Lessons for Postgres at Scale

How to Tame a Mastodon

David & Elizabeth Christensen | SCaLE 20x

~~How to Tame Mastodon~~

~~How to Tame Mastodon~~

How to Tame a Mastodon!

About us

crunchy data

David

Database Engineer

Postgres Consulting

Full stack dev background

@pg_dwc

Elizabeth

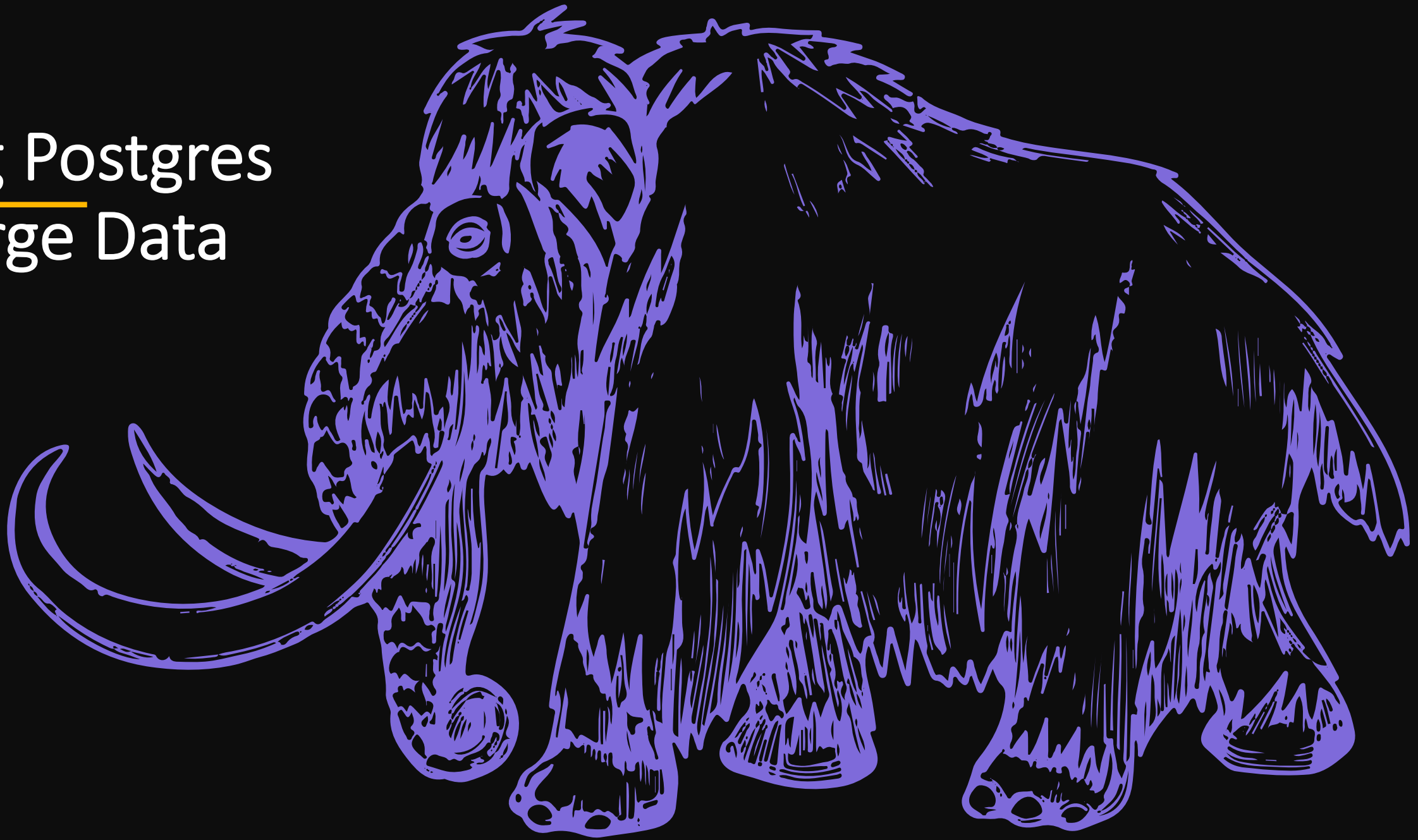
Customer success

Marketing

Kansas City Postgres

@sqlliz

Big Postgres
Large Data



Big Postgres Transactions

Big Postgres Replicas

Real Life Environment

OLTP Database

100 dev, no DBA

Heroku to Crunchy Bridge migration

25TB database with significant growth

15 replicas

WAL volume of 150GB/hr: 2-3 WAL files/sec

Transaction volume of 230M+/hr on primary alone


THIS IS FINE.

