PERCONALIVE

Cleaning the Room Everything You Need To Know About Vacuum

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Who am I?

I’m Charly Batista :)

- PostgreSQL Tech Leader @ Percona
- Database lover
- Working with IT for over 20 years
- Craft beer and coffee lover
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Agenda

MVCC

- What are and why do we need transactions?
- MVCC, what exactly is it?
- MVCC on Postgres

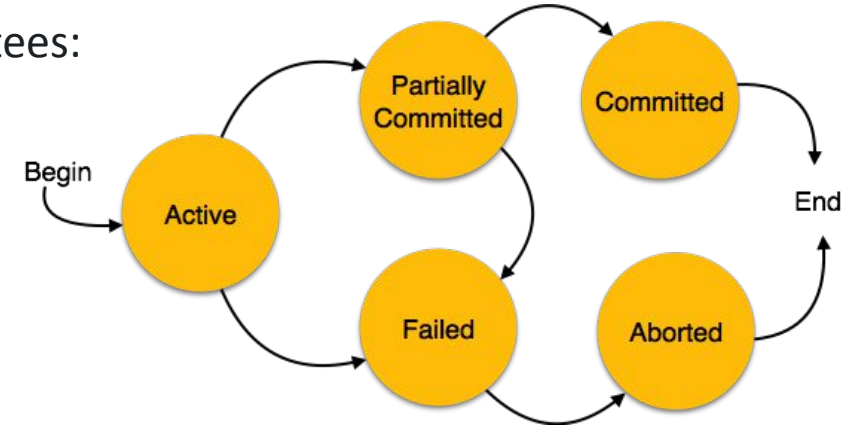
Vacuum and Autovacuum

- What is vacuum?
- How about autovacuum?
- Settings and tuning

MVCC

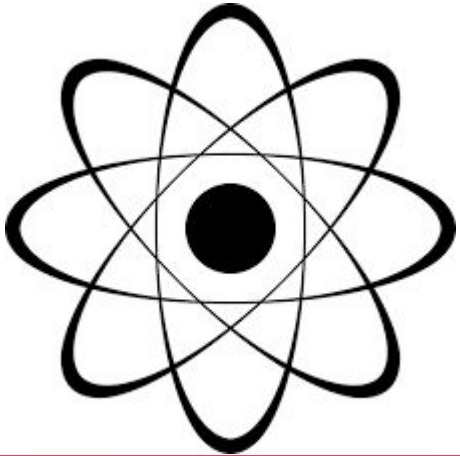
What are transactions?

- A transaction is a logical, atomic unit of work that contains one or more SQL
- Transaction are all about guarantees:
  - Atomicity
  - Consistency
  - Isolation
  - Durability



Atomicity

- An atomic transaction is an indivisible and irreducible series of database operations such that either all occur, or nothing occurs:
  - Indivisible
  - All or nothing



Atomicity

- Example bank transfer
  - John transfers $100 to Alice
    - *Withdraw $100 from John's bank account*
    - *Deposit $100 into Alice's bank account*

Consistency

- A transaction must keep the database in a valid state:
  - Any transactions started in the future necessarily see the effects of other transactions committed in the past
  - Database constraints are not violated, particularly once a transaction commits
  - Operations in transactions are performed accurately, correctly, and with validity, with respect to application semantics

Isolation

- Determines how transaction integrity is visible to other users
- Makes the transaction think it is the only transaction working inside the database
- Ideally prevent race conditions
- Also help prevent anomalies like dirty read, phantom read, etc

Isolation

- There are different levels of isolation
  - Read Uncommitted
  - Read Committed
  - Repeatable Read
  - Serializable
- Postgres default transaction isolation = 'read committed'

Durability

- Committed transactions can not be rolled back
- Committed transactions must survive

How about MVCC?

- Multiversion concurrency control
- Concurrency control method commonly used by databases
- Optimistic - means no locking
  - Readers and Writers do not block each other
- First perform changes in a protected area then change the database state
- Main idea: Version your database (Multiversion :-D)

MVCC on Postgres

MVCC on Postgres

- Read uncommitted not really implemented on Postgres
- No Rollback segments for UNDO
  - UNDO management is within tables
- Rows are never really deleted
- A tuple contains the hidden columns to help managing transactions
  - xmin, xmax, cmin, cmax, …

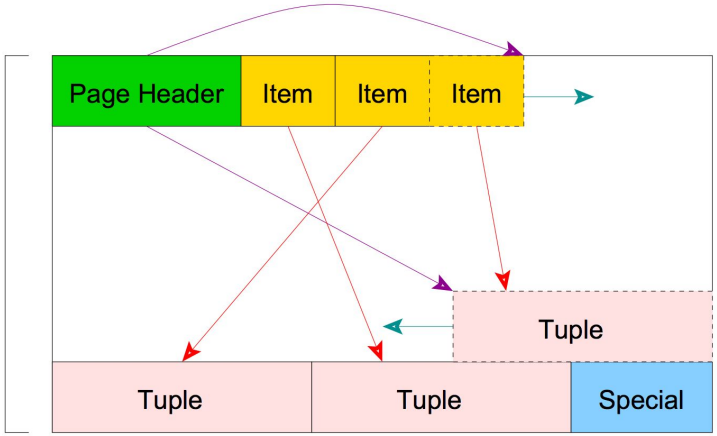
MVCC on Postgres

- Transaction identifiers (xid or transaction IDs) are 32-bit unsigned integer
- ID's 0, 1 and 2 are reserved.
- Can be inspected, for example "`select xmin, xmax, cmin, cmax, a from tb1;`"

