DATABASE MANAGMENT SYSTEMS

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OBJECTIVES

- Describe the uses and applications of databases
- Develop and apply Entity-Relationship (ER) model
- Design and develop a database with multiple tables using a relational DBMS
- Apply queries and manage a database using SQL
- Normalize relations in a relational database system

Course Content

1.Introduction to Database Management Systems

2. Data Modeling Using the Entity Relationship (ER) Model

3. Relational Data Model

4. Data Manipulation using SQL and SQL Programming

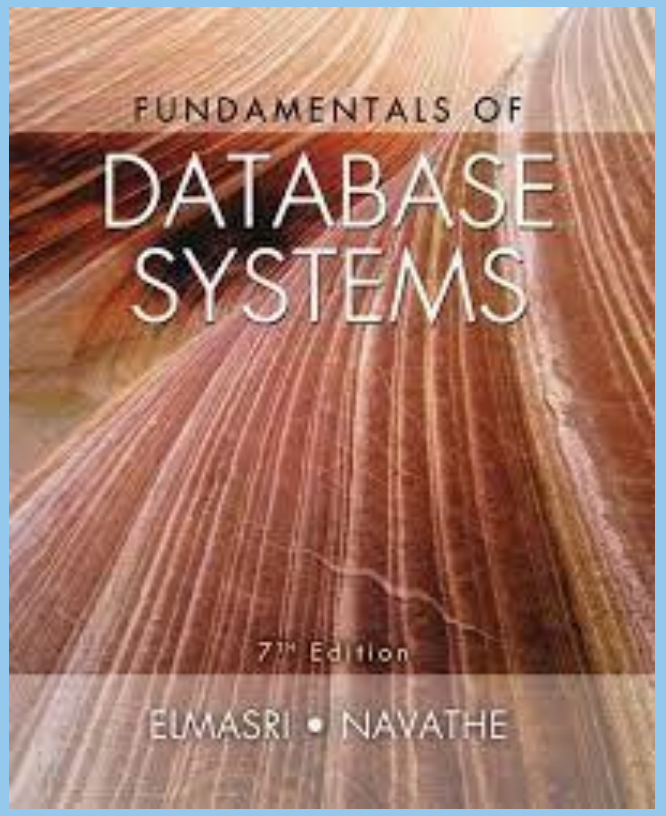
5. Data Views

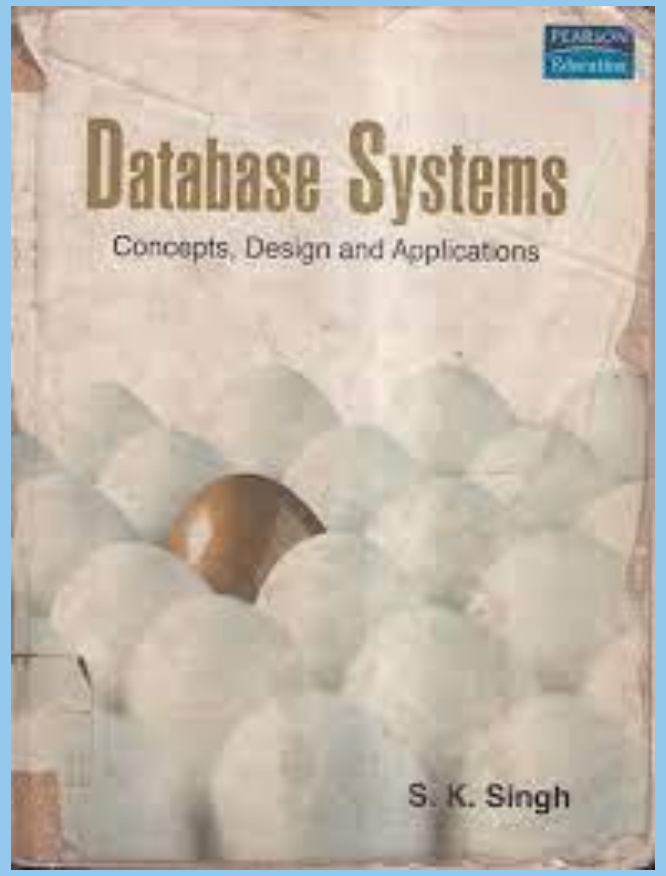
6. Data Security

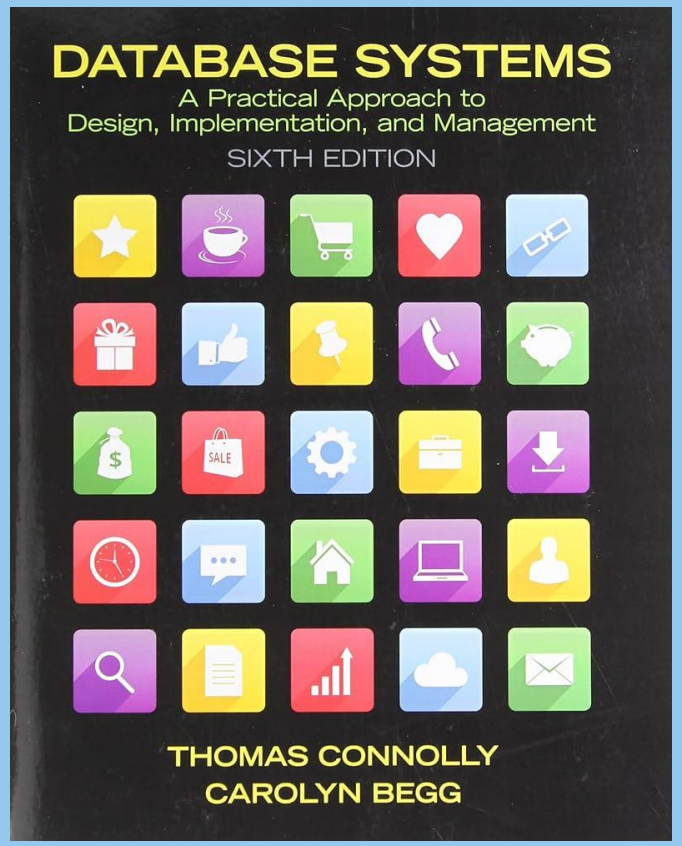
7. Database Design Process

8. Data Normalization Process and the Normal Forms

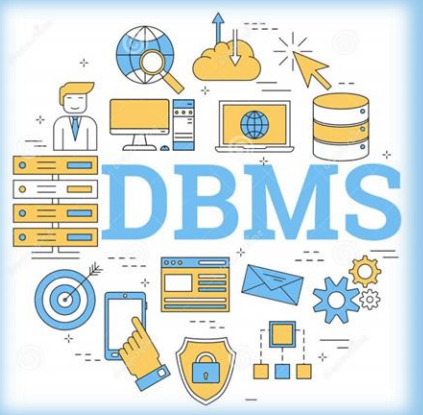
Recommended Text







Evaluation Criteria



CA 40% + FE 60% = Z 100%

80% attendance is a must

What is Data?

Raw facts and figures that on their own have no meaning, and used to generate information.

Ex:- Text, numbers, images, videos, speech…etc.

Gayani, Maleesha, Pathum, 26/09/2023, Aqua, Tida, Toyota

What is Information?

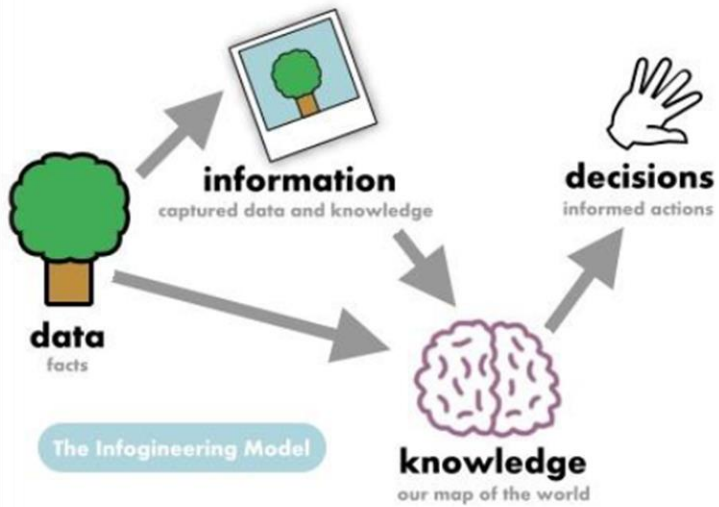
Data that has been processed within a context to give it meaning

Gayani, Maleesha, Pathum, 26/09/2023, Aqua, Tida, Toyota

Toyota is a car manufacturer.
Maleesha is a car owner.

Vehicles		
Owner	Model	Purchase Date
Pathum	Aqua	26/09/2023
Maleesha	Tida	20/08/2023

Data, Information & Knowledge



Data

- 100

Information

- 100 miles

Knowledge

- 100 miles is quite a far distance.

