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DATABASE FUNDAMENTALS

• Introduction

- Database Management System or DBMS in short refers to the technology of storing and retrieving user's data with utmost efficiency along with appropriate Security measures.
- The database is a collection of inter-related data which is used to retrieve, insert and delete the data efficiently.
- It is also used to organize the data in the form of a table, schema, views and reports etc.,
- For Example: The college Database organizes the data about the admin, staff, students and faculty etc.
- Using the database, you can easily retrieve, insert and delete information.
- Database management system is a software which is used to manage the database.

DATABASE MANAGEMENT SYSTEM

- For example : MySQL, Oracle, etc. are a very Popular commercial database which is used in different applications.
- DBMS provides an interface to perform various operations like database creation, storing data in it, updating data, creating a table in the database and a lot more.
- It provides protection and security to the database.
- In the case of multiple users, it also maintains data consistency

* DBMS allows users the following tasks :

1. Data Definition : It is used for creation, modification, and removal of definition that defines the organization of data in the database.
2. Data Updation : It is used for the insertion, modification, and delete of the actual data in the database.
3. Data Retrieval : It is used to retrieve the data from the database which can be used by applications for various purposes.
4. User Administration : It is used for registering and monitoring users, maintain data integrity enforcing data security, dealing with concurrency control, monitoring performance and recovering information corrupted by unexpected failure.

* Characteristics of DBMS

1. It uses a digital repository established on a server to store and manage the information.
2. It can provide a clear and logical view of the process that manipulates data.

3. DBMS contains automatic backup and recovery procedures.
4. It contains ACID properties which maintain data in a healthy state in case of failure.
5. It can reduce the complex relationship between data.
6. It is used to support manipulation and processing of data.
7. It is used to provide security of data.
8. It can view the database from different viewpoints according to the requirements of the user.

* Advantages of DBMS

1. controls database redundancy
2. Data sharing
3. Easily maintained
4. Reduce time
5. Backup
6. Multiple User Interface

* Disadvantages of DBMS

- cost of Hardware and Software
- Size
- complexity
- Higher impact of failure

CONCEPT OF DATABASE

TO store and manage data efficiently in the database let us understand some key terms:

1. Database Schema: It is a design of the database. Or we can say that it is a skeleton of the database that is used to represent the structure, types of data will be stored in the rows and columns, constraints, relationships between the tables.

2. Data Constraint: In a database, sometimes we put some restrictions on the table that what type of data can be stored in one or more columns of the tables, it can be done by using constraints. Constraints are

are defined while we are creating a table.

3. Data dictionary or Metadata : Metadata is known as the data about the data.
- Or we can say the database schema along with different types of constraints on the data is stored by DBMS in the directory is known as Metadata.

4. Database Instance : In the database instance is used to define the complete database environment and its components. Or we can say that it is a set of memory structures and background processes that are used to process and access the database files.

5. Query : In a database, a query is used to access the data from the Database.
- So users have to write queries to retrieve or manipulate data from the database.

6. Data manipulation : In a database, we can easily manipulate data using the three main operations that is Insertion, Deletion and updation.

7. Data Engine: It is an underlying component that is used to create and manage various database queries.

* Types of Database

- Centralized Database
- Distributed Database
- NOSQL Database
- Cloud Database
- Relational Database
- Network Database
- Object-Oriented Database
- Hierarchical Database

1.> Centralized Database

- It is the type of database that stores data at a centralized database system.
- It comforts the users to access the stored data from different locations through several applications.
- These applications contain the authentication process to let users access data securely.
- An Example: of a centralized database can be Central Library that carries a central database of each library in a college/University.

> Advantages of Centralized Database

- It has decreased the risk of data management. i.e., manipulation of data will not affect the core data.
- Data Consistency is maintained as it manages data in a central repository.
- It provides better data quality, which enables organizations to establish data standards.
- It is less costly because fewer vendors are required to handle the data sets.

> Disadvantage of Centralized Database

- The size of the centralized database is large, which increases the response time for fetching the data.
- It is not easy to update such an extensive database system.
- If any server failure occurs, entire data will be lost, which could be a huge loss.

