Informix 14.10 Now Supports Common Table Expressions!

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Common Table Expression Syntax

```
Syntax
WITH cte_name (Column1, Column2,.....ColumnN)
AS (CTE Definition) -- Write a query
        [,cte_name2 AS (CTE2 definition)…] – multiple/recursive CTEs
SELECT ……
FROM cte_name – Using CTE
```

SELECT/INSERT/UPDATE/DELETE … reference CTE name

- CTE makes SQL more readable
- CTE provides programming feature to SQL

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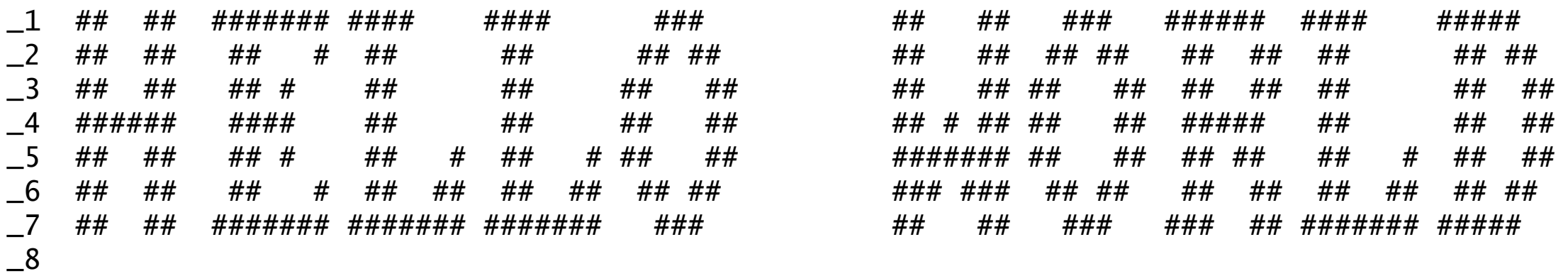
HELLO WORLD – SQL Version

```
Database selected.
```



