PostgreSQL for Developers

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Dimitri Fontaine dimitri@2ndQuadrant.fr

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Dimitri Fontaine

2ndQuadrant France
PostgreSQL Major Contributor

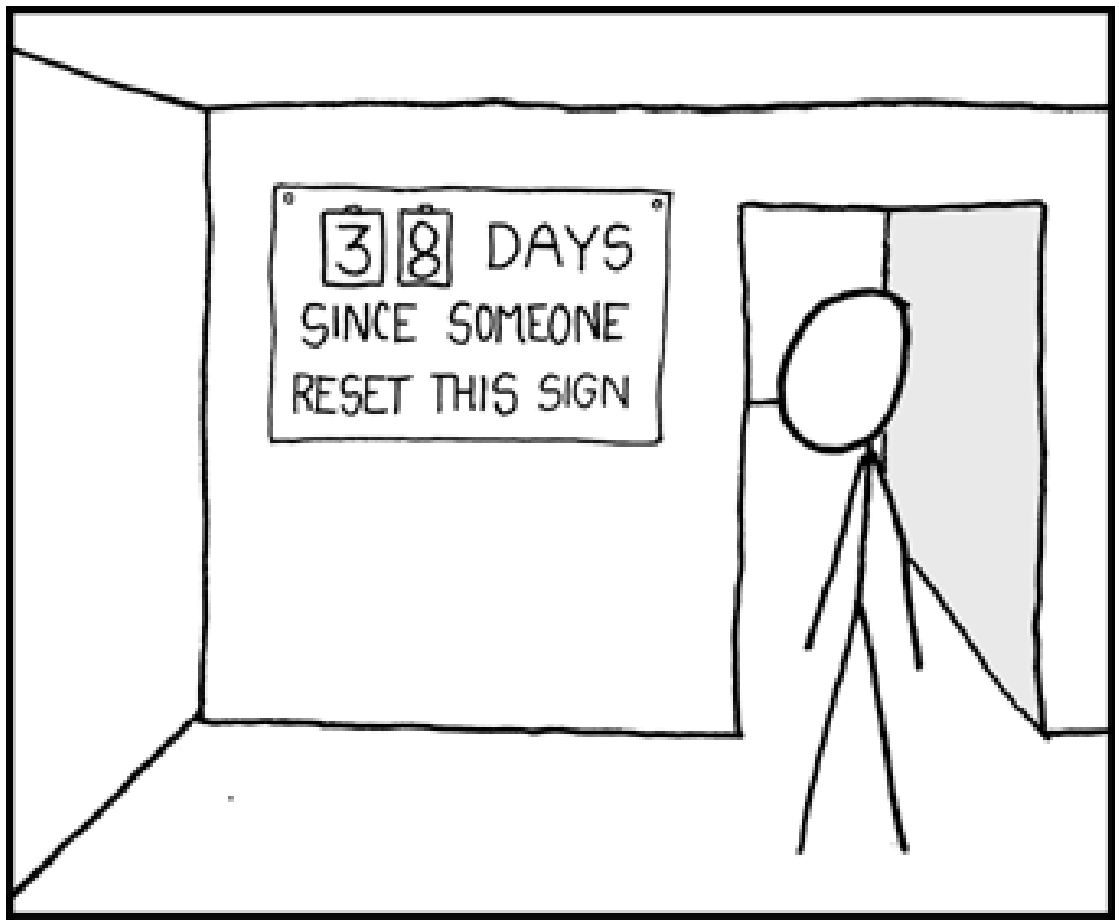
- `pgloader`
- `prefix`, `skytools`, `debian`, ...
- `CREATE EXTENSION`
- `CREATE EVENT TRIGGER`

Tools and development languages

You're already using plenty of tools and languages already I'm sure, let's look at a typical web developer environment

- HTML
- Javascript
- *JQuery*
- SQL

A simple project



Project definition and scope

Let's try and solve so,ething simple to get started:

- Managing a counter that can recycle
- Adding new measures in a time based fashion
- Do monthly reports to allow for invoicing
- Analyze the counter behavior

