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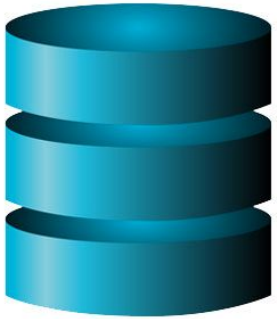
Introduction to Database

What is Database?

Database is a collection of information organized for easy access, management and maintenance.

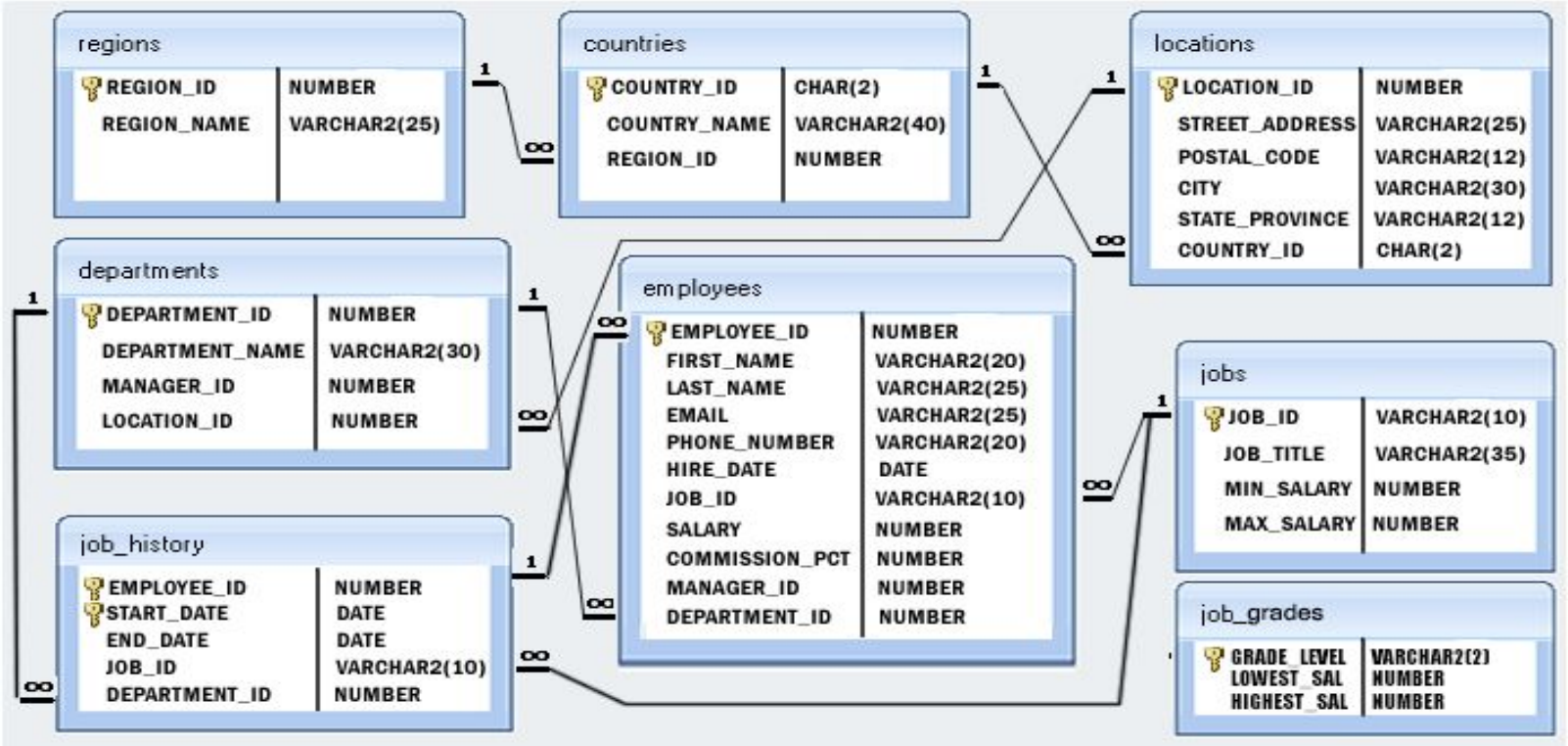
- Examples:
  - Telephone directory
  - Customer data
  - Product inventory
  - Visitors' register
  - Weather records



