logically equivalent to ANSI Serializable. Because ANSI Serializable is more restrictive than ANSI Repeatable Read, IBM Informix Repeatable Read can be used when ANSI Repeatable Read is desired (although IBM Informix Repeatable Read is more restrictive than is necessary in such contexts).

The Repeatable Read isolation level asks the database server to put a lock on every row the program examines and fetches. The locks that are placed are shareable for an ordinary cursor and promotable for an update cursor. The locks are placed individually as each row is examined. They are not released until the cursor closes or a transaction ends.

Repeatable Read allows a program that uses a scroll cursor to read selected rows more than once and to be sure that they are not modified or deleted between readings. ([SQL programming](#) describes scroll cursors.) No lower isolation level guarantees that rows still exist and are unchanged the second time they are read.

Repeatable Read isolation places the largest number of locks and holds them the longest. Therefore, it is the level that reduces concurrency the most. If your program uses this level of isolation, think carefully about how many locks it places, how long they are held, and what the effect can be on other programs.

In addition to the effect on concurrency, the large number of locks can be a problem. The database server records the number of locks by each program in a lock table. If the maximum number of locks is exceeded, the lock table fills up, and the database server cannot place a lock. An error code is returned. The person who administers the Informix database server system can monitor the lock table and tell you when it is heavily used.

The isolation level in an ANSI-compliant database is set to Serializable by default. The Serializable isolation level is required to ensure that operations behave according to the ANSI standard for SQL.

Update cursors

An update cursor is a special kind of cursor that applications can use when the row might potentially be updated. To use an update cursor, execute SELECT FOR UPDATE in your application. Update cursors use *promotable locks*; that is, the database server places an update lock (meaning other users can still view the row) when the application fetches the row, but the lock is changed to an exclusive lock when the application updates the row using an update cursor and UPDATE...WHERE CURRENT OF.

The advantage of using an update cursor is that you can view the row with the confidence that other users cannot change it or view it with an update cursor while you are viewing it and before you update it.

Tip: In an ANSI-compliant database, update cursors are unnecessary because any select cursor behaves the same as an update cursor.

The pseudocode in the following figure shows when the database server places and releases locks with a cursor.

Figure 1. Locks Placed for Update

```
declare update cursor
begin work
open the cursor
fetch the row      ← Add an update lock for this row.
do stuff
update the row (use WHERE CURRENT OF) ← Promote lock to
commit work        ← Release lock. exclusive.
```

Retain update locks

If a user has the isolation level set lower than Repeatable Read, the database server releases update locks placed on rows as soon as the next row is fetched from a cursor. With this feature, you can use the `RETAIN UPDATE LOCKS` clause to retain an update lock until the end of a transaction when you set any of the following isolation levels:

- Dirty Read
- Committed Read
- Cursor Stability

This feature lets you avoid the overhead of Repeatable Read isolation level or workarounds such as dummy updates on a row. When the `RETAIN UPDATE LOCKS` feature is turned on and an update lock is implicitly placed on a row during a fetch of a `SELECT...FOR UPDATE` statement, the update lock is not released until the end of the transaction. With the `RETAIN UPDATE LOCKS` feature, only update locks are held until end of transaction, whereas the Repeatable Read isolation level holds both update locks and shared locks until end of transaction.

The following example shows how to use the `RETAIN UPDATE LOCKS` clause when you set the isolation level to Committed Read.

```
SET ISOLATION TO COMMITTED READ RETAIN UPDATE LOCKS
```

To turn off the `RETAIN UPDATE LOCKS` feature, set the isolation level without the `RETAIN UPDATE LOCKS` clause. When you turn off the feature, update locks are not released directly. However, from this point on, a subsequent fetch releases the update lock of the immediately preceding fetch but not of earlier fetch operations. A close cursor releases the update lock on the current row.

For more information about how to use the `RETAIN UPDATE LOCKS` feature when you specify an isolation level, see the *IBM® Informix® Guide to SQL: Syntax*.

Exclusive locks that occur with some SQL statements

When you execute an `INSERT`, `UPDATE`, or `DELETE` statement, the database server uses *exclusive locks*. An exclusive lock means that no other users can update or delete the item until the database server removes the lock. In addition, no other users can view the row unless they are using the Dirty Read isolation level.

When the database server removes the exclusive lock depends on whether the database supports transaction logging.

For more information about these exclusive locks, see [Locks placed with INSERT, UPDATE, and DELETE statements](#).

The behavior of the lock types

IBM® Informix® database servers store locks in an internal lock table. When the database server reads a row, it checks if the row or its associated page, table, or database is listed in the lock table. If it is in the lock table, the database server must also check the lock type. The lock table can contain the following types of locks.

Lock name	Description	Statement usually placing the lock
S	Shared lock	SELECT
X	Exclusive lock	INSERT, UPDATE, DELETE
U	Update lock	SELECT in an update cursor
B	Byte lock	Any statement that updates VARCHAR columns

In addition, the lock table might store *intent locks*. An intent lock can be an intent shared (IS), intent exclusive (IX), or intent shared exclusive (SIX). An intent lock is the lock the database server (lock manager) places on a higher granularity object when a lower granularity object needs to be locked. For example, when a user locks a row or page in Shared lock mode, the database server places an IS (intent shared) lock on the table to provide an instant check that no other user holds an X lock on the table. In this case, intent locks are placed on the table only and not on the row or page. Intent locks can be placed at the level of a row, page, or table only.

The user does not have direct control over intent locks; the lock manager internally manages all intent locks.

The following table shows what locks a user (or the database server) can place if another user (or the database server) holds a certain type of lock. For example, if one user holds an exclusive lock on an item, another user requesting any kind of lock (exclusive, update or shared) receives an error. In addition, the database server is unable to place any intent locks on an item if a user holds an exclusive lock on the item.

	Hold X lock	Hold U lock	Hold S lock	Hold IS lock	Hold SIX lock	Hold IX lock
Request X lock	No	No	No	No	No	No
Request U lock	No	No	Yes	Yes	No	No
Request S lock	No	Yes	Yes	Yes	No	No
Request IS lock	No	Yes	Yes	Yes	Yes	Yes
Request SIX lock	No	No	No	Yes	No	No
Request IX lock	No	No	No	Yes	No	Yes

For information about how locking affects performance, see your *IBM Informix Performance Guide*.

Control data modification with access modes

IBM® Informix® database servers support access modes. Access modes affect read and write concurrency for rows within transactions and are set with the SET TRANSACTION statement. You can use access modes to control data modification among shared files.

Transactions are read-write by default. If you specify that a transaction is read-only, that transaction cannot perform the following tasks:

- Insert, delete, or update table rows
- Create, alter, or drop any database object such as a schema, table, temporary table, index, or stored routine
- Grant or revoke privileges
- Update statistics
- Rename columns or tables

Read-only access mode prohibits updates.

You can execute stored routines in a read-only transaction as long as the routine does not try to perform any restricted operations.

For information about how to use the SET TRANSACTION statement to specify an access mode, see the *IBM Informix Guide to SQL: Syntax*.

Set the lock mode

The lock mode determines what happens when your program encounters locked data. One of the following situations occurs when a program attempts to fetch or modify a locked row:

- The database server immediately returns an error code in SQLCODE or SQLSTATE to the program.
- The database server suspends the program until the program that placed the lock removes the lock.
- The database server suspends the program for a time and then, if the lock is not removed, the database server sends an error-return code to the program.

You choose among these results with the SET LOCK MODE statement.

- [Waiting for locks](#)
- [Not waiting for locks](#)
- [Limited time wait](#)
- [Handle a deadlock](#)
- [Handling external deadlock](#)

Waiting for locks

When a user encounters a lock, the default behavior of a database server is to return an error to the application. If you prefer to wait indefinitely for a lock (this choice is best for many applications), you can execute the following SQL statement:

```
SET LOCK MODE TO WAIT
```

When this lock mode is set, your program usually ignores the existence of other concurrent programs. When your program needs to access a row that another program has locked, it waits until the lock is removed, then proceeds. In most cases, the delays are imperceptible.

You can also wait for a specific number of seconds, as in the following example:

```
SET LOCK MODE TO WAIT 20
```

Not waiting for locks

The disadvantage of waiting for locks is that the wait might become long (although properly designed applications should hold their locks briefly). When the possibility of a long delay is not acceptable, a program can execute the following statement:

```
SET LOCK MODE TO NOT WAIT
```

When the program requests a locked row, it immediately receives an error code (for example, error -107 *Record is locked*), and the current SQL statement terminates. The program must roll back its current transaction and try again.

The initial setting is not waiting when a program starts up. If you are using SQL interactively and see an error related to locking, set the lock mode to wait. If you are writing a program, consider making that one of the first embedded SQL statements that the program executes.

Limited time wait

You can ask the database server to set an upper limit on a wait with the following statement:

```
SET LOCK MODE TO WAIT 17
```

This statement places an upper limit of 17 seconds on the length of any wait. If a lock is not removed in that time, the error code is returned.

Handle a deadlock

A *deadlock* is a situation in which a pair of programs blocks the progress of each other. Each program has a lock on some object that the other program wants to access. A deadlock arises only when all programs concerned set their lock modes to wait for locks.

The IBM® Informix® database server detects deadlocks immediately when they only involve data at a single network server. It prevents the deadlock from occurring by returning an error code (error -143 `ISAM error: deadlock detected`) to the second program to request a lock. The error code is the one the program receives if it sets its lock mode to not wait for locks. If your program receives an error code related to locks even after it sets lock mode to wait, you know the cause is an impending deadlock.

Handling external deadlock

A deadlock can also occur between programs on different database servers. In this case, the database server cannot instantly detect the deadlock. (Perfect deadlock detection requires excessive communications traffic among all database servers in a network.) Instead, each database server sets an upper limit on the amount of time that a program can wait to obtain a lock on data at a different database server. If the time expires, the database server assumes that a deadlock was the cause and returns a lock-related error code.

In other words, when external databases are involved, every program runs with a maximum lock-waiting time. The DBA can set or modify the maximum for the database server.

Simple concurrency

If you are not sure which choice to make concerning locking and concurrency, you can use the following guideline: If your application accesses non-static tables, and there is no risk of deadlock, have your program execute the following statements when it starts up (immediately after the first `CONNECT` or `DATABASE` statement):

```
SET LOCK MODE TO WAIT
SET ISOLATION TO REPEATABLE READ
```

Ignore the return codes from both statements. Proceed as if no other programs exist. If no performance problems arise, you do not need to read this section again.

Hold cursors

When transaction logging is used, IBM® Informix® guarantees that anything done within a transaction can be rolled back at the end of it. To handle transactions reliably, the database server normally applies the following rules:

- When a transaction ends, all cursors are closed.
- When a transaction ends, all locks are released.

The rules that are used to handle transactions reliably are normal with most database systems that support transactions, and they do not cause any trouble for most applications. However, circumstances exist in which using standard transactions with cursors is not possible. For example, the following code works fine without transactions. However, when transactions are added, closing the cursor conflicts with using two cursors simultaneously.

```
EXEC SQL DECLARE master CURSOR FOR
EXEC SQL DECLARE detail CURSOR FOR FOR UPDATE
EXEC SQL OPEN master;
while (SQLCODE == 0)
{
    EXEC SQL FETCH master INTO
    if (SQLCODE == 0)
    {
        EXEC SQL BEGIN WORK;
        EXEC SQL OPEN detail USING
        EXEC SQL FETCH detail
        EXEC SQL UPDATE WHERE CURRENT OF detail
        EXEC SQL COMMIT WORK;
    }
}
EXEC SQL CLOSE master;
```

In this design, one cursor is used to scan a table. Selected records are used as the basis for updating a different table. The problem is that when each update is treated as a separate transaction (as the pseudocode in the previous example shows), the `COMMIT WORK` statement following the `UPDATE` closes all cursors, including the master cursor.

The simplest alternative is to move the `COMMIT WORK` and `BEGIN WORK` statements to be the last and first statements, respectively, so that the entire scan over the master table is one large transaction. Treating the scan of the master table as one large transaction is sometimes possible, but it can become impractical if many rows need to be updated. The number of locks can be too large, and they are held for the duration of the program.

A solution that IBM Informix database servers support is to add the keywords WITH HOLD to the declaration of the master cursor. Such a cursor is referred to as a *hold cursor* and is not closed at the end of a transaction. The database server still closes all other cursors, and it still releases all locks, but the hold cursor remains open until it is explicitly closed.

Before you attempt to use a hold cursor, you must be sure that you understand the locking mechanism described here, and you must also understand the programs that are running concurrently. Whenever COMMIT WORK is executed, all locks are released, including any locks placed on rows fetched through the hold cursor.

The removal of locks has little importance if the cursor is used as intended, for a single forward scan over a table. However, you can specify WITH HOLD for any cursor, including update cursors and scroll cursors. Before you do this, you must understand the implications of the fact that all locks (including locks on entire tables) are released at the end of a transaction.

The SQL statement cache

The SQL statement cache is a feature that lets you store in a buffer identical SQL statements that are executed repeatedly so the statements can be reused among different user sessions without the need for per-session memory allocation. Statement caching can dramatically improve performance for applications that contain a large number of prepared statements. However, performance improvements are less dramatic when statement caching is used to cache statements that are prepared once and executed many times.

Use SQL to turn on or turn off statement caching for an individual database session when statement caching is enabled for the database server. The following statement shows how to use SQL to turn on caching for the current database session:

```
SET STATEMENT CACHE ON
```

The following statement shows how to use SQL to turn off caching for the current database session:

```
SET STATEMENT CACHE OFF
```

If you attempt to turn on or turn off statement caching when caching is disabled, the database server returns an error.

For information about syntax for the SET STATEMENT CACHE statement, see the *IBM® Informix® Guide to SQL: Syntax*. For information about the STMT_CACHE and STMT_CACHE_SIZE configuration parameters, see the *IBM Informix Administrator's Reference* and your *IBM Informix Performance Guide*. For information about the STMT_CACHE environment variable, see the *IBM Informix Guide to SQL: Reference*.

Summary

Whenever multiple programs have access to a database concurrently (and when at least one of them can modify data), all programs must allow for the possibility that another program can change the data even as they read it. The database server provides a mechanism of locks and isolation levels that usually allow programs to run as if they were alone with the data.

The SET STATEMENT CACHE statement allows you to store in a buffer identical SQL statements that are used repeatedly. When statement caching is turned on, the database server stores the identical statements so they can be reused among different user sessions without the need for per-session memory allocation.

Create and use SPL routines

This section describes how to create and use SPL routines. An SPL routine is a user-defined routine written in IBM® Informix® Stored Procedure Language (SPL). IBM Informix SPL is an extension to SQL that provides flow control, such as looping and branching. Anyone who has the Resource privilege on a database can create an SPL routine.

Routines written in SQL are parsed, optimized as far as possible, and then stored in the system catalog tables in executable format. An SPL routine might be a good choice for SQL-intensive tasks. SPL routines can execute routines written in C or other external languages, and external routines can execute SPL routines.

You can use SPL routines to perform any task that you can perform in SQL and to expand what you can accomplish with SQL alone. Because SPL is a language native to the database, and because SPL routines are parsed and optimized when they are created rather than at runtime, SPL routines can improve performance for some tasks. SPL routines can also reduce traffic between a client application and the database server and reduce program complexity.

The syntax for each SPL statement is described in the *IBM Informix Guide to SQL: Syntax*. Examples accompany the syntax for each statement.

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Introduction to SPL routines

An SPL *routine* is a generic term that includes SPL *procedures* and SPL *functions*. An SPL procedure is a routine written in SPL and SQL that does not return a value. An SPL function is a routine written in SPL and SQL that returns a single value, a value with a complex data type, or multiple values. Generally, a routine written in SPL that returns a value is an SPL function.

You use SQL and SPL statements to write an SPL routine. SPL statements can be used only inside the CREATE PROCEDURE, CREATE PROCEDURE FROM, CREATE FUNCTION, and CREATE FUNCTION FROM statements. All these statements are available with SQL APIs such as IBM® Informix® ESQL/C. The CREATE PROCEDURE and CREATE FUNCTION statements are available with DB-Access.

To list all SPL routines in a database, run this command, which creates and displays the schema for a database:

```
dbschema -d database_name -f all
```

- [What you can do with SPL routines](#)

What you can do with SPL routines

You can accomplish a wide range of objectives with SPL routines, including improving database performance, simplifying writing applications, and limiting or monitoring access to data.

Because an SPL routine is stored in an executable format, you can use it to execute frequently repeated tasks to improve performance. When you execute an SPL routine rather than straight SQL code, you can bypass repeated parsing, validity checking, and query optimization.

You can use an SPL routine in a data-manipulation SQL statement to supply values to that statement. For example, you can use a routine to perform the following actions:

- Supply values to be inserted into a table
- Supply a value that makes up part of a condition clause in a SELECT, DELETE, or UPDATE statement

These actions are two possible uses of a routine in a data-manipulation statement, but others exist. In fact, any expression in a data-manipulation SQL statement can consist of a routine call.

You can also issue SQL statements in an SPL routine to hide those SQL statements from a database user. Rather than having all users learn how to use SQL, one experienced SQL user can write an SPL routine to encapsulate an SQL activity and let others know that the routine is stored in the database so that they can execute it.

You can write an SPL routine to be run with the DBA privilege by a user who does not have the DBA privilege. This feature allows you to limit and control access to data in the database. Alternatively, an SPL routine can monitor the users who access certain tables or data. For more information about how to use SPL routines to control access to data, see the *IBM Informix Database Design and Implementation Guide*.

You also can write SPL routines that use Dynamic SQL. For an overview with detailed examples of how to create and use prepared objects and Dynamic SQL in SPL routines, see this IBM® developerWorks® article: [Dynamic SQL support in Informix® Dynamic Server Stored Procedure Language](#).

SPL routines format

An SPL routine consists of a beginning statement, a statement block, and an ending statement. Within the statement block, you can use SQL or SPL statements.

- [The CREATE PROCEDURE or CREATE FUNCTION statement](#)
- [Example of a complete routine](#)
- [Create an SPL routine in a program](#)
- [Dropping a routine in a local or remote database](#)

The CREATE PROCEDURE or CREATE FUNCTION statement

You must first decide if the routine that you are creating returns values or not. If the routine does not return a value, use the CREATE PROCEDURE statement to create an SPL procedure. If the routine returns a value, use the CREATE FUNCTION statement to create an SPL function.

To create an SPL routine, use one CREATE PROCEDURE or CREATE FUNCTION statement to write the body of the routine and register it.

- [Begin and end the routine](#)
- [Specify a routine name](#)
- [Add a specific name](#)
- [Add a parameter list](#)
- [Add a return clause](#)
- [Add display labels](#)
- [Specify whether the SPL function is variant](#)
- [Add a modifier](#)
- [Specify a DOCUMENT clause](#)
- [Specify a listing file](#)

- [Add comments](#)

Begin and end the routine

To create an SPL routine that does not return values, start with the CREATE PROCEDURE statement and end with the END PROCEDURE keyword. The following figure shows how to begin and end an SPL procedure.

Figure 1. Begin and end an SPL procedure.

```
CREATE PROCEDURE new_price( per_cent REAL )  
.  
.  
.  
END PROCEDURE;
```

For more information about naming conventions, see the Identifier segment in the *IBM Informix Guide to SQL: Syntax*.

To create an SPL function that returns one or more values, start with the CREATE FUNCTION statement and end with the END FUNCTION keyword. The following figure shows how to begin and end an SPL function.

Figure 2. Begin and end an SPL function.

```
CREATE FUNCTION discount_price( per_cent REAL)  
RETURNING MONEY;  
.  
.  
.  
END FUNCTION;
```

In SPL routines, the END PROCEDURE or END FUNCTION keywords are required.

Important: For compatibility with earlier IBM® Informix® products, you can use CREATE PROCEDURE with a RETURNING clause to create a user-defined routine that returns a value. Your code will be easier to read and to maintain, however, if you use CREATE PROCEDURE for SPL routines that do not return values (SPL procedures) and CREATE FUNCTION for SPL routines that return one or more values (SPL functions).

Specify a routine name

You specify a name for the SPL routine immediately following the CREATE PROCEDURE or CREATE FUNCTION statement and before the parameter list, as the figure shows.

Figure 1. Specify a name for the SPL routine.

```
CREATE PROCEDURE add_price (arg INT )
```

IBM® Informix® allows you to create more than one SPL routine with the same name but with different parameters. This feature is known as *routine overloading*. For example, you might create each of the following SPL routines in your database:

```
CREATE PROCEDURE multiply (a INT, b FLOAT)  
CREATE PROCEDURE multiply (a INT, b SMALLINT)  
CREATE PROCEDURE multiply (a REAL, b REAL)
```

If you call a routine with the name **multiply()**, the database server evaluates the name of the routine and its arguments to determine which routine to execute.

Routine resolution is the process in which the database server searches for a routine signature that it can use, given the name of the routine and a list of arguments. Every routine has a *signature* that uniquely identifies the routine based on the following information:

- The type of routine (procedure or function)
- The routine name
- The number of parameters
- The data types of the parameters
- The order of the parameters

The routine signature is used in a CREATE, DROP, or EXECUTE statement if you enter the full parameter list of the routine. For example, each statement in the following figure uses a routine signature.

Figure 2. Routine signatures.

```
CREATE FUNCTION multiply(a INT, b INT);  
  
DROP PROCEDURE end_of_list(n SET, row_id INT);  
  
EXECUTE FUNCTION compare_point(m point, n point);
```

Add a specific name

Because IBM® Informix® supports routine overloading, an SPL routine might not be uniquely identified by its name alone. However, a routine can be uniquely identified by a *specific name*. A specific name is a unique identifier that you define in the CREATE PROCEDURE or CREATE FUNCTION statement, in addition to the routine name. A specific name is defined with the SPECIFIC keyword and is unique in the database. Two routines in the same database cannot have the same specific name, even if they have different owners.

A specific name can be up to 128 bytes long. The following figure shows how to define the specific name **calc1** in a CREATE FUNCTION statement that creates the **calculate()** function.

