DBMS

MySQL

Dineshkumar Thangavel

Introduction: Why Database?

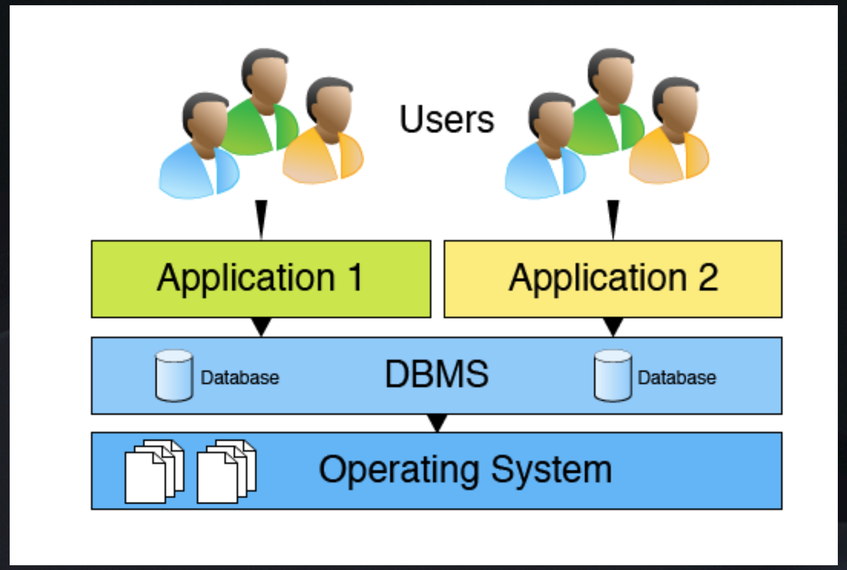
- Imagine your college stores student marks in Excel sheets — easy for 10 students, chaos for 10,000. Files get duplicated, lost, corrupted, and updating is a nightmare.
- **Database Management System (DBMS)** — a software to **store, organize, and manage** data efficiently.

Student_ID	Name	Dept	Marks
S101	Arun	CSE	89
S102	Meena	IT	95

SELECT Name, Marks FROM Student WHERE Dept = 'IT';

Database System Overview

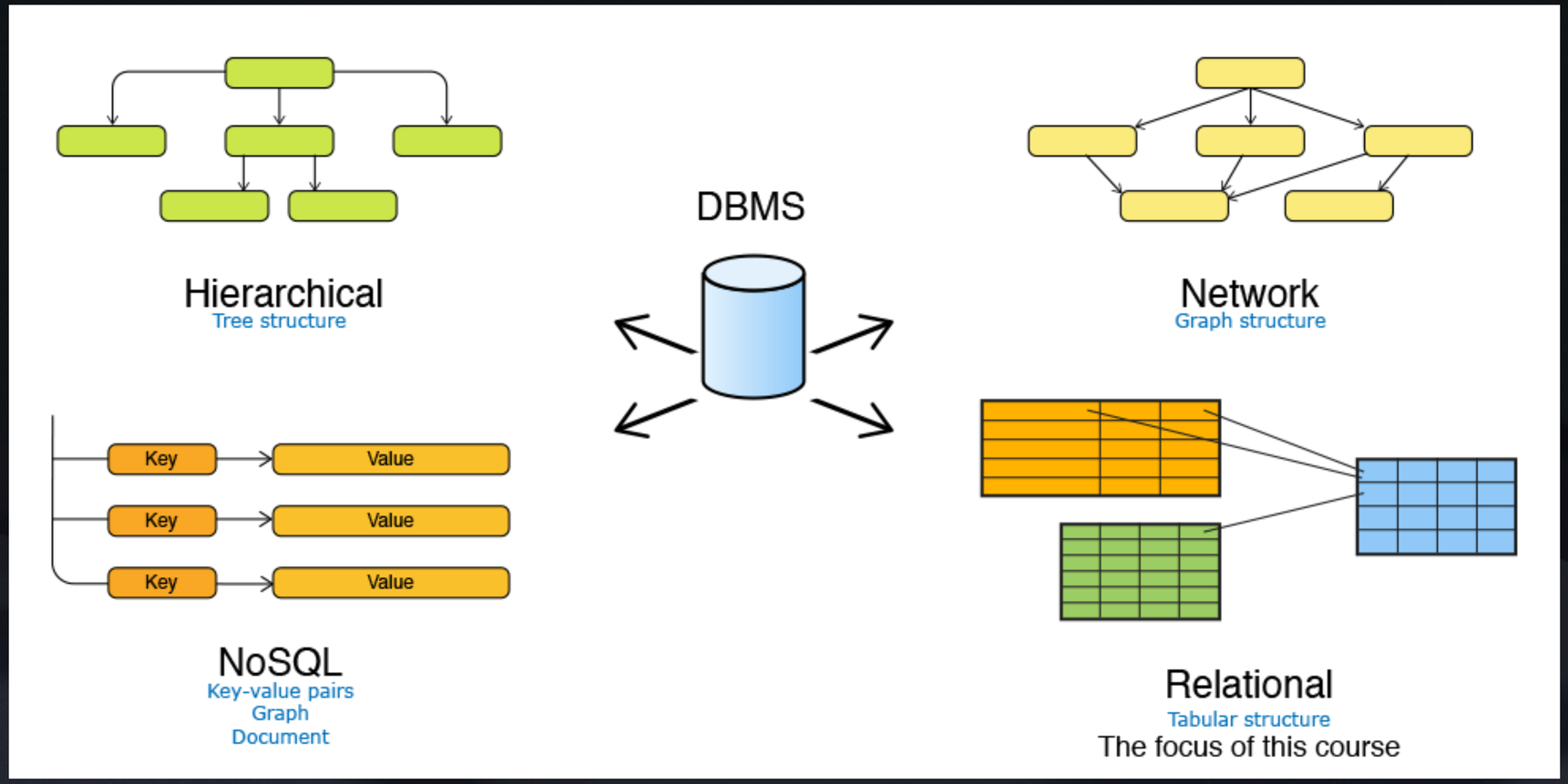
- A Database is a shared collection of logically related data and description of these data, designed to meet the information needs of an organization.
- A Database Management System(DBMS) is a software system that enables users to define, create, maintain, and control access to the database. Database Systems typically have high costs and require high-end hardware configurations.
- An Application Program communicates with a database by issuing an appropriate request (typically a SQL statement)



File System vs DBMS

Feature	File System	DBMS
Data Storage	In files (e.g., .txt, .csv)	In tables (rows & columns)
Redundancy	High	Reduced
Data Security	Poor	High (controlled access)
Data Sharing	Difficult	Multi-user support
Backup & Recovery	Manual	Automatic (Transaction logs)

Types of Database



DBMS vs RDBMS

Concept	DBMS	RDBMS
Data Storage	File-based	Table-based (relations)
Relationships	Not supported	Supported (via keys)
Example	dBase, FoxPro	MySQL, Oracle, PostgreSQL
Normalization	No	Yes
Query Language	Proprietary	SQL

DBMS Architecture

1. External Level (User View)

- What the user sees (e.g., marks report of their own department).