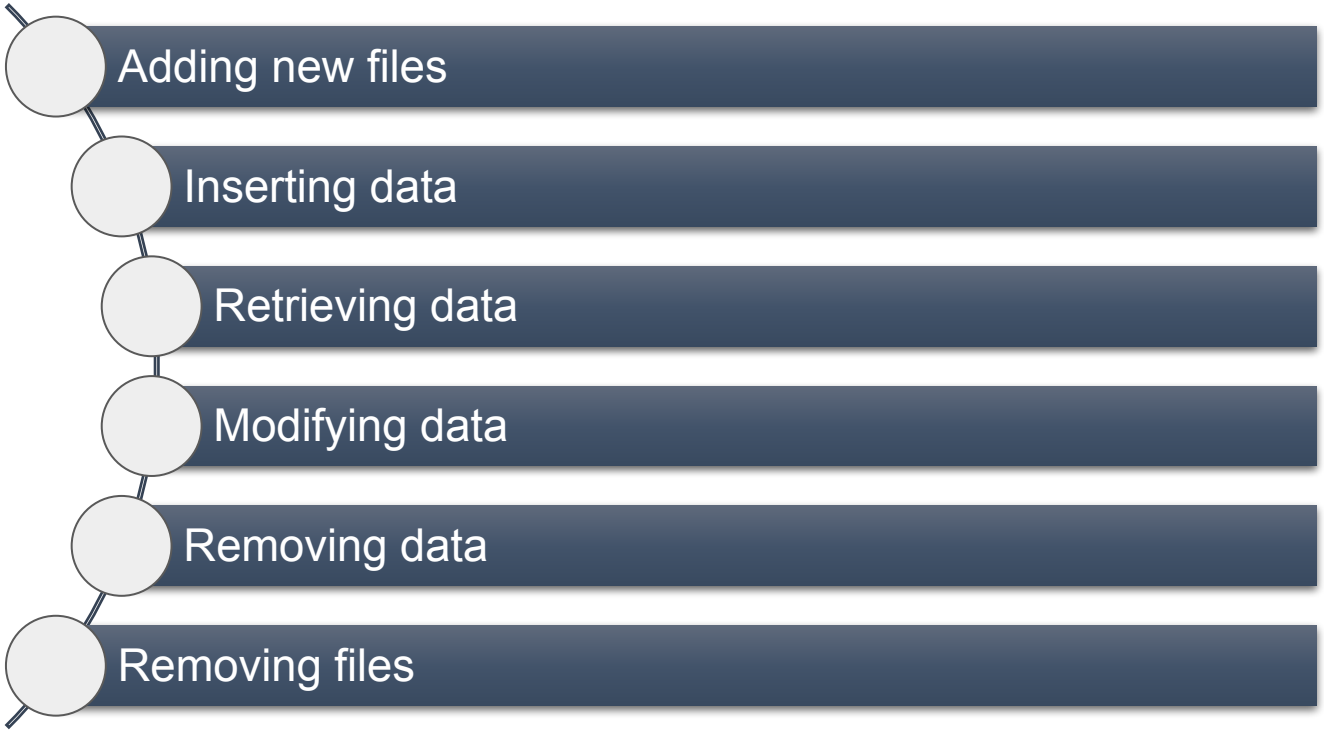
Types of Data Models

- **Record based logical model**
  - Hierarchical data model
  - Network data model
  - Relational data model
- **Object based logical model**
  - Entity relationship model

E/R Diagram



DBMS Operations



Advantages of DBMS

- Sharing of data across applications
- Reduced data redundancy
- Enhanced security mechanism
- Data independence
- Better flexibility
- Enforce integrity constraints
- Better transaction support
- Enforce standards
- Backup and recovery features

Introduction to RDBMS

- A relational database refers to a database that stores data in a structured format, using rows and columns.
- This makes it easier to locate and access specific values within the database.
- It is "relational" because the values within each table are related to each other. Tables may also be related to other tables.
- The relational structure makes it possible to run queries across multiple tables at once.

Features of RDBMS

- Every piece of information is stored in the form of tables
- Has primary keys for unique identification of rows
- Has foreign keys to ensure data integrity
- Provides SQL for data access
- Uses indexes for faster data retrieval
- Gives access privileges to ensure data security

RDBMS VS TRADITIONAL APPROACH

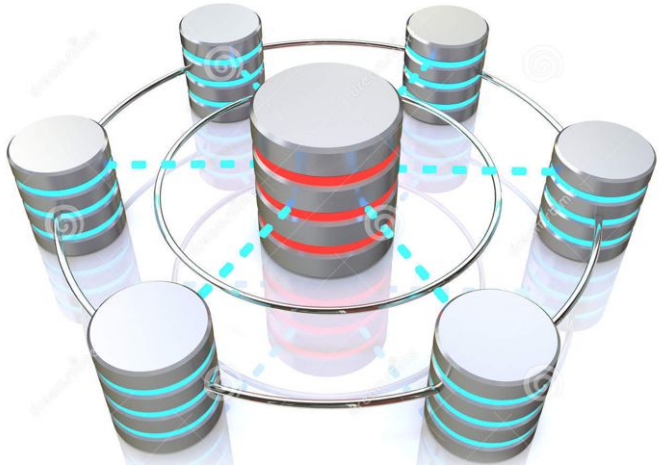
- The key difference is that RDBMS (relational database management system) applications store data in a tabular form, whereas in tradition approach, applications store data as files.

- There can be, but there will be no “relation” between the tables, like in a RDBMS. In traditional approach, data is generally stored in either a hierarchical form or a navigational form. This means that a single data unit will have one parent node and zero, one or more children nodes.