SQL: we start with DDLs

Joe Celko: 80% of the job is to define the schema

Example (DDL)

```
create table mesures(date timestamptz primary key,
                     mesure integer);


dim=# \d mesures
\d mesures
            Table "public.mesures"
 Column |           Type           | Modifiers
--------+--------------------------+-----------
 date   | timestamp with time zone | not null
 mesure | integer                  |
Indexes:
    "mesures_pkey" PRIMARY KEY, btree (date)
```

We take a very simple model for the presentation

```
create table measures(tick int, nb int);

insert into measures
     values (1, 0), (2, 10), (3, 20), (4, 30), (5, 40),
            (6, 0), (7, 20), (8, 30), (9, 60);
```

Testing data

Let's take some measures as if they came out of our counter, starting at 0, and with a *reset* in there. In that example, the global usage measured is 40 + 60 = 100.

```
select * from measures;
 tick | nb
------+----
    1 |  0
    2 | 10
    3 | 20
    4 | 30
    5 | 40
    6 |  0
    7 | 20
    8 | 30
    9 | 60
(9 rows)
```

Aside: PostgreSQL knows about arrays

```
select array_agg(nb) from measures;
         array_agg
----------------------------
 {0,10,20,30,40,0,20,30,60}
(1 row)
```

Finding the last counter value before *reset*

Write some SQL here

```
 tick | nb | max
------+----+-----
    1 |  0 |
    2 | 10 |
    3 | 20 |
    4 | 30 |
    5 | 40 |  40
    6 |  0 |
    7 | 20 |
    8 | 30 |
    9 | 60 |  60
(9 rows)
```

Window Functions: lead() over()

```
select tick,
       nb,
       lead(nb) over (order by tick)
  from measures;
```

```
 tick | nb | lead
------+----+------
    1 |  0 |   10
    2 | 10 |   20
    3 | 20 |   30
    4 | 30 |   40
    5 | 40 |    0
    6 |  0 |   20
    7 | 20 |   30
    8 | 30 |   60
    9 | 60 |
(9 rows)
```

Window Functions and CASE

```
select tick, nb,
       case when lead(nb) over w < nb
            then nb

            when lead(nb) over w is null
            then nb

            else null
        end as max
  from measures
window w as (order by tick);
```

```
 tick | nb | max
------+----+-----
    1 |  0 |
    2 | 10 |
    3 | 20 |
    4 | 30 |
    5 | 40 |  40
    6 |  0 |
    7 | 20 |
    8 | 30 |
    9 | 60 |  60
(9 rows)
```