2. Conceptual Level (Logical View)

- Logical structure of the entire database (tables, relations).

3. Internal Level (Physical View)

- How data is stored physically (indexes, blocks, etc.)

Real-Life Analogy:

Like a college —

- Student sees marks (external view),
- Staff knows how subjects relate (conceptual),
- IT admin manages files on the server (internal).

Important DBMS Terms

Term	Description
Database	Organized collection of data
Table	Collection of rows & columns
Tuple (Row)	Single record
Attribute (Column)	Field of data
Schema	Structure definition
Instance	Actual data at a point in time

Keys in RDBMS

```
CREATE TABLE Department (
  Dept_ID INT PRIMARY KEY,
  Dept_Name VARCHAR(30)
);

CREATE TABLE Student (
  Student_ID INT PRIMARY KEY,
  Name VARCHAR(30),
  Dept_ID INT,
  FOREIGN KEY (Dept_ID) REFERENCES Department(Dept_ID)
);
```

Key Type	Description	Example
Primary Key	Unique identifier	Student_ID
Foreign Key	Links to another table	Dept_ID in Student table
Candidate Key	All possible unique keys	Roll_No, Aadhaar_No
Super Key	Candidate + extra attributes	(Roll_No, Name)
Composite Key	Combination of columns	(Student_ID, Course_ID)

Schema vs Instance

- **Schema** → Structure (like class in OOP)
- **Instance** → Actual data (like objects)

Example:

CREATE TABLE Student (ID INT, Name VARCHAR(20));
Schema = column design
Instance = the actual rows inside it.
•

MySql Workbench Setup

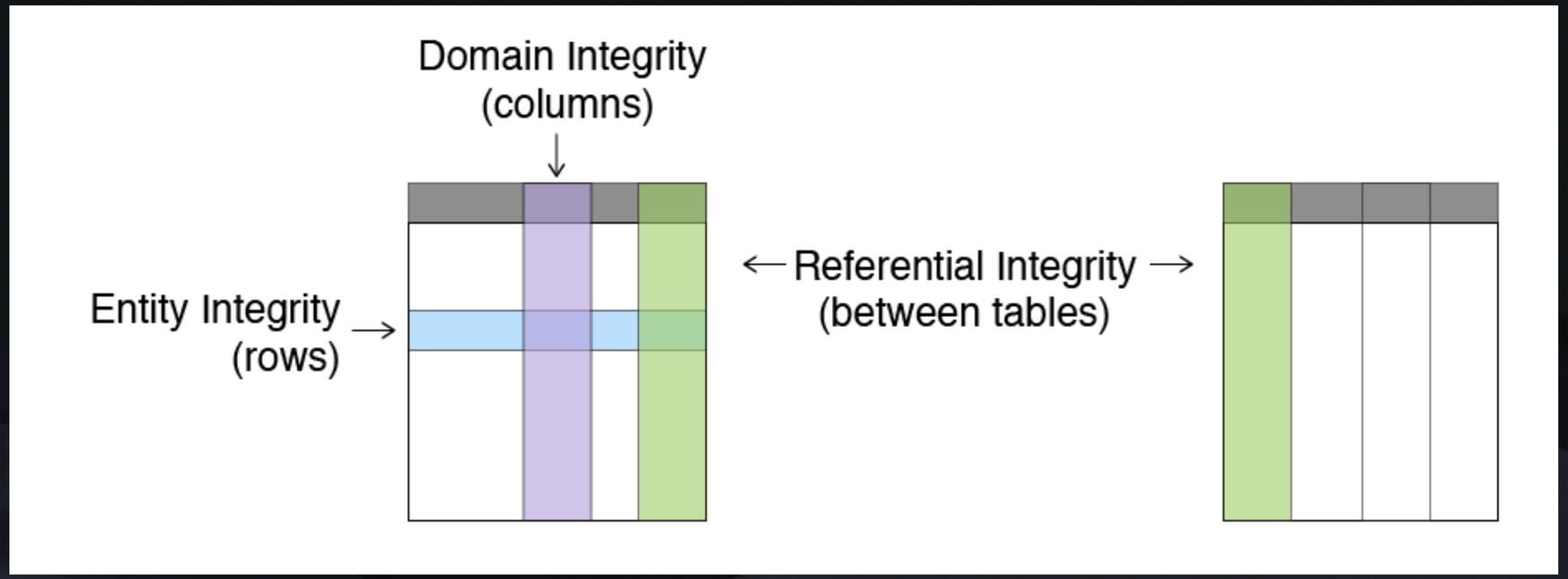
Steps:

1. Open MySQL Workbench → New Connection
2. Test Connection (root / password)
3. Create a new database
4. Create a table
5. Insert sample data
6. Retrieve data

Integrity Constrains in DBMS

Integrity Type	Definition	Example / Enforced Through
Entity Integrity	Ensures each row (record) in a table can be uniquely identified. A table must have a column or combination of columns (Primary Key) that cannot be NULL.	🔷 Enforced using **PRIMARY KEY** 🔷 Example:Student_ID in Student table uniquely identifies each student.
Domain Integrity	Ensures that the values in each column are valid and fall within a defined domain (data type, format, or business rule).	🔷 Enforced using **DATA TYPE**, **CHECK**, **DEFAULT**, and **NOT NULL** constraints. 🔷 Example:Gender CHAR(1) CHECK (Gender IN ('M','F'))
Referential Integrity	Ensures relationships between tables remain consistent — a foreign key value in one table must exist as a primary key value in the referenced table.	🔷 Enforced using **FOREIGN KEY** 🔷 Example:Dept_ID in Student must exist in Department(Dept_ID)

Integrity Constrains in DBMS



Why is an ER Model?

