SQL Joins, Normalization (Day 3)

⇒ **Note**

- To show who is PK and FK open DB diagram then right click on relation then properties.
- If you restored DB of someone Diagrams will not be appeared so right click on DB ⇒ properties ⇒ Files ⇒ write in Owner (sa).

Joins types

1. **Cross Join**:

This query returns the Cartesian product of employees and departments.

```
-- Cartesian product (Cross Join)
SELECT e.EmployeeName, d.DepartmentName
FROM Employee e
CROSS JOIN Department d;
```

2. Inner Join (Equi-Join):

This query fetches employees who belong to a department, using the foreign key `DepartmentID`.

```
-- Inner Join (Employees with Departments)
SELECT e.EmployeeName, d.DepartmentName
FROM Employee e
INNER JOIN Department d
ON e.DepartmentID = d.DepartmentID;
```

3. Outer Joins:

a. Left Outer Join:

Returns all employees and their departments, even if the employee is not assigned to any department (departments can be `NULL`).

```
-- Left Outer Join (All Employees with or without Department)
SELECT e.EmployeeName, d.DepartmentName
FROM Employee e
LEFT OUTER JOIN Department d
ON e.DepartmentID = d.DepartmentID;
```

b. Right Outer Join:

Returns all departments and their employees, even if no employee is assigned to that department (employees can be `NULL`).

```
-- Right Outer Join (All Departments with or without Employees)
SELECT e.EmployeeName, d.DepartmentName
FROM Employee e
RIGHT OUTER JOIN Department d
ON e.DepartmentID = d.DepartmentID;
```

c. Full Outer Join:

Returns all employees and departments, even if no matching pairs exist.

```
-- Full Outer Join (All Employees and Departments, even if no match)
SELECT e.EmployeeName, d.DepartmentName
```

```
FROM Employee e
FULL OUTER JOIN Department d
ON e.DepartmentID = d.DepartmentID;
```

4. Self Join (Unary Relationship):

This query returns employees and their managers. It assumes that employees are linked to their manager via the `ManagerID` in the same table.

```
-- Self Join (Employee and their Manager)
SELECT e1.EmployeeName AS Employee, e2.EmployeeName AS Manager
FROM Employee e1
INNER JOIN Employee e2
ON e1.ManagerID = e2.EmployeeID;
```

Some Quaries

1. Select employees, their projects, and working hours:

This query retrieves employee names, project names, and the hours they worked on each project.

```
-- Select employee names, project names, and their working hours
SELECT e.EmployeeName, p.ProjectName, w.Hours
FROM Employee e
INNER JOIN Works_for w ON e.EmployeeID = w.EmployeeID
INNER JOIN Project p ON p.ProjectID = w.ProjectID;
```

2. Select employee names, project names, hours, and department names:

This query retrieves employees, their projects, hours worked, and the departments they belong to.

```
-- Select employee names, project names, hours, and department names
SELECT e.EmployeeName, p.ProjectName, w.Hours, d.DepartmentName
FROM Employee e
INNER JOIN Works_for w ON e.EmployeeID = w.EmployeeID
```

```
INNER JOIN Project p ON p.ProjectID = w.ProjectID
INNER JOIN Department d ON d.DepartmentID = e.DepartmentID;
```

3. Update hours for male employees:

Increase the working hours by 10 for male employees.

```
-- Update working hours for male employees
UPDATE Works_for
SET Hours += 10
FROM Employee e
INNER JOIN Works_for w ON e.EmployeeID = w.EmployeeID
WHERE e.Gender = 'M';
```

String Operations:

4. Using `ISNULL` to replace NULL values:

If `EmployeeName` is `NULL`, replace it with 'hi' (this does not update the actual value in the table).

```
-- Replace NULL values in EmployeeName with 'hi'
SELECT ISNULL(EmployeeName, 'NoName') AS EmployeeName
FROM Employee;
```

5. Using `COALESCE` for multi-level replacements:

If `EmployeeName` is `NULL`, replace it with `LastName`. If `LastName` is also `NULL`, use 'Omar'.

```
-- Multi-level replacement using COALESCE
SELECT COALESCE(EmployeeName, LastName, 'Omar') AS EmployeeNam
e
FROM Employee
```

6. Concatenating different data types:

To concatenate different data types (such as string and numeric), you must convert numeric types to string.

```
-- Concatenate EmployeeName and Salary after converting Salary to varch
ar
SELECT COALESCE(EmployeeName, 'hi') + ' ' + CONVERT(VARCHAR(10),
Salary) AS EmployeeInfo
FROM Employee;
```

7. Handle NULL in concatenation:

If one of the concatenated values is `NULL`, the result would be `NULL`, so handle this using `ISNULL`.

```
-- Handle NULL in concatenation for Salary
SELECT COALESCE(EmployeeName, 'hi') + ' ' + CONVERT(VARCHAR(10), I
SNULL(Salary, 0)) AS EmployeeInfo
FROM Employee;
```

8. Using `CONCAT` for type-safe concatenation:

`CONCAT` automatically converts all types to string, replacing `NULL` with an empty string.

```
-- Use CONCAT to safely concatenate EmployeeName and Salary
SELECT CONCAT(EmployeeName, ' ', Salary) AS EmployeeInfo
FROM Employee;
```

