Databases - Tutorial 10
Concurrency Control- Transactions

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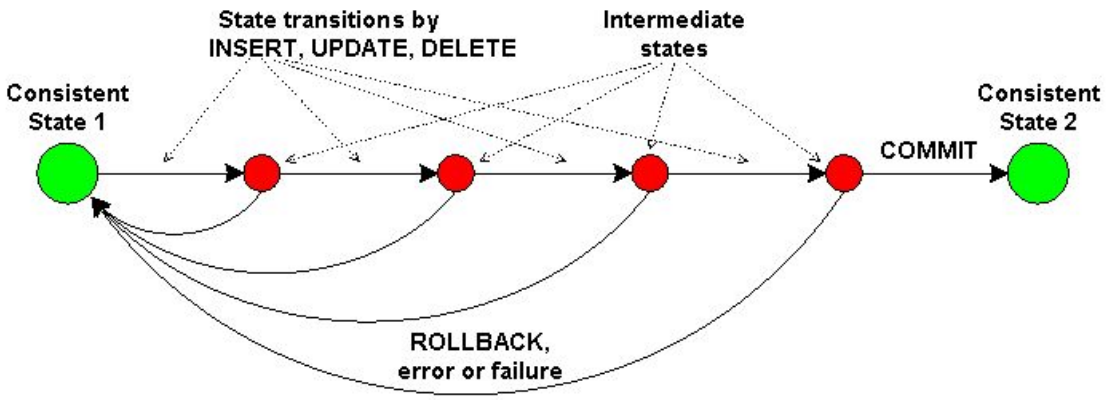
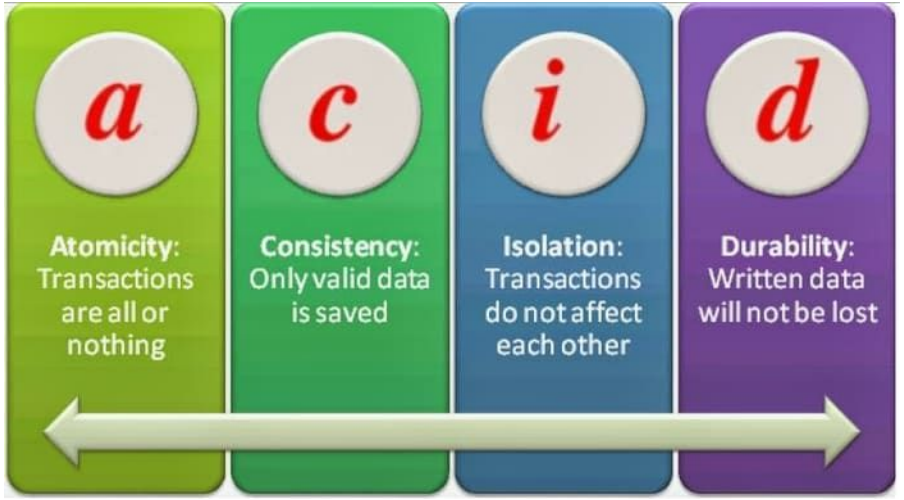
What is a transaction?

- A transaction is a s**et of operations performed by an application that transfers a database from one correct state to another correct state (consistency)**, provided that the transaction is completed **(atomicity)** and without interference from other transactions **(isolation)**.



Transactions

- **Atomicity** − ensures that all operations within the work unit are completed successfully. Otherwise, the transaction is aborted at the point of failure and all the previous operations are rolled back to their former state.
- **Consistency** − ensures that the database properly changes states upon a successfully committed transaction.
- **Isolation** − enables transactions to operate independently of and transparent to each other.
- **Durability** − ensures that the result or effect of a committed transaction persists in case of a system failure.



Read Phenomena

DIRTY READ

A transaction **reads** data written by other concurrent **uncommitted** transaction

NON-REPEATABLE READ

A transaction **reads** the **same row twice** and sees different value because it has been **modified** by other **committed** transaction

PHANTOM READ

A transaction **re-executes** a query to **find rows** that satisfy a condition and sees a **different set** of rows, due to changes by other **committed** transaction

SERIALIZATION ANOMALY

The result of a **group** of concurrent **committed transactions** is **impossible to achieve** if we try to run them **sequentially** in any order without overlapping

Non-repeatable read vs Phantom read

- User A runs the same query twice.
- In between, User B runs a transaction and commits.
- Non-repeatable read: The A row that user A has queried has a different value the second time.
- Phantom read: All the rows in the query have the same value before and after, but **different rows are being selected** (because B has deleted or inserted some).

