The art of data retention in PostgreSQL

data egret

Your remote PostgreSQL DBA team

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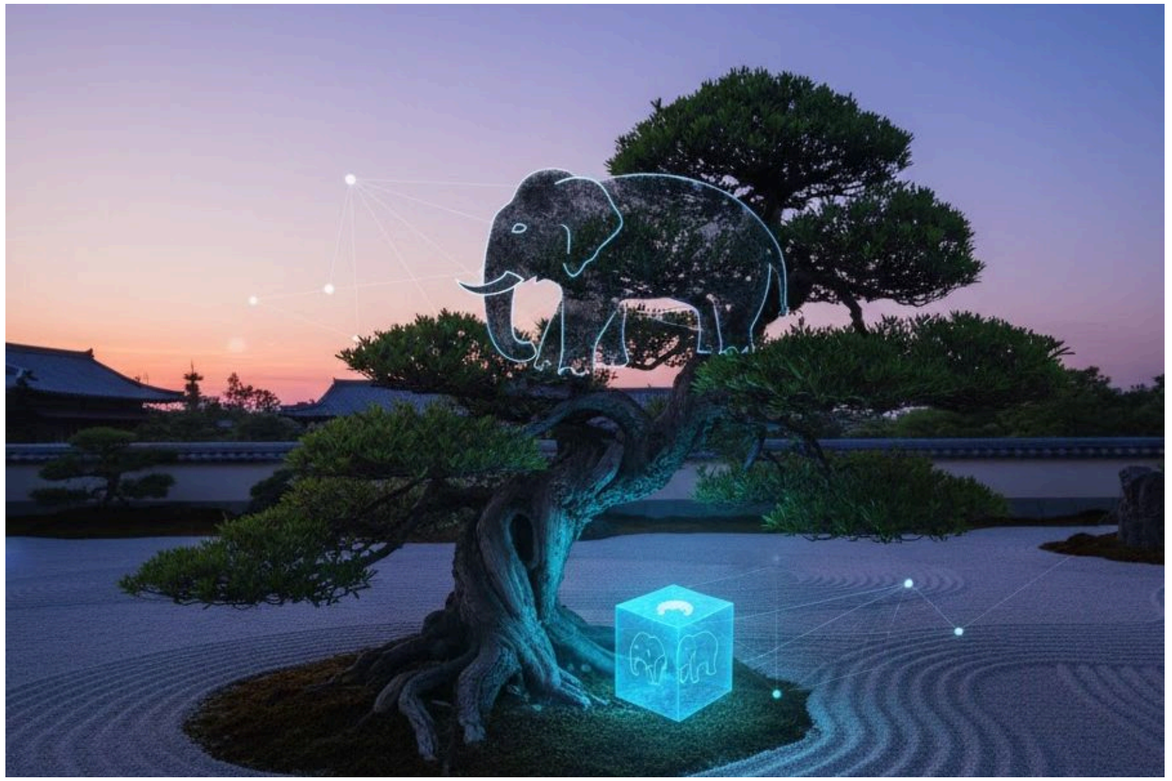
The art of data retention in PostgreSQL



Balancing performance, cost, and discipline in growing databases

Every database starts small

- A few tables
- A few thousand rows
- A mix of tests and early production traffic

The calm before the storm

- Everything still fitted in memory
- Everything was fast
- Nobody was worried

Six months later

The hidden cost of big tables

- More data to scan, even with indexes
- VACUUM and autovacuum become heavier
- Cache efficiency drops
- Backups and replication slow down
- Higher risk of downtime 🔥

How can we save disk space when data grows?

- Data always grows faster than we expect
- Can PostgreSQL compress our way out of this?