Wisdom

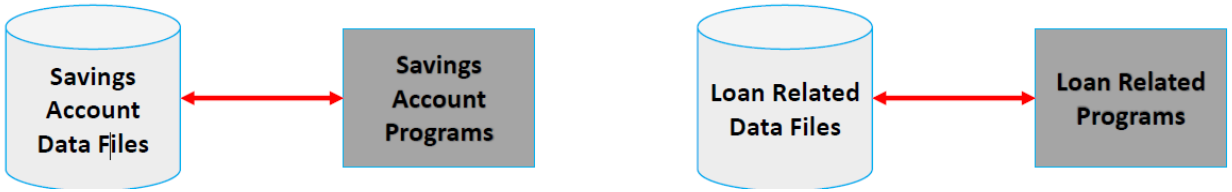
- It is very difficult to walk 100 miles by any person, but vehicle transport is okay

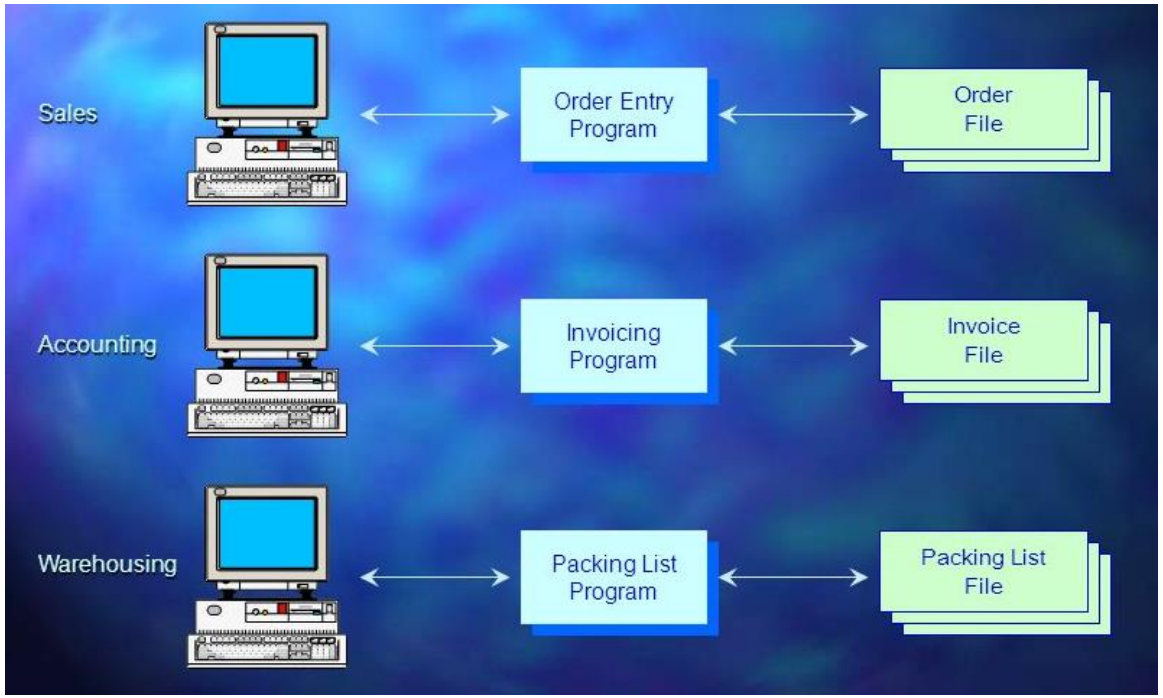
Evolution of Databases

1. File-Based Data Processing

❖ A collection of application programs that perform services for the end users.

❖ Each application has data files that correspond to only that application.

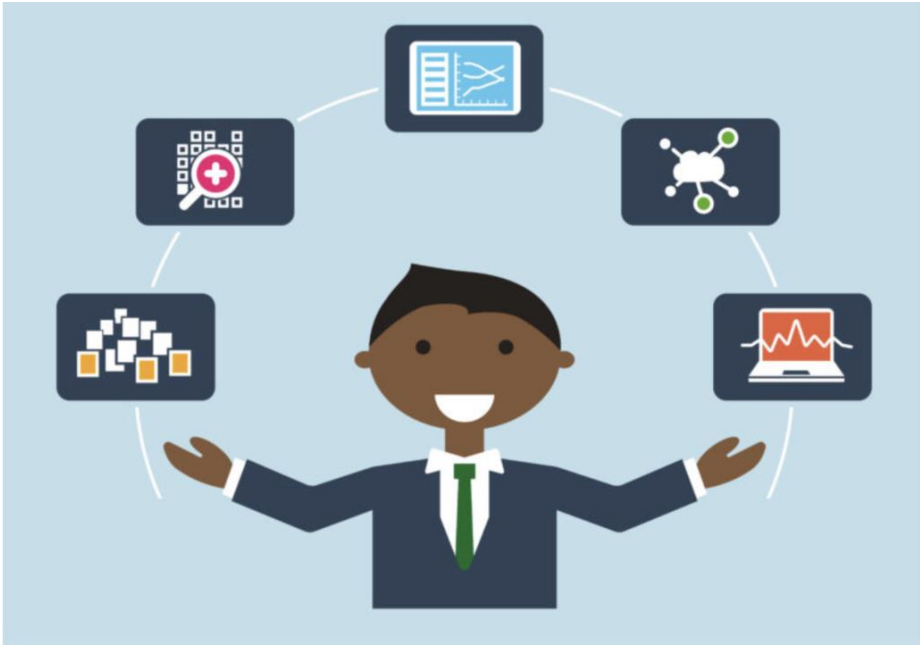




Limitations of File-Based Approach

❖Separation and isolation of data

- Each program maintains its own set of data.
- Users of one program may be unaware of potentially useful data held by other programs.
- When data is isolated in separate files, it is more difficult to access data that should be available.



Limitations of File-Based Approach

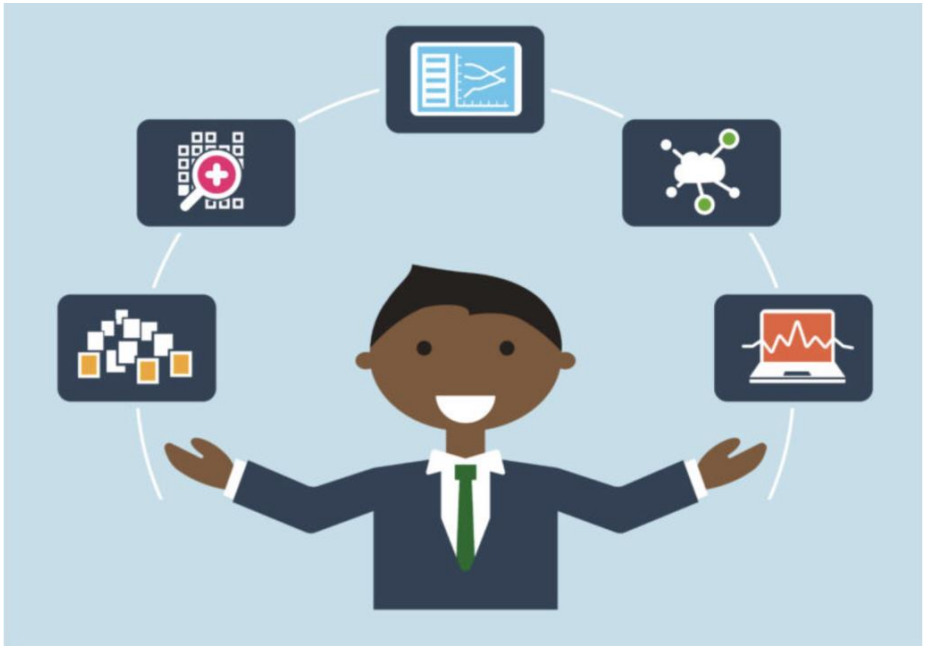
❖Duplication of data

- Same data is held by different programs.
- Duplication is wasteful.
- It costs time and money to enter the data more than once.
- It takes additional storage space, again with associated costs.
- Different values and/or different formats for the same item.
- Duplication can lead to loss of data integrity (i.e. data is no longer consistent).

Limitations of File-Based Approach

❖Incompatible file formats

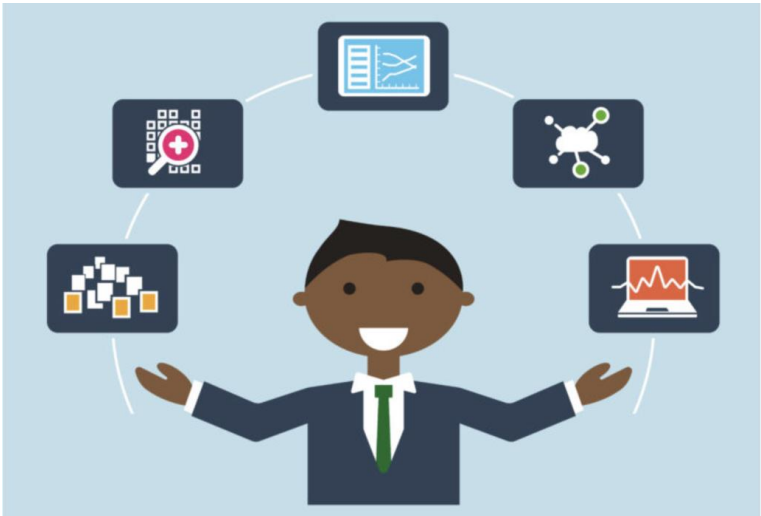
- Structures are dependent on the application programming language.
- Programs are written in different languages (e.g. COBOL, C), and so cannot easily access each other's files.



Limitations of File-Based Approach

❖Fixed queries of application programs

- Programs are written to satisfy particular functions.
- Any new requirement needs a new program.

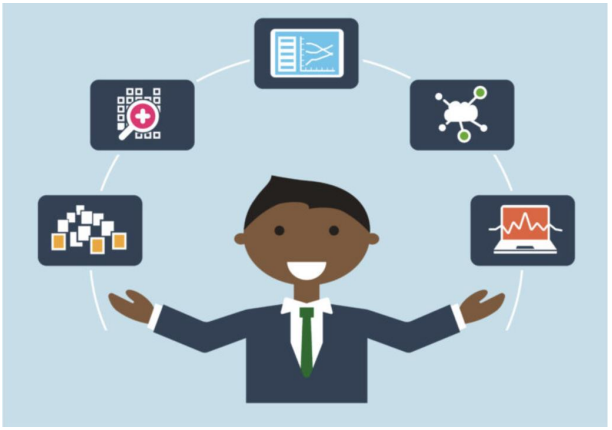


Limitations of File-Based Approach

❖Data Dependency

- File structure is defined in the program code (physical structure and storage of the data files and records are defined in the application code).

- Changes to an existing structure are difficult to make.



