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DATABASE MANAGEMENT SYSTEMS: AN INTRODUCTION

Dr.Raj Kumar Singh
Librarian Lalta Singh Govt. P.G. College Adalahat, Mirzapur, (U.P.) India-231302

ABSTRACT
The librarian has to acquire, store, has to compile and maintain several files containing the information. Those files collectively form a database. The database is a collection of interrelated data stored together without harmful or unnecessary redundancy to serve one or more applications in an optimal fashion .I try to define definition, objectives, function and elements of DBMS, etc.

Key Words: DBMS, Network, DDL, DBML, etc.

INTRODUCTION

The basic objective of the library professionals is providing the right information by the right readers as required by them. Provision of information is vital to any library if it has to function properly in this competitive environment. The librarian has to acquire, store, has to compile and maintain several files containing the information. Those files collectively form a database. The database is a collection of interrelated data stored together without harmful or unnecessary redundancy to serve one or more applications in an optimal fashion . The data are stored in such a fashion that they are independent of the programs of people using the data. Addition of new data, modification and retrieval of existing data within the database are accomplished by a common and controlled approach.

The control its data centrally, the library has to adopt the database system. Prior to this the data were controlled by individual files or data sets, which often resulted in data scattering and redundancy. Adoption of database system helps the data to be organized suitably with the following advantages :

- encoding of data is possible,
- relationship among the data items and programs can be made,
- data repetition and redundant can be raduced,
- data integrity and consistency can be maintained,
- sharing of data is made easy,
- standards can be enforced to administer the database, and
- data can be structured as per the requirement of the organization /library.

The basic hierarchy of data organization from the lower level to the higher is field→record→file→database. The hierarchy of data organization is provided in Fig. 1.

Database systems are rapidly gaining popularity among the libraries and the commercial vendors. Even some vendors have developed computers that are dedicated entirely to database operations. Since databases involve voluminous data and numerous operations, they require systems which manage the databases and maintain them in accordance with the varying needs of the users. The Database Management System (DBMS) aims to fulfill this requirement.

Definition and objectives of DBMS

A database management is defined as a software package used for creation, access, manipulation and maintenance of a database (2). It is a mechanism for organizing, structuring and storing a large volume of data and accessing the same without disturbing the required features of the data i.e. maintaining the data independence. The primary objectives of the database management systems are (6).

- to avoid unnecessary duplication of data,

- to ensure data integrity and consistency,
- to enable rapid updating,
- To facilitate use by more than one user at a time,
- to provide data security,
- to make the data independent of application programs, and
- to facilitate maintenance of standards.

DBMS Functions

The following functions are provided by a DBMS (5) :

i) **Transaction processing :** Transaction is an unit of work or database operation which helps to update, delete, modify a set of records within the database. The changes made by the transaction in the database can be made permanent or can be rolled back to its original state if required.

ii) **Concurrency management :** It is a management activity in which the concurrent operations of the database are coordinated. It allows concurrency while maintaining the consistency of the shared data.

iii) **Recovery :** In case of transaction failures the database is returned to its original state without creating any adverse effects on its functioning.

iv) **Security :** Protects the data against unauthorized access. Depending upon the privileges given to the users, the access to the database is controlled.

v) **Language interface :** The data is manipulated by using manipulation commands. It facilitates an environment where the users need not worry about the physical implementation while working with it.

vi) **Data catalogue :** (also called data dictionary). It is a system database that provides the descriptions of data, relationships, constraints and the schema in the database (i.e. a metadata).

vii) **Storage management :** It is a mechanism for the management of permanent storage of the data. The storage manager interfaces with the operating system to access the physical storage.

Elements of DBMS

DBMS is a complex software package which interprets the user commands for the computer to operate as required. The users command language can be as simple as "DISPLAY EMPLOYEE NAMES" to tabular formats. The main elements of DBMS are given below :

Data Definition Language (DDL)

Describes the content and format of data to be stored, defines the structure of database, brings out relationship between records and indexing strategies, forms the link between the logical and physical view of data.

Schema : Logical structure of the database.

Subschema : When an application program is used by the user, utilizing the same database it becomes a subschema. A set of DDL statements are used to construct a subschema. More than one subschemas can be operated at a time in DBMS.

Data Manipulation Language (DML)

Provides a set of procedural commands for processing the data i.e. storing, manipulating and retrieving the data. Some of the manipulation verbs and their corresponding operands are mentioned below :

- Verbs Operands
- Delete Record Key, Field name, Record name or Filename
- Insert Record Key, Field name, Record name or Filename
- Display Record Key, Field name, Record name or Filename
- Sort File name
- Add Sort File name

The verbs are combined with operands to manipulate data. Example : DELETE EMPLOYEE AGE

Since the DDL provides the linkage between the logical view of data and its physical location, the DML can be easily used to access the data with its logical names rather than the physical storage locations. The DML generally

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supports several high-level programming languages.