Compression: the first idea

- PostgreSQL does have a form of compression: **TOAST**
- But TOAST is not a traditional compression system
  - TOAST = *The Oversized Attribute Storage Technique*
- It exists to handle **large values that do not fit in a page**

How PostgreSQL stores data

- PostgreSQL stores data in fixed-size **pages** (8 KB by default)
- If a row value is too large to fit in that page, TOAST comes in

What TOAST does

- Compresses large values using an internal algorithm
- If still too big, moves them to a **TOAST table** (`pg_toast_XXX`)
- The main table stores only a **pointer** instead of the full data

TOAST and compression

- Default: `pglz`
- Recommended: `lz4`
  - Faster in most cases
  - Similar compression ratio
- How to enable `lz4`:
  - `default_toast_compression = 'lz4';`
  - or `ALTER TABLE t1 ALTER COLUMN c2 SET COMPRESSION lz4;`

Example

```
CREATE TABLE compress_lz4 (
    id         serial PRIMARY KEY,
    details    text COMPRESSION lz4
);

INSERT INTO compress_lz4 (details)
SELECT
    repeat(md5(random()::text), 5000)   -- ~160 KB strings
FROM generate_series(1, 1_000_000) i;
```

Table	Rows	Size
compress_lz4	1,000,000	710 MB
compress_pglz	1,000,000	1.9 GB

Why compression alone is not enough

- Only helps for big text, JSONB, or bytea columns
- Does nothing for regular numeric or short text data
- Does not control table growth or vacuum overhead
- You still need to manage what stays and what goes

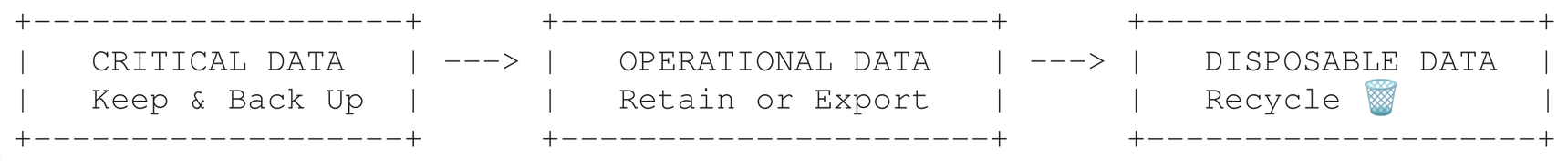
> *Compression saves bytes, not discipline.*

From chaos to structure

The real path: data retention

1. The problem: data keeps growing
2. Principles: classify data and plan retention
3. Techniques: partitioning, archiving
4. The way of the database: discipline and foresight

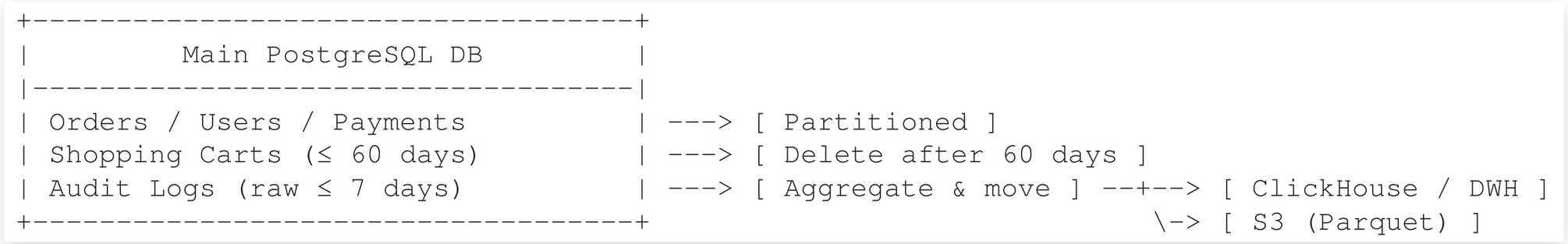
Not all data is equal



Defining data lifecycles

- Decide how long to keep each data type
- Define where it goes when it becomes old
- Set clear rules for safe deletion
- Keep only what is useful or required

