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Normalization

- Problem:
  - Data redundancy

rollno	name	Branch	hod	office_tel
401	Akon	CSE	Mr. X	53337
402	Bkon	CSE	Mr. X	53337
403	Ckon	CSE	Mr. X	53337
404	Dkon	CSE	Mr. X	53337

  - Branch, HOD and Office_Tel is repeated

Insertion Anomaly

- New student. Has to enter Branch details
- OR has to keep it NULL
- To insert 100s of students of the same branch, Branch info will be repeated for all of them

Updation Anomaly

- If Mr. X leaves the college or not HOD anymore, all student records to be updated
- Leave out some by mistake, data inconsistency

Deletion Anomaly

- Two different info kept together: Student and Branch
- At end of the academic year, if Student records deleted, Branch info is also lost

Normalization Rules

1NF

For a table to be in the First Normal Form, it should follow the following 4 rules:

1. It should only have single (atomic) valued attributes/columns.
   - Each column of your table should be single valued which means they should not contain multiple values
2. Values stored in a column should be of the same domain
   - This is more of a "Common Sense" rule. In each column the values stored must be of the same kind or type
   - If you have a column dob to save date of births of a set of people, then you cannot or you must not save 'names' of some of them in that column along with 'date of birth' of others in that column. It should hold only 'date of birth' for all the records/rows
3. All the columns in a table should have unique names.
4. And the order in which data is stored, does not matter.

Example:

Problem:

roll_no	name	subject
101	Akon	OS, CN
103	Ckon	Java
102	Bkon	C, C++

Solution:

roll_no	name	subject
101	Akon	OS
101	Akon	CN
103	Ckon	Java
102	Bkon	C
102	Bkon	C++

Note: Using the First Normal Form, data redundancy increases, as there will be many columns with same data in multiple rows but each row as a whole will be unique.

2NF

For a table to be in the Second Normal Form,

1. It should be in the First Normal form.
2. And, it should not have Partial Dependency.

Example: Student table

student_id (PK)	Name	reg_no	branch	address
10	Akon	07-WY	CSE	New York
11	Akon	08-WY	IT	Maine

- Using a student_id, we can fetch details (like name) of any student uniquely identifying each row
- This is **Functional Dependency**

So, what is Partial Dependency?

Example: Subject table

subject_id (PK)	subject_name
1	Java
2	C++
3	Php

Score table

score_id	student_id	subject_id	marks	teacher
1	10	1	70	Java Teacher
2	10	2	75	C++ Teacher
3	11	1	80	Java Teacher

- Student_Id + Subject_Id are ***composite key => PK***
    - To uniquely identify each row for a student and a subject
- Column *teacher* is dependent only on subject
    - Teacher's name depends only on subject
- This is ***Partial Dependency***
- When for a composite key, any attribute of the table depends on only part of the PK and not on the complete PK

Solution:

Subject table

subject_id	subject_name	teacher
1	Java	Java Teacher
2	C++	C++ Teacher
3	Php	Php Teacher

Score table

score_id	student_id	subject_id	marks
1	10	1	70
2	10	2	75
3	11	1	80

3NF

For a table to be in the Third Normal Form when,

1. It is in the Second Normal form.
2. And, it doesn't have Transitive Dependency.

Example:

Student Table

student_id	name	reg_no	branch	address
10	Akon	07-WY	CSE	Kerala
11	Akon	08-WY	IT	Gujarat
12	Bkon	09-WY	IT	Rajasthan

Subject Table

subject_id	subject_name	teacher
1	Java	Java Teacher
2	C++	C++ Teacher
3	Php	Php Teacher

Score Table

score_id	student_id	subject_id	marks	exam_name	total_marks
1	10	1	70		
2	10	2	75		
3	11	1	80		

- Student_Id + Subject_Id are ***composite key => PK***
- Exam_name depends on both keys
  - E.g.;
    - Mechanical Engg student has Workshop exam
    - Science student has Practical exam
- Total_marks???
  - Depends on exam_name
  - Exam_name is not a PK or even part of the CK-PK
  - This is ***Transitive Dependency***
- When a non-prime attribute depends on another non-prime attribute rather than on the PK, we have Transitive Dependency

Solution:

Take out the columns exam_name and total_marks from Score table and put them in an Exam table and use the exam_id wherever required

Score Table: In 3rd Normal Form

score_id	student_id	subject_id	marks	exam_id

The new Exam table

exam_id	exam_name	total_marks
1	Workshop	200
2	Mains	70
3	Practicals	30

The advantage of removing transitive dependency is,

- Amount of data duplication is reduced.
- Data integrity achieved.