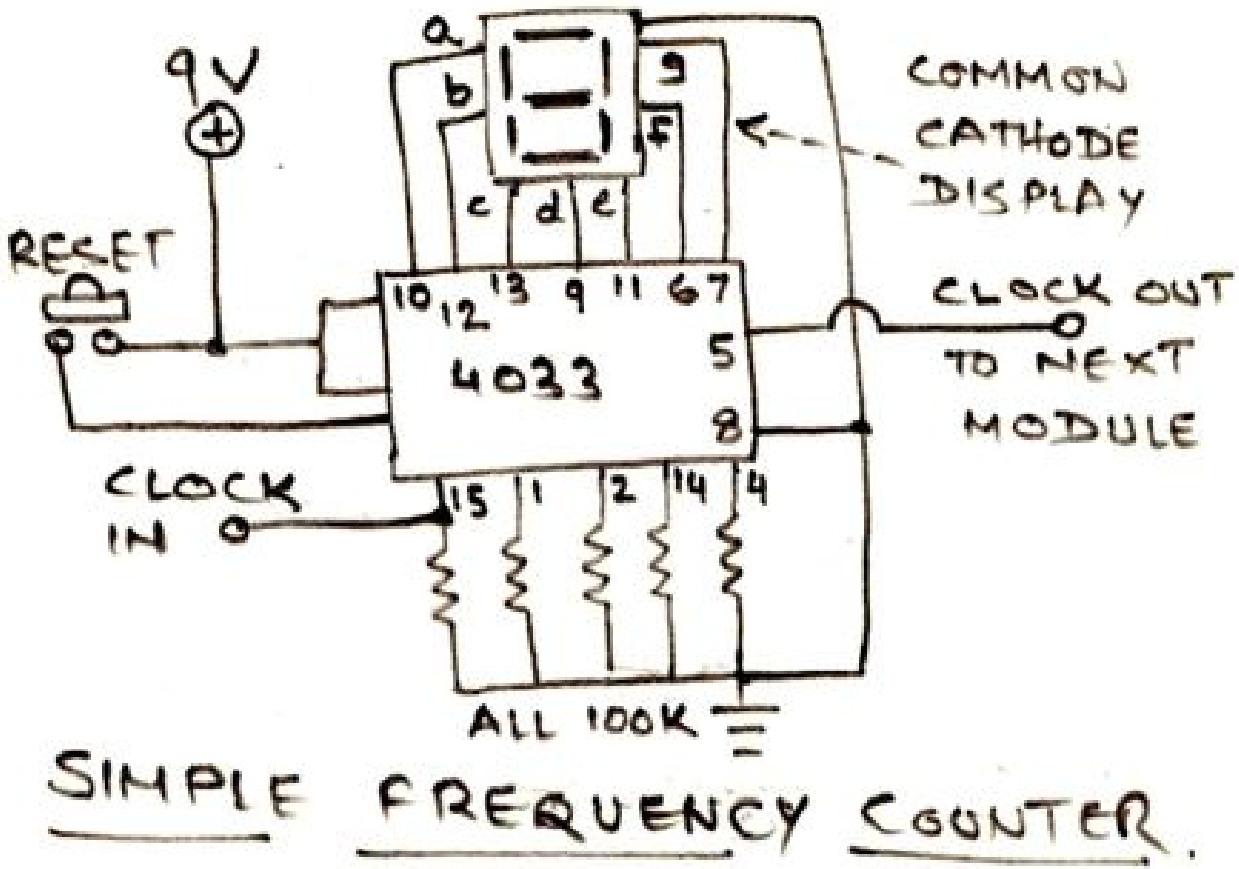
Window Functions and WHERE clause

```
with t(tick, nb, max) as (
  select tick, nb,
         case when lead(nb) over w < nb then nb
              when lead(nb) over w is null then nb
              else null
          end as max
    from measures
  window w as (order by tick)
)
select tick, nb, max from t where max is not null;
 tick | nb | max
------+----+-----
    5 | 40 |  40
    9 | 60 |  60
(2 rows)
```

Common Table Expressions to complement WITH

```
with t(tops) as (
  select case when lead(nb) over w < nb then nb
              when lead(nb) over w is null then nb
              else null
          end as max
    from measures
  window w as (order by tick)
)
select sum(tops) from t;
 sum
-----
 100
(1 row)
```

Getting usage from the counter: done. SQL. 9 lines.



Let's test with more than one cycle

```
insert into measures
     values (10, 0), (11, 10), (12, 30), (13, 35), (14, 45),
            (15, 25), (16, 50), (17, 100), (18, 110);
```

Visualizing the cycles

```
with t(tick, nb, max) as (
  select tick, nb,
         case when lead(nb) over w < nb then nb
              when lead(nb) over w is null then nb
              else null
          end as max
    from measures
  window w as (order by tick)
)
select tick, nb, max from t where max is not null;
 tick | nb  | max
------+-----+-----
    5 |  40 |  40
    9 |  60 |  60
   14 |  45 |  45
   18 | 110 | 110
(4 rows)
```

Resource usage, with several cycles

```
with t(tops) as (
  select case when lead(nb) over w < nb then nb
              when lead(nb) over w is null then nb
              else null
          end as max
    from measures
  window w as (order by tick)
)
select sum(tops) from t;
 sum
-----
 255
(1 row)
```

Limit measure taken into account

Limit measures period (time range)

```
select tick, nb
  from measures
 where tick >= 4 and tick < 14;
```

tick	nb
4	30
5	40
6	0
7	20
8	30
9	60
10	0
11	10
12	30
13	35

Limit measures period using first_value

```
select nb,
   first_value(nb) over w as first,
   case when lead(nb) over w < nb
        then nb

        when lead(nb) over w is null
        then nb

        else null
    end as max
  from measures
 where tick >= 4 and tick < 14
window w as (order by tick);
```

```
 nb | first | max
----+-------+-----
 30 |    30 |
 40 |    30 |  40
  0 |    30 |
 20 |    30 |
 30 |    30 |
 60 |    30 |  60
  0 |    30 |
 10 |    30 |
 30 |    30 |
 35 |    30 |  35
(10 rows)
```

