17 - PostgreSQL 17 Performance Tuning: Using Partial Indexes

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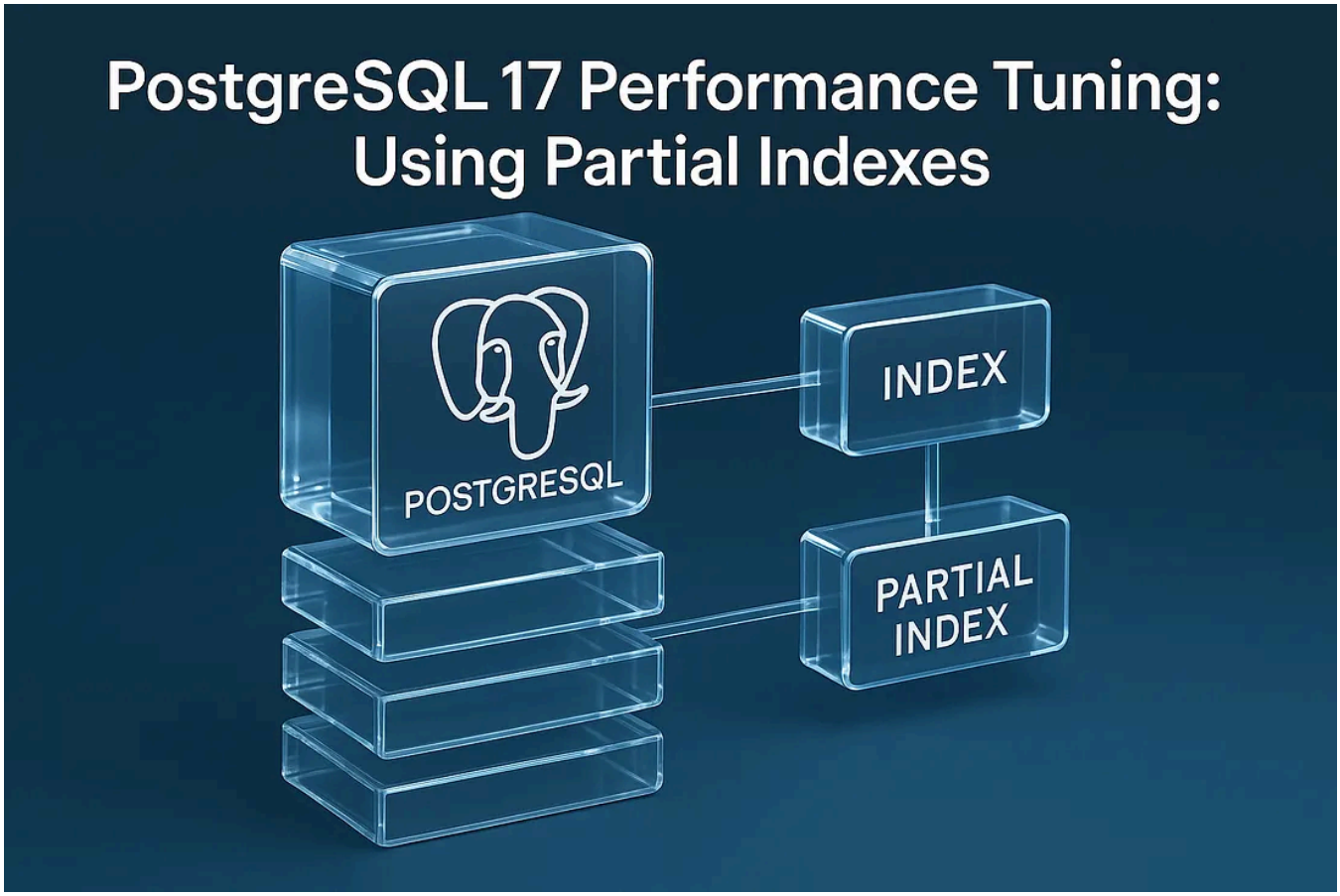
Jeyaram Ayyalusamy Following



Even though we usually create indexes on all rows of a table, PostgreSQL also allows you to create an index on **just a subset of records.** This type of index is called a **partial index.**

A partial index is smaller than a full index because it only covers rows that match a condition. Since there's less data in the index, it is faster to scan and cheaper to maintain. This is especially useful when queries consistently filter for a **small subset** of rows.

