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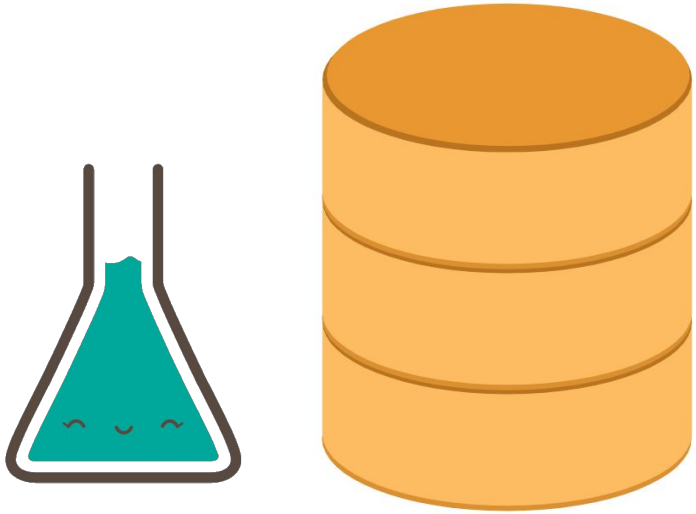


ACID

Atomicity, Consistency, Isolation and Durability in Relational Database Systems

Agenda

- What is a Transaction?
- Atomicity
- Isolation
- Consistency
- Durability

Transaction

- A collection of queries
- One unit of work
- E.g. Account deposit (SELECT, UPDATE, UPDATE)

Transaction

ACCOUNT_ID	BALANCE
1	$900
2	$600

Send $100 From Account 1 to Account 2

BEGIN TX1

SELECT BALANCE **FROM** ACCOUNT **WHERE** ID = 1

BALANCE > 100

UPDATE ACCOUNT **SET** BALANCE **=** BALANCE - 100 **WHERE** ID = 1

UPDATE ACCOUNT **SET** BALANCE **=** BALANCE + 100 **WHERE** ID = 2

COMMIT TX1

Atomicity

- All queries must succeed. If one fails all should rollback.

A problem has been detect and Windows has been shut down to prevent damage
to your computer.

THREAD_STUCK_IN_DEVICE_DRIVER

If this is the first time you've seen this Stop error screen,
restart your computer. If this screen appears again, follow these steps:

Check to make sure any new hardware or software is properly installed.
If this is a new installation, ask your hardware or software manufacturer
for any Windows updates you might need.

If problems continue, disable or remove any newly installed hardware
or software. Disable BIOS memory options such as caching or shadowing.
If you need to use Safe Mode to remove or disable components, restar
your computer, press F8 to select Advanced Startup options, and then
select Safe Mode.

Technical information:

*** STOP: 0x000000EA (0x00000000, 0x00000000)

Atomicity

ACCOUNT_ID	BALANCE
1	$900
2	$500

- After we restarted the machine the account has been debited but the other account has not been credited.
- An atomic transaction is a transaction that will rollback all queries if one of the queries failed.

Isolation

- Can my inflight transaction see changes made by other transactions?
- Read phenomena
- Isolation Levels