Figure 1. Define the specific name.

```
CREATE FUNCTION calculate(a INT, b INT, c INT)
  RETURNING INT
  SPECIFIC calc1;
. . .
END FUNCTION;
```

Because the owner **bsmith** has given the SPL function the specific name **calc1**, no other user can define a routine—SPL or external—with the specific name **calc1**. Now you can refer to the routine as **bsmith.calculate** or with the **SPECIFIC** keyword **calc1** in any statement that requires the **SPECIFIC** keyword.

Add a parameter list

When you create an SPL routine, you can define a parameter list so that the routine accepts one or more arguments when it is invoked. The parameter list is optional.

A parameter to an SPL routine must have a name and can be defined with a default value. The following are the categories of data types that a parameter can specify:

- Built-in data types
- Opaque data types
- Distinct data types
- Row types
- Collection types
- Smart large objects (CLOB and BLOB)

The parameter list cannot specify any of the following data types directly:

- SERIAL
- SERIAL8
- BIGSERIAL
- TEXT
- BYTE

For the serial data types, however, a routine can return numerically equivalent values that are cast to a corresponding integer type (INT, INT8, or BIGINT). Similarly, for a routine to support the simple large object data types, the parameter list can include the **REFERENCES** keyword to return a descriptor that points to the storage location of the TEXT or BYTE object.

The following figure shows examples of parameter lists.

Figure 1. Examples of different parameter lists.

```
CREATE PROCEDURE raise_price(per_cent INT);

CREATE FUNCTION  raise_price(per_cent INT DEFAULT 5);

CREATE PROCEDURE update_emp(n employee_t);
CREATE FUNCTION  update_nums( list1 LIST(ROW (a VARCHAR(10),
                                             b VARCHAR(10),
                                             c INT) NOT NULL ));
```

When you define a parameter, you accomplish two tasks at once:

- You request that the user supply a value when the routine is executed.
- You implicitly define a variable (with the same name as the parameter name) that you can use as a local variable in the body of the routine.

If you define a parameter with a default value, the user can execute the SPL routine with or without the corresponding argument. If the user executes the SPL routine without the argument, the database server assigns the parameter the default value as an argument.

When you invoke an SPL routine, you can give an argument a NULL value. SPL routines handle NULL values by default. However, you cannot give an argument a NULL value if the argument is a collection element.

- [Simple large objects as parameters](#)
- [Undefined arguments](#)

Simple large objects as parameters

Although you cannot define a parameter with a simple large object (a large object that contains TEXT or BYTE data types), you can use the **REFERENCES** keyword to define a parameter that points to a simple large object, as the following figure shows.

Figure 1. Use of the **REFERENCES** keyword.

```
CREATE PROCEDURE proc1(lo_text REFERENCES TEXT)

CREATE FUNCTION proc2(lo_byte REFERENCES BYTE DEFAULT NULL)
```

The **REFERENCES** keyword means that the SPL routine is passed a descriptor that contains a pointer to the simple large object, not the object itself.

Undefined arguments

When you invoke an SPL routine, you can specify all, some, or none of the defined arguments. If you do not specify an argument, and if its corresponding parameter does not have a default value, the argument, which is used as a variable within the SPL routine, is given a status of *undefined*.

Undefined is a special status used for SPL variables that have no value. The SPL routine executes without error, as long as you do not attempt to use the variable that has the status undefined in the body of the routine.

The undefined status is not the same as a NULL value. (The NULL value means that the value is not known, or does not exist, or is not applicable.)

Add a return clause

If you use CREATE FUNCTION to create an SPL routine, you must specify a return clause that returns one or more values.

Tip: If you use the CREATE PROCEDURE statement to create an SPL routine, you have the option of specifying a return clause. Your code will be easier to read and to maintain, however, if you instead use the CREATE FUNCTION statement to create a routine that returns values.

To specify a return clause, use the RETURNING or RETURNS keyword with a list of data types the routine will return. The data types can be any SQL data types except SERIAL, SERIAL8, TEXT, or BYTE.

The return clause in the following figure specifies that the SPL routine will return an INT value and a REAL value.

Figure 1. Specify the return clause.

```
FUNCTION find_group(id INT)
  RETURNING INT, REAL;
. . .
END FUNCTION;
```

After you specify a return clause, you must also specify a RETURN statement in the body of the routine that explicitly returns the values to the calling routine. For more information on writing the RETURN statement, see [Return values from an SPL function](#).

To specify that the function should return a simple large object (a TEXT or BYTE value), you must use the REFERENCES clause, as in the following figure, because an SPL routine returns only a pointer to the object, not the object itself.

Figure 2. Use of the REFERENCES clause.

```
CREATE FUNCTION find_obj(id INT)
  RETURNING REFERENCES BYTE;
```

Add display labels

You can use CREATE FUNCTION to create a routine that specifies names for the display labels for the values returned. If you do not specify names for the display labels, the labels will display as **expression**.

In addition, although using CREATE FUNCTION for routines that return values is recommended, you can use CREATE PROCEDURE to create a routine that returns values and specifies display labels for the values returned.

If you choose to specify a display label for one return value, you must specify a display label for every return value. In addition, each return value must have a unique display label.

To add display labels, you must specify a return clause, use the RETURNING keyword. The return clause in the following figure specifies that the routine will return an INT value with a `serial_num` display label, a CHAR value with a `name` display label, and an INT value with a `points` display label. You could use either CREATE FUNCTION or CREATE PROCEDURE in the following figure.

Figure 1. Specify the return clause.

```
CREATE FUNCTION p(inval INT DEFAULT 0)
  RETURNING INT AS serial_num, CHAR (10) AS name, INT AS points;
  RETURN (inval + 1002), "Newton", 100;
END FUNCTION;
```

The returned values and their display labels are shown in the following figure.

Figure 2. Returned values and their display labels.

<code>serial_num</code>	<code>name</code>	<code>points</code>
1002	Newton	100

Tip: Because you can specify display labels for return values directly in a SELECT statement, when a SPL routine is used in a SELECT statement, the labels will display as **expression**. For more information on specifying display labels for return values in a SELECT statement, see [Compose SELECT statements](#).

Specify whether the SPL function is variant

When you create an SPL function, the function is variant by default. A function is variant if it returns different results when it is invoked with the same arguments or if it modifies a database or variable state. For example, a function that returns the current date or time is a variant function.

Although SPL functions are variant by default, if you specify WITH NOT VARIANT when you create a function, the function cannot contain any SQL statements. You can define a functional index only on a nonvariant function.

Add a modifier

When you write SPL functions, you can use the WITH clause to add a modifier to the CREATE FUNCTION statement. In the WITH clause, you can specify the COMMUTATOR or NEGATOR functions. The other modifiers are for external routines.

Restriction: You can use the COMMUTATOR or NEGATOR modifiers with SPL functions only. You cannot use any modifiers with SPL procedures.

- [The COMMUTATOR modifier](#)
- [The NEGATOR modifier](#)

The COMMUTATOR modifier

The COMMUTATOR modifier allows you to specify an SPL function that is the *commutator function* of the SPL function you are creating. A commutator function accepts the same arguments as the SPL function you are creating, but in opposite order, and returns the same value. The commutator function might be more cost effective for the SQL optimizer to execute.

For example, the functions **lessthan(a,b)**, which returns TRUE if **a** is less than **b**, and **greaterthan(b,a)**, which returns TRUE if **b** is greater than or equal to **a**, are commutator functions. The following figure uses the WITH clause to define a commutator function.

Figure 1. Define a commutator function.

```
CREATE FUNCTION lessthan( a dtype1, b dtype2 )
  RETURNING BOOLEAN
  WITH ( COMMUTATOR = greaterthan );
. . .
END FUNCTION;
```

The optimizer might use **greaterthan(b,a)** if it is less expensive to execute than **lessthan(a,b)**. To specify a commutator function, you must own both the commutator function and the SPL function you are writing. You must also grant the user of your SPL function the Execute privilege on both functions.

For a detailed description of granting privileges, see the description of the GRANT statement in the *IBM® Informix® Guide to SQL: Syntax*.

The NEGATOR modifier

The NEGATOR modifier is available for Boolean functions. Two Boolean functions are *negator functions* if they take the same arguments, in the same order, and return complementary Boolean values.

For example, the functions **equal(a,b)**, which returns TRUE if **a** is equal to **b**, and **notequal(a,b)**, which returns FALSE if **a** is equal to **b**, are negator functions. The optimizer might choose to execute the negator function you specify if it is less expensive than the original function.

The following figure shows how to use the WITH clause of a CREATE FUNCTION statement to specify a negator function.

Figure 1. Specify a negator function.

```
CREATE FUNCTION equal( a dtype1, b dtype2 )
  RETURNING BOOLEAN
  WITH ( NEGATOR = notequal );
. . .
END FUNCTION;
```

Tip: By default, any SPL routine can handle NULL values that are passed to it in the argument list. In other words, the HANDLESNULLS modifier is set to YES for SPL routines, and you cannot change its value.

For more information on the COMMUTATOR and NEGATOR modifiers, see the Routine Modifier segment in the *IBM® Informix® Guide to SQL: Syntax*.

Specify a DOCUMENT clause

The DOCUMENT and WITH LISTING IN clauses follow END PROCEDURE or END FUNCTION statements.

The DOCUMENT clause lets you add comments to your SPL routine that another routine can select from the system catalog tables, if needed. The DOCUMENT clause in the following figure contains a usage statement that shows a user how to run the SPL routine.

Figure 1. Usage statement that shows a user how to run the SPL routine.

```
CREATE FUNCTION raise_prices(per_cent INT)
. . .
END FUNCTION
DOCUMENT "USAGE: EXECUTE FUNCTION raise_prices (xxx)",
        "xxx = percentage from 1 - 100";
```

Remember to place single or double quotation marks around the literal clause. If the literal clause extends past one line, place quotation marks around each line.

Specify a listing file

The WITH LISTING IN option allows you to direct any compile-time warnings that might occur to a file.

The following figure shows how to log the compile-time warnings in /tmp/warn_file when you work on UNIX.

Figure 1. Log the compile-time warnings on UNIX.

```
CREATE FUNCTION raise_prices(per_cent INT)
...
END FUNCTION
WITH LISTING IN '/tmp/warn_file'
```

The following figure shows how to log the compile-time warnings in \tmp\listfile when you work on Windows.

Figure 2. Log the compile-time warnings on Windows.

```
CREATE FUNCTION raise_prices(per_cent INT)
...
END FUNCTION
WITH LISTING IN 'C:\tmp\listfile'
```

Always remember to place single or double quotation marks around the file name or path name.

Add comments

You can add a comment to any line of an SPL routine, even a blank line.

To add a comment, use any of the following comment notation styles:

- Place a double hyphen (--) at the left of the comment.
- Enclose the comment text between a pair of braces ({ ... }).
- Delimit the comment between C-style "slash and asterisk" comment indicators (/* ... */).

To add a multiple-line comment, take one of the following actions:

- Place a double hyphen before each line of the comment
- Enclose the entire comment within the pair of braces.
- Place /* at the left of the first line of the comment, and place */ at the end of the last line of the comment.

Braces as comment indicators are IBM® Informix® an extension to the ANSI/ISO standard for the SQL language. All three comment styles are also valid in SPL routines.

If you use braces or C-style comment indicators to delimit the text of a comment, the opening indicator must be in the same style as the closing indicator.

All the examples in the following figure are valid comments.

Figure 1. Valid comment examples.

```
SELECT * FROM customer -- Selects all columns and rows

SELECT * FROM customer
-- Selects all columns and rows
-- from the customer table

SELECT * FROM customer
{ Selects all columns and rows
  from the customer table }

SELECT * FROM customer
/* Selects all columns and rows
   from the customer table */
```

Important: Braces ({ }) can be used to delimit comments and also to delimit the list of elements in a collection. To ensure that the parser correctly recognizes the end of a comment or list of elements in a collection, use the double hyphen (--) for comments in an SPL routine that handles collection data types.

Example of a complete routine

The following CREATE FUNCTION statement creates a routine that reads a customer address:

```
CREATE FUNCTION read_address (lastname CHAR(15)) -- one argument
RETURNING CHAR(15), CHAR(15), CHAR(20), CHAR(15), CHAR(2)
CHAR(5); -- 6 items

DEFINE p_lname, p_fname, p_city CHAR(15);
--define each routine variable
DEFINE p_add CHAR(20);
DEFINE p_state CHAR(2);
DEFINE p_zip CHAR(5);

SELECT fname, address1, city, state, zipcode
INTO p_fname, p_add, p_city, p_state, p_zip
FROM customer
WHERE lname = lastname;

RETURN p_fname, lastname, p_add, p_city, p_state, p_zip;
--6 items
```

```

END FUNCTION;

DOCUMENT 'This routine takes the last name of a customer as',
  --brief description
  'its only argument. It returns the full name and address',
  'of the customer.'

WITH LISTING IN 'pathname' -- modify this pathname according
-- to the conventions that your operating system requires

-- compile-time warnings go here
; -- end of the routine read_address

```

Create an SPL routine in a program

To use an SQL API to create an SPL routine, put the text of the CREATE PROCEDURE or CREATE FUNCTION statement in a file. Use the CREATE PROCEDURE FROM or CREATE FUNCTION FROM statement and refer to that file to compile the routine. For example, to create a routine to read a customer name, you can use a statement such as the one in the previous example and store it in a file. If the file is named read_add_source, the following statement compiles the **read_address** routine:

```
CREATE PROCEDURE FROM 'read_add_source';
```

The following example shows how the previous SQL statement looks in the Informix® ESQL/C program:

```

/* This program creates whatever routine is in *
 * the file 'read_add_source'.
 */
#include <stdio.h>
EXEC SQL include sqlca;
EXEC SQL include sqlda;
EXEC SQL include datetime;
/* Program to create a routine from the pwd */

main()
{
  EXEC SQL database play;
  EXEC SQL create procedure from 'read_add_source';
}

```

Dropping a routine in a local or remote database

After you create an SPL routine, you cannot change the body of the routine. Instead, you need to drop the routine and re-create it. Before you drop the routine, however, make sure that you have a copy of its text somewhere outside the database.

In general, use DROP PROCEDURE with an SPL procedure name and DROP FUNCTION with an SPL function name, as the following figure shows. Figure 1. DROP PROCEDURE and DROP FUNCTION.

```

DROP PROCEDURE raise_prices;
DROP FUNCTION read_address;

```

Tip: You can also use DROP PROCEDURE with a function name to drop an SPL function. However, it is recommended that you use DROP PROCEDURE only with procedure names and DROP FUNCTION only with function names.

If the database has other routines of the same name (overloaded routines), you cannot drop the SPL routine by its routine name alone. To drop a routine that has been overloaded, you must specify either its signature or its specific name. The following figure shows two ways that you might drop a routine that is overloaded. Figure 2. Drop a routine that is overloaded.

```

DROP FUNCTION calculate(INT, INT, INT);
  -- this is a signature

DROP SPECIFIC FUNCTION calc1;
  -- this is a specific name

```

If you do not know the type of a routine (function or procedure), you can use the DROP ROUTINE statement to drop it. DROP ROUTINE works with either functions or procedures. DROP ROUTINE also has a SPECIFIC keyword, as the following figure shows.

Figure 3. The DROP ROUTINE statement.

```

DROP ROUTINE calculate;
DROP SPECIFIC ROUTINE calc1;

```

Before you drop an SPL routine stored on a remote database server, be aware of the following restriction. You can drop an SPL routine with a fully qualified routine name in the form database@dbservername:owner.routinename only if the routine name alone, without its arguments, is enough to identify the routine.

Restrictions on data types in distributed operations

SPL routines that access tables in databases of non-local database servers, or that are invoked as UDRs of a database of another database server, can only have non-opaque built-in data types as their arguments or returned values.

If the tables or the UDR resides on another database of the same instance, however, the arguments and returned values of routines written in SPL (or in external languages that supports) can be the built-in opaque data types BLOB, BOOLEAN, CLOB, and LVARCHAR. They can also be UDTs or DISTINCT data types if the

following conditions are true:

- The remote database has the same server as the current database.
- The UDT arguments are explicitly cast to a built-in data type.
- The DISTINCT types are based on built-in types and are explicitly cast to built-in types.
- The SPL routine and all the casts are defined in all participating databases.

Define and use variables

Any variable that you use in an SPL routine, other than a variable that is implicitly defined in the parameter list of the routine, must be defined in the body of the routine.

The value of a variable is held in memory; the variable is not a database object. Therefore, rolling back a transaction does not restore the values of SPL variables.

To define a variable in an SPL routine, use the DEFINE statement. DEFINE is not an executable statement. DEFINE must appear after the CREATE PROCEDURE statement and before any other statements. The examples in the following figure are all legal variable definitions.

Figure 1. Variable definitions.

```
DEFINE a INT;  
DEFINE person person_t;  
DEFINE GLOBAL gl_out INT DEFAULT 13;
```

For more information on DEFINE, see the description in the *IBM® Informix® Guide to SQL: Syntax*.

An SPL variable has a name and a data type. The variable name must be a valid identifier, as described in the Identifier segment in the *IBM Informix Guide to SQL: Syntax*.

- [Declare local variables](#)
- [Declare global variables](#)
- [Assign values to variables](#)

Declare local variables

You can define a variable to be either *local* or *global* in scope. This section describes local variables. In an SPL routine, local variables:

- Are valid only for the duration of the SPL routine
- Are reset to their initial values or to a value the user passes to the routine, each time the routine is executed
- Cannot have default values

You can define a local variable on any of the following data types:

- Built-in data types (except SERIAL, SERIAL8, BIGSERIAL, TEXT, or BYTE)
- Any extended data type (row type, opaque, distinct, or collection type) that is defined in the database prior to execution of the SPL routine

The scope of a local variable is the statement block in which it is declared. You can use the same variable name outside the statement block with a different definition.

For more information on defining global variables, see [Declare global variables](#).

- [Scope of local variables](#)
- [Declare variables of built-in data types](#)
- [Declare variables for smart large objects](#)
- [Declare variables for simple large objects](#)
- [Declare collection variables](#)
- [Declare row-type variables](#)
- [Declare opaque- and distinct-type variables](#)
- [Declare variables for column data with the LIKE clause](#)
- [Declare PROCEDURE type variables](#)
- [Subscripts with variables](#)
- [Variable and keyword ambiguity](#)

Scope of local variables

A local variable is valid within the statement block in which it is defined and within any nested statement blocks, unless you redefine the variable within the statement block.

In the beginning of the SPL procedure in the following figure, the integer variables **x**, **y**, and **z** are defined and initialized.

Figure 1. Define and initialize variables.

```
CREATE PROCEDURE scope()  
  DEFINE x,y,z INT;  
  LET x = 5;  
  LET y = 10;  
  LET z = x + y; --z is 15
```

```

BEGIN
    DEFINE x, q INT;
    DEFINE z CHAR(5);
    LET x = 100;
    LET q = x + y; -- q = 110
    LET z = 'silly'; -- z receives a character value
END
LET y = x; -- y is now 5
LET x = z; -- z is now 15, not 'silly'
END PROCEDURE;

```

The BEGIN and END statements mark a nested statement block in which the integer variables **x** and **q** are defined as well as the CHAR variable **z**. Within the nested block, the redefined variable **x** masks the original variable **x**. After the END statement, which marks the end of the nested block, the original value of **x** is accessible again.

Declare variables of built-in data types

A variable that you declare as a built-in SQL data type can hold a value retrieved from a column of that built-in type. You can declare an SPL variable as most built-in types, except BIGSERIAL, SERIAL, and SERIAL8, as the following figure illustrates.

Figure 1. Built-in type variables.

```

DEFINE x INT;
DEFINE y INT8;
DEFINE name CHAR(15);
DEFINE this_day DATETIME YEAR TO DAY;

```

You can declare SPL variables of appropriate integer data types (such as BIGINT, INT, or INT8) to store the values of serial columns or of sequence objects.

Declare variables for smart large objects

A variable for a BLOB or CLOB object (or a data type that contains a smart large object) does not contain the object itself but rather a pointer to the object. The following figure shows how to define a variable for BLOB and CLOB objects.

Figure 1. Variables for BLOB or CLOB objects.

```

DEFINE a_blob BLOB;
DEFINE b_clob CLOB;

```

Declare variables for simple large objects

A variable for a simple large object (a TEXT or BYTE object) does not contain the object itself but rather a pointer to the object. When you define a variable on the TEXT or BYTE data type, you must use the keyword REFERENCES before the data type, as the following figure shows.

Figure 1. Use the REFERENCES keyword before the data type.

```

DEFINE t REFERENCES TEXT;
DEFINE b REFERENCES BYTE;

```

Declare collection variables

In order to hold a collection fetched from the database, a variable must be of type SET, MULTISSET, or LIST.

Important: A collection variable must be defined as a local variable. You cannot define a collection variable as a global variable.

A variable of SET, MULTISSET, or LIST type is a collection variable that holds a collection of the type named in the DEFINE statement. The following figure shows how to define typed collection variables.

Figure 1. Define typed collection variables.

```

DEFINE a SET ( INT NOT NULL );

DEFINE b MULTISSET ( ROW (  b1 INT,
                           b2 CHAR(50),
                           ) NOT NULL );

DEFINE c LIST ( SET (DECIMAL NOT NULL) NOT NULL );

```

You must always define the elements of a collection variable as NOT NULL. In this example, the variable **a** is defined to hold a SET of non-NULL integers; the variable **b** holds a MULTISSET of non-NULL row types; and the variable **c** holds a LIST of non-NULL sets of non-NULL decimal values.

In a variable definition, you can nest complex types in any combination or depth to match the data types stored in your database.

You cannot assign a collection variable of one type to a collection variable of another type. For example, if you define a collection variable as a SET, you cannot assign another collection variable of MULTISSET or LIST type to it.

Declare row-type variables

Row-type variables hold data from named or unnamed row types. You can define a *named row variable* or an *unnamed row variable*. Suppose you define the named row types that the following figure shows.