Why Use Partial Indexes?

Imagine a **task management system** stored in a `products`-like table. Rows representing tasks still pending are flagged as **`open`**, while completed ones are marked as **`done`**.

Over time, most rows will be marked **`done`**, and only a small fraction will be **`open`**. But in practice, users will frequently query the **`open`** tasks.

👉 If we create a full index on the `status` column, PostgreSQL will index all 10 million rows (both `open` and `done`). This consumes space and slows down writes, even though most queries only care about the small subset (`open`).

👉 Instead, if we create a **partial index only for `status = 'open'`**, PostgreSQL can use a much smaller, faster index, while ignoring rows that don't matter.

Step 1: Create Products Table with 10 Million Rows

```
CREATE TABLE products (
    product_id   BIGSERIAL PRIMARY KEY,
    product_name TEXT,
    category     TEXT,
    status       TEXT,         -- 'open' or 'done'
    price        NUMERIC,
    stock_qty    INT
);
```

```
postgres=# CREATE TABLE products (
    product_id   BIGSERIAL PRIMARY KEY,
    product_name TEXT,
    category     TEXT,
    status       TEXT,         -- 'open' or 'done'
    price        NUMERIC,
    stock_qty    INT
);
CREATE TABLE
postgres=#
```

```
-- 1M rows with status = 'open' (~10%)
INSERT INTO products (product_name, category, price, stock_qty, status)
SELECT
    'Product_' || g,
    'Category_' || (g % 50),
    round((random() * 500)::numeric, 2),
    (random() * 1000)::int,
    'open'
FROM generate_series(1, 1000000) g;

-- 2.5M rows with status = 'done' (~25%)
INSERT INTO products (product_name, category, price, stock_qty, status)
SELECT
    'Product_' || g,
    'Category_' || (g % 50),
    round((random() * 500)::numeric, 2),
    (random() * 1000)::int,
    'done'
FROM generate_series(1000001, 3500000) g;

-- 3M rows with status = 'denied' (~30%)
INSERT INTO products (product_name, category, price, stock_qty, status)
SELECT
    'Product_' || g,
    'Category_' || (g % 50),
    round((random() * 500)::numeric, 2),
    (random() * 1000)::int,
    'denied'
FROM generate_series(3500001, 6500000) g;
```

```
-- 3.5M rows with status = 'new' (~35%)
INSERT INTO products (product_name, category, price, stock_qty, status)
SELECT
    'Product_' || g,
    'Category_' || (g % 50),
    round((random() * 500)::numeric, 2),
    (random() * 1000)::int,
    'new'
FROM generate_series(6500001, 10000000) g;
```

```
postgres=# -- 1M rows with status = 'open' (~10%)
INSERT INTO products (product_name, category, price, stock_qty, status)
SELECT
    'Product_' || g,
    'Category_' || (g % 50),
    round((random() * 500)::numeric, 2),
    (random() * 1000)::int,
    'open'
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INSERT INTO products (product_name, category, price, stock_qty, status)
SELECT
    'Product_' || g,
    'Category_' || (g % 50),
```

```
    round((random() * 500)::numeric, 2),
    (random() * 1000)::int,
    'new'
FROM generate_series(6500001, 10000000) g;

INSERT 0 1000000
INSERT 0 2500000
INSERT 0 3000000
INSERT 0 3500000
postgres=#
postgres=# ANALYZE products;
ANALYZE
postgres=#
```

```
postgres=# SELECT status, COUNT(*)
FROM products
GROUP BY status;
 status |  count
--------+---------
 denied | 3000000
 done   | 2500000
 new    | 3500000
 open   | 1000000
(4 rows)
```

Step 2: Full Index vs Partial Index

Full Index on Status

```
CREATE INDEX idx_products_status ON products(status);
```

```
postgres=# CREATE INDEX idx_products_status ON products(status);
CREATE INDEX
postgres=#
```

```
postgres=# analyze products;
ANALYZE
postgres=#
```

Covers **all 10M rows.**

- Size is large (hundreds of MBs).
- Every insert/update must maintain this index, even for rows where `status = 'done'`.