Challenges & Solutions

Maintenance needs to be done, but maintenance has risks

- Table size
- Transactions
- Replicas

Big Table Problems

Big Table Problem: Adding Columns

```
ALTER TABLE restaurant ADD COLUMN
feedback TEXT
DEFAULT compliments_to_the_chef()
```

Locks during rewrite

Solution: Multi-step column changes

ADD COLUMN

- ALTER TABLE restaurant ADD COLUMN feedback

ADD DEFAULT

- ALTER TABLE restaurant ALTER COLUMN feedback DEFAULT compliments_to_the_chef()

UPDATE

- UPDATE TABLE restaurant SET feedback TO DEFAULT

Big Table Problem: Adding Constraints

```
ALTER TABLE
favorite_bands ADD
CONSTRAINT name_check
 CHECK (name = 'Led Zeppelin')
```

Locks during validation

Solution: Postpone Validation

ALTER

- **ALTER TABLE** favorite_bands ADD **CONSTRAINT** name_check CHECK (name = 'Led Zeppelin') **NOT VALID**

VALIDATE

- ALTER TABLE favorite_bands VALIDATE **CONSTRAINT** name_check

Big Table Problem: Index Creation

The naïve approach is time consuming and locks

```
CREATE INDEX ON customers
(last_name, first_name)
```

Blocks writes during index creation

Solution: Create Index Concurrently

CREATE INDEX CONCURRENTLY

- ALTER Quick lock
- Runtime tradeoff
- You break it you clean it up

Big Table Problem: Unused Indexes

Queries change

High index overhead

Some redundant indexes

Solution: Index analysis/ cleanup

Combine indexes

- Combine **btrees where they make sense**

Look for unused indexes

- Pg_stat_user_indexes
- Pg_statio_user_indexes

Gather data on all nodes

- Unused on primary != unused in cluster
- Reset for active stats

Big Table Problem: Skewed Data

Data skews

Falling back to seq scan

Still maintain whole index

Solution: Partial indexes

CREATE INDEX foo ... WHERE bar = 1

Handy for data skew

Only has data for qual

- Faster updates
- Only relevant data

Big Table Problem: Vacuum

Vacuum required

Causing I/O performance degradation

Long & sporadic vacuums

Solution: Vacuum-related configuration

Tune autovacuum

- Autovacuum_workers = 6
- Maintenance_work_mem = 30GB

Per-table tuning

- autovacuum_vacuum_insert_scale_factor=0, autovacuum_vacuum_insert_threshold=<constant>