Definition:

- The Entity–Relationship (ER) model is a conceptual blueprint of your database — it shows how data entities relate to one another.

Simple Analogy:

- ER model is like the architect's blueprint before constructing a building (database). Tables = Rooms, Relationships = Doors connecting rooms.

Key Components of an ER Model

Component	Description	Example
Entity	A real-world object that we store data about.	Student, Course, LibraryBook
Attribute	Property or characteristic of an entity.	Name, Age, Dept
Relationship	Association between entities.	Student **enrolls in** Course

Types of Attributes

Attribute Type	Description	Example
Simple	Cannot be divided further.	Name, Age
Composite	Can be divided into subparts.	Address = (Street, City, Pincode)
Derived	Computed from other attributes.	Age derived from DOB
Multivalued	Can have multiple values.	Phone_Number

Types of Entities

Entity Type	Description	Example
Strong Entity	Exists independently (has its own primary key).	Student(Student_ID)
Weak Entity	Depends on another entity (no complete key).	Dependent of Employee

Types of Relationships

Notation:

- Diamond → Relationship
- Lines → Cardinality (1 or M)

Type	Meaning	Example	Cardinality
One-to-One (1:1)	Each entity of A is related to exactly one of B.	Each Student has one ID Card.	1:1
One-to-Many (1:N)	One record in A can relate to many in B.	Department → Students.	1:N
Many-to-Many (M:N)	Many in A can relate to many in B.	Student ↔ Course.	M:N

Cardinality in ER Model

Symbol	Meaning	Explanation	Example
||	**Exactly One (Mandatory One)**	Each record must be associated with **one and only one** related record.	Every *Student* must belong to **exactly one Department**.
○||	**Zero or One (Optional One)**	Relationship is **optional** — an entity may or may not be related, but if it is, only to one.	Each *Employee* **may or may not** have a *Parking Space*.
○<	**Zero, One, or More (Optional Many)**	An entity can be associated with **none, one, or many** records.	A *Customer* **may or may not** have *Orders*, but can have many.
<||	**One or More (Mandatory Many)**	An entity **must** have at least one related record, and possibly many.	Each *Department* **must have** one or more *Students*.

Why Normalization?

Definition:

- Normalization is a process of organizing data in a database to reduce redundancy and improve data integrity.

Simple Analogy:

- Imagine a messy timetable pasted in 10 places in a college.
  If one class timing changes, you have to update all 10 — that's redundancy and leads to inconsistency.

- Normalization fixes that — one source of truth.

Problems Before Normalization

Problem Type	Example	Description
Data Redundancy	Doctor name repeated for every patient	Same info stored multiple times
Update Anomaly	Change doctor’s phone in one row, miss others	Data inconsistency
Insertion Anomaly	Can’t add new doctor until a patient is added	Missing dependency
Deletion Anomaly	Delete last patient → lose doctor info	Unintended data loss

Term	Description	Example (Real-life Context)
Functional Dependency (A → B)	Attribute **A** determines attribute **B**. Knowing A gives exactly one value of B.	Student_ID → Name Each student ID uniquely determines a student name.
Determinant	Attribute (or set of attributes) that *determines* the value of another.	In Student_ID → Name, **Student_ID** is the determinant.
Dependent	Attribute whose value *depends on* another attribute.	In Student_ID → Name, **Name** is dependent on Student_ID.
Fully Functional Dependency	A non-key attribute depends on the *entire composite key* and not part of it.	(OrderID, ProductID) → Quantity Quantity depends on both OrderID & ProductID.
Partial Dependency	A non-key attribute depends on *part of a composite key* instead of the full key.	(OrderID, ProductID) → Quantity and ProductID → ProductName ⇒ ProductName partially depends on key.
Transitive Dependency	A non-key attribute depends on *another non-key attribute*.	Student_ID → Dept_Name and Dept_Name → Dept_Loc ⇒ Student_ID → Dept_Loc (transitive).

Hospital Database (Unnormalized Form)

Observation:

- Doctor details are repeated for every patient.
- If Dr. Kiran changes phone number → multiple updates needed.

Patient_ID	Patient_Name	Doctor_Name	Doctor_Phone	Treatment	Room_No
P101	Arun	Dr. Kiran	9876543210	Fever	R101
P102	Meena	Dr. Kiran	9876543210	Cold	R102
P103	Kavi	Dr. Ravi	9786542109	Fracture	R103

Step 1: First Normal Form (1NF)

Rule:

- Each cell should hold atomic (single) values.
- No repeating groups or arrays.

Patient_ID	Treatment	Room_No
P101	Fever, Cold	R101

- ✅ The Hospital table already satisfies atomicity since all values are single.

However, for clarity:

- 1NF = Eliminate repeating groups → one value per cell.

💬 Example of NOT in 1NF:

- → After 1NF, each treatment becomes a separate row.

Step 2: Second Normal Form (2NF)

Rule:

- Must be in 1NF, and
- No partial dependency — every non-key attribute depends on the entire primary key.

Let's assume primary key = (Patient_ID, Doctor_Name) (composite).

- But Doctor's phone depends only on Doctor_Name — not Patient_ID.
  👉 Partial dependency detected!
- So, we split the table.
- Now, no partial dependencies — each non-key attribute depends fully on the primary key.

Patient_ID	Patient_Name	Treatment	Room_No	Doctor_Name
P101	Arun	Fever	R101	Dr. Kiran
P102	Meena	Cold	R102	Dr. Kiran
P103	Kavi	Fracture	R103	Dr. Ravi

Doctor_Name	Doctor_Phone
Dr. Kiran	9876543210
Dr. Ravi	9786542109

Step 3: Third Normal Form (3NF)

Rule:

- Must be in 2NF, and
- No transitive dependency (non-key attribute depending on another non-key).
- In Table Patient, Room_No might depend on Treatment (say all “Fever” patients go to R101). That’s transitive dependency.