Query Example

Now run a query for open tasks:

```
EXPLAIN ANALYZE
SELECT * FROM products WHERE status = 'open';
```

```
postgres=# EXPLAIN ANALYZE
SELECT * FROM products WHERE status = 'open';
                                                                QUERY PLAN
-------------------------------------------------------------------------------------------
 Bitmap Heap Scan on products  (cost=10979.37..203257.63 rows=985669 width=49)
```

```
   Recheck Cond: (status = 'open'::text)
   Heap Blocks: exact=10310
   ->  Bitmap Index Scan on idx_products_status  (cost=0.00..10732.95 rows=9856
         Index Cond: (status = 'open'::text)
 Planning Time: 1.067 ms
 Execution Time: 6343.627 ms
(7 rows)

postgres=#
```

Partial Index on Status = ‘open’

```
DROP INDEX idx_products_status;
```

```
postgres=# DROP INDEX idx_products_status;
DROP INDEX
postgres=#
```

```
CREATE INDEX idx_products_open ON products(status) WHERE status = 'open';
```

```
postgres=# CREATE INDEX idx_products_open ON products(status) WHERE status = 'c
CREATE INDEX
postgres=#
```

```
analyze products;
```

```
postgres=# analyze products;
ANALYZE
postgres=#
```

- Covers only **1M rows** (10% of total).
- Much smaller, cheaper to maintain.
- Perfect for queries that only look at `open` rows.

Step 3: Query Example

Now run a query for open tasks:

```
EXPLAIN ANALYZE
```

```
SELECT * FROM products WHERE status = 'open';
```

```
postgres=# EXPLAIN ANALYZE
SELECT * FROM products WHERE status = 'open';
                                                                  QUERY PLAN
-----------------------------------------------------------------------------------------------
 Bitmap Heap Scan on products  (cost=8417.18..200578.87 rows=956335 width=49) (
   Recheck Cond: (status = 'open'::text)
   Heap Blocks: exact=10310
   ->  Bitmap Index Scan on idx_products_open  (cost=0.00..8178.10 rows=956335
 Planning Time: 1.010 ms
 Execution Time: 1294.439 ms
(6 rows)

postgres=#
```

👉 PostgreSQL will use `idx_products_open`, skipping all the `done` rows. The query is much faster because the index is tiny.

If you query for `status = 'done'`, PostgreSQL won't use this index — it will either do a sequential scan or use another index, depending on the query.

Step 4: Measuring Index Space

Check how much space indexes use compared to the table:

```
SELECT
    pg_size_pretty(pg_relation_size('products')) AS table_only,
    pg_size_pretty(pg_indexes_size('products')) AS indexes_only,
    pg_size_pretty(pg_total_relation_size('products')) AS total_with_indexes;
```

```
postgres=# SELECT
    pg_size_pretty(pg_relation_size('products')) AS table_only,
    pg_size_pretty(pg_indexes_size('products')) AS indexes_only,
    pg_size_pretty(pg_total_relation_size('products')) AS total_with_indexes;
 table_only | indexes_only | total_with_indexes
------------+--------------+--------------------
 805 MB     | 221 MB       | 1027 MB
(1 row)

postgres=#
```

It's common to see indexes taking **more space than the table itself.** That's why it's so important to measure index usage vs cost. Partial indexes help reduce wasted space.

When to Use Partial Indexes

Partial indexes make sense when:

- Your table has **a few very common values** (e.g., `status = 'done'`) and queries mostly target the **less frequent values** (e.g., `status = 'open'`).
- The excluded values cover at least **25% or more** of the table.
- You know your data patterns well (e.g., gender, nationality, active/inactive users).

Partial indexes trade **bigger space savings** and **faster lookups** for less flexibility, but when applied wisely, they can make queries significantly faster while reducing index maintenance costs.

Key Takeaways

- A full index on 10M rows can be huge and expensive to maintain.
- A partial index only on frequently queried rows (e.g., `status = 'open'`) is **smaller, cheaper, and faster.**
- Always measure **space usage vs query benefit** before adding indexes.
- PostgreSQL 17 makes partial indexes just as powerful as full ones — but far more efficient in the right scenarios.

