(auto)VACUUM and You.

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The Plan.

- Part I: Intro
- Part II: VACUUM
- Part II: Autovacuum
- Part III: Adjusting autovacuum parameters

Part I: Intro.

My first VACUUM.

- Data ”warehouse”
- Added a bunch of rows daily
- Deleted a bunch of rows daily
- Ooooh, reports!

Uh, why are my queries so slow?

- Did I write some dumb SQL?
- No, I needed VACUUM and ANALYZE

Adding a bunch of rows

- The planner needs fresh statistics to work with
- Adding ”a bunch” of rows can change the distribution of your data
- ...causing a sub-optimal plan.
- ANALYZE fixes this.

Deleting a bunch of rows

- They're not gone, *you just can't see them*.
- They take up space unecessarily.
- Indexes point to all versions of a row.
- VACUUM fixes this.
- UPDATEs, too
- ”Why can't they just call it 'garbage collection' like everybody else does?”

A little MVCC.

- transaction isolation
- allows multiple people to work in the db without @#$%ing things up
- accomplished via xids
  - wraparound is VERY BAD
- data changes result in dead/obsolete rows
  - which hang around, causing problems
  - ...until you VACUUM.

Part II: VACUUM

table stats: pg_stat_user_tables

```
pgbench=# SELECT relname,
n_tup_ins, n_tup_upd, n_tup_del,
n_live_tup, n_dead_tup,
last_vacuum, last_analyze
FROM pg_stat_user_tables
WHERE relname = 'pgbench_accounts';
-[ RECORD 1 ]----+------------------------------
relname          | pgbench_accounts
n_tup_ins        | 100000
n_tup_upd        | 73254
n_tup_del        | 0
n_live_tup       | 100002
n_dead_tup       | 4710
last_vacuum      |
last_analyze     | 2014-02-17 20:06:29.900437-08
```

pg_stat_user_tables

- n_tup_* = incrementing counters
- n_live_tup = this is a guess :)
- n_dead_tup = reset by a vacuum.
- last_* fields = last manual/auto vac/analyze
- combine with \watch (9.3) for additional fun

table stats: pgstattuple

- contrib module
  - 9.3: CREATE EXTENSION pgstattuple;
- one-stop shopping!

```
pgbench=# SELECT tuple_count, tuple_percent,
dead_tuple_count, dead_tuple_percent
FROM pgstattuple('pgbench_accounts');
-[ RECORD 1 ]------+--------
tuple_count        | 100000
tuple_percent      | 91.06
dead_tuple_count   | 1592
dead_tuple_percent | 1.45
```

planner stats: pg_class

```
pgbench=# SELECT relname, reltuples
FROM pg_class
WHERE relname = 'pgbench_accounts';
-[ RECORD 1 ]----------------
relname   | pgbench_accounts
reltuples | 100002
```

more planner stats: pg_stats

```
pgbench=# SELECT tablename, attname,
most_common_vals
FROM pg_stats
WHERE tablename = 'pgbench_tellers';

    tablename     | attname  | most_common_vals
------------------+----------+--------------------
 pgbench_tellers | tid      |
 pgbench_tellers | tbalance | {-20716,-5820}
 pgbench_tellers | filler   |
 pgbench_tellers | bid      | {1,2,3,4,5,…98,99,100}
```

VACUUM (the manual kind)

- VACUUM
- VACUUM FULL
- VACUUM FREEZE
- VACUUM ANALYZE
- must be table owner or superuser

VACUUM

- removes dead rows
  - cleans up your indexes
- updates your xids
- (hint bits)
- SHARE UPDATE EXCLUSIVE lock

VACUUM FULL

- frees up actual disk space
- ACCESS EXCLUSIVE lock
  - ...and it's rewriting the table on disk, so you need double the space.
- don't bother if the table's just going to refill.

VACUUM FREEZE

- sets a special xid value: relFrozenXid
  - prevent xid wraparound
- ACCESS EXCLUSIVE lock
- recommended after very large loads to tables that will see a lot of OLTP

VACUUM ANALYZE

- updates the planner statistics
- SHARE UPDATE EXCLUSIVE
- ANALYZE is actually its own separate thing you can run by itself!

