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Baizid MD Ashadzzaman
Designation: Adjunct Lecturer
Email: baizid.md.ashadzzaman@gmail.com
Phone: 8801862420119

Course Contents:

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Introduction: Database-System Applications, Purpose of Database Systems, View of Data, Database Languages, Relational Databases, Database Design, Data Storage and Querying, Transaction Management, Database Architecture, Data Mining and Information, Retrieval, Specialty Databases, Database Users and Administrators.	

Introduction To Database

Data: **Data is a collection of discrete or continuous values that convey information.** In general, data is a distinct piece of information that is gathered and translated for specific purpose. There are different kinds of data, such as follows: Sound, Video, Single character, Number (integer or floating-point), Picture, Boolean (true or false), Text (string) etc.

- ❖ In a computer's storage, data is stored in the form of a series of binary digits (bits) that contain the value 1 or 0.
- ❖ Data is a collection of a small unit of information. It can be used in a variety of forms like text, numbers, media, bytes, etc. it can be stored in pieces of paper or electronic memory, etc.

Database :

Database is an organized collection of related data where the data is stored and organized for the specific purpose.

In other words, A **database is an organized collection of interrelated data,** so that it can be easily accessed and managed. You can organize data into tables, rows, columns, and index it to make it easier to find relevant information.

- ❖ The main purpose of the database is to operate a large amount of information by storing, retrieving, and managing data.
- ❖ There are many databases available like MySQL, Sybase, Oracle, MongoDB, Informix, PostgreSQL, SQL Server, etc.
- ❖ Modern databases are managed by the database management system (DBMS).

DBMS (Database Management System)

DBMS stands for Database Management System. It is a collection of application programs which allow the user to organize, restore and retrieve information about data efficiently.

In other words, Database management System is a software which is used to store and retrieve the database. For example, Oracle, MySQL, etc.; these are some popular DBMS tools.

- DBMS provides the interface to perform the various operations like creation, deletion, modification, etc.
- DBMS allows the user to create their databases as per their requirement.
- DBMS accepts the request from the application and provides specific data through the operating system.
- DBMS contains the group of programs which acts according to the user instruction.
- It provides security to the database.

Advantage of DBMS

❖ Controls redundancy

It stores all the data in a single database file, so it can control data redundancy.

❖ Data sharing

An authorized user can share the data among multiple users.

❖ Backup

It provides Backup and recovery subsystem. This recovery system creates automatic data from system failure and restores data if required.

❖ Multiple user interfaces

It provides a different type of user interfaces like GUI, application interfaces.

Disadvantage of DBMS

➤ Size

It occupies large disk space and large memory to run efficiently.

➤ Cost

DBMS requires a high-speed data processor and larger memory to run DBMS software, so it is costly.

➤ Complexity

DBMS creates additional complexity and requirements.

File System

The file system is basically a way of arranging the files in a storage like a hard disk. The file system organizes the files and helps in the retrieval of files when they are required. File systems consist of different files which are grouped into directories. The directories further contain other folders and files. The file system performs basic operations like management, file naming, giving access rules, etc. Example: NTFS(New Technology File System), EXT(Extended File System)

DBMS(Database Management System)

Database Management System is basically software that manages the collection of related data. It is used for storing data and retrieving the data effectively when it is needed. It also provides proper security measures for protecting the data from unauthorized access. In Database Management System the data can be fetched by SQL queries and relational algebra. It also provides mechanisms for data recovery and data backup.

Example: Oracle, MySQL, MS SQL server

Difference between File System and DBMS

Basics	File System	DBMS
Structure	The file system is a way of arranging the files in a storage medium within a computer.	DBMS is software for managing the database.
Data Redundancy	Redundant data can be present in a file system.	In DBMS there is no redundant data.
Backup and Recovery	It doesn't provide Inbuilt mechanism for backup and recovery of data if it is lost.	It provides tools for backup and recovery of data even if it is lost.
Query processing	There is no efficient query processing in the file system.	Efficient query processing is there in DBMS.
Consistency	There is less data consistency in the file system.	There is more data consistency because of the process of normalization.
Complexity	It is less complex as compared to DBMS.	It has more complexity in handling as compared to the file system.
Security Constraints	File systems provide less security in comparison to DBMS.	DBMS has more security mechanisms as compared to file systems.
Cost	It is less expensive than DBMS.	It has a comparatively higher cost than a file system.
User Access	Only one user can access data at a time.	Multiple users can access data at a time.
Data Abstraction	It give details of storage and representation of data	It hides the internal details of Database
Example	Cobol, C++	Oracle, SQL Server

Data Models in DBMS

A Data Model in Database Management System (DBMS) is the concept of tools that are developed to summarize the description of the database. Data Models provide us a transparent picture of data which helps us in creating an actual database. A data model provides a way to describe the design of a database at the physical, logical, and view levels.

Therefore, there are four data models used for understanding the structure of the database.

Relational Model: The relational model uses a collection of tables to represent both data and the relationships among those data. Each table has multiple columns, and each column has a unique name. Tables are also known as relations. The relational model is an example of a record-based model. The relational data model is the most widely used data model, and a vast majority of current database systems are based on the relational model.

Entity-Relationship Model(ER Model): It is basically a conceptual design of any database which is easy to design the view of data.

An ER model is the logical representation of data as objects and relationships among them. These objects are known as entities, and relationship is an association among these entities. It was widely used in database designing. A set of attributes describe the entities. For example, student_name, student_id describes the 'student' entity.