✅ Partial indexes are a powerful tuning tool when your workload is focused on a **small subset of values** inside a very large table.

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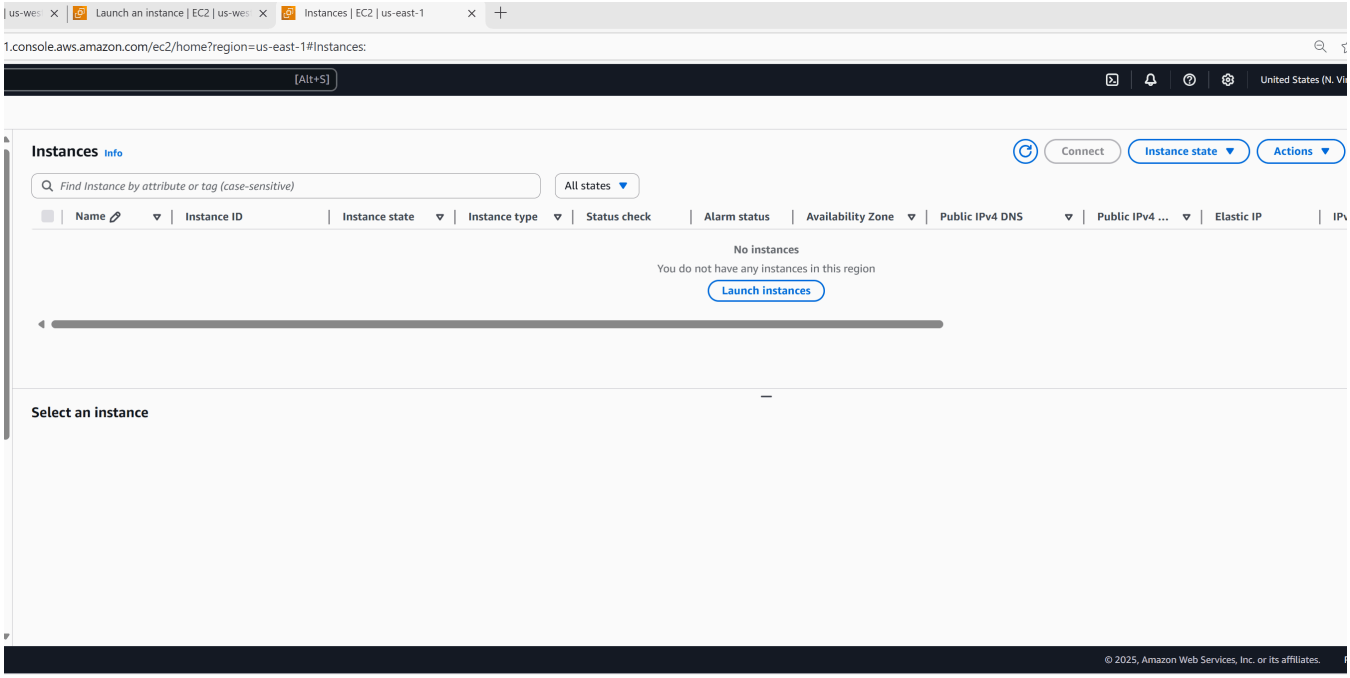