2.> Distributed Database

- Unlike a centralized database system, in distributed systems, data is distributed among different database systems of an organization.
- These database systems are connected via

communication links. Such links help the end users to access the data easily.

Examples of the Distributed database are Apache Cassandra, HBase, Ignite etc.,

3.> Relational Database

- This database is based on the relational data model, which stores data in the form of rows (tuple) and columns (attributes), and together forms a table (relation).
- A relational database uses SQL for storing, manipulating as well as maintaining the data.
- E.F. Codd invented the database in 1970.
- Each table in the database carries a key that makes the data unique from others.
- Eg: MySQL, Microsoft SQL Server, Oracles etc.,
- There are following four commonly known properties of a relational model known as ACID properties were,

A means Atomicity
C means Consistency
I means Isolation
D means Durability

4.> NoSQL Database

- Non-SQL / Not only SQL is a type of database that is used for storing a wide range of data sets.
- It is not a relational database as it stores data not only in tabular form but in several different ways.
- It came into existence when the demand for building technologies in modern applications increased.
- Thus, NoSQL presented a wide variety of database technologies in response to the demands.

- It is of four types:
  1. Key-value Storage
  2. Document-oriented Database
  3. Graph Database
  4. Wide-Column Stores

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5. Cloud Database

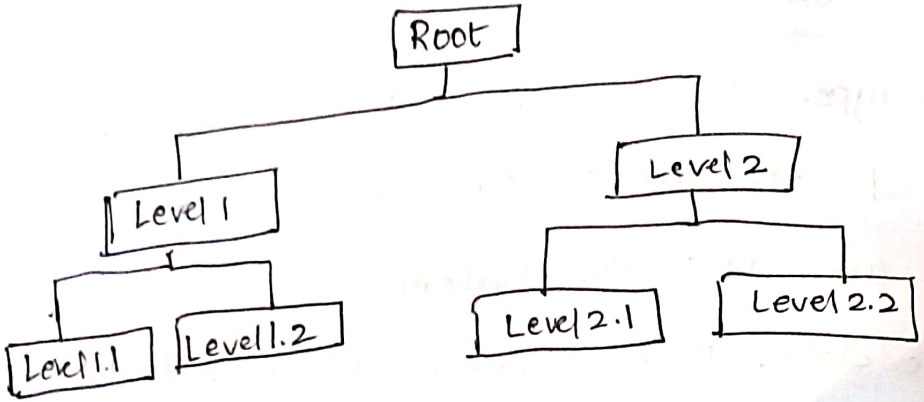
- A type of database where data is stored in a virtual environment and executed over the Cloud computing platform.
- It provides users with various Cloud computing services (Saas, Paas, Iaas etc) for accessing the database.
- There are numerous cloud platforms, but the best options are:
  - Amazon Web Services (AWS)
  - Microsoft Azure
  - Kamatera
  - PhonixNAP
  - ScienceSoft
  - Google Cloud SQL etc..

6. Object-Oriented Database

- The type if database that uses the object based data model approach for storing data in the database System.
- The data is represented and stored as objects which are similar to the objects used in the object-oriented programming language.

7. Hierarchical Database

- It is the type of database that stores data in the form of parent-children relationship nodes.
- Here, it organizes data in a tree-like structure. Data get stored in the form of records that are connected via links.
- On the other hand, each parent record can have multiple child records.



8. Network Databases

- It is the database that typically follows the network data model. Here, the representation of data is in the form of nodes connected via links between them.
- Unlike the hierarchical database, it allows each record to have multiple children and parent nodes to form a generalized graph structure.

9. Personal Database

- Collecting and storing data on the user's system defines a Personal Database.
- The database is basically designed for a Single User.

10. Operational Database

- The type of database which creates and Updates the database in real-time.
- It is basically designed for executing and handling the daily data operations in Several businesses.
- For example, An organization uses operational databases for manages per day transactions.

11. Enterprise Database

- Large organitions or enterprise use this database for managing a massive amount of data.
- It helps organizations to increase and improve their efficiency.
- Such a database allows simultaneous access to users.