Resource usage in a given period

```
with t as (
  select tick,
         first_value(nb) over w as first,
         case when lead(nb) over w < nb then nb
              when lead(nb) over w is null then nb
              else null
          end as max
    from measures
   where tick >= 4 and tick < 14
  window w as (order by tick)
)
select sum(max) - min(first) as sum from t;
 sum
-----
 105
(1 row)
```

Counter behavior: *reset*

Partitionning on the *reset*

```
with tops as (
  select tick, nb,
         case when lead(nb) over w < nb then nb
              when lead(nb) over w is null then nb
             else null
         end as max
    from measures
  window w as (order by tick)
)
  select tick, nb, max,
         (select tick
            from tops t2
           where t2.tick >= t1.tick and max is not null
        order by t2.tick
           limit 1) as p
    from tops t1;
```

Partitioning on *reset*

tick	nb	max	p
1	0		5
2	10		5
3	20		5
4	30		5
5	40	40	5
6	0		9
7	20		9
8	30		9
9	60	60	9

tick	nb	max	p
10	0		14
11	10		14
12	30		14
13	35		14
14	45	45	14
15	25		18
16	50		18
17	100		18
18	110	110	18

Time range partitioning with PARTITION BY

```
with tops as ( <case lead() over()> ),
     parts as ( <self join limit 1> ),
     ranges as (
  select                                    start | end | max
      first_value(tick) over w as start,-------+-----+-----
      last_value(tick) over w as end,         1 |   5 |  40
      max(max) over w                         6 |   9 |  60
    from parts                               10 |  14 |  45
  window w as (PARTITION BY p                15 |  18 | 110
               order by tick)              (4 rows)
)
select * from ranges
 where max is not null;
```

PostgreSQL knows about ranges: in4range()

```
with tops as ( <case lead() over()> ),
     parts as ( <self join limit 1> ),
     ranges as (
  select int4range(
           first_value(tick) over w,
           last_value(tick) over w,
           '[]') as range,
         max(max) over w as compteur
    from parts
  window w as (partition by p
                   order by tick)
)
select range, compteur
  from ranges
 where compteur is not null;
```

