



A database management system (DBMS) or database system in short, is a software that can be used to create and manage databases. DBMS lets users to create a database, store, manage, update/modify and retrieve data from that database by users or application programs. Some examples of open source and commercial DBMS include MySQL, Oracle, PostgreSQL, SQL Server, Microsoft Access, MongoDB.

A database system hides certain details about how data are actually stored and maintained. Thus, it provides users with an abstract view of the data. A database system has a set of programs through which users or other programs can access, modify and retrieve the stored data.

The DBMS serves as an interface between the database and end users or application programs. Retrieving data from a database through special type of commands is called querying the database. In addition, users can modify the structure of the database itself through a DBMS.

Databases are widely used in various fields. Some applications are given in Table 7.3.

Table 7.3 Use of Database in Real-life Applications

Application	Database to maintain data about
Banking	customer information, account details, loan details, transaction details, etc.
Crop Loan	kisan credit card data, farmer's personal data, land area and cultivation data, loan history, repayment data, etc.
Inventory Management	product details, customer information, order details, delivery data, etc.
Organisation Resource Management	employee records, salary details, department information, branch locations, etc.
Online Shopping	items description, user login details, users preferences details, etc.

7.3.1 File System to DBMS

Let us revisit our school example where two data files were maintained (Table 7.1 by office and Table 7.2 by teacher). Let us now design a database to store data of those two files. We know that tables in a database are linked or related through one or more common columns or fields. In our example, the STUDENT (Table 7.1) file and ATTENDANCE (Table 7.2) file have RollNumber and SName as common field names. In order to convert

Some database management systems include a graphical user interface for users to create and manage databases. Other database systems use a command line interface that requires users to use programming commands to create and manage databases.



these two files into a database, we need to incorporate the following changes:

- SName need not be maintained in ATTENDANCE file as it is already there in STUDENT. Details for a student can be retrieved through the common field RollNumber in both the files.
- If two siblings are in the same class, then same guardian details (GName, GPhone and GAddress) are maintained for both the siblings. We know this is a redundancy and by using a database we can avoid this. So let us split the STUDENT file into two file (STUDENT file and GUARDIAN) file so that each guardian data are maintained only once.
- One and more guardians can have the same name. So it will not be possible to identify which guardian is related to which student. In such case, we need to create an additional column, say GUID (Guardian ID) that will take unique value for each record in the GUARDIAN file. The column GUID will also be kept with STUDENT file for relating these two files.

High Cost is incurred while shifting from file system to DBMS:

- Purchasing sophisticated hardware and software.
- Training users for querying.
- Recurrent cost to take regular backup and perform recovery operations.

Note: We could distinguish guardians by their phone numbers also. But, phone number can change, and therefore may not truly distinguish guardian.

Figure 7.1 shows the related data files for the STUDENT, GUARDIAN and ATTENDANCE details. Note that this is not the complete database schema since it does not show any relationship among tables.

STUDENT	GUARDIAN	ATTENDANCE
RollNumber SName SDateofBirth GUID	GUID GName GPhone GAddress	AttendanceDate RollNumber AttendanceStatus

Figure 7.1: Record structure of three files in STUDENTATTENDANCE Database

The tables shown at Figure 7.1 are empty, which are to be populated with actual data as shown in Table 7.4, 7.5 and 7.6.

Table 7.4 Snapshot of STUDENT table

RollNumber	SName	SDateofBirth	GUID
1	Atharv Ahuja	2003-05-15	4444444444444
2	Daizy Bhutia	2002-02-28	1111111111111



3	Taleem Shah	2002-02-28	
4	John Dsouza	2003-08-18	333333333333
5	Ali Shah	2003-07-05	101010101010
6	Manika P.	2002-03-10	466444444666

Table 7.5 Snapshot of GUARDIAN table

GUID	GName	GPhone	GAddress
444444444444	Amit Ahuja	5711492685	G-35, Ashok Vihar, Delhi
111111111111	Baichung Bhutia	3612967082	Flat no. 5, Darjeeling Appt., Shimla
101010101010	Himanshu Shah	4726309212	26/77, West Patel Nagar, Ahmedabad
333333333333	Danny Dsouza		S -13, Ashok Village, Daman
466444444666	Sujata P.	3801923168	HNO-13, B- block, Preet Vihar, Madurai

Table 7.6 Snapshot of ATTENDANCE table

Date	RollNumber	Status
2018-09-01	1	P
2018-09-01	2	P
2018-09-01	3	A
2018-09-01	4	P
2018-09-01	5	A
2018-09-01	6	P
2018-09-02	1	P
2018-09-02	2	P
2018-09-02	3	A
2018-09-02	4	A
2018-09-02	5	P
2018-09-02	6	P

Figure 7.2 shows a simplified database called STUDENTATTENDANCE, which is used to maintain data about the student, guardian and attendance. As shown here, the DBMS maintains a single repository of data at a centralized location and can be used by multiple users (office staff, teacher) at the same time.

7.3.2 Key Concepts in DBMS

In order to efficiently manage data using a DBMS, let us understand certain key terms:

(A) Database Schema

Database Schema is the design of a database. It is the skeleton of the database that represents the structure (table names and their fields/columns), the type of data each column can hold, constraints on the data to be stored (if any), and the relationships among the tables.