Isolation Levels

Following are the different types of isolations available in SQL Server.

- READ COMMITTED
- READ UNCOMMITTED
- REPEATABLE READ
- SERIALIZABLE
- SNAPSHOT

Read Committed

In select query it will take only committed values of table. If any transaction is opened and incomplete on table in others sessions then select query will wait till no transactions are pending on same table.

Read Committed is the default transaction isolation level.

Read committed example 1:

Session 1

```
begin tran
update emp set Salary=999 where ID=1
waitfor delay '00:00:15'
commit
```

Session 2

```
set transaction isolation level read committed
select Salary from Emp where ID=1
```

Run both sessions side by side.

Output

999

In second session, it returns the result only after execution of complete transaction in first session because of the lock on Emp table. We have used wait command to delay 15 seconds after updating the Emp table in transaction.

Read committed example 2

Session1

```
begin tran
select * from Emp
waitfor delay '00:00:15'
commit
```

Session2

```
set transaction isolation level read committed
select * from Emp
```

Run both sessions side by side.

Output

1000

In session2, there won't be any delay in execution because in session1 Emp table is used under transaction but it is not used update or delete command hence Emp table is not locked.

Read committed example 3

Session 1

```
begin tran
select * from emp
waitfor delay '00:00:15'
update emp set Salary=999 where ID=1
commit
```

Session 2

```
set transaction isolation level read committed
select Salary from Emp where ID=1
```

Run both sessions side by side.

Output

1000

In session2, there won't be any delay in execution because when session2 is executed Emp table in session1 is not locked (used only select command, locking on Emp table occurs after wait delay command).

Read Uncommitted

If any table is updated(insert or update or delete) under a transaction and same transaction is not completed that is not committed or roll backed then uncommitted values will displaly(Dirty Read) in select query of "Read Uncommitted" isolation transaction sessions. There won't be any delay in select query execution because this transaction level does not wait for committed values on table.

Read uncommitted example 1

Session 1

```
        begin tran
        update emp set Salary=999 where ID=1
        waitfor delay '00:00:15'
        rollback
```

Session 2

```
        set transaction isolation level read uncommitted
        select Salary from Emp where ID=1
```

Run both sessions at a time one by one.

Output

999

Select query in Session2 executes after update Emp table in transaction and before transaction rolled back. Hence 999 is returned instead of 1000.

Serializable

Serializable Isolation is similar to Repeatable Read Isolation but the difference is it prevents Phantom Read. This works based on range lock. If table has index then it locks records based on index range used in WHERE clause(like where ID between 1 and 3). If table doesn't have index then it locks complete table.

Serializable Example 1

Assume table does not have index column.

Session 1

```
    set transaction isolation level serializable
```

```
begin tran
select * from emp
waitfor delay '00:00:15'
select * from Emp
rollback
```

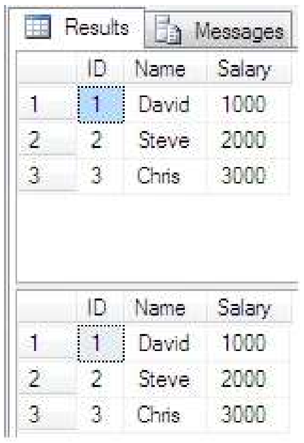
Session 2

```
insert into Emp(ID,Name,Salary)
values( 11,'Stewart',11000)
```

Run both sessions side by side.

Output

Result in Session 1.



Results Messages

	ID	Name	Salary
1	1	David	1000
2	2	Steve	2000
3	3	Chris	3000

	ID	Name	Salary
1	1	David	1000
2	2	Steve	2000
3	3	Chris	3000

Complete Emp table will be locked during the transaction in Session 1. Unlike "Repeatable Read", insert query in Session 2 will wait till session 1 execution is completed. Hence Phantom read is prevented and both queries in session 1 will display same number of rows.

Serializable Example 2

Assume table has primary key on column "ID". In our example script, primary key is not added. Add primary key on column Emp.ID before executing below examples.

Session 1

```
set transaction isolation level serializable
begin tran
select * from emp where ID between 1 and 3
```

```
    waitfor delay '00:00:15'
    select * from Emp where ID between 1 and 3
    rollback
```

Session 2

```
    insert into Emp(ID,Name,Salary)
    values( 11,'Stewart',11000)
```

Run both sessions side by side.