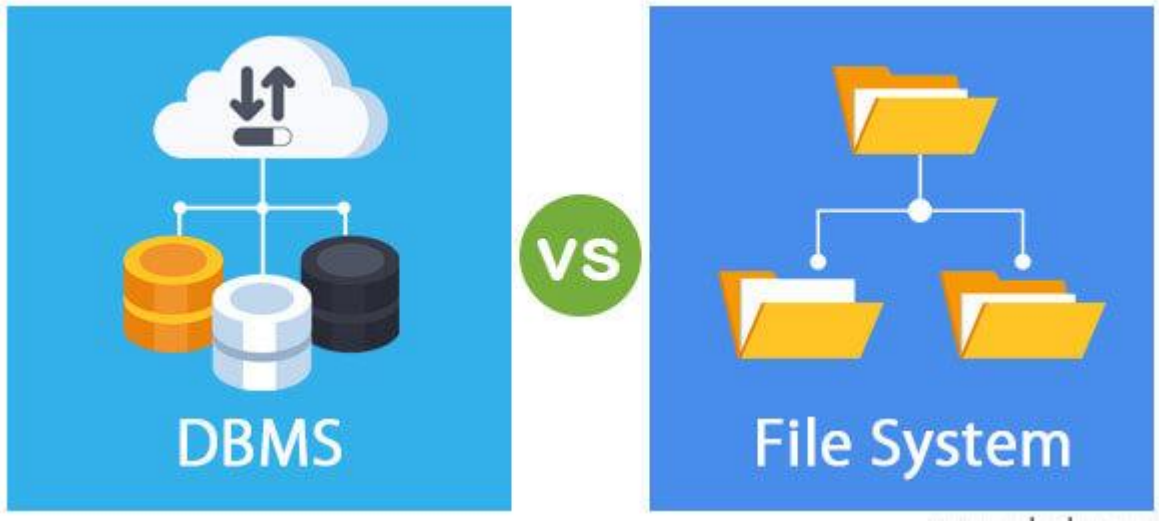
Evolution of Databases

2. DBMS

- Hierarchical Model
- Network Data Model
- Object Oriented Model
- Object Relational Model
- **Relational Model**
- NoSQL

Why Databases & DBMS?

Overcome the limitations in file-based approach



What is a **Database?**

Organized Collection of Data /Information
(Logically related data)

What is DBMS?

general-purpose software system that facilitates the processes of defining, constructing, manipulating, and sharing databases among various users and applications.

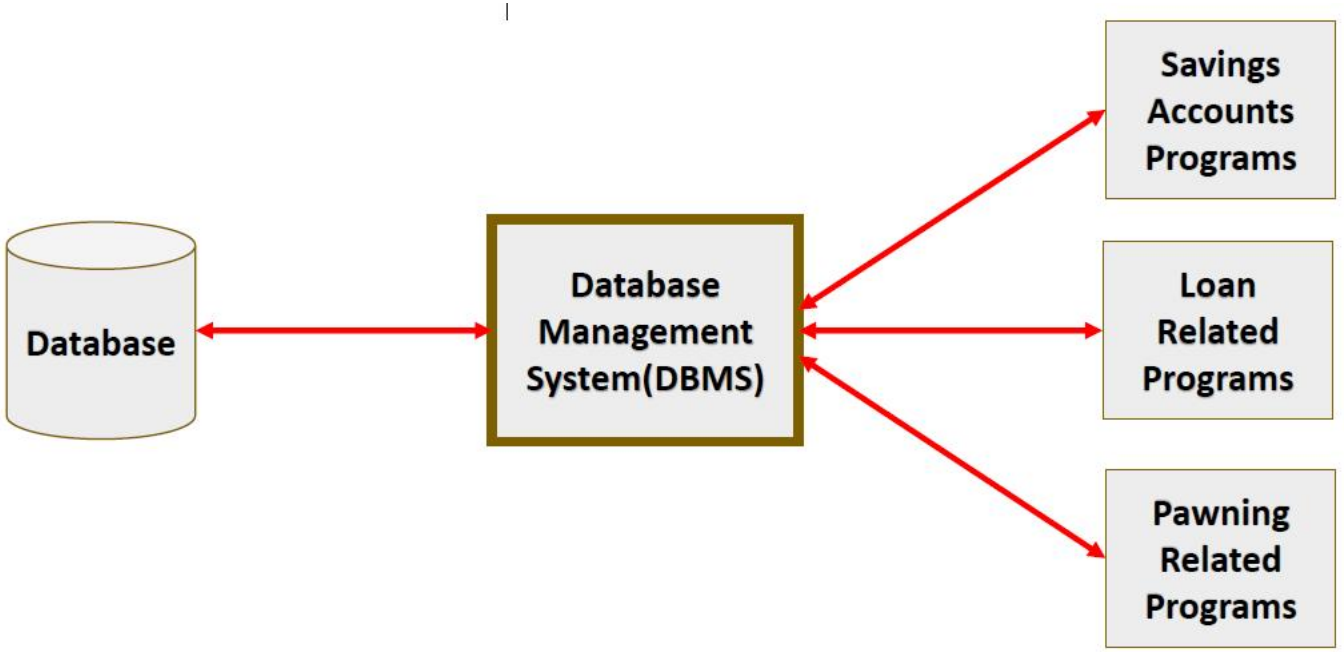
The software that manages and controls access to the database.

DBMS provides the following facilities:

- It allows users to define the database, usually through **a Data Definition Language (DDL)**
- It allows users to insert, update, delete, and retrieve data from the database, usually through **a Data Manipulation Language (DML)**
- It provides controlled access to the database.

Database Approach

All applications interact with the same interface with same data in a central database.



DATABASE MANAGEMENT SYSTEM

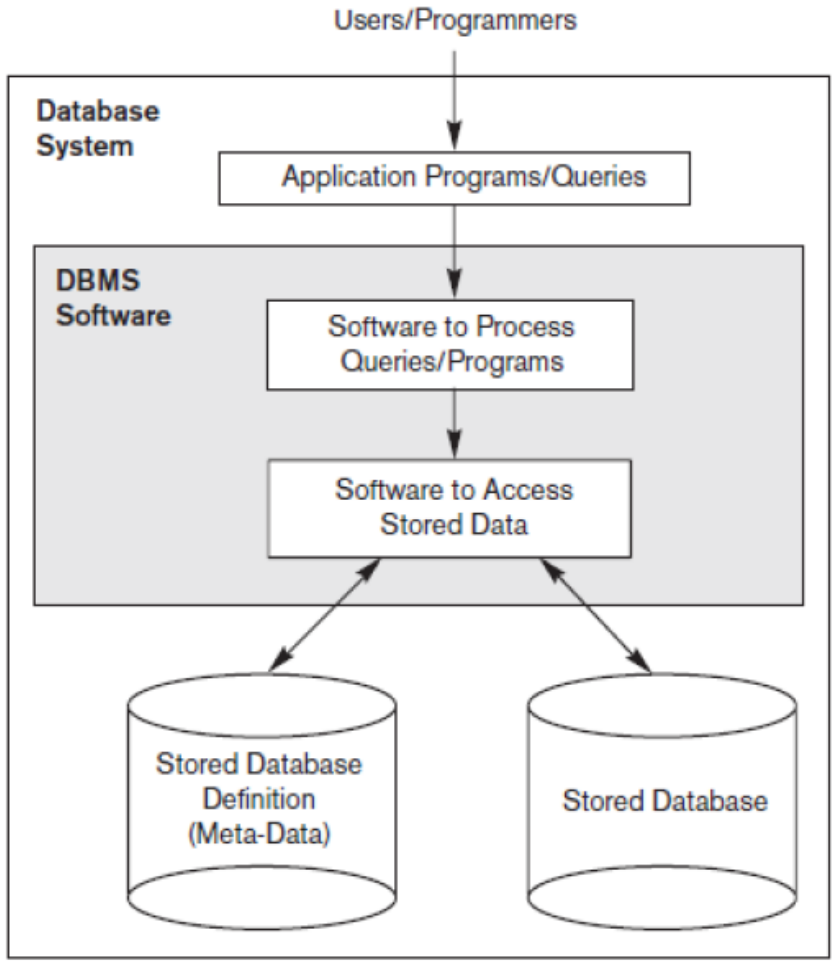
DATABASE

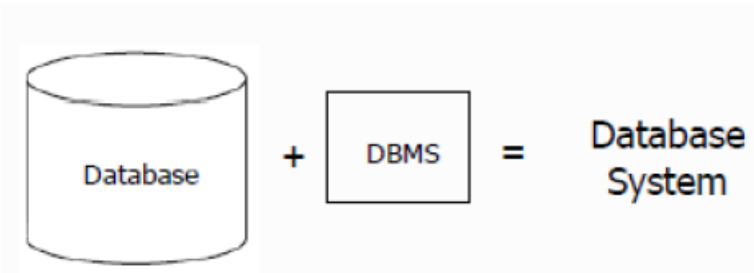
MANAGEMENT SYSTEM

MySQL | Oracle | SQL Server | PostgreSQL | . . .