1 row(s) retrieved.

```
Database closed.
```

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SQL Version Banner with CTE

```
with fonts(c, c1, c2,c3,c4,c5,c6,c7,c8) as (
select * from table(multiset{ -- vga 8x8 fonts
ROW(' ', '0x00', '0x00', '0x00', '0x00', '0x00', '0x00', '0x00', '0x00'), ROW('!', '0x18', '0x3C', '0x3C', '0x18', '0x18', '0x00', '0x18', '0x00'),
ROW('A', '0x0C', '0x1E', '0x33', '0x33', '0x3F', '0x33', '0x33', '0x00'), ROW('B', '0x3F', '0x66', '0x66', '0x3E', '0x66', '0x66', '0x3F', '0x00'),
ROW('C', '0x3C', '0x66', '0x03', '0x03', '0x03', '0x66', '0x3C', '0x00'), ROW('D', '0x1F', '0x36', '0x66', '0x66', '0x66', '0x36', '0x1F', '0x00'),
ROW('E', '0x7F', '0x46', '0x16', '0x1E', '0x16', '0x46', '0x7F', '0x00'), ROW('F', '0x7F', '0x46', '0x16', '0x1E', '0x16', '0x06', '0x0F', '0x00'),
ROW('G', '0x3C', '0x66', '0x03', '0x03', '0x73', '0x66', '0x7C', '0x00'), ROW('H', '0x33', '0x33', '0x33', '0x3F', '0x33', '0x33', '0x33', '0x00'),
ROW('I', '0x1E', '0x0C', '0x0C', '0x0C', '0x0C', '0x0C', '0x1E', '0x00'), ROW('J', '0x78', '0x30', '0x30', '0x30', '0x33', '0x33', '0x1E', '0x00'),
ROW('K', '0x67', '0x66', '0x36', '0x1E', '0x36', '0x66', '0x67', '0x00'), ROW('L', '0x0F', '0x06', '0x06', '0x06', '0x46', '0x66', '0x7F', '0x00'),
ROW('M', '0x63', '0x77', '0x7F', '0x7F', '0x6B', '0x63', '0x63', '0x00'), ROW('N', '0x63', '0x67', '0x6F', '0x7B', '0x73', '0x63', '0x63', '0x00'),
ROW('O', '0x1C', '0x36', '0x63', '0x63', '0x63', '0x36', '0x1C', '0x00'), ROW('P', '0x3F', '0x66', '0x66', '0x3E', '0x06', '0x06', '0x0F', '0x00'),
ROW('Q', '0x1E', '0x33', '0x33', '0x33', '0x3B', '0x1E', '0x38', '0x00'), ROW('R', '0x3F', '0x66', '0x66', '0x3E', '0x36', '0x66', '0x67', '0x00'),
ROW('S', '0x1E', '0x33', '0x07', '0x0E', '0x38', '0x33', '0x1E', '0x00'), ROW('T', '0x3F', '0x2D', '0x0C', '0x0C', '0x0C', '0x0C', '0x1E', '0x00'),
ROW('U', '0x33', '0x33', '0x33', '0x33', '0x33', '0x33', '0x3F', '0x00'), ROW('V', '0x33', '0x33', '0x33', '0x33', '0x33', '0x1E', '0x0C', '0x00'),
ROW('W', '0x63', '0x63', '0x63', '0x6B', '0x7F', '0x77', '0x63', '0x00'), ROW('X', '0x63', '0x63', '0x36', '0x1C', '0x1C', '0x36', '0x63', '0x00'),
ROW('Y', '0x33', '0x33', '0x33', '0x1E', '0x0C', '0x0C', '0x1E', '0x00'), ROW('Z', '0x7F', '0x63', '0x31', '0x18', '0x4C', '0x66', '0x7F', '0x00'),
ROW('~', '0x6E', '0x3B', '0x00', '0x00', '0x00', '0x00', '0x00', '0x00')})),
text(str) as (select 'HELLO WORLD'), -- text string to display
xword(str, o, c, c1, c2,c3,c4,c5,c6,c7,c8) as ( -- get all fonts data for above string
    select str, 1, c, c1, c2,c3,c4,c5,c6,c7,c8 from text, fonts where c = substr(str, 1, 1)
    union all
    select str, o+1, c, c1, c2,c3,c4,c5,c6,c7,c8 from fonts, xword where fonts.c = substr(str, o+1, 1) and o < length(str)),
x(n, p) as (    select 1, 128 union all select n+1, p/2 from x where n < 8), -- for (p =128, n = 1; i <= 8; n++) p>>1;
show as (select  sum ((case when bitand(to_number(c1)::int, p) > 0 then '#' else ' ' end)::lvarchar)::char(8) as c1,
          -- pixel to '#' or ' '
        sum ((case when bitand(to_number(c2)::int, p) > 0 then '#' else ' ' end)::lvarchar)::char(8) as c2,
        sum ((case when bitand(to_number(c3)::int, p) > 0 then '#' else ' ' end)::lvarchar)::char(8) as c3,
        sum ((case when bitand(to_number(c4)::int, p) > 0 then '#' else ' ' end)::lvarchar)::char(8) as c4,
        sum ((case when bitand(to_number(c5)::int, p) > 0 then '#' else ' ' end)::lvarchar)::char(8) as c5,
        sum ((case when bitand(to_number(c6)::int, p) > 0 then '#' else ' ' end)::lvarchar)::char(8) as c6,
        sum ((case when bitand(to_number(c7)::int, p) > 0 then '#' else ' ' end)::lvarchar)::char(8) as c7,
        sum ((case when bitand(to_number(c8)::int, p) > 0 then '#' else ' ' end)::lvarchar)::char(8) as c8
          from x cross join xword group by xword.o order by xword.o desc)
select  sum(c1::lvarchar) as _1, sum(c2::lvarchar) as _2, sum(c3::lvarchar) as _3, sum(c4::lvarchar) as _4, -- display the result
        sum(c5::lvarchar) as _5, sum(c6::lvarchar) as _6, sum(c7::lvarchar) as _7, sum(c8::lvarchar) as _8 from show;
```

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Recursive CTE

A recursive query 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.

An example of a recursive query computing the factorial of numbers from 0 to 9 is the following:

```
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;
```

C: for (n = 0, fact = 1; n < 9; n = n+1) { fact *= (n + 1); }

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Informix CTE supports

- Simple CTE
- Recursive CTE
- Multiple CTEs in one query
- CTE with Select, Insert, Update, Delete statements
- CTE in view
- CTE in SPL
- CTE in Trigger
- Recursive CTE CYCLE clause
- Other SQL changes
  - Select <expression> without ‘from table’