Case study: an e-commerce platform



Partitioning in PostgreSQL

- Helps with:
  - Faster queries on recent or relevant data
  - Easier clean-up
    - Drop old partitions instead of running large DELETEs
  - Reduced bloat and lower VACUUM overhead

Declarative partitioning

- **Partitioned table**
  - Defines only the structure
  - Indexes and constraints are automatically propagated to partitions
- **Partitions**
  - Each partition is a regular table and can be queried directly
  - Supports default partitions
  - Sub-partitions are also supported
  - Partitions can be attached or detached

https://www.postgresql.org/docs/current/ddl-partitioning.html

List partitioning

- The table is divided into partitions by listing specific key values
- Each partition contains rows matching those values
- The partition key must be a single column

Example

```
CREATE TABLE customers (
  id serial,
  country text,
  name text
) PARTITION BY LIST (country);

CREATE TABLE customers_eu PARTITION OF customers FOR VALUES IN ('FR', 'DE', 'ES');
CREATE TABLE customers_us PARTITION OF customers FOR VALUES IN ('US', 'CA');
CREATE TABLE customers_other PARTITION OF customers DEFAULT;
```

Hash partitioning

- Distributes data evenly across partitions
- Uses a **modulus** and **remainder** to decide where each row goes
- Each partition holds rows where `hash(key) % modulus = remainder`

Example

```
CREATE TABLE customers (
  id serial,
  country text,
  name text
) PARTITION BY HASH (country);

CREATE TABLE customers_p0 PARTITION OF customers FOR VALUES WITH (modulus 3, remainder 0);
CREATE TABLE customers_p1 PARTITION OF customers FOR VALUES WITH (modulus 3, remainder 1);
CREATE TABLE customers_p2 PARTITION OF customers FOR VALUES WITH (modulus 3, remainder 2);
```

Range partitioning

- The table is divided into ranges based on one or more key columns
- Each range must be unique and cannot overlap with another
- Range bounds are inclusive at the lower end and exclusive at the upper end
- Use `MINVALUE` or `MAXVALUE` for open-ended ranges

Example

```sql
-- Create the parent table and define range partitioning on order_date
CREATE TABLE orders (
  order_id      bigint GENERATED BY DEFAULT AS IDENTITY,
  customer_id   bigint NOT NULL,
  order_date    date NOT NULL,
  total_amount  numeric NOT NULL,
  PRIMARY KEY (order_date, order_id)
) PARTITION BY RANGE (order_date);

-- Create monthly partitions for Q1 2025
CREATE TABLE orders_2025_01 PARTITION OF orders
  FOR VALUES FROM ('2025-01-01') TO ('2025-02-01');

CREATE TABLE orders_2025_02 PARTITION OF orders
  FOR VALUES FROM ('2025-02-01') TO ('2025-03-01');

CREATE TABLE orders_2025_03 PARTITION OF orders
  FOR VALUES FROM ('2025-03-01') TO ('2025-04-01');

-- Create an index on the parent table (simple, not concurrent)
CREATE INDEX orders_customer_id_idx ON orders (customer_id);
```

The benefits of partitioning

- Faster queries
- Easier clean-up
- Better long-term performance

> *“Partitions follow your business logic: by month, by region, by customer, making data easier to manage and maintain.”*

But old data never leaves on its own

- Old partitions are:
  - Still on disk
  - Still vacuumed
  - Still backed up
  - Still costing money

Cleaning up old partitions

- Old partitions can be:
  - Exported
  - Detached
  - Dropped

```
-- Option 1: Export with COPY
COPY orders_2025_01 TO '/archive/orders_2025_01.csv' CSV;

-- Option 2: Export with pg_dump
pg_dump -Fc -Z 3 -t orders_2025_01 yourdb > orders_2025_01.sql

-- Detach or drop after export
ALTER TABLE orders DETACH PARTITION orders_2025_01 CONCURRENTLY;
DROP TABLE orders_2025_01;
```