Other Utilities

The DBMS is generally provided with other utilities or a range of ancillary software to perform other works, such as,

- Database manager : Which helps in the physical administration of data i.e. dumping, logging, recovery, reorganization, design, redesign, store and retrieval of data.
- Data dictionary : Which helps the database administration, designer, systems analyst and even the end-user to coordinate and keep track of the data.
- Query language : Which helps to access data and display it on the terminal easily and quickly.
- Report Generator : Which helps to produce hardcopy (paper) reports, saves time and money for both the user and the programming staff.

Operational stages of DBMS

The operational stages of a DBMS passes through different layers. The user who can be an individual typing a query or it can be an application program of another computer system requesting the services of the database, needs to interact with the external layer. The data elements are physically stored at the lowest layer. The application objects exist at the middle layer i.e. the conceptual layer. The different layers of DBMS operation are illustrated in Fig. 2.

The database designer describes the data elements in a machine-readable script called conceptual schema. The DBMS has a complier or translator program that accepts the schema, transform it into a compact form and stores it in the data dictionary. The database user requests for a service from the database. The DBMS responds to this request using data dictionary to confirm the existence and availability of the data elements requested. The DML facility of the DBMS interacts with the conventional programming language of the users to form what is known as the 'Host Language'. The host language facilitates the whole program to be compiled using the standard complier or assembler. The requested data items and any error3 messages are passed to the user through the user-interface module. The DBMS environment is illustrated in Fig. 3.

The relationship between data elements are expressed in different ways. The organization of data elements constitute the structure of the DBMS. Each one forms a database model. A data model specifies the rules according to which data are structured and also the associated operations that the permitted. It is a technique of formal data description, data relationships and user constraints (6). Five approaches (i.e. models) to database organizations are available :

- Hierarchical data model
- Network data model
- Relational data model
- Object-Oriented data model
- Deductive inference data model

The evolution of DBMS based on these models are illustrated in Fig. 4.

In the beginning the data were simply organized in individual files. These file systems were prevalent during 1950's. Most of these files contained records in sequential order and the records contained fields in the same order. The access to these records were based on indexes i.e. ISAM (Indexed Sequential Access Method) and VSAM (Virtual Storage Access Method). The file system had its own disadvantages like data redundancy, data inconsistency, poor data sharing, incompatible to changes, low productivity and high maintenance cost.

1960's and 70's witnessed the emergence of hierarchical and network systems. The systematic developments into the structure of the database management started with thesessystems. The 1980's saw the introduction of the relational database systems which soon became popular among the database designers.

Although object-oriented and deductive systems are slowly emerging and points the way to future, relational system is currently the most popular database model. Salient features of the different database models are summarized below.

Hierarchical database model

In the hierarchical model the structure of the database is represented as a tree, in which the database begins with a 'root' and branching into 'nodes' with hierarchical links between nodes. This is illustrated in Fig. 5.

Root : The staring point of the free structure i.e. 'a'
Nodes : Branches of the root i.e. 'a1', 'a21', 'a22'
Generation : Levels of the hierarchy, the Fig. has 4 generations

Each record in this model other than the 'root' is connected with a record hierarchically superior to it. Thus to insert a record, one has to select the parent record first. When a record is deleted, all the descendents of the record are also deleted. The links between the records are predetermined and fixed during the life of the database. For example, the records of 'a22' are always linked to the records of 'a2' within the database designed in the example cited in Fig. 5. One good example of hierarchical model is the IBM's Information Management System (MIS) which is used on the concept of tree structure. Although the performance of the hierarchical model is quite high, it becomes unnecessarily complex and costly to maintain.

Network database model

Network database model is a modification of the hierarchical model. In this case a record is linked to as many superiors as possible unlike the hierarchical model in which a record is linked to only are superior. Thus the data structure is many-to-many instead of one-to-many and look like a graph rather than a tree. Any node can be linked with any other node without restriction. The link is established by means of a 'pointer' which is a field containing the address of the related record. A simple network model is illustrated in Fig. 6.

Interest in database designing based on the network approach actually began with the recommendations of CODASYL (Conference on Data System Languages) Data Base Task Group (DBTG) in 1971. Network models require understanding of both record types and links and their interrelationships. Although this model overcomes some of the difficulties encountered in the hierarchical model, it becomes complex in structure with high maintenance cost. Like hierarchical model it is not easily amenable to changes. Examples of network database systems are Cullinets IDMS (Integrated DMS) and Cincon systems TOTAL.