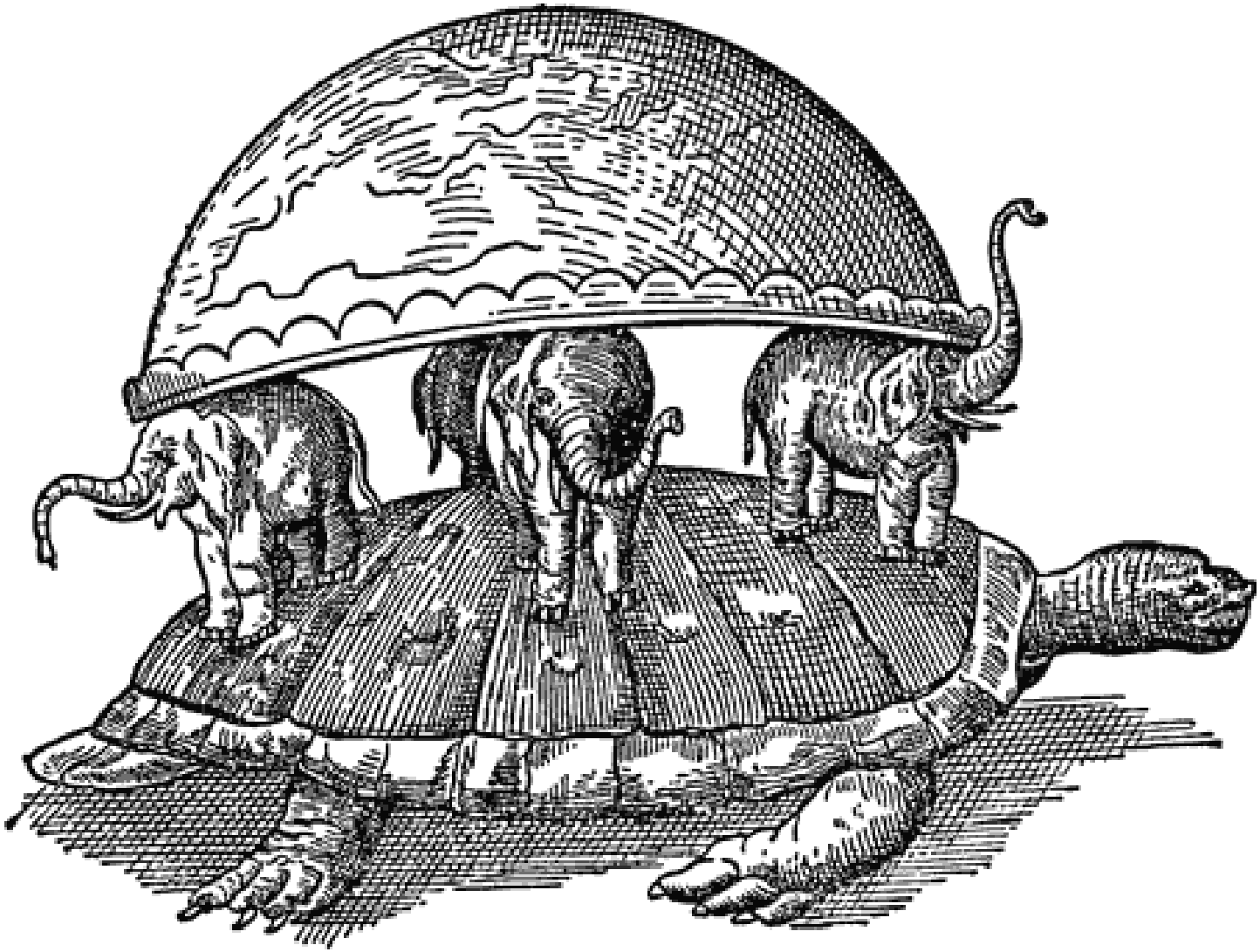
```
  range   | compteur
----------+----------
 [1,6)    |       40
 [6,10)   |       60
 [10,15)  |       45
 [15,19)  |      110
(4 rows)
```

Usage by range using @>

```
with tops as ( <case lead() over()> ),
     parts as ( <self join limit 1> ),
     ranges as ( <int4range()
                   over (partition by
                         order by)> )
select range, compteur
  from ranges
 where compteur is not null
       and range @> 11;
```

```
  range   | compteur
----------+----------
 [10,15) |       45
(1 row)
```

Extensions and data types

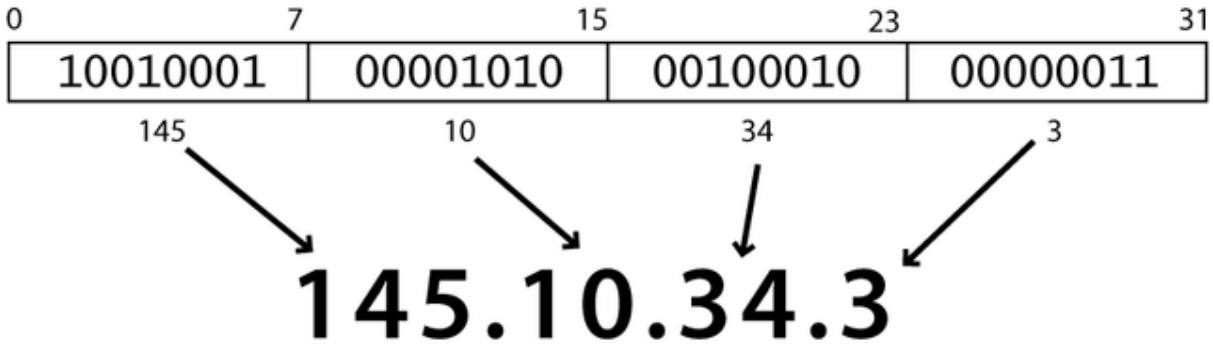


Some extensions example

46 Contribs, Community extensions, Private ones...

- hll
- cube
- ltree
- citext
- hstore
- earthdistance
- pgq
- pg_trgm
- wildspeed
- plproxy
- PostGIS
- ip4r
- intarray
- prefix
- pgfincore
- pgcrypto
- pg_stattuple
- pg_buffercache
- pg_stat_statements
- pgfincore

