chaper 1 Objectives

- To understand the nature and characteristics of databases.
- To survey some important and interesting database applications.
- To gain a general understanding of tables and relationships.
- To describe the components of a Microsoft Access database system and explain the functions they perform.
- To describe the components of enterprise-class database system and explain the functions they perform.
- To define the term database management system(DBMS) and describe the functions of a DBMS.
- To define the term database and describe what is contained within the database.
- To define the term metadata and provide examples of metadata.
- To define and understand database design from existing data.
- To define and understand database design as new systems development.
- To define and understand database design in database redesign.
- To understand the history and development of database processing.

Contents

1. The Characteristics of Databases

- The purpose of a database is to help people track of things, and the most commonly used type of database is the **relational database.**
- A relational database stores data in tables. **Data** are recorded facts and numbers. A **table** has rows and columns, like those in a spreadsheet. A database usually has multiple tables, and each table contains data about a different type of thing. For example, Figure1-1 shows a database with two tables: the Student table holds data about students, and the Class table holds data about classes.
- Each **row** of table has data about a particular occurrence or **instance** of the thing of interest. For example, each row of the Student table has data one of four students: Cooke,Lau, Harris, and Greence.Similarly, each row of the Class table has data about a particular class. Because each row *records* the data for a specific instance, rows are also known as **records**. Each **column** of a table stores a characteristic common to all rows. For example, the first column of Student Stores StudentNumber, the second column stores LastName, and so forth.

1. The Characteristics of Databases

➢A Note on Naming Conventions

Figure 1-1

The **Student** table

This row stores the data for Sam Cooke

student

StudentNumber	LastName	FristName	EmailAddress
1	Cooke	Sam	Sam.Cooke@OurU.edu
2	Lau	Marcia	Marcia.Lau@OurU.edu
3	Harris	Louis	Louis.Harris@OurU.edu
4	Greene	Grace	Grace.Greene@OurU.edu
*			

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The **Class** table

This column stores the ClassName for each class

Class

ClassNumber	ClassName	Term	Section
10	Chem101	Fall08	1
20	Chem101	Fall08	2
30	Chem101	Spring09	1
40	Acct101	Fall08	1
50	Acct102	Spring09	1
*			

记录: 第 1 项(共 5 项) 无筛选器 搜索

1. The Characteristics of Databases

➢A Database Has Data and Relationships

Figure 1-2

The **Student** table

student

StudentNumber	LastName	FristName	EmailAddress
1	Cooke	Sam	Sam.Cooke@OurU.edu
2	Lau	Marcia	Marcia.Lau@OurU.edu
3	Harris	Louis	Louis.Harris@OurU.edu
4	Greene	Grace	Grace.Greene@OurU.edu
*			

记录: 第 1 项(共 4 项) 无筛选器 搜索

The **Class** table

Class

ClassNumber	ClassName	Term	Section
10	Chem101	Fall08	1
20	Chem101	Fall08	2
30	Chem101	Spring09	1
40	Acct101	Fall08	1
50	Acct102	Spring09	1
*			

记录: 第 1 项(共 5 项) 无筛选器 搜索

The **Grade** table-but who do these grades belong to?

Gra...

ID
3.7
3.5
3.7
3.1
3.0
3.5
*

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Figure1-1 illustrates how database tables are structured to store data, but a database is not complete unless it aslo shows the relationship among the rows of data. To see why this is important, examine Figure1-2. In this figure ,the database contains all of the basic data shown in Figure1-1 together with a **Grade** table. Unfortunately, the relationships between the data are missing. A database contains both data and the relationships among the data. Example:baseball scores.

1. The Characteristics of Databases

- **A Database Has Data and Relationships**

By comparing Figure1-2 and Figure1-3, we can see how the primaty key of **Student** and **Class** were added to the **Grade** with a primaty key of (StudentNumber,ClassNumber) to uniquely identify each row. More important , in Grade StudentNumber and ClassNumber each now serves as a foreign key. A foreign key provides the link between two tables. By adding a foreign key, we can create a relationship between tables.