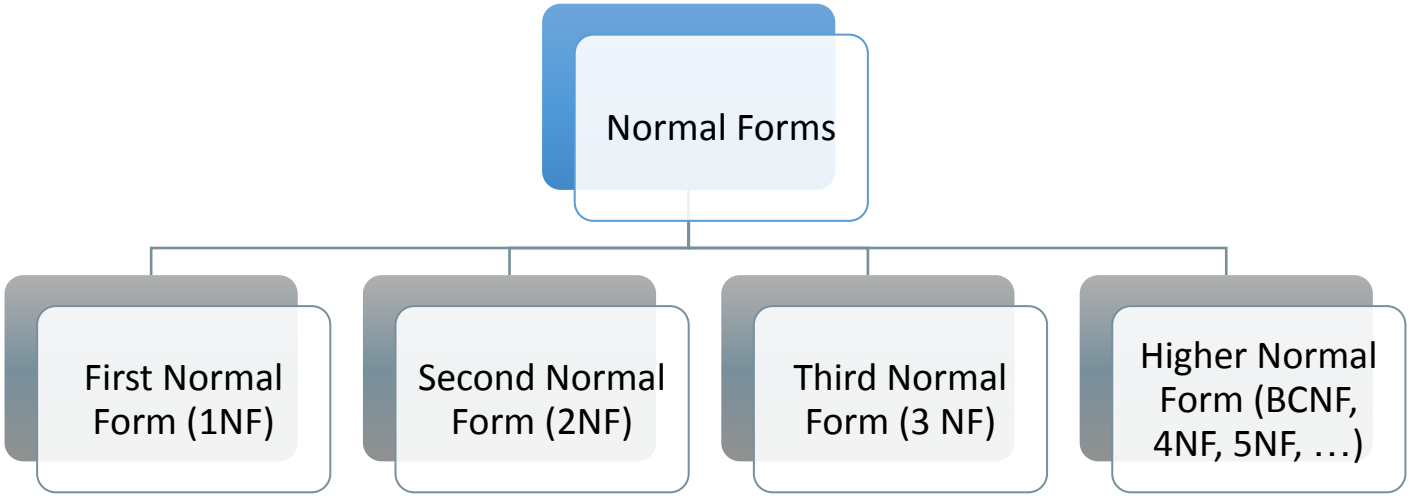
Normalization

Normalization

- Decompose larger, complex table into simpler and smaller ones
- Moves from lower normal forms to higher normal forms.

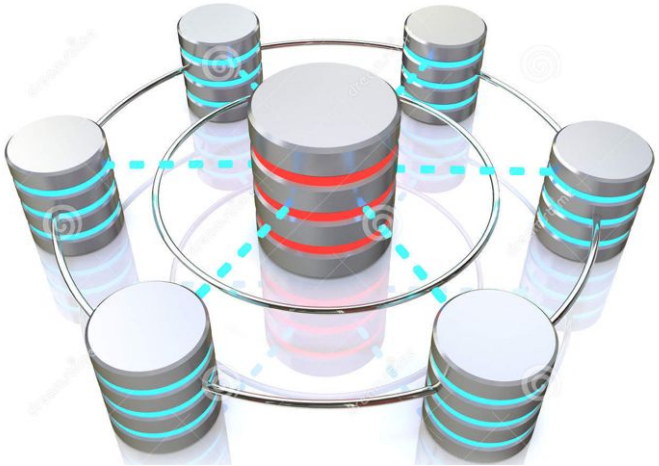


Normalization and Normal Forms



Need for Normalization

- In order to produce good database design
- To ensure all database operations to be efficiently performed
- Avoid any expensive DBMS operations
- Avoid unnecessary replication of information



Need for Normalization

- **RAW DATABASE**

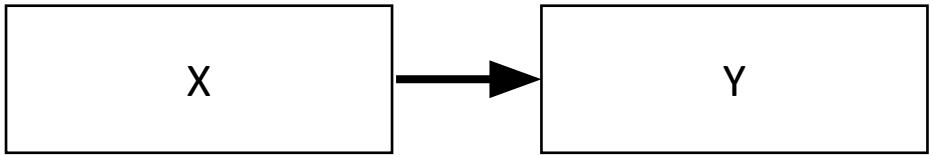
Student_Details	Course_details		Pre-requisite	Result_details	
0101 Tim 11/4/1985	M1 Advance maths	7	Basic Math	02/11/2015 82	A
0102 Rob 10/04/1986	P4 Advance Physics	8	Basic Physics	21/11/2015 89	A
0103 Mary 11/07/1985	B3 Advance Biology	10	Basic Biology	12/11/2015 62	B
0104 Rob 10/04/1986	H6 Advance History	9	Basic History	21/11/2015 89	A
0105 Tom 03/08/1988	C3 Advance Chemistry	11	Basic Biology	12/11/2015 50	C

Functional Dependency

- Consider the relation
  - Result (Student#, Course#, CourseName#, Marks#, Grade#)
    - Student# and course# together defines exactly one value of marks. Student#, course# ,Marks
    - Student# and course# determines Marks or Marks is functionally dependent on student# and course#
- Other functional dependencies in the relation:
  - Course# - CourseName
  - Marks# - Grade

Functional Dependency

- In a given relation R, X and Y are attributes. Attribute Y is functionally dependent on attribute X if each value of X determines exactly one value of Y.