Pattern Matching with `LIKE`:

9. Pattern matching examples:

> **(_) is one char and (%) is zero or more char**

```
-- 1. Select all employees where EmployeeName contains 'r'
SELECT * FROM Employee WHERE EmployeeName LIKE '%r%';

-- 2. Select employees where EmployeeName ends with 'r'
SELECT * FROM Employee WHERE EmployeeName LIKE '%r';
```

```
-- 3. Select employees where EmployeeName starts with 'r'
SELECT * FROM Employee WHERE EmployeeName LIKE 'r%';

-- 4. Select employees where the second character is 'r'
SELECT * FROM Employee WHERE EmployeeName LIKE '_r%';

-- 5. Select employees where EmployeeName starts with 'o' and ends with
'r'
SELECT * FROM Employee WHERE EmployeeName LIKE 'o%r';

-- 6. Select employees where EmployeeName starts with 'o' or 'a' and ends
with 'r'
SELECT * FROM Employee WHERE EmployeeName LIKE '[oa]%r';

-- 7. Select employees where EmployeeName starts with anything but 'a',
'b', or 'c' and ends with 'r'
SELECT * FROM Employee WHERE EmployeeName LIKE '[^abc]%r';

-- 8. Select employees where EmployeeName starts with a character betwe
en 'a' and 'h' and ends with 'r'
SELECT * FROM Employee WHERE EmployeeName LIKE '[a-h]%r';

-- 9. Select employees where EmployeeName ends with a percent sign (%)
SELECT * FROM Employee WHERE EmployeeName LIKE '%[%]';

-- 10. Select employees where EmployeeName contains an underscore (_)
SELECT * FROM Employee WHERE EmployeeName LIKE '%[_]%';

--11.If you're trying to find employee names with at least two underscores,
you'd write:
SELECT * FROM Employee WHERE EmployeeName LIKE '%[_]%[_]%';

--12. find employee names begin and end with underscores, you'd write:
SELECT * FROM Employee WHERE EmployeeName LIKE '[_] % [_]';
```

Ordering Results:

10. Order by column position:

Order results by the second column.

```
-- Order by the second column
SELECT * FROM Employee ORDER BY 2;
```

11. Order by multiple columns:

Order by `EmployeeName` in ascending order, and if names are equal, order by `LastName` in descending order.

```
-- Order by EmployeeName (ascending) and LastName (descending)
SELECT * FROM Employee
ORDER BY EmployeeName ASC, LastName DESC;
```

Key Improvements:

1. **Consistent naming**: Use descriptive and consistent naming for columns and tables.
2. **Joins**: Utilize explicit `INNER JOIN` and `OUTER JOIN` syntax for clarity.
3. **String operations**: Use `ISNULL`, `COALESCE`, and `CONCAT` appropriately for handling `NULL` values and concatenation.
4. **Pattern matching**: Clearly demonstrate usage of pattern matching with `LIKE`.
5. **Order by**: Use meaningful ordering, including column positions and multi-column sorting.

Normalization

Normalization: Minimizing Redundancy and Inconsistencies

Normalization is a fundamental process in database design that helps reduce redundancy and avoid data anomalies such as insertion, deletion, and modification issues. It involves breaking larger tables into smaller, more manageable related tables and establishing relationships between them.

Key Points of Normalization:

1. **DB Design Approaches**:
    - Databases can be designed using **Entity-Relationship Diagrams (ERD)** or by applying **Normalization** rules.
    - **ERD** provides a visual representation of the entities and relationships, while **Normalization** is a systematic approach for improving data integrity.
2. **Breaking Tables**:
    - In **Normalization**, you take a large, unstructured table and break it into two or more smaller tables, establishing relationships between them using primary and foreign keys.
3. **Stages of Normalization**:
    - **Normalization** follows a series of steps, each aimed at eliminating different types of redundancy and dependency issues. If a table violates certain rules, it is said to be **denormalized**.
4. **Working on Existing Data**:
    - Normalization can be applied to **data already existing** in a database, Excel sheets, or other sources to restructure it for better integrity and efficiency.
5. **Reinitialize DB for Correctness**:
    - By applying normalization, you ensure that the database tables are correctly structured and maintain the integrity of the data.
6. **Mapping Verification**:
    - You can check the correctness of table relationships by examining whether they follow the **Normalization rules**. This helps ensure that the structure avoids redundancy and anomalies.
7. **Avoiding Anomalies**:
    - **Insertion Anomaly**: Adding new rows forces the duplication of data.
    - **Deletion Anomaly**: Deleting a row may cause a loss of valuable data in the future.
    - **Modification Anomaly**: Changing data in one row forces changes in other rows due to duplicated information.

Benefits of Normalization:

- **Redundancy Removed**: Instructor data is no longer repeated for every student enrolled in a course.
- **Anomalies Avoided**:
  - **Insertion Anomaly**: You can now add a new student without duplicating instructor information.
  - **Deletion Anomaly**: Deleting a student's enrollment record does not delete the instructor.
  - **Modification Anomaly**: If the instructor's email changes, you only need to update it in one place.