VACUUM VERBOSE

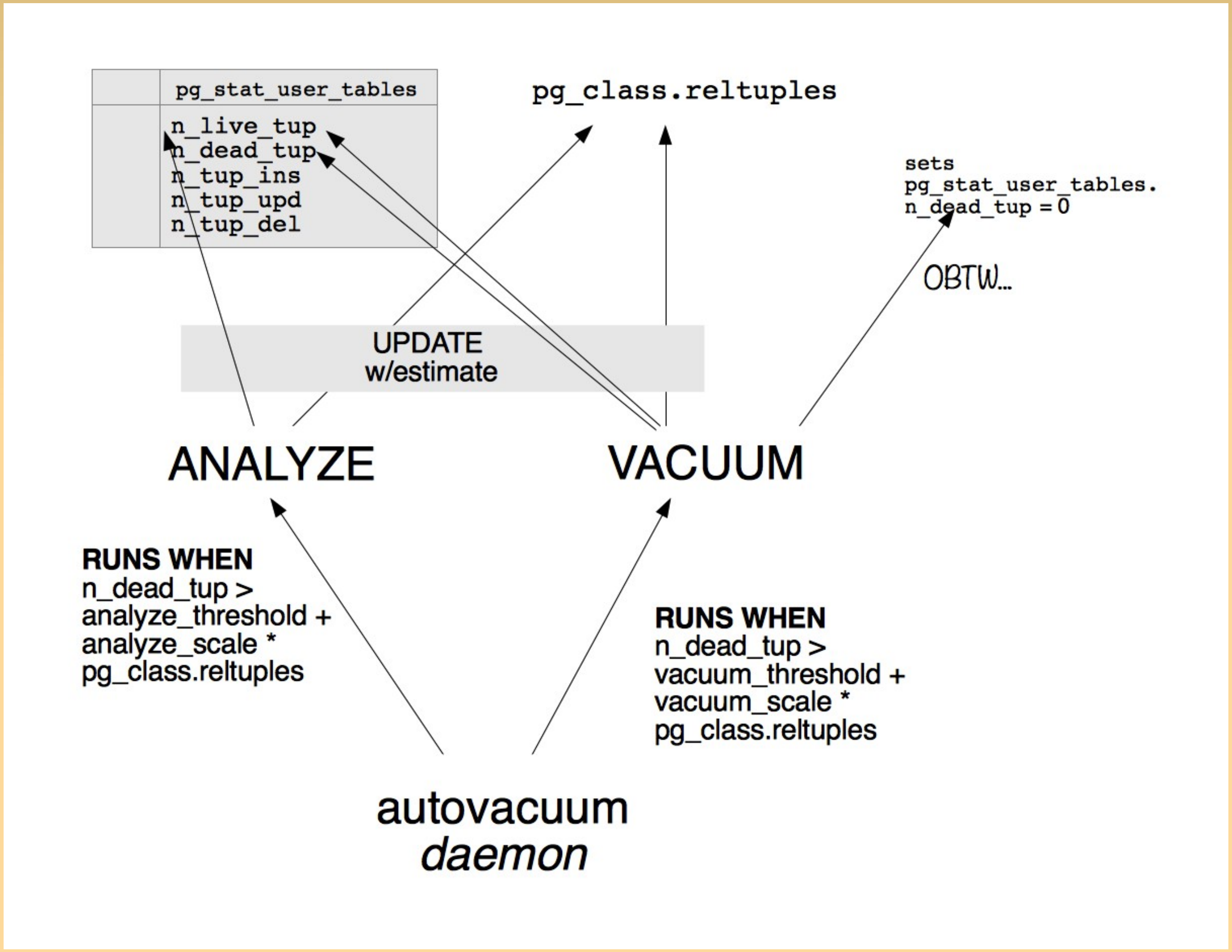
```
pgbench=# vacuum verbose pgbench_branches;
INFO:  vacuuming "public.pgbench_branches"
INFO:  index "pgbench_branches_pkey" now contains 1 row
versions in 2 pages
DETAIL:  0 index row versions were removed.
0 index pages have been deleted, 0 are currently reusable.
CPU 0.00s/0.00u sec elapsed 0.00 sec.
INFO:  "pgbench_branches": found 166 removable, 1
nonremovable row versions in 1 out of 1 pages
DETAIL:  0 dead row versions cannot be removed yet.
There were 203 unused item pointers.
0 pages are entirely empty.
CPU 0.00s/0.00u sec elapsed 0.00 sec.
```

ANALYZE VERBOSE

```
pgbench=# analyze verbose;
INFO:  analyzing "public.pgbench_branches"
INFO:  "pgbench_branches": scanned 1 of 1 pages, containing 1 live rows and 166 dead rows; 1 rows in sample, 1 estimated total rows
```

Part III: autovacuum

How this is supposed to work.