Transaction T1	Transaction T2
R (A)	
W (A)	
⋮	
	R (A) // Dirty Read
	W (A)
	Commit
Failure	

1. T1 reads the value of A.
2. T1 updates the value of A in the buffer.
3. T2 reads the value of A from the buffer.
4. T2 writes the updated the value of A.
5. T2 commits.
6. T1 fails in later stages and rolls back.

Transaction T1	Transaction T2
R (X)	
	R (X)
W (X)	
	R (X) // Unrepeated Read

1. T1 reads the value of X (= 10 say).
2. T2 reads the value of X (= 10).
3. T1 updates the value of X (from 10 to 15 say) in the buffer.
4. T2 again reads the value of X (but = 15).

Transaction T1	Transaction T2
R (X)	
	R (X)
Delete (X)	
	Read (X)

Phantom Read Problem

1. T1 reads X.
2. T2 reads X.
3. T1 deletes X.
4. T2 tries reading X but does not find it.

4 Standard Isolation Levels

American National Standards Institute - ANSI

Low → High

1. **READ UNCOMMITTED**
   Can see data written by uncommitted transaction
2. **READ COMMITTED**
   Only see data written by committed transaction
3. **REPEATABLE READ**
   Same read query always returns same result
4. **SERIALIZABLE**
   Can achieve same result if execute transactions serially in some order instead of concurrently

Isolation Level	Dirty Read	Nonrepeatable Read	Phantom Read	Serialization Anomaly
Read uncommitted	Allowed, but not in PG	Possible	Possible	Possible
Read committed	Not possible	Possible	Possible	Possible
Repeatable read	Not possible	Not possible	Allowed, but not in PG	Possible
Serializable	Not possible	Not possible	Not possible	Not possible

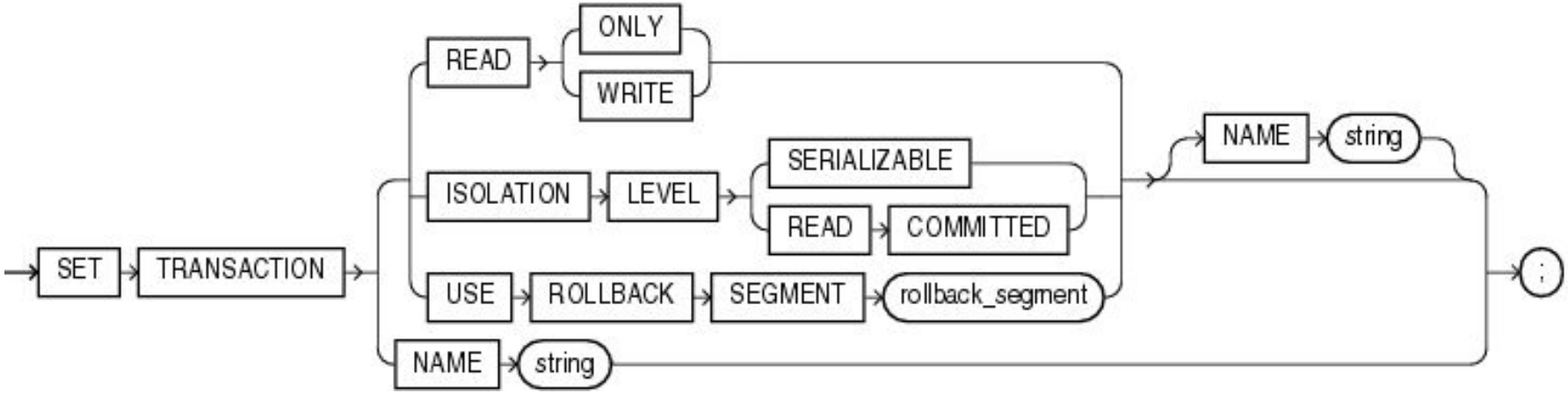
The SQL standard defines one additional level, `READ UNCOMMITTED`. In PostgreSQL `READ UNCOMMITTED` is treated as `READ COMMITTED`

```
ERROR:  could not serialize access due to read/write dependencies among
transactions
```

Read committed vs Repeatable read

Read committed is an isolation level that guarantees that any data read was committed at the moment is read. It simply restricts the reader from seeing any intermediate, uncommitted, 'dirty' read. It makes no promise whatsoever that if the transaction re-issues the read, will find the Same data, data is free to change after it was read.

Repeatable read is a higher isolation level, that in addition to the guarantees of the read committed level, it also guarantees that any data read cannot change, if the transaction reads the same data again, it will find the previously read data in place, unchanged, and available to read.