Functional Dependencies

Functional dependencies (FDs) describe the relationships between columns in a database table. If column **A** determines column **B**, this is represented as **A → B**, meaning for every unique value of **A**, there is only one corresponding value of **B**.

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1. Full Functional Dependency (FFD)

A full functional dependency occurs when a non-key attribute is fully dependent on the entire **composite key**. If you remove any part of the composite key, the dependency no longer holds.

Example:

In a company database, suppose we have a table for **project assignments** where both **EmployeeID** and **ProjectID** together determine how many **HoursWorked** an employee spends on a project. This is a full dependency because both columns are needed to determine the number of hours worked.

```
-- Table: ProjectAssignment
CREATE TABLE ProjectAssignment (
    EmployeeID INT,
    ProjectID INT,
    HoursWorked INT,
    PRIMARY KEY (EmployeeID, ProjectID)  -- Composite Primary Key
```

```
);

-- Insert Example Data
INSERT INTO ProjectAssignment (EmployeeID, ProjectID, HoursWorked) VA
LUES
(1, 101, 30),
(2, 101, 20),
(1, 102, 25),
(2, 102, 15);

-- Full Dependency: EmployeeID, ProjectID → HoursWorked
```

In this case, **EmployeeID** and **ProjectID** together determine the **HoursWorked**, so the functional dependency is:

`(EmployeeID, ProjectID) → HoursWorked`

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2. Partial Functional Dependency (PFD)

A partial functional dependency occurs when a non-key attribute depends on **part** of a composite key. This typically happens when a column depends on one of the components of the composite primary key but not the entire key.

Example:

Let's say we have a table where **EmployeeID** and **DepartmentID** together form a composite key, and each **DepartmentID** determines the **Manager** of that department. This represents a **partial dependency**.

```
-- Table: EmployeeDepartment
CREATE TABLE EmployeeDepartment (
    EmployeeID INT,
    DepartmentID INT,
    Manager VARCHAR(100),
    PRIMARY KEY (EmployeeID, DepartmentID)  -- Composite Primary Key
);

-- Insert Example Data
INSERT INTO EmployeeDepartment (EmployeeID, DepartmentID, Manager)
VALUES
(1, 1, 'John Smith'),
```

```
(2, 1, 'John Smith'),
(3, 2, 'Mary Jones');

-- Partial Dependency: DepartmentID → Manager
```

Here, the manager is determined solely by **DepartmentID**, not by **EmployeeID**. Therefore, there is a **partial dependency**:

`DepartmentID → Manager`

To resolve this, we could move the **Manager** column to a separate **Department** table, making it fully dependent on **DepartmentID**:

```
-- Table: Department
CREATE TABLE Department (
    DepartmentID INT PRIMARY KEY,
    Manager VARCHAR(100)
);

-- Insert Data
INSERT INTO Department (DepartmentID, Manager) VALUES
(1, 'John Smith'),
(2, 'Mary Jones');
```

---

3. Transitive Functional Dependency (TFD)

A transitive dependency occurs when a non-key attribute depends on another non-key attribute, which is itself determined by the primary key. This creates an indirect relationship.

Example:

Suppose we have a table where **EmployeeID** determines the **ZipCode**, and the **ZipCode** determines the **City**. This is a **transitive dependency** because **City** depends on **ZipCode**, which is determined by **EmployeeID**.

```
-- Table: Employee
CREATE TABLE Employee (
    EmployeeID INT PRIMARY KEY,
    EmployeeName VARCHAR(100),
    ZipCode VARCHAR(10),
```

```
    City VARCHAR(100)
);

-- Insert Example Data
INSERT INTO Employee (EmployeeID, EmployeeName, ZipCode, City) VALU
ES
(1, 'Alice', '90210', 'Beverly Hills'),
(2, 'Bob', '10001', 'New York'),
(3, 'Charlie', '94105', 'San Francisco');

-- Transitive Dependency: ZipCode → City
```

In this case, **City** depends on **ZipCode**, and **ZipCode** is determined by **EmployeeID**, making this a transitive dependency:

`EmployeeID → ZipCode → City`

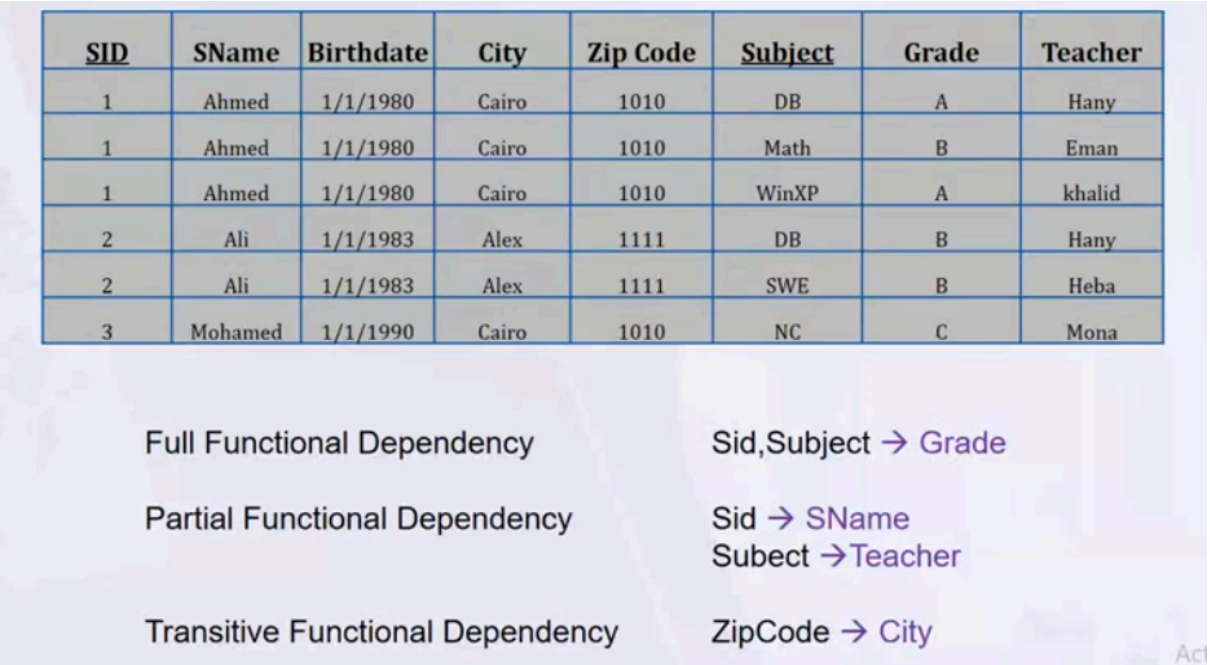
To remove the transitive dependency, we can create a separate **ZipCode** table that stores the **City**:

```
-- Table: ZipCode
CREATE TABLE ZipCode (
    ZipCode VARCHAR(10) PRIMARY KEY,
    City VARCHAR(100)
);

-- Insert Data
INSERT INTO ZipCode (ZipCode, City) VALUES
('90210', 'Beverly Hills'),
('10001', 'New York'),
('94105', 'San Francisco');

-- Modified Employee Table
CREATE TABLE Employee (
    EmployeeID INT PRIMARY KEY,
    EmployeeName VARCHAR(100),
    ZipCode VARCHAR(10),
    FOREIGN KEY (ZipCode) REFERENCES ZipCode(ZipCode)
);
```

Now, **ZipCode** determines **City** in its own table, and **EmployeeID** only determines the **ZipCode**, avoiding the transitive dependency.

Summary of Functional Dependencies in SQL:

- **Full Functional Dependency**: Occurs when a non-key column depends on the entire composite primary key.
- **Partial Functional Dependency**: Occurs when a non-key column depends on part of the composite primary key.
- **Transitive Functional Dependency**: Occurs when a non-key column depends on another non-key column, which is itself determined by the primary key.



SID	SName	Birthdate	City	Zip Code	Subject	Grade	Teacher
1	Ahmed	1/1/1980	Cairo	1010	DB	A	Hany
1	Ahmed	1/1/1980	Cairo	1010	Math	B	Eman
1	Ahmed	1/1/1980	Cairo	1010	WinXP	A	khalid
2	Ali	1/1/1983	Alex	1111	DB	B	Hany
2	Ali	1/1/1983	Alex	1111	SWE	B	Heba
3	Mohamed	1/1/1990	Cairo	1010	NC	C	Mona

Steps in Normalization

Step 1: Zero Normal Form (0NF)

At this stage, the table is unnormalized. It contains multivalued attributes or repeating groups.

Example: Employee Table in 0NF

Here, the employee table contains repeating groups (multiple phone numbers for the same employee) and is in **0NF**.

```
-- Table: Employee in 0NF
CREATE TABLE Employee (
    EmployeeID INT,
    EmployeeName VARCHAR(100),
    Department VARCHAR(100),
    PhoneNumber VARCHAR(100),    -- Repeating group (multivalued attribut
e)
    Address VARCHAR(255)
);

-- Insert Example Data
INSERT INTO Employee (EmployeeID, EmployeeName, Department, Phone
Number, Address) VALUES
(1, 'Alice', 'HR', '12345, 67890', '123 Main St'),
(2, 'Bob', 'Sales', '98765', '456 Oak St');
```

The **PhoneNumber** column contains multiple values, which violates normalization rules.

Step 2: First Normal Form (1NF)

In **1NF**, we remove repeating groups and multivalued attributes. Each column must contain atomic values (a single value per cell).

Transform to 1NF:

We split the multivalued attribute **PhoneNumber** into multiple rows.

```
-- Table: Employee in 1NF
CREATE TABLE Employee (
    EmployeeID INT,
    EmployeeName VARCHAR(100),
    Department VARCHAR(100),
    Address VARCHAR(255)
);

CREATE TABLE EmployeePhone (
```

```
    EmployeeID INT,
    PhoneNumber VARCHAR(100),
    PRIMARY KEY (EmployeeID, PhoneNumber),
    FOREIGN KEY (EmployeeID) REFERENCES Employee(EmployeeID)
);

-- Insert Example Data into Employee
INSERT INTO Employee (EmployeeID, EmployeeName, Department, Addres
s) VALUES
(1, 'Alice', 'HR', '123 Main St'),
(2, 'Bob', 'Sales', '456 Oak St');

-- Insert Example Data into EmployeePhone
INSERT INTO EmployeePhone (EmployeeID, PhoneNumber) VALUES
(1, '12345'),
(1, '67890'),
(2, '98765');
```

Now, the **PhoneNumber** column contains only atomic values, and each phone number is linked to a single employee in a separate table.