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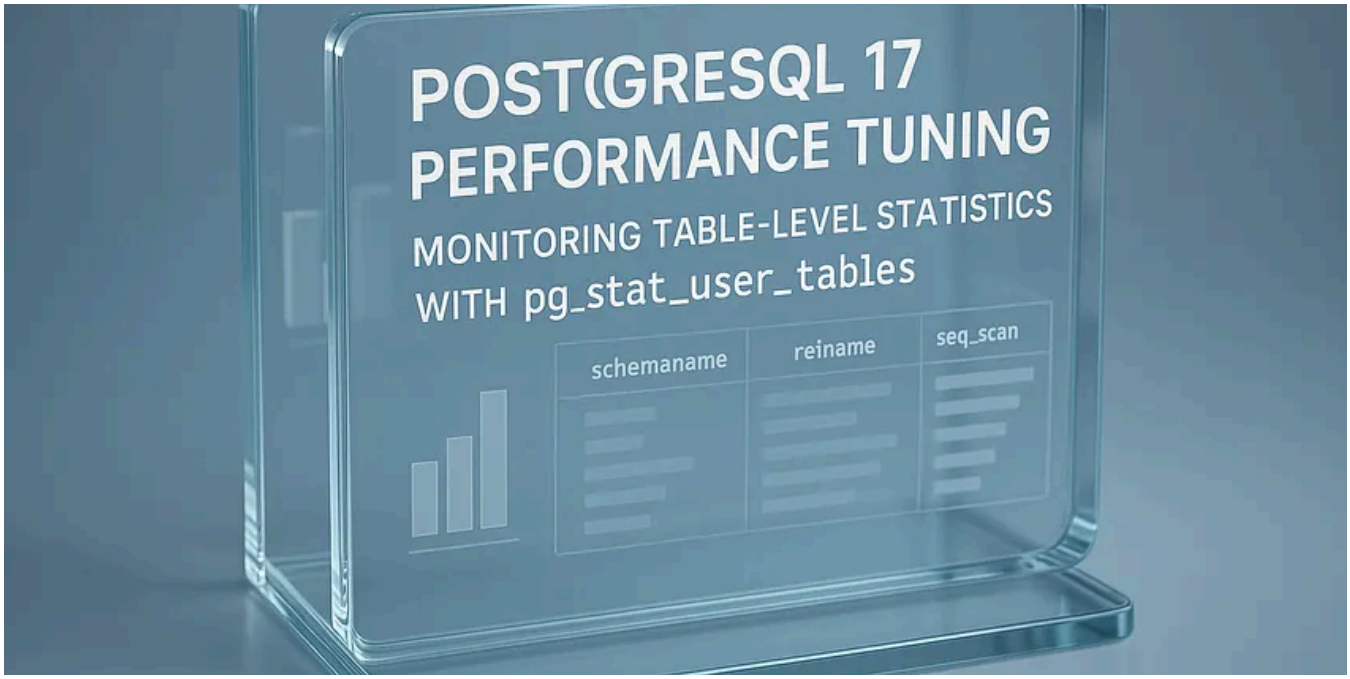

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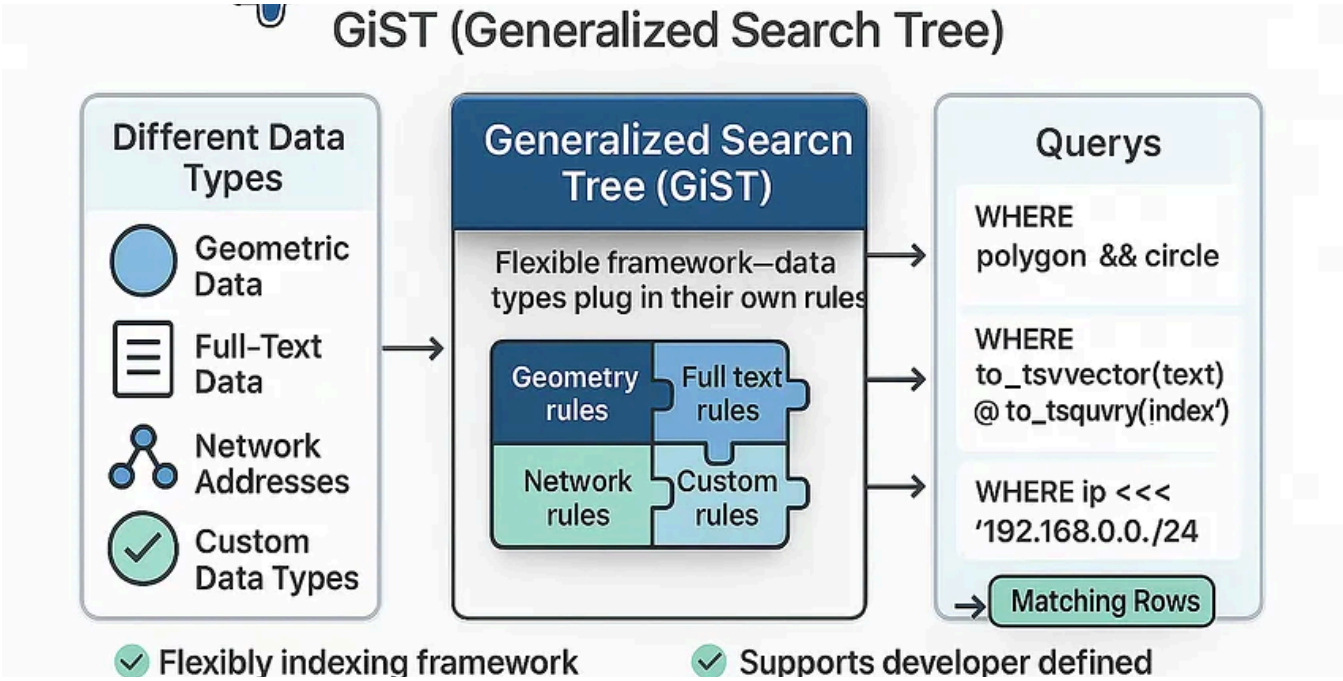

