Database Management System

Introduction

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Data vs Information

Computer Data

- Data is a collection of values. Those values can be characters, numbers, or any other data type.
- Computer data is a bunch of 1's and 0's, known as binary data.
- Computer data is processed by the computer's CPU and is stored digitally in files and folders on the computer's hard disk.

Information

- When data are processed, interpreted, organized, structured or presented in a given context so as to make them meaningful or useful, they are called information.
- Data is raw material (i.e. bits of information) and Information is the product.

Example of Data:

UIU, Email:, Mr. X, x@cse.uiu.ac.bd,
Dept. of CSE, Lecturer

Example of Information :

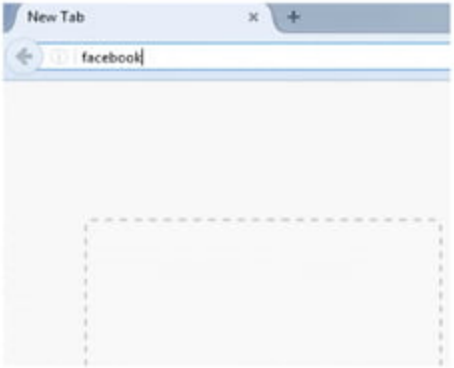
Mr. X
Lecturer
Dept. of CSE
UIU
Email: x@cse.uiu.ac.bd

Data vs Information

Web-based Information System

Web-based Information System

An information system that uses *Internet web technologies* to deliver information and services, to users or other information systems/applications.



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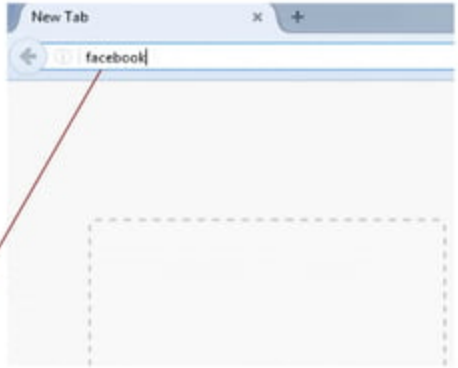
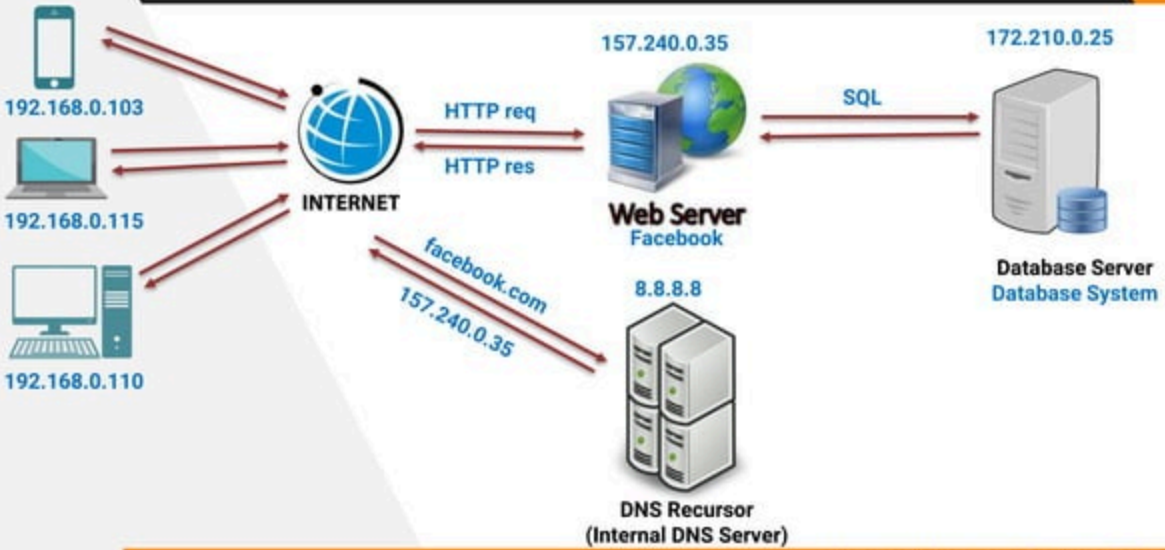
An information system that uses *Internet web technologies* to deliver information and services, to users or other information systems/applications.