Step 3: Second Normal Form (2NF)

In **2NF**, we remove **partial dependencies**. A table is in 2NF if it is in 1NF and all non-key attributes are fully dependent on the primary key. If we have a composite key, no non-key column should depend on part of that key.

Example:

Let's say an employee works on multiple projects, and the **ProjectID** and **EmployeeID** together form the primary key. We will move any attributes that depend on only part of the composite key to a new table.

Unnormalized Table (1NF):

```
-- Unnormalized EmployeeProject Table in 1NF
CREATE TABLE EmployeeProject (
    EmployeeID INT,
    ProjectID INT,
    ProjectName VARCHAR(100),
```

```
    HoursWorked INT,
    Department VARCHAR(100),    -- Partial dependency: Department depen
ds on EmployeeID, not ProjectID
    PRIMARY KEY (EmployeeID, ProjectID)
);
```

Here, the **Department** depends only on **EmployeeID** (part of the composite key), which violates 2NF.

Transform to 2NF:

We move **Department** to a separate **Employee** table because it depends only on **EmployeeID**.

```
-- Table: Employee in 2NF
CREATE TABLE Employee (
    EmployeeID INT PRIMARY KEY,
    EmployeeName VARCHAR(100),
    Department VARCHAR(100),    -- No partial dependency now
    Address VARCHAR(255)
);

-- Table: EmployeeProject in 2NF
CREATE TABLE EmployeeProject (
    EmployeeID INT,
    ProjectID INT,
    ProjectName VARCHAR(100),
    HoursWorked INT,
    PRIMARY KEY (EmployeeID, ProjectID),
    FOREIGN KEY (EmployeeID) REFERENCES Employee(EmployeeID)
);

-- Insert Example Data
INSERT INTO Employee (EmployeeID, EmployeeName, Department, Addres
s) VALUES
(1, 'Alice', 'HR', '123 Main St'),
(2, 'Bob', 'Sales', '456 Oak St');

INSERT INTO EmployeeProject (EmployeeID, ProjectID, ProjectName, Hours
```

```
Worked) VALUES
(1, 101, 'Project A', 30),
(2, 102, 'Project B', 20);
```

Now, **Department** has been moved to the **Employee** table because it only depends on **EmployeeID**, achieving 2NF.

Step 4: Third Normal Form (3NF)

In **3NF**, we remove **transitive dependencies**. A table is in 3NF if it is in 2NF and there are no transitive dependencies (non-key columns depending on other non-key columns).

Example:

If **ZipCode** determines **City**, and **EmployeeID** determines **ZipCode**, then **City** depends on a non-key column (**ZipCode**), creating a transitive dependency.

Unnormalized Table (2NF):

```
-- Unnormalized Employee Table in 2NF
CREATE TABLE Employee (
    EmployeeID INT PRIMARY KEY,
    EmployeeName VARCHAR(100),
    Department VARCHAR(100),
    Address VARCHAR(255),
    ZipCode VARCHAR(10),     -- Transitive dependency: City depends on Zip
Code
    City VARCHAR(100)
);
```

Here, **City** depends on **ZipCode**, which is not part of the primary key.

Transform to 3NF:

We move **City** to a separate table where it is determined by **ZipCode**, eliminating the transitive dependency.

```
-- Table: Employee in 3NF
CREATE TABLE Employee (
    EmployeeID INT PRIMARY KEY,
```

```
    EmployeeName VARCHAR(100),
    Department VARCHAR(100),
    Address VARCHAR(255),
    ZipCode VARCHAR(10),
    FOREIGN KEY (ZipCode) REFERENCES ZipCodeTable(ZipCode)
);

-- Table: ZipCodeTable
CREATE TABLE ZipCodeTable (
    ZipCode VARCHAR(10) PRIMARY KEY,
    City VARCHAR(100)
);

-- Insert Example Data into Employee
INSERT INTO Employee (EmployeeID, EmployeeName, Department, Addres
s, ZipCode) VALUES
(1, 'Alice', 'HR', '123 Main St', '90210'),
(2, 'Bob', 'Sales', '456 Oak St', '10001');

-- Insert Example Data into ZipCodeTable
INSERT INTO ZipCodeTable (ZipCode, City) VALUES
('90210', 'Beverly Hills'),
('10001', 'New York');
```

Now, **City** depends on **ZipCode** in a separate table, and **Employee** only determines **ZipCode**, achieving 3NF.