Functional Dependency Types

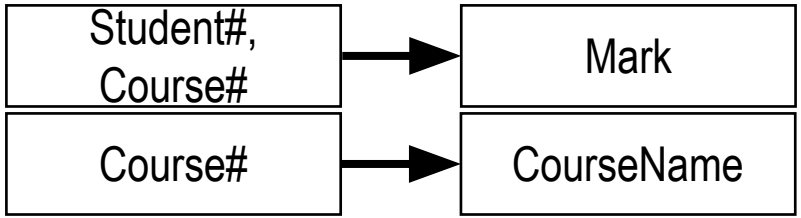
Partial Functional Dependency

Transitive Dependency

Functional Dependency Types

Partial Functional Dependency

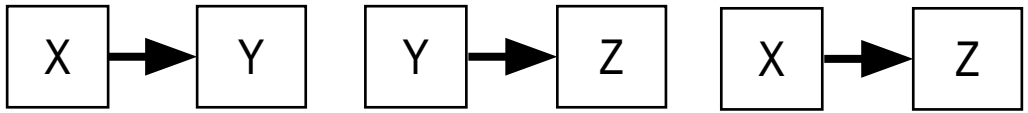
- Attribute Y is partially dependent on attribute X, if and only if it is dependent on the subset of attribute X.
- REPORT (Student#, Course#, StudentName, CourseName, Marks, Grade)

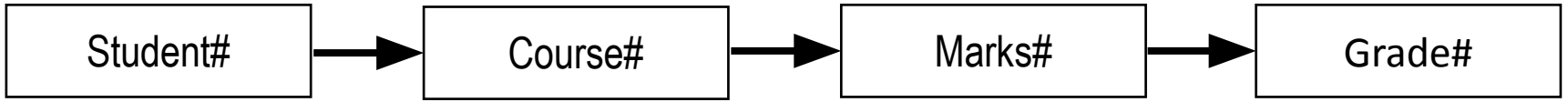


Functional Dependency Types

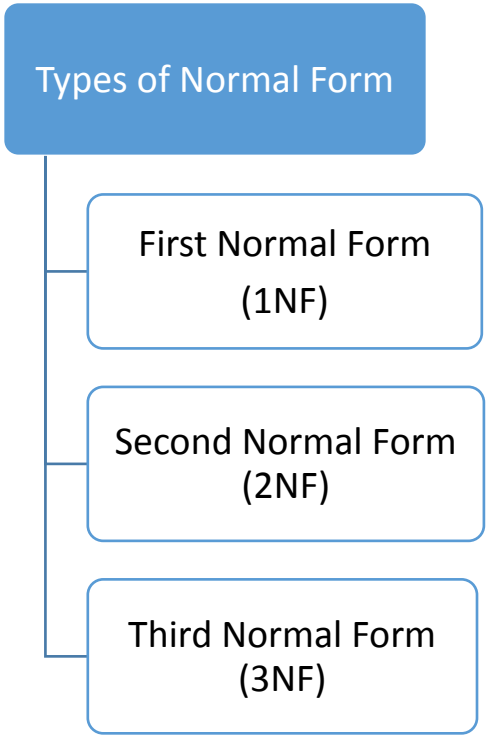
Transitive Dependency

X, Y, Z are three attributes





Normalization



Second Normal Form – (2NF)

Student Marks Table in1NF

Student#	Student_Name	DOB	Course #	CourseName	Pre Requisite	Duration in days	Date of Exam	Marks	Grade
0101	Tim	11/4/1985	M1	Advance Math	Basic Math	7	02/11/2015	82	A
0102	Rob	10/04/1986	P4	Advance Physics	Basic Physics	8	21/11/2015	89	A
0103	Mary	11/07/1985	B3	Advance Biology	Basic Biology	10	12/11/2015	62	B

Second Normal Form – (2NF)

- Student# ,Course# ⟶ Marks
- Student#, Course# ⟶ Grade
- Marks ⟶ Grade
- Student# ⟶ StudentName, DOB
- Course# ⟶ CourseName, Pre-Requisite,
- DurationDays, Date of exam

Partial Dependency with the Key attribute

Split/Decompose the tables to remove partial dependencies

Second Normal Form – (2NF)

Student Table

Student#	Student_Name	Date Of Birth
0101	Tim	11/4/1985
0102	Rob	10/04/1986
0103	Mary	11/07/1985