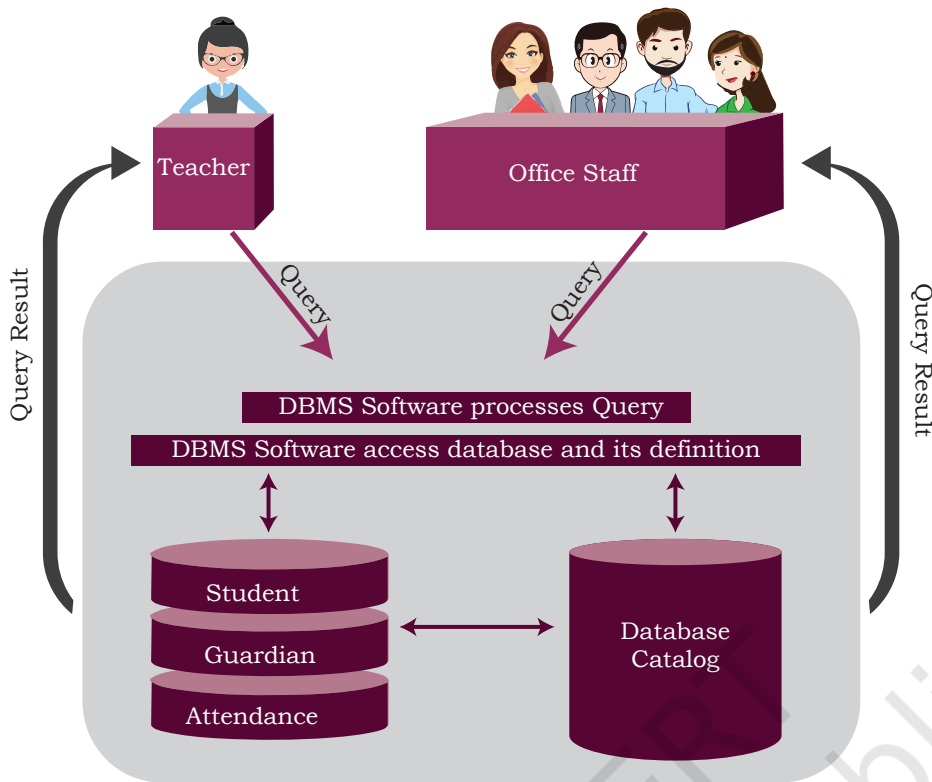


Figure 7.3: StudentAttendance Database Environment

Database schema is also called the visual or logical architecture as it tells us how the data are organised in a database.

(B) Data Constraint

Sometimes we put certain restrictions or limitations on the type of data that can be inserted in one or more columns of a table. This is done by specifying one or more constraints on that column(s) while creating the tables. For example, one can define the constraint that the column *mobile number* can only have non-negative integer values of exactly 10 digits. Since each student shall have one unique roll number, we can put the NOT NULL and UNIQUE constraints on the RollNumber column. Constraints are used to ensure accuracy and reliability of data in the database

(C) Meta-data or Data Dictionary

The database schema along with various constraints on the data is stored by DBMS in a database catalog or dictionary, called meta-data. A meta-data is data about the data.

(D) Database Instance

When we define database structure or schema, state of database is empty i.e. no data entry is there. After



loading data, the state or snapshot of the database at any given time is the database instance. We may then retrieve data through queries or manipulate data through updation, modification or deletion. Thus, the state of database can change, and thus a database schema can have many instances at different times.

(E) Query

A query is a request to a database for obtaining information in a desired way. Query can be made to get data from one table or from a combination of tables. For example, “find names of all those students present on Attendance Date 2000-01-02” is a query to the database. To retrieve or manipulate data, the user needs to write query using a query language called, which is discussed in chapter 8.

(F) Data Manipulation

Modification of database consists of three operations viz. Insertion, Deletion or Update. Suppose Rivaan joins as a new student in the class then the student details need to be added in STUDENT as well as in GUARDIAN files of the Student Attendance database. This is called Insertion operation on the database. In case a student leaves the school, then his/her data as well as her guardian details need to be removed from STUDENT, GUARDIAN and ATTENDANCE files, respectively. This is called Deletion operation on the database. Suppose Atharv’s Guardian has changed his mobile number, his GPhone should be updated in GUARDIAN file. This is called Update operation on the database.

(G) Database Engine

Database engine is the underlying component or set of programs used by a DBMS to create database and handle various queries for data retrieval and manipulation.

Limitations of DBMS

Increased Complexity:

Use of DBMS increases the complexity of maintaining functionalities like security, consistency, sharing and integrity

Increased data vulnerability:

As data are stored centrally, it increases the chances of loss of data due to any failure of hardware or software. It can bring all operations to a halt for all the users.

7.4 RELATIONAL DATA MODEL

Different types of DBMS are available and their classification is done based on the underlying data model. A data model describes the structure of the database, including how data are defined and represented, relationships among data, and the constraints. The most commonly used data model is Relational Data Model. Other types of data models include object-oriented data model, entity-relationship data model, document model and hierarchical data model. This book discusses the DBMS based on relational data model.