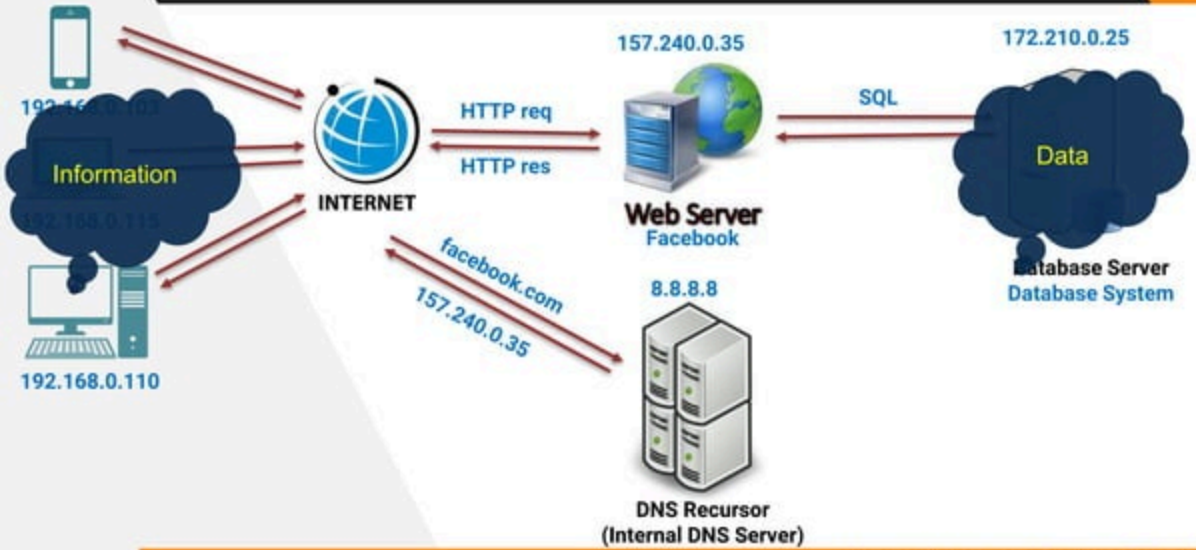


What is happening in the background !!!!

Web-based System >> Background Process



Web-based System >> Background Process

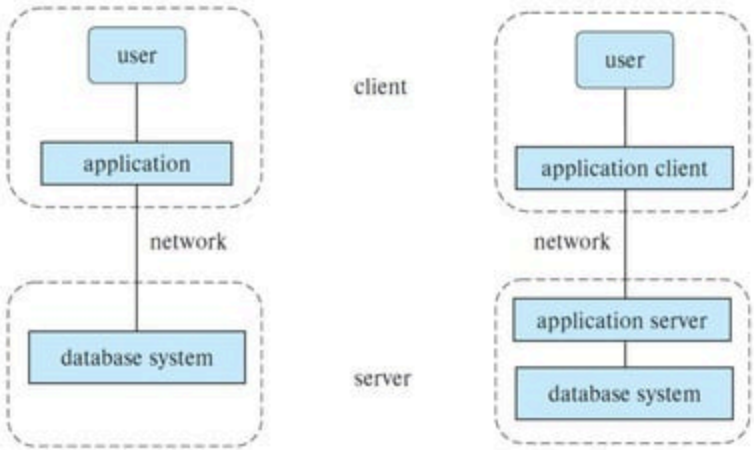


Web-based System >> Two-tier vs Three-tier Architecture

Two-tier Architecture
The application resides at the client machine, and invokes database system functionality at the server machine through query language statements.

Three-tier Architecture
The client machine acts as a front end that communicates with an application server. The application server, in turn, communicates with a database system to access data.

The business logic of the application, which says what actions to carry out under what conditions, is embedded in the application server, instead of being distributed across multiple clients.