My table isn't being vacuumed!
(dramatization)

```
SELECT relname, n_live_tup, n_dead_tup,
last_autovacuum, last_autoanalyze
FROM pg_stat_user_tables
WHERE relname = 'pgbench_accounts';
```

```
-[ RECORD 1 ]----+-------------------
relname          | pgbench_accounts
n_live_tup       | 1000000
n_dead_tup       | 9499
last_autovacuum  |
last_autoanalyze |
```

Is autovacuum even running?

- ps -ef | grep vacuum
- `postgres 1101 972 0 06:37 ? 00:00:33 postgres: autovacuum launcher process`
- in postgresql.conf:

```
autovacuum = on #default
track_counts = true #default
```

- psql shell:

```
pgbench=# SELECT name, setting || unit AS setting FROM pg_settings
WHERE category = 'Autovacuum';
pgbench=# SHOW autovacuum;
```

autovacuum: do the math.

- in postgresql.conf:

```
#autovacuum_vacuum_threshold = 50
   # min number of row updates before vacuum
#autovacuum_vacuum_scale_factor = 0.2
   # fraction of table size before vacuum
```

autovacuum: do the math.

- in postgresql.conf:

```
#autovacuum_vacuum_threshold = 50
   # min number of row updates before vacuum
#autovacuum_vacuum_scale_factor = 0.2
   # fraction of table size before vacuum
```

- vacuum threshold = autovacuum_vacuum_threshold + autovacuum_vacuum_scale_factor * pgclass.reltuples
- 1000 row table = 50 + (0.2 * 1000) = 250
- 1,000,000 row table = 50 + (0.2 * 1000000) = 200,050
- 9500 dead tuples is not even close

lather, rinse, repeat

- in postgresql.conf:

```
#autovacuum_analyze_threshold = 50
   # min number of row updates before analyze
#autovacuum_analyze_scale_factor = 0.1
   # fraction of table size before analyze
```

- analyze threshold = autovacuum_analyze_threshold + autovacuum_anayze_scale_factor * pgclass.reltuples
- 1000 row table = 50 + (0.1 * 1000) = 150
- 1,000,000 row table = 50 + (0.1 * 1000000) = 100,050

Caveats!

- You still need to manually:
  - VACUUM [FREEZE] ANALYZE after a large load.
  - ANALYZE temp tables.
- THIS JUST IN:
  - apply the latest update! Has a fix for potential data corruption if you have frequent xid wrap.
  - Also some new tuning params I haven't tried yet :)

Part IV: Adjusting autovacuum parameters

GUCs

- 6 of 'em:
  - autovacuum_vacuum_threshold
  - autovacuum_vacuum_scale_factor
  - autovacuum_max_workers
  - autovacuum_nap_time
  - autovacuum_cost_limit
  - autovacuum_cost_delay
- + autovacuum_analyze_threshold and scale_factor

Before we begin...

- have a backup!
- have metrics!
- change ONE thing at a time: measure, change, remeasure, repeat.
- make use of 'include' in postgresql.conf

My picks

- CPU, mem, I/O, connections, locks, long queries, vac jobs, …
- from the Pg activity log:
  - log_line_prefix in a pgbadger-compatible format

    ```
    %t [%p]: [%l-1]
    ```
  - log_min_duration_statement = [YMMV]
  - log_autovacuum_min_duration = [YMMV]
  - log_lock_waits = on
- collect table stats JFK
- \watch!

sample log message from autovacuum

- `log_autovacuum_min_duration = 0`

-
  ```
  %LOG:  automatic vacuum of table
  "ttrss.public.ttrss_feedbrowser_cache": index scans: 1
  pages: 0 removed, 11 remain
  tuples: 303 removed, 303 remain
  buffer usage: 82 hits, 0 misses, 10 dirtied
  avg read rate: 0.000 MB/s, avg write rate: 3.585 MB/s
  system usage: CPU 0.00s/0.00u sec elapsed 0.02 sec
  ```

-
  ```
  %LOG:  automatic analyze of table
  "ttrss.public.ttrss_feedbrowser_cache" system usage: CPU
  0.00s/0.00u sec elapsed 0.03 sec
  ```