Step 3: Third Normal Form (3NF)

Patient_ID	Patient_Name	Doctor_Name	Treatment_ID
P101	Arun	Dr. Kiran	T01
P102	Meena	Dr. Kiran	T02
P103	Kavi	Dr. Ravi	T03

Doctor_Name	Doctor_Phone
Dr. Kiran	9876543210
Dr. Ravi	9786542109

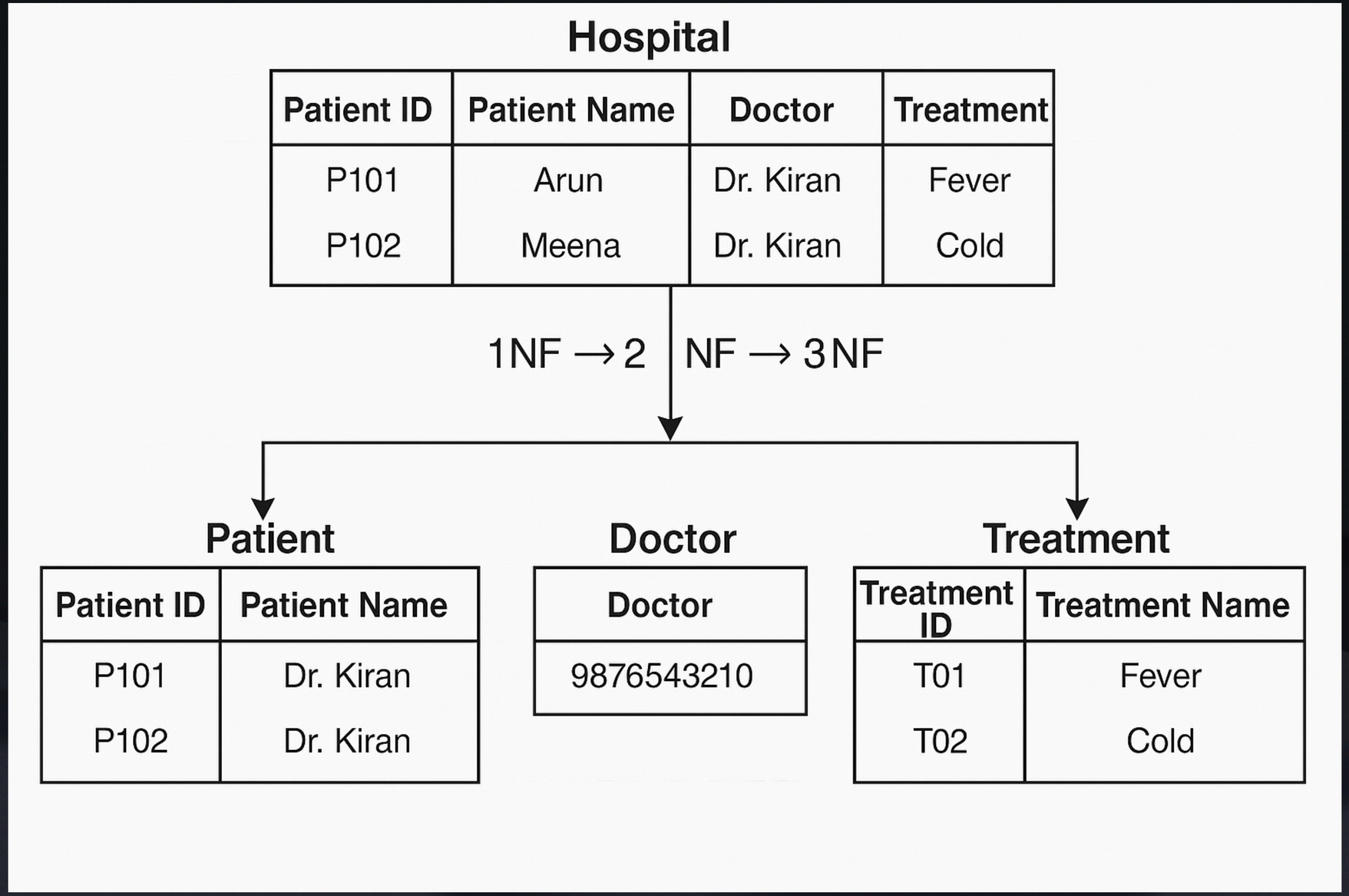
Treatment_ID	Treatment_Name	Room_No
T01	Fever	R101
T02	Cold	R102
T03	Fracture	R103

Final 3NF Schema (Hospital DB)

- ✅ Data redundancy eliminated
- ✅ Easy to update Doctor/Room separately
- ✅ Perfectly relational

Table	Primary Key	Purpose
Patient	Patient_ID	Stores patient personal info
Doctor	Doctor_Name	Stores doctor contact info
Treatment	Treatment_ID	Stores treatment details

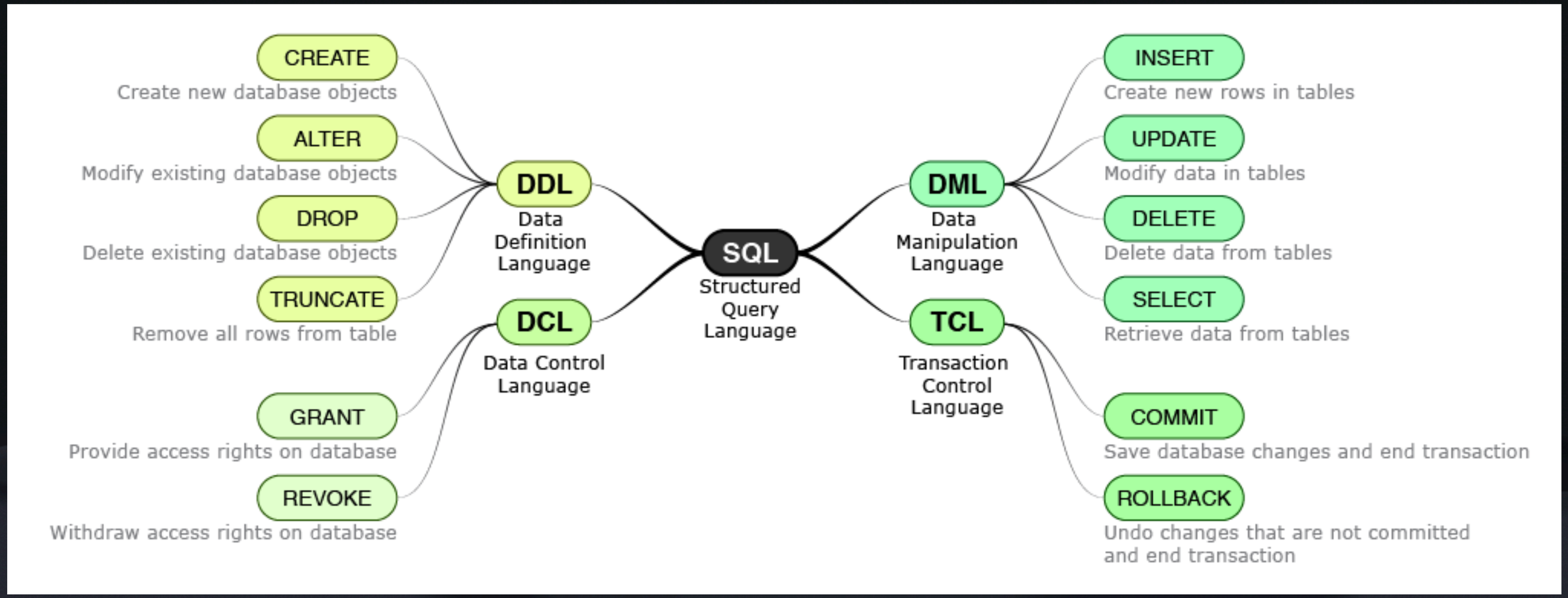
Hospital Database Normalization ER Diagram