Vacuum

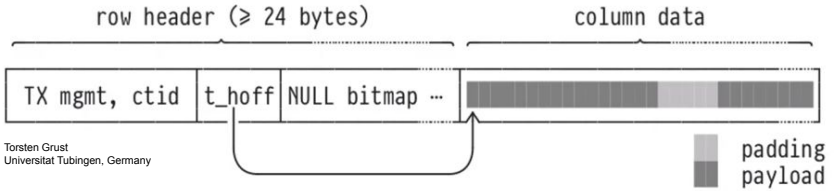
A short pick into a Postgres data file

- A Postgres data file is divided into 8kb pages
- A page has:
  - A 24 bytes header
  - Line pointers (pointer to the data tuple)
  - The data tuple itself
  - A special are in the end of the page



A short pick into a Postgres data file

- The data tuple is where the data lives
- A tuple has:
  - A 24+ bytes header
  - The payloader (data)
  - Padding



Torsten Grust
Universitat Tubingen, Germany

A short pick into a Postgres data file

- The tuple header has information important to us today:
  - t_xmin
  - t_xmax
  - t_infomask
  - t_infomask2

Field	Type	Length	Description
t_xmin	TransactionId	4 bytes	insert XID stamp
t_xmax	TransactionId	4 bytes	delete XID stamp
t_cid	CommandId	4 bytes	insert and/or delete CID stamp (overlays with t_xvac)
t_xvac	TransactionId	4 bytes	XID for VACUUM operation moving a row version
t_ctid	ItemPointerData	6 bytes	current TID of this or newer row version
t_infomask2	uint16	2 bytes	number of attributes, plus various flag bits
t_infomask	uint16	2 bytes	various flag bits
t_hoff	uint8	1 byte	offset to user data

What are the problems we need to solve?

- Postgres doesn’t have undo logs
  - Everything goes to the data files!
- Postgres doesn’t physically remove rows on delete
  - No matter how many rows you remove, the file doesn’t shrink!
- Postgres doesn’t do inplace update but a “delete + insert”
  - Every update duplicate the row and leave the garbage behind!

What are the problems we need to solve?

- Postgres optimizer uses table/index statistics
  - They are not updated after every transaction, too expensive!
  - If the transaction doesn’t update, who update the statistics?
- Postgres uses a 32 bits (4 bytes) transaction identifier
  - It is finite and relatively small, you’ll eventually run out of XID!
  - It can wraparound. Ok, will start from zero again, then what?

Vacuum to rescue

- **VACUUM** — garbage-collect and optionally analyze a database
- Here we'll talk about 4 major variations of vacuum on Postgres:
  - Full
  - Freeze
  - Vacuum
  - Autovacuum

Vacuum to rescue

- **Only rows that are not in any currently running transactions can be vacuumed**
  - It means that long running transactions can prevent dead rows to be removed;
  - Long running transactions can prevent vacuum to freeze old transaction IDs;

Vacuum to rescue

- How does it work?

Live demo time!!!

Autovacuum

- We are here to talk about **vacuum**, not autovacuum, but…
- **Always have the parameter autovacuum set to ON**
- Background Process that tracks the usage and activity information;
- We cannot really control when it runs;
- PostgreSQL identifies the tables needing vacuum or analyze depending on certain parameters, for example threshold and scale factor;

Autovacuum

- Setting global parameters alone may not be appropriate, all the time.
- Regardless of the table size, if the condition for autovacuum is reached, a table is eligible for autovacuum vacuum or analyze.
  - Consider 2 tables with ten records and a million records.
  - Frequency at which a vacuum or an analyze runs automatically could be greater for the table with just ten records.

Autovacuum

- Use table level autovacuum settings instead.
- ALTER TABLE foo.bar SET (autovacuum_vacuum_scale_factor = 0, autovacuum_vacuum_threshold = 100);

- Autovacuum reads block_size pages of a table from disk (default of 8KB), and modifies/writes to the pages containing dead tuples;
- Involves both read and write IO and may be heavy on big tables with huge amount of dead tuples;

Vacuum

Congratulations, we made it to the end!!!

- If we need to learn one thing from this presentation is:
  NEVER DISABLE YOUR AUTOVACUUM
- Transactions are not free, don’t let a transaction open for a long time;
- Transaction IDs are not unlimited, make sure your autovacuum is able to freeze them;
- Vacuum is able to prevent bloating to increase but not able to pack the table;

Congratulations, we made it to the end!!!

- Vacuum FULL is the only one able to return disk space back, but it locks the table;
- Sometimes we need to have per-table autovacuum configuration;
- Again, NEVER DISABLE YOUR AUTOVACUUM. If it’s causing problems is because you didn’t understand how it works and you may need to make it more aggressive!!!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