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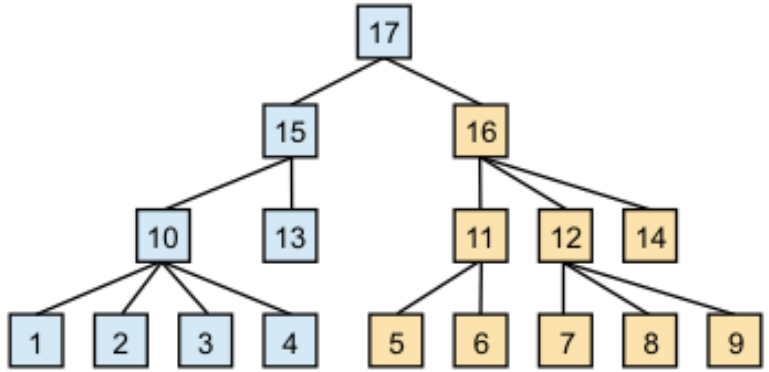
RCTE Use Case – Tree/Hierarchical Dataset

```
CREATE TABLE employee(
                empid  INTEGER,
                name   CHAR(10),
                mgrid  INTEGER
);
INSERT INTO employee VALUES  ( 1, 'Jones',     10);")
INSERT INTO employee VALUES  ( 2, 'Hall',      10);")
INSERT INTO employee VALUES  ( 3, 'Kim',       10);")
INSERT INTO employee VALUES  ( 4, 'Lindsay',   10);")
INSERT INTO employee VALUES  ( 5, 'McKeough',  11);")
INSERT INTO employee VALUES  ( 6, 'Barnes',    11);")
……
INSERT INTO employee VALUES  (16, 'Goyal',     17);")
INSERT INTO employee VALUES  (17, 'Urbassek',  NULL);")
```

Figure 1. Relationships of Elements in a Reporting Hierarchy



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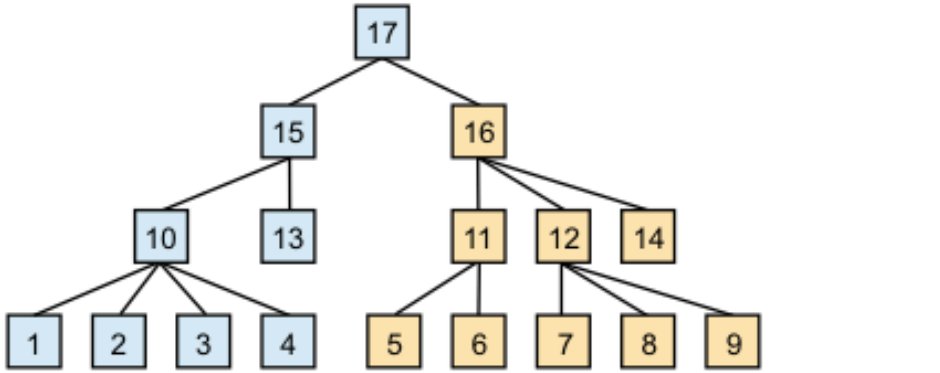
RCTE Use Case – Tree/Hierarchical Dataset

```
WITH cte AS (
  SELECT empid, name, mgrid, 1 AS level
    FROM employee
    WHERE name = 'Goyal'
  UNION ALL
  SELECT t.empid, t.name, t.mgrid,
                  (cte.level + 1)
    FROM employee t, cte
  where t.mgrid = cte.empid
  )
SELECT * from cte ;
```

Figure 1. Relationships of Elements in a Reporting Hierarchy



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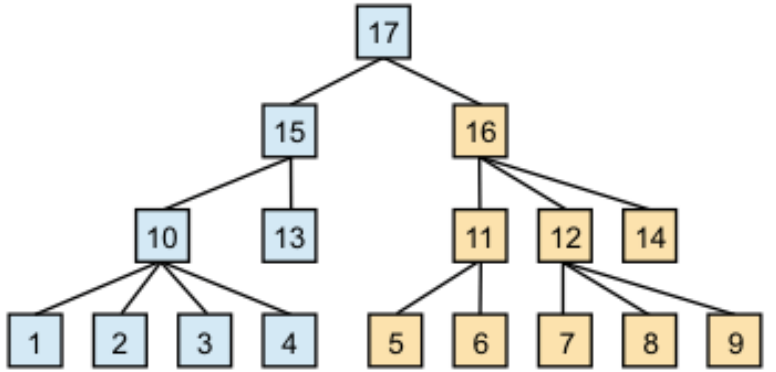
RCTE Use Case – Tree/Hierarchical Dataset

empid	name	mgrid	level
16	Goyal	17	1
14	Scott	16	2
12	Henry	16	2
9	Shoeman	12	3
8	Smith	12	3
7	ONeil	12	3
11	Zander	16	2
6	Barnes	11	3
5	McKeough	11	3