IP Ranges, ip4r



IP Ranges, ip4r

```
table geolite.blocks limit 10;
        iprange          | locid
-------------------------+-------
 1.0.0.0/24              |    17
 1.0.1.0-1.0.3.255       |    49
 1.0.4.0/23              | 14409
 1.0.6.0/23              |    17
 1.0.8.0/21              |    49
 1.0.16.0/20             | 14614
 1.0.32.0/19             | 47667
 1.0.64.0/18             |   111
 1.0.128.0-1.0.147.255   |   209
 1.0.148.0/24            | 22537
(10 rows)
```

IP Ranges, ip4r, Geolocation

PostgreSQL allows using SQL and JOINs to match IP4R with geolocation.

```
select *
  from geolite.blocks
  join geolite.location
       using(locid)
 where iprange
           >>=
       '74.125.195.147';
```

IP Ranges, ip4r, Geolocation

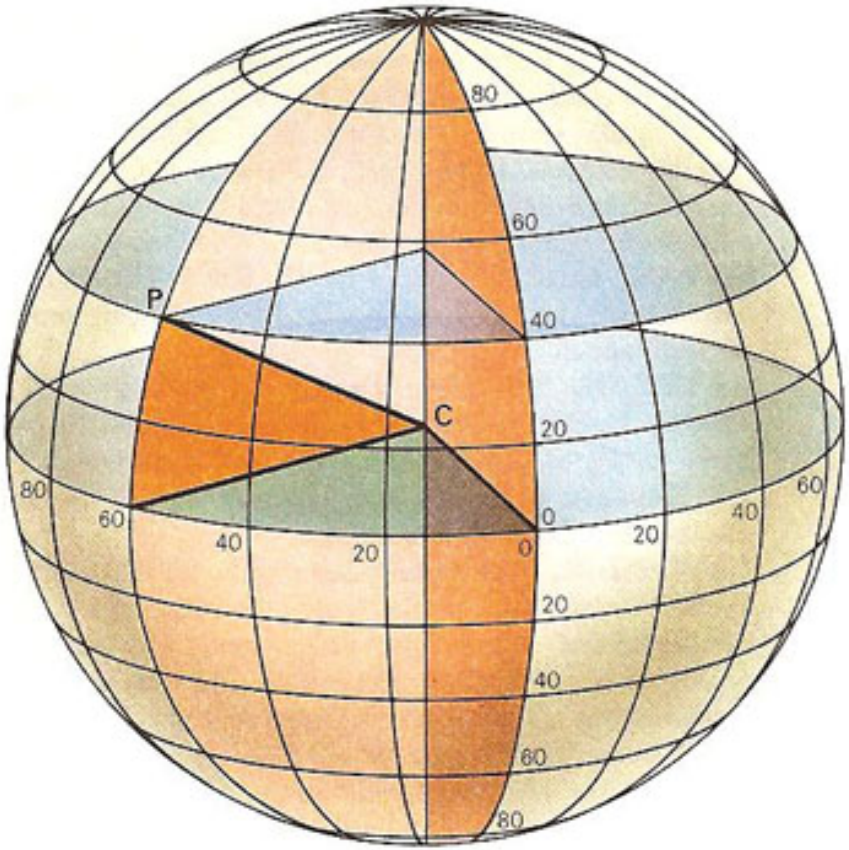
PostgreSQL allows using SQL and JOINs to match IP4R with geolocation.

```
select *
  from geolite.blocks
  join geolite.location
       using(locid)
 where iprange
           >>=
       '74.125.195.147';
```

```
-[ RECORD 1 ]----------------------
locid      | 2703
iprange    | 74.125.189.24-74.125.
country    | US
region     | CA
city       | Mountain View
postalcode | 94043
location   | (-122.0574,37.4192)
metrocode  | 807
areacode   | 650

Time: 1.335 ms
```