(a) Two-tier architecture (b) Three-tier architecture

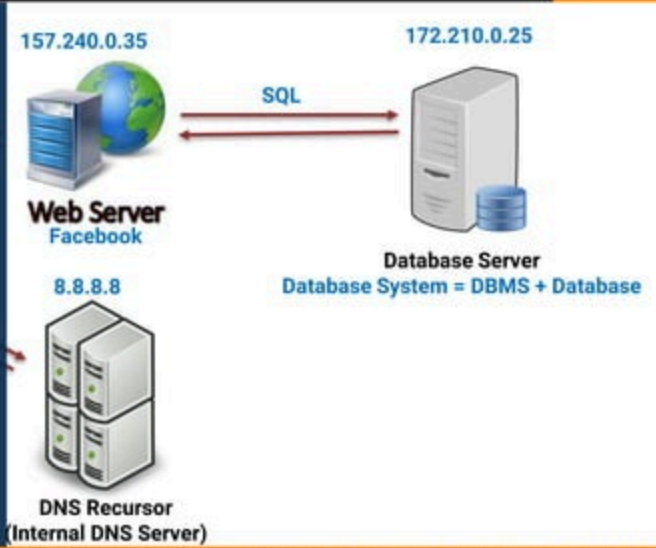
Database vs Database Management System

Database

A database is an organized collection of interrelated data, generally stored and accessed electronically from a computer system.

Database Management System

A DBMS is software that interacts with end users, applications, and the database itself to control the storage, organization, and retrieval of data.

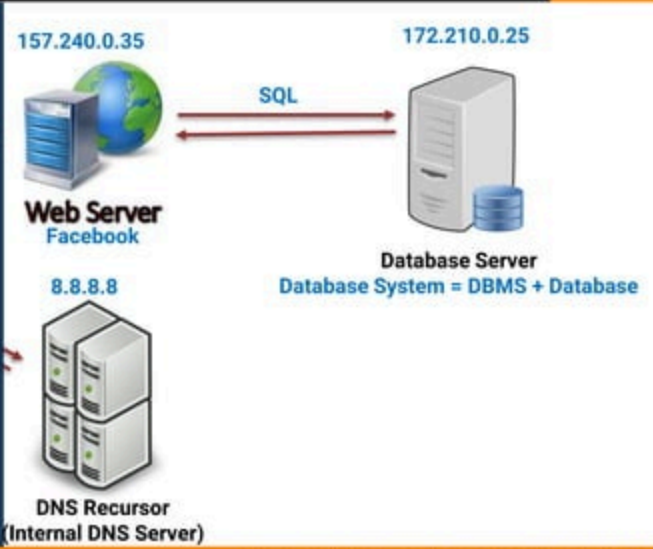


SQL – Structured Query Language

Structured Query Language (SQL)

- A special kind of programming language that is used for communicating with the database.
- It is designed for managing data held in a relational database management system (RDBMS).

- Types of SQL commands:
  - DDL – Data Definition Language
    CREATE, DROP, ALTER, TRUNCATE
  - DML – Data Manipulation Language
    INSERT, UPDATE, DELETE
  - DQL – Data Query Language
    SELECT
  - DCL – Data Control Language
    GRANT, REVOKE
  - TCL – Transaction Control Language
    COMMIT, ROLLBACK, SAVEPOINT

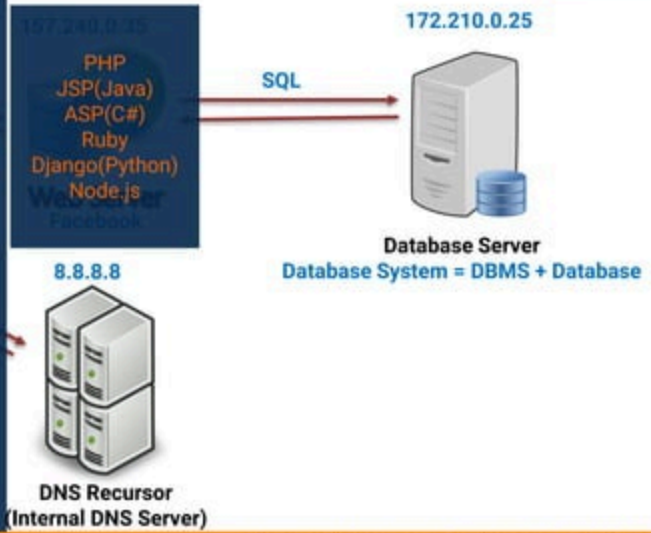


Web-based System >> DBMS

A DBMS
understands the commands and the queries which define what data is required by the app or website