Figure 1. Named and unnamed row variables.

```
CREATE ROW TYPE zip_t
(
  z_code      CHAR(5),
  z_suffix    CHAR(4)
);

CREATE ROW TYPE address_t
(
  street      VARCHAR(20),
  city        VARCHAR(20),
  state       CHAR(2),
  zip         zip_t
);

CREATE ROW TYPE employee_t
(
  name        VARCHAR(30),
  address     address_t,
  salary      INTEGER
);

CREATE TABLE employee OF TYPE employee_t;
```

If you define a variable with the name of a named row type, the variable can only hold data of that row type. In the following figure, the **person** variable can only hold data of **employee_t** type.

Figure 2. Defining the person variable.

```
DEFINE person employee_t;
```

To define a variable that holds data stored in an unnamed row type, use the ROW keyword followed by the fields of the row type, as the following figure shows. Figure 3. Use the ROW keyword followed by the fields of the row type.

```
DEFINE manager ROW (name      VARCHAR(30),
                    department VARCHAR(30),
                    salary     INTEGER );
```

Because unnamed row types are type-checked for structural equivalence only, a variable defined with an unnamed row type can hold data from any unnamed row type that has the same number of fields and the same type definitions. Therefore, the variable **manager** can hold data from any of the row types in the following figure.

Figure 4. Unnamed row types.

```
ROW ( name      VARCHAR(30),
      department VARCHAR(30),
      salary     INTEGER );

ROW ( french    VARCHAR(30),
      spanish   VARCHAR(30),
      number    INTEGER );

ROW ( title     VARCHAR(30),
      musician  VARCHAR(30),
      price     INTEGER );
```

Important: Before you can use a row type variable, you must initialize the row variable with a LET statement or SELECTINTO statement.

Declare opaque- and distinct-type variables

Opaque-type variables hold data retrieved from opaque data types. *Distinct-type variables* hold data retrieved from distinct data types. If you define a variable with an opaque data type or a distinct data type, the variable can only hold data of that type.

If you define an opaque data type named **point** and a distinct data type named **centerpoint**, you can define SPL variables to hold data from the two types, as the following figure shows.

Figure 1. Defining SPL variables to hold opaque and distinct data types.

```
DEFINE a point;
DEFINE b centerpoint;
```

The variable **a** can only hold data of type **point**, and **b** can only hold data of type **centerpoint**.

Declare variables for column data with the LIKE clause

If you use the LIKE clause, the database server defines a variable to have the same data type as a column in a table or view.

If the column contains a collection, row type, or nested complex type, the variable has the complex or nested complex type defined in the column.

In the following figure, the variable **loc1** defines the data type for the **locations** column in the **image** table.

Figure 1. Define the loc1 data type for the locations column in the image table.

```
DEFINE loc1 LIKE image.locations;
```

Declare PROCEDURE type variables

In an SPL routine, you can define a variable of type PROCEDURE and assign the variable the name of an existing SPL routine or external routine. Defining a variable of PROCEDURE type indicates that the variable is a call to a user-defined routine, not a built-in routine of the same name.

For example, the statement in the following figure defines **length** as an SPL procedure or SPL function, not as the built-in LENGTH function.

Figure 1. Define length as an SPL procedure.

```
DEFINE length PROCEDURE;  
LET x = length( a,b,c );
```

This definition disables the built-in **LENGTH** function within the scope of the statement block. You would use such a definition if you had already created an SPL or external routine with the name LENGTH.

Because IBM® Informix® supports routine overloading, you can define more than one SPL routine or external routine with the same name. If you call any routine from an SPL routine, determines which routine to use, based on the arguments specified and the routine determination rules. For information about routine overloading and routine determination, see *IBM Informix User-Defined Routines and Data Types Developer's Guide*.

Tip: If you create an SPL routine with the same name as an aggregate function (**SUM**, **MAX**, **MIN**, **AVG**, **COUNT**) or with the name **extend**, you must qualify the routine name with an owner name.

Subscripts with variables

You can use subscripts with variables of CHAR, VARCHAR, NCHAR, NVARCHAR, BYTE, or TEXT data type. The subscripts indicate the starting and ending character positions that you want to use within the variable.

Subscripts must always be constants. You cannot use variables as subscripts. The following figure illustrates how to use a subscript with a CHAR(15) variable.

Figure 1. A subscript with a CHAR(15) variable.

```
DEFINE name CHAR(15);  
LET name[4,7] = 'Ream';  
SELECT fname[1,3] INTO name[1,3] FROM customer  
WHERE lname = 'Ream';
```

In this example, the customer's last name is placed between positions 4 and 7 of **name**. The first three characters of the customer's first name is retrieved into positions 1 through 3 of **name**. The part of the variable that is delimited by the two subscripts is referred to as a *substring*.

Variable and keyword ambiguity

If you declare a variable whose name is an SQL keyword, ambiguities can occur. The following rules for identifiers help you avoid ambiguities for SPL variables, SPL routine names, and built-in function names:

- Defined variables take the highest precedence.
- Routines defined with the PROCEDURE keyword in a DEFINE statement take precedence over SQL functions.
- SQL functions take precedence over SPL routines that exist but are not identified with the PROCEDURE keyword in a DEFINE statement.

In general, avoid using an ANSI-reserved word for the name of the variable. For example, you cannot define a variable with the name **count** or **max** because they are the names of aggregate functions. For a list of the reserved keywords that you should avoid using as variable names, see the Identifier segment in the *IBM® Informix® Guide to SQL: Syntax*.

For information about ambiguities between SPL routine names and SQL function names, see the *IBM Informix Guide to SQL: Syntax*.

- [Variables and column names](#)
- [Variables and SQL functions](#)

Variables and column names

If you use the same identifier for an SPL variable that you use for a column name, the database server assumes that each instance of the identifier is a variable. Qualify the column name with the table name, using dot notation, in order to use the identifier as a column name.

In the SELECT statement in the following figure, **customer.lname** is a column name and **lname** is a variable name.

Figure 1. Column names and variable names in a SELECT statement.

```
CREATE PROCEDURE table_test()
    DEFINE lname CHAR(15);
    LET lname = 'Miller';

    SELECT customer.lname INTO lname FROM customer
        WHERE customer_num = 502;
    . . .
END PROCEDURE;
```

Variables and SQL functions

If you use the same identifier for an SPL variable as for an SQL function, the database server assumes that an instance of the identifier is a variable and disallows the use of the SQL function. You cannot use the SQL function within the block of code in which the variable is defined. The example in the following figure shows a block within an SPL procedure in which the variable called **user** is defined. This definition disallows the use of the **USER** function in the **BEGIN END** block. Figure 1. A procedure that disallows the use of the **USER** function in the **BEGIN END** block.

```
CREATE PROCEDURE user_test()
    DEFINE name CHAR(10);
    DEFINE name2 CHAR(10);
    LET name = user; -- the SQL function

    BEGIN
        DEFINE user CHAR(15); -- disables user function
        LET user = 'Miller';
        LET name = user; -- assigns 'Miller' to variable name
    END
    . . .
    LET name2 = user; -- SQL function again
```

Declare global variables

A *global variable* has its value stored in memory and is available to other SPL routines, run by the same user session, on the same database. A global variable has the following characteristics:

- It requires a default value.
- It can be used in any SPL routine, although it must be defined in each routine in which it is used.
- It carries its value from one SPL routine to another until the session ends.

Restriction: You cannot define a collection variable as a global variable. The following figure shows two SPL functions that share a global variable. Figure 1. Two SPL functions that share a global variable.

```
CREATE FUNCTION func1() RETURNING INT;
    DEFINE GLOBAL gvar INT DEFAULT 2;
    LET gvar = gvar + 1;
    RETURN gvar;
END FUNCTION;

CREATE FUNCTION func2() RETURNING INT;
    DEFINE GLOBAL gvar INT DEFAULT 5;
    LET gvar = gvar + 1;
    RETURN gvar;
END FUNCTION;
```

Although you must define a global variable with a default value, the variable is only set to the default the first time you use it. If you execute the two functions in the following figure in the order given, the value of **gvar** would be 4. Figure 2. Global variable default values.

```
EXECUTE FUNCTION func1();
EXECUTE FUNCTION func2();
```

But if you execute the functions in the opposite order, as the following figure shows, the value of **gvar** would be 7. Figure 3. Global variable default values.

```
EXECUTE FUNCTION func2();
EXECUTE FUNCTION func1();
```

For more information, see [Executing routines](#).

Assign values to variables

Within an SPL routine, use the **LET** statement to assign values to the variables you have already defined.

If you do not assign a value to a variable, either by an argument passed to the routine or by a **LET** statement, the variable has an undefined value.

An undefined value is different from a **NULL** value. If you attempt to use a variable with an undefined value within the SPL routine, you receive an error.

You can assign a value to a routine variable in any of the following ways:

- Use a LET statement.
 - Use a SELECT INTO statement.
 - Use a CALL statement with a procedure that has a RETURNING clause.
 - Use an EXECUTE PROCEDURE INTO or EXECUTE FUNCTION INTO statement.
- [The LET statement](#)
 - [Other ways to assign values to variables](#)

The LET statement

With a LET statement, you can use one or more variable names with an equal (=) sign and a valid expression or function name. Each example in the following figure is a valid LET statement.

Figure 1. Valid LET statements.

```
LET a = 5;
LET b = 6; LET c = 10;
LET a,b = 10,c+d;
LET a,b = (SELECT cola,colb
          FROM tabl WHERE cola=10);
LET d = func1(x,y);
```

IBM® Informix® allows you to assign a value to an opaque-type variable, a row-type variable, or a field of a row type. You can also return the value of an external function or another SPL function to an SPL variable.

Suppose you define the named row types **zip_t** and **address_t**, as [Figure 1](#) shows. Anytime you define a row-type variable, you must initialize the variable before you can use it. The following figure shows how you might define and initialize a row-type variable. You can use any row-type value to initialize the variable.

Figure 2. Define and initialize a row-type variable.

```
DEFINE a address_t;
LET a = ROW ('A Street', 'Nowhere', 'AA',
            ROW(NULL, NULL))::address_t
```

After you define and initialize the row-type variable, you can write the LET statements that the following figure shows.

Figure 3. Write the LET statements.

```
LET a.zip.z_code = 32601;
LET a.zip.z_suffix = 4555;
-- Assign values to the fields of address_t
```

Tip: Use dot notation in the form **variable.field** or **variable.field.field** to access the fields of a row type, as [Handle row-type data](#) describes.

Suppose you define an opaque-type **point** that contains two values that define a two-dimensional point, and the text representation of the values is '(x,y)'. You might also have a function **circum()** that calculates the circumference of a circle, given the point '(x,y)' and a radius **r**.

If you define an opaque-type **center** that defines a point as the center of a circle, and a function **circum()** that calculates the circumference of a circle, based on a point and the radius, you can write variable declarations for each. In the following figure, **c** is an opaque type variable and **d** holds the value that the external function **circum()** returns.

Figure 4. Writing variable declarations.

```
DEFINE c point;
DEFINE r REAL;
DEFINE d REAL;

LET c = '(29.9,1.0)' ;
-- Assign a value to an opaque type variable

LET d = circum( c, r );
-- Assign a value returned from circum()
```

The *IBM Informix Guide to SQL: Syntax* describes in detail the syntax of the LET statement.

Other ways to assign values to variables

You can use the SELECT statement to fetch a value from the database and assign it directly to a variable, as the following figure shows.

Figure 1. Fetch a value from the database and assign it directly to a variable.

```
SELECT fname, lname INTO a, b FROM customer
WHERE customer_num = 101
```

Use the CALL or EXECUTE PROCEDURE statements to assign values returned by an SPL function or an external function to one or more SPL variables. You might use either of the statements in the following figure to return the full name and address from the SPL function **read_address** into the specified SPL variables.

Figure 2. Return the full name and address from the SPL function.

```
EXECUTE FUNCTION read_address('Smith')
INTO p_fname, p_lname, p_add, p_city, p_state,
     p_zip;

CALL read_address('Smith')
```

```
RETURNING p_fname, p_lname, p_add, p_city,  
          p_state, p_zip;
```

Expressions in SPL routines

You can use any SQL expression in an SPL routine, except for an aggregate expression. The *IBM® Informix® Guide to SQL: Syntax* provides the complete syntax and descriptions for SQL expressions.

The following examples contain SQL expressions:

```
var1  
var1 + var2 + 5  
read_address('Miller')  
read_address(lastname = 'Miller')  
get_duedate(acct_num) + 10 UNITS DAY  
fname[1,5] || ' ' || lname '(415)' || get_phonenum(cust_name)
```

Writing the statement block

Every SPL routine has at least one statement block, which is a group of SQL and SPL statements between the CREATE statement and the END statement. You can use any SPL statement or any allowed SQL statement within a statement block. For a list of SQL statements that are not allowed within an SPL statement block, see the description of the statement block segment in the *IBM® Informix® Guide to SQL: Syntax*.

- [Implicit and explicit statement blocks](#)
- [The FOREACH loop](#)
- [The FOREACH loop to define cursors](#)
- [An IF - ELIF - ELSE structure](#)
- [Add WHILE and FOR loops](#)
- [Exit a loop](#)

Implicit and explicit statement blocks

In an SPL routine, the *implicit statement block* extends from the end of the CREATE statement to the beginning of the END statement. You can also define an *explicit statement block*, which starts with a BEGIN statement and ends with an END statement, as the following figure shows.

Figure 1. Explicit statement block.

```
BEGIN  
  DEFINE distance INT;  
  LET distance = 2;  
END
```

The explicit statement block allows you to define variables or processing that are valid only within the statement block. For example, you can define or redefine variables, or handle exceptions differently, for just the scope of the explicit statement block.

The SPL function in the following figure has an explicit statement block that redefines a variable defined in the implicit block.

Figure 2. An explicit statement block that redefines a variable defined in the implicit block.

```
CREATE FUNCTION block_demo()  
  RETURNING INT;  
  DEFINE distance INT;  
  LET distance = 37;  
  BEGIN  
    DEFINE distance INT;  
    LET distance = 2;  
  END  
  RETURN distance;  
  
END FUNCTION;
```

In this example, the implicit statement block defines the variable **distance** and gives it a value of 37. The explicit statement block defines a different variable named **distance** and gives it a value of 2. However, the RETURN statement returns the value stored in the first **distance** variable, or 37.

The FOREACH loop

A FOREACH loop defines a *cursor*, a specific identifier that points to one item in a group, whether a group of rows or the elements in a collection.

The FOREACH loop declares and opens a cursor, fetches rows from the database, works on each item in the group, and then closes the cursor. You must declare a cursor if a SELECT, EXECUTE PROCEDURE, or EXECUTE FUNCTION statement might return more than one row. After you declare the cursor, you place the SELECT, EXECUTE PROCEDURE, or EXECUTE FUNCTION statement within it.

An SPL routine that returns a group of rows is called a *cursor routine* because you must use a cursor to access the data it returns. An SPL routine that returns no value, a single value, or any other value that does not require a cursor is called a *noncursor routine*. The FOREACH loop declares and opens a cursor, fetches rows or

a collection from the database, works on each item in the group, and then closes the cursor. You must declare a cursor if a SELECT, EXECUTE PROCEDURE, or EXECUTE FUNCTION statement might return more than one row or a collection. After you declare the cursor, you place the SELECT, EXECUTE PROCEDURE, or EXECUTE FUNCTION statement within it.

In a FOREACH loop, you can use an EXECUTE FUNCTION or SELECT INTO statement to execute an external function that is an iterator function.

The FOREACH loop to define cursors

A FOREACH loop begins with the FOREACH keyword and ends with END FOREACH. Between FOREACH and END FOREACH, you can declare a cursor or use EXECUTE PROCEDURE or EXECUTE FUNCTION. The two examples in the following figure show the structure of FOREACH loops.

Figure 1. Structure of FOREACH loops.

```
FOREACH cursor FOR
  SELECT column INTO variable FROM table
  . . .
END FOREACH;

FOREACH
  EXECUTE FUNCTION name() INTO variable;
END FOREACH;
```

The following figure creates a routine that uses a FOREACH loop to operate on the **employee** table.

Figure 2. A FOREACH loop that operates on the employee table.

```
CREATE PROCEDURE increase_by_pct( pct INTEGER )
  DEFINE s INTEGER;

  FOREACH sal_cursor FOR
    SELECT salary INTO s FROM employee
      WHERE salary > 35000
    LET s = s + s * ( pct/100 );
    UPDATE employee SET salary = s
      WHERE CURRENT OF sal_cursor;
  END FOREACH;

END PROCEDURE;
```

The routine in preceding figure performs these tasks within the FOREACH loop:

- Declares a cursor
- Selects one **salary** value at a time from **employee**
- Increases the salary by a percentage
- Updates **employee** with the new salary
- Fetches the next salary value

The SELECT statement is placed within a cursor because it returns all the salaries in the table greater than 35000.

The WHERE CURRENT OF clause in the UPDATE statement updates only the row on which the cursor is currently positioned, and sets an *update cursor* on the current row. An update cursor places an update lock on the row so that no other user can update the row until your update occurs.

An SPL routine will set an update cursor automatically if an UPDATE or DELETE statement within the FOREACH loop uses the WHERE CURRENT OF clause. If you use WHERE CURRENT OF, you must explicitly reference the cursor within the FOREACH statement. If you are using an update cursor, you can add a BEGIN WORK statement before the FOREACH statement and a COMMIT WORK statement after END FOREACH, as the following figure shows.

Figure 3. Set an update cursor automatically.

```
BEGIN WORK;
  FOREACH sal_cursor FOR
    SELECT salary INTO s FROM employee WHERE salary > 35000;
    LET s = s + s * ( pct/100 );
    UPDATE employee SET salary = s WHERE CURRENT OF sal_cursor
  END FOREACH;
COMMIT WORK;
```

For each iteration of the FOREACH loop in the preceding figure, a new lock is acquired (if you use row level locking). The COMMIT WORK statement releases all of the locks (and commits all of the updated rows as a single transaction) after the last iteration of the FOREACH loop.

To commit an updated row after each iteration of the loop, you must open the cursor WITH HOLD, and include the BEGIN WORK and COMMIT WORK statements *within* the FOREACH loop, as in the following SPL routine.

Figure 4. Committing an updated row after each iteration of the loop.

```
CREATE PROCEDURE serial_update();
  DEFINE p_col2 INT;
  DEFINE i INT;
  LET i = 1;
  FOREACH cur_su WITH HOLD FOR
    SELECT col2 INTO p_col2 FROM customer WHERE 1=1
    BEGIN WORK;
      UPDATE customer SET customer_num = p_col2 WHERE CURRENT OF cur_su;
    COMMIT WORK;
    LET i = i + 1;
  END FOREACH;
END PROCEDURE;
```

SPL routine **serial_update()** commits each row as a separate transaction.

- [Restriction for FOREACH loops](#)

Restriction for FOREACH loops

Within a FOREACH loop, the SELECT query must complete execution before any DELETE, INSERT, or UPDATE operation that changes the data set of the SELECT cursor. One way to ensure that the SELECT query completes, use an ORDER BY clause in the SELECT statement. The ORDER BY clause creates an index on the columns and prevents errors caused by UPDATE, INSERT, DELETE statements modifying the query results of the SELECT statement in the same FOREACH loop

An IF - ELIF - ELSE structure

The following SPL routine uses an IF - ELIF - ELSE structure to compare the two arguments that the routine accepts.

Figure 1. An IF - ELIF - ELSE structure to compare two arguments.

```
CREATE FUNCTION str_compare( str1 CHAR(20), str2 CHAR(20))
RETURNING INTEGER;

DEFINE result INTEGER;

IF str1 > str2 THEN
    LET result = 1;
ELIF str2 > str1 THEN
    LET result = -1;
ELSE
    LET result = 0;
END IF
RETURN result;
END FUNCTION;
```

Suppose you define a table named **manager** with the columns that the following figure shows.

Figure 2. Define the manager table.

```
CREATE TABLE manager
(
    mgr_name    VARCHAR(30),
    department  VARCHAR(12),
    dept_no     SMALLINT,
    direct_reports SET( VARCHAR(30) NOT NULL ),
    projects LIST( ROW ( pro_name VARCHAR(15),
    pro_members SET( VARCHAR(20) NOT NULL ) )
    NOT NULL),
    salary      INTEGER,
);
```

The following SPL routine uses an IF - ELIF - ELSE structure to check the number of elements in the SET in the **direct_reports** column and call various external routines based on the results.

Figure 3. An IF - ELIF - ELSE structure to check the number of elements in the SET.

```
CREATE FUNCTION checklist( d SMALLINT )
RETURNING VARCHAR(30), VARCHAR(12), INTEGER;

DEFINE name VARCHAR(30);
DEFINE dept VARCHAR(12);
DEFINE num INTEGER;

SELECT mgr_name, department,
    CARDINALITY(direct_reports)
FROM manager INTO name, dept, num
WHERE dept_no = d;
IF num > 20 THEN
    EXECUTE FUNCTION add_mgr(dept);
ELIF num = 0 THEN
    EXECUTE FUNCTION del_mgr(dept);
ELSE
    RETURN name, dept, num;
END IF;

END FUNCTION;
```

The **cardinality()** function counts the number of elements that a collection contains. For more information, see [Cardinality function](#).

An IF - ELIF - ELSE structure in an SPL routine has up to the following four parts:

- An IF THEN condition
If the condition following the IF statement is TRUE, the routine executes the statements in the IF block. If the condition is false, the routine evaluates the ELIF condition.

The expression in an IF statement can be any valid condition, as the Condition segment of the *IBM® Informix® Guide to SQL: Syntax* describes. For the complete syntax and a detailed discussion of the IF statement, see the *IBM Informix Guide to SQL: Syntax*.
- One or more ELIF conditions (optional)

The routine evaluates the ELIF condition only if the IF condition is false. If the ELIF condition is true, the routine executes the statements in the ELIF block. If the ELIF condition is false, the routine either evaluates the next ELIF block or executes the ELSE statement.

- An ELSE condition (optional)
The routine executes the statements in the ELSE block if the IF condition and all of the ELIF conditions are false.
- An END IF statement
The END IF statement ends the statement block.

Add WHILE and FOR loops

Both the WHILE and FOR statements create execution loops in SPL routines. A WHILE loop starts with a WHILE *condition*, executes a block of statements as long as the condition is true, and ends with END WHILE.