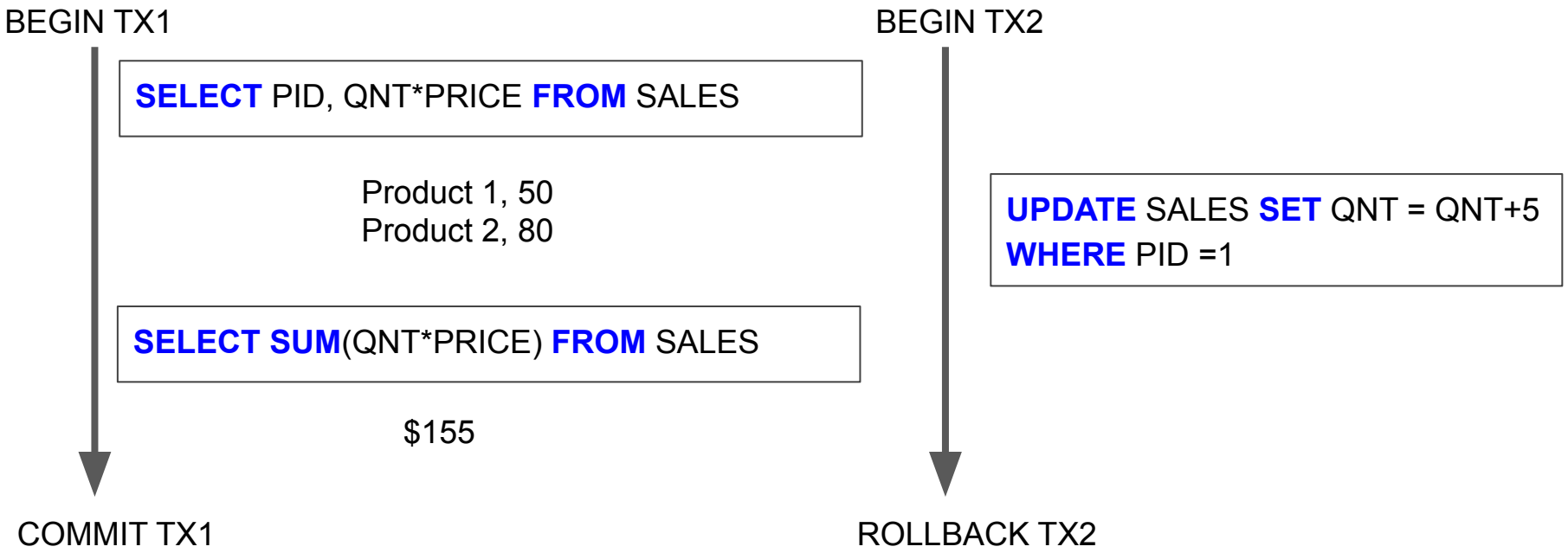
Isolation - Read phenomena

- Dirty reads
- Non-repeatable reads
- Phantom reads
- (Lost updates)

Dirty Reads

SALES

PID	QNT	PRICE
Product 1	10	$5
Product 2	20	$4



Non-repeatable read

SALES

PID	QNT	PRICE
Product 1	**15**	$5
Product 2	20	$4

BEGIN TX1

SELECT PID, QNT*PRICE **FROM** SALES

Product 1, 50
Product 2, 80

BEGIN TX2

UPDATE SALES **SET** QNT = QNT+5
WHERE PID =1

COMMIT TX2

SELECT SUM(QNT*PRICE) **FROM** SALES

$155

COMMIT TX1

Phantom read

SALES

PID	QNT	PRICE
Product 1	10	$5
Product 2	20	$4
Product 3	10	$1

BEGIN TX1

SELECT PID, QNT*PRICE **FROM** SALES

Product 1, 50
Product 2, 80

BEGIN TX2

INSERT INTO SALES
VALUES (‘Product 3’, 10, 1)

COMMIT TX2

SELECT SUM(QNT*PRICE) **FROM** SALES

$140

COMMIT TX1

Isolation - Isolation Levels for inflight transaction

- **Read uncommitted**
  - No Isolation, any change from the outside is visible to the transaction
- **Read committed**
  - Each query in a transaction only sees committed stuff
- **Repeatable Read**
  - Each query in a transaction only sees committed updates at the beginning of transaction
- **Serializable**
  - Transactions are serialized.

Isolation Levels vs read phenomena

Isolation levels vs read phenomena [edit]

Isolation level	Dirty reads	Lost updates	Non-repeatable reads	Phantoms
Read Uncommitted	may occur	may occur	may occur	may occur
Read Committed	don't occur	may occur	may occur	may occur
Repeatable Read	don't occur	don't occur	don't occur	may occur
Serializable	don't occur	don't occur	don't occur	don't occur

https://en.wikipedia.org/wiki/Isolation_(database_systems)

Consistency

- Consistency in Data
- Consistency in reads

Consistency in Data

- Defined by the user
- Referential integrity (foreign keys)
- Atomicity
- Isolation

Consistency in Data

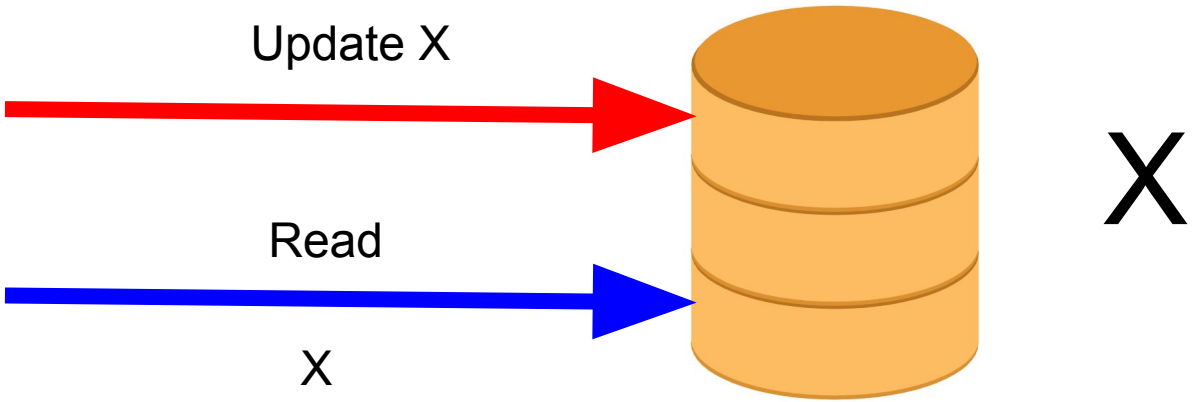
Pictures

ID **(PK)**	BLOB	LIKES
1	xx	2
2	xx	1

Picture_Likes

USER **(PK)**	PICTURE_ID **(PK)(FK)**
Jon	1
Edmond	1
Jon	2

Consistency in reads



Consistency in reads

- If a transaction committed a change will a new transaction immediately see the change?
- Relational and NoSQL databases suffer from this
- Eventual consistency

Durability

- Committed transactions must be persisted in a durable non-volatile storage.

Summary

- What is a Transaction?
- Atomicity
- Isolation
- Consistency
- Durability