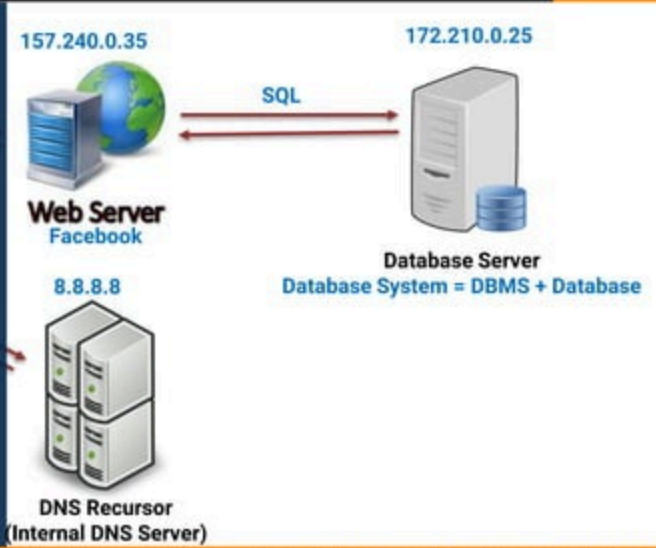
and

thus use the meaningful method of accessing the database to retrieve the information.

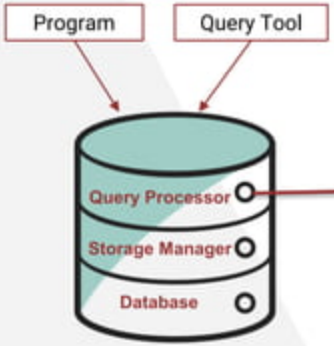


DBMS >> Key Features

- Minimizes data redundancy.
- Provides data consistency.
- Easy to write, update, search, delete data.
- Provides atomicity of updates.
- Concurrency control for multiple users.
- Provides data isolation.
- Provides high level of security.
- Easy to add/update different integrity constraints.



Database System Structure >> Query Processor

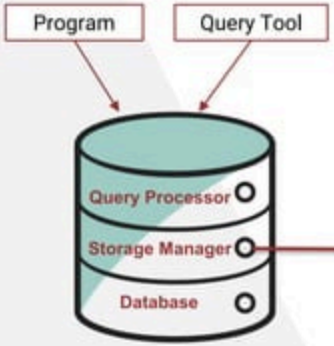


Query Processor

- **DDL interpreter**: interprets DDL statements and records the definitions in the data dictionary.
- **DML compiler**: translates DML query statements into low-level instructions that the query evaluation engine understands.

  Also performs query optimization i.e. it picks lowest cost evaluation plan from a number of alternative evaluation plans.
- **Query evaluation engine**: executes low-level instructions generated by the DML compiler.

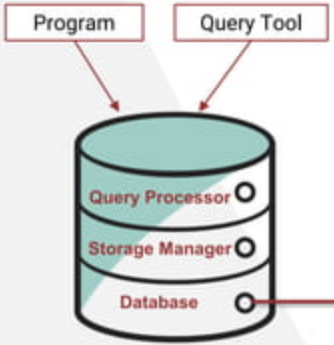
Database System Structure >> Storage Manager



Storage Manager

- **Authorization and integrity manager** tests for the satisfaction of integrity constraints and checks the authority of users to access data.
- **Transaction manager** ensures that the database remains in a consistent (correct) state despite system failures, and that concurrent transaction executions proceed without conflicting.
- **File manager** manages the allocation of space on disk storage and the data structures used to represent information stored on disk.
- **Buffer manager** is responsible for fetching data from disk storage into main memory, and deciding what data to cache in main memory.