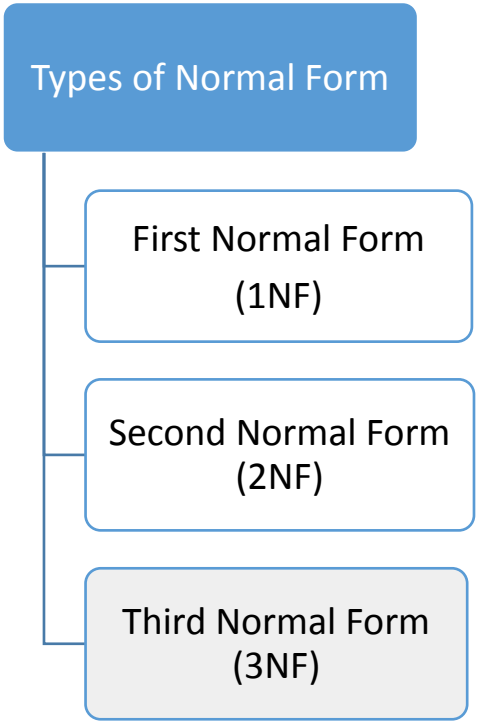
Result Table

Student#	Course#	Marks	Grade
0101	M1	82	A
0102	P4	89	A
0103	B3	62	B

Course Table

Course#	CourseName	Prerequisite	Durationindays	Date Of Exam
M1	Advance Math	Basic Math	7	02/11/2015
P4	Advance Physics	Basic Physics	8	21/11/2015
B3	Advance Biology	Basic Biology	10	12/11/2015

Third Normal Form – (3NF)



- A relation R is said to be in 3NF if and only if:
- It is in 2NF.
- No transitive dependency exists between non-key attributes and key attributes through another non-key attribute.

Third Normalization – (3NF)

Result_table

Student#	Course#	Marks	Grade
0101	M1	82	A
0102	P4	89	A
0103	B3	62	B

Student# ,Course# ⟶ Marks

Student#, Course# ⟶ Grade

Marks ⟶ Grade

Student#,Course#⟶ Marks⟶ Grade:TD → Remove

Third Normalization – (3NF)

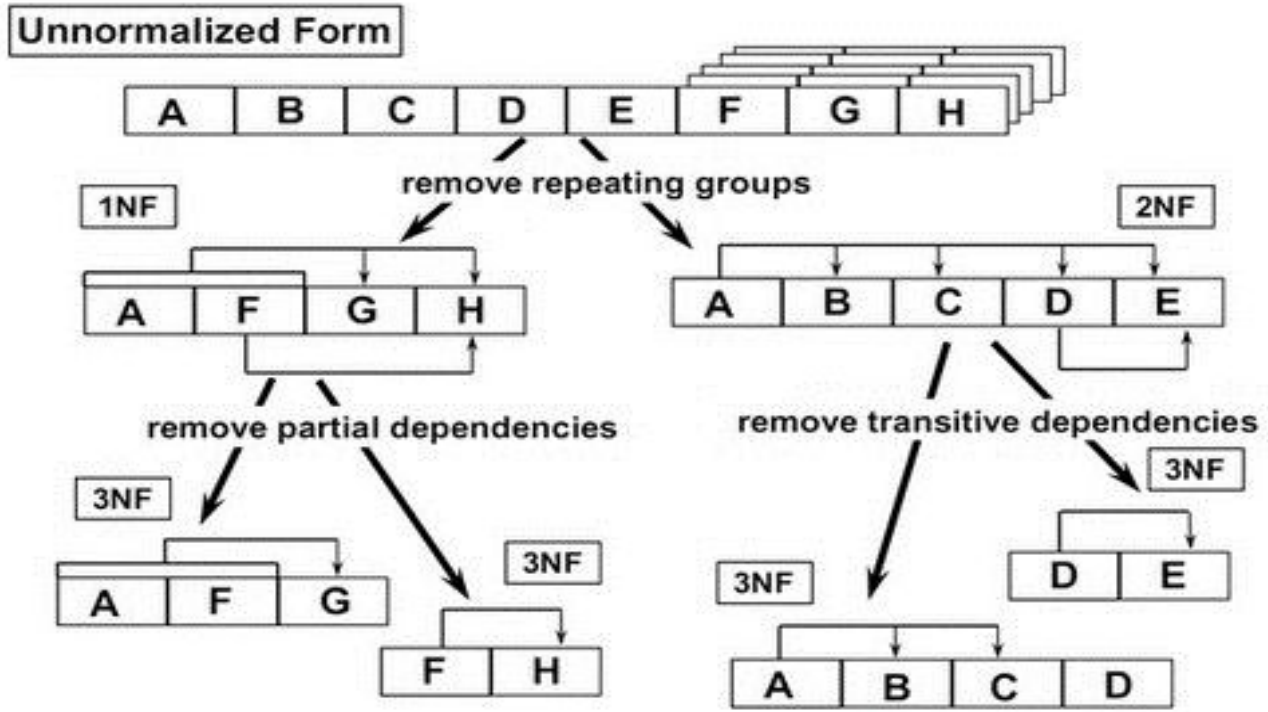
Result Table

Student#	Course#	Marks
0101	M1	82
0102	P4	89
0103	B3	62

Marks Grade Table

Marks	Grade
82	A
89	A
62	B

Normalization In Nutshell



Advantages And Disadvantages Of Normalization

ADVANTAGES	DISADVANTAGE
• Based on mathematical foundation • Removes the redundancy to a large extent • After 3NF, data redundancy is minimized to the extent of foreign keys • Removes the anomalies present in INSERTs, UPDATEs and DELETEs	• Data retrieval or SELECT operation performance will be severely affected • Normalization might not always represent real world scenarios

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Introduction to SQL

What is SQL ?