Mini Student Task

Emp_ID	Emp_Name	Dept_Name	Dept_Loc	Manager_Name

Introduction to SQL



Types of SQL Operators

Category	Description
Arithmetic Operators	Perform mathematical operations
Comparison Operators	Compare one value with another
Logical Operators	Combine multiple conditions
Range / Matching Operators	Check for specific ranges or patterns
Set Operators	Combine results from multiple queries
Special Operators	Miscellaneous (IS NULL, EXISTS, ANY, ALL, etc.)

Arithmetic Operators

```
SELECT Product_Name, Price, Stock, Price * Stock AS Total_Value

FROM Product;
```

Operator	Description	Example
+	Addition	Price + 500
-	Subtraction	Stock - 2
*	Multiplication	Price * Quantity
/	Division	Price / 2
%	Modulus	Stock % 2

Comparison Operators

```
SELECT Product_Name, Price

FROM Product

WHERE Price > 10000;
```

Operator	Description	Example
=	Equal to	City = 'Chennai'
<> or !=	Not equal to	Category_ID <> 2
>	Greater than	Price > 10000
<	Less than	Stock < 10
>=	Greater than or equal to	Rating >= 4
<=	Less than or equal to	Stock <= 5

Logical Operators

```
SELECT Name, City

FROM Customer

WHERE City = 'Chennai' OR City = 'Madurai';
```

Operator	Description	Example
AND	Returns TRUE if *all* conditions are true	Price > 5000 AND Stock > 10
OR	Returns TRUE if *any* condition is true	City = 'Chennai' OR City = 'Madurai'
NOT	Reverses the result	NOT (City = 'Chennai')

Range Operators

a) BETWEEN

Used to filter within a range (inclusive).

SELECT Product_Name, Price

FROM Product

WHERE Price BETWEEN 1000 AND 5000;

✅ Shows all products priced between ₹1,000 and ₹5,000.

b) IN

Used to test whether a value matches any value in a list.

SELECT Name, City

FROM Customer

WHERE City IN ('Chennai', 'Madurai', 'Coimbatore');

✅ Lists customers from the given cities.

c) NOT IN

Inverse of IN — excludes matches.

SELECT Name, City

FROM Customer

WHERE City NOT IN ('Chennai', 'Madurai');

✅ Lists customers who are not from Chennai or Madurai.

Pattern Matching Operator — LIKE

Used for partial string matches.

💡 Examples:

SELECT Name FROM Customer WHERE Name LIKE 'A%';

✅ Names starting with “A”.

SELECT Email FROM Customer WHERE Email LIKE '%gmail.com';

✅ All customers using Gmail.

SELECT Product_Name FROM Product WHERE Product_Name LIKE '_a%';

✅ Product names where 2nd letter is ‘a’.

Wildcard	Description
%	Matches zero or more characters
_	Matches exactly one character

NULL Operators

a) IS NULL

Finds rows where a value is NULL.

SELECT Name, Pincode

FROM Customer

WHERE Pincode IS NULL;

✅ Lists customers without a Pincode.

b) IS NOT NULL

Finds rows where a value exists.

SELECT Name

FROM Customer

WHERE Phone IS NOT NULL;

✅ Lists customers who have provided phone numbers.

Special Operators

a) EXISTS

Checks if a subquery returns any rows.

```
SELECT Name
FROM Customer c
WHERE EXISTS (
  SELECT 1 FROM Orders o WHERE o.Customer_ID = c.Customer_ID
);
```

✅ Returns only customers who have placed at least one order.

b) ANY

Compares a value to any value returned by a subquery.

```
SELECT Product_Name, Price
FROM Product
WHERE Price > ANY (SELECT Price FROM Product WHERE Category_ID = 2);
```

✅ Shows products costlier than at least one item in Category 2.

c) ALL

Compares a value to all values returned by a subquery.

```
SELECT Product_Name, Price
FROM Product
WHERE Price > ALL (SELECT Price FROM Product WHERE Category_ID = 2);
```

✅ Shows products costlier than every item in Category 2.

Set Operators

SELECT City FROM Customer

UNION

SELECT City FROM Supplier;

Operator	Description	Removes Duplicates?
UNION	Combines results	✅ Removes duplicates
UNION ALL	Combines results	❌ Keeps duplicates
INTERSECT	Returns common results	✅
EXCEPT / MINUS	Returns rows in first query but not in second	✅

Assignment Operator

UPDATE Product

SET Stock = Stock + 5

WHERE Product_Name = 'Laptop';

Operator	Description	Example
=	Assigns a value to a column	SET Stock = Stock + 10

Concatenation Operator

```
SELECT CONCAT(Name, ' - ', City) AS CustomerInfo

FROM Customer;
```

SQL Joins - Inner Join

- Returns only rows that have matching values in both tables.

```
SELECT c.Customer_ID, c.Customer_Name, c.City, o.Order_ID, o.Product,
o.Amount
FROM Customer c
INNER JOIN Orders o
ON c.Customer_ID = o.Customer_ID;
```

Customer_ID	Customer_Name	City	Order_ID	Product	Amount
C1	Arjun	Chennai	O1	Laptop	55000
C1	Arjun	Chennai	O2	Mouse	800
C2	Meena	Madurai	O3	Chair	2500

Order_ID	Customer_ID	Product	Amount
O1	C1	Laptop	55000
O2	C1	Mouse	800
O3	C2	Chair	2500
O4	C5	Headphones	1200