What about less active but still accessible data

- Keep it accessible, just not on your fastest storage
- Common approaches:
  - Separate PostgreSQL **tablespace**
  - Separate PostgreSQL **instance**
  - **External object storage** (for example, S3 or Azure Blob)
  - **Data warehouse** (for example, ClickHouse or BigQuery)

Option A: another tablespace in the same cluster

- Move older partitions to slower or cheaper disks
- Queries still use the same tables and indexes
- Requires minimal application changes

```
-- Create a tablespace on cheaper storage
CREATE TABLESPACE orders_archive LOCATION '/mnt/archive/pg';

-- Move a partition to the archive tablespace
ALTER TABLE orders_2025_02 SET TABLESPACE orders_archive;
```

Understanding tablespaces

- Physical storage for database objects (not a logical concept)
- Represented by a normal directory outside **PGDATA**, linked symbolically
- Common use cases:
  - Distributing I/O load and data volume
  - Enforcing storage quotas via the filesystem
  - Isolating temporary or sorting operations

Option B: external archiving

FDW	Reads from	Example use case
file_fdw	CSV or TSV files	Logs and simple exports
postgres_fdw	Other PostgreSQL databases	Cross-database archiving or reporting
pg_parquet	Parquet with S3, GCS, or Azure	Object storage
pg_lake	Parquet, CSV, JSON, Iceberg	Analytics and AI workloads

```
CREATE FOREIGN TABLE hits ()
SERVER pg_lake options (path 'az://your_container_name/hits.parquet');

SELECT count(*) FROM hits;
```

Putting it together: a simple retention workflow

- **Keep**: data that is legally or operationally required
- **Move**: less active data to slower or cheaper storage
- **Archive**: historical data that should live outside PostgreSQL
- **Drop**: data that is no longer needed and safe to remove

Automating retention policies

- Define a clear retention period per table or dataset (for example, 12 months)
- Always archive before dropping data (export or offload)
- Monitor logs or alerts to track when partitions are removed
- Test automation in staging before running it in production

Tools for automation

Tool	Purpose
pg_partman	Automatically create and drop partitions based on time or ID
pg_cron / cron	Schedule SQL tasks and scripts
pg_timetable	PostgreSQL-native job scheduler with advanced workflows
COPY / pg_dump	Export data before dropping

Production pitfalls to avoid

Operation	Common issue
`ALTER TABLE ... SET COMPRESSION`	No effect on existing data unless the table is rewritten (e.g. with `CLUSTER`)
Rewriting large tables	CPU-intensive; run during off-hours
Index without `CONCURRENTLY`	Blocks reads and writes; can block traffic
Too many partitions	Slows query planning and autovacuum
Dropping large partitions	May cause locks or replication lag

The way of the database

Where to go from here:

1. **Understand your data**
2. **Partition** what grows continuously
3. **Set retention rules**: delete or archive
4. **Automate** lifecycle tasks
5. **Monitor** and adjust over time

Discipline is scalability

> *“Like the code of Bushido, discipline brings freedom.*
> *Freedom from chaos, slow queries, and sleepless nights.”*

Data retention is not about deletion; it is about **preserving what truly matters**.

Questions and feedback

contact@dataegret.com

Need some help with PostgreSQL? ;-)
*Get in touch with **Data Egret** to talk about PostgreSQL*
and, in particular, about training.

Bonus appendix

- Partitioning an existing table
- Indexing partitioned tables
- Creating and using tablespaces
- Automating retention with `pg_cron`

Partitioning an existing table

1. Create an empty partitioned copy
2. Add a trigger to sync new inserts, updates, and deletes
3. Backfill data in safe batches
4. Build indexes concurrently if needed
5. Switch over in a single transaction

Partitioning an existing table (Adyen approach)

1. Rename the original table as a *mammoth* partition
2. Create a new parent partitioned table with the original name
3. Add the *mammoth* table as the first child
4. Create empty replacement partitions
5. Backfill data into the new partitions in safe batches
6. Detach the *mammoth* and attach the new partitions
7. Validate constraints afterwards if needed