Object-based Data Model: Both the data and the relationship are contained in a single structure that is known as an object in this model. The object-relational data model combines features of the object-oriented data model and relational data model. An extension of the ER model with notions of functions, encapsulation, and object identity, as well. This model supports a rich type system that includes structured and collection types.

Semi structured Data Model: This type of data model is different from the other three data models. The semi structured data model allows the data specifications at places where the individual data items of the same type may have different attributes sets. The Extensible Markup Language, also known as XML, is widely used for representing the semi structured data.

Database Languages

A DBMS has appropriate languages and interfaces to express database queries and updates. Database languages can be used to read, store and update the data in the database.

Types of Database Languages

DDL , DML , DCL , TCL

1. Data Definition Language (DDL)

- DDL stands for Data Definition Language. It is used to define database structure or pattern.
- It is also used to create schema, tables, indexes etc. in the database.
- Using the DDL statements, you can create the skeleton of the database.
- Data definition language is used to store the information of metadata like the number of tables and schemas, their names, indexes, columns in each table etc.

Here are some tasks that come under DDL:

- o Create: It is used to create objects in the database.
- o Alter: It is used to alter the structure of the database.
- o Drop: It is used to delete objects from the database.
- o Truncate: It is used to remove all records from a table.
- o Rename: It is used to rename an object.
- o Comment: It is used to comment on the data dictionary.

2. Data Manipulation Language (DML)

DML stands for Data Manipulation Language. It is used for accessing and manipulating data in a database. It handles user requests.

Here are some tasks that come under DML:

- o Select: It is used to retrieve data from a database.
- o Insert: It is used to insert data into a table.
- o Update: It is used to update existing data within a table.
- o Delete: It is used to delete all records from a table.
- o Merge: It performs UPSERT operation, i.e., insert or update operations.

Data Control Language (DCL)

DCL stands for Data Control Language. It is used to retrieve the stored or saved data. DCL is also used for granting and revoking user access on database

Here are some tasks that come under DCL:

- o Grant: It is used to give user access to a database.
- o Revoke: It is used to take back permissions from the user.

4. Transaction Control Language (TCL)

TCL is used to run the changes made by the DML statement. TCL can be grouped into a logical transaction.

Here are some tasks that come under TCL:

- o Commit: It is used to save the transaction on the database.
- o Rollback: It is used to restore the database to original since the last Commit

Database Users and Administrators

Database Users and User Interfaces

- Naive Users : Naive Users are the unsophisticated who don't have any DBMS knowledge but they frequently use the database applications in their daily life. For examples, Railway's ticket booking users are naive users. Clerks in any bank is a naive user because they don't have any DBMS knowledge but they still use the database and perform their given task
- Sophisticated Users : Sophisticated users can be engineers, scientists, business analyst, who are familiar with the database. They can develop their own database applications according to their requirement. They don't write the program code but they interact the database by writing SQL queries directly through the query processor.
- Application Programmers : Application Programmers also referred as System Analysts or simply Software Engineers who writes the code for the application programs. They are the computer professionals. These programs could be written in Programming languages such as Visual Basic, Developer, C, FORTRAN, COBOL etc. Application programmers design, debug, test, and maintain set of programs called "canned transactions" for the Naive users in order to interact with database.
- Specialized users : Specialized users are sophisticated users who write specialized database application that does not fit into the traditional data-processing framework. Among these applications are computer aided-design systems, knowledge-base and expert systems etc.

Database Administrator

A person who has central control over the database system is called a database administrator(DBA). The functions of a DBA include:

- **Schema definition:** The DBA creates the original database schema by executing a set of data definition statements in the DDL.
- **Schema and physical-organization modification:** The DBA perform changes to the schema and physical organization according to the needs of the organization, or to alter the physical organization to improve performance.
- **Database Maintenance:** The Database Maintenance includes the following process
 - ◆ Regular backing up the database
 - ◆ Ensuring the disk space for performing required operation
 - ◆ Monitoring the jobs running on the database

Structure of Database Management System

The database system is divided into three components: Query Processor, Storage Manager, and Disk Storage. These are explained as following below.

1. Query Processor: It interprets the requests (queries) received from end user via an application program into instructions. It also executes the user request which is received from the DML compiler.

Query Processor contains the following components –

- ❖ DML Compiler: It processes the DML statements into low level instruction (machine language), so that they can be executed.
- ❖ DDL Interpreter: It processes the DDL statements into a set of table containing meta data (data about data).
- ❖ Embedded DML Pre-compiler: It processes DML statements embedded in an application program into procedural calls.
- ❖ Query Optimizer: It executes the instruction generated by DML Compiler.

2. Storage Manager

The storage manager is the component of a database system that provides the interface between the low-level data stored in the database and the application programs and queries submitted to the system.

The storage manager is responsible for the interaction with the file manager. The raw data are stored on the disk using the file system provided by the operating system. The storage manager translates the various DML statements into low-level file-system commands. Thus, the storage manager is responsible for storing, retrieving, and updating data in the database.

The storage manager components include:

- **Authorization and integrity manager:** This tests for the satisfaction of integrity constraints and checks the authority of users to access data.
- **Transaction Manager:** It controls concurrent access by performing the operations in a scheduled way that it receives the transaction. Thus, it ensures that the database remains in the consistent state before and after the execution of a transaction.
- **File Manager:** It manages the file space and the data structure used to represent information in the database.
- **Buffer Manager:** It is responsible for cache memory and the transfer of data between the secondary storage and main memory.

3. Disk Storage: It contains the following components –

- ❖ Data Files: It stores the data.
- ❖ Data Dictionary: It contains the information about the structure of any database object. It is the repository of information that governs the metadata.
- ❖ Indices: It provides faster retrieval of data item