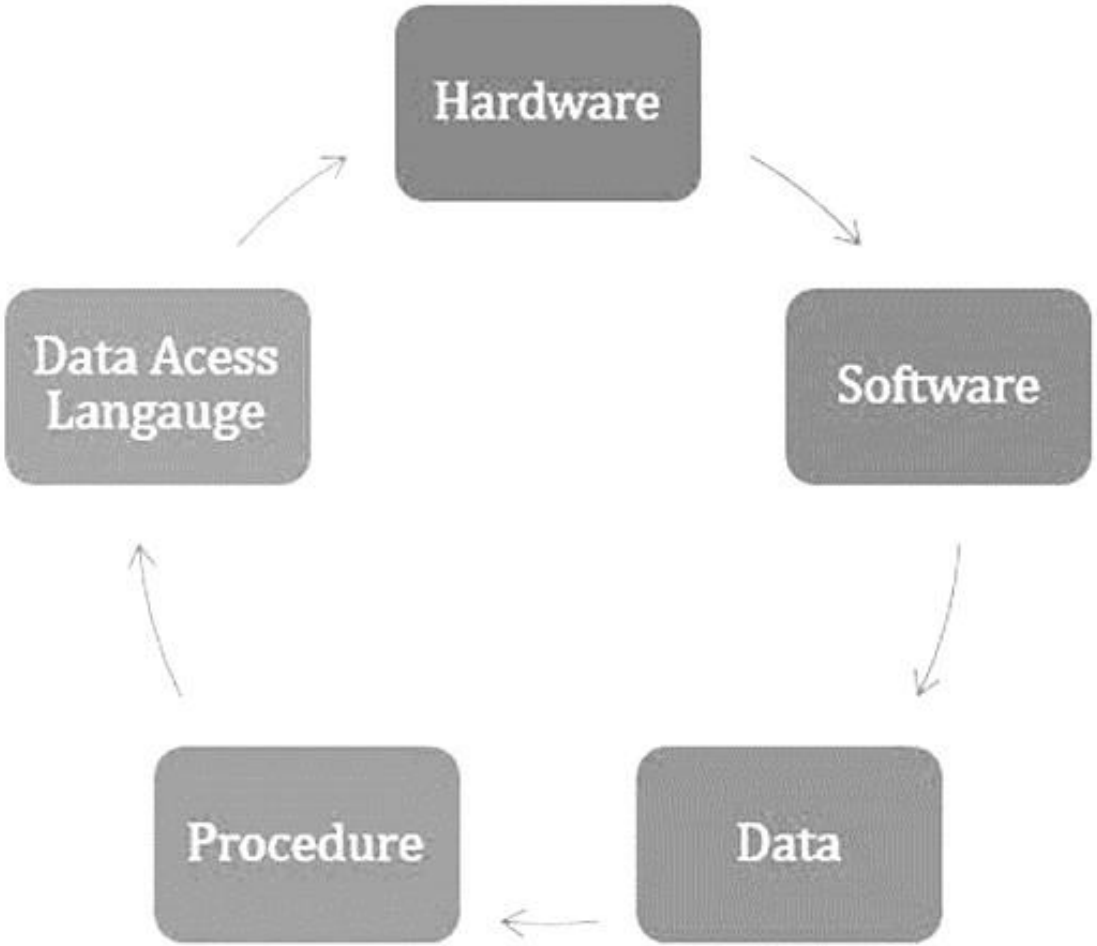
- Managing a Collection
- Easy to retrieve ,insert or manipulate data.
- Accessing data manually may produce human errors.

Database System Environment





Major Components of DBMS



Database Users

Actors on the Scene

- ★ Database Administrators
- ★ Database Designers
- ★ End Users
- ★ System Analysts & Application Programmers

Workers Behind the Scene

- ★ System designers & implementers
- ★ Tool developers
- ★ Operators & maintenance personnel

Database End Users

Casual end users

occasionally access the database

may need different information each time

use a query language to specify their requests

typically middle- or high-level managers or other occasional browsers.

Naive end users

constantly querying and updating the database

use standard types of queries and updates

need to know very little about the DBMS (access the database through specially written application program)

Sophisticated end users

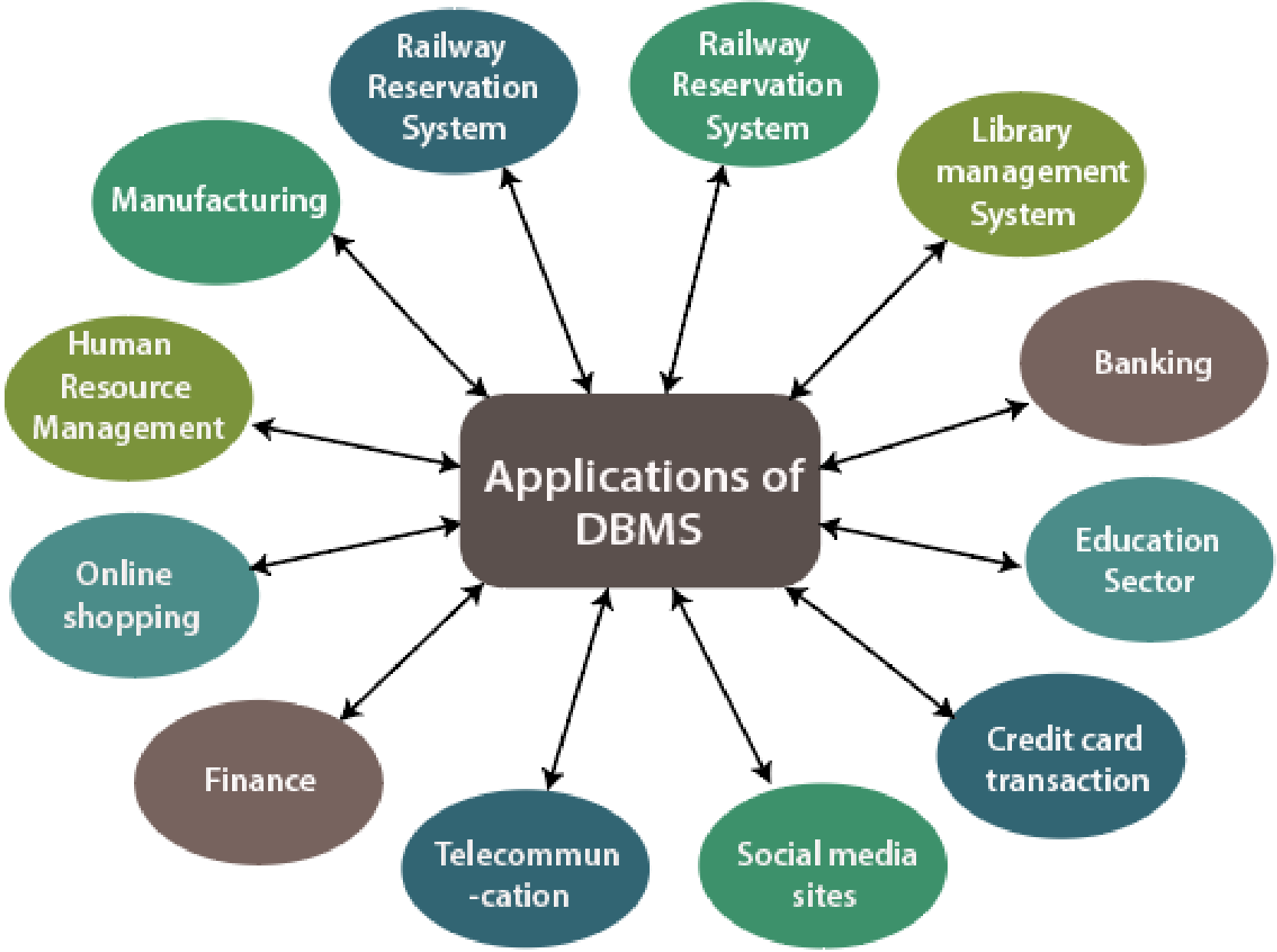
thoroughly familiarize themselves with the facilities of the DBMS

implement their applications to meet their complex requirements

Stand-alone users

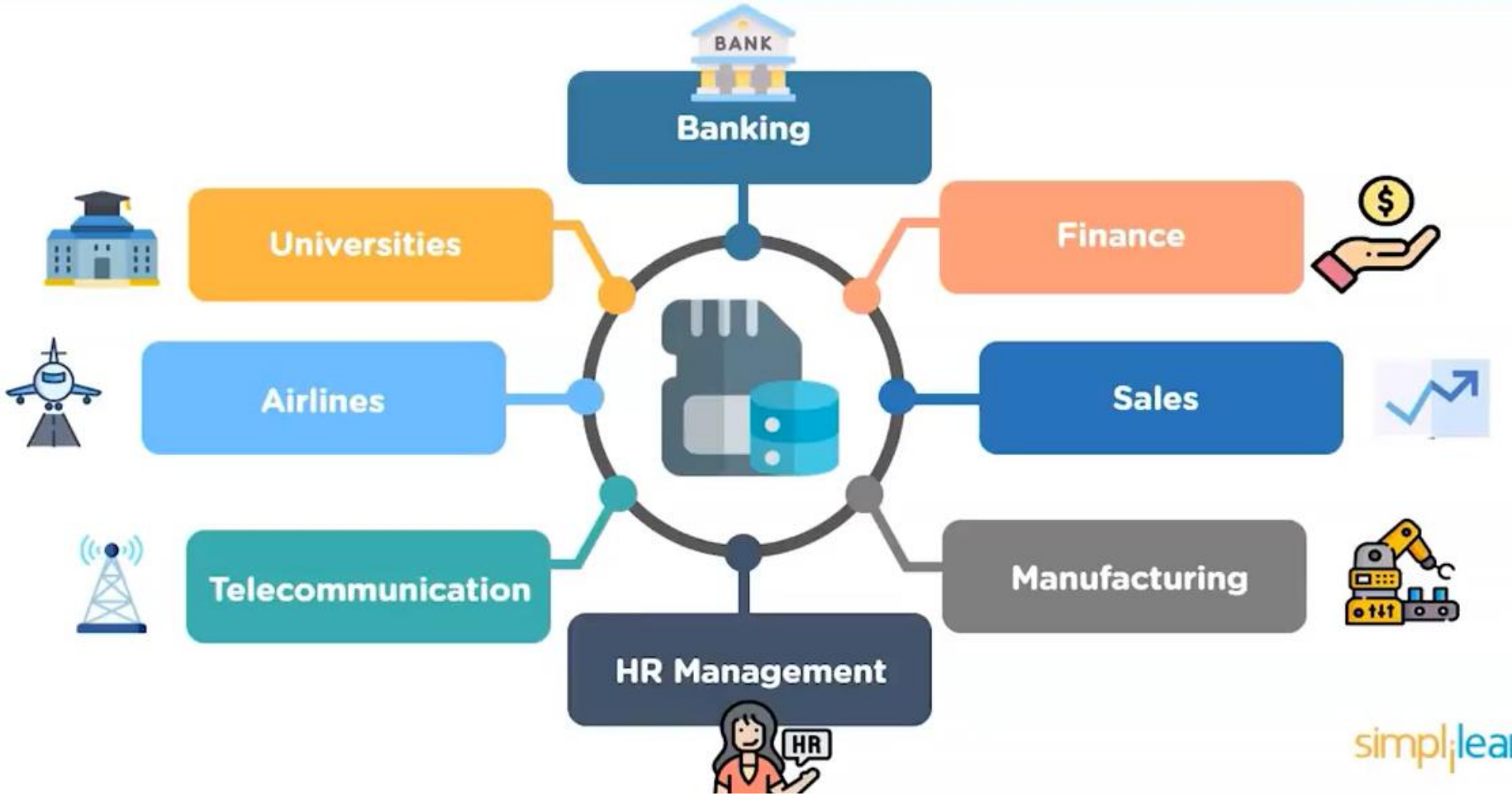
maintain personal databases

use ready-made program packages that provide easy-to-use menu-based or graphics-based interfaces