⑥Difference between DBMS & RDBMS

DBMS	RDBMS
• DBMS applications store data as file.	• RDBMS applications store data in a tabular form.
• In DBMS, data is generally stored in either a hierarchical form or a navigational form.	• In RDBMS, the tables have an identifier called primary key and the data values are stored in the form of tables.
• DBMS uses file system to store data, so there will be no relation between the tables.	• RDBMS, data values are stored in the form of tables, so a relationship between these data values will be stored in the form of a table as well.
• DBMS has to provide some uniform methods to access the stored information.	• It supports a tabular structure of the data and a relationship between them to access the stored information.
• Normalization is not present in DBMS	• Normalization is present.
• DBMS has not apply any security with regards to data manipulation.	• RDBMS defines the integrity constraint for the purpose of ACID (Atomicity, Consistency, Isolation & Durability) property

• DBMS does not support distributed database.	• RDBMS supports distributed database.
• DBMS is meant to be for small organization and deal with small data. It supports single user.	• RDBMS is designed to handle large amount of data. It supports multiple users.
• Examples of DBMS are file systems, xml etc.,	• Eg: RDBMS are: mysql, postgre, sql

★ Types of DBMS Architecture

1. 1-tier
2. 2-tier
3. 3-tier

> 1-Tier Architecture

• In this architecture, the database is directly available to the user. It means the user can directly sit on the DBMS & uses it.

• Any change done here will directly be done on the database itself.

• It doesn't provide a handy tool for end users.

• The 1-tier architecture is used for development of the local application, where programmers can directly communicate with the database for the quick response.

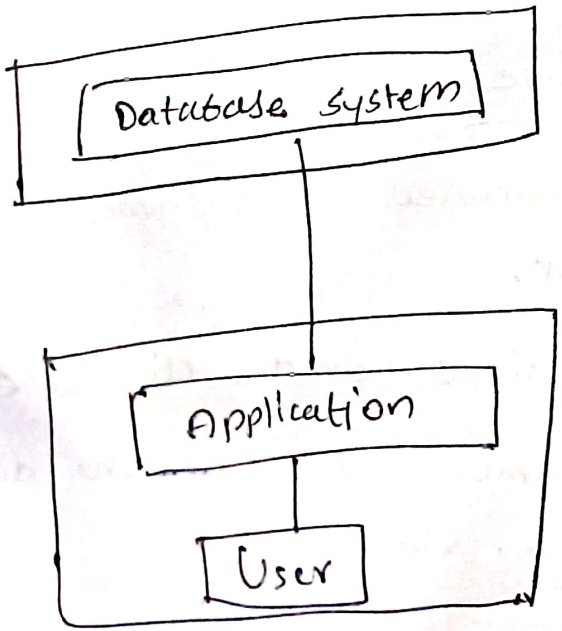
> 2-Tier Architecture

• The 2-tier architecture is same as basic client-Server.

• The applications on the client end can directly communicate with the database at the server side.

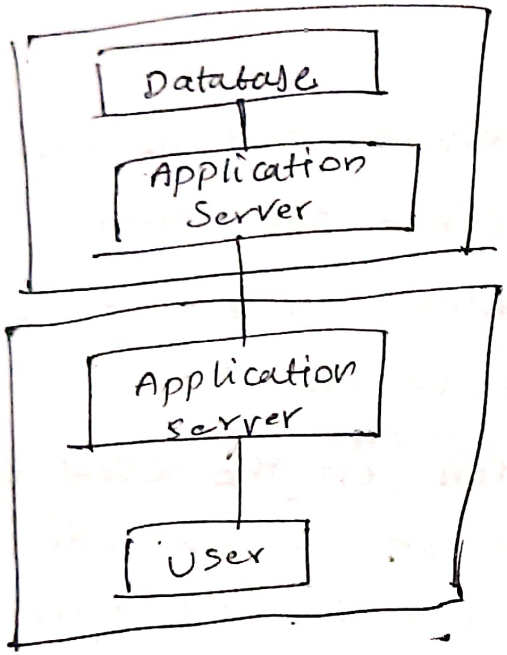
• for this interaction, API's like: ODBC, JDBC are used.