Database System Structure >> Database

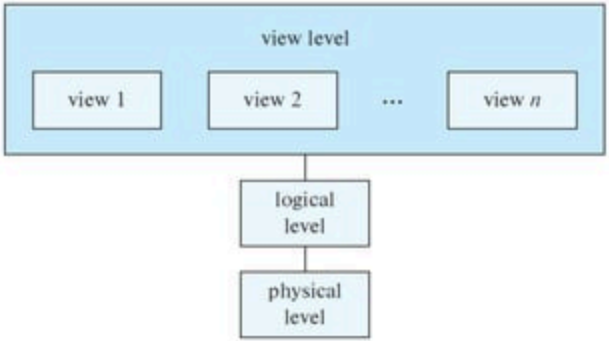


Database

- **Data files**, which store the database itself.
- **Data dictionary**, which stores metadata about the structure of the database, in particular the schema of the database.
- **Indices**, which provide fast access to data items. A database index provides pointers to those data items that hold a particular value.

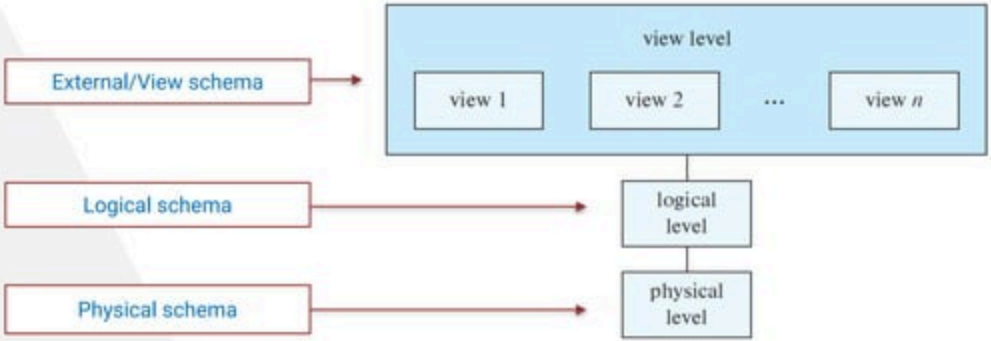
Data Abstraction

- A database system is a collection of interrelated data(DB) and a set of programs (DBMS) that allow users to access and modify these data.
- A major purpose of a database system is to provide users with an abstract view of the data. That is, the system hides certain details of how the data are stored and maintained.
- To simplify users' interactions with the system, developers hide the complexity from users through several levels of data abstraction.



Database Schema

- Schema describes the overall design of the database at different levels.
- Each schema (logical) corresponds to a data model that is a collection of conceptual tools and languages for describing data, data relationships, data semantics, and consistency constraints.



Types of Data Models

- High-level conceptual data model
  - E-R Model
  - Object oriented Model
- Record based logical data models
  - These models specify logical structure of database with records, fields and attributes.
  - Relational Model – collections of tables
  - Hierarchical Model – collections of trees
  - Network Model – collections of records and links (graphs)
- Physical data models (physical level)

SQL vs NoSQL Database

SQL	NoSQL
Relational Database	Non-relational Database
SQL databases use structured query language and have a predefined schema.	NoSQL databases have dynamic schemas for unstructured data.
SQL databases are vertically scalable.	NoSQL databases are horizontally scalable.
SQL databases are table based.	NoSQL databases are document, key-value, graph or wide-column stores.
• SQLite • PostgreSQL • Oracle • MySQL • Microsoft SQL server	• MongoDB • Cassandra

Relational DBMS >> MySQL

Student

student_id	name	age
1	ABC	25
2	DEF	20
3	GHI	22
4	JKL	27

Course

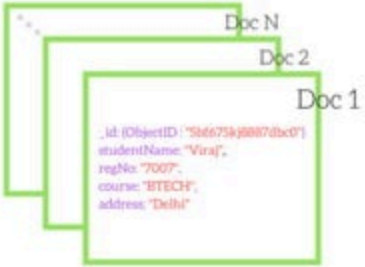
course_id	name	faculty
1	Java	X
2	Python	Y
3	CPP	W
4	JS	M

Student_Course

student_id	course_Id	marks
1	4	85
1	3	90
2	3	70
4	2	67

Non-relational DBMS >> MongoDB

Collection 1



Collection 2

THANKS!

Any questions?