Target daily vacuums

Big Table Problem: Large single table

Many Rows

Recent vs Historical

Vacuum, Indexes

Periodic Data Removal

Huge table solution: Partitioning

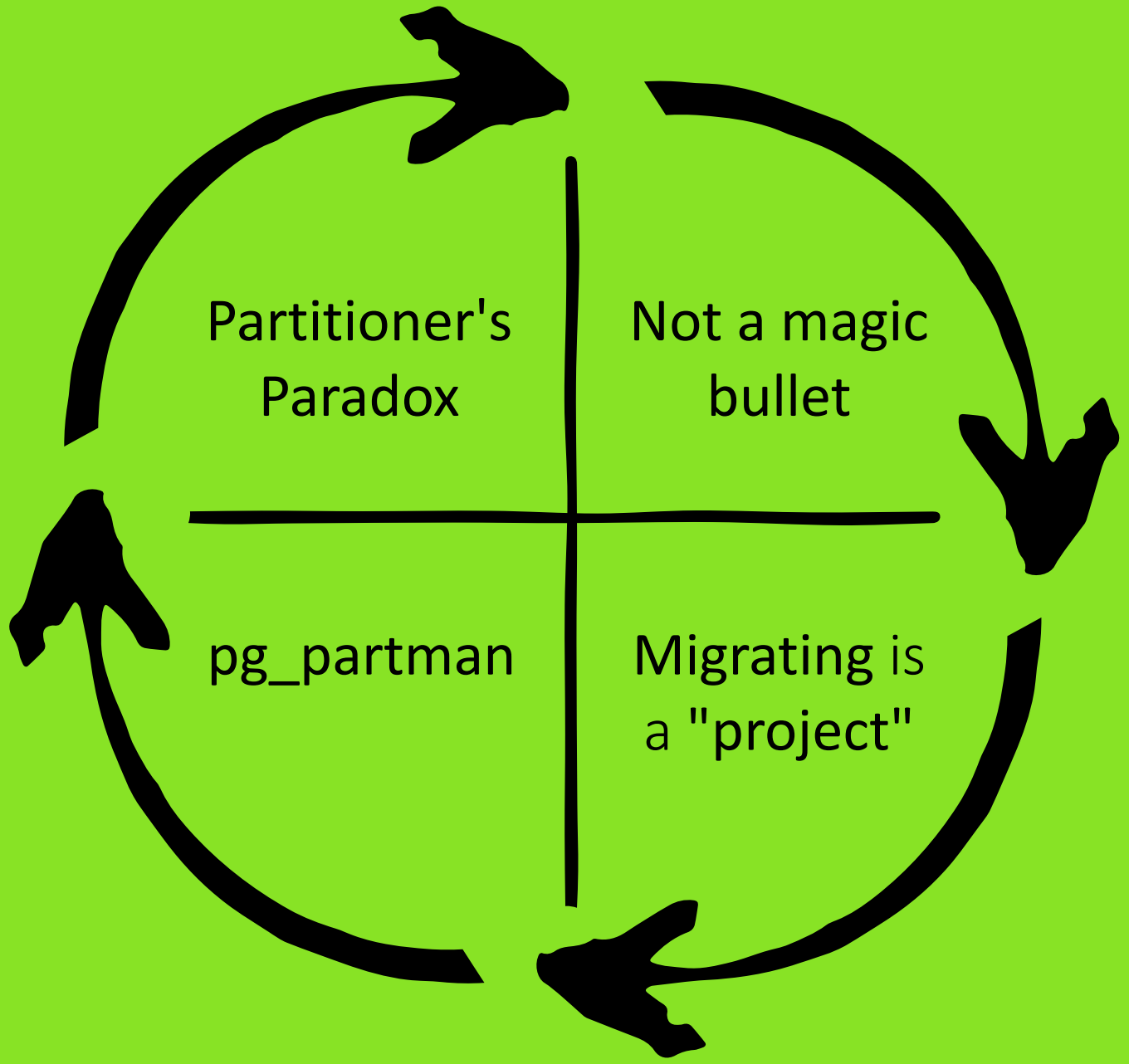
Break into smaller tables

- Queries don't need to know
- Can tune/index partitions individually

Helps with data lifecycle management

- ATTACH PARTITION
- DETACH PARTITION
- Sometimes performance

Partitioning Caveats



Big Table Problem: Wasted Table Space

Column Order affects Padding

Wasted space

Many column issue

Big table solution: Optimize Table Size

Order by size

- Fixed-size, **largest to smallest**
- Variable length or NULLable last

Non-trivial

- (bool, bigint, bool, bigint, bool, bigint) = 72 bytes
- (bigint, bigint, bigint, bool, bool, bool) = 52 bytes
- 30% savings