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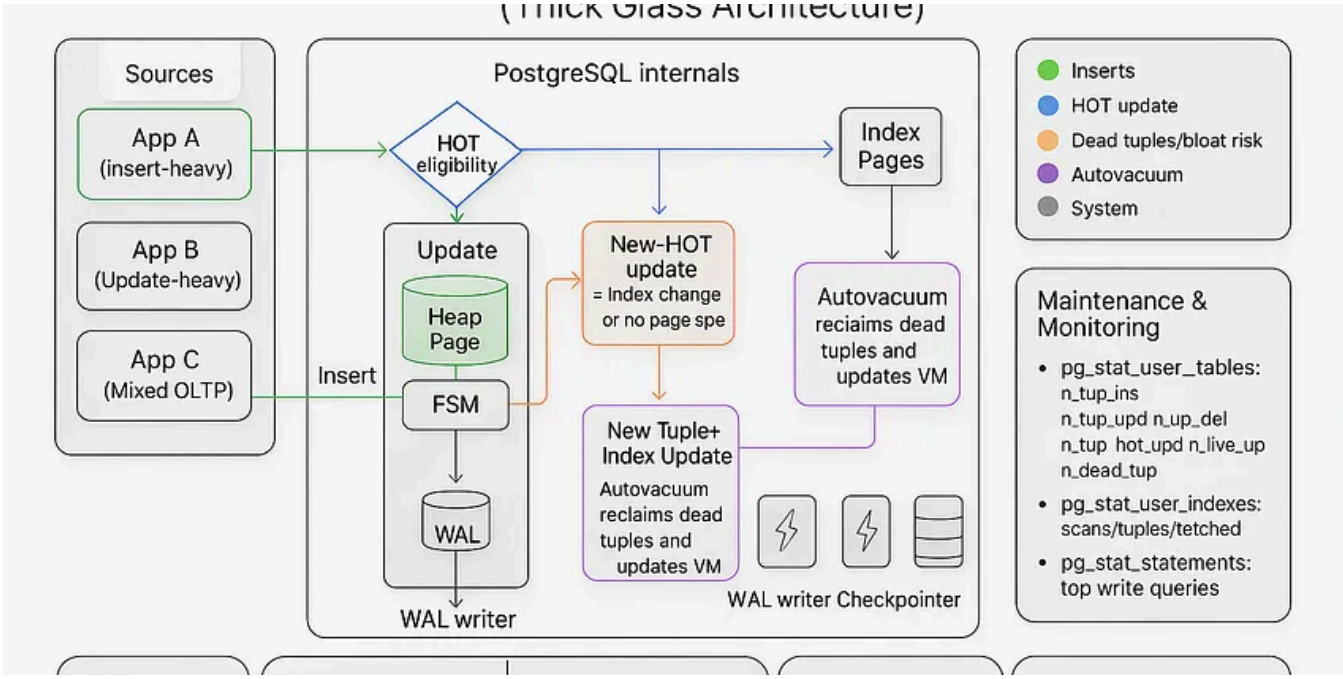