The following figure shows a valid WHILE condition. The routine executes the WHILE loop as long as the condition specified in the WHILE statement is true. Figure 1. Routine to execute the WHILE loop as long as the condition specified in the WHILE statement is true.

```
CREATE PROCEDURE test_rows( num INT )  
  
    DEFINE i INTEGER;  
    LET i = 1;  
  
    WHILE i < num  
        INSERT INTO table1 (numbers) VALUES (i);  
        LET i = i + 1;  
    END WHILE;  
  
END PROCEDURE;
```

The SPL routine in the previous figure accepts an integer as an argument and then inserts an integer value into the **numbers** column of **table1** each time it executes the WHILE loop. The values inserted start at 1 and increase to `num - 1`.

Be careful that you do not create an endless loop, as the following figure shows.

Figure 2. Routine to accept an integer as an argument and then insert an integer value into the numbers column.

```
CREATE PROCEDURE endless_loop()  
  
    DEFINE i INTEGER;  
    LET i = 1;  
    WHILE ( 1 = 1 )          -- don't do this!  
        LET i = i + 1;  
        INSERT INTO table1 VALUES (i);  
    END WHILE;  
  
END PROCEDURE;
```

A FOR loop extends from a FOR statement to an END FOR statement and executes for a specified number of iterations, which are defined in the FOR statement. The following figure shows several ways to define the iterations in the FOR loop.

For each iteration of the FOR loop, the iteration variable (declared as *i* in the examples that follow) is reset, and the statements within the loop are executed with the new value of the variable.

Figure 3. Defining iterations in the FOR loop.

```
FOR i = 1 TO 10  
    . . .  
END FOR;  
  
FOR i = 1 TO 10 STEP 2  
    . . .  
END FOR;  
  
FOR i IN (2,4,8,14,22,32)  
    . . .  
END FOR;  
  
FOR i IN (1 TO 20 STEP 5, 20 to 1 STEP -5, 1,2,3,4,5)  
    . . .  
END FOR;
```

In the first example, the SPL procedure executes the FOR loop as long as *i* is between 1 and 10, inclusive. In the second example, *i* steps from 1 to 3, 5, 7, and so on, but never exceeds 10. The third example checks whether *i* is within a defined set of values. In the fourth example, the SPL procedure executes the loop when *i* is 1, 6, 11, 16, 20, 15, 10, 5, 1, 2, 3, 4, or 5—in other words, 13 times.

Tip: The main difference between a WHILE loop and a FOR loop is that a FOR loop is guaranteed to finish, but a WHILE loop is not. The FOR statement specifies the exact number of times the loop executes, unless a statement causes the routine to exit the loop. With WHILE, it is possible to create an endless loop.

Exit a loop

In a FOR, FOREACH, LOOP, or WHILE loop that has no label, you can use the CONTINUE or EXIT statement to control the execution of the loop.

- CONTINUE causes the routine to skip the statements in the rest of the loop and move to the next iteration of the FOR, LOOP, or WHILE statement.

- EXIT ends the loop and causes the routine to continue executing with the first statement following the END FOR, the END LOOP, or the END WHILE keywords.

Remember that EXIT must be followed by the FOREACH keyword when it appears within a FOREACH statement that is the innermost loop of nested loop statements. EXIT can appear with no immediately following keyword when it appears within the FOR, LOOP, or WHILE statement, but an error is issued if you specify a keyword that does not match the loop statement from which the EXIT statement was issued. An error is also issued if EXIT appears outside the context of a loop statement.

For more information about loops in SPL routines, including labelled loops, see *IBM® Informix® Guide to SQL: Syntax*.

The following figure shows examples of CONTINUE and EXIT within a FOR loop.

Figure 1. Examples of CONTINUE and EXIT within a FOR loop.

```
FOR i = 1 TO 10
  IF i = 5 THEN
    CONTINUE FOR;
  . . .
  ELIF i = 8 THEN
    EXIT FOR;
  END IF;
END FOR;
```

Tip: You can use CONTINUE and EXIT to improve the performance of SPL routines so that loops do not execute unnecessarily.

Return values from an SPL function

SPL functions can return one or more values. To have your SPL function return values, you need to include the following two parts:

1. Write a RETURNING clause in the CREATE PROCEDURE or CREATE FUNCTION statement that specifies the number of values to be returned and their data types.
2. In the body of the function, enter a RETURN statement that explicitly returns the values.

Tip: You can define a routine with the CREATE PROCEDURE statement that returns values, but in that case, the routine is actually a function. It is recommended that you use the CREATE FUNCTION statement when the routine returns values.

After you define a return clause (with a RETURNING statement), the SPL function can return values that match those specified in number and data type, or no values at all. If you specify a return clause, and the SPL routine returns no actual values, it is still considered a function. In that case, the routine returns a NULL value for each value defined in the return clause.

An SPL function can return variables, expressions, or the result of another function call. If the SPL function returns a variable, the function must first assign the variable a value by one of the following methods:

- A LET statement
- A default value
- A SELECT statement
- Another function that passes a value into the variable

Each value an SPL function returns can be up to 32 kilobytes long.

Important: The return value for an SPL function must be a specific data type. You cannot specify a generic row or generic collection data type as a return type.

- [Return a single value](#)
- [Return multiple values](#)

Return a single value

The following figure shows how an SPL function can return a single value.

Figure 1. SPL function that returns a single value.

```
CREATE FUNCTION increase_by_pct(amt DECIMAL, pct DECIMAL)
  RETURNING DECIMAL;

DEFINE result DECIMAL;

LET result = amt + amt * (pct/100);

RETURN result;

END FUNCTION;
```

The **increase_by_pct** function receives two arguments of DECIMAL value, an amount to be increased and a percentage by which to increase it. The return clause specifies that the function will return one DECIMAL value. The RETURN statement returns the DECIMAL value stored in **result**.

Return multiple values

An SPL function can return more than one value from a single row of a table. The following figure shows an SPL function that returns two column values from a single row of a table.

Figure 1. SPL function that returns two column values from a single row of a table.

```
CREATE FUNCTION birth_date( num INTEGER )
RETURNING VARCHAR(30), DATE;

DEFINE n VARCHAR(30);
DEFINE b DATE;

SELECT name, bdate INTO n, b FROM emp_tab
WHERE emp_no = num;
RETURN n, b;

END FUNCTION;
```

The function returns two values (a name and birthdate) to the calling routine from one row of the **emp_tab** table. In this case, the calling routine must be prepared to handle the VARCHAR and DATE values returned.

The following figure shows an SPL function that returns more than one value from more than one row.

Figure 2. SPL function that returns more than one value from more than one row.

```
CREATE FUNCTION birth_date_2( num INTEGER )
RETURNING VARCHAR(30), DATE;
DEFINE n VARCHAR(30);
DEFINE b DATE;
FOREACH cursor1 FOR
SELECT name, bdate INTO n, b FROM emp_tab
WHERE emp_no > num
RETURN n, b WITH RESUME;
END FOREACH;
END FUNCTION;
```

In preceding figure, the SELECT statement fetches two values from the set of rows whose employee number is higher than the number the user enters. The set of rows that satisfy the condition could contain one row, many rows, or zero rows. Because the SELECT statement can return many rows, it is placed within a cursor. Tip: When a statement within an SPL routine returns no rows, the corresponding SPL variables are assigned NULL values.

The RETURN statement uses the WITH RESUME keywords. When RETURN WITH RESUME is executed, control is returned to the calling routine. But the next time the SPL function is called (by a FETCH or the next iteration of a cursor in the calling routine), all the variables in the SPL function keep their same values, and execution continues at the statement immediately following the RETURN WITH RESUME statement.

If your SPL routine returns multiple values, the calling routine must be able to handle the multiple values through a cursor or loop, as follows:

- If the calling routine is an SPL routine, it needs a FOREACH loop.
- If the calling routine is an ESQL/C program, it needs a cursor declared with the DECLARE statement.
- If the calling routine is an external routine, it needs a cursor or loop appropriate to the language in which the routine is written.

Important: The values returned by a UDR from external databases of a local server must be built-in data types or UDTs explicitly cast to built-in types or DISTINCT types based on built-in types and explicitly cast to built-in types. In addition, you must define the UDR and all the casts in the participating databases.

An example of SQL operations you can perform across databases follows:

```
database db1;
create table ltab1(lcol1 integer, lcol2 boolean, lcol3 lvarchar);
insert into ltab1 values(1, 't', "test string 1");

database db2;
create table rtab1(r1col1 boolean, r1col2 blob, r1col3 integer)
put r1col2 in (sbsp);
create table rtab2(r2col1 lvarchar, r2col2 clob) put r2col2 in (sbsp);
create table rtab3(r3col1 integer, r3col2 boolean,
r3col3 lvarchar, r3col4 circle);

create view rvw1 as select * from rtab3;
```

(The example is a cross-database Insert.)

```
database db1;
create view lvw1 as select * from db2:rtab2;
insert into db2:rtab1 values('t',
filetoblob('blobfile', 'client', 'db2:rtab1', 'r1col2'), 100);
insert into db2:rtab2 values("inserted directly to rtab2",
filetoclob('clobfile', 'client', 'db2:rtab2', 'r2col2'));
insert into db2:rtab3 (r3col1, r3col2, r3col3)
select lcol1, lcol2, lcol3 from ltab1;
insert into db2:rvw1 values(200, 'f', "inserted via rvw1");
insert into lvw1 values ("inserted via lvw1", NULL);
```

Handle row-type data

In an SPL routine, you can use named ROW types and unnamed ROW types as parameter definitions, arguments, variable definitions, and return values. For information about how to declare a ROW variable in SPL, see [Declare row-type variables](#).

The following figure defines a row type **salary_t** and an **emp_info** table, which are the examples that this section uses.

Figure 1. Define a row type salary_t and an emp_info table

```
CREATE ROW TYPE salary_t(base MONEY(9,2), bonus MONEY(9,2))

CREATE TABLE emp_info (emp_name VARCHAR(30), salary salary_t);
```

The **emp_info** table has columns for the employee name and salary information.

- [Precedence of dot notation](#)
- [Update a row-type expression](#)

Precedence of dot notation

With IBM® Informix®, a value that uses dot notation (as in **proj.name**) in an SQL statement in an SPL routine is interpreted as having one of three meanings, in the following order of precedence:

1. *variable.field*
2. *column.field*
3. *table.column*

In other words, the expression **proj.name** is first evaluated as *variable.field*. If the routine does not find a variable **proj**, it evaluates the expression as *column.field*. If the routine does not find a column **proj**, it evaluates the expression as *table.column*. (If the names cannot be resolved as identifiers of objects in the database or of variables or fields that were declared in the SPL routine, then an error is returned.)

Update a row-type expression

From within an SPL routine, you can use a ROW variable to update a row-type expression. The following figure shows an SPL procedure **emp_raise** that is used to update the **emp_info** table when an employee's base salary increases by a certain percentage.

Figure 1. SPL procedure used to update the emp_info table.

```
CREATE PROCEDURE emp_raise( name VARCHAR(30),
                           pct DECIMAL(3,2) )

  DEFINE row_var salary_t;

  SELECT salary INTO row_var FROM emp_info
     WHERE emp_name = name;

  LET row_var.base = row_var.base * pct;

  UPDATE emp_info SET salary = row_var
     WHERE emp_name = name;

END PROCEDURE;
```

The SELECT statement selects a row from the **salary** column of **emp_info** table into the ROW variable **row_var**.

The **emp_raise** procedure uses SPL dot notation to directly access the **base** field of the variable **row_var**. In this case, the dot notation means *variable.field*. The **emp_raise** procedure recalculates the value of **row_var.base** as $(row_var.base * pct)$. The procedure then updates the **salary** column of the **emp_info** table with the new **row_var** value.

Important: A row-type variable must be initialized as a row before its fields can be set or referenced. You can initialize a row-type variable with a SELECT INTO statement or LET statement.

Handle collections

A *collection* is a group of elements of the same data type, such as a SET, MULTISSET, or LIST.

A table might contain a collection stored as the contents of a column or as a field of a ROW type within a column. A collection can be either simple or nested. A *simple collection* is a SET, MULTISSET, or LIST of built-in, opaque, or distinct data types. A *nested collection* is a collection that contains other collections.

- [Collection data types](#)
- [Prepare for collection data types](#)
- [Insert elements into a collection variable](#)
- [Select elements from a collection](#)
- [Delete a collection element](#)
- [Update a collection element](#)
- [Update the entire collection](#)
- [Insert into a collection](#)

Collection data types

The following sections of the chapter rely on several different examples to show how you can manipulate collections in SPL programs.

The basics of handling collections in SPL programs are illustrated with the **numbers** table, as the following figure shows.

Figure 1. Handle collections in SPL programs.

```
CREATE TABLE numbers
(
  id INTEGER PRIMARY KEY,
  primes      SET( INTEGER NOT NULL ),
  evens       LIST( INTEGER NOT NULL ),
  twin_primes LIST( SET( INTEGER NOT NULL )
                  NOT NULL )
);
```

The **primes** and **evens** columns hold simple collections. The **twin_primes** column holds a nested collection, a LIST of SETs. (Twin prime numbers are pairs of consecutive prime numbers whose difference is 2, such as 5 and 7, or 11 and 13. The **twin_primes** column is designed to allow you to enter such pairs.

Some examples in this chapter use the **polygons** table in the following figure to illustrate how to manipulate collections. The **polygons** table contains a collection to represent two-dimensional graphical data. For example, suppose that you define an opaque data type named **point** that has two double-precision values that represent the **x** and **y** coordinates of a two-dimensional point whose coordinates might be represented as '1.0, 3.0'. Using the **point** data type, you can create a table that contains a set of points that define a polygon.

Figure 2. Manipulate collections.

```
CREATE OPAQUE TYPE point ( INTERNALLENGTH = 8 );

CREATE TABLE polygons
(
  id          INTEGER PRIMARY KEY,
  definition  SET( point NOT NULL )
);
```

The **definition** column in the **polygons** table contains a simple collection, a SET of **point** values.

Prepare for collection data types

Before you can access and handle an individual element of a simple or nested collection, you must perform the following tasks:

- Declare a collection variable to hold the collection.
- Declare an element variable to hold an individual element of the collection.
- Select the collection from the database into the collection variable.

After you take these initial steps, you can insert elements into the collection or select and handle elements that are already in the collection.

Each of these steps is explained in the following sections, using the **numbers** table as an example.

Tip: You can handle collections in any SPL routine.

- [Declare a collection variable](#)
- [Declare an element variable](#)
- [Select a collection into a collection variable](#)

Declare a collection variable

Before you can retrieve a collection from the database into an SPL routine, you must declare a collection variable. The following figure shows how to declare a collection variable to retrieve the **primes** column from the **numbers** table.

Figure 1. Declare a collection variable.

```
DEFINE p_coll SET( INTEGER NOT NULL );
```

The DEFINE statement declares a collection variable **p_coll**, whose type matches the data type of the collection stored in the **primes** column.

Declare an element variable

After you declare a collection variable, you declare an element variable to hold individual elements of the collection. The data type of the element variable must match the data type of the collection elements.

For example, to hold an element of the SET in the **primes** column, use an element variable declaration such as the one that the following figure shows.

Figure 1. An element variable declaration.

```
DEFINE p INTEGER;
```

To declare a variable that holds an element of the **twin_primes** column, which holds a nested collection, use a variable declaration such as the one that the following figure shows.

Figure 2. A variable declaration.

```
DEFINE s SET( INTEGER NOT NULL );
```

The variable **s** holds a SET of integers. Each SET is an element of the LIST stored in **twin_primes**.

Select a collection into a collection variable

After you declare a collection variable, you can fetch a collection into it. To fetch a collection into a collection variable, enter a SELECT INTO statement that selects the collection column from the database into the collection variable you have named.

For example, to select the collection stored in one row of the **primes** column of **numbers**, add a SELECT statement, such as the one that the following figure shows, to your SPL routine.

Figure 1. Add a SELECT statement to select the collection stored in one row.

```
SELECT primes INTO p_coll FROM numbers
WHERE id = 220;
```

The WHERE clause in the SELECT statement specifies that you want to select the collection stored in just one row of **numbers**. The statement places the collection into the collection variable **p_coll**, which [Figure 1](#) declares.

The variable **p_coll** now holds a collection from the **primes** column, which could contain the value SET {5, 7, 31, 19, 13}.

Insert elements into a collection variable

After you retrieve a collection into a collection variable, you can insert a value into the collection variable. The syntax of the INSERT statement varies slightly, depending on the type of the collection to which you want to add values.

- [Insert into a SET or MULTISET](#)
- [Insert into a LIST](#)
- [Check the cardinality of a LIST collection](#)
- [Syntax of the VALUES clause](#)

Insert into a SET or MULTISET

To insert into a SET or MULTISET stored in a collection variable, use an INSERT statement and follow the TABLE keyword with the collection variable, as the following figure shows.

Figure 1. Insert into a SET or MULTISET stored in a collection variable.

```
INSERT INTO TABLE (p_coll) VALUES (3) ;
```

The TABLE keyword makes the collection variable a collection-derived table. Collection-derived tables are described in the section [Handle collections in SELECT statements](#). The collection that the previous figure derives is a virtual table of one column, with each element of the collection representing a row of the table. Before the insert, consider **p_coll** as a virtual table that contains the rows (elements) that the following figure shows.

Figure 2. Virtual table elements.

```
5
7
31
19
13
```

After the insert, **p_coll** might look like the virtual table that the following figure shows.

Figure 3. Virtual table elements.

```
5
7
31
19
13
3
```

Because the collection is a SET, the new value is added to the collection, but the position of the new element is undefined. The same principle is true for a MULTISET.

Tip: You can only insert one value at a time into a simple collection.

Insert into a LIST

If the collection is a LIST, you can add the new element at a specific point in the LIST or at the end of the LIST. As with a SET or MULTISET, you must first define a collection variable and select a collection from the database into the collection variable.

The following figure shows the statements you need to define a collection variable and select a LIST from the **numbers** table into the collection variable.

Figure 1. Defining a collection variable and selecting a LIST.

```
DEFINE e_coll LIST(INTEGER NOT NULL) ;
```

```
SELECT evens INTO e_coll FROM numbers
WHERE id = 99;
```

At this point, the value of **e_coll** might be `LIST {2,4,6,8,10}`. Because **e_coll** holds a LIST, each element has a numbered position in the list. To add an element at a specific point in a LIST, add an *AT position* clause to the INSERT statement, as the following figure shows. Figure 2. Add an element at a specific point in a LIST.

```
INSERT AT 3 INTO TABLE(e_coll) VALUES(12);
```

Now the LIST in **e_coll** has the elements {2,4,12,6,8,10}, in that order.

The value you enter for the *position* in the AT clause can be a number or a variable, but it must have an INTEGER or SMALLINT data type. You cannot use a letter, floating-point number, decimal value, or expression.

Check the cardinality of a LIST collection

At times you might want to add an element at the end of a LIST. In this case, you can use the **cardinality()** function to find the number of elements in a LIST and then enter a position that is greater than the value **cardinality()** returns.

IBM® Informix® allows you to use the **cardinality()** function with a collection that is stored in a column but not with a collection that is stored in a collection variable. In an SPL routine, you can check the cardinality of a collection in a column with a SELECT statement and return the value to a variable.

Suppose that in the **numbers** table, the **evens** column of the row whose **id** column is 99 still contains the collection `LIST {2,4,6,8,10}`. This time, you want to add the element 12 at the end of the LIST. You can do so with the SPL procedure **end_of_list**, as the following figure shows. Figure 1. The end_of_list SPL procedure.

```
CREATE PROCEDURE end_of_list()

DEFINE n SMALLINT;
DEFINE list_var LIST(INTEGER NOT NULL);

SELECT CARDINALITY(evens) FROM numbers INTO n
WHERE id = 100;

LET n = n + 1;

SELECT evens INTO list_var FROM numbers
WHERE id = 100;

INSERT AT n INTO TABLE(list_var) VALUES(12);

END PROCEDURE;
```

In **end_of_list**, the variable **n** holds the value that **cardinality()** returns, that is, the count of the items in the LIST. The LET statement increments **n**, so that the INSERT statement can insert a value at the last position of the LIST. The SELECT statement selects the collection from one row of the table into the collection variable **list_var**. The INSERT statement inserts the element 12 at the end of the list.

Syntax of the VALUES clause

The syntax of the VALUES clause is different when you insert into an SPL collection variable from when you insert into a collection column. The syntax rules for inserting literals into collection variables are as follows:

- Use parentheses after the VALUES keyword to enclose the complete list of values.
- If you are inserting into a simple collection, you do not need to use a type constructor or brackets.
- If you are inserting into a nested collection, you need to specify a literal collection.

Select elements from a collection

Suppose you want your SPL routine to select elements from the collection stored in the collection variable, one at a time, so that you can handle the elements.

To move through the elements of a collection, you first need to declare a cursor using a FOREACH statement, just as you would declare a cursor to move through a set of rows. The following figure shows the FOREACH and END FOREACH statements, with no statements between them yet.

Figure 1. FOREACH and END FOREACH statements.

```
FOREACH cursor1 FOR
. . .
END FOREACH
```

The FOREACH statement is described in [The FOREACH loop](#) and the *IBM® Informix® Guide to SQL: Syntax*.

The next topic, [The collection query](#), describes the statements that are omitted between the FOREACH and END FOREACH statements.

The examples in the following sections are based on the **polygons** table of [Figure 2](#).

- [The collection query](#)
After you declare the cursor between the FOREACH and END FOREACH statements, you enter a special, restricted form of the SELECT statement known as a *collection query*.
- [Add the collection query to the SPL routine](#)

The collection query

After you declare the cursor between the FOREACH and END FOREACH statements, you enter a special, restricted form of the SELECT statement known as a *collection query*.

A collection query is a SELECT statement that uses the FROM TABLE keywords followed by the name of a collection variable. The following figure shows this structure, which is known as a *collection-derived table*.

Figure 1. Collection-derived table.

```
FOREACH cursor1 FOR
    SELECT * INTO pnt FROM TABLE(vertices)
    . . .
END FOREACH
```

The SELECT statement uses the collection variable **vertices** as a collection-derived table. You can think of a collection-derived table as a table of one column, with each element of the collection being a row of the table. For example, you can visualize the SET of four points stored in **vertices** as a table with four rows, such as the one that the following figure shows.