Railway Reservation System
Railway Reservation System
Manufacturing
Library management System
Human Resource Management
Banking
Applications of DBMS
Online shopping
Education Sector
Finance
Credit card transaction
Telecommun -cation
Social media sites


DBMS

Application of DBMS

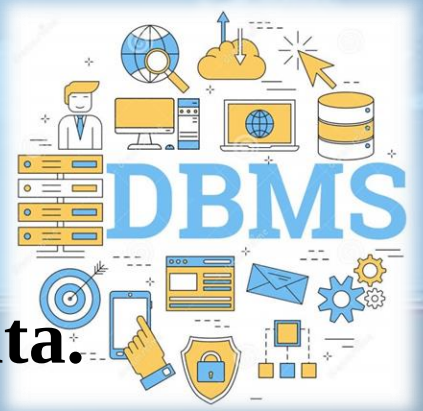


Data Dictionary(Meta Data)

A subsystem that keeps track of the definitions of data items in the database which includes

- ❖ elementary-level data items (fields/attributes)
- ❖ relationships that exists between various data structures
- ❖ files or relational tables
- ❖ indexes that are used to access data quickly

•Most DBMS keep the data dictionary hidden from users to prevent them from accidentally destroying its contents.



- Data that describe the properties or characteristics of other data.
- Some of these properties include the name of the data item, data type, length, minimum and maximum allowable values (where appropriate), rules or constraints and a brief description of each data item.
- Meta data allow database designers and users to understand what data exist, what the data mean.
- Data without clear meaning can be confusing, misinterpreted or erroneous.

Data Dictionary(Meta Data)

DATA

emlployee_id	first_name	last_name	nin	dept_id
44	Simon	Martinez	HH 45 09 73 D	1
45	Thomas	Goldstein	SA 75 35 42 B	2
46	Eugene	Cornelsen	NE 22 63 82	2
47	Andrew	Petculescu	XY 29 87 61 A	1
48	Ruth	Stadick	MA 12 89 36 A	15
49	Barry	Scardelis	AT 20 73 18	2
50	Sidney	Hunter	HW 12 94 21 C	6
51	Jeffrey	Evans	LX 13 26 39 B	6
52	Doris	Berndt	YA 49 88 11 A	3
53	Diane	Eaton	BE 08 74 68 A	1

DATA DICTIONARY (METADATA)

Column	Data Type	Description
emlployee_id	int	Primary key of a table
first_name	nvarchar(50)	Employee first name
last_name	nvarchar(50)	Employee last name
nin	nvarchar(15)	National Identification Number
position	nvarchar(50)	Current postion title, e.g. Secretary
dept_id	int	Employee deparmtnet. Ref: Departmetns
gender	char(1)	M = Male, F = Female, Null = unknown
employment_start_date	date	Start date of employment in organization.
employment_end_date	date	Employment end date.

Functions of DBMS

- Data definitions
- Data retrieval
- Data manipulation
- Access control
- Data sharing
- Data integrity

ORACLE DATABASE

MySQL

mongoDB

Microsoft SQL Server

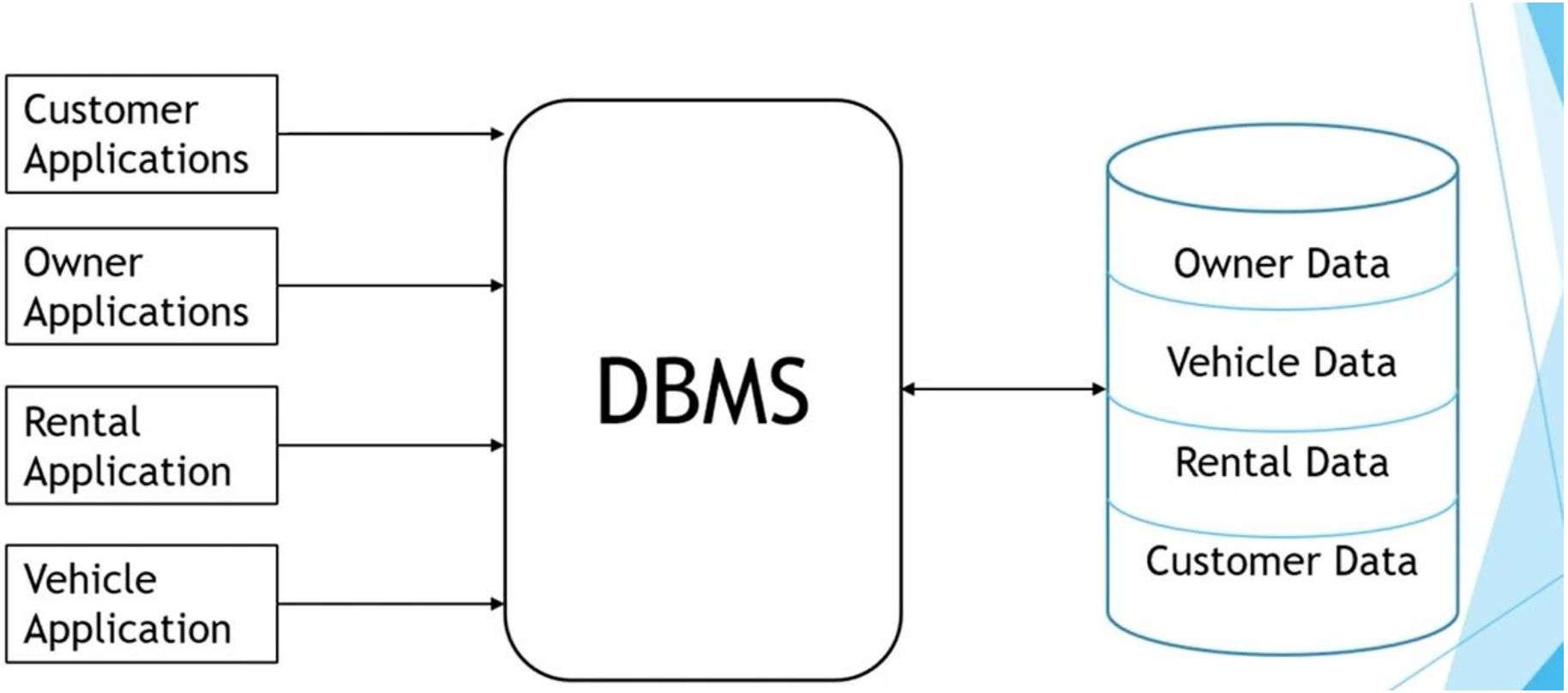
MariaDB

PostgreSQL

IBM DB2

Microsoft Access

Vehicle Rental System



Database Building Blocks

File / Table

A collection of related records

Field

Field represents an attribute, or a characteristic, or a piece of information

Record

A record is a group of related fields

Customers

Id	FirstName	LastName	ContactNo
1	Kasun	Perera	0981234567
2	Aruna	Peiris	0892345672
3	Nilani	Aponsu	6912345769

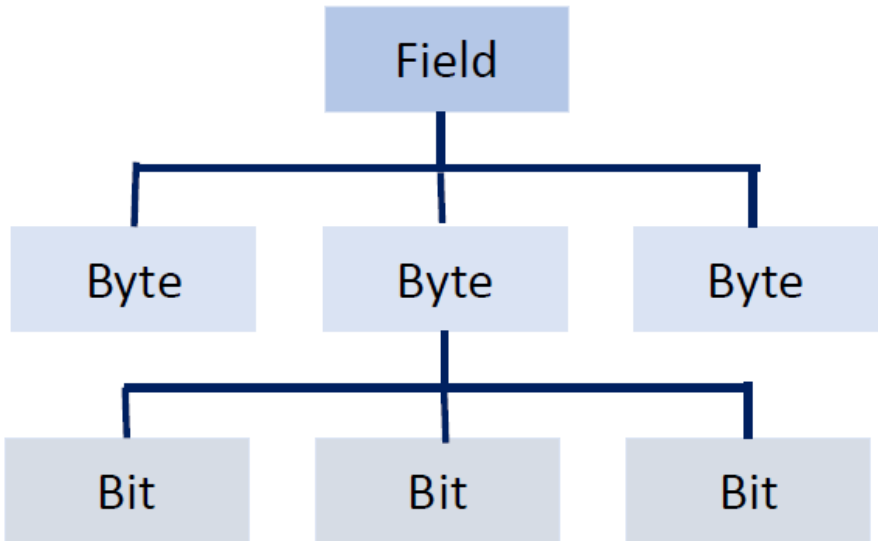
Advantages of DBMS:

- Data can Store in Tables
- Can Reduce Data Redundancy
- Data Consistency
- Multiple Users can Access
- Security