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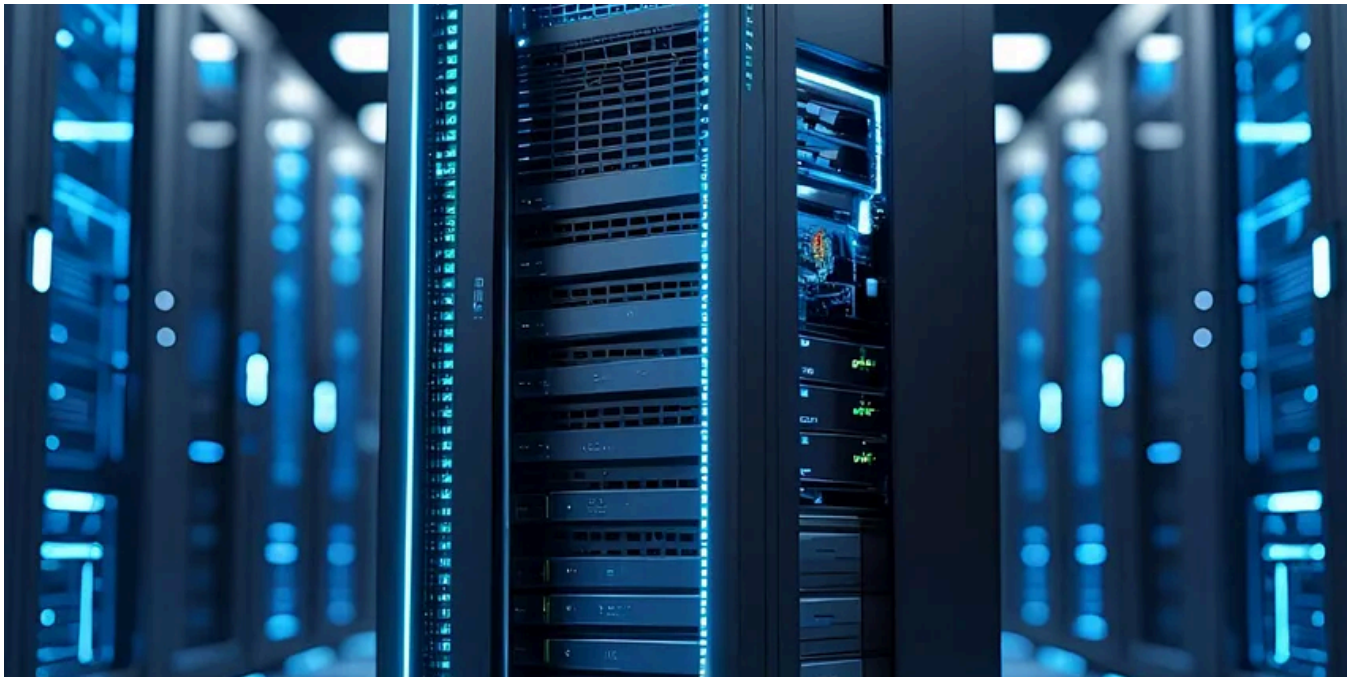