Figure 2. Table with four rows.

```
' (3.0,1.0) '
' (8.0,1.0) '
' (3.0,4.0) '
' (8.0,4.0) '
```

After the first iteration of the FOREACH statement in the previous figure, the collection query selects the first element in **vertices** and stores it in **pnt**, so that **pnt** contains the value ' (3.0,1.0) '.

Tip: Because the collection variable **vertices** contains a SET, not a LIST, the elements in **vertices** have no defined order. In a real database, the value ' (3.0,1.0) ' might not be the first element in the SET.

Add the collection query to the SPL routine

Now you can add the cursor defined with FOREACH and the collection query to the SPL routine, as the following example shows.

Figure 1. Cursor defined with FOREACH and the collection query.

```
CREATE PROCEDURE shapes()
    DEFINE vertices SET( point NOT NULL );
    DEFINE pnt point;

    SELECT definition INTO vertices FROM polygons
        WHERE id = 207;

    FOREACH cursor1 FOR
        SELECT * INTO pnt FROM TABLE(vertices)
        . . .
    END FOREACH
    . . .
END PROCEDURE;
```

The statements shown above form the framework of an SPL routine that handles the elements of a collection variable. To decompose a collection into its elements, use a collection-derived table. After the collection is decomposed into its elements, the routine can access elements individually as rows of the collection-derived table. Now that you have selected one element in **pnt**, you can update or delete that element, as [Update a collection element](#) and [Delete a collection element](#) describe.

For the complete syntax of the collection query, see the SELECT statement in the *IBM® Informix® Guide to SQL: Syntax*. For the syntax of a collection-derived table, see the Collection-Derived Table segment in the *IBM Informix Guide to SQL: Syntax*.

Tip: If you are selecting from a collection that contains no elements or zero elements, you can use a collection query without declaring a cursor. However, if the collection contains more than one element and you do not use a cursor, you will receive an error message.

Attention: In the program fragment above, the database server would have issued a syntax error if the query (

```
SELECT * INTO pnt FROM TABLE(vertices)
```

) within the FOREACH cursor definition had ended with a semicolon (;) character as a statement terminator. Here the END FOREACH keywords are the logical statement terminator.

Delete a collection element

After you select an individual element from a collection variable into an element variable, you can delete the element from the collection. For example, after you select a point from the collection variable **vertices** with a collection query, you can remove the point from the collection.

The steps involved in deleting a collection element include:

1. Declare a collection variable and an element variable.
2. Select the collection from the database into the collection variable.

3. Declare a cursor so that you can select elements one at a time from the collection variable.
4. Write a loop or branch that locates the element that you want to delete.
5. Delete the element from the collection using a DELETE WHERE CURRENT OF statement that uses the collection variable as a collection-derived table.

The following figure shows a routine that deletes one of the four points in **vertexes**, so that the polygon becomes a triangle instead of a rectangle.
Figure 1. Routine that deletes one of the four points.

```
CREATE PROCEDURE shapes()

  DEFINE vertexes SET( point NOT NULL );
  DEFINE pnt point;

  SELECT definition INTO vertexes FROM polygons
    WHERE id = 207;

  FOREACH cursor1 FOR
    SELECT * INTO pnt FROM TABLE(vertexes)
    IF pnt = '(3,4)' THEN
      -- calls the equals function that
      -- compares two values of point type
      DELETE FROM TABLE(vertexes)
        WHERE CURRENT OF cursor1;
      EXIT FOREACH;
    ELSE
      CONTINUE FOREACH;
    END IF;
  END FOREACH
END PROCEDURE;
```

In previous figure, the FOREACH statement declares a cursor. The SELECT statement is a collection-derived query that selects one element at a time from the collection variable **vertexes** into the element variable **pnt**.

The IF THEN ELSE structure tests the value currently in **pnt** to see if it is the point '(3,4)'. Note that the expression **pnt = '(3,4)'** calls the instance of the **equal()** function defined on the point data type. If the current value in **pnt** is '(3,4)', the DELETE statement deletes it, and the EXIT FOREACH statement exits the cursor.

Tip: Deleting an element from a collection stored in a collection variable does not delete it from the collection stored in the database. After you delete the element from a collection variable, you must update the collection stored in the database with the new collection. For an example that shows how to update a collection column, see [Update the collection in the database](#).

The syntax for the DELETE statement is described in the *IBM® Informix® Guide to SQL: Syntax*.

- [Update the collection in the database](#)
- [Delete the entire collection](#)

Update the collection in the database

After you change the contents of a collection variable in an SPL routine (by deleting, updating, or inserting an element), you must update the database with the new collection.

To update a collection in the database, add an UPDATE statement that sets the collection column in the table to the contents of the updated collection variable. For example, the UPDATE statement in the following figure shows how to update the **polygons** table to set the **definition** column to the new collection stored in the collection variable **vertexes**.

Figure 1. Update a collection in the database.

```
CREATE PROCEDURE shapes()

  DEFINE vertexes SET(point NOT NULL);
  DEFINE pnt point;

  SELECT definition INTO vertexes FROM polygons
    WHERE id = 207;

  FOREACH cursor1 FOR
    SELECT * INTO pnt FROM TABLE(vertexes)
    IF pnt = '(3,4)' THEN
      -- calls the equals function that
      -- compares two values of point type
      DELETE FROM TABLE(vertexes)
        WHERE CURRENT OF cursor1;
      EXIT FOREACH;
    ELSE
      CONTINUE FOREACH;
    END IF;
  END FOREACH

  UPDATE polygons SET definition = vertexes
    WHERE id = 207;

END PROCEDURE;
```

Now the **shapes()** routine is complete. After you run **shapes()**, the collection stored in the row whose ID column is 207 is updated so that it contains three values instead of four.

You can use the **shapes()** routine as a framework for writing other SPL routines that manipulate collections.

The elements of the collection now stored in the **definition** column of row 207 of the **polygons** table are listed as follows:

```
'(3,1)'  
'(8,1)'  
'(8,4)'
```

Delete the entire collection

If you want to delete all the elements of a collection, you can use a single SQL statement. You do not need to declare a cursor. To delete an entire collection, you must perform the following tasks:

- Define a collection variable.
- Select the collection from the database into a collection variable.
- Enter a DELETE statement that uses the collection variable as a collection-derived table.
- Update the collection from the database.

The following figure shows the statements that you might use in an SPL routine to delete an entire collection.

Figure 1. SPL routine to delete an entire collection.

```
DEFINE vertexes SET( INTEGER NOT NULL );  
  
SELECT definition INTO vertexes FROM polygons  
WHERE id = 207;  
  
DELETE FROM TABLE(vertexes);  
  
UPDATE polygons SET definition = vertexes  
WHERE id = 207;
```

This form of the DELETE statement deletes the entire collection in the collection variable **vertexes**. You cannot use a WHERE clause in a DELETE statement that uses a collection-derived table.

After the UPDATE statement, the **polygons** table contains an empty collection where the **id** column is equal to 207.

The syntax for the DELETE statement is described in the *IBM® Informix® Guide to SQL: Syntax*.

Update a collection element

You can update a collection element by accessing the collection within a cursor just as you select or delete an individual element.

If you want to update the collection **SET{100, 200, 300, 500}** to change the value 500 to 400, retrieve the SET from the database into a collection variable and then declare a cursor to move through the elements in the SET, as the following figure shows.

Figure 1. Update the collection element.

```
DEFINE s SET(INTEGER NOT NULL);  
DEFINE n INTEGER;  
  
SELECT numbers INTO s FROM orders  
WHERE order_num = 10;  
  
FOREACH cursor1 FOR  
  SELECT * INTO n FROM TABLE(s)  
  IF ( n == 500 ) THEN  
    UPDATE TABLE(s) (x)  
    SET x = 400 WHERE CURRENT OF cursor1;  
    EXIT FOREACH;  
  ELSE  
    CONTINUE FOREACH;  
  END IF;  
END FOREACH
```

The UPDATE statement uses the collection variable **s** as a collection-derived table. To specify a collection-derived table, use the TABLE keyword. The value (x) that follows (s) in the UPDATE statement is a *derived column*, a column name you supply because the SET clause requires it, even though the collection-derived table does not have columns.

Think of the collection-derived table as having one row and looking something like the following example:

100	200	300	500
-----	-----	-----	-----

In this example, x is a fictitious column name for the “column” that contains the value 500. You only specify a derived column if you are updating a collection of built-in, opaque, distinct, or collection type elements. If you are updating a collection of row types, use a field name instead of a derived column, as [Update a collection of row types](#) describes.

- [Update a collection with a variable](#)

Update a collection with a variable

You can also update a collection with the value stored in a variable instead of a literal value.

The SPL procedure in the following figure uses statements that are similar to the ones that [Figure 1](#) shows, except that this procedure updates the SET in the **direct_reports** column of the **manager** table with a variable, rather than with a literal value. [Figure 2](#) defines the **manager** table.

Figure 1. Update a collection with a variable.

```
CREATE PROCEDURE new_report(mgr VARCHAR(30) ,
    old VARCHAR(30) , new VARCHAR(30) )

    DEFINE s SET (VARCHAR(30) NOT NULL);
    DEFINE n VARCHAR(30);

    SELECT direct_reports INTO s FROM manager
        WHERE mgr_name = mgr;

    FOREACH cursor1 FOR
        SELECT * INTO n FROM TABLE(s)
        IF ( n == old ) THEN
            UPDATE TABLE(s) (x)
                SET x = new WHERE CURRENT OF cursor1;
            EXIT FOREACH;
        ELSE
            CONTINUE FOREACH;
        END IF;
    END FOREACH

    UPDATE manager SET mgr_name = s
        WHERE mgr_name = mgr;

END PROCEDURE;
```

The UPDATE statement nested in the FOREACH loop uses the collection- derived table **s** and the derived column **x**. If the current value of *n* is the same as **old**, the UPDATE statement changes it to the value of **new**. The second UPDATE statement stores the new collection in the **manager** table.

Update the entire collection

If you want to update all the elements of a collection to the same value, or if the collection contains only one element, you do not need to use a cursor. The statements in the following figure show how you can retrieve the collection into a collection variable and then update it with one statement.

Figure 1. Retrieve and update the collection.

```
DEFINE s SET (INTEGER NOT NULL);

SELECT numbers INTO s FROM orders
    WHERE order_num = 10;

UPDATE TABLE(s) (x) SET x = 0;

UPDATE orders SET numbers = s
    WHERE order_num = 10;
```

The first UPDATE statement in this example uses a derived column named **x** with the collection-derived table **s** and gives all the elements in the collection the value 0. The second UPDATE statement stores the new collection in the database.

- [Update a collection of row types](#)
- [Update a nested collection](#)

Update a collection of row types

To update a collection of ROW types, you can take these steps:

1. Declare a collection variable whose field data types match those of the ROW types in the collection.
2. Set the individual fields of the collection variable to the correct data values for the ROW type.
3. For each ROW type, update the entire row of the collection derived table using the collection variable.

The **manager** table in [Figure 2](#) has a column named **projects** that contains a LIST of ROW types with the definition that the following figure shows.

Figure 1. LIST of ROW types definition.

```
projects    LIST( ROW( pro_name VARCHAR(15),
    pro_members SET(VARCHAR(20) NOT NULL) ) NOT NULL)
```

To access the ROW types in the LIST, declare a cursor and select the LIST into a collection variable. After you retrieve each ROW type value in the **projects** column, however, you cannot update the **pro_name** or **pro_members** fields individually. Instead, for each ROW value that needs to be updated in the collection, you must replace the entire ROW with values from a collection variable that include the new field values, as the following figure shows.

Figure 2. Access the ROW types in the LIST.

```
CREATE PROCEDURE update_pro( mgr VARCHAR(30) ,
    pro VARCHAR(15) )

    DEFINE p LIST(ROW(a VARCHAR(15), b SET(VARCHAR(20)
        NOT NULL) ) NOT NULL);
    DEFINE r ROW(p_name VARCHAR(15), p_member SET(VARCHAR(20) NOT NULL) );
```

```

LET r = ROW("project", "SET{'member'}");

SELECT projects INTO p FROM manager
WHERE mgr_name = mgr;

FOREACH cursor1 FOR
  SELECT * INTO r FROM TABLE(p)
  IF (r.p_name == 'Zephyr') THEN
    LET r.p_name = pro;
    UPDATE TABLE(p) (x) SET x = r
    WHERE CURRENT OF cursor1;
  EXIT FOREACH;
END IF;
END FOREACH

UPDATE manager SET projects = p
WHERE mgr_name = mgr;

END PROCEDURE;

```

Before you can use a row-type variable in an SPL program, you must initialize the row variable with a LET statement or a SELECT INTO statement. The UPDATE statement nested in the FOREACH loop of the previous figure sets the **pro_name** field of the row type to the value supplied in the variable **pro**.

Tip: To update a value in a SET in the **pro_members** field of the ROW type, declare a cursor and use an UPDATE statement with a derived column, as [Update a collection element](#) explains.

Update a nested collection

If you want to update a collection of collections, you must declare a cursor to access the outer collection and then declare a nested cursor to access the inner collection.

For example, suppose that the **manager** table has an additional column, **scores**, which contains a LIST whose element type is a MULTISET of integers, as the following figure shows.

Figure 1. Update a collection of collections.

```

scores      LIST(MULTISET(INT NOT NULL) NOT NULL);

```

To update a value in the MULTISET, declare a cursor that moves through each value in the LIST and a nested cursor that moves through each value in the MULTISET, as the following figure shows.

Figure 2. Update a value in the MULTISET.

```

CREATE FUNCTION check_scores ( mgr VARCHAR(30) )
  SPECIFIC NAME nested;
  RETURNING INT;

DEFINE l LIST( MULTISET( INT NOT NULL ) NOT NULL );
DEFINE m MULTISET( INT NOT NULL );
DEFINE n INT;
DEFINE c INT;

SELECT scores INTO l FROM manager
WHERE mgr_name = mgr;

FOREACH list_cursor FOR
  SELECT * FROM TABLE(l) INTO m;

  FOREACH set_cursor FOR
    SELECT * FROM TABLE(m) INTO n;
    IF (n == 0) THEN
      DELETE FROM TABLE(m)
      WHERE CURRENT OF set_cursor;
    ENDIF;
  END FOREACH;
  LET c = CARDINALITY(m);
  RETURN c WITH RESUME;
END FOREACH

END FUNCTION

WITH LISTING IN '/tmp/nested.out';

```

The SPL function selects each MULTISET in the **scores** column into **l**, and then each value in the MULTISET into **m**. If a value in **m** is 0, the function deletes it from the MULTISET. After the values of 0 are deleted, the function counts the remaining elements in each MULTISET and returns an integer.

Tip: Because this function returns a value for each MULTISET in the LIST, you must use a cursor to enclose the EXECUTE FUNCTION statement when you execute the function.

Insert into a collection

You can insert a value into a collection without declaring a cursor. If the collection is a SET or MULTISET, the value is added to the collection but the position of the new element is undefined because the collection has no particular order. If the value is a LIST, you can add the new element at a specific point in the LIST or at the end of the LIST.

In the **manager** table, the **direct_reports** column contains collections of SET type, and the **projects** column contains a LIST. To add a name to the SET in the **direct_reports** column, use an INSERT statement with a collection-derived table, as the following figure shows. Figure 1. Insert a value into a collection.

```
CREATE PROCEDURE new_emp( emp VARCHAR(30), mgr VARCHAR(30) )

DEFINE r SET(VARCHAR(30) NOT NULL);

SELECT direct_reports INTO r FROM manager
WHERE mgr_name = mgr;

INSERT INTO TABLE (r) VALUES(emp);

UPDATE manager SET direct_reports = r
WHERE mgr_name = mgr;

END PROCEDURE;
```

This SPL procedure takes an employee name and a manager name as arguments. The procedure then selects the collection in the **direct_reports** column for the manager the user has entered, adds the employee name the user has entered, and updates the **manager** table with the new collection.

The INSERT statement in the previous figure inserts the new employee name that the user supplies into the SET contained in the collection variable **r**. The UPDATE statement then stores the new collection in the **manager** table.

Notice the syntax of the VALUES clause. The syntax rules for inserting literal data and variables into collection variables are as follows:

- Use parentheses after the VALUES keyword to enclose the complete list of values.
- If the collection is SET, MULTISSET, or LIST, use the type constructor followed by brackets to enclose the list of values to be inserted. In addition, the collection value must be enclosed in quotes.

```
VALUES( "SET{ 1,4,8,9 }" )
```

- If the collection contains a row type, use ROW followed by parentheses to enclose the list of values to be inserted:

```
VALUES( ROW( 'Waters', 'voyager_project' ) )
```

- If the collection is a nested collection, nest keywords, parentheses, and brackets according to how the data type is defined:

```
VALUES( "SET{ ROW('Waters', 'voyager_project'),
ROW('Adams', 'horizon_project') }")
```

For more information on inserting values into collections, see [Modify data](#).

- [Insert into a nested collection](#)

Insert into a nested collection

If you want to insert into a nested collection, the syntax of the VALUES clause changes. Suppose, for example, that you want to insert a value into the **twin_primes** column of the **numbers** table that [Figure 1](#) shows.

With the **twin_primes** column, you might want to insert a SET into the LIST or an element into the inner SET. The following sections describe each of these tasks.

- [Insert a collection into the outer collection](#)
- [Insert a value into the inner collection](#)

Insert a collection into the outer collection

Inserting a SET into the LIST is similar to inserting a single value into a simple collection.

To insert a SET into the LIST, declare a collection variable to hold the LIST and select the entire collection into it. When you use the collection variable as a collection-derived table, each SET in the LIST becomes a row in the table. You can then insert another SET at the end of the LIST or at a specified point.

For example, the **twin_primes** column of one row of numbers might contain the following LIST, as the following figure shows. Figure 1. Sample LIST.

```
LIST( SET{3,5}, SET{5,7}, SET{11,13} )
```

If you think of the LIST as a collection-derived table, it might look similar to the following. Figure 2. Thinking of the LIST as a collection-derived table.

```
{3,5}
{5,7}
{11,13}
```

You might want to insert the value "SET{17,19}" as a second item in the LIST. The statements in the following figure show how to do this. Figure 3. Insert a value in the LIST.

```
CREATE PROCEDURE add_set()

DEFINE l_var LIST( SET( INTEGER NOT NULL ) NOT NULL );
```

```

SELECT twin_primes INTO l_var FROM numbers
WHERE id = 100;

INSERT AT 2 INTO TABLE (l_var) VALUES( "SET{17,19}" );

UPDATE numbers SET twin_primes = l
WHERE id = 100;

END PROCEDURE;

```

In the INSERT statement, the VALUES clause inserts the value SET {17,19} at the second position of the LIST. Now the LIST looks like the following figure. Figure 4. LIST items.

```

{3,5}
{17,19}
{5,7}
{11,13}

```

You can perform the same insert by passing a SET to an SPL routine as an argument, as the following figure shows. Figure 5. Passing a SET to an SPL routine as an argument.

```

CREATE PROCEDURE add_set( set_var SET(INTEGER NOT NULL),
row_id INTEGER );

DEFINE list_var LIST( SET(INTEGER NOT NULL) NOT NULL );
DEFINE n SMALLINT;

SELECT CARDINALITY(twin_primes) INTO n FROM numbers
WHERE id = row_id;

LET n = n + 1;

SELECT twin_primes INTO list_var FROM numbers
WHERE id = row_id;

INSERT AT n INTO TABLE( list_var ) VALUES( set_var );

UPDATE numbers SET twin_primes = list_var
WHERE id = row_id;

END PROCEDURE;

```

In **add_set()**, the user supplies a SET to add to the LIST and an INTEGER value that is the **id** of the row in which the SET will be inserted.

Insert a value into the inner collection

In an SPL routine, you can also insert a value into the inner collection of a nested collection. In general, to access the inner collection of a nested collection and add a value to it, perform the following steps:

1. Declare a collection variable to hold the entire collection stored in one row of a table.
2. Declare an element variable to hold one element of the outer collection. The element variable is itself a collection variable.
3. Select the entire collection from one row of a table into the collection variable.
4. Declare a cursor so that you can move through the elements of the outer collection.
5. Select one element at a time into the element variable.
6. Use a branch or loop to locate the inner collection you want to update.
7. Insert the new value into the inner collection.
8. Close the cursor.
9. Update the database table with the new collection.

As an example, you can use this process on the **twin_primes** column of **numbers**. For example, suppose that **twin_primes** contains the values that the following figure shows, and you want to insert the value 18 into the last SET in the LIST. Figure 1. The twin_primes list.

```
LIST( SET( {3,5}, {5,7}, {11,13}, {17,19} ) )
```

The following figure shows the beginning of a procedure that inserts the value. Figure 2. Procedure that inserts the value.

```

CREATE PROCEDURE add_int()

DEFINE list_var LIST( SET( INTEGER NOT NULL ) NOT NULL );
DEFINE set_var SET( INTEGER NOT NULL );

SELECT twin_primes INTO list_var FROM numbers
WHERE id = 100;

```

So far, the **add_int** procedure has performed steps 1, 2, and 3. The first DEFINE statement declares a collection variable that holds the entire collection stored in one row of numbers.

The second DEFINE statement declares an element variable that holds an element of the collection. In this case, the element variable is itself a collection variable because it holds a SET. The SELECT statement selects the entire collection from one row into the collection variable, **list_var**.

The following figure shows how to declare a cursor so that you can move through the elements of the outer collection. Figure 3. Declare a cursor to move through the elements of the outer collection.

```
FOREACH list_cursor FOR
  SELECT * INTO set_var FROM TABLE( list_var);

FOREACH element_cursor FOR
```

Executing routines

You can execute an SPL routine or external routine in any of these ways:

- Using a stand-alone EXECUTE PROCEDURE or EXECUTE FUNCTION statement that you execute from DB-Access
- Calling the routine explicitly from another SPL routine or an external routine
- Using the routine name with an expression in an SQL statement

An additional mechanism for executing routines supports only the **sysdbopen** and **sysdbclose** procedures, which the DBA can define. If a **sysdbopen** procedure whose owner matches the login identifier of a user exists in the database when the user connects to the database by the CONNECT or DATABASE statement, that routine is executed automatically. If no **sysdbopen** routine has an owner that matches the login identifier of the user, but a PUBLIC.**sysdbopen** routine exists, that routine is executed. This automatic invocation enables the DBA to customize the session environment for users at connection time. The **sysdbclose** routine is similarly invoked when the user disconnects from the database. (For more information about these session configuration routines, see the *IBM® Informix® Guide to SQL: Syntax* and the *IBM Informix Administrator's Guide*.)