Figure 1. Relationships of Elements in a Reporting Hierarchy



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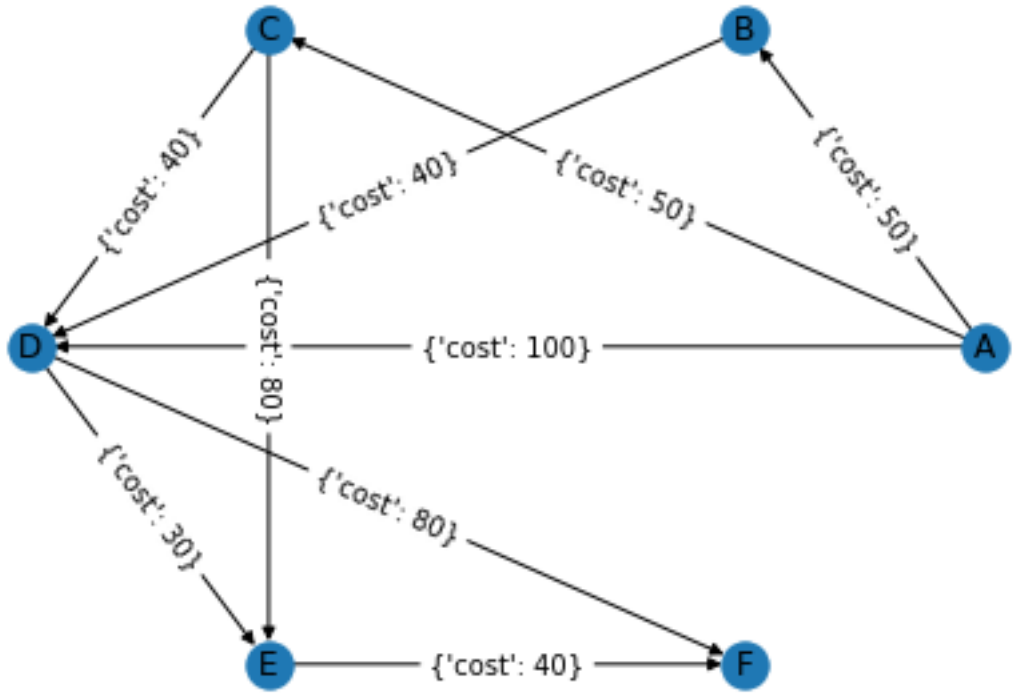
RCTE Use Case – Graph Dataset

6 cities A, B, C, D, E, and F, with cost between cities.

```
create table loc (id int, name char(10));
insert into loc values (1, 'A');
insert into loc values (2, 'B');
insert into loc values (3, 'C');
insert into loc values (4, 'D');
insert into loc values (5, 'E');
insert into loc values (6, 'F');

create table road(start int, end int, cost int);
insert into road values (1, 2, 50);
insert into road values (1, 3, 50);
insert into road values (1, 4, 100);
insert into road values (2, 4, 40);
insert into road values (3, 4, 40);
insert into road values (3, 5, 80);
insert into road values (4, 5, 30);
insert into road values (4, 6, 80);
insert into road values (5, 6, 40);
```



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RCTE Use Case – Graph Dataset

```
-- list all paths from ‘A’ to ‘F’
with cte(id, path, cost, name, level) as (
   SELECT f.id, (trim(a.name) || " -> " || f.name)::lvarchar, r.cost, f.name, 1
      FROM loc a, road r, loc f
      WHERE a.name = 'A' AND r.start = a.id AND r.end = f.id
   UNION ALL
   SELECT f.id, trim(a.path) || " -> " || trim(f.name), a.cost + r.cost, f.name, level + 1
      FROM cte a, road r, loc f
      WHERE r.start = a.id AND r.end = f.id
)
select path::char(24) as path, cost, level from cte
where name = 'F’ order by cost;
```

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Use Case – Graph Dataset

path	cost	level
A -> B -> D -> E -> F	160	4
A -> C -> D -> E -> F	160	4
A -> D -> E -> F	170	3
A -> C -> D -> F	170	3
A -> B -> D -> F	170	3
A -> C -> E -> F	170	3
A -> D -> F	180	2

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Recursive CTE Cycle Detection

Recursive CTE Optional Cycle Clause

CYCLE <column list> SET <cycle pseudo column>

TO <value1> DEFAULT <value2>

The CYCLE option allows you to safeguard against cyclic data. Not only will it terminate repeating cycles but it also allows you to optionally output a cycle mark indicator that may lead you to find cyclic data.

