

Database Design - 2nd Edition

Adrienne Watt

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Chapter 2 Fundamental Concepts

Adrienne Watt & Nelson Eng

What Is a Database?

A *database* is a shared collection of related data used to support the activities of a particular organization. A database can be viewed as a repository of data that is defined once and then accessed by various users as shown in Figure 2.1.

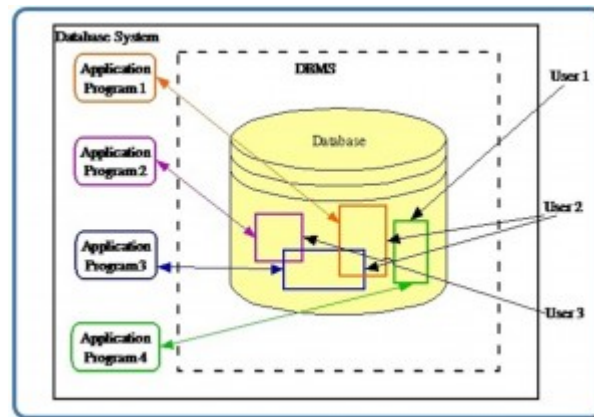


Figure 2.1. A database is a repository of data.

Database Properties

A database has the following properties:

- It is a representation of some aspect of the real world or a collection of *data elements* (facts) representing real-world information.
- A database is logical, coherent and internally consistent.
- A database is designed, built and populated with data for a specific purpose.
- Each data item is stored in a field.
- A combination of fields makes up a *table*. For example, each field in an employee table contains data about an individual employee.

A database can contain many tables. For example, a membership system may contain an address table and an individual member table as shown in Figure 2.2. Members of Science World are individuals, group homes, businesses and corporations who have an active membership to Science World. Memberships can be purchased for a one- or two-year period, and then renewed for another one- or two-year period.

In Figure 2.2, Minnie Mouse renewed the family membership with Science World. Everyone with membership ID#100755 lives at 8932 Rodent Lane. The individual members are Mickey Mouse, Minnie Mouse, Mighty Mouse, Door Mouse, Tom Mouse, King Rat, Man Mouse and Moose Mouse.

Membership

ID EXPIRY DATE Prev Exp Stat Cat

Name Res

Address

City Prov Country

Notes

Cards # Members #Years

FirstName	LastName	YYMM	G	BARCODE	V	DATE	TIME	F
Mickey	Mouse	0000	M	10000001	4	20130810	10:12:29	y
Minnie	Mouse	0000	F	10000002	4	20130810	10:12:29	y
Mighty	Mouse	0000	M	10000003	4	20130810	10:12:29	y
Door	Mouse	0000	F	10000004	4	20130810	10:12:29	y
Tom	Mouse	0000	M	10000005	4	20130810	10:12:29	y
King	Rat	0000	M	10000006	4	20130810	10:12:29	y
Man	Mouse	0000	M	10000007	4	20130810	10:12:29	y
Moose	Mouse	0000	M	10000008	4	20130810	10:12:29	y

Records: 1 of 1 | No Filter | Search

Figure 2.2. Membership system at Science World by N. Eng.

Database Management System

A *database management system (DBMS)* is a collection of programs that enables users to create and maintain databases and control all access to them. The primary goal of a DBMS is to provide an environment that is both convenient and efficient for users to retrieve and store information.

With the database approach, we can have the traditional banking system as shown in Figure 2.3. In this bank example, a DBMS is used by the Personnel Department, the Account Department and the Loan Department to access the shared corporate database.

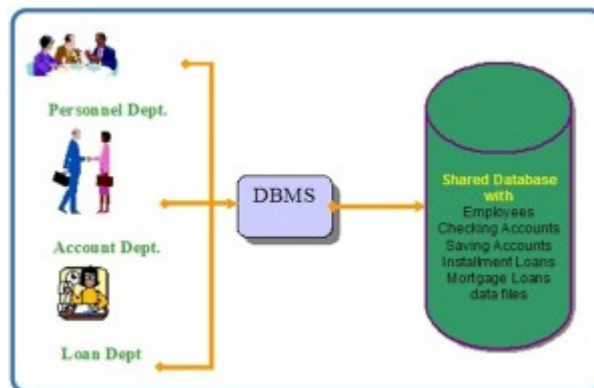


Figure 2.3. A bank database management system (DBMS).

Key Terms

data elements: facts that represent real-world information

database: a shared collection of related data used to support the activities of a particular organization

database management system (DBMS): a collection of programs that enables users to create and maintain databases and control all access to them

table: a combination of fields

Exercises

1. What is a database management system (DBMS)?
2. What are the properties of a DBMS?
3. Provide three examples of a real-world database (e.g., the library contains a database of books).

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The following material was written by Nelson Eng:

1. Example under *Database Properties*
2. Key Terms

The following material was written by Adrienne Watt:

1. Exercises

Chapter 3 Characteristics and Benefits of a Database

Adrienne Watt

Managing information means taking care of it so that it works for us and is useful for the tasks we perform. By using a DBMS, the information we collect and add to its database is no longer subject to accidental disorganization. It becomes more accessible and integrated with the rest of our work. Managing information using a database allows us to become strategic users of the data we have.

We often need to access and re-sort data for various uses. These may include:

- Creating mailing lists
- Writing management reports
- Generating lists of selected news stories
- Identifying various client needs

The processing power of a database allows it to manipulate the data it houses, so it can:

- Sort
- Match
- Link
- Aggregate
- Skip fields
- Calculate
- Arrange

Because of the versatility of databases, we find them powering all sorts of projects. A database can be linked to:

- A website that is capturing registered users
- A client-tracking application for social service organizations
- A medical record system for a health care facility
- Your personal address book in your email client
- A collection of word-processed documents
- A system that issues airline reservations

Characteristics and Benefits of a Database

There are a number of characteristics that distinguish the database approach from the file-based system or approach. This chapter describes the benefits (and features) of the database system.

Self-describing nature of a database system

A database system is referred to as *self-describing* because it not only contains the database itself, but also *metadata* which defines and describes the data and relationships between tables in the database. This information is used by the DBMS

software or database users if needed. This separation of data and information about the data makes a database system totally different from the traditional file-based system in which the data definition is part of the application programs.

Insulation between program and data

In the file-based system, the structure of the data files is defined in the application programs so if a user wants to change the structure of a file, all the programs that access that file might need to be changed as well.

On the other hand, in the database approach, the data structure is stored in the system catalogue and not in the programs. Therefore, one change is all that is needed to change the structure of a file. This insulation between the programs and data is also called program-data independence.

Support for multiple views of data

A database supports multiple views of data. A *view* is a subset of the database, which is defined and dedicated for particular users of the system. Multiple users in the system might have different views of the system. Each view might contain only the data of interest to a user or group of users.

Sharing of data and multiuser system

Current database systems are designed for multiple users. That is, they allow many users to access the same database at the same time. This access is achieved through features called *concurrency control strategies*. These strategies ensure that the data accessed are always correct and that data integrity is maintained.

The design of modern multiuser database systems is a great improvement from those in the past which restricted usage to one person at a time.

Control of data redundancy

In the database approach, ideally, each data item is stored in only one place in the database. In some cases, data redundancy still exists to improve system performance, but such redundancy is controlled by application programming and kept to minimum by introducing as little redundancy as possible when designing the database.

Data sharing

The integration of all the data, for an organization, within a database system has many advantages. First, it allows for data sharing among employees and others who have access to the system. Second, it gives users the ability to generate more information from a given amount of data than would be possible without the integration.

Enforcement of integrity constraints

Database management systems must provide the ability to define and enforce certain constraints to ensure that users enter valid information and maintain data integrity. A *database constraint* is a restriction or rule that dictates what can be entered or edited in a table such as a postal code using a certain format or adding a valid city in the City field.

There are many types of database constraints. *Data type*, for example, determines the sort of data permitted in a field, for example numbers only. *Data uniqueness* such as the primary key ensures that no duplicates are entered. Constraints can be simple (field based) or complex (programming).

Restriction of unauthorized access

Not all users of a database system will have the same accessing privileges. For example, one user might have *read-only access* (i.e., the ability to read a file but not make changes), while another might have *read and write privileges*, which is the ability to both read and modify a file. For this reason, a database management system should provide a security subsystem to create and control different types of user accounts and restrict unauthorized access.

Data independence

Another advantage of a database management system is how it allows for data independence. In other words, the system data descriptions or data describing data (metadata) are separated from the application programs. This is possible because changes to the data structure are handled by the database management system and are not embedded in the program itself.

Transaction processing

A database management system must include concurrency control subsystems. This feature ensures that data remains consistent and valid during transaction processing even if several users update the same information.

Provision for multiple views of data

By its very nature, a DBMS permits many users to have access to its database either individually or simultaneously. It is not important for users to be aware of how and where the data they access is stored

Backup and recovery facilities

Backup and recovery are methods that allow you to protect your data from loss. The database system provides a separate process, from that of a network backup, for backing up and recovering data. If a hard drive fails and the database stored on the hard drive is not accessible, the only way to recover the database is from a backup.

If a computer system fails in the middle of a complex update process, the recovery subsystem is responsible for making sure that the database is restored to its original state. These are two more benefits of a database management system.

Key Terms

concurrency control strategies: features of a database that allow several users access to the same data item at the same time

data type: determines the sort of data permitted in a field, for example numbers only

data uniqueness: ensures that no duplicates are entered

database constraint: a restriction that determines what is allowed to be entered or edited in a table

metadata: defines and describes the data and relationships between tables in the database

read and write privileges: the ability to both read and modify a file

read-only access: the ability to read a file but not make changes

self-describing: a database system is referred to as self-describing because it not only contains the database itself, but also metadata which defines and describes the data and relationships between tables in the database

view: a subset of the database

Exercises

1. How is a DBMS distinguished from a file-based system?
2. What is data independence and why is it important?
3. What is the purpose of managing information?
4. Discuss the uses of databases in a business environment.
5. What is metadata?

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1. Introduction
2. Key Terms
3. Exercises