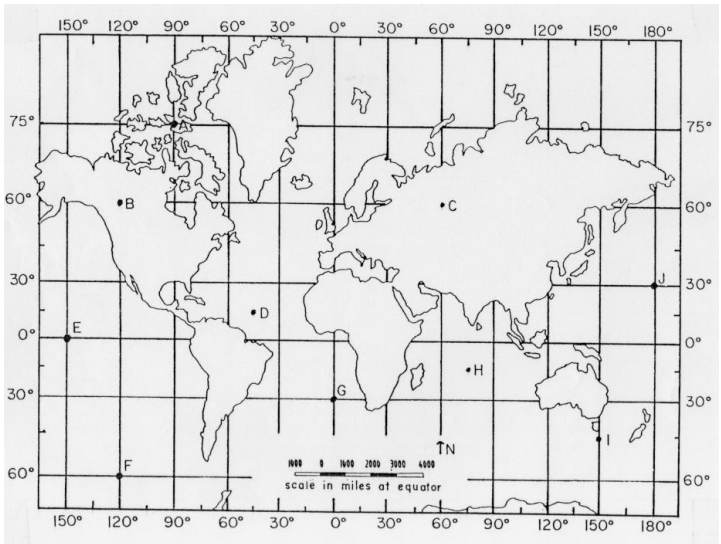
Earth Distance



How Far is The Nearest Pub

The `point` datatype is in-core

```
#   CREATE TABLE pubnames
    (
      id    bigint,
      pos   POINT,
      name text
    );
```



How Far is The Nearest Pub

```
  select name, pos
    from pubnames
order by pos <-> point(-6.25,53.346)
    limit 3;
```

```
          Pub Name             |            pos
-------------------------------+---------------------------
 Ned's                         | (-6.2519967,53.3458267)
 Sub Lounge                    | (-6.2542332,53.3469085)
 O'Neill's of Pearse Street    | (-6.2524389,53.3448589)
(3 rows)

Time: 18.679 ms
```

How Far is The Nearest Pub

```
CREATE INDEX on pubnames USING GIST(pos);
```

```
  select name,
         pos
    from pubnames
order by pos <-> point(-0.12,51)
   limit 3;
```

```
  name   |          pos
---------+------------------
 Ned's   | (-6.25,53.34
 Sub Lo  | (-6.25,53.34
 O'Neil  | (-6.25,53.34
(3 rows)

Time: 0.849 ms
```

How Far is The Nearest Pub, in Miles please.

```
create extension cube;
create extension earthdistance;
```

```
  select name,
   pos <@> point(-6.25,53.34) miles
    from pubnames
order by pos <-> point(-6.25,53.34)
   limit 3;
```

```
  name   | miles
---------+-------
 Ned's   |  0.06
 Sub Lo  |  0.07
 O'Neil  |  0.12
(3 rows)

Time: 1.335 ms
```

Some pubs far away from here...

```
select c.name as city,
pos <@> point(-6.25,53.34) as miles
 from pubnames p,
   lateral (select name
              from cities c
          order by c.pos <-> p.pos
             limit 1) c
order by pos <-> point(-6.25,53.34)
         desc
  limit 5;
```

```
    city    |  miles
------------+--------
 Canterbury | 399.44
 Canterbury | 378.91
 Canterbury | 392.08
 Canterbury | 397.30
 Canterbury | 379.68
(5 rows)

Time: 636.445 ms
```

Geolocation: `ip4r` meets earthdistance

Some pubs nearby... some place...

```
with geoloc as
 (
  select location as l
    from location
    join blocks using(locid)
   where iprange
         >>=
         '212.58.251.195'
 )
  select name,
         pos <@> l miles
    from pubnames, geoloc
order by pos <-> l
   limit 10;
```

```
        name          | miles
----------------------+-------
 Blue Anchor          | 0.299
 Dukes Head           | 0.360
 Blue Ball            | 0.337
 Bell (aka The Rat)   | 0.481
 on the Green         | 0.602
 Fox & Hounds         | 0.549
 Chequers             | 0.712
 Sportsman            | 1.377
 Kingswood Arms       | 1.205
 Tattenham Corner     | 2.007
(10 rows)

Time: 3.275 ms
```

Conclusion

You are already using SQL, make the best out of it!