Customer_ID	Customer_Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Ravi	Coimbatore
C4	Priya	Salem

SQL Joins - Left Join

- Returns all records from the left table (Customer),
- and the matching rows from the right table (Orders).
- If no match → NULL on right side.

```
SELECT c.Customer_ID, c.Customer_Name, c.City, o.Order_ID, o.Product,
o.Amount
FROM Customer c
LEFT JOIN Orders o
ON c.Customer_ID = o.Customer_ID;
```

Customer_ID	Customer_Name	City	Order_ID	Product	Amount
C1	Arjun	Chennai	O1	Laptop	55000
C1	Arjun	Chennai	O2	Mouse	800
C2	Meena	Madurai	O3	Chair	2500
C3	Ravi	Coimbatore	NULL	NULL	NULL
C4	Priya	Salem	NULL	NULL	NULL

Order_ID	Customer_ID	Product	Amount
O1	C1	Laptop	55000
O2	C1	Mouse	800
O3	C2	Chair	2500
O4	C5	Headphones	1200

Customer_ID	Customer_Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Ravi	Coimbatore
C4	Priya	Salem

SQL Joins - Full Outer Join

- Returns all records when there's a match in either left or right table.
- Non-matching rows show NULLs on respective sides.

```
SELECT c.Customer_ID, c.Customer_Name, c.City, o.Order_ID, o.Product, o.Amount
FROM Customer c
LEFT JOIN Orders o ON c.Customer_ID = o.Customer_ID
UNION
SELECT c.Customer_ID, c.Customer_Name, c.City, o.Order_ID, o.Product, o.Amount
FROM Customer c
RIGHT JOIN Orders o ON c.Customer_ID = o.Customer_ID;
```

Customer_ID	Customer_Name	City	Order_ID	Product	Amount
C1	Arjun	Chennai	O1	Laptop	55000
C1	Arjun	Chennai	O2	Mouse	800
C2	Meena	Madurai	O3	Chair	2500
C3	Ravi	Coimbatore	NULL	NULL	NULL
C4	Priya	Salem	NULL	NULL	NULL
NULL	NULL	NULL	O4	Headphones	1200

Order_ID	Customer_ID	Product	Amount
O1	C1	Laptop	55000
O2	C1	Mouse	800
O3	C2	Chair	2500
O4	C5	Headphones	1200

Customer_ID	Customer_Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Ravi	Coimbatore
C4	Priya	Salem

SQL Joins - Cross Join

- Returns the Cartesian product of both tables —
- each row from left table combines with all rows from right table.

```
SELECT c.Customer_Name, o.Product
FROM Customer c
CROSS JOIN Orders o;
```

Customer_Name	Product
Arjun	Laptop
Arjun	Mouse
Arjun	Chair
Arjun	Headphones
.....	.....

Order_ID	Customer_ID	Product	Amount
O1	C1	Laptop	55000
O2	C1	Mouse	800
O3	C2	Chair	2500
O4	C5	Headphones	1200

Customer_ID	Customer_Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Ravi	Coimbatore
C4	Priya	Salem

What Is a Subquery

- A subquery (or inner query) is a query nested inside another query.
  It allows you to perform complex operations by combining multiple steps into one SQL statement.

Think of it like this:

- “The inner query gives me a list;
  The outer query uses that list to decide what to do.”

Example:

```
SELECT column_list
FROM table_name
WHERE column operator (SELECT column FROM table WHERE condition);
```

Classification of Subqueries

1️⃣ Based on DEPENDENCY (how it relates to the outer query) → Classification

Classification	Meaning	Outer Query Reference	Execution	Example
Non-Correlated Subquery	Independent query — runs first and gives a result	❌ No reference to outer query	Runs **once**	SELECT Product_Name FROM Product WHERE Price > (SELECT AVG(Price) FROM Product);
Correlated Subquery	Dependent on outer query — runs once per outer row	✅ References outer query	Runs **repeatedly**	SELECT Name FROM Customer c WHERE EXISTS (SELECT 1 FROM Orders o WHERE o.Customer_ID = c.Customer_ID);

Types of Subqueries

2️⃣ Based on POSITION or RESULT (what it returns or where it's used) → Types

Type	Description	Returns
Single-row	Returns one value	One value
Multi-row	Returns multiple rows	Multiple values
Multi-column	Returns multiple columns	Multiple values/columns
Correlated	Refers to outer query	Varies per row
Nested	Subquery inside another subquery	Any type
Inline View	Subquery used in FROM clause	Virtual table

Example 1 — Products costlier than the average price

```
SELECT Product_Name, Price

FROM Product

WHERE Price > (SELECT AVG(Price) FROM Product);
```

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Amoun
O1	C1	55000
O2	C1	3000
O3	C2	2500

Prod_ID	Prod_Name	Price
P1	Laptop	55000
P2	Mouse	800
P3	Chair	2500
P4	Mobile	25000

Example 2 — Customers who placed at least one order

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Amoun
O1	C1	55000
O2	C1	3000
O3	C2	2500

Prod_ID	Prod_Name	Price
P1	Laptop	55000
P2	Mouse	800
P3	Chair	2500
P4	Mobile	25000

```
SELECT Name

FROM Customer

WHERE Customer_ID IN (SELECT Customer_ID FROM Orders);
```

Example 3 — Products matching any order amount

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Amoun
O1	C1	55000
O2	C1	3000
O3	C2	2500

Prod_ID	Prod_Name	Price
P1	Laptop	55000
P2	Mouse	800
P3	Chair	2500
P4	Mobile	25000

```
SELECT Product_Name, Price

FROM Product

WHERE Price IN (SELECT Amount FROM Orders);
```

Example 4 — Second highest order amount

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Amoun
O1	C1	55000
O2	C1	3000
O3	C2	2500

Prod_ID	Prod_Name	Price
P1	Laptop	55000
P2	Mouse	800
P3	Chair	2500
P4	Mobile	25000

```
SELECT MAX(Amount)

FROM Orders

WHERE Amount < (SELECT MAX(Amount) FROM Orders);
```

Example 1 — Orders above each customer’s own average amount

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Amoun
O1	C1	55000
O2	C1	3000
O3	C2	2500

Prod_ID	Prod_Name	Price
P1	Laptop	55000
P2	Mouse	800
P3	Chair	2500
P4	Mobile	25000

```
SELECT DISTINCT c.Name
FROM Customer c
JOIN Orders o ON c.Customer_ID = o.Customer_ID
WHERE o.Amount > (
  SELECT AVG(o2.Amount)
  FROM Orders o2
  WHERE o2.Customer_ID = c.Customer_ID
);
```