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Recursive CTE Cycle Detection

```
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
```

SELECT id, pid, CONNECT_BY_ISLEAF leaf, CONNECT_BY_ISCYCLE cycle FROM cycle
        START WITH id = 1 **CONNECT BY** nocycle PRIOR id = pid;

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Informix Recursive CTE Performance

- 12.10 Connect By 1,000,000 loops 75 seconds
- 14.10 Connect By 1,000,000 loops 35 seconds

```
select count(*) from (
SELECT LEVEL, MOD(LEVEL,2), MOD(LEVEL,4)
FROM sysmaster:sysdual CONNECT BY LEVEL <= 1000000)
-- because of extra join, cycle detection, and internal temp table writing operations
```

- 14.10 RCTE 1,000,000 loops 3 seconds

```
select count(*) from ( with cte(n)
as (select 1 as n
   union all select n+1 from cte where n < 1000000)
   select n, mod(n,2), mod(n,4) from cte);
```

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Informix Recursive CTE Limit

- Does not support multiple recursive subqueries in one RCTE
- Make sure type cast and enough space in the recursive subquery because of the recursive CTE columns are pre-defined from the non-recursive subquery

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CTE Fun Queries in Informix

- Helper function for string aggregation and dbaccess setup
  - We need a string aggregation helper function for fun queries

```
create function plus(s1 lvarchar, s2 lvarchar)
    returning lvarchar;
    return s1 || s2;
end function;
```

  - Set environment variable DBACCESS_COLUMNS=180
- Mandelbrot Set
- Julia Set – a beautiful tree like image
- SQL Version Banner program

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CTE Fun Queries in Informix – Mandelbrot Set

```
WITH
x(n) AS ( select -70 UNION ALL select n+1 from x where n < 40),
y(j) AS ( select -30 UNION ALL select j+1 from y where j < 30),
q (r, i, rx, ix, g) AS (
    SELECT  n::float * 0.02, j::float * 0.04, 0::float, 0::float, 0
        FROM (select n from x) cross join (select j from y)
    UNION ALL
    SELECT  r, i,
        CASE WHEN ABS(rx * rx + ix * ix) <= 2 THEN rx * rx - ix * ix END + r,
        CASE WHEN ABS(rx * rx + ix * ix) <= 2 THEN 2 * rx * ix END + i,
        g + 1 FROM q WHERE rx IS NOT NULL AND g < 100),
Zt (i, r, x) AS (
    SELECT i, r, SUBSTR('@@B%8&WM#*oaqwmOOUcrt/\|()1{}[]?-_+~<>i!l;;:,```.',
        50 - (MAX(g)/2)::int, 1) as x
        FROM q GROUP BY i, r order by r desc)
SELECT  sum(x::lvarchar) as x from Zt group by i order by i;
-- port from PostgreSQL https://explainextended.com/2013/12/31/happy-new-year-5/
-- dbaccess cte Mandelbrot.sql | grep '^x'
```

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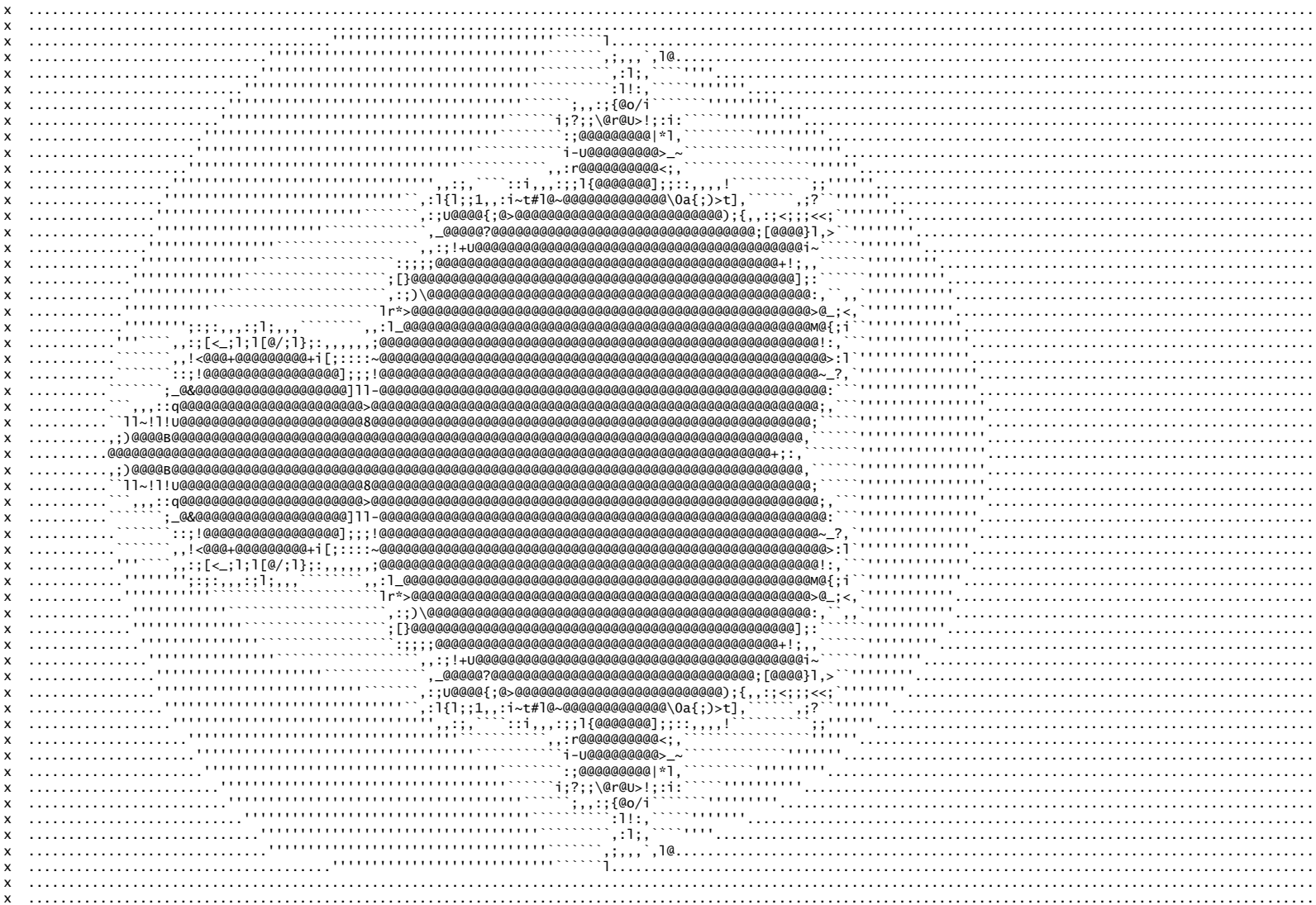
CTE Fun Queries in Informix – Mandelbrot Set