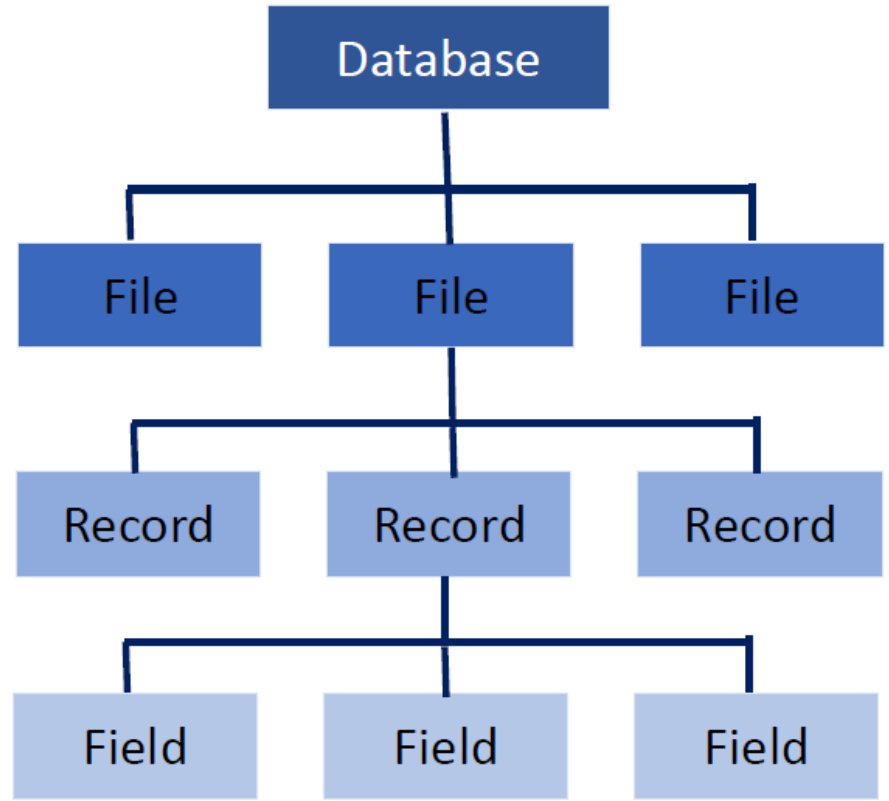
- Data can Store in Tables

Subject Code	Subject Name

Student Name	Grade	Address


Field
Byte
Byte
Byte
Bit
Bit
Bit


DBMS


Database
File
File
File
Record
Record
Record
Field
Field
Field

Advantages of DBMS:

- Can Reduce Data Redundancy

- Data can Store in Tables
- Can Reduce Data Redundancy
- Data Consistency
- Multiple Users can Access
- Security

Student Name	Grade	Subject	Teacher
Kamal	9	Science	Mr. Roshan
Amal	9	Science	Mr. Roshan
Saman	10	Science	Mr. Roshan
Pawan	8	Science	Mr. Roshan
Nimal	10	Science	Mr. Roshan

→ Normalization

Advantages of DBMS:

- Data Consistency & Integrity

- Data can Store in Tables
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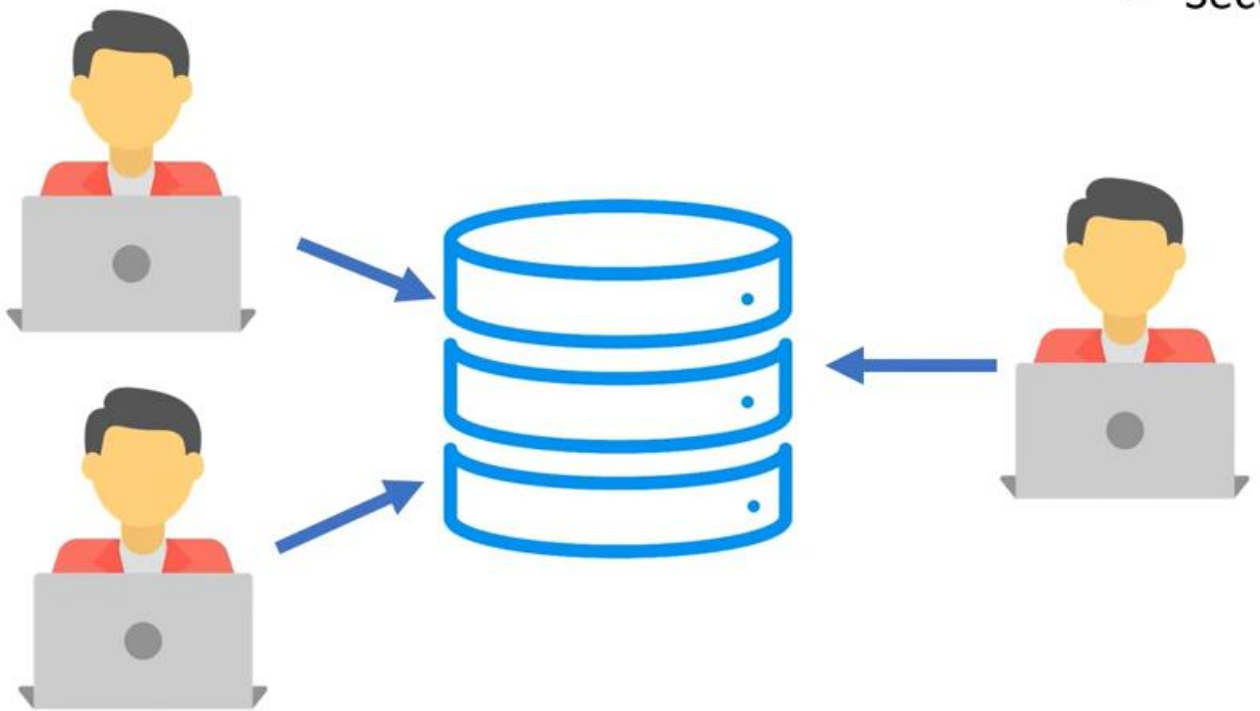

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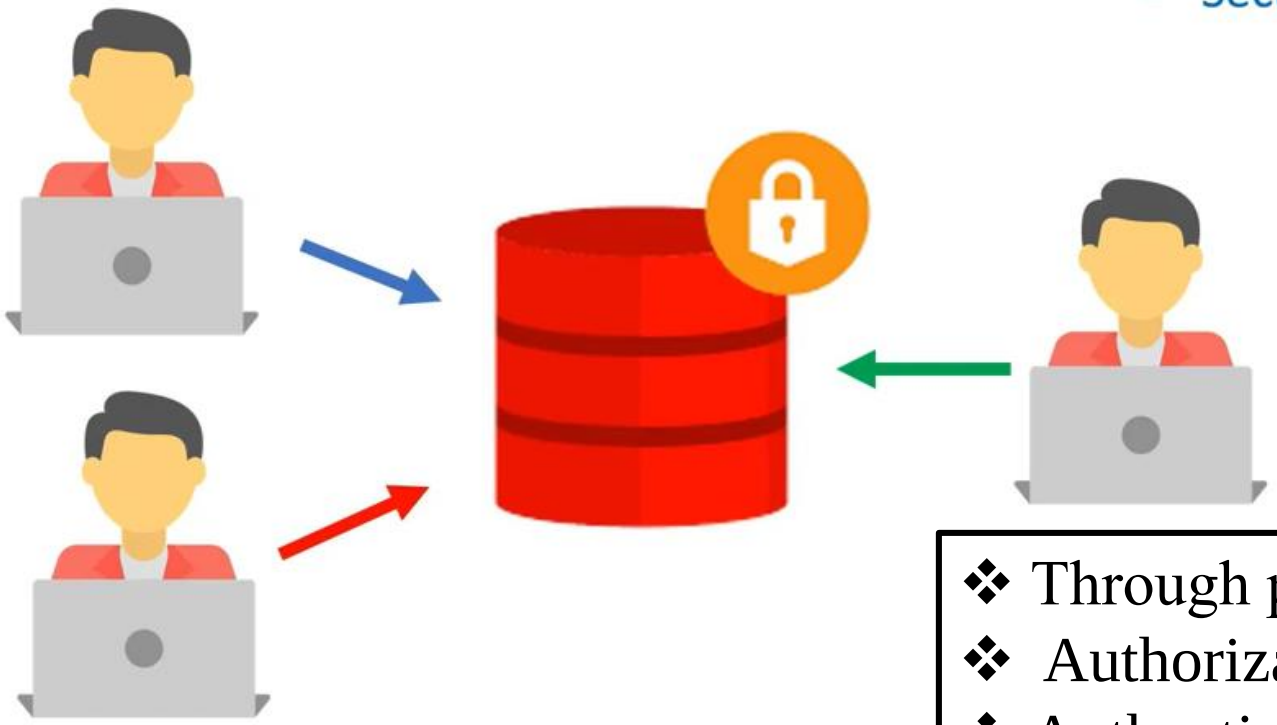

- Through passwords, data views… etc.
- Authorization
- Authentication
- Backups & Recovery

Advantages of DBMS:

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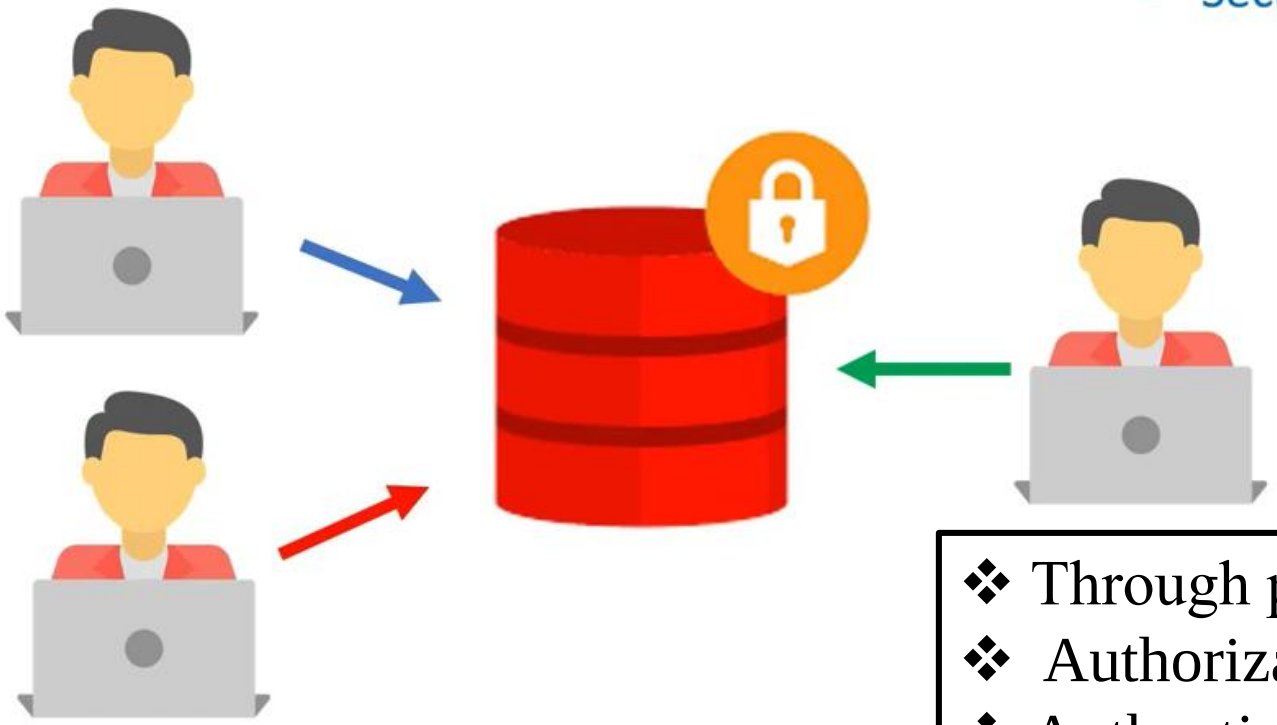

- Through passwords, data views… etc.
- Authorization
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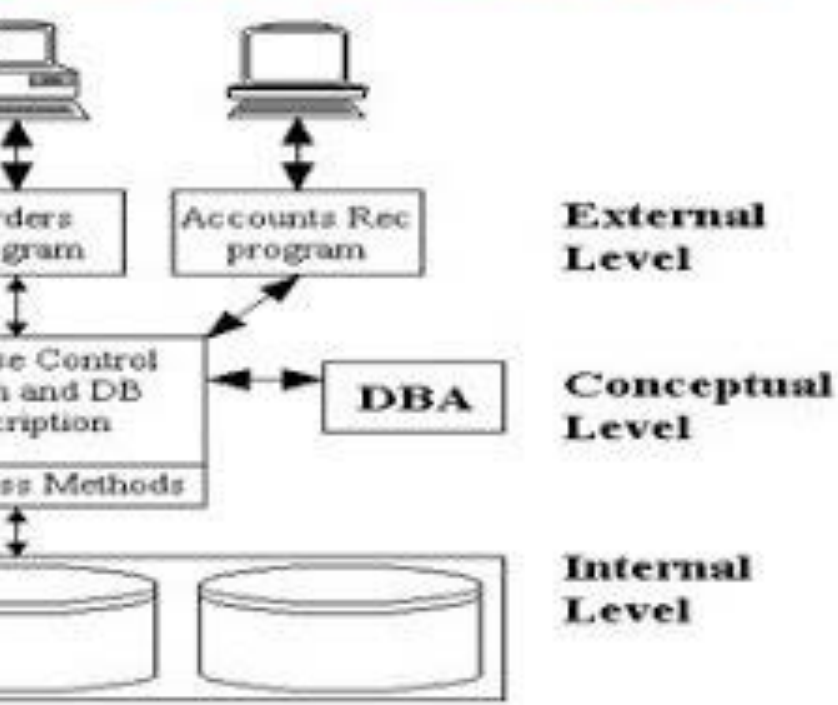
Advantages of DBMS:

- **Data Independence**
- **Enforcement of standards**
- **Improved data integrity**
- **Improved data accessibility and responsiveness**
- **Increased concurrency**

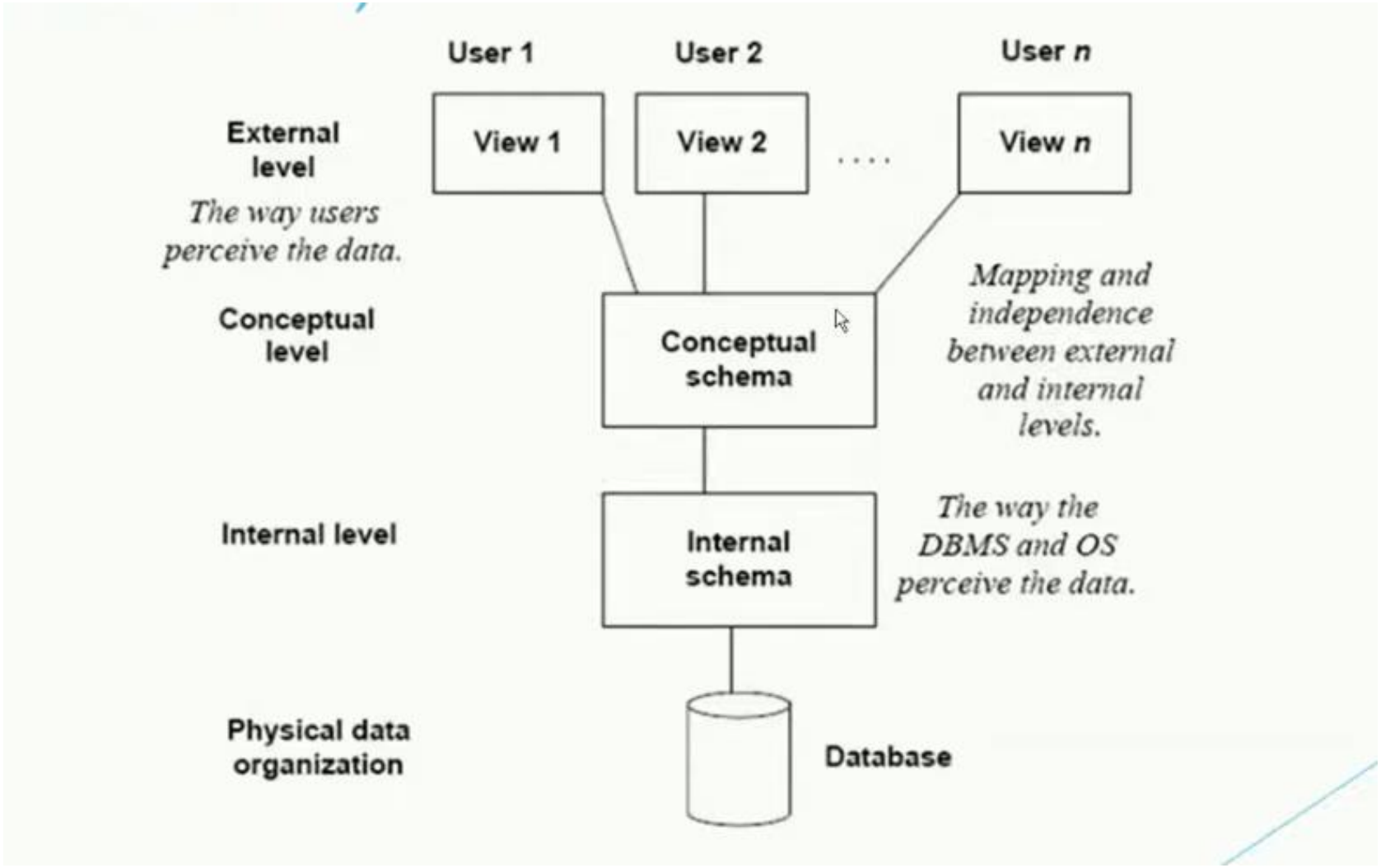
Disadvantages of DBMS:

- Cost of Staff training
- Cost of DBMS software
- Cost of Hardware

DATABASE SYSTEM ARCHITECTURE



3 Level Schema Architecture



External Level

- External level is the closest to the end users and it is concerned with the way the data is viewed by the individual users.

Conceptual Level

- This level has a conceptual schema which describes the structure of the whole database for a community of users.

Internal Level

- Internal Level is the one concerned with the way the data is actually stored.

External view 1

sNo	fName	lName	age	salary

External view 2

staffNo	lName	branchNo

Conceptual level

staffNo	fName	lName	DOB	salary	branchNo

Internal level

```
struct STAFF {
        int staffNo;
        int branchNo;
        char fName [15];
        char lName [15];
        struct date dateOf Birth;
        float salary;
        struct STAFF *next;                    /* pointer to next Staff record */
};
index staffNo; index branchNo;                 /* define indexes for staff */
```

Data Independence

- Data independence is the capacity to change the schema at one level of a database system without having to change the schema at the next higher level.
  - Logical Data Independence
  - Physical Data Independence

Data Independence

- Logical Data Independence :
  - The capacity to change the conceptual schema without having to change the external schema or application program.