An *external routine* is a routine written in C or some other external language.

- [The EXECUTE statements](#)
- [The CALL statement](#)
- [Execute routines in expressions](#)
- [Execute an external function with the RETURN statement](#)
- [Execute cursor functions from an SPL routine](#)
- [Dynamic routine-name specification](#)

The EXECUTE statements

You can use EXECUTE PROCEDURE or EXECUTE FUNCTION to execute an SPL routine or external routine. In general, it is best to use EXECUTE PROCEDURE with procedures and EXECUTE FUNCTION with functions.

Tip: For backward compatibility, the EXECUTE PROCEDURE statement allows you to use an SPL function name and an INTO clause to return values. However, *it is recommended* that you use EXECUTE PROCEDURE only with procedures and EXECUTE FUNCTION only with functions.

You can issue EXECUTE PROCEDURE and EXECUTE FUNCTION statements as stand-alone statements from DB-Access or from within an SPL routine or external routine. If the routine name is unique within the database, and if it does not require arguments, you can execute it by entering just its name and parentheses after EXECUTE PROCEDURE, as the following figure shows.

Figure 1. Execute a procedure.

```
EXECUTE PROCEDURE update_orders();
```

The INTO clause is never present when you invoke a procedure with the EXECUTE statement because a procedure does not return a value.

If the routine expects arguments, you must enter the argument values within parentheses, as the following figure shows.

Figure 2. Execute a procedure with arguments.

```
EXECUTE FUNCTION scale_rectangles(107, 1.9)
  INTO new;
```

The statement executes a function. Because a function returns a value, EXECUTE FUNCTION uses an INTO clause that specifies a variable where the return value is stored. The INTO clause must always be present when you use an EXECUTE statement to execute a function.

If the database has more than one procedure or function of the same name, IBM® Informix® locates the right function based on the data types of the arguments. For example, the statement in the previous figure supplies INTEGER and REAL values as arguments, so if your database contains multiple routines named **scale_rectangles()**, the database server executes only the **scale_rectangles()** function that accepts INTEGER and REAL data types.

The parameter list of an SPL routine always has parameter names as well as data types. When you execute the routine, the parameter names are optional. However, if you pass arguments by name (instead of just by value) to EXECUTE PROCEDURE or EXECUTE FUNCTION, as in the following figure, resolves the routine-by-routine name and arguments only, a process known as *partial routine resolution*.

Figure 3. Execute a routine passing arguments by name.

```
EXECUTE FUNCTION scale_rectangles( rectid = 107,
  scale = 1.9 ) INTO new_rectangle;
```

You can also execute an SPL routine stored on another database server by adding a *qualified routine name* to the statement; that is, a name in the form database@dbserver:owner_name.routine_name, as in the following figure.

Figure 4. Execute an SPL routine stored on another database server.

```
EXECUTE PROCEDURE informix@davinci:bsmith.update_orders();
```

When you execute a routine remotely, the owner_name in the qualified routine name is optional.

The CALL statement

You can call an SPL routine or an external routine from an SPL routine using the CALL statement. CALL can execute both procedures and functions. If you use CALL to execute a function, add a RETURNING clause and the name of an SPL variable (or variables) that will receive the value (or values) the function returns.

Suppose, for example, that you want the **scale_rectangles** function to call an external function that calculates the area of the rectangle and then returns the area with the rectangle description, as in the following figure.

Figure 1. Call an external function.

```
CREATE FUNCTION scale_rectangles( rectid INTEGER,
    scale REAL )
    RETURNING rectangle_t, REAL;

    DEFINE rectv rectangle_t;
    DEFINE a REAL;
    SELECT rect INTO rectv
        FROM rectangles WHERE id = rectid;
    IF ( rectv IS NULL ) THEN
        LET rectv.start = (0.0,0.0);
        LET rectv.length = 1.0;
        LET rectv.width = 1.0;
        LET a = 1.0;
        RETURN rectv, a;
    ELSE
        LET rectv.length = scale * rectv.length;
        LET rectv.width = scale * rectv.width;
        CALL area(rectv.length, rectv.width) RETURNING a;
        RETURN rectv, a;
    END IF;

END FUNCTION;
```

The SPL function uses a CALL statement that executes the external function **area()**. The value **area()** returns is stored in **a** and returned to the calling routine by the RETURN statement.

In this example, **area()** is an external function, but you can use CALL in the same manner with an SPL function.

Execute routines in expressions

Just as with built-in functions, you can execute SPL routines (and external routines from SPL routines) by using them in expressions in SQL and SPL statements. A routine used in an expression is usually a function, because it returns a value to the rest of the statement.

For example, you might execute a function by a LET statement that assigns the return value to a variable. The statements in the following figure perform the same task. They execute an external function within an SPL routine and assign the return value to the variable **a**.

Figure 1. Execute an external function within an SPL routine.

```
LET a = area( rectv.length, rectv.width );

CALL area( rectv.length, rectv.width ) RETURNING a;
-- these statements are equivalent
```

You can also execute an SPL routine from an SQL statement, as the following figure shows. Suppose you write an SPL function, **increase_by_pct**, which increases a given price by a given percentage. After you write an SPL routine, it is available for use in any other SPL routine.

Figure 2. Execute an SPL routine from an SQL statement.

```
CREATE FUNCTION raise_price ( num INT )
    RETURNING DECIMAL;

    DEFINE p DECIMAL;

    SELECT increase_by_pct(price, 20) INTO p
        FROM inventory WHERE prod_num = num;

    RETURN p;

END FUNCTION;
```

The example selects the **price** column of a specified row of **inventory** and uses the value as an argument to the SPL function **increase_by_pct**. The function then returns the new value of **price**, increased by 20 percent, in the variable **p**.

Execute an external function with the RETURN statement

You can use a RETURN statement to execute any external function from within an SPL routine. The following figure shows an external function that is used in the RETURN statement of an SPL program.

Figure 1. A RETURN statement to execute an external function from within an SPL routine.

```
CREATE FUNCTION c_func() RETURNS int
LANGUAGE C;

CREATE FUNCTION spl_func() RETURNS INT;
    RETURN(c_func());
END FUNCTION;
```

```
EXECUTE FUNCTION spl_func();
```

When you execute the **spl_func()** function, the **c_func()** function is invoked, and the SPL function returns the value that the external function returns.

Execute cursor functions from an SPL routine

A cursor function is a user-defined function that returns one or more rows of data and therefore requires a cursor to execute. A cursor function can be either of the following functions:

- An SPL function whose RETURN statement includes WITH RESUME
- An external function that is defined as an iterator function

The behavior of a cursor function is the same whether the function is an SPL function or an external function. However, an SPL cursor function can return more than one value per iteration, whereas an external cursor function (iterator function) can return only one value per iteration.

To execute a cursor function from an SPL routine, you must include the function in a FOREACH loop of an SPL routine. The following examples show different ways to execute a cursor function in a FOREACH loop:

```
FOREACH SELECT cur_func1(col_name) INTO spl_var FROM tbl1
  INSERT INTO tab2 VALUES (spl_var);
END FOREACH
```

```
FOREACH EXECUTE FUNCTION cur_func2() INTO spl_var
  INSERT INTO tab2 VALUES (spl_var);
END FOREACH
```

Dynamic routine-name specification

Dynamic routine-name specification allows you to execute an SPL routine from another SPL routine, by building the name of the called routine within the calling routine. Dynamic routine-name specification simplifies how you can write an SPL routine that calls another SPL routine whose name is not known until runtime. The database server lets you specify an SPL variable instead of the explicit name of an SPL routine in the EXECUTE PROCEDURE or EXECUTE FUNCTION statement.

In the following figure, the SPL procedure **company_proc** updates a large company sales table and then assigns an SPL variable named **salesperson_proc** to hold the dynamically created name of an SPL procedure that updates another, smaller table that contains the monthly sales of an individual salesperson.

Figure 1. Dynamic routine-name specification.

```
CREATE PROCEDURE company_proc ( no_of_items INT,
  itm_quantity SMALLINT, sale_amount MONEY,
  customer VARCHAR(50), sales_person VARCHAR(30) )

DEFINE salesperson_proc VARCHAR(60);

-- Update the company table
INSERT INTO company_tbl VALUES (no_of_items, itm_quantity,
  sale_amount, customer, sales_person);

-- Generate the procedure name for the variable salesperson_proc
LET salesperson_proc = sales_person || "." || "tbl" ||
  current_month || "_" || current_year || "_proc" ;

-- Execute the SPL procedure that the salesperson_proc
-- variable specifies
EXECUTE PROCEDURE salesperson_proc (no_of_items,
  itm_quantity, sale_amount, customer)
END PROCEDURE;
```

In example, the procedure **company_proc** accepts five arguments and inserts them into **company_tbl**. Then the LET statement uses various values and the concatenation operator || to generate the name of another SPL procedure to execute. In the LET statement:

sales_person
An argument passed to the **company_proc** procedure.

current_month
The current month in the system date.

current_year
The current year in the system date.

Therefore, if a salesperson named Bill makes a sale in July 1998, **company_proc** inserts a record in **company_tbl** and executes the SPL procedure **bill.tbl07_1998_proc**, which updates a smaller table that contains the monthly sales of an individual salesperson.

- [Rules for dynamic routine-name specification](#)

Rules for dynamic routine-name specification

You must define the SPL variable that holds the name of the dynamically executed SPL routine as CHAR, VARCHAR, NCHAR, or NVARCHAR type. You must also give the SPL variable a valid and non-NULL name.

The SPL routine that the dynamic routine-name specification identifies must exist before it can be executed. If you assign the SPL variable the name of a valid SPL routine, the EXECUTE PROCEDURE or EXECUTE FUNCTION statement executes the routine whose name is contained in the variable, even if a built-in function of the same name exists.

In an EXECUTE PROCEDURE or EXECUTE FUNCTION statement, you cannot use two SPL variables to create a variable name in the form *owner.routine_name*. However, you can use an SPL variable that contains a fully qualified routine name, for example, *bill.proc1*. The following figure shows both cases. Figure 1. SPL variable that contains a fully qualified routine name.

```
EXECUTE PROCEDURE owner.variable.proc_variable;  
-- this is not allowed  
  
LET proc1 = bill.proc1;  
EXECUTE PROCEDURE proc1; -- this is allowed
```

Privileges on routines

Privileges differentiate users who can create a routine from users who can execute a routine. Some privileges accrue as part of other privileges. For example, the DBA privilege includes permissions to create routines, execute routines, and grant these privileges to other users.

- [Privileges for registering a routine](#)
- [Privileges for executing a routine](#)
- [Privileges on objects associated with a routine](#)
- [DBA privileges for executing a routine](#)

Privileges for registering a routine

To register a routine in the database, an authorized user wraps the SPL commands in a CREATE FUNCTION or CREATE PROCEDURE statement. The database server stores a registered SPL routine internally. The following users qualify to register a new routine in the database:

- Any user with the DBA privilege can register a routine with or without the DBA keyword in the CREATE statement. For an explanation of the DBA keyword, see [DBA privileges for executing a routine](#).
- A user who does not have the DBA privilege needs the Resource privilege to register an SPL routine. The creator is the owner of the routine. A user who does not have the DBA privilege cannot use the DBA keyword to register the routine.

A DBA must give other users the Resource privilege needed to create routines. The DBA can also revoke the Resource privilege, preventing the user from creating further routines.

- Besides holding the DBA privilege or the Resource privilege on the database in which the UDR is registered, the user who creates a UDR must also hold the Usage privilege on the programming language in which the UDR is written. These SQL statements can grant language-level Usage privileges for specific programming languages:
 - GRANT USAGE ON LANGUAGE C
 - GRANT USAGE ON LANGUAGE JAVA
 - GRANT USAGE ON LANGUAGE SPL

Besides an individual user, the grantee of these privileges can also be a user-defined role, or the PUBLIC group. After language-level Usage privileges are granted to a role, any user who holds that role can enable all the access privileges of the role by using the SET ROLE statement of SQL to specify that role as the current role.

For external routines written in the C language or the Java™ language, if the IFX_EXTEND_ROLE configuration parameter is enabled, only users to whom the DBSA has granted EXTERNAL role has been granted can register, drop, or alter external UDRs or DataBlade modules. This parameter is enabled by default. By setting the IFX_EXTEND_ROLE configuration parameter to OFF or to 0, the DBSA can disable the requirement of holding the EXTEND role for DDL operations on DataBlade modules and external UDRs. This security feature has no effect, however, on SPL routines.

In summary, a user who holds the database-level and language-level discretionary access privileges that are identified above (and who also holds the EXTEND role, if IFX_EXTEND_ROLE is enabled and the UDR is an external routine) can reference UDRs in the following SQL statements:

- The DBA or a user can register a new UDR with the CREATE FUNCTION, CREATE FUNCTION FROM, CREATE PROCEDURE, CREATE PROCEDURE FROM, CREATE ROUTINE, or CREATE ROUTINE FROM statement.
- The DBA or the owner of an existing UDR can cancel the registration of that UDR with the DROP FUNCTION, DROP PROCEDURE, or DROP ROUTINE statement.
- The DBA or the owner of an existing UDR can modify the definition of that UDR with the ALTER FUNCTION, ALTER PROCEDURE, or ALTER ROUTINE statement.

Privileges for executing a routine

The Execute privilege enables users to invoke a routine. The routine might be invoked by the EXECUTE or CALL statements, or by using a function in an expression. The following users have a default Execute privilege, which enables them to invoke a routine:

- By default, any user with the DBA privilege can execute any routine in the database.
- If the routine is registered with the qualified CREATE DBA FUNCTION or CREATE DBA PROCEDURE statements, only users with the DBA privilege have a default Execute privilege for that routine.

- If the database is not ANSI compliant, user **public** (any user with Connect database privilege) automatically has the Execute privilege to a routine that is not registered with the DBA keyword.
- In an ANSI-compliant database, the procedure owner and any user with the DBA privilege can execute the routine without receiving additional privileges.
- [Grant and revoke the Execute privilege](#)
- [Execute privileges with COMMUTATOR and NEGATOR functions](#)

Grant and revoke the Execute privilege

Routines have the following GRANT and REVOKE requirements:

- The DBA can grant or revoke the Execute privilege to any routine in the database.
- The creator of a routine can grant or revoke the Execute privilege on that particular routine. The creator forfeits the ability to grant or revoke by including the AS *grantor* clause with the GRANT EXECUTE ON statement.
- Another user can grant the Execute privilege if the owner applied the WITH GRANT keywords in the GRANT EXECUTE ON statement.

A DBA or the routine owner must explicitly grant the Execute privilege to non-DBA users for the following conditions:

- A routine that was registered with the DBA keyword
- A routine in an ANSI-compliant database
- A routine in a database that is not ANSI-compliant, but with the NODEFDAC environment variable set to *yes*.
-

An owner can restrict the Execute privilege on a routine even though the database server grants that privilege to public by default. To do this, issue the REVOKE EXECUTE ON PUBLIC statement. The DBA and owner can still execute the routine and can grant the Execute privilege to specific users, if applicable.

Execute privileges with COMMUTATOR and NEGATOR functions

Important: If you explicitly grant the Execute privilege on an SPL function that is the commutator or negator function of a UDR, you must also grant that privilege on the commutator or the negator function before the grantee can use either. You cannot specify COMMUTATOR or NEGATOR modifiers with SPL procedures. The following example demonstrates both limiting privileges for a function and its negator to one group of users. Suppose you create the following pair of negator functions:

```
CREATE FUNCTION greater(y PERCENT, z PERCENT)
RETURNS BOOLEAN
NEGATOR= less(y PERCENT, z PERCENT);
. . .
CREATE FUNCTION less(y PERCENT, z PERCENT)
RETURNS BOOLEAN
NEGATOR= greater(y PERCENT, z PERCENT);
```

By default, any user can execute both the function and negator. The following statements allow only **accounting** to execute these functions:

```
REVOKE EXECUTE ON FUNCTION greater FROM PUBLIC;
REVOKE EXECUTE ON FUNCTION less FROM PUBLIC;
GRANT accounting TO mary, jim, ted;
GRANT EXECUTE ON FUNCTION greater TO accounting;
GRANT EXECUTE ON FUNCTION less TO accounting;
```

A user might receive the Execute privilege accompanied by the WITH GRANT OPTION authority to grant the Execute privilege to other users. If a user loses the Execute privilege on a routine, the Execute privilege is also revoked from all users who were granted the Execute privilege by that user.

For more information, see the GRANT and REVOKE statement descriptions in the *IBM® Informix® Guide to SQL: Syntax*.

Privileges on objects associated with a routine

The database server checks the existence of any referenced objects and verifies that the user invoking the routine has the necessary privileges to access the referenced objects.

Objects referenced by a routine can include:

- Tables and columns
- Sequence objects
- User-defined data types
- Other routines executed by the routine

When a routine is run, the effective privilege is defined as the union of:

- The privileges of the user running the routine,
- The privileges that the owner has with the GRANT option.

By default, the database administrator has all the privileges in a database with the GRANT option. Therefore, users executing routines that are owned by database administrators can select from all of the tables in a given database.

A GRANT EXECUTE ON statement confers to the grantee any table-level privileges that the grantor received from a GRANT statement that contained the WITH GRANT keywords.

The owner of the routine, and not the user who runs the routine, owns the unqualified objects created in the course of executing the routine. For example, assume user **howie** registers an SPL routine that creates two tables, with the following SPL routine:

```
CREATE PROCEDURE promo()  
.  
.  
.  
    CREATE TABLE newcatalog  
    (  
        catlog_num INTEGER  
        cat_advert VARCHAR(255, 65)  
        cat_picture BLOB  
    ) ;  
    CREATE TABLE dawn.mailers  
    (  
        cust_num INTEGER  
        interested_in SET(catlog_num INTEGER)  
    ) ;  
END PROCEDURE;
```

User **julia** runs the routine, which creates the table **newcatalog**. Because no owner name qualifies table name **newcatalog**, the routine owner (**howie**) owns **newcatalog**. By contrast, the qualified name **dawn.maillist** identifies **dawn** as the owner of **maillist**.

DBA privileges for executing a routine

If a DBA creates a routine using the DBA keyword, the database server automatically grants the Execute privilege only to other users with the DBA privilege. A DBA can, however, explicitly grant the Execute privilege on a DBA routine to a user who does not have the DBA privilege.

When a user executes a routine that was registered with the DBA keyword, that user assumes the privileges of a DBA for the duration of the routine. If a user who does not have the DBA privilege runs a DBA routine, the database server implicitly grants a temporary DBA privilege to the invoker. Before exiting a DBA routine, the database server implicitly revokes the temporary DBA privilege.

Objects created in the course of running a DBA routine are owned by the user who executes the routine, unless a statement in the routine explicitly names someone else as the owner. For example, suppose that **tony** registers the **promo()** routine with the DBA keyword, as follows:

```
CREATE DBA PROCEDURE promo()  
.  
.  
.  
    CREATE TABLE catalog  
    .  
    .  
    .  
    CREATE TABLE libby.mailers  
    .  
    .  
    .  
END PROCEDURE;
```

Although **tony** owns the routine, if **marty** runs it, then **marty** owns the **catalog** table, but user **libby** owns **libby.mailers** because her name qualifies the table name, making her the table owner.

A called routine does not inherit the DBA privilege. If a DBA routine executes a routine that was created without the DBA keyword, the DBA privileges do not affect the called routine.

If a routine that is registered without the DBA keyword calls a DBA routine, the caller must have Execute privileges on the called DBA routine. Statements within the DBA routine execute as they would within any DBA routine.

The following example demonstrates what occurs when a DBA and non-DBA routine interact. Suppose procedure **dbspc_cleanup()** executes another procedure **clust_catalog()**. Suppose also that the procedure **clust_catalog()** creates an index and that the SPL source code for **clust_catalog()** includes the following statements:

```
CREATE CLUSTER INDEX c_clust_ix ON catalog (catalog_num);
```

The DBA procedure **dbspc_cleanup()** invokes the other routine with the following statement:

```
EXECUTE PROCEDURE clust_catalog(catalog);
```

Assume **tony** registered **dbspc_cleanup()** as a DBA procedure and **clust_catalog()** is registered without the DBA keyword, as the following statements show:

```
CREATE DBA PROCEDURE dbspc_cleanup(loc CHAR)  
CREATE PROCEDURE clust_catalog(catalog CHAR)  
GRANT EXECUTE ON dbspc_cleanup(CHAR) to marty;
```

Suppose user **marty** runs **dbspc_cleanup()**. Because index **c_clust_ix** is created by a non-DBA routine, **tony**, who owns both routines, also owns **c_clust_ix**. By contrast, **marty** would own index **c_clust_ix** if **clust_catalog()** is a DBA procedure, as the following registering and grant statements show:

```
CREATE PROCEDURE dbspc_cleanup(loc CHAR);  
CREATE DBA PROCEDURE clust_catalog(catalog CHAR);  
GRANT EXECUTE ON clust_catalog(CHAR) to marty;
```

Notice that **dbspc_cleanup()** need not be a DBA procedure to call a DBA procedure.

Find errors in an SPL routine

When you use CREATE PROCEDURE or CREATE FUNCTION to write an SPL routine with DB-Access, the statement fails when you select **Run** from the menu, if a syntax error occurs in the body of the routine.

If you are creating the routine in DB-Access, when you choose the **Modify** option from the menu, the cursor moves to the line that contains the syntax error. You can select **Run** and **Modify** again to check subsequent lines.

- [Compile-time warnings](#)
- [Generate the text of the routine](#)

Compile-time warnings

If the database server detects a potential problem, but the syntax of the SPL routine is correct, the database server generates a warning and places it in a listing file. You can examine this file to check for potential problems before you execute the routine.