Summary of Normalization Process:

1. **0NF**: Raw table with multivalued attributes and repeating groups.
2. **1NF**: Remove multivalued attributes, ensuring each cell has atomic values.
3. **2NF**: Eliminate partial dependencies by moving attributes to new tables if they depend only on part of a composite primary key.
4. **3NF**: Remove transitive dependencies by ensuring that non-key attributes depend only on the primary key.

Each step reduces redundancy and improves data integrity, ensuring a clean and optimized database design.

LAB

```
-- Create Database
CREATE DATABASE CompanyDB;

-- Use the CompanyDB
USE CompanyDB;

-- Create Departments Table
CREATE TABLE Departments (
    DepartmentID INT PRIMARY KEY,  -- Unique identifier for each department
    DepartmentName VARCHAR(100) NOT NULL,        -- Name of the departme
    ManagerID INT,                               -- ID of the department manager
    --FOREIGN KEY (ManagerID) REFERENCES Employees(EmployeeID)  -- Ref
);

-- Step 1: Alter the Departments table to add the foreign key constraint
ALTER TABLE Departments
ADD CONSTRAINT fk_Manager
FOREIGN KEY (ManagerID) REFERENCES Employees(EmployeeID);

-- Create Employees Table
CREATE TABLE Employees (
    EmployeeID INT PRIMARY KEY ,     -- Unique identifier for each employee
    SSN VARCHAR(11) NOT NULL UNIQUE,             -- Social Security Number (
    EmployeeName VARCHAR(100) NOT NULL,          -- Employee's name
    SupervisorSSN VARCHAR(11),                   -- Supervisor's SSN (can be NUl
    Salary DECIMAL(10, 2) CHECK (Salary >= 0),     -- Employee's salary
    Birthdate DATE,                              -- Employee's birth date
    Address VARCHAR(255),                        -- Employee's address
    DepartmentID INT,                            -- ID of the department employee belo
    FOREIGN KEY (DepartmentID) REFERENCES Departments(DepartmentID)  -
);
```

```
-- Create Projects Table
CREATE TABLE Projects (
    ProjectID INT PRIMARY KEY,       -- Unique identifier for each project
    ProjectName VARCHAR(100) NOT NULL,            -- Name of the project
    Location VARCHAR(100),                    -- Location of the project
    DepartmentID INT,                         -- ID of the controlling department
    FOREIGN KEY (DepartmentID) REFERENCES Departments(DepartmentID)  -
);

-- Create Dependents Table
CREATE TABLE Dependents (
    DependentID INT PRIMARY KEY,     -- Unique identifier for each dependent
    EmployeeID INT,                           -- ID of the employee the dependent be
    DependentName VARCHAR(100) NOT NULL,          -- Name of the depende
    Relationship VARCHAR(50),                 -- Relationship to the employee
    Birthdate DATE,                           -- Birthdate of the dependent
    FOREIGN KEY (EmployeeID) REFERENCES Employees(EmployeeID)  -- Refe
);

-- Create Works_For Table (Associative Table for Employee-Project relationshi
CREATE TABLE Works_For (
    EmployeeID INT,                           -- ID of the employee
    ProjectID INT,                          -- ID of the project
    HoursPerWeek INT CHECK (HoursPerWeek >= 0),    -- Hours per week emp
    PRIMARY KEY (EmployeeID, ProjectID),          -- Composite primary key
    FOREIGN KEY (EmployeeID) REFERENCES Employees(EmployeeID),  -- Refe
    FOREIGN KEY (ProjectID) REFERENCES Projects(ProjectID)    -- Reference t
);

INSERT INTO Departments (DepartmentID, DepartmentName, ManagerID) VAl
(1, 'Human Resources', NULL),
(2, 'Finance', NULL),
(3, 'IT', NULL),
(4, 'Marketing', NULL),
(5, 'Sales', NULL),
(6, 'Customer Support', NULL),
(7, 'Research and Development', NULL),
```

```
(8, 'Production', NULL),
(9, 'Logistics', NULL),
(10, 'Legal', NULL),
(11, 'Purchasing', NULL),
(12, 'Public Relations', NULL),
(13, 'Training', NULL),
(14, 'Quality Assurance', NULL),
(15, 'Safety', NULL),
(16, 'IT Support', NULL),
(17, 'Administration', NULL),
(18, 'Business Development', NULL),
(19, 'Data Analytics', NULL),