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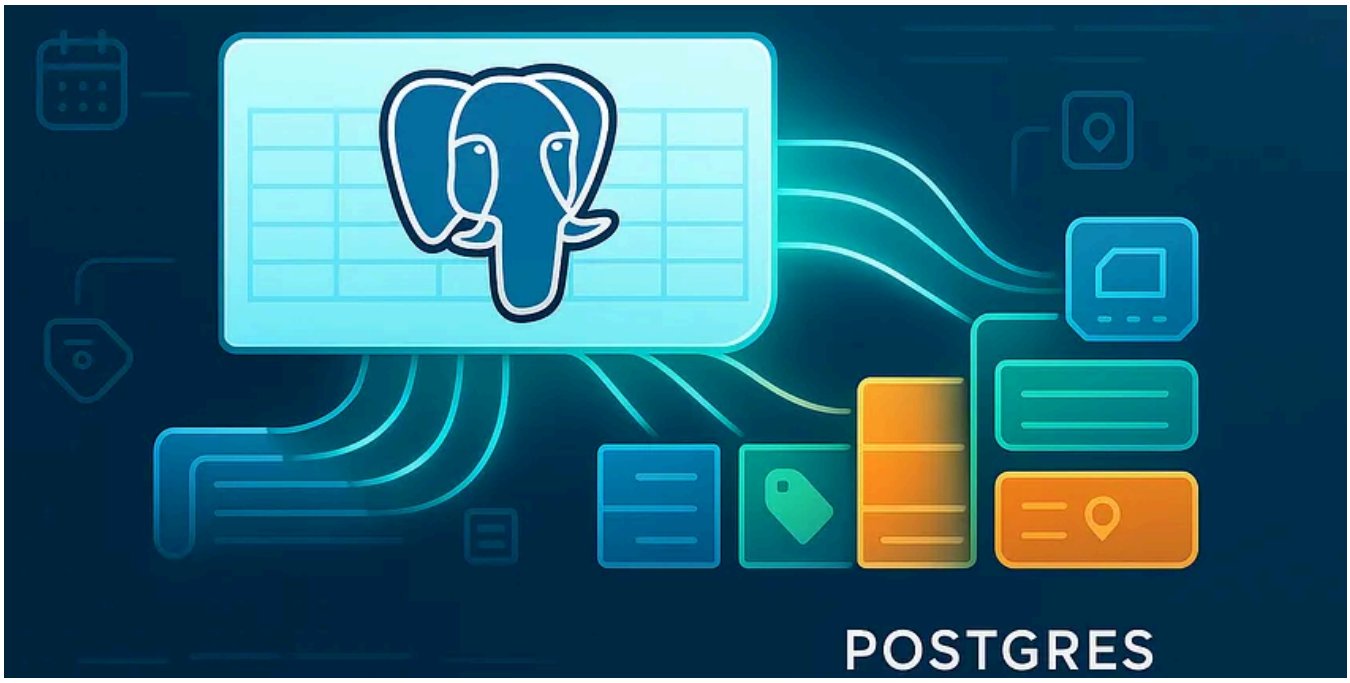

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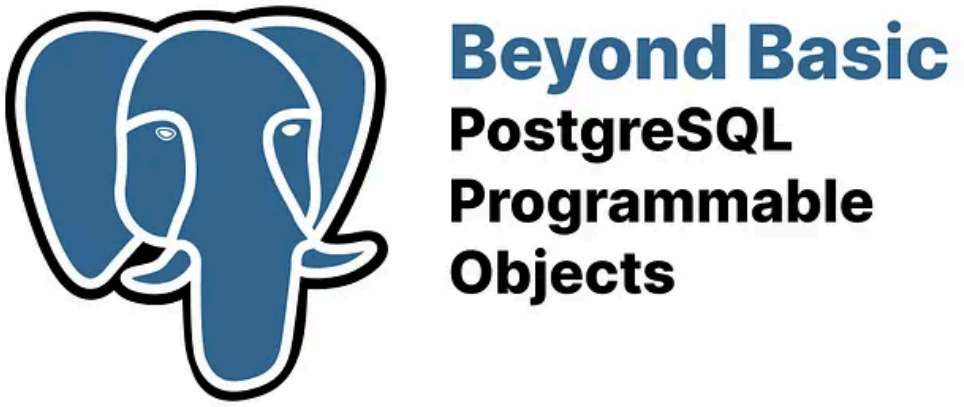

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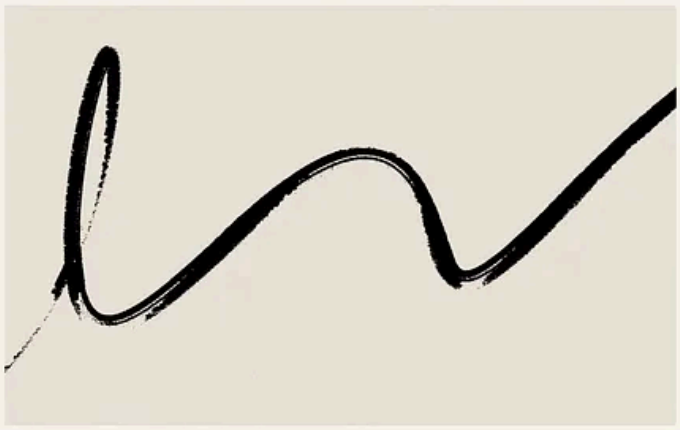

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