Programming language specifically designed for working with Database to…

- CREATE
- MANIPULATE
- SHARE/ACCESS

Why SQL?

SQL is widely popular because it offers the following advantages:

- Allows users to **access data** in the relational database management systems.
- Allows users to **describe the data**.
- Allows users to **define the data** in a database and manipulate that data.

SQL Terms

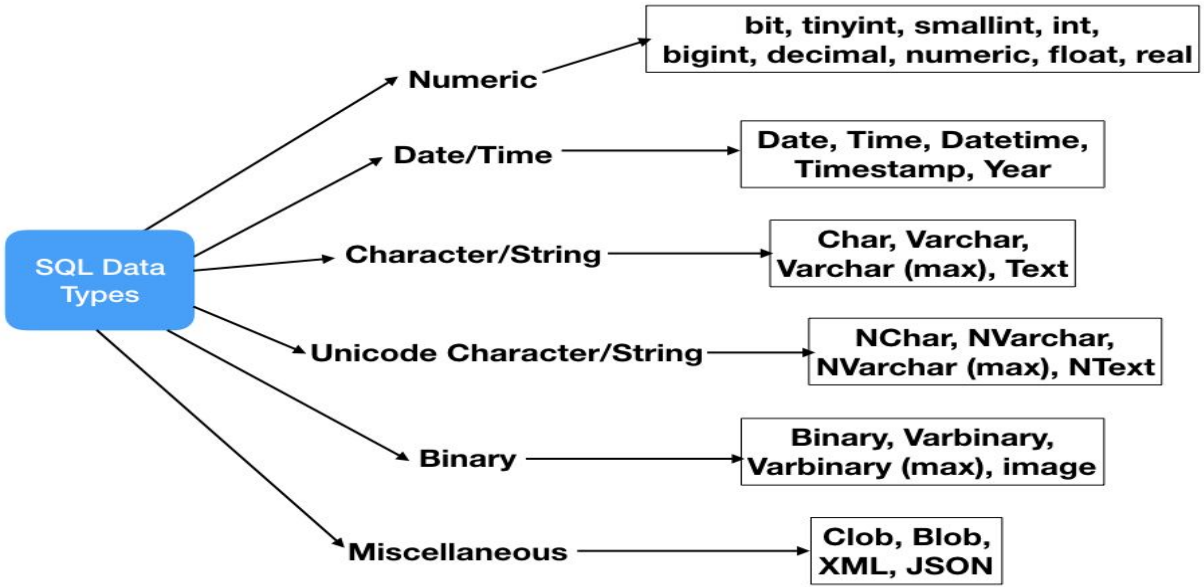
Data

Data is defined as facts or figures, or information that's stored in or used by a computer.

Database

A database is a collection of information that is organized so that it can be easily accessed, managed and updated.

SQL Data Types



SQL Constraints

- Constraints are the rules enforced on data columns on a table.
- These are used to limit the type of data that can go into a table.
- Constraints can either be column level or table level.

Constraint	Description
NOT NULL	Ensures that a column cannot have a NULL value.
DEFAULT	Provides a default value for a column when none is specified.
UNIQUE	Ensures that all the values in a column are different
PRIMARY	Uniquely identifies each row/record in a database table
FOREIGN	Uniquely identifies a row/record in any another database table
CHECK	The CHECK constraint ensures that all values in a column satisfy certain conditions.
INDEX	Used to create and retrieve data from the database very quickly.

Subsets of SQL

SQL Command Groups

- **DDL** (Data Definition Language) : creation of objects
- **DML** (Data Manipulation Language) : manipulation of data
- **DCL** (Data Control Language) : assignment and removal of permissions
- **TCL** (Transaction Control Language) : saving and restoring changes to a database

DDL - Data Definition Language

Command	Description
CREATE	Create objects in the database
ALTER	Alters the structure of the database object
DROP	Delete objects from the database
TRUNCATE	Remove all records from a table permanently
COMMENT	Add comments to the data dictionary
RENAME	Rename an object

DDL - Data Definition Language – Create Command

```
CREATE TABLE employees (
  employee_id INT (11) UNSIGNED NOT NULL,
  first_name VARCHAR(20),
  last_name VARCHAR(25) NOT NULL,
  salary int(7) NOT NULL,
  PRIMARY KEY (employee_id));
```

employee_id	first_name	last_name	salary

DDL - Data Definition Language – Alter Command

```
ALTER TABLE employees ADD COLUMN
contact INT(10);
```

employee_id	first_name	last_name	salary	contact
101	Steven	Cohen	10000	
102	Edwin	Thomas	15000	
103	Harry	Potter	20000	