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CTE Fun Queries in Informix – Julia Set

```
WITH
x(n) AS (
    select -40 UNION ALL
    select n+1 from x where n < 40),
q (r, i, rx, ix, g) AS (
    SELECT  x + r::float * step, y + i::float * step,
            x + r::float * step, y + i::float * step, 0 FROM    (
        SELECT  0.25 x, -0.55 y, 0.002 step, r, I FROM (select n as r from x)
        cross join (select n as i from x))
        UNION ALL
        SELECT  r, i,
                CASE WHEN (rx * rx + ix * ix) < 1E8 THEN
                pow((rx * rx + ix * ix), 0.75) * COS(1.5 * ATAN2(ix, rx)) END - 0.2,
                CASE WHEN (rx * rx + ix * ix) < 1E8 THEN
                pow((rx * rx + ix * ix), 0.75) * SIN(1.5 * ATAN2(ix, rx)) END,
                g + 1
        FROM    q
        WHERE   rx IS NOT NULL AND g < 99),
Zt (i, r, x) AS (
    SELECT i, r, SUBSTR(" .:-=+*#%@", (MAX(g) /10 +1)::int, 1) as x
    FROM q GROUP BY i, r order by r)
SELECT  sum(x::lvarchar) as x from Zt group by i order by i;
-- port from PostgreSQL https://explainextended.com/2013/12/31/happy-new-year-5/
-- dbaccess cte Julia.sql | grep '^x'
```