Caveats

High Transaction Challenges

High Transaction Problems: WAL Generation

Archives single files

Restore can't catch **up with archive**

No breathing room for replay

WAL Size Workarounds

pgBackRest

- Async archive/restore
- Daemon mode

Force restore failure

- Switches to streaming
- Replica catches up

Change WAL segment size

- wal_segment_size

High Transaction Problems: SERIAL limits

4 byte runs out at ~2 million

Running out of SERIAL ids

Solutions

Add `bigints`

How much is affected

- Need to see how much you need to fix

Go with negative ids

- Will get you double the ids

Use bigints for ids

- 8 bytes is big enough for anyone

High Transaction Problems: pgBouncer Limits

100% usage

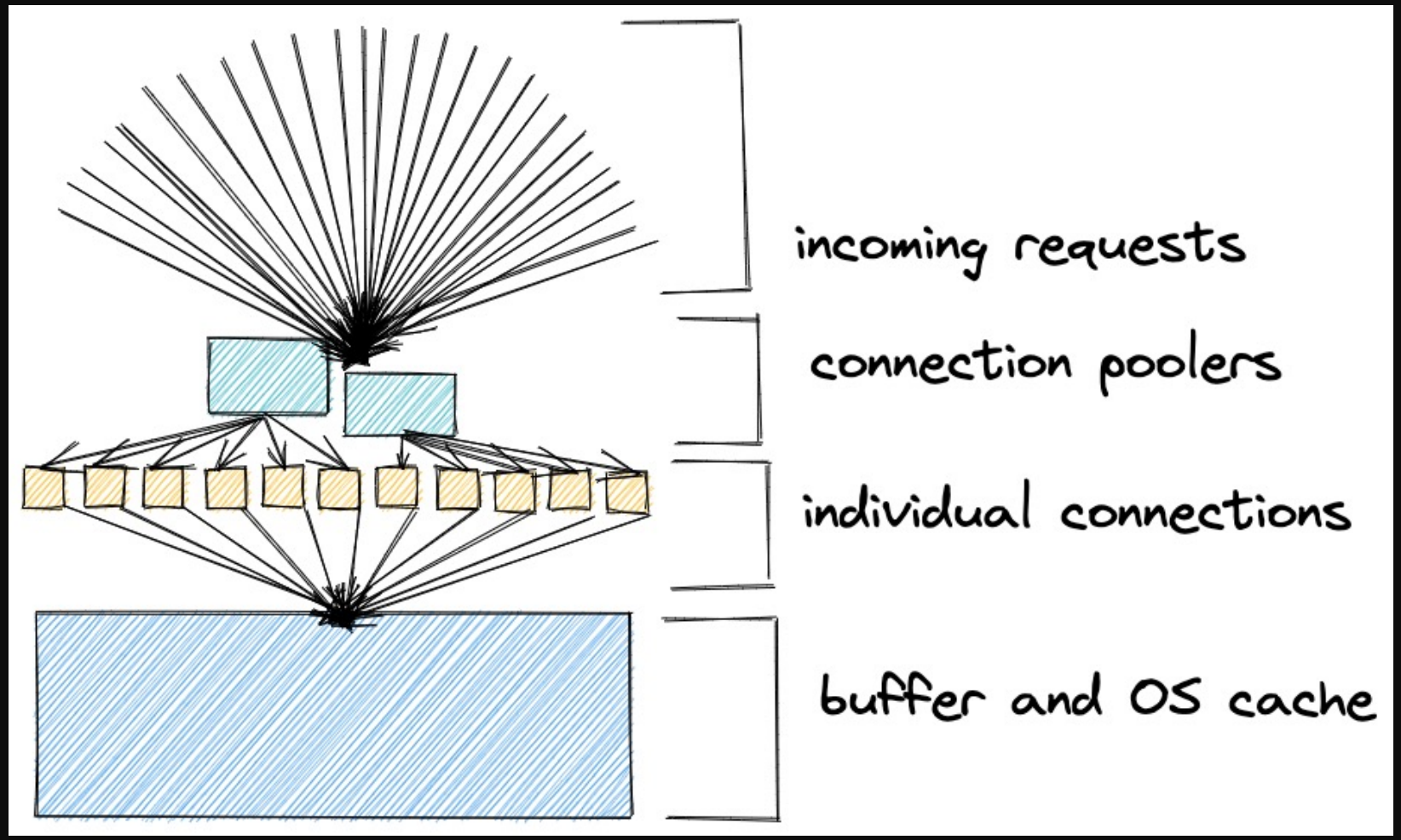
= Bottleneck

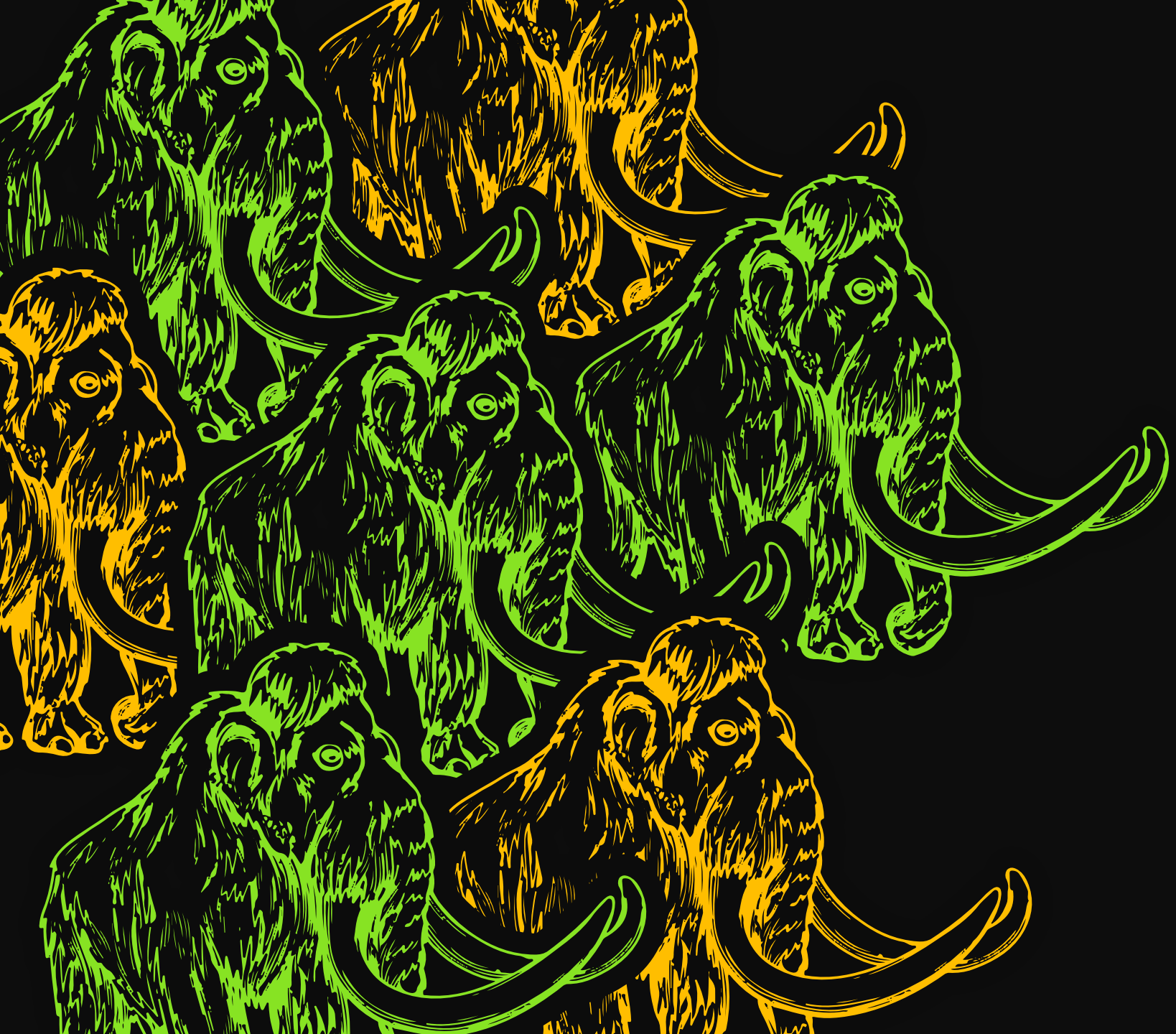
PgBouncer solution: Multi-Bouncer

Use systemd to multiplex

(Semi-)Arbitrary numbers of concurrent PgBouncers

Multi-Bouncer





Read Replica Scaling Challenges

Many Replicas: Why?

- Reduce load on the primary
- Redundancy
- Different purposes:
  - HA
  - Load Balancing fast queries
  - Reporting/Analytics
  - Delayed Standby

Read Replica Problems: Management

Working with replicas at scale

Manual

Inconsistent

Replica Management

Automate tool chains

Managed Postgres + APIs

Centralize Monitoring & Data Collection

Read Replica Problems: Different Query Workloads

Replicas have different needs

Replicas have different performance

Solutions for separate query workloads

Look at each machine

- Can't just look at primary
- Pg_stat_* and pg_statio_* views
- Pg_stat_statements, auto_analyze

Tuning/analysis over time/trending

Central point for information

- Can write back to primary to give stats history
- Third-party services

Read Replica Problems: Lag

Locking can cause lag

Need up to date information

Solutions for lag: tuning

Statement timeouts

Max standby archive delay

Max standby streaming delay

Read Replica Problems: Long running analytics

Logical replication not able to keep up

Queries can impact primary

Solutions for long analytics

Hot_standby_feedback

- =off

Archive only replica

- Not streaming
- Dedicating specific replicas to analytics only

How did we tame the Mastodon?

- Minimize locks
- Be smart about indexing
- Per table vacuum tuning
- Partition if you can
- Update schema to maximize space and reduce padding
- Look at multi pgBouncer
- Planned replicas

Thanks to

Greg Sabino Mullane

Keith Fiske

Samantha Wheatley

crunchydata

Related links

Running Multiple PgBouncers

3 Tips for Large Postgres Databases

Integer Overflow and SERIAL limits