DDL - Data Definition Language – Rename Command

```
ALTER TABLE employees RENAME
COLUMN contact TO job_code;
```

employee_id	first_name	last_name	salary	job_code
101	Steven	Cohen	10000	
102	Edwin	Thomas	15000	
103	Harry	Potter	20000	

DDL - Data Definition Language – Truncate Command

```
TRUNCATE TABLE employees;
```

employee_id	first_name	last_name	salary
101	Steven	Cohen	10000
102	Edwin	Thomas	15000
103	Harry	Potter	20000

DDL - Data Definition Language – Drop Command

```
DROP TABLE table_name;

DROP TABLE employees;
```

employee_id	first_name	last_name	salary
101	Steven	Cohen	10000
102	Edwin	Thomas	15000
103	Harry	Potter	20000

DML – Data Manipulation Language

Command	Description
INSERT	Insert data into a table
UPDATE	Updates existing data within a table
DELETE	Deletes unwanted/all records from a table

DML – Data Manipulation Language – INSERT Command

```
INSERT INTO employees
(employee_id,first_name,last_name,salary)
VALUES (101, 'Steven', 'King', 10000);
```

```
INSERT INTO employees
(employee_id,first_name,last_name,salary
) VALUES (102, 'Edwin', 'Thomas', 15000
);
```

```
INSERT INTO employees
(employee_id,first_name,last_name,salary
) VALUES (103, 'Harry', 'Potter',
20000);
```

employee_id	first_name	last_name	salary
101	Steven	King	10000
102	Edwin	Thomas	15000
103	Harry	Potter	20000

DML – Data Manipulation Language – UPDATE Command

```
UPDATE employees
SET last_name='Cohen'
WHERE employee_id=101;
```

employee_id	first_name	last_name	salary
101	Steven	Cohen	10000
102	Edwin	Thomas	15000
103	Harry	Potter	20000

DML – Data Manipulation Language - DELETE Command

```
DELETE FROM employees WHERE
employee_id IN (101,103);
```

employee_id	first_name	last_name	salary
101	Steven	Cohen	10000
102	Edwin	Thomas	15000
103	Harry	Potter	20000

DCL - Data Control Language

Command	Description
GRANT	Gives user's access privileges to database
REVOKE	Withdraw access privileges given with the GRANT command

TCL - Transaction Control

Command	Description
COMMIT	Save work done
ROLLBACK	Restore database to original state since the last COMMIT
SAVEPOINT	Identify a point in a transaction to which you can later roll back

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SQL Operators

SQL Operators - Filter

WHERE Clause :

- Used to specify a condition while fetching the data from a single table or by joining with multiple tables.
- Not only used in the SELECT statement, but it is also used in the UPDATE, DELETE statement, etc.,

employee_id	first_name	last_name	salary
101	Steven	Cohen	10000
102	Edwin	Thomas	15000
103	Harry	Potter	20000

e.g.

```
SELECT * FROM employees WHERE
employee_id=101;
```

employee_id	first_name	last_name	salary
101	Steven	Cohen	10000

The example mentioned above extracts all the columns from the table ‘employees’ whose employee_id=101

SQL Operators – Logical

OPERATOR	ILLUSTRATIVE EXAMPLE	RESULT
AND	(5<2) AND (5>3)	FALSE
OR	(5<2) OR (5>3)	TRUE
NOT	NOT (5<2)	TRUE

Sample Queries:

```
SELECT * FROM employees WHERE first_name = 'Steven'  and salary = 15000;

SELECT * FROM employees WHERE first_name = 'Steven'  OR salary =15000;

SELECT * FROM employees WHERE first_name = 'Steven'  and salary !=10000;
```

SQL Operators – Comparison

Comparison Operator's	
SYMBOL	**MEANING**
=	Equal to
<	Less than
<=	Less than or equal to
>	Greater than
>=	Greater than or equal to
< > or !=	Not equal to

Sample Queries:

```
SELECT * FROM employees WHERE first_name =
'Steven' AND salary <=10000;

SELECT * FROM employees WHERE first_name =
'Steven' OR salary >=10000;

SELECT * FROM employees WHERE first_name =
'Steven' and salary <>10000;
```

SQL Operators – Special

Special Operator's	
BETWEEN	Checks an attribute value within range
LIKE	Checks an attribute value matches a given string pattern
IS NULL	Checks an attribute value is null
IN	Checks an attribute value matches any value within a value list
DISTINCT	Limits values to unique values

Sample Queries:

```
SELECT * FROM employees WHERE salary
between 10000 and 20000;

SELECT * FROM employees WHERE
first_name like 'Steven';

SELECT * FROM employees WHERE salary is
null;

SELECT * FROM employees where salary in
(10000,12000,20000);

SELECT DISTINCT(first_name) from
employees;
```

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SQL Functions

SQL Operators – Aggregations

Aggregation function's	
AVG():	Returns the average value from specified columns
COUNT():	Returns number of table rows
MAX():	Returns largest value among the records
MIN():	Returns smallest value among the records
SUM():	Returns the sum of specified column values