The file name and path name of the listing file are specified in the WITH LISTING IN clause of the CREATE PROCEDURE or CREATE FUNCTION statement. For information about how to specify the path name of the listing file, see [Specify a DOCUMENT clause](#).

If you are working on a network, the listing file is created on the system where the database resides. If you provide an absolute path name and file name for the file, the file is created at the location you specify.

For UNIX, if you provide a relative path name for the listing file, the file is created in your home directory on the computer where the database resides. (If you do not have a home directory, the file is created in the **root** directory.)

For Windows, if you provide a relative path name for the listing file, the default directory is your current working directory if the database is on the local computer. Otherwise the default directory is %INFORMIXDIR%\bin.

After you create the routine, you can view the file that is specified in the WITH LISTING IN clause to see the warnings that it contains.

Generate the text of the routine

After you create an SPL routine, it is stored in the **sysprocbody** system catalog table. The **sysprocbody** system catalog table contains the executable routine, as well as its text.

To retrieve the text of the routine, select the **data** column from the **sysprocbody** system catalog table. The **datakey** column for a text entry has the code **T**.

The SELECT statement in the following figure reads the text of the SPL routine **read_address**.
Figure 1. SELECT statement to read the text of the SPL routine.

```
SELECT data FROM informix.sysprocbody
WHERE datakey = 'T'           -- find text lines
AND procid =
  ( SELECT procid
    FROM informix.sysprocedures
    WHERE informix.sysprocedures.procname =
      'read_address' )
```

Debug an SPL routine

After you successfully create and run an SPL routine, you can encounter logic errors. If the routine has logic errors, use the TRACE statement to help find them. You can trace the values of the following items:

- Variables
- Arguments
- Return values
- SQL error codes
- ISAM error codes

To generate a listing of traced values, first use the SQL statement SET DEBUG FILE to name the file that is to contain the traced output. When you create the SPL routine, include a TRACE statement.

The following methods specify the form of TRACE output.

Statement

Action

TRACE ON

Traces all statements except SQL statements. Prints the contents of variables before they are used. Traces routine calls and returned values.

TRACE PROCEDURE

Traces only the routine calls and returned values.

TRACE *expression*

Prints a literal or an expression. If necessary, the value of the expression is calculated before it is sent to the file.

The following figure demonstrates how you can use the TRACE statement to monitor how an SPL function executes.

Figure 1. The TRACE statement.

```

CREATE FUNCTION read_many (lastname CHAR(15))
RETURNING CHAR(15), CHAR(15), CHAR(20), CHAR(15),
CHAR(2), CHAR(5);

DEFINE p_lname,p_fname, p_city CHAR(15);
DEFINE p_add CHAR(20);
DEFINE p_state CHAR(2);
DEFINE p_zip CHAR(5);
DEFINE lcount, i INT;

LET lcount = 1;

TRACE ON;          -- Trace every expression from here on
TRACE 'Foreach starts'; -- Trace statement with a literal

FOREACH
SELECT fname, lname, address1, city, state, zipcode
INTO p_fname, p_lname, p_add, p_city, p_state, p_zip
FROM customer
WHERE lname = lastname
RETURN p_fname, p_lname, p_add, p_city, p_state, p_zip
WITH RESUME;
LET lcount = lcount + 1; -- count of returned addresses
END FOREACH

TRACE 'Loop starts'; -- Another literal
FOR i IN (1 TO 5)
BEGIN
RETURN i , i+1, i*i, i/i, i-1,i WITH RESUME;
END
END FOR;

END FUNCTION;

```

With the TRACE ON statement, each time you execute the traced routine, entries are added to the file you specified in the SET DEBUG FILE statement. To see the debug entries, view the output file with any text editor.

The following list contains some of the output that the function in previous example generates. Next to each traced statement is an explanation of its contents.

Statement

Action

TRACE ON
Echoes TRACE ON statement.

TRACE Foreach starts
Traces expression, in this case, the literal string Foreach starts.

start select cursor
Provides notification that a cursor is opened to handle a FOREACH loop.

select cursor iteration
Provides notification of the start of each iteration of the select cursor.

expression: (+lcount, 1)
Evaluates the encountered expression, (lcount+1), to 2.

let lcount = 2
Echoes each LET statement with the value.

Exception handling

You can use the ON EXCEPTION statement to trap any exception (or error) that the database server returns to your SPL routine or any exception that the routine raises. The RAISE EXCEPTION statement lets you generate an exception within the SPL routine.

In an SPL routine, you cannot use exception handling to handle the following conditions:

- Success (row returned)
- Success (no rows returned)
- [Error trapping and recovering](#)
- [Scope of control of an ON EXCEPTION statement](#)
The scope of the ON EXCEPTION statement extends from the statement that immediately follows the ON EXCEPTION statement, and ends at the end of the statement block in which the ON EXCEPTION statement is issued. If the SPL routine includes no explicit statement blocks, the scope is all subsequent statements in the routine.
- [User-generated exceptions](#)

Error trapping and recovering

The ON EXCEPTION statement provides a mechanism to trap any error.

To trap an error, enclose a group of statements in a statement block marked with BEGIN and END and add an ON EXCEPTION IN statement at the beginning of the statement block. If an error occurs in the block that follows the ON EXCEPTION statement, you can take recovery action.

The following figure shows an ON EXCEPTION statement within a statement block.
Figure 1. Trap errors.

```
BEGIN
DEFINE c INT;
ON EXCEPTION IN
(
-206, -- table does not exist
-217 -- column does not exist
) SET err_num

IF err_num = -206 THEN
CREATE TABLE t (c INT);
INSERT INTO t VALUES (10);
-- continue after the insert statement
ELSE
ALTER TABLE t ADD(d INT);
LET c = (SELECT d FROM t);
-- continue after the select statement.
END IF
END EXCEPTION WITH RESUME

INSERT INTO t VALUES (10); -- fails if t does not exist

LET c = (SELECT d FROM t); -- fails if d does not exist
END
```

When an error occurs, the SPL interpreter searches for the innermost ON EXCEPTION declaration that traps the error. The first action after trapping the error is to reset the error. When execution of the error action code is complete, and if the ON EXCEPTION declaration that was raised included the WITH RESUME keywords, execution resumes automatically with the statement *following* the statement that generated the error. If the ON EXCEPTION declaration did not include the WITH RESUME keywords, execution exits the current block entirely.

Scope of control of an ON EXCEPTION statement

The scope of the ON EXCEPTION statement extends from the statement that immediately follows the ON EXCEPTION statement, and ends at the end of the statement block in which the ON EXCEPTION statement is issued. If the SPL routine includes no explicit statement blocks, the scope is all subsequent statements in the routine.

For the exceptions specified in the IN clause (or for all exceptions, if no IN clause is specified), the scope of the ON EXCEPTION statement includes all statements that follow the ON EXCEPTION statement within the same statement block. If other statement blocks are nested within that block, the scope also includes all statements in the nested statement blocks that follow the ON EXCEPTION statement, and any statements in statement blocks that are nested within those nested blocks.

The following pseudocode shows where the exception is valid within the routine. That is, if error 201 occurs in any of the indicated blocks, the action labeled *a201* occurs.

Figure 1. ON EXCEPTION statement scope of control.

```
CREATE PROCEDURE scope()
DEFINE i INT;
. . .
BEGIN
. . .
ON EXCEPTION IN (201)
-- do action a201
END EXCEPTION
BEGIN
-- nested statement block aa
-- do action, a201 valid here
END
BEGIN
-- nested statement block bb
-- do action, a201 valid here
END
WHILE i < 10
-- do something, a201 is valid here
END WHILE

END
-- end of statement block A
BEGIN
-- begin statement block B
-- do something
-- a201 is NOT valid here
END
END PROCEDURE;
```

User-generated exceptions

You can generate your own error using the RAISE EXCEPTION statement, as the following figure shows.
Figure 1. The RAISE EXCEPTION statement.

```
BEGIN
ON EXCEPTION SET esql, eisam -- trap all errors
IF esql = -206 THEN -- table not found
-- recover somehow
```

```

ELSE
    RAISE exception esql, eisam; -- pass the error up
END IF
END EXCEPTION
-- do something
END

```

In the example, the ON EXCEPTION statement uses two variables, **esql** and **eisam**, to hold the error numbers that the database server returns. The IF clause executes if an error occurs and if the SQL error number is -206. If any other SQL error is caught, it is passed out of this BEGINEND block to the last BEGINEND block of the previous example.

- [Simulate SQL errors](#)
- [RAISE EXCEPTION to exit nested code](#)

Simulate SQL errors

You can generate errors to simulate SQL errors, as the following figure shows. If the user is **pault**, then the SPL routine acts as if that user has no update privileges, even if the user really does have that privilege.

Figure 1. Simulate SQL errors.

```

BEGIN
    IF user = 'pault' THEN
        RAISE EXCEPTION -273; -- deny Paul update privilege
    END IF
END

```

RAISE EXCEPTION to exit nested code

The following figure shows how you can use the RAISE EXCEPTION statement to break out of a deeply nested block.

Figure 1. The RAISE EXCEPTION statement.

```

BEGIN
    ON EXCEPTION IN (1)
    END EXCEPTION WITH RESUME -- do nothing significant (cont)

    BEGIN
        FOR i IN (1 TO 1000)
            FOREACH select ..INTO aa FROM t
                IF aa < 0 THEN
                    RAISE EXCEPTION 1; -- emergency exit
                END IF
            END FOREACH
        END FOR
        RETURN 1;
    END

    --do something; -- emergency exit to
    -- this statement.
    TRACE 'Negative value returned';
    RETURN -10;
END

```

If the innermost condition is true (if **aa** is negative), then the exception is raised and execution jumps to the code following the END of the block. In this case, execution jumps to the TRACE statement.

Remember that a BEGINEND block is a *single* statement. If an error occurs somewhere inside a block and the trap is outside the block, the rest of the block is skipped when execution resumes, and execution begins at the next statement.

Unless you set a trap for this error somewhere in the block, the error condition is passed back to the block that contains the call and back to any blocks that contain the block. If no ON EXCEPTION statement exists that is set to handle the error, execution of the SPL routine stops, creating an error for the routine that is executing the SPL routine.

Check the number of rows processed in an SPL routine

Within SPL routines, you can use the **DBINFO** function to find out the number of rows that have been processed in SELECT, INSERT, UPDATE, DELETE, EXECUTE PROCEDURE, and EXECUTE FUNCTION statements.

The following figure shows an SPL function that uses the **DBINFO** function with the 'sqlca.sqlerrd2' option to determine the number of rows that are deleted from a table.

Figure 1. Determine the number of rows deleted from a table.

```

CREATE FUNCTION del_rows ( pnumb INT )
RETURNING INT;

DEFINE nrows INT;

DELETE FROM sec_tab WHERE part_num = pnumb;

```

```
LET nrows = DBINFO('sqlca.sqlerrd2');  
  
RETURN nrows;  
  
END FUNCTION;
```

To ensure valid results, use this option after SELECT and EXECUTE PROCEDURE or EXECUTE FUNCTION statements have completed executing. In addition, if you use the 'sqlca.sqlerrd2' option within cursors, make sure that all rows are fetched before the cursors are closed, to ensure valid results.

Summary

SPL routines provide many opportunities for streamlining your database process, including enhanced database performance, simplified applications, and limited or monitored access to data. You can also use SPL routines to handle extended data types, such as collection types, row types, opaque types, and distinct types. For syntax diagrams of SPL statements, see the *IBM® Informix® Guide to SQL: Syntax*.

Create and use triggers

This section describes each component of the CREATE TRIGGER statement, illustrates some uses for triggers, and describes the advantages of using an SPL routine as a triggered action.

In addition, this section describes INSTEAD OF trigger that can be defined on views.

An SQL trigger is a mechanism that resides in the database. It is available to any user who has permission to use it. An SQL trigger specifies that when a data-manipulation language (DML) operation (an INSERT, SELECT, DELETE, or UPDATE statement) occurs on a particular table, the database server automatically performs one or more additional actions. For triggers defined on views, the triggered action on the base tables of the view replaces the triggering event. For triggers on tables or views, the triggered actions can be INSERT, DELETE, UPDATE, EXECUTE PROCEDURE or EXECUTE FUNCTION statements.

IBM® Informix® also supports user-defined routines written in C or in Java™ as triggered actions.

For information on how to write a C UDR to obtain metadata information about trigger events, see the *IBM Informix DataBlade API Programmer's Guide*.

- [When to use triggers](#)
- [How to create a trigger](#)
- [Triggered actions](#)
- [Trigger routines](#)
- [Triggers in a table hierarchy](#)
- [Select triggers](#)
- [Re-entrant triggers](#)
- [INSTEAD OF triggers on views](#)
- [Trace triggered actions](#)
- [Generate error messages](#)
- [Summary](#)

When to use triggers

Because a trigger resides in the database and anyone who has the required privilege can use it, a trigger lets you write a set of SQL statements that multiple applications can use. It lets you avoid redundant code when multiple programs need to perform the same database operation.

You can use triggers to perform the following actions, as well as others that are not found in this list:

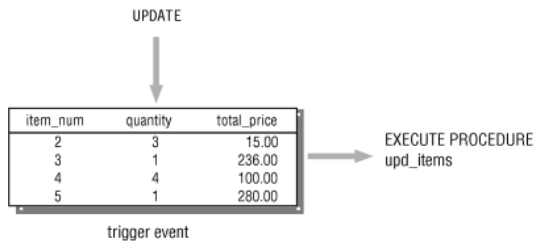
- Create an audit trail of activity in the database. For example, you can track updates to the orders table by updating corroborating information to an audit table.
- Implement a business rule. For example, you can determine when an order exceeds a customer's credit limit and display a message to that effect.
- Derive additional data that is not available within a table or within the database. For example, when an update occurs to the **quantity** column of the **items** table, you can calculate the corresponding adjustment to the **total_price** column.
- Enforce referential integrity. When you delete a customer, for example, you can use a trigger to delete corresponding rows that have the same customer number in the **orders** table.

How to create a trigger

You use the CREATE TRIGGER statement to define a new trigger. The CREATE TRIGGER statement is a data-definition statement that associates SQL statements, called the *triggered action*, with a precipitating event on a table. When the event occurs, it triggers the associated SQL statements, which are stored in the database.

In this example, the triggering event is an UPDATE statement that references the **quantity** column of the **items** table. The following figure illustrates the relationship of the DML operation that activates the trigger, called the trigger event, to the triggered action.

Figure 1. Trigger event and triggered action



The CREATE TRIGGER statement consists of clauses that perform the following actions:

- Declare a name for the trigger .
- Specify the DML operation on a specified table or view as the triggering event.
- Define the SQL operations that this event triggers.

An optional clause, called the REFERENCING clause, is discussed in [FOR EACH ROW triggered actions](#).

To create a trigger, use DB-Access or one of the SQL APIs. This section describes the CREATE TRIGGER statement as you enter it with the interactive Query-language option in DB-Access. In an SQL API, you precede the statement with the symbol or keywords that identify it as an embedded statement.

- [Declare a trigger name](#)
- [Specify the trigger event](#)
- [Define the triggered actions](#)
- [A complete CREATE TRIGGER statement](#)

Declare a trigger name

The trigger name identifies the trigger, and must be unique among trigger names within the database. The trigger name follows the words CREATE TRIGGER in the statement. Like any SQL identifier, can be up to 128 bytes in length, beginning with a letter and consisting of letters, digits, and the underscore (_) symbol. In the following example, the portion of the CREATE TRIGGER statement that is shown declares the name **upqty** for the trigger:

```
CREATE TRIGGER upqty      -- declare trigger name
```

Specify the trigger event

The *trigger event* is the type of DML statement that activates the trigger. When a statement of this type is performed on the table, the database server executes the SQL statements that make up the triggered action. For tables, the trigger event can be an INSERT, SELECT, DELETE, or UPDATE statement. For UPDATE or SELECT trigger event, you can specify one or more columns in the table to activate the trigger. If you do not specify any columns, then an UPDATE or SELECT of any column in the table activates the trigger. You can define multiple INSERT, DELETE, UPDATE and SELECT triggers on the same table, and multiple INSERT, DELETE, and UPDATE triggers on the same view.

You can only create a trigger on a table or view in the current database. Triggers cannot reference a remote table or view.

In the following excerpt from a CREATE TRIGGER statement, the trigger event is defined as an update of the **quantity** column in the **items** table:

```
CREATE TRIGGER upqty
  UPDATE OF quantity ON items      -- an UPDATE trigger event
```

This portion of the statement identifies the table on which you define the trigger. If the trigger event is an insert or delete operation, only the type of statement and the table name are required, as the following example shows:

```
CREATE TRIGGER ins_qty
  INSERT ON items      -- an INSERT trigger event
```

Define the triggered actions

The *triggered actions* are the SQL statements that are performed when the trigger event occurs. The triggered actions can consist of INSERT, DELETE, UPDATE, EXECUTE FUNCTION and EXECUTE PROCEDURE statements. In addition to specifying what actions are to be performed, however, you must also specify when they are to be performed in relation to the triggering statement. You have the following choices:

- Before the triggering statement executes
- After the triggering statement executes
- For each row that is affected by the triggering statement

A single trigger on a table can define actions for each of these times.

To define a triggered action, specify when it occurs and then provide the SQL statement or statements to execute. You specify when the action is to occur with the keywords BEFORE, AFTER, or FOR EACH ROW. The triggered actions follow, enclosed in parentheses. The following triggered-action definition specifies that the SPL routine **upd_items_p1** is to be executed before the triggering statement:

```
BEFORE (EXECUTE PROCEDURE upd_items_p1) -- a BEFORE action
```

A complete CREATE TRIGGER statement

To define a complete CREATE TRIGGER statement, combine the trigger-name clause, the trigger-event clause, and the triggered-action clause. The following CREATE TRIGGER statement is the result of combining the components of the statement from the preceding examples. This trigger executes the SPL routine **upd_items_p1** whenever the **quantity** column of the **items** table is updated.

```
CREATE TRIGGER upqty
  UPDATE OF quantity ON items
  BEFORE (EXECUTE PROCEDURE upd_items_p1);
```

If a database object in the trigger definition, such as the SPL routine **upd_items_p1** in this example, does not exist when the database server processes the CREATE TRIGGER statement, it returns an error.

Triggered actions

To use triggers effectively, you need to understand the relationship between the triggering statement and the resulting triggered actions. You define this relationship when you specify the time that the triggered action occurs; that is, BEFORE, AFTER, or FOR EACH ROW.

- [BEFORE and AFTER triggered actions](#)
- [FOR EACH ROW triggered actions](#)
- [SPL routines as triggered actions](#)

BEFORE and AFTER triggered actions

Triggered actions that occur before or after the trigger event execute only once. A BEFORE triggered action executes before the *triggering statement*, that is, before the occurrence of the trigger event. An AFTER triggered action executes after the action of the triggering statement is complete. BEFORE and AFTER triggered actions execute even if the triggering statement does not process any rows.

Among other uses, you can use BEFORE and AFTER triggered actions to determine the effect of the triggering statement. For example, before you update the **quantity** column in the **items** table, you could call the SPL routine **upd_items_p1** to calculate the total quantity on order for all items in the table, as the following example shows. The procedure stores the total in a global variable called **old_qty**.

```
CREATE PROCEDURE upd_items_p1()
  DEFINE GLOBAL old_qty INT DEFAULT 0;
  LET old_qty = (SELECT SUM(quantity) FROM items);
END PROCEDURE;
```

After the triggering update completes, you can calculate the total again to see how much it has changed. The following SPL routine, **upd_items_p2**, calculates the total of **quantity** again and stores the result in the local variable **new_qty**. Then it compares **new_qty** to the global variable **old_qty** to see if the total quantity for all orders has increased by more than 50 percent. If so, the procedure uses the RAISE EXCEPTION statement to simulate an SQL error.

```
CREATE PROCEDURE upd_items_p2()
  DEFINE GLOBAL old_qty INT DEFAULT 0;
  DEFINE new_qty INT;
  LET new_qty = (SELECT SUM(quantity) FROM items);
  IF new_qty > old_qty * 1.50 THEN
    RAISE EXCEPTION -746, 0, 'Not allowed - rule violation';
  END IF
END PROCEDURE;
```

The following trigger calls **upd_items_p1** and **upd_items_p2** to prevent an extraordinary update on the **quantity** column of the **items** table:

```
CREATE TRIGGER up_items
  UPDATE OF quantity ON items
  BEFORE (EXECUTE PROCEDURE upd_items_p1())
  AFTER (EXECUTE PROCEDURE upd_items_p2());
```

If an update raises the total quantity on order for all items by more than 50 percent, the RAISE EXCEPTION statement in **upd_items_p2** terminates the trigger with an error. When a trigger fails in a database that has transaction logging, the database server rolls back the changes that both the triggering statement and the triggered actions make. For more information on what happens when a trigger fails, see the CREATE TRIGGER statement in the *IBM® Informix® Guide to SQL: Syntax*.

FOR EACH ROW triggered actions

A FOR EACH ROW triggered action executes once for each row that the triggering statement affects. For example, if the triggering statement has the following syntax, a FOR EACH ROW triggered action executes once for each row in the **items** table in which the **manu_code** column has a value of 'KAR':

```
UPDATE items SET quantity = quantity * 2
  WHERE manu_code = 'KAR';
```

If the triggering event does not process any rows, a FOR EACH ROW triggered action does not execute.

For a trigger on a table, if the triggering event is a SELECT statement, the trigger is called a Select trigger, and the triggered actions execute after all processing on the retrieved row is complete. The triggered actions might not execute immediately; however, because a FOR EACH ROW action executes for every instance of a row that the query returns. For example, in a SELECT statement with an ORDER BY clause, all rows must be qualified against the WHERE clause before they are sorted and returned.