- The user interfaces and application programs are run on the client-side.
- The server side is responsible to provide the functionalities like: query processing and transaction management.
- To communicate with the DBMS, client-side application establishes a connection with the server side.



3-Tier Architecture

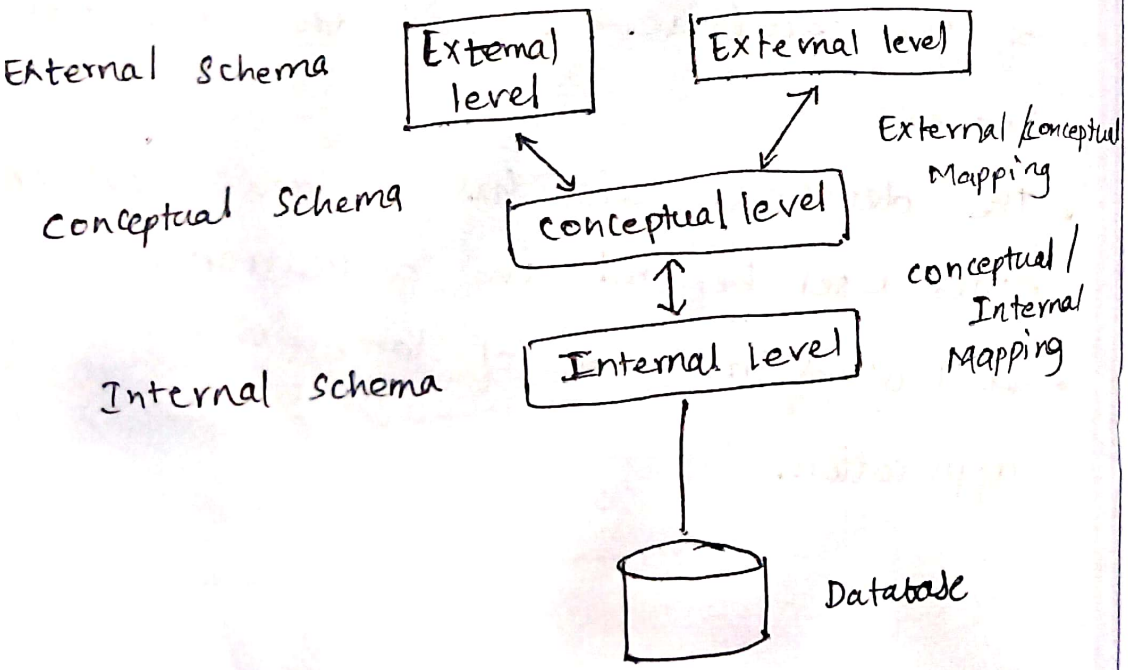
- A 3-tier architecture contains another layer between the client and server.
- In this architecture, client can't directly communicate with the server.
- The application on the client-end interacts with an application server when further communicated with the DB system.
- End user has no idea about the existence of the database beyond the application server.
- The database also has no idea about any other user beyond the application.
- It is used in case of large web application.



Server

Client

he three Schema architecture is as follows:



Normalization:

- This is the process of organizing a database to minimize redundancy and dependency by breaking down complex tables into smaller, more manageable ones.
- It's important to understand normalization because it helps you create efficient and scalable databases, reduces data inconsistency and duplication, and makes it easier to update and maintain the database over time
- This information is often skipped over in introductory material because it can be technical and complex, but it is crucial for understanding how to properly design and maintain a database.

Objectives of three Schema Architecture

- The main objective of three level architecture is to enable multiple users to access the same data with a personalized view while storing the underlying data only once.
- Thus, it seperates the user's view from the Physical structure of the database.
- This seperation is desirable for the following Reasons:

- Different users need different views of the same data.
- The approach in which a particular user needs to see the data may change over time.
- The users of the database should not worry about the physical implementation and internal workings of the database such as data compression and encryption techniques, hashing, optimization of the

- Different users should be able to access the same data according to their requirements.
- DBA should be able to change the conceptual structure of the database without affecting the user's.
- Internal structure of the DB should be unaffected by changes to aspects of the storage.