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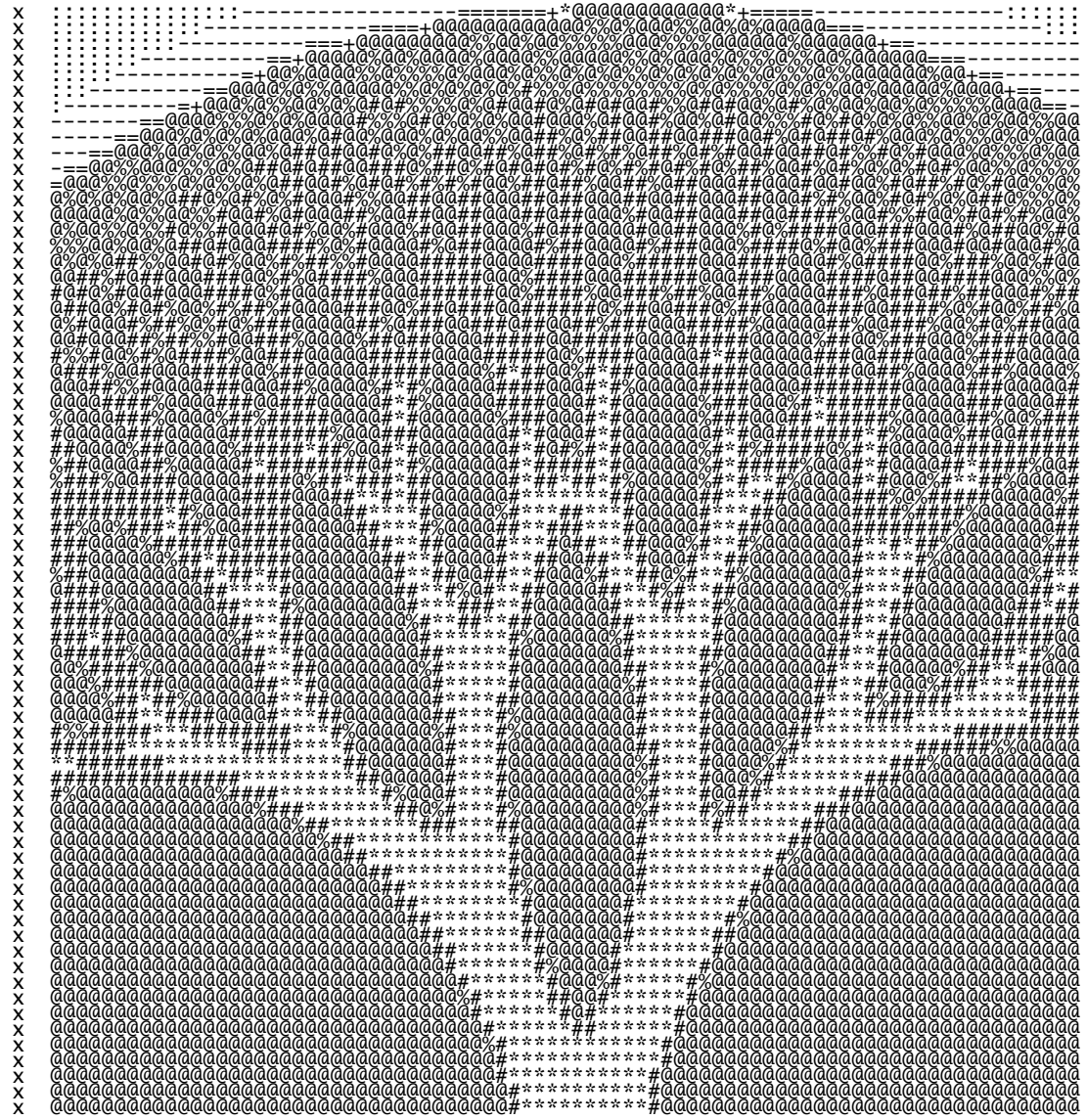
CTE Fun Queries in Informix – Julia Set