1. The Characteristics of Databases

➤A Database Has Data and Relationships

Figure 1-3

The **Student** table

student

StudentNumber	LastName	FristName	EmailAddress
1	Cooke	Sam	Sam.Cooke@OurU.edu
2	Lau	Marcia	Marcia.Lau@OurU.edu
3	Harris	Louis	Louis.Harris@OurU.edu
4	Greene	Grace	Grace.Greene@OurU.edu

记录: 第 1 项(共 4 项) 无筛选器 搜索

The **Class** table

Class

ClassNumber	ClassName	Term	Section
10	Chem101	Fall08	1
20	Chem101	Fall08	2
30	Chem101	Spring09	1
40	Acct101	Fall08	1
50	Acct102	Spring09	1

记录: 第 1 项(共 5 项) 无筛选器 搜索

The **Grade** table with foreign keys-now each grade is linked back to the **Student** and **Class** tables

Grade

StudentNumber	ClassNumber	Grade
1	10	3.7
1	40	3.5
2	20	3.7
3	30	3.1
4	40	3.0
4	50	3.5

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Figure1-3 shows the complete database that contains not only the data about students, classes, and grades, but also the relationships among the rows in the those table. For example, StudentNumber 1,who is Sam Cooke, earned a Grade of 3.7 in Class Number 10, which is Chem101. He also earned a Grade 3.5 in ClassNumber 40, which is Acct101.

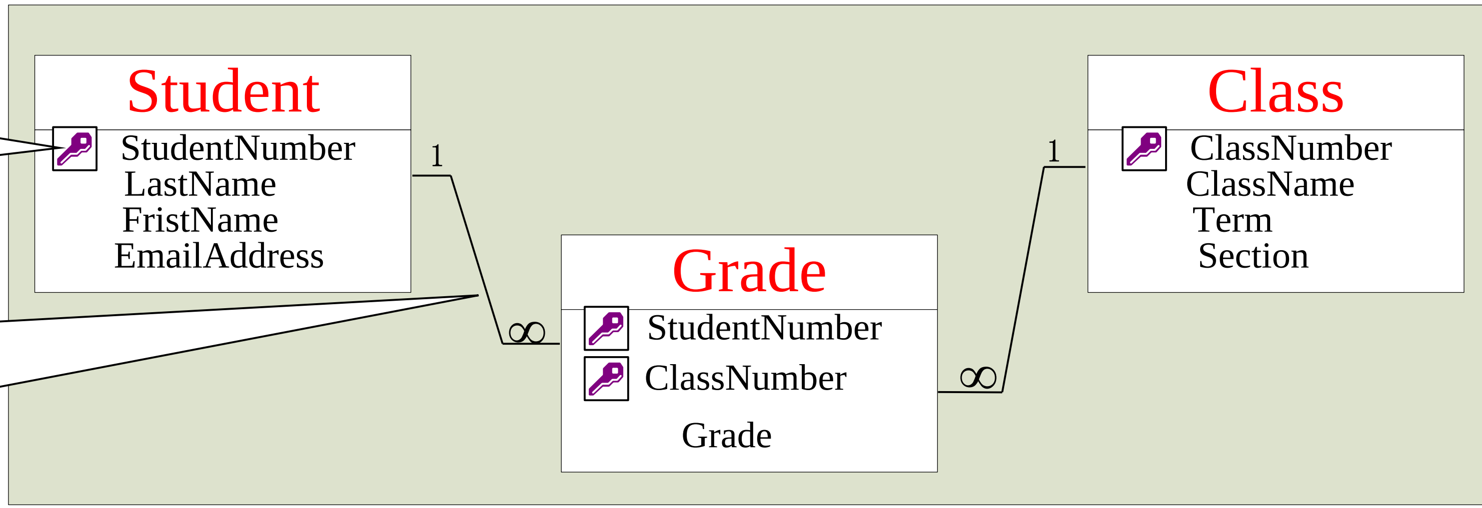
Figure1-3 illustrates an important characteristic of batabase processing. Each row in a table is uniquely indentified by a **primary key**, and the values of these keys are used to create the relationships between the tables. For example, in the **Student** table,StudentNumber serves as the ptimary key. Each value of StudentNumber is unique, and uniquely indentifies on student. Thus, StudentNumber 1 identifies Sam Cooke. Similarly, ClassNumber in the **Class** table identifies each class.