SET
TRANSACTION
READ
ONLY
WRITE
ISOLATION
LEVEL
SERIALIZABLE
READ
COMMITTED
USE
ROLLBACK
SEGMENT
rollback_segment
NAME
string
NAME
string
;

Transaction Control

The following commands are used to control transactions.

- **COMMIT** − to save the changes.
- **ROLLBACK** − to roll back the changes.
- **SAVEPOINT** − creates points within the groups of transactions in which to ROLLBACK.
- **SET TRANSACTION** − Places a name on a transaction +isolation .

```
SET TRANSACTION transaction_mode [,
...]
SET TRANSACTION SNAPSHOT snapshot_id

ISOLATION LEVEL { SERIALIZABLE |
REPEATABLE READ | READ COMMITTED
| READ UNCOMMITTED }
MODE {READ WRITE | READ ONLY}
```

```
+----+----------+-----+-----------+----------+
| ID | NAME     | AGE | ADDRESS   | SALARY   |
+----+----------+-----+-----------+----------+
|  1 | Ramesh   |  32 | Ahmedabad |  2000.00 |
|  2 | Khilan   |  25 | Delhi     |  1500.00 |
|  3 | kaushik  |  23 | Kota      |  2000.00 |
|  4 | Chaitali |  25 | Mumbai    |  6500.00 |
|  5 | Hardik   |  27 | Bhopal    |  8500.00 |
|  6 | Komal    |  22 | MP        |  4500.00 |
|  7 | Muffy    |  24 | Indore    | 10000.00 |
+----+----------+-----+-----------+----------+
```

```
SQL> DELETE FROM CUSTOMERS
   WHERE AGE = 25;
SQL> COMMIT;
```

```
+----+----------+-----+-----------+----------+
| ID | NAME     | AGE | ADDRESS   | SALARY   |
+----+----------+-----+-----------+----------+
|  1 | Ramesh   |  32 | Ahmedabad |  2000.00 |
|  3 | kaushik  |  23 | Kota      |  2000.00 |
|  5 | Hardik   |  27 | Bhopal    |  8500.00 |
|  6 | Komal    |  22 | MP        |  4500.00 |
|  7 | Muffy    |  24 | Indore    | 10000.00 |
+----+----------+-----+-----------+----------+
```

```
SQL> DELETE FROM CUSTOMERS
   WHERE AGE = 25;
SQL> ROLLBACK;
```

```
+----+----------+-----+-----------+----------+
| ID | NAME     | AGE | ADDRESS   | SALARY   |
+----+----------+-----+-----------+----------+
|  1 | Ramesh   |  32 | Ahmedabad |  2000.00 |
|  2 | Khilan   |  25 | Delhi     |  1500.00 |
|  3 | kaushik  |  23 | Kota      |  2000.00 |
|  4 | Chaitali |  25 | Mumbai    |  6500.00 |
|  5 | Hardik   |  27 | Bhopal    |  8500.00 |
|  6 | Komal    |  22 | MP        |  4500.00 |
|  7 | Muffy    |  24 | Indore    | 10000.00 |
+----+----------+-----+-----------+----------+
```

```
+----+----------+-----+-----------+----------+
| ID | NAME     | AGE | ADDRESS   | SALARY   |
+----+----------+-----+-----------+----------+
|  1 | Ramesh   |  32 | Ahmedabad |  2000.00 |
|  2 | Khilan   |  25 | Delhi     |  1500.00 |
|  3 | kaushik  |  23 | Kota      |  2000.00 |
|  4 | Chaitali |  25 | Mumbai    |  6500.00 |
|  5 | Hardik   |  27 | Bhopal    |  8500.00 |
|  6 | Komal    |  22 | MP        |  4500.00 |
|  7 | Muffy    |  24 | Indore    | 10000.00 |
+----+----------+-----+-----------+----------+
```

```
SQL> SAVEPOINT SP1;
Savepoint created.
SQL> DELETE FROM CUSTOMERS WHERE ID=1;
1 row deleted.
SQL> SAVEPOINT SP2;
Savepoint created.
SQL> DELETE FROM CUSTOMERS WHERE ID=2;
1 row deleted.
SQL> SAVEPOINT SP3;
Savepoint created.
SQL> DELETE FROM CUSTOMERS WHERE ID=3;
1 row deleted.
```

```
SQL> ROLLBACK TO SP2;
Rollback complete.
```

```
SQL> SELECT * FROM CUSTOMERS;
+----+----------+-----+-----------+----------+
| ID | NAME     | AGE | ADDRESS   | SALARY   |
+----+----------+-----+-----------+----------+
|  2 | Khilan   |  25 | Delhi     |  1500.00 |
|  3 | kaushik  |  23 | Kota      |  2000.00 |
|  4 | Chaitali |  25 | Mumbai    |  6500.00 |
|  5 | Hardik   |  27 | Bhopal    |  8500.00 |
|  6 | Komal    |  22 | MP        |  4500.00 |
|  7 | Muffy    |  24 | Indore    | 10000.00 |
+----+----------+-----+-----------+----------+
6 rows selected.
```