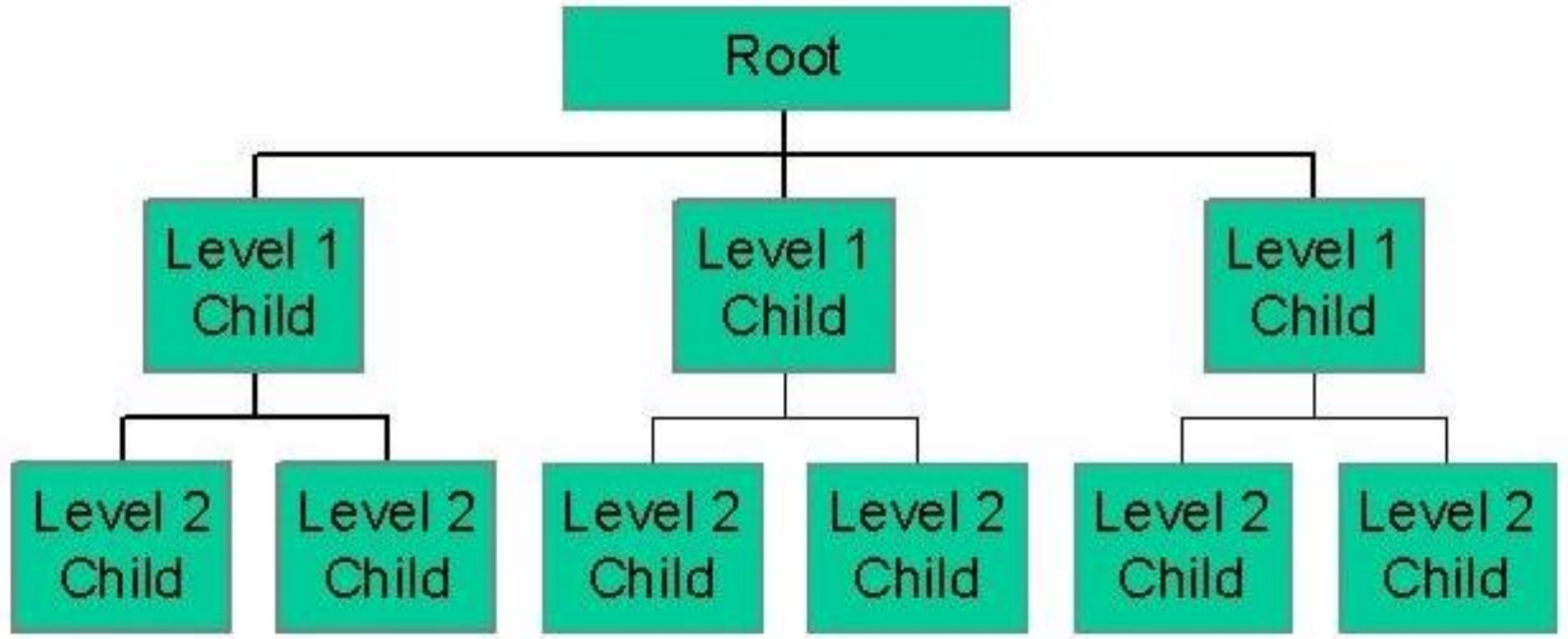
- Physical Data Independence :
  - The capacity to change the internal schema without having to change conceptual schemas.

Data Models **in DBMS**

Structure/ Format of a Database

- ❖Hierarchical Database Model
- ❖Network Database Model
- ❖Relational Database Model

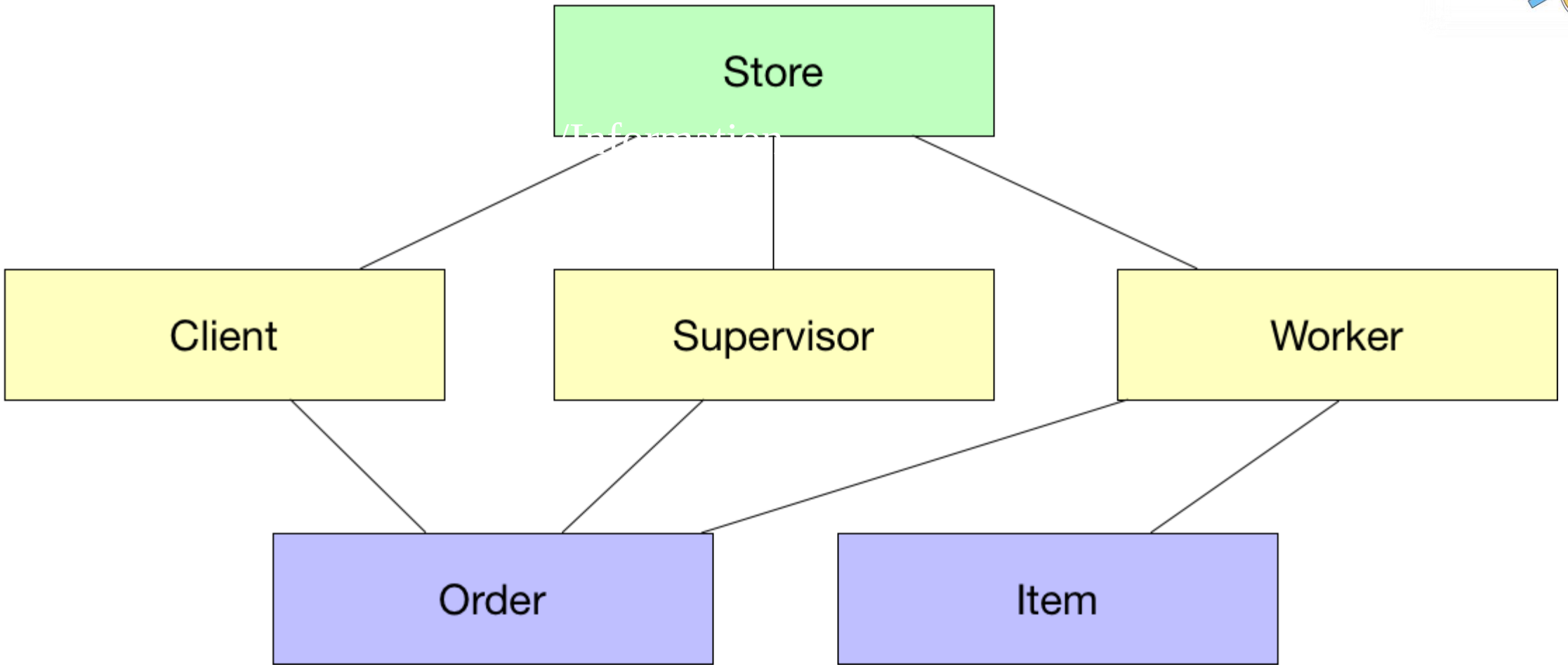
Hierarchical Database Model



- Structure of Data organized in a tree
- Model using parent – child relationship

Network Database Model

Allows multiple records to be linked to the same owner file.



Relational Database Model

Primary Key

Course	Duration	Type
Data Science	5 Months	Cohort Based
Full Stack	5 Months	Cohort Based
Software Development	6 Months	1:1
Product Management	4 Months	Cohort Based

Tuples(Rows)

Attributes (Columns)

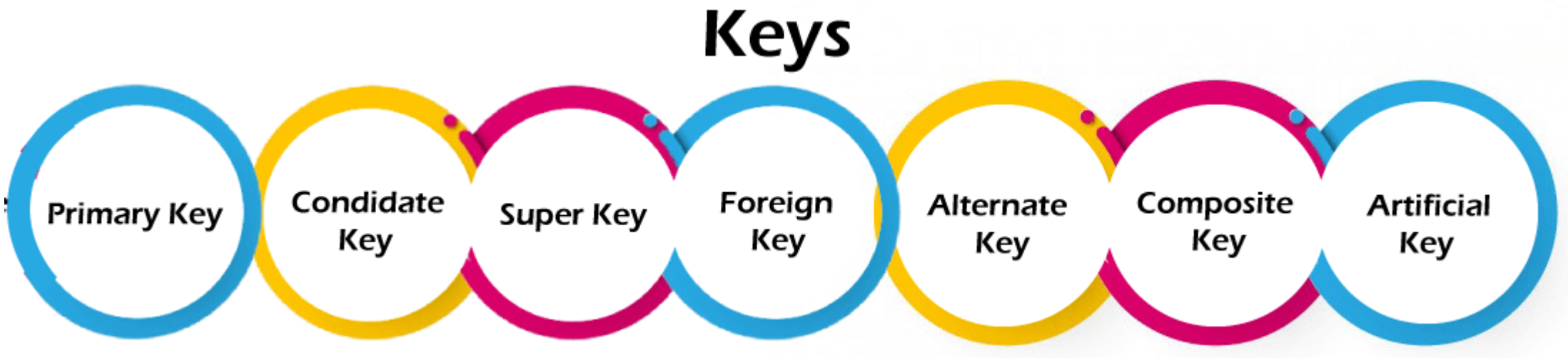
- Relation : A named two dimensional table consisting of rows and columns of data.
- Tuple : A row in a relation
- Attribute : A column in a relation
- Degree of a relation : The number of attributes in a relation
- Cardinality of a relation : The number of tuples in a relation

Properties of a Relation

1) Each relation in a database must have a unique name.
2) An entry at the intersection of each row and column is atomic or single valued.
3) Each tuple must be unique, no two in a relation are identical.
4) Each attribute of a relation can be interchanged without changing the meaning or use of the relation.
5) The rows of a relation can be interchanged or stored in any sequence.

Key

Minimal Set of attributes that uniquely identifies each tuple in a relation.



- Candidate Key :
  - In a given relation there may be more than one set of attributes that could be chosen as a key.
- Primary Key :
  - When one of the candidate keys is selected as the relation key, it is called the Primary Key.
- Alternate Key :
  - Other Candidate Keys which are not selected as the Primary Key.

Primary Key

Alternate Key

- E.g.:- Student(IndexNo, NICNo, Name, Gender, Address, Telephone)

Candidate Keys

- Composite Key :
  - A key consisting of more than one attribute.
    - E.g.: Item(SupplierID, ItemID, ItemName, Quantity)

Composite Key

- Foreign Key :
  - It is an attribute or set of attributes in one relation which is a Primary key of another relation

Employee

Foreign Key

Primary Key

EmpID	EmpName	DeptNo
1203	Dasun	2
1321	Tharindu	2
1361	Damith	1
1377	Nirmal	2

Referencing Table

Primary Key

Department

DeptNo	DeptName
1	IT
2	Accounting

Referred Table

Summary

- What is Data, Information & Knowledge.
- Evolution of databases.
    1. File-Based Data Processing
        - Limitations of File-Based Approach
    2. DBMS
- Database Approach
- Database System Environment
- Major Components of DBMS
- Applications of DBMS
- Data Dictionary(Meta Data)
- Functions of DBMS
- Database Building Blocks
- Advantages of DBMS
- Disadvantages of DBMS
- Database System Architecture
- Data models in DBMS
- Properties of a Relation
- keys

Thank you