Sample Queries:

```
SELECT avg(salary) FROM
employees;

SELECT count(*)  FROM employees;

SELECT min(salary) FROM
employees;

SELECT max(salary) FROM
employees;

SELECT sum(salary) FROM
employees;
```

SQL GROUP BY Clause

- Arrange identical data into groups.
- This GROUP BY clause follows the WHERE clause in a SELECT statement and precedes the ORDER BY clause if used.

e.g.,

```
SELECT
SUM(salary),department_id
FROM employees
WHERE salary >=15000
GROUP BY department_id
```

employee_id	first_name	last_name	salary	department_id
103	Harry	Potte	20000	12
102	Edwin	Thomas	15000	11
101	Steven	Cohen	10000	10
100	Erik	John	10000	12

SUM(salary)	department_id
20000	12
15000	11

SQL HAVING Clause

- Used with aggregate functions due to its non-performance in the WHERE clause.
- Must follow the GROUP BY clause in a query and must also precede the ORDER BY clause if used.

e.g.,

```
SELECT AVG(salary),department_id
FROM employees
WHERE salary >=10000
GROUP BY department_id
HAVING count(department_id)>=2
```

employee_id	first_name	last_name	salary	department_id
103	Harry	Potte	20000	12
102	Edwin	Thomas	15000	11
101	Steven	Cohen	10000	10
100	Erik	John	10000	12

AVG(salary)	department_id
15000	12

SQL ORDER BY Clause

- Used to sort output of SELECT statement
- Default is to sort in ASC (Ascending)
- Can Sort in Reverse (Descending) Order with "DESC" after the column name

employee_id	first_name	last_name	salary
101	Steven	Cohen	10000
102	Edwin	Thomas	15000
103	Harry	Potter	20000

e.g.,

```
SELECT * FROM employees
ORDER BY salary DESC;
```

employee_id	first_name	last_name	salary
103	Harry	Potter	20000
102	Edwin	Thomas	15000
101	Steven	Cohen	10000

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SQL Set Operators

SQL UNION ALL

- Used to combine the results of two SELECT statements including duplicate rows.
- The same rules that apply to the UNION clause will apply to the UNION ALL operator.

SYNTAX:

```
SELECT a.col1,b.col2,...,a.coln FROM table1 a,table1 b WHERE a.commonfield = b.commonfield
UNION ALL
SELECT a.col1, b.col2,..., a.coln FROM table1 a, table1 b
WHERE a.commonfield = b.commonfield
```

SQL UNION ALL

Product1

CATEGORY_ID	PRODUCT_NAME
1	Nokia
2	Samsung
3	HP
6	Nikon

Product2

CATEGORY_ID	PRODUCT_NAME
1	Samsung
2	LG
3	HP
5	Dell
6	Apple
10	Playstation

e.g.,

```
SELECT product_name FROM product1
UNION ALL
SELECT product_name FROM
product2;
```

PRODUCT_NAME
Nokia
Samsung
HP
Nikon
Samsung
LG
HP
Dell
Apple
Playstation

SQL UNION

- Used to combine the result-set of two or more SELECT statements removing duplicates
- Each SELECT statement within the UNION must have the same number of columns
- The selected columns must be of similar data types and must be in the same order in each SELECT statement
- More than two queries can be clubbed using more than one UNION statement

SQL UNION

Product1

CATEGORY_ID	PRODUCT_NAME
1	Nokia
2	Samsung
3	HP
6	Nikon

Product2

CATEGORY_ID	PRODUCT_NAME
1	Samsung
2	LG
3	HP
5	Dell
6	Apple
10	Playstation

e.g.,

```
SELECT product_name FROM product1
UNION
SELECT product_name FROM
product2;
```

PRODUCT_NAME
Nokia
Samsung
HP
Nikon
LG
Dell
Apple
Playstation

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SQL Case

SQL CASE Statement

- The CASE statement goes through conditions and returns a value when the first condition is met (like an IF-THEN-ELSE statement).
- So, once a condition is true, it will stop reading and return the result. If no conditions are true, it returns the value in the ELSE clause.
- If there is no ELSE part and no conditions are true, it returns NULL.

```
CASE
  WHEN condition1 THEN result1
  WHEN condition2 THEN result2
  WHEN conditionN THEN resultN
  ELSE result
END;
```

```
SELECT OrderID, Quantity,
CASE
    WHEN Quantity > 30 THEN 'The quantity is
greater than 30'
    WHEN Quantity = 30 THEN 'The quantity is
30'
    ELSE 'The quantity is under 30'
END AS QuantityText
FROM OrderDetails;
```

```
CASE department_name
WHEN 'CS’
THEN UPDATE Faculty SET department='Computer
Science’;
WHEN 'EC’
THEN UPDATE Faculty SET
department='Electronics and Communication’;
ELSE UPDATE Faculty SET
department='Humanities and Social Sciences’;
END CASE
```

THANK YOU