Example 2 — Customers who placed more than one order

```
SELECT c.Name
FROM Customer c
WHERE (
  SELECT COUNT(*)
  FROM Orders o
  WHERE o.Customer_ID = c.Customer_ID
) > 1;
```

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Amoun
O1	C1	55000
O2	C1	3000
O3	C2	2500

Prod_ID	Prod_Name	Price
P1	Laptop	55000
P2	Mouse	800
P3	Chair	2500
P4	Mobile	25000

Example 3 — Products costlier than their category’s average

```
SELECT p.Product_Name, p.Price

FROM Product p

WHERE p.Price > (

  SELECT AVG(p2.Price)

  FROM Product p2

  WHERE p2.Category_ID = p.Category_ID

);
```

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Amoun
O1	C1	55000
O2	C1	3000
O3	C2	2500

Prod_ID	Prod_Name	Price
P1	Laptop	55000
P2	Mouse	800
P3	Chair	2500
P4	Mobile	25000

Show every product’s price along with the average price of all products.

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Amoun
O1	C1	55000
O2	C1	3000
O3	C2	2500

Prod_ID	Prod_Name	Price
P1	Laptop	55000
P2	Mouse	800
P3	Chair	2500
P4	Mobile	25000

```
SELECT
    Product_Name,
    Price,
    (SELECT AVG(Price) FROM Product) AS AvgPrice
FROM Product;
```

List customers whose *total purchase value* is above ₹10 000.

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Amoun
O1	C1	55000
O2	C1	3000
O3	C2	2500

Prod_ID	Prod_Name	Price
P1	Laptop	55000
P2	Mouse	800
P3	Chair	2500
P4	Mobile	25000

```
SELECT Name, TotalSpent
FROM (
    SELECT c.Customer_ID, c.Name, SUM(o.Amount) AS TotalSpent
    FROM Customer c
    JOIN Orders o ON c.Customer_ID = o.Customer_ID
    GROUP BY c.Customer_ID, c.Name
) AS CustomerTotals
WHERE TotalSpent > 10000;
```

Show customers whose total spending is greater than the average total spending of all customers.

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Amoun
O1	C1	55000
O2	C1	3000
O3	C2	2500

Prod_ID	Prod_Name	Price
P1	Laptop	55000
P2	Mouse	800
P3	Chair	2500
P4	Mobile	25000

```
SELECT Customer_ID, SUM(Amount) AS TotalSpent

FROM Orders

GROUP BY Customer_ID

HAVING SUM(Amount) >

    ( SELECT AVG(CustomerTotal)

     FROM ( SELECT SUM(Amount) AS CustomerTotal

          FROM Orders

          GROUP BY Customer_ID ) AS Totals );
```

Find customers who have placed at least one order.

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Amoun
O1	C1	55000
O2	C1	3000
O3	C2	2500

Prod_ID	Prod_Name	Price
P1	Laptop	55000
P2	Mouse	800
P3	Chair	2500
P4	Mobile	25000

```
SELECT Name

FROM Customer c

WHERE EXISTS ( SELECT 1

        FROM Orders o

        WHERE o.Customer_ID = c.Customer_ID );
```

Show products priced higher than **any** order amount.

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Amoun
O1	C1	55000
O2	C1	3000
O3	C2	2500

Prod_ID	Prod_Name	Price
P1	Laptop	55000
P2	Mouse	800
P3	Chair	2500
P4	Mobile	25000

```
SELECT Product_Name, Price

FROM Product

WHERE Price > ANY ( SELECT Amount FROM Orders );
```

Show products priced higher than **all** order amounts.

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Amoun
O1	C1	55000
O2	C1	3000
O3	C2	2500

Prod_ID	Prod_Name	Price
P1	Laptop	55000
P2	Mouse	800
P3	Chair	2500
P4	Mobile	25000

```
SELECT Product_Name, Price

FROM Product

WHERE Price > ALL ( SELECT Amount FROM Orders );
```

Display the name of the customer who made the *costliest order*.

```
SELECT Name
FROM Customer
WHERE Customer_ID IN (
    SELECT Customer_ID
    FROM Orders
    WHERE Amount = (
        SELECT MAX(Amount) FROM Orders
    )
);
```

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Amoun
O1	C1	55000
O2	C1	3000
O3	C2	2500

Prod_ID	Prod_Name	Price
P1	Laptop	55000
P2	Mouse	800
P3	Chair	2500
P4	Mobile	25000

Summary

Type	Meaning	Operators Used	Example	Belongs To
Single-row Subquery	Returns one value	=, <, >, >=, <=	WHERE Price > (SELECT AVG(Price) FROM Product);	Usually Non-Correlated
Multi-row Subquery	Returns multiple values	IN, ANY, ALL	WHERE Customer_ID IN (SELECT Customer_ID FROM Orders);	Usually Non-Correlated
Multi-column Subquery	Returns multiple columns	IN (col1, col2)	WHERE (dept_id, job_id) IN (SELECT dept_id, job_id FROM employees);	Usually Non-Correlated
Existence Subquery	Checks if rows exist in subquery	EXISTS, NOT EXISTS	WHERE EXISTS (SELECT 1 FROM Orders o WHERE o.Customer_ID = c.Customer_ID);	Usually **Correlated**

What Are Aggregate Functions?

Aggregate functions perform calculations on a set of rows and return a single value.