Session 1

```
postgres=# BEGIN TRANSACTION ISOLATION LEVEL REPEATABLE READ;
BEGIN
postgres=# SELECT pg_export_snapshot();
 pg_export_snapshot
---------------------
 00000003-0000000F-1
(1 row)

postgres=# select * from t1 where id=897;
 id | name
----+------
(0 rows)
```

Session 2

```
postgres=# select * from t1 where id=897;
 id | name
----+------
(0 rows)

postgres=# insert into t1 values(897, 'test');
INSERT 0 1
postgres=# select * from t1 where id=897;
 id  | name
-----+------
 897 | test
(1 row)
```

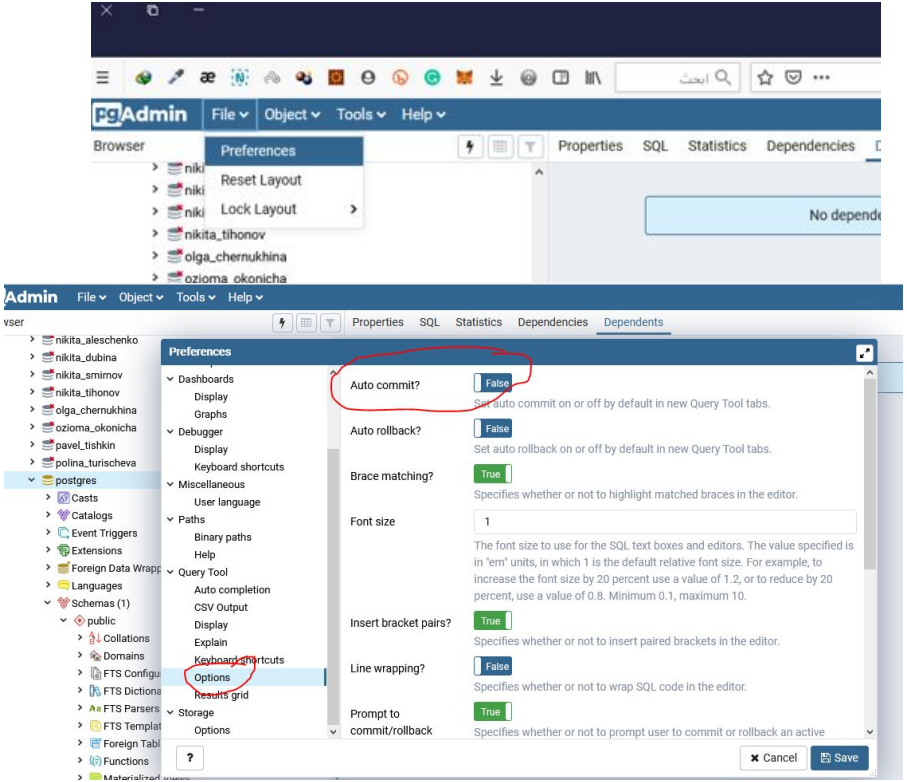
Session 3

```
postgres=#
postgres=# select * from t1 where id=897;
 id  | name
-----+------
 897 | test
(1 row)

postgres=#  BEGIN TRANSACTION ISOLATION LEVEL REPEATABLE READ;
BEGIN
postgres=# SET TRANSACTION SNAPSHOT '00000003-0000000F-1';
SET
postgres=# select * from t1 where id=897;
 id | name
----+------
(0 rows)
```

How to deactivate auto commit in pgAdmin?

- File□ preference
- Query tool □ Options □ Auto commit (False)



Useful Links

- https://www.tutorialspoint.com/sql/sql-transactions.htm
- https://habr.com/en/company/postgrespro/blog/467437/
- https://www.gatevidyalay.com/concurrency-problems-in-transaction/
- https://www.postgresqltutorial.com/postgresql-show-tables/
- https://www.enterprisedb.com/postgres-tutorials/how-work-postgresql-transactions
- https://developpaper.com/postgresql-set-transaction-snapshot/