(20, 'Product Management', NULL);

INSERT INTO Employees (EmployeeID, SSN, EmployeeName, SupervisorSSN,
(1, '123-45-6789', 'John Smith', NULL, 55000, '1985-06-15', '123 Main St, Cityv
(2, '234-56-7890', 'Jane Doe', '123-45-6789', 60000, '1983-05-10', '456 Elm S
(3, '345-67-8901', 'Michael Johnson', '123-45-6789', 50000, '1987-04-12', '78
(4, '456-78-9012', 'Emily Davis', '234-56-7890', 70000, '1990-03-08', '321 Pin
(5, '567-89-0123', 'Chris Wilson', '234-56-7890', 48000, '1989-07-22', '654 M
(6, '678-90-1234', 'Anna Brown', '345-67-8901', 52000, '1991-08-30', '987 Ce
(7, '789-01-2345', 'James Taylor', '456-78-9012', 58000, '1988-09-19', '654 Bi
(8, '890-12-3456', 'Linda Anderson', '567-89-0123', 59000, '1986-11-15', '321
(9, '901-23-4567', 'David Thomas', '678-90-1234', 64000, '1984-12-05', '123 S
(10, '012-34-5678', 'Sarah Martinez', '789-01-2345', 62000, '1992-10-25', '456
(11, '123-45-6780', 'Daniel Garcia', '890-12-3456', 53000, '1980-02-14', '789 P
(12, '234-56-7891', 'Jessica Rodriguez', '901-23-4567', 47000, '1993-01-30', '
(13, '345-67-8902', 'Thomas Lee', '012-34-5678', 55000, '1995-03-20', '654 P
(14, '456-78-9013', 'Laura Wilson', '123-45-6780', 61000, '1982-06-11', '987 Pl
(15, '567-89-0124', 'Brian Martin', '234-56-7891', 49000, '1988-07-29', '654 W
(16, '678-90-1235', 'Megan Clark', '345-67-8902', 57000, '1984-08-20', '321 P
(17, '789-01-2346', 'Patricia Lewis', '456-78-9013', 56000, '1991-09-09', '123 L
(18, '890-12-3457', 'Kevin Walker', '567-89-0124', 50000, '1983-10-31', '456 R
(19, '901-23-4568', 'Amy Hall', '678-90-1235', 48000, '1990-11-20', '789 Daisy
(20, '012-34-5679', 'Mark Allen', '789-01-2346', 45000, '1986-12-12', '321 Lily

INSERT INTO Projects (ProjectID, ProjectName, Location, DepartmentID) VALU
(1, 'Project Alpha', 'Cairo', 1),
```

```
(2, 'Project Beta', 'Alexandria', 2),
(3, 'Project Gamma', 'Cairo', 3),
(4, 'Project Delta', 'Alexandria', 4),
(5, 'Project Epsilon', 'Cairo', 5),
(6, 'Project Zeta', 'Alexandria', 6),
(7, 'Project Eta', 'Cairo', 7),
(8, 'Project Theta', 'Alexandria', 8),
(9, 'Project Iota', 'Cairo', 9),
(10, 'Project Kappa', 'Alexandria', 10),
(11, 'Project Lambda', 'Cairo', 11),
(12, 'Project Mu', 'Alexandria', 12),
(13, 'Project Nu', 'Cairo', 13),
(14, 'Project Xi', 'Alexandria', 14),
(15, 'Project Omicron', 'Cairo', 15),
(16, 'Project Pi', 'Alexandria', 16),
(17, 'Project Rho', 'Cairo', 17),
(18, 'Project Sigma', 'Alexandria', 18),
(19, 'Project Tau', 'Cairo', 19),
(20, 'Project Upsilon', 'Alexandria', 20);


INSERT INTO Dependents (DependentID, EmployeeID, DependentName, Relat
(1, 1, 'Alice Smith', 'Daughter', '2010-05-14'),
(2, 1, 'Bob Smith', 'Son', '2012-11-23'),
(3, 2, 'Charlie Doe', 'Son', '2011-07-19'),
(4, 3, 'Daniel Johnson', 'Brother', '1985-02-15'),
(5, 4, 'Eva Davis', 'Sister', '1995-03-18'),
(6, 5, 'Fiona Wilson', 'Daughter', '2008-04-25'),
(7, 6, 'George Brown', 'Son', '2015-01-10'),
(8, 7, 'Hannah Taylor', 'Daughter', '2013-06-12'),
(9, 8, 'Ian Anderson', 'Son', '2014-08-22'),
(10, 9, 'Jack Thomas', 'Brother', '1980-09-30'),
(11, 10, 'Karen Martinez', 'Sister', '1992-10-14'),
(12, 11, 'Larry Garcia', 'Brother', '1988-01-05'),
(13, 12, 'Megan Rodriguez', 'Daughter', '2007-12-20'),
(14, 13, 'Nancy Lee', 'Sister', '1991-11-25'),
(15, 14, 'Oscar Wilson', 'Son', '2015-03-17'),
(16, 15, 'Paula Martin', 'Daughter', '2016-07-28'),
```

```
(17, 16, 'Quinn Clark', 'Daughter', '2012-04-05'),
(18, 17, 'Ryan Lewis', 'Son', '2014-06-30'),
(19, 18, 'Sophie Hall', 'Daughter', '2011-09-09'),
(20, 19, 'Tom Allen', 'Son', '2009-12-12');


INSERT INTO Works_For (EmployeeID, ProjectID, HoursPerWeek) VALUES
(1, 1, 40),
(1, 2, 20),
(2, 1, 30),
(2, 3, 25),
(3, 4, 35),
(3, 5, 20),
(4, 6, 40),
(5, 7, 15),
(6, 8, 30),
(7, 9, 20),
(8, 10, 35),
(9, 11, 40),
(10, 12, 30),
(11, 13, 25),
(12, 14, 20),
(13, 15, 15),
(14, 16, 40),
(15, 17, 30),
(16, 18, 35),
(17, 19, 20),
(18, 20, 25);
```

Below are the SQL queries to execute the requested operations on the `CompanyDB` database.