GUCs: when will vac happen

```
#autovacuum_vacuum_threshold = 50
    # min number of row updates before vacuum

#autovacuum_vacuum_scale_factor = 0.2
    # fraction of table size before vacuum
```

```
    live_tup   |  50 th, 0.2 sf  +|  5k th, 0.2 sf    |  50 th, 0.02 sf
               |    (default)     |                   |
  -------------+------------------+-------------------+-------------------
          1,000 |              250 |             5,200 |                 70
         10,000 |            2,050 |             7,000 |                250
        100,000 |           20,050 |            25,000 |              2,050
      1,000,000 |          200,050 |           205,000 |             20,050
     10,000,000 |        2,000,050 |         2,005,000 |            200,050
    100,000,000 |       20,000,050 |        20,005,000 |          2,000,050
  1,000,000,000 |      200,000,050 |       200,005,000 |         20,000,050
```

GUCs: how many tables can be vacced at ~ the same time

- #autovacuum_max_workers = 3

  # max number of autovacuum subprocesses
  - **requires a restart**
- #autovacuum_naptime = 1min

  # time between autovacuum runs
- These are per-cluster.
- Be mindful of maintenance_work_mem:

  av_max_workers * maint_work_mem < memory

GUCs: how fast can I make this thing go

- #autovacuum_vacuum_cost_limit = -1
  # default vacuum cost limit for autovacuum,

  # -1 means use vacuum_cost_limit (default: 200 ”credits”)
- #autovacuum_vacuum_cost_delay = 20ms
  # default vacuum cost delay for autovacuum, in milliseconds;
  # -1 means use vacuum_cost_delay (default: 0ms)
- speed this up by:
  - increasing cost_limit to some value in the hundreds, or (and?)
  - setting cost_delay to 0

An unfriendly reminder.

- All 6 of these GUCs that we just looked at* interact together.
- If your table changes size dramatically, you will likely need to readjust these settings.
- You still need to manually:
  - VACUUM [FREEZE] ANALYZE after a large load.
  - ANALYZE temp tables.
- ISN'T THIS FUN.

*and some others that outside the scope of this talk

per-table adjustment

- can't do this with naptime or max_workers
- `CREATE TABLE mytable (blahblah) WITH (autovacuum_vacuum_threshold = 2000);`
- `ALTER TABLE mytable SET (autovacuum_vacuum_threshold = 2000);`
- view with \d+:

  Options: autovacuum_vacuum_threshold=2000
- `-- reset to value from postgresql.conf!`

  `ALTER TABLE mytable RESET (autovacuum_vacuum_threshold);`

Epilogue.

OH !#@*&(%!!! (reenactment)

```
pgbench=# SELECT relname,
n_tup_ins AS ins, n_tup_upd AS upd, n_tup_del AS del,
n_live_tup AS live, n_dead_tup AS dead,
last_autovacuum AS l_aa, last_autoanalyze AS l_av
FROM pg_stat_user_tables;

     relname      | ins | upd | del | live | dead | l_aa | l_av
------------------+-----+-----+-----+------+------+------+------
 pgbench_branches |   0 |   0 |   0 |    0 |    0 |      |
 pgbench_tellers  |   0 |   0 |   0 |    0 |    0 |      |
 pgbench_history  |   0 |   0 |   0 |    0 |    0 |      |
 pgbench_accounts |   0 |   0 |   0 |    0 |    0 |      |
(4 rows)
```

streaming rep + vacuum

- table stats don't get replicated
- planner stats do, but we can't see those
- You can't run a VACUUM on the standby:

```
postgres=# vacuum mytable;
 ERROR:  cannot execute VACUUM during recovery
```

- vacuum jobs are WAL logged

Wishlist

- An easier way to see what's being vacuumed & the progress thereof
  - combo of ps & looking at the locks table hoping to catch something going by
- A way to view the vacuum queue & see WHO'S NEXT.

Help! (and further reading)

- Pg docs + -admin + Pg wiki
- xid wraparound:

  https://devcenter.heroku.com/articles/postgresql-concurrency
- Josh B's ”Freezing Your Tuples Off” series
- https://wiki.postgresql.org/wiki/VacuumHeadaches
- http://rhaas.blogspot.com/2011/03/troubleshooting-stuck-vacuums.html

Thank you!