- [The REFERENCING clause](#)
- [The WHEN condition](#)

The REFERENCING clause

When you create a FOR EACH ROW triggered action, you must usually indicate in the triggered action statements whether you are referring to the value of a column before or after the effect of the triggering statement. For example, imagine that you want to track updates to the **quantity** column of the **items** table. To do this, create the following table to record the activity:

```
CREATE TABLE log_record
(
  item_num    SMALLINT,
  ord_num     INTEGER,
  username    CHARACTER(8),
  update_time DATETIME YEAR TO MINUTE,
  old_qty     SMALLINT,
  new_qty     SMALLINT);
```

To supply values for the **old_qty** and **new_qty** columns in this table, you must be able to refer to the old and new values of **quantity** in the **items** table; that is, the values before and after the effect of the triggering statement. The REFERENCING clause enables you to do this.

The REFERENCING clause lets you create two prefixes that you can combine with a column name, one to reference the old value of the column, and one to reference its new value. These prefixes are called *correlation names*. You can create one or both correlation names, depending on your requirements. You indicate which one you are creating with the keywords OLD and NEW. The following REFERENCING clause creates the correlation names **pre_upd** and **post_upd** to refer to the old and new values in a row:

```
REFERENCING OLD AS pre_upd NEW AS post_upd
```

The following triggered action creates a row in **log_record** when **quantity** is updated in a row of the **items** table. The INSERT statement refers to the old values of the **item_num** and **order_num** columns and to both the old and new values of the **quantity** column.

```
FOR EACH ROW(INSERT INTO log_record
VALUES (pre_upd.item_num, pre_upd.order_num, USER,
CURRENT, pre_upd.quantity, post_upd.quantity));
```

The correlation names defined in the REFERENCING clause apply to all rows that the triggering statement affects.

Important: If you refer to a column name that is not qualified by a correlation name, the database server makes no special effort to search for the column in the definition of the triggering table. You must always use a correlation name with a column name in SQL statements in a FOR EACH ROW triggered action, unless the statement is valid independent of the triggered action. For more information, see the CREATE TRIGGER statement in the *IBM® Informix® Guide to SQL: Syntax*.

The WHEN condition

As an option for triggers on tables, you can precede a triggered action with a WHEN clause to make the action dependent on the outcome of a test. The WHEN clause consists of the keyword WHEN followed by the condition statement given in parentheses. In the CREATE TRIGGER statement, the WHEN clause follows the keywords BEFORE, AFTER, or FOR EACH ROW and precedes the triggered-action list.

When a WHEN condition is present, if it evaluates to *true*, the triggered actions execute in the order in which they appear. If the WHEN condition evaluates to *false* or *unknown*, the actions in the triggered-action list do not execute. If the trigger specifies FOR EACH ROW, the condition is evaluated for each row also.

In the following trigger example, the triggered action executes only if the condition in the WHEN clause is true; that is, if the post-update unit price is greater than two times the pre-update unit price:

```
CREATE TRIGGER up_price
UPDATE OF unit_price ON stock
REFERENCING OLD AS pre NEW AS post
FOR EACH ROW WHEN(post.unit_price > pre.unit_price * 2)
(INSERT INTO warn_tab
VALUES(pre.stock_num, pre.manu_code, pre.unit_price,
post.unit_price, CURRENT));
```

For more information on the WHEN condition, see the CREATE TRIGGER statement in the *IBM® Informix® Guide to SQL: Syntax*.

SPL routines as triggered actions

Probably the most powerful feature of triggers is the ability to call an SPL routine as a triggered action. The EXECUTE PROCEDURE or EXECUTE FUNCTION statement, which calls an SPL routine, lets you pass data from the triggering table to the SPL routine and also to update the triggering table with data returned by the SPL routine. SPL also lets you define variables, assign data to them, make comparisons, and use procedural statements to accomplish complex tasks within a triggered action.

- [Pass data to an SPL routine](#)
- [Using SPL](#)

- [Update nontriggering columns with data from an SPL routine](#)

Pass data to an SPL routine

You can pass data to an SPL routine in the argument list of the EXECUTE PROCEDURE or EXECUTE FUNCTION statement. The EXECUTE PROCEDURE statement in the following example passes values from the **quantity** and **total_price** columns of the **items** table to the SPL routine **calc_totpr**:

```
CREATE TRIGGER upd_totpr
  UPDATE OF quantity ON items
  REFERENCING OLD AS pre_upd NEW AS post_upd
  FOR EACH ROW(EXECUTE PROCEDURE calc_totpr(pre_upd.quantity,
    post_upd.quantity, pre_upd.total_price) INTO total_price);
```

Passing data to an SPL routine lets you use data values in the operations that the routine performs.

Using SPL

The EXECUTE PROCEDURE statement in the preceding trigger calls the SPL routine that the following example shows. The procedure uses SPL to calculate the change that needs to be made to the **total_price** column when **quantity** is updated in the **items** table. The procedure receives both the old and new values of **quantity** and the old value of **total_price**. It divides the old total price by the old quantity to derive the unit price. It then multiplies the unit price by the new quantity to obtain the new total price.

```
CREATE PROCEDURE calc_totpr(old_qty SMALLINT, new_qty SMALLINT,
  total MONEY(8)) RETURNING MONEY(8);
  DEFINE u_price LIKE items.total_price;
  DEFINE n_total LIKE items.total_price;
  LET u_price = total / old_qty;
  LET n_total = new_qty * u_price;
  RETURN n_total;
END PROCEDURE;
```

In this example, SPL lets the trigger derive data that is not directly available from the triggering table.

Update nontriggering columns with data from an SPL routine

Within a triggered action, the INTO clause of the EXECUTE PROCEDURE statement lets you update nontriggering columns in the triggering table. The EXECUTE PROCEDURE statement in the following example calls the **calc_totpr** SPL procedure that contains an INTO clause, which references the column **total_price**:

```
FOR EACH ROW(EXECUTE PROCEDURE calc_totpr(pre_upd.quantity,
  post_upd.quantity, pre_upd.total_price) INTO total_price);
```

The value that is updated into **total_price** is returned by the RETURN statement at the conclusion of the SPL procedure. The **total_price** column is updated for each row that the triggering statement affects.

Trigger routines

You can define specialized SPL routines, called *trigger routines*, that can be invoked only from the FOR EACH ROW section of the triggered action. Unlike ordinary UDRs that EXECUTE FUNCTION or EXECUTE PROCEDURE routines can call from the triggered action list, trigger routines include their own REFERENCING clause that defines correlation names for the old and new column values in rows that the triggered action modifies. These correlation names can be referenced in SPL statements within the trigger routine, providing greater flexibility in how the triggered action can modify data in the table or view.

Trigger routines can also use trigger-type Boolean operators, called DELETING, INSERTING, SELECTING, and UPDATING, to identify what type of trigger has called the trigger routine. Trigger routines can also invoke the **mi_trigger*** routines, which are sometimes called *trigger introspection routines*, to obtain information about the context in which the trigger routine has been called.

Trigger routines are invoked by EXECUTE FUNCTION or EXECUTE PROCEDURE statements that include the WITH TRIGGER REFERENCES keywords. These statements must call the trigger routine from the FOR EACH ROW section of the triggered action, rather than from the BEFORE or AFTER sections.

For information about syntax features that the CREATE FUNCTION, CREATE PROCEDURE, EXECUTE FUNCTION, and EXECUTE PROCEDURE statements of SQL support for defining and executing trigger routines, see your *IBM® Informix® Guide to SQL: Syntax*. For more information about the **mi_trigger*** routines, see your *IBM Informix DataBlade API Programmer's Guide*.

Triggers in a table hierarchy

When you define a trigger on a supertable, any subtables in the table hierarchy also inherit the trigger. Consequently when you perform operations on tables in the hierarchy, triggers can execute for any table in the hierarchy that is a subtable of the table on which a trigger is defined.

Select triggers

When the CREATE TRIGGER statement defines as its triggering event any query on a specific table (

```
SELECT ON table
```

or

```
SELECT ON column-list ON table
```

), the resulting trigger object is a *Select trigger* on the specified *table*. The same trigger can also be activated by queries on a view that includes triggering columns from *table* as its base table. SELECT statements cannot, however, be the trigger events for INSTEAD OF triggers on a view.

If the CREATE TRIGGER statement also includes a *column-list* in the definition of an enabled Select trigger event, and the Projection list of a subsequent query on the specified table does not include any of the specified columns, that query cannot be a triggering event for the Select trigger.

Warning:

Select triggers are not reliable for auditing. Do not attempt to create a Select trigger on a table, or on a subset of its columns, for the purpose of performing application-specific auditing. In general, it is not possible, to track the number of SELECT actions on a table by creating a Select trigger to insert an audit record into an audit table each time a user queries a certain table.

For example, suppose that you define a Select trigger on the table **AuditedTable** and that a user who holds Select privileges on **AuditedTable** issues the following query:

```
SELECT a.* FROM (SELECT * FROM AuditedTable) AS a;
```

The database server issues no error, but the SELECT trigger on **AuditedTable** will not be activated by this query. A query that included a set operator, such as UNION or INTERSECT, or any other syntax that Select triggers do not support, would be similarly invisible to an audit-record strategy that is based on Select triggers.

Because of the numerous restrictions on the execution of Select triggers, as partially listed in this chapter, the resulting Select trigger actions will typically correspond to only a subset (that might be empty) of whatever logical Select events you are attempting to enumerate.

- [SELECT statements that execute triggered actions](#)
- [Restrictions on execution of Select triggers](#)
- [Select triggers on tables in a table hierarchy](#)

SELECT statements that execute triggered actions

When you create a select trigger, only certain types of select statements can execute the actions defined on that trigger. A select trigger executes for the following types of SELECT statements only:

- Stand-alone SELECT statements
 - Collection subqueries in the select list of a SELECT statement
 - SELECT statements embedded in user-defined routines
 - Views
-
- [Stand-alone SELECT statements](#)
 - [Collection subqueries in the projection list of a query](#)
 - [SELECT statements embedded in user-defined routines](#)
 - [Views](#)

Stand-alone SELECT statements

Suppose you define the following Select trigger on a table:

```
CREATE TRIGGER hits_trig SELECT OF col_a ON tab_a
REFERENCING OLD AS hit
FOR EACH ROW (INSERT INTO hits_log
VALUES (hit.col_a, CURRENT, USER));
```

A Select trigger executes when the triggering column appears in the select list of a stand-alone SELECT statement. The following statement executes a triggered action on the **hits_trig** trigger for each instance of a row that the database server returns:

```
SELECT col_a FROM tab_a;
```

Collection subqueries in the projection list of a query

A Select trigger executes when the triggering column appears in a collection subquery that occurs in the projection list of another SELECT statement. The following statement executes a triggered action on the **hits_trig** trigger for each instance of a row that the collection subquery returns:

```
SELECT MULTISET(SELECT col_a FROM tab_a) FROM ...
```

SELECT statements embedded in user-defined routines

A select trigger that is defined on a SELECT statement embedded in a user defined routine (UDR) executes a triggered action in the following instances only:

- The UDR appears in the select list of a SELECT statement
- The UDR is invoked with an EXECUTE PROCEDURE statement

Suppose you create a routine **new_proc** that contains the statement `SELECT col_a FROM tab_a`. Each of the following statements executes a triggered action on the **hits_trig** trigger for each instance of a row that the embedded SELECT statement returns:

```
SELECT new_proc() FROM tab_b;  
EXECUTE PROCEDURE new_proc;
```

Views

Select triggers execute a triggered action for views whose base tables contain a reference to a triggering column. You cannot, however, define a Select trigger on a view.

Suppose you create the following view:

```
CREATE VIEW view_tab AS  
SELECT * FROM tab_a;
```

The following statements execute a triggered action on the **hits_trig** trigger for each instance of a row that the view returns:

```
SELECT * FROM view_tab;  
  
SELECT col_a FROM tab_a;
```

Restrictions on execution of Select triggers

The following types of SELECT statements do not trigger any actions when they reference a table or column on which an enabled Select trigger is defined.

- No triggering column is referenced in the Projection list (for example, a column that appears only in the WHERE clause of a SELECT statement does not execute a Select trigger).
- The SELECT statement references a remote table.
- The SELECT statement calls an aggregate function or an OLAP window aggregation function.
- The SELECT statement includes a set operator (UNION, UNION ALL, INTERSECT, MINUS, or EXCEPT)
- The SELECT statement includes the DISTINCT or UNIQUE keyword.
- The UDR expression that contains the SELECT statement is not in the Projection list.
- The SELECT statement appears within an INSERT INTO statement.
- The SELECT statement appears within a scroll cursor.
- The trigger is a cascading Select trigger.

A cascading Select trigger is a trigger whose actions includes an SPL routine that itself has a triggering SELECT statement. The actions of a cascading Select trigger do not execute, however, and the database server does not return an error.

Select triggers on tables in a table hierarchy

When you define a select trigger on a supertable, any subtables in the table hierarchy also inherit the trigger.

For information about overriding and disabling inherited triggers, see [Triggers in a table hierarchy](#).

Re-entrant triggers

A *re-entrant trigger* refers to a case in which the triggered action can reference the triggering table. In other words, both the triggering event and the triggered action can operate on the same table. For example, suppose the following UPDATE statement represents the triggering event:

```
UPDATE tab1 SET (col_a, col_b) = (col_a + 1, col_b + 1);
```

The following triggered action is legal because column **col_c** is not a column that the triggering event has updated:

```
UPDATE tab1 SET (col_c) = (col_c + 3);
```

In the preceding example, a triggered action on **col_a** or **col_b** would be illegal because a triggered action cannot be an UPDATE statement that references a column that was updated by the triggering event.

Important: Select triggers cannot be re-entrant triggers. If the triggering event is a SELECT statement, the triggered action cannot operate on the same table. For a list of the rules that describe those situations in which a trigger can and cannot be re-entrant, see the CREATE TRIGGER statement in the *IBM® Informix® Guide to SQL: Syntax*.

INSTEAD OF triggers on views

A view is a synthetic table that you create with the CREATE VIEW statement and define with a SELECT statement. Each view consists of the set of rows and columns that the SELECT statement in the view definition returns each time you refer to the view in a query. To insert, update, or delete rows in the base tables of a view, you can define an INSTEAD OF trigger.

Unlike a trigger on a table, the INSTEAD OF trigger on a view causes IBM® Informix® to ignore the triggering event, and instead perform only the triggered action.

For information on the CREATE VIEW statement and the INSTEAD OF trigger syntax and rules, including an example of an INSTEAD OF trigger that will insert rows on a view, see the *IBM Informix Guide to SQL: Syntax*.

- [INSTEAD OF trigger to update on a view](#)

INSTEAD OF trigger to update on a view

After you create one or more tables (like those named **dept** and **emp** in the following example), and then created a view (like the one named **manager_info**) from **dept** and **emp**, you can use an INSTEAD OF trigger to update that view.

The following CREATE TRIGGER statement creates **manager_info_update**, an INSTEAD OF trigger that is designed to update rows within the **dept** and **emp** tables through the **manager_info** view.

```
CREATE TRIGGER manager_info_update
  INSTEAD OF UPDATE ON manager_info
  REFERENCING NEW AS n
  FOR EACH ROW
  (EXECUTE PROCEDURE updtab (n.empno, n.empname, n.deptno,));

CREATE PROCEDURE updtab (eno INT, ename CHAR(20), dno INT,)
  DEFINE deptcode INT;
  UPDATE dept SET manager_num = eno where deptno = dno;
  SELECT deptno INTO deptcode FROM emp WHERE empno = eno;
  IF dno !=deptcode THEN
    UPDATE emp SET deptno = dno WHERE empno = eno;
  END IF;
END PROCEDURE;
```

After the tables, view, trigger, and SPL routine have been created, the database server treats the following UPDATE statement as a triggering event:

```
UPDATE manager_info
  SET empno = 3666, empname = "Steve"
  WHERE deptno = 01;
```

This triggering UPDATE statement is not executed, but this event causes the trigger action to be executed instead, invoking the **updtab()** SPL routine. The UPDATE statements in the SPL routine update values into both the **emp** and **dept** base tables of the **manager_info** view.

Trace triggered actions

If a triggered action does not behave as you expect, place it in an SPL routine and use the SPL TRACE statement to monitor its operation. Before you start the trace, you must direct the output to a file with the SET DEBUG FILE TO statement.

- [Example of TRACE statements in an SPL routine](#)
- [Example of TRACE output](#)

Example of TRACE statements in an SPL routine

The following example shows TRACE statements that you add to the SPL routine **items_pct**. The SET DEBUG FILE TO statement directs the trace output to the file that the path name specifies. The TRACE ON statement begins tracing the statements and variables within the procedure.

```
CREATE PROCEDURE items_pct(mac CHAR(3))
  DEFINE tp MONEY;
  DEFINE mc_tot MONEY;
  DEFINE pct DECIMAL;
  SET DEBUG FILE TO 'pathname';

  TRACE 'begin trace';
  TRACE ON;
  LET tp = (SELECT SUM(total_price) FROM items);
  LET mc_tot = (SELECT SUM(total_price) FROM items
    WHERE manu_code = mac);
  LET pct = mc_tot / tp;
  IF pct > .10 THEN
    RAISE EXCEPTION -745;
  END IF
  TRACE OFF;
```

```
END PROCEDURE;

CREATE TRIGGER items_ins
INSERT ON items
REFERENCING NEW AS post_ins
FOR EACH ROW(EXECUTE PROCEDURE items_pct (post_ins.manu_code));
```

Example of TRACE output

The following example shows sample trace output from the `items_pct` procedure as it appears in the file that was named in the SET DEBUG FILE TO statement. The output reveals the values of procedure variables, procedure arguments, return values, and error codes.

```
trace expression :begin trace
trace on
expression:
  (select (sum total_price)
   from items)
evaluates to $18280.77 ;
let tp = $18280.77
expression:
  (select (sum total_price)
   from items
   where (= manu_code, mac))
evaluates to $3008.00 ;
let mc_tot = $3008.00
expression: (/ mc_tot, tp)
evaluates to 0.16
let pct = 0.16
expression: (> pct, 0.1)
evaluates to 1
expression: (- 745)
evaluates to -745
raise exception :-745, 0, ''
exception : looking for handler
SQL error = -745 ISAM error = 0 error string = ''
exception : no appropriate handler
```

For more information about how to use the TRACE statement to diagnose logic errors in SPL routines, see [Create and use SPL routines](#).

Generate error messages

When a trigger fails because of an SQL statement, the database server returns the SQL error number that applies to the specific cause of the failure.

When the triggered action is an SPL routine, you can generate error messages for other error conditions with one of two reserved error numbers. The first one is error number -745, which has a generalized and fixed error message. The second one is error number -746, which allows you to supply the message text, up to a maximum of 70 bytes.

- [Apply a fixed error message](#)
- [Generate a variable error message](#)

Apply a fixed error message

You can apply error number -745 to any trigger failure that is not an SQL error. The following fixed message is for this error: -745 Trigger execution has failed.

You can apply this message with the RAISE EXCEPTION statement in SPL. The following example generates error -745 if `new_qty` is greater than `old_qty` multiplied by 1.50:

```
CREATE PROCEDURE upd_items_p2()
  DEFINE GLOBAL old_qty INT DEFAULT 0;
  DEFINE new_qty INT;
  LET new_qty = (SELECT SUM(quantity) FROM items);
  IF new_qty > old_qty * 1.50 THEN
    RAISE EXCEPTION -745;
  END IF
END PROCEDURE
```

If you are using DB-Access, the text of the message for error -745 displays on the bottom of the screen, as the following figure shows.
Figure 1. Error message -745 with fixed message

```
Press CTRL-W for Help
SQL: New Run  Modify  Use-editor  Output  Choose Save  Info  Drop  Exit
Modify the current SQL statements using the SQL editor.

----- stores8@myserver ----- Press CTRL-W for Help -----

INSERT INTO items VALUES( 2, 1001, 2, 'HRO', 1, 126.00);
```

745: Trigger execution has failed.

If your trigger calls a procedure that contains an error through an SQL statement in your SQL API, the database server sets the SQL error status variable to -745 and returns it to your program. To display the text of the message, follow the procedure that your IBM® Informix® application development tool provides for retrieving the text of an SQL error message.

Generate a variable error message

Error number -746 allows you to provide the text of the error message. Like the preceding example, the following one also generates an error if **new_qty** is greater than **old_qty** multiplied by 1.50. However, in this case the error number is -746, and the message text `Too many items for Mfr.` is supplied as the third argument in the RAISE EXCEPTION statement. For more information on the syntax and use of this statement, see the RAISE EXCEPTION statement in [Create and use SPL routines](#).

```
CREATE PROCEDURE upd_items_p2()
  DEFINE GLOBAL old_qty INT DEFAULT 0;
  DEFINE new_qty INT;
  LET new_qty = (SELECT SUM(quantity) FROM items);
  IF new_qty > old_qty * 1.50 THEN
    RAISE EXCEPTION -746, 0, 'Too many items for Mfr.';
  END IF
END PROCEDURE;
```

If you use DB-Access to submit the triggering statement, and if **new_qty** is greater than **old_qty**, you will get the result that the following figure shows. Figure 1. Error Number -746 with User-Specified message Text

```
Press CTRL-W for Help
SQL:  New Run  Modify  Use-editor Output Choose Save Info Drop Exit
Modify the current SQL statements using the SQL editor.

----- store7@myserver ----- Press CTRL-W for Help -----

INSERT INTO items VALUES( 2, 1001, 2, 'HRO', 1, 126.00);
```

746: Too many items for Mfr.

If you invoke the trigger through an SQL statement in an SQL API, the database server sets **sqlcode** to -746 and returns the message text in the **sqlerrm** field of the SQL communications area (SQLCA). For more information about how to use the SQLCA, see your SQL API publication.

Summary

To introduce triggers, this chapter discussed the following topics:

- The components of the CREATE TRIGGER statement
- Types of DML statements that can be triggering events
- Types of SQL statements that can be triggered actions
- How to create BEFORE and AFTER triggered actions and how to use them to determine the impact of the triggering statement
- How to create a FOR EACH ROW triggered action and how to use the REFERENCING clause to refer to the values of columns both before and after the action of the triggering statement
- INSTEAD OF triggers on views, whose triggering event is ignored, but whose triggered actions can modify the base tables of the view
- The advantages of using SPL routines as triggered actions
- Special features of calls to trigger routines as triggered actions

- How to trace triggered actions if they behave unexpectedly
- How to generate two types of error messages within a triggered action.