Query 1: Display the Department ID, Name, and ID and Name of its Manager

```
SELECT
    d.DepartmentID,
```

```
    d.DepartmentName,
    e.EmployeeID AS ManagerID,
    e.EmployeeName AS ManagerName
FROM
    Departments d
LEFT JOIN
    Employees e ON d.ManagerID = e.EmployeeID;
```

Query 2: Display the Name of the Departments and the Name of the Projects Under Its Control

```
SELECT
    d.DepartmentName,
    p.ProjectName
FROM
    Departments d
JOIN
    Projects p ON d.DepartmentID = p.DepartmentID;
```

Query 3: Display Full Data About All the Dependents Associated with the Name of the Employee They Depend On

```
SELECT
    e.EmployeeName AS EmployeeName,
    d.*
FROM
    Dependents d
JOIN
    Employees e ON d.EmployeeID = e.EmployeeID;
```

Query 4: Display the ID, Name, and Location of the Projects in Cairo or Alexandria

```
SELECT
    ProjectID,
    ProjectName,
    Location
```

```
FROM
    Projects
WHERE
    Location IN ('Cairo', 'Alexandria');
```

Query 5: Display the Full Data of the Projects with a Name Starting with "A"

```
SELECT
    *
FROM
    Projects
WHERE
    ProjectName LIKE 'A%';
```

Query 6: Display All Employees in Department 30 Whose Salary is Between 1000 and 2000 LE Monthly

```
SELECT
    *
FROM
    Employees
WHERE
    DepartmentID = 30 AND
    Salary BETWEEN 1000 AND 2000;
```

Query 7: Retrieve Names of All Employees in Department 10 Who Work More Than or Equal to 10 Hours Per Week on "AL Rabwah" Project

```
SELECT
    e.EmployeeName
FROM
    Employees e
JOIN
    Works_For wf ON e.EmployeeID = wf.EmployeeID
JOIN
```

```
    Projects p ON wf.ProjectID = p.ProjectID
WHERE
    e.DepartmentID = 10 AND
    wf.HoursPerWeek >= 10 AND
    p.ProjectName = 'AL Rabwah';
```

Query 8: Find Names of Employees Who Are Directly Supervised by Kamel Mohamed

```
SELECT
    e.EmployeeName
FROM
    Employees e
WHERE
    e.SupervisorSSN = (SELECT SSN FROM Employees WHERE EmployeeNa
me = 'Kamel Mohamed');
```

Query 9: Retrieve Names of All Employees and the Names of the Projects They Are Working On, Sorted by Project Name

```
SELECT
    e.EmployeeName,
    p.ProjectName
FROM
    Employees e
JOIN
    Works_For wf ON e.EmployeeID = wf.EmployeeID
JOIN
    Projects p ON wf.ProjectID = p.ProjectID
ORDER BY
    p.ProjectName;
```

Query 10: For Each Project Located in Cairo City, Find Project Number, Controlling Department Name, Department Manager Last Name, Address, and Birthdate

```
SELECT
    p.ProjectID,
    d.DepartmentName,
    e.EmployeeName AS ManagerLastName,
    e.Address,
    e.Birthdate
FROM
    Projects p
JOIN
    Departments d ON p.DepartmentID = d.DepartmentID
JOIN
    Employees e ON d.ManagerID = e.EmployeeID
WHERE
    p.Location = 'Cairo';
```

Query 11: Display All Data of the Managers

```
SELECT
    *
FROM
    Employees
WHERE
    EmployeeID IN (SELECT DISTINCT ManagerID FROM Departments WHE
RE ManagerID IS NOT NULL);
```

Query 12: Display All Employees Data and the Data of Their Dependents Even If They Have No Dependents

```
SELECT
    e.*,
    d.*
FROM
    Employees e
LEFT JOIN
    Dependents d ON e.EmployeeID = d.EmployeeID;
```

Data Manipulating Language

1. Insert Your Personal Data to the Employee Table as a New Employee in Department Number 30

```
INSERT INTO Employees (EmployeeID, SSN, EmployeeName, SupervisorSS
N, Salary, Birthdate, Address, DepartmentID) VALUES
(21, '102672', 'Your Name', NULL, 3000, 'YYYY-MM-DD', 'Your Address', 3
0);
```

Replace `'Your Name'`, `'YYYY-MM-DD'`, *and* `'Your Address'` *with your actual data.*

2. Insert Another Employee with Your Friend's Personal Data as New Employee in Department Number 30

```
INSERT INTO Employees (EmployeeID, SSN, EmployeeName, SupervisorSS
N, Salary, Birthdate, Address, DepartmentID) VALUES
(22, '102660', 'Friend\\'s Name', NULL, NULL, 'YYYY-MM-DD', 'Friend\\'s A
ddress', 30);
```

Replace `'Friend's Name'`, `'YYYY-MM-DD'`, *and* `'Friend's Address'` *with your friend's actual data.*

3. Upgrade Your Salary by 20% of Its Last Value

```
UPDATE Employees
SET Salary = Salary * 1.2
WHERE SSN = '102672'; -- Your SSN
```