Function	Description	Example
COUNT()	Number of rows	COUNT(*)
SUM()	Total of numeric column	SUM(Amount)
AVG()	Average value	AVG(Price)
MIN()	Lowest value	MIN(Price)
MAX()	Highest value	MAX(Price)

Example 1 — Total Order Count

```
SELECT COUNT(*) AS TotalOrders FROM Orders;
```

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Product	Amount
O1	C1	Laptop	55000
O2	C1	Mouse	800
O3	C2	Chair	2500
O4	C2	Table	4000
O5	C3	Phone	1200

Example 2 — Total Sales Amount

SELECT SUM(Amount) AS TotalSales FROM Orders;

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Product	Amount
O1	C1	Laptop	55000
O2	C1	Mouse	800
O3	C2	Chair	2500
O4	C2	Table	4000
O5	C3	Phone	1200

Example 3 — Average Order Value

SELECT AVG(Amount) AS AvgOrderValue FROM Orders;

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Product	Amount
O1	C1	Laptop	55000
O2	C1	Mouse	800
O3	C2	Chair	2500
O4	C2	Table	4000
O5	C3	Phone	1200

Example 4 — Minimum and Maximum Order Amount

SELECT MIN(Amount) AS MinOrder, MAX(Amount) AS MaxOrder FROM Orders;

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Product	Amount
O1	C1	Laptop	55000
O2	C1	Mouse	800
O3	C2	Chair	2500
O4	C2	Table	4000
O5	C3	Phone	1200

Example 1 — Total Sales per Customer

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Product	Amount
O1	C1	Laptop	55000
O2	C1	Mouse	800
O3	C2	Chair	2500
O4	C2	Table	4000
O5	C3	Phone	1200

```
SELECT Customer_ID, SUM(Amount) AS TotalSpent
FROM Orders
GROUP BY Customer_ID;
```

Customer_ID	TotalSpent
C1	55800
C2	6500
C3	1200

Example 2 — Average Order Amount per Customer

```
SELECT Customer_ID, AVG(Amount) AS AvgOrder

FROM Orders

GROUP BY Customer_ID;
```

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Product	Amount
O1	C1	Laptop	55000
O2	C1	Mouse	800
O3	C2	Chair	2500
O4	C2	Table	4000
O5	C3	Phone	1200

Total purchase amount of each product bought by each customer.

```
SELECT Customer_ID, Product, SUM(Amount) AS ProductTotal

FROM Orders

GROUP BY Customer_ID, Product;
```

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Product	Amount
O1	C1	Laptop	55000
O2	C1	Mouse	800
O3	C2	Chair	2500
O4	C2	Table	4000
O5	C3	Phone	1200

Find unique customers

SELECT COUNT(DISTINCT Customer_ID) AS UniqueCustomers

FROM Orders;

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Product	Amount
O1	C1	Laptop	55000
O2	C1	Mouse	800
O3	C2	Chair	2500
O4	C2	Table	4000
O5	C3	Phone	1200

Example 1 — Customers Who Spent > 5000

```
SELECT Customer_ID, SUM(Amount) AS TotalSpent
FROM Orders
GROUP BY Customer_ID
HAVING SUM(Amount) > 5000;
```

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Product	Amount
O1	C1	Laptop	55000
O2	C1	Mouse	800
O3	C2	Chair	2500
O4	C2	Table	4000
O5	C3	Phone	1200

Example 2 — Customers with Average Order > 2000

```
SELECT Customer_ID, AVG(Amount) AS AvgOrder

FROM Orders

GROUP BY Customer_ID

HAVING AVG(Amount) > 2000;
```

Cust_ID	Name	City
C1	Arjun	Chennai
C2	Meena	Madurai
C3	Priya	Salem

Order_ID	Cust_ID	Product	Amount
O1	C1	Laptop	55000
O2	C1	Mouse	800
O3	C2	Chair	2500
O4	C2	Table	4000
O5	C3	Phone	1200

Difference Between WHERE and HAVING

Clause	Works On	When Evaluated	Example
WHERE	Individual rows	Before GROUP BY	WHERE Amount > 1000
HAVING	Aggregated groups	After GROUP BY	HAVING SUM(Amount) > 5000

Case When..Else End

Example 1 — Classify Orders as High, Medium, or Low Value

```
SELECT
    Order_ID,
    Amount,
    CASE
        WHEN Amount >= 20000 THEN 'High Value'
        WHEN Amount BETWEEN 5000 AND 19999 THEN 'Medium Value'
        ELSE 'Low Value'
    END AS OrderCategory
FROM Orders;
```

Case When..Else End

Example — Count high-value vs low-value orders

```
SELECT

  SUM(CASE WHEN Amount >= 10000 THEN 1 ELSE 0 END) AS HighValueOrders,

  SUM(CASE WHEN Amount < 10000 THEN 1 ELSE 0 END) AS LowValueOrders

FROM Orders;
```

What is an Index?

Example — Count high-value vs low-value orders

An Index is like a book's index — it speeds up data lookup in a table

without scanning every row

It's a data structure (usually B-Tree or Hash) maintained by the database

Syntax:

```
CREATE INDEX index_name ON table_name (column_name);
```

Example 1 — Create an Index on Customer City

```
CREATE INDEX idx_customer_city ON Customer(City);
```

Query:

```
SELECT * FROM Customer WHERE City = 'Chennai';
```

Example 2 — Composite Index (Multiple Columns)

CREATE INDEX idx_customer_city_name ON Customer(City, Name);

Drop:

DROP INDEX idx_customer_city ON Customer;

Transactions — Ensuring Data Integrity

What is a Transaction?

- A Transaction is a set of SQL operations that execute together as a single unit.
- Either all succeed, or none take effect

ACID Properties:

Property	Meaning	Example
Atomicity	All or nothing	If order fails, stock rollback
Consistency	Keeps DB valid	Total debits = credits
Isolation	Transactions don’t interfere	Parallel transfers
Durability	Changes survive crash	After COMMIT data stays

Transaction

Syntax:

```
START TRANSACTION;


-- operations

UPDATE Product SET Stock = Stock - 1 WHERE Product_ID = 'P1';

INSERT INTO Orders VALUES ('O9','C2','P1',20000);


COMMIT;
```

RollBack

```
START TRANSACTION;


UPDATE Product SET Stock = Stock - 10 WHERE Product_ID = 'P1';


-- Suppose an error occurs here

ROLLBACK;
```

SAVEPOINT Example

Save intermediate points in a transaction

```
START TRANSACTION;

UPDATE Product SET Stock = Stock - 2 WHERE Product_ID = 'P1';

SAVEPOINT sp1;

UPDATE Product SET Stock = Stock - 3 WHERE Product_ID = 'P2';

ROLLBACK TO sp1;  -- undo second update only

COMMIT;
```

Autocommit Mode

```
SET autocommit = 0;

START TRANSACTION;

-- statements

COMMIT;
```

Combined Example

```
START TRANSACTION;


UPDATE Product

SET Stock = Stock - 1

WHERE Product_ID = 'P1';


INSERT INTO Orders (Order_ID, Customer_ID, Product, Amount)

VALUES ('O9', 'C2', 'Laptop', 55000);


COMMIT;
```


T.I.M.E.
Triumphant Institute of Management Education Pvt. Ltd

Thank You