Email : imam@cse.uiu.ac.bd

Reference:
Database System Concepts by S. Sudarshan, Henry F. Korth, Abraham Silberschatz

Working with Databases and MySQL

Database Management Systems

present by:
Rushit Bhadaniya

Introduction to TOC

CSE 2233

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Different Normal Forms

First Normal Form (1NF) >>

- All the columns/attributes are single valued.
- Primary key exists.
- Functional Dependencies are identified.

Second Normal Form (2NF) >>

- It is in 1NF.
- No partial dependency exists; that is no non-prime attribute is dependent on the proper subset of any candidate key of table.
- Prime attribute: an attribute that is a part of any candidate key is known as prime attribute.
- For each non-trivial FD of the form **X → Y**
  - Either Y is a prime/key attribute.
  - If Y is non-prime then X is **not a proper subset** of any candidate key of the table. That is either fully dependent on the candidate key or fully dependent on other non-prime attributes.
- Example:
  - Given, R = {A, B, C, D, E, F, G} and F = {A→B, C→DEF, E→F, AC → BDEFG }
  - Here, Candidate Key={ AC }, proper subset={ {}, A, C }, non-prime attributes = { B, D, E, F, G }
  - But in A → B, B is non-prime and A is a proper subset of candidate key
  - So it is not in 2NF

Third Normal Form (3NF) >>

- It is in 2NF.
- No transitive dependency exists.
- For each non-trivial FD of the form **X → Y**
  - Either Y is a prime/key attribute
  - If Y is non-prime then X is a superkey of the table.
- Example:
  - If R={C, D, E, F} and F={ C → DEF, E → F }
  - Here, candidate key = { C }, proper subset = {φ}, non-prime attributes = {D, E, F}
  - In C → DEF; D,E,F each is non-prime and C is not proper subset of candidate key and it is a superkey and in E → F; F is non-prime and E is also not a proper subset of candidate keys but not superkey.
  - So, it is in 2NF but not in 3NF

Boyce-Codd Normal Form (BCNF/3.5NF) >>

- It is in 3NF.
- For each no trivial FD of the form **X → Y**
  - X is the superkey of the table.
- If we do not have redundancy in **F**, then for each **X → Y** of $\mathbf{F_c}$, X must be a candidate key.
- Example:
  - If R = {A, B, C, D} and F = { AB → CD, C → B }
  - Here, Candidate Keys = { AB, AC }
  - $(AB)^+$ = ABCD i.e. superkey and $(C)^+$ = CB not a superkey but B is a key/prime attribute
  - So, it is in 3NF but not in BCNF(as C is not a superkey)

MySQL - Rank Related Queries

Type 1 >> Show the highest salary value

```
SELECT MAX(SALARY)
FROM employees;
```

Type 1.1 >> Show the highest salary holder employee details

```
SELECT *
FROM employees
WHERE SALARY = (
                    SELECT MAX(SALARY)
                    FROM employees
                );
```

[If more than one employees receive the maximum salary, then all of them will be shown]

practice 1: Show the lowest salary value.
practice 1.1: Show the lowest salary holder employee details.

Type 2 >> Show the nth highest salary value

```
SELECT SALARY
FROM employees as emp1
WHERE n-1 = (
                SELECT COUNT(DISTINCT SALARY)
                FROM employees as emp2
                WHERE emp2.SALARY>emp1.SALARY
            );

/* for 4th highest salary value, use n-1=4-1=3 */
/* for 2nd highest salary value, use n-1=2-1=1 */
```

Type 2.2 >> Show the nth highest salary holder employee details

```
SELECT *
FROM employees as emp1
WHERE n-1 = (
                SELECT COUNT(DISTINCT SALARY)
                FROM employees as emp2
                WHERE emp2.SALARY>emp1.SALARY
            );
```

practice 2: Show the 3rd highest salary value.
practice 2.1: Show the 3rd highest salary holder employee details.
practice 3: Show the 50th highest salary value.
practice 3.1: Show the 50th highest salary holder employee details.
practice 4: Show the 10th lowest salary value.
practice 4.1: Show the 10th lowest salary holder employee details.

WEL COME

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OF SCIENCE AND MANAGEMENT

Normalization
- Fifth Normal Form

- Ms.S.Athilakshmi

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INTRODUCTION TO DATABASE

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