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SQL Version Banner with CTE

```
with fonts(c, c1, c2,c3,c4,c5,c6,c7,c8) as (
select * from table(multiset{ -- vga 8x8 fonts
ROW(' ', '0x00', '0x00', '0x00', '0x00', '0x00', '0x00', '0x00', '0x00'), ROW('!', '0x18', '0x3C', '0x3C', '0x18', '0x18', '0x00', '0x18', '0x00'),
ROW('A', '0x0C', '0x1E', '0x33', '0x33', '0x3F', '0x33', '0x33', '0x00'), ROW('B', '0x3F', '0x66', '0x66', '0x3E', '0x66', '0x66', '0x3F', '0x00'),
ROW('C', '0x3C', '0x66', '0x03', '0x03', '0x03', '0x66', '0x3C', '0x00'), ROW('D', '0x1F', '0x36', '0x66', '0x66', '0x66', '0x36', '0x1F', '0x00'),
ROW('E', '0x7F', '0x46', '0x16', '0x1E', '0x16', '0x46', '0x7F', '0x00'), ROW('F', '0x7F', '0x46', '0x16', '0x1E', '0x16', '0x06', '0x0F', '0x00'),
ROW('G', '0x3C', '0x66', '0x03', '0x03', '0x73', '0x66', '0x7C', '0x00'), ROW('H', '0x33', '0x33', '0x33', '0x3F', '0x33', '0x33', '0x33', '0x00'),
ROW('I', '0x1E', '0x0C', '0x0C', '0x0C', '0x0C', '0x0C', '0x1E', '0x00'), ROW('J', '0x78', '0x30', '0x30', '0x30', '0x33', '0x33', '0x1E', '0x00'),
ROW('K', '0x67', '0x66', '0x36', '0x1E', '0x36', '0x66', '0x67', '0x00'), ROW('L', '0x0F', '0x06', '0x06', '0x06', '0x46', '0x66', '0x7F', '0x00'),
ROW('M', '0x63', '0x77', '0x7F', '0x7F', '0x6B', '0x63', '0x63', '0x00'), ROW('N', '0x63', '0x67', '0x6F', '0x7B', '0x73', '0x63', '0x63', '0x00'),
ROW('O', '0x1C', '0x36', '0x63', '0x63', '0x63', '0x36', '0x1C', '0x00'), ROW('P', '0x3F', '0x66', '0x66', '0x3E', '0x06', '0x06', '0x0F', '0x00'),
ROW('Q', '0x1E', '0x33', '0x33', '0x33', '0x3B', '0x1E', '0x38', '0x00'), ROW('R', '0x3F', '0x66', '0x66', '0x3E', '0x36', '0x66', '0x67', '0x00'),
ROW('S', '0x1E', '0x33', '0x07', '0x0E', '0x38', '0x33', '0x1E', '0x00'), ROW('T', '0x3F', '0x2D', '0x0C', '0x0C', '0x0C', '0x0C', '0x1E', '0x00'),
ROW('U', '0x33', '0x33', '0x33', '0x33', '0x33', '0x33', '0x3F', '0x00'), ROW('V', '0x33', '0x33', '0x33', '0x33', '0x33', '0x1E', '0x0C', '0x00'),
ROW('W', '0x63', '0x63', '0x63', '0x6B', '0x7F', '0x77', '0x63', '0x00'), ROW('X', '0x63', '0x63', '0x36', '0x1C', '0x1C', '0x36', '0x63', '0x00'),
ROW('Y', '0x33', '0x33', '0x33', '0x1E', '0x0C', '0x0C', '0x1E', '0x00'), ROW('Z', '0x7F', '0x63', '0x31', '0x18', '0x4C', '0x66', '0x7F', '0x00'),
ROW('~', '0x6E', '0x3B', '0x00', '0x00', '0x00', '0x00', '0x00', '0x00')})),
text(str) as (select 'THANK YOU'), -- text string to display
xword(str, o, c, c1, c2,c3,c4,c5,c6,c7,c8) as ( -- get all fonts data for above string
    select str, 1, c, c1, c2,c3,c4,c5,c6,c7,c8 from text, fonts where c = substr(str, 1, 1)
    union all
    select str, o+1, c, c1, c2,c3,c4,c5,c6,c7,c8 from fonts, xword where fonts.c = substr(str, o+1, 1) and o < length(str)),
x(n, p) as (    select 1, 128 union all select n+1, p/2 from x where n < 8), -- for (p =128, n = 1; i <= 8; n++) p>>1;
show as (select  sum ((case when bitand(to_number(c1)::int, p) > 0 then '#' else ' ' end)::lvarchar)::char(8) as c1,
          -- pixel to '#' or ' '
        sum ((case when bitand(to_number(c2)::int, p) > 0 then '#' else ' ' end)::lvarchar)::char(8) as c2,
        sum ((case when bitand(to_number(c3)::int, p) > 0 then '#' else ' ' end)::lvarchar)::char(8) as c3,
        sum ((case when bitand(to_number(c4)::int, p) > 0 then '#' else ' ' end)::lvarchar)::char(8) as c4,
        sum ((case when bitand(to_number(c5)::int, p) > 0 then '#' else ' ' end)::lvarchar)::char(8) as c5,
        sum ((case when bitand(to_number(c6)::int, p) > 0 then '#' else ' ' end)::lvarchar)::char(8) as c6,
        sum ((case when bitand(to_number(c7)::int, p) > 0 then '#' else ' ' end)::lvarchar)::char(8) as c7,
        sum ((case when bitand(to_number(c8)::int, p) > 0 then '#' else ' ' end)::lvarchar)::char(8) as c8
          from x cross join xword group by xword.o order by xword.o desc)
select  sum(c1::lvarchar) as _1, sum(c2::lvarchar) as _2, sum(c3::lvarchar) as _3, sum(c4::lvarchar) as _4, -- display the result
        sum(c5::lvarchar) as _5, sum(c6::lvarchar) as _6, sum(c7::lvarchar) as _7, sum(c8::lvarchar) as _8 from show;
```

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Thank You

```
Database selected.

_1  ######  ##  ##    ##    ##   ## ###  ##          ##  ##    ###   ##  ##
_2  # ## #  ##  ##   ####   ###  ##  ##  ##          ##  ##   ## ##  ##  ##
_3    ##    ##  ##  ##  ##  #### ##  ## ##          ##  ##  ##   ## ##  ##
_4    ##    ######  ##  ##  ## ####  ####            ####   ##   ## ##  ##
_5    ##    ##  ##  ######  ##  ###  ## ##            ##    ##   ## ##  ##
_6    ##    ##  ##  ##  ##  ##   ##  ##  ##           ##     ## ##  ##  ##
_7   ####   ##  ##  ##  ##  ##   ## ###  ##          ####     ###   ######
_8

1 row(s) retrieved.

Database closed.
```

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Questions

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