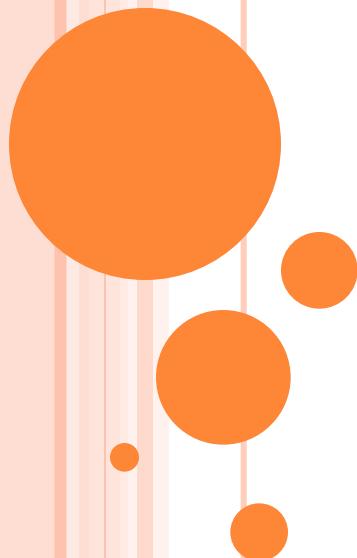


DATABASE MANAGEMENT SYSTEM



INTRODUCTION

- **Dr. Syed Khaldoon Khurshid**

Assistant Professor

Department of Computer Science and Engineering

University of Engineering and Technology, Lahore

- **Teaching Experience**

More than fifteen years

- **Areas of Interest**

Database Management Systems

Information Retrieval Systems

Knowledge base Systems

Future Technologies

Entrepreneurship



CONTACT

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- Google group to be joined by students:

<https://groups.google.com/forum/#!forum/database-system-session-15>



QUIZZES

**There can be number of
surprise quizzes throughout
the semester.**



MID TERM, FINAL EXAM AND TOTAL MARKS

- Mid-term Exam 30 Marks
- Final Exam 40 Marks
- Class Project 30 Marks

- Marks Allocation:
 - Class Project 30 + Mid-term 30 + Final 40
 - **Total = 100 Marks**



GRADING CRITERIA:

A : 80% and Above

B : 70% to 79%

C : 60% to 69%

D : 50% to 59%

F : 49% and Below



BOOK

- **Database Systems Design,**
Implementation and Management

Peter Rob and Carlos Coronel 7th Edition

- All Contents will be covered in the lectures slides.



CHAPTER 9

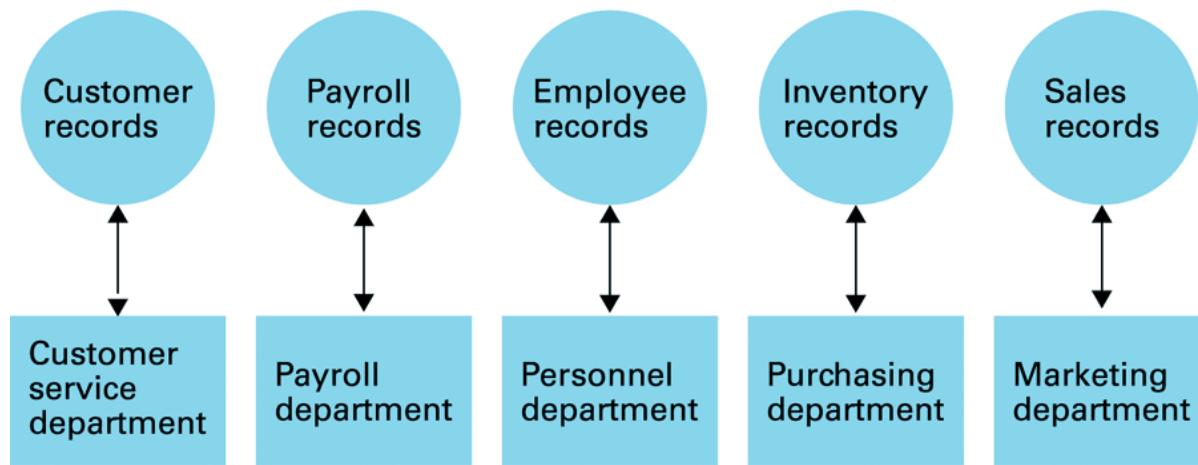
Database Structures

- (Large) integrated collections of data that can be accessed quickly
- Combination of data structures (chap. 7) and file structures (chap. 8)

9.1: Historical Perspective

- Originally: departments of large organizations stored all data separately in *flat files*

a. File-oriented information system

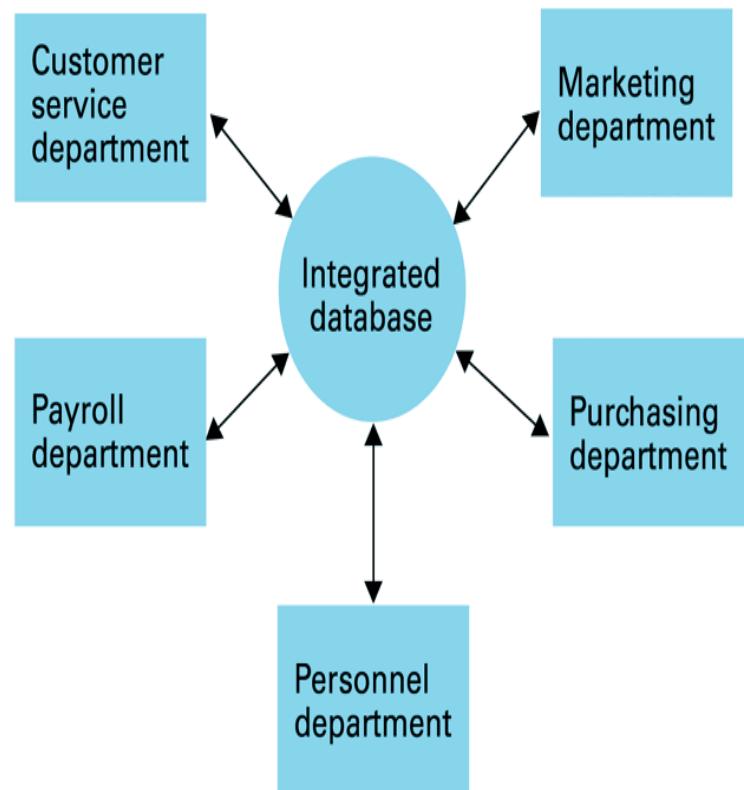


- Problems: redundancy & inconsistencies

9.1: Integrated Database System

- Better approach: integrate all data in a single system, to be accessed by all departments.
- Schema and Subschema
Example:
University student and faculty records