Adyen: Efficiently RePartitioning Large Tables in PostgreSQL

Indexing partitioned tables

- Index on the parent table:
  - Automatically applies to all partitions (existing and future)
  - Cannot be created concurrently, which can block reads and writes

```
CREATE INDEX ON orders (customer_id);
```

Indexing partitions manually

- Manual control with `ON ONLY`:
  - Skips automatic propagation
  - Allows per-partition indexes to be created concurrently

```
CREATE INDEX ON ONLY orders (customer_id);
CREATE INDEX CONCURRENTLY ON orders_2025_01 (customer_id);
ALTER INDEX orders_customer_id_idx
  ATTACH PARTITION orders_2025_01_customer_id_idx;
```

Example: indexing range partitions

```sql
-- Define the index on the parent "ONLY"
CREATE INDEX orders_customer_id_idx ON ONLY orders (customer_id);

-- Create the indexes on each existing partition CONCURRENTLY
CREATE INDEX CONCURRENTLY orders_2025_01_customer_id_idx ON orders_2025_01 (customer_id);
CREATE INDEX CONCURRENTLY orders_2025_02_customer_id_idx ON orders_2025_02 (customer_id);
CREATE INDEX CONCURRENTLY orders_2025_03_customer_id_idx ON orders_2025_03 (customer_id);

-- Attach the per-partition indexes to the parent index
ALTER INDEX orders_customer_id_idx ATTACH PARTITION orders_2025_01_customer_id_idx;
ALTER INDEX orders_customer_id_idx ATTACH PARTITION orders_2025_02_customer_id_idx;
ALTER INDEX orders_customer_id_idx ATTACH PARTITION orders_2025_03_customer_id_idx;

-- Tip: once the parent partitioned index exists,
-- any new partition you create will automatically receive a matching child index.
```

Creating and using tablespaces

```
-- Create a new tablespace
CREATE TABLESPACE ssd LOCATION '/mnt/ssd/pg';

-- Assign it to a database
CREATE DATABASE mydb TABLESPACE ssd;
ALTER DATABASE mydb SET default_tablespace TO ssd;

-- Assign it to a specific table
CREATE TABLE some_table (...) TABLESPACE ssd;

-- Move an existing table (requires an exclusive lock)
ALTER TABLE some_table SET TABLESPACE ssd;
```

Automating retention with `pg_cron`

- Automatically:
  - Detach old partitions (older than 12 months)
  - Export to `/archive`
  - Drop from the live database
- Scheduled with:

```
-- Schedule a nightly job at 03:00
SELECT cron.schedule(
  job_name   => 'detach_export_drop_old_partitions',
  schedule   => '0 3 * * *',
  command    => 'CALL detach_export_drop_old_partitions();'
);
```

Example: procedure to export and prune old partitions

```
CREATE OR REPLACE PROCEDURE detach_export_drop_old_partitions ()
LANGUAGE plpgsql
AS $$
DECLARE
  part RECORD;
BEGIN
  FOR part IN
    SELECT tablename FROM pg_tables
    WHERE schemaname = 'public' AND tablename LIKE 'orders_20%%'
    AND tablename < to_char(current_date - interval '12 months', '"orders_"YYYY_MM')
  LOOP
    RAISE LOG 'Retention: handling %', part.tablename;
    -- 1) Detach from the parent table
    EXECUTE format('ALTER TABLE orders DETACH PARTITION %I;', part.tablename);
    -- 2) Export the partition to CSV (server-side path)
    EXECUTE format('COPY %I TO ''/archive/%I.csv'' WITH CSV HEADER;', part.tablename, part.tablename);
    -- 3) Drop the detached table
    EXECUTE format('DROP TABLE IF EXISTS %I CASCADE;', part.tablename);
  END LOOP;
END;
$$;
```