1. The Characteristics of Databases

➢A Database Has Data and Relationships

Figure 1-4

The **Student** table- the key symbol shows the primary key



The relationship between **Student** and **Grade**—the number 1 and the infinity symbol indicate that one student may be lanked to many classes by StudentNumber

Figure1-4 shows a Misrosoft Assecc 2007 veiw of the tables and relationship shown in Figure 1-3. In Figure1-4, primary keys in each table are marked with key symbols, and connecting lines representing the relationship are drawn from the foregin keys(in **Grade**) to the corresponding primary keys(in **Student** and in **Class**). The symbols on the relationship line (the number 1 and infinity symbol) mean that, for example, one student in **Student** can be linked to many grades in **Grade**.

1. The Characteristics of Databases

➢ Database Create Information

In order to make decisions, we need information upon which to base those desitions. Since we have aleady defined *data* as recorded facts and numbers, we can now define **information** as:

- Knowledge derived from data.
- Data presented in a meaningful context.
- Data processed by summing, ordering, averaging, grouping, comparing or other similar operations.

Databases record facts and figures, so they record data. They do so, however, in a way that enables them to produce information. The data in Figure1-3 can be manipulated to produce a student's GPA, the average GPA for a class, the average number of students in a class, and so forth. In Chaper 2, you will be introduced to a language called Structured Quqery Language(SQL) that you can use to produce information from database data.

To summarize, relational database store data in tables, and they represent the relationships among the rows of those tables. They do so in a way that facilitates the production of information .

2. Database Example

Today, database technology is part of amlost every information system. This fact is not surprising when we consider that every information system needs to store data and the relationship among those data. Still, the vast array of applications that use this technology is staggering. Consider, for example, the applications listed in Figure 1-5.

- Single-User Database Application

In Figure 1-5, the first applications is used by a single salesperson to keep track of the customers she has called and the contracts that she's had with them. Most salespeople do not build their own contract manager applications; instead, they licence ptoducts such as GoldMine or ACT!

- Multiuser Database Application

The next applications in Figure 1-5 are those that involve more than one user. The patient-scheduling application. for example, may have 15 to 50 users. These users will be appointment clerks, office administrators, nurses, denists, doctors, and so forth. A database like this one may have as many as 100,000 rows of data in perhaps 5 or 10 different tables.

2. Database Example

When more than one user employs a database application, these is aways the chance that one user's work may interfere with oather's. Two appointment clerks, for example, might assign the same appointment to two different patients. Special concurrency-control mechanisms are used to coordinate activity aginest the database to prevent such chnflict.

The third row of Figure 1-5 shows an even larger database application. A customer relationship management(CRM) system is an information system that manages customer contacts from initial solictation through acceptance, purchase, continuing purchase,support, and so forth. CRM systems are used by salespeople, sales managers, customer service and support staff, and other personal. A CRM database in a larger company might have 500 users and 10 million or more rows in perhaps 50 or more tables. According to Microsoft, in 2004 Verizon had an SQL Server customer database that containal more than 15 terabytes of data. If that data were published in books, a bookshelf 450 miles long would be required to hold them.

2. Database Example

Applicasion	Example Users	Numbers of Users	Typical Size	Remarks
Sales contact manager	Salesperson	1	2,000 rows	Products such as GoldMine and Act! are database centric
Patient appointment (doctor, dentist)	Medical office	15 to 50	100,000 rows	Vertical market software vendors in corporate database into their software products.
Customer Relationship Management(CRM)	Sales, marketing, or customer service departments	500	10 million rows	Major vendors such as Siebel and PeopleSoft build applications around for database
Enterprise Resource Planning(ERP)	An entire orginization	5,000	10 million +rows	SAP uses a database as a central repository for ERP data.
E-commerce site	Internet users	Possibly millions	1 billion +rows	Drugstore.com has a database that grows at the rate of 20 million rows per day!
Digital dashboard	Senior managers	500	100,000 rows	Extractions,summaries, and consolidations of operational database.
Data mining	Business analysts	25	100,000 to million +	Data are extracted, reformatted, cleaned, and filtered for use by statistical data mining tools.