Output

Since Session 1 is filtering IDs between 1 and 3, only those records whose IDs range between 1 and 3 will be locked and these records can not be modified and no new records with ID range between 1 to 3 will be inserted. In this example, new record with ID=11 will be inserted in Session 2 without any delay.

Snapshot

Snapshot isolation is similar to Serializable isolation. The difference is Snapshot does not hold lock on table during the transaction so table can be modified in other sessions. Snapshot isolation maintains versioning in Tempdb for old data in case of any data modification occurs in other sessions then existing transaction displays the old data from Tempdb.

Snapshot Example 1

Session 1

```
    set transaction isolation level snapshot
    begin tran
    select * from Emp
    waitfor delay '00:00:15'
    select * from Emp
    rollback
```

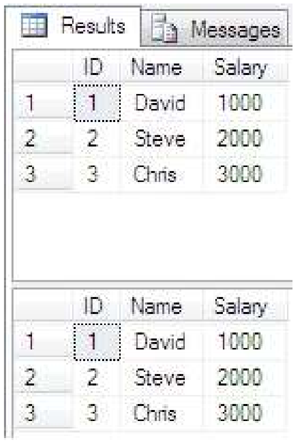
Session 2

```
    insert into Emp(ID,Name,Salary) values( 11,'Stewart',11000)
    update Emp set Salary=4444 where ID=4
    select * from Emp
```

Run both sessions side by side.

Output

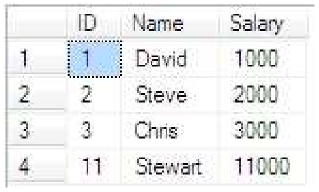
Result in Session 1.



	ID	Name	Salary
1	1	David	1000
2	2	Steve	2000
3	3	Chris	3000

	ID	Name	Salary
1	1	David	1000
2	2	Steve	2000
3	3	Chris	3000

Result in Session 2.

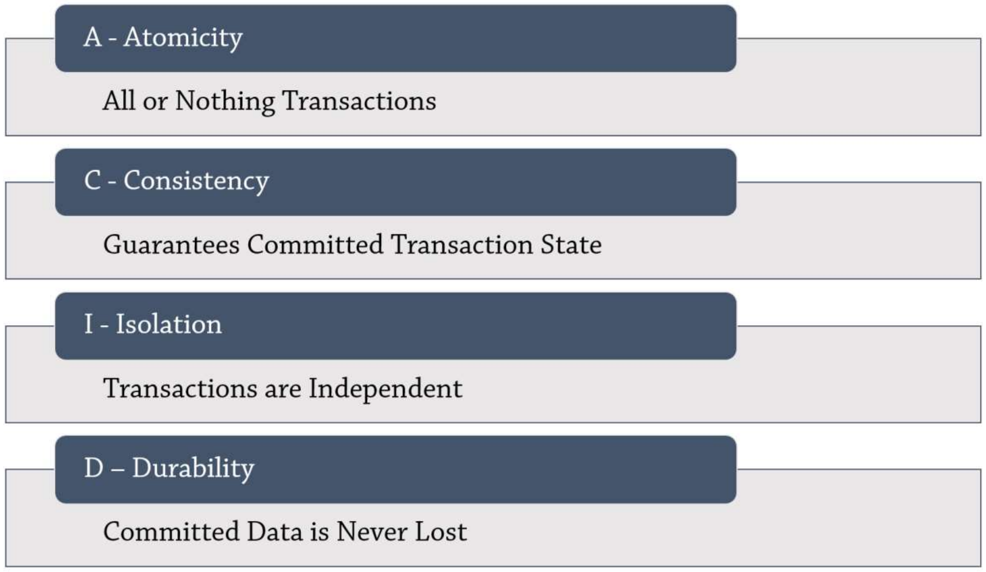


	ID	Name	Salary
1	1	David	1000
2	2	Steve	2000
3	3	Chris	3000
4	11	Stewart	11000

Session 2 queries will be executed in parallel as transaction in session 1 won't lock the table Emp.

ACID

- **Atomicity**
  - All or Nothing Txns
- **Consistency**
  - Guarantees that a transaction never leaves your database in a half-finished state
- **Isolation**
  - Keeps transactions separated from each other until they're finished
- **Durability**
  - Guarantees that the database will keep track of pending changes in such a way that the server can recover from an abnormal termination


A - Atomicity
All or Nothing Transactions
C - Consistency
Guarantees Committed Transaction State
I - Isolation
Transactions are Independent
D – Durability
Committed Data is Never Lost