Relational database model

The most popular database structure currently used is based on the relational model. It is because of its immense user base, its power to organize data. Its performance as a data management tool and its use in many commercial applications like DB2, Oracle, Sybase, MS-SQL Server, MS-Access etc. In the relational model the data are viewed as a collection of non-hierarchical time-varying relations. For data manipulation the mathematical relations, i.e. the operations and expressions of relational algebra are used. The users need not know the exact physical structures to use the database. However, they should have some knowledge on how the data has been partitioned into the various relations.

Data elements in the relational model are organized into tables. Each table corresponds to an entity and each row in the table represents an instance or attribute of that entity. The rows and columns in the table are roughly analogous to records and data elements in a non-hierarchical setting. Each row in a table is called a tuple (i.e. 'a group of'). In a table each column represents one attribute. Each row is unique. Two rows from the same table must differ at least in one cell value. A cell represents the data that lies at the intersection of a column and a row. It contains only one value. Tables (i) to (iv) illustrate the tables designed for organizing data on research grants in a library.

(i) Table Name : SOURCE

Source ID	Source Name
S1	DST
S2	ICAR
S3	ICMR
S4	UGC

(ii) Table Name : AREA OF RESEARCH

Source ID	Source Name
A1	Area Name
A2	Medicine
A3	Biotechnology
A4	Genetics

(iii) Table Name : GRANT

Grant ID	Area Name	Source ID	Amount
G1	Biotechnology	S3	2,00,000
G2	Biotechnology	S1	50000
G3	Genetics	S4	100000
G4	Microbiology	S2	40000
G5	Medicine	S1	10000

(iv) Table Name : SAG

Grant ID	Source ID	SAG Amount	Area ID
G1	S3	200000	A2
G2	S1	50000	A2
G3	S4	100000	A4

Tables illustrating the relations in a relational database model

Tables SAG (Source, Area of Research, Grant) provides the relationship among the other three tables. The table contents are manipulated in the relational model by using the relational functions, such as.

- SELECT : Lists all the row values for each attribute or selected row values, yields horizontal subset of a table.
- PROJECT : Produces list of all values for selected attributes, yields a vertical subset of a table.
- JOIN : Combines information from two or more tables, most powerful function of the relational database.
- UNION : Combines all the rows from two tables which are compatible i.e. the columns and domains should be identical.
- INTERSECT : Produces a listing containing data from the rows that appear in two tables, which are compatible i.e. INTERSECT not possible between attributes in which one is numeric and the other is character-based.
- DIFFERENCE : Yields information in all rows in one table that are not found in the other table, subtracts one table from the other.
- PRODUCT : Produces a list of all pairs of rows from two tables.
- DIVIDE : One table is divided by another table in which one table has two columns and the other has one column.

Very few DBMS are capable of supporting all the eight functions. However,

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three relational functions i.e. SELECT, PROJECT, JOIN are provided in all DBMS. Relational data model is flexible in retrieval and easy to master. Therefore, it is the most popular model among the database models. But lack of predefined access paths makes it highly uneconomical and not well suited for large scale data structures.

Object-Oriented database model

In the object-oriented model the entity is taken not as the attributes of data types such as integer, numeric, character etc, but as a class. A class represents both object attributes as well as the behaviour of the entity. For example as STUDENT class will have not only the student attributes like name, roll no., date of birth etc., but also voting power, reading interests, courses taken etc. Similarly TEACHER class will have teacher attributes like name, rank, salary etc as well as attributes like giving advices, publishing articles, consultancy work etc. Therefore within the object, the class attributes take specific values, which distinguish one object from another. The behaviour pattern of the class is shared by all the objects belonging to the class. Fig. 7.illustrates a simple object-oriented database model.

Object-Oriented model is claimed to be more flexible in data representation than the relational model, takes groups of data for processing, understands complex objects easy to maintain and change and improves productivity. Although not widely used at present, they are found in specialized applications in the commercial world. Examples are ONTOS, GemStone, ObjectStore from Object Design, OpenODB etc.

Deductive/Inference database model

Deductive database model puts emphasis on rules for new data combinations as per requirements. It stores as little data as possible. Although it has some potentialities to become an alternative data structure based on inferential relationships among data elements, it is not popularly used at present.

Conclusion

Although theoretically a DBMS has lots of promises, there exists many limitations. Few limitations are : data sharing is not always possible due to sense of ownership; inaccurate data often goes undetected; problems in data security and data independence; difficult in retrieving data in cases where the relations are not pre-defined. Inspite of these difficulties, DBMS has bright prospect in organizing data files in libraries. The structure of the database has to be planned suitably at the higher level before being implemented.

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