2. Database Example

➢ **Reporting and Data Mining Database Applications**

Two other example applications in Figure 1-5 are digital dashboards and data mining applications. These applications use the data generated by order processing and other operational systems to produce information to help manage the enterprise. Such applications do not generate new data, but instead summarize existing data to provide insights to management. Digital dashboards and other reporting systems assess past and current performance. Data mining applications predict future performance. We will consider such applications in Chapter 15. The bottom line is that database technology is used in almost every information system and involves databases ranging in size from a few thousand rows to many millions of rows.

By the way Do not assume that just because a database is small that its structure is simple. For example, consider parts distribution for a company that sells $1 million in parts per year and parts distribution for a company that sells $100 million in parts per year. Despite the difference in sales, the companies have similar databases. Both have the same kinds of data, about the same number of tables of data, and the same level of complexity in data relationships. Only the amount of data varies from one to the other. Thus, although a database for a small business may be small, it is not necessarily simple

2. Database Example

Enterprise resource planning(ERP) is an information system that touches every department in a manufacturing company. It includes sales, production planning, purchasing, and other business functions. SAP is the leading vendor of ERP applications, and a key element of its product is a database that integrates data from these various business functions. An ERP system may have 5,000 or more users and perhaps 100 million rows in several hundred tables.

- **E-Commerce Database Applications**

E-commerce is another important database application. Databases are a key component of e commerce order entry, billing, shipping, and customer support. Surprisingly, however, the largest databases at an e-commerce site are not order-processing databases. The largest databases are those that track customer browser behavior. Most of the prominent e-commerce companies, such as Amazon.com (www.amazon.com) and Drugstore.com(www.drugstore.com) keep track of the Web pages and the Web page components that they send to their customers. They also track customer clicks, additions to shopping carts, order purchases, abandoned shopping carts, and so forth. E commerce companies use Web activity databases to determine which items on a Web page are popular and successful and which are not. They also can conduct experiments to determine if a purple background generates more orders than a blue one, and so forth. Such Web usage data-bases are huge. For example, Drugstore.com adds 20 million rows to its Web log database each day!

3.The Components of a Database System

As shown in Figure 1-6, a database system is typically defined to consist of four components: users, the database application, the database management system (DBMS), and the database. However, given the importance of **Structured Query Language (SQL)**, an internationally recognized standard language that is understood by all commercial DBMS products, in database processing and the fact that database applications typically send SQL statements to the DBMS for processing, we can refine our illustration of a database system to appear as shown in Figure 1-7.

Starting from the right of Figure 1-7, the **database** is a collection of related tables and other structures. The **database management system (DBMS)** is a computer program used to create, process, and administer the database.The DBMS receives requests encoded in SQL and translates those requests into actions on the database. The DBMS is a large, complicated program that is licensed from a software vendor; companies almost never write their own DBMS programs.

A **database application** is a set of one or more computer programs that serves as an intermediary between the user and the DBMS. Application programs read or modify database data by sending SQL statements to the DBMS. Application programs also present data to users in the format of forms and reports. Application programs can be acquired from software vendors, and they are also frequently written in-house. The knowledge you gain from this text will help you write database applications.

Users, the fourth component of a database system, employ a database application to keep track of things. They use forms to read, enter, and query data, and they produce reports to convey information.

3.The Components of a Database System

Figure 1-6

The Components of a Database System

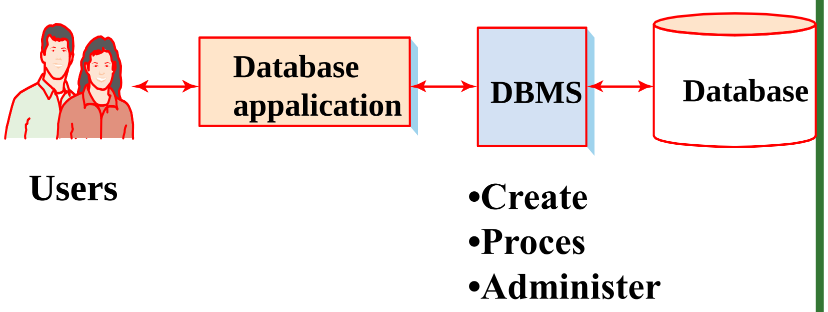
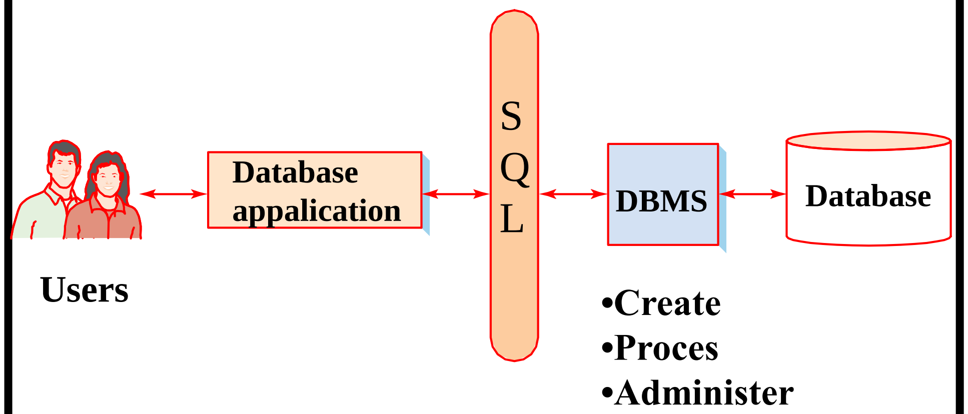


Figure 1-7

The Components of a
Database Systems with SQL



3.The Components of a Database System

➢ **Database Applications and SQL**

Figure 1-7 shows the database applications that users interact with directly. Figure 1-8 lists the basic functions of database applications.

First, an application program creates and processes forms. Figure 1-9 shows a typical form for entering and processing student enrollment data for the Student-Class-Grade database shown in Figures 1-3 and 1-4. Notice that this form hides the structure of the underlying tables from the user. By comparing the tables and data in Figures 1-3 and 1-4 to the form in Figure 1-9, we can see that data from the CLASS table appears at the top of the form, while data from the STUDENT table is presented in a tabular section labeled Class Enrollment Data.

The goal of this form, like that for all data entry forms, is to present the data in a format that is useful for the users, regardless of the underlying table structure. Behind the form, the application processes the database in accordance with the users' actions. The application generates an SQL statement to insert, update, or delete data for any of the tables that underlie this form.

The second function of application programs is to process user queries. The application program first generates a query request and sends it to the DBMS. Results are then formatted and returned to the user. Applications use SQL statements and pass them to the DBMS for processing. To give you a taste of SQL, here is a sample SQL statement for processing the STUDENT table in Figure 1-1:

```
SELECT    LastName, FirstName, EmailAddress
FROM      STUDENT
WHERE     StudentNumber > 2;
```

3.The Components of a Database System

➢**Database Applications and SQL**

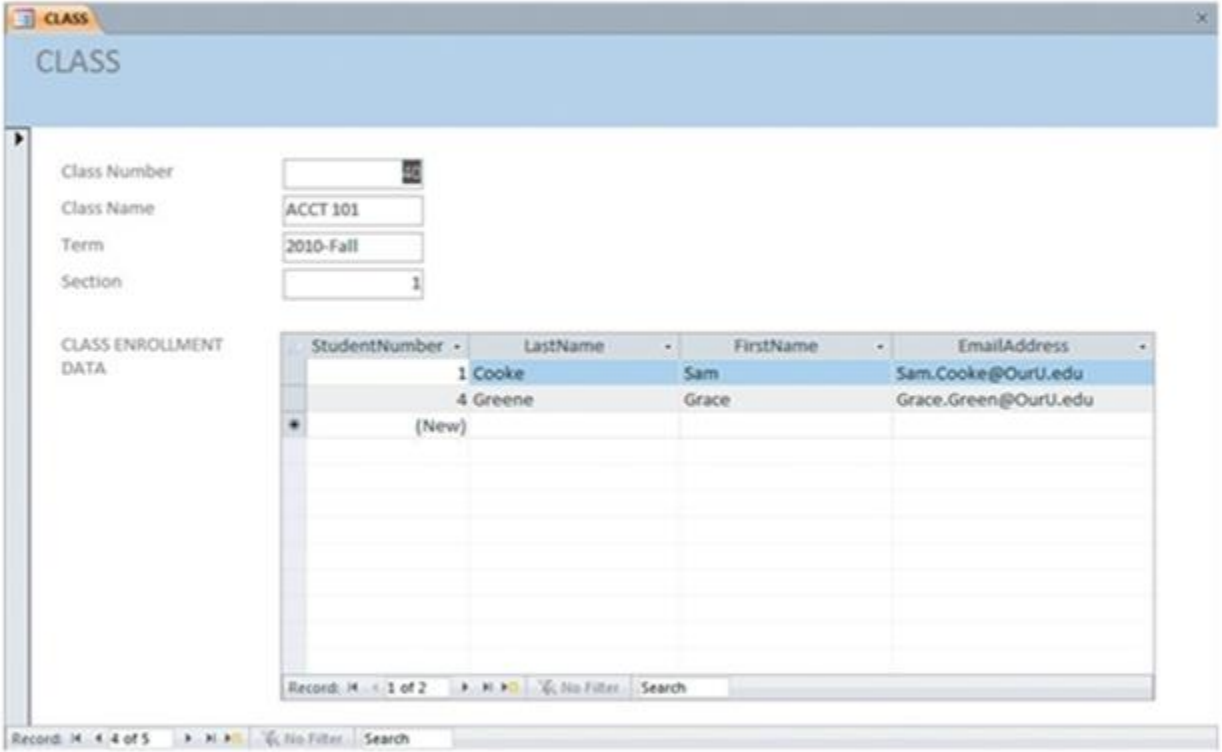
Figure 1-8

Basic Functions of Application Programs

- Create and process forms
- Process user queries
- Create and process reports
- Execute application logic
- Control application

➢Database Applications and SQL

Figure 1-9 An Example Data Entry Form



➢ Database Applications and SQL

This SQL statement is a query statement, which asks the DBMS to obtain specific data from a database. In this case, the query asks for the last name, first name, and e-mail address of all students having a StudentNumber greater than 2. The results of this SQL statement are shown (as displayed in Microsoft Access 2010) in Figure 1-10. As shown in Figure 1-10, running this SQL statement will produce the LastName, FirstName, and EmailAddress for students Harris and Greene.

Figure 1-10 Example SQL Query Results

Query1

LastName	FirstName	EmailAddress
Harris	Lou	Lou.Harris@OurU.edu
Greene	Grace	Grace.Green@OurU.edu

Record: 1 of 2 No Filter Search

3.The Components of a Database System

➢ Database Applications and SQL

The third function of an application is to create and process reports. This function is somewhat similar to the second because the application program first queries the DBMS for data (again using SQL). The application then formats the query results as a report. Figure 1-11 shows a report that displays all the Student-Class-Grade data shown in Figure 1-3 sorted by ClassNumber and LastName. Notice that the report, like the form in Figure 1-9, is structured according to the users' needs, not according to the underlying table structure.

In addition to generating forms, queries, and reports, the application program takes other actions to update the database in accordance with application-specific logic. For example, suppose a user using an order entry application requests 10 units of a particular item. Suppose further that when the application program queries the database (via the DBMS), it finds that only 8 units are in stock. What should happen? It depends on the logic of that particular application. Perhaps no units should be removed from inventory, and the user should be notified, or perhaps the 8 units should be removed and 2 more placed on back order. Perhaps some other action should be taken. Whatever the case, it is the job of the application program to execute the appropriate logic.

3.The Components of a Database System

➢ Database Applications and SQL

Finally, the last function for application programs listed in Figure 1-8 is to control the application. This is done in two ways. First, the application needs to be written so that only logical options are presented to the user. For example, the application may generate a menu with user choices. In this case, the application needs to ensure that only appropriate choices are available. Second, the application needs to control data activities with the DBMS. The application might direct the DBMS, for example, to make a certain set of data changes as a unit. The application might tell the DBMS to either make all these changes or none of them.

Figure 1-11 Example Report

Class Grade Report

ClassNumber	ClassName	Term	Section	LastName	FirstName	Grade
10	CHEM 101	2010-Fall	1			
				Cooke	Sam	3.7
20	CHEM 101	2010-Fall	2			
				Lau	Marcia	3.7
30	CHEM 101	2011-Spring	1			
				Harris	Lou	3.1
40	ACCT 101	2010-Fall	1			
				Cooke	Sam	3.5
				Greene	Grace	3.0
50	ACCT 101	2011-Spring	1			
				Greene	Grace	3.5

3.The Components of a Database System

➢ The DBMS

The DBMS, or database management system, creates, processes, and administers the database. A DBMS is a large, complicated product that is almost always licensed from a software vendor. One DBMS product is Microsoft Access. Other commercial DBMS products are Oracle Database and MySQL, both from Oracle Corporation; SQL Server, from Microsoft; and DB2, from IBM. Dozens of other DBMS products exist, but these five have the lion's share of the market. Figure 1 12 lists the functions of a DBMS.

A DBMS is used to create a database and to create the tables and other supporting structures inside that database. As an example of the latter, suppose that we have an EMPLOYEE table with 10,000 rows and that this table includes a column, DepartmentName, that records the name of the department in which an employee works. Furthermore, suppose that we frequently need to access employee data by DepartmentName. Because this is a large database, searching through the table to find, for example, all employees in the accounting department would take a long time. To improve performance, we can create an index (akin to the index at the back of a book) for DepartmentName to show which employees are in which departments. Such an index is an example of a supporting structure that is created and main-tained by a DBMS.

The next two functions of a DBMS are to read and modify database data. To do this, a DBMS receives SQL and other requests and transforms those requests into actions on the database files. Another DBMS function is to maintain all the database structures. For example, from time to time it might be necessary to change the format of a table or another supporting structure. Developers use a DBMS to make such changes.

3.The Components of a Database System

➢The DBMS

Figure 1-12 Functions of a DBMS

- Create database
- Create tables
- Create supporting structures (e.g., indexes)
- Read database data
- Modify (insert, update, or delete) database data • Maintain database structures
- Enforce rules
- Control concurrency
- Provide security
- Perform backup and recovery

3.The Components of a Database System

➢ **The DBMS**

With most DBMS products, it is possible to declare rules about data values and have a DBMS enforce them. For example, in the Student-Class-Grade database tables in Figure 1-3, what would happen if a user mistakenly entered a value of 9 for StudentNumber in the GRADE table? No such student exists, so such a value would cause numerous errors. To prevent this situation, it is possible to tell the DBMS that any value of StudentNumber in the GRADE table must already be a value of StudentNumber in the STUDENT table. If no such value exists, the insert or update request should be disallowed. The DBMS then enforces these rules, which are called referential integrity constraints.

The last three functions of a DBMS listed in Figure 1-12 have to do with database administration. A DBMS controls concurrency by ensuring that one user's work does not inappropriately interfere with another user's work. This important (and complicated) function is discussed in Chapter 9. Also, a DBMS contains a security system that ensures that only authorized users perform authorized actions on the database. For example, users can be prevented from seeing certain data. Similarly, users' actions can be confined to making only certain types of data changes on specified data.

Finally, a DBMS provides facilities for backing up database data and recovering it from backups, when necessary. The database, as a centralized repository of data, is a valuable organizational asset. Consider, for example, the value of a book database to a company such asAmazon.com. Because the database is so important, steps need to be taken to ensure that no data will be lost in the event of errors, hardware or software problems, or natural or human catastrophes.

3.The Components of a Database System

The Database

The last component in Figure 1-7 is the database. A database is a self-describing collection of integrated tables. Integrated tables are tables that store both data and the relationships among the data. The tables in Figure 1-3 are integrated because they store not just student, class, and grade data, but also data about the relationships among the rows of data.

A database is self-describing because it contains a description of itself. Thus, databases contain not only tables of user data, but also tables of data that describe that user data. Such descriptive data is called metadata because it is data about data. The form and format of metadata varies from DBMS to DBMS. Figure 1-13 shows generic metadata tables that describe the tables and columns for the database in Figure 1-3.

You can examine metadata to determine if particular tables, columns, indexes, or other structures exist in a database. For example, the following statement queries the Microsoft SQL Server metadata table SYSOBJECTS to determine if a user table (Type = ‘U’) named CLASS exists in the database. If it does, the table is dropped (removed) from the database.

```
IF  EXISTS
     (SELECT    *
        FROM    SYSOBJECTS
       WHERE    [Name]='CLASS'
         AND    Type='U')
DROP  TABLE  CLASS;
```

Do not be concerned with the syntax of this statement. You will learn what it means and how to write such statements yourself as we proceed. For now, just understand that this is one way that database administrators use metadata.

3.The Components of a Database System

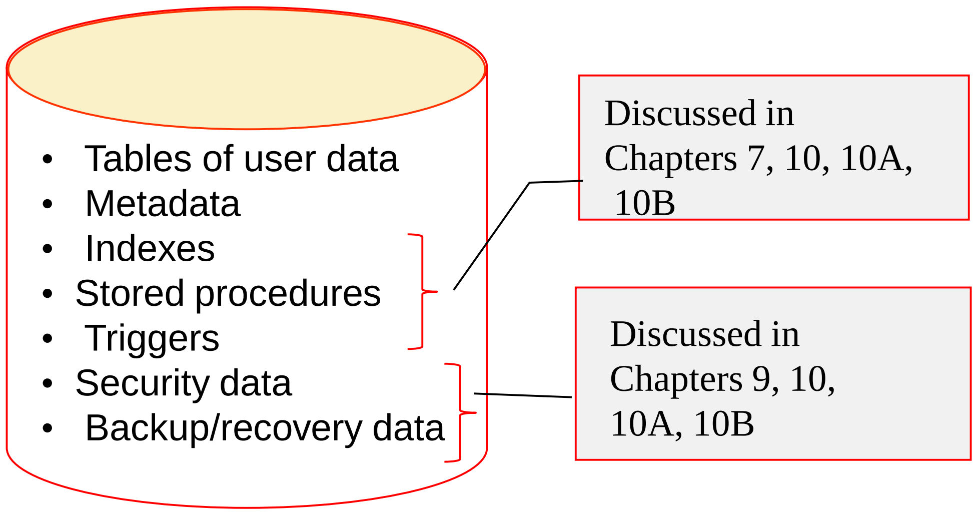
- **The Database**

ColumnName	TableName	DataType	Length(bytes)
StudentNumber	STUDENT	Integer	4
Lastname	STUDENT	Text	25
Firstname	STUDENT	Text	25
EmailAddress	STUDENT	Text	100
ClassNumber	CLASS	Integer	4
Name	CLASS	Text	25
Term	CLASS	Text	12
Section	CLASS	Integer	4
StudentNumber	GRADE	Integer	4
ClassNumber	GRADE	Integer	4
Grade	GRADE	Decimal	(2, 1)

3.The Components of a Database System

➢The Database

Figure 1-14 Database Contents



3.The Components of a Database System

➢ The Database

In addition to user tables and metadata, databases contain other elements, as shown in Figure 1-14. These other components will be described in detail in subsequent chapters. For now, however, understand that indexes are structures that speed the sorting and searching of database data. Triggers and stored procedures are programs that are stored within the database. Triggers are used to maintain database accuracy and consistency and to enforce data constraints. Stored procedures are used for database administration tasks and are sometimes part of database applications. You will learn more about these different elements in Chapters 7, 10, 10A, and 10B.

Security data define users, groups, and allowed permissions for users and groups. The particulars depend on the DBMS product in use. Finally, backup and recovery data are used to save database data
to backup devices as well as to recover the database data when needed. You will learn more about security and backup and recovery data in Chapters 9, 10, 10A, and 10B.

By the way Because metadata is stored in tables, you can use SQL to query it, as just illustrated. Thus, by learning how to write SQL to query user tables, you will also learn how to write SQL to query metadata. To do that, you just apply the SQL statements to metadata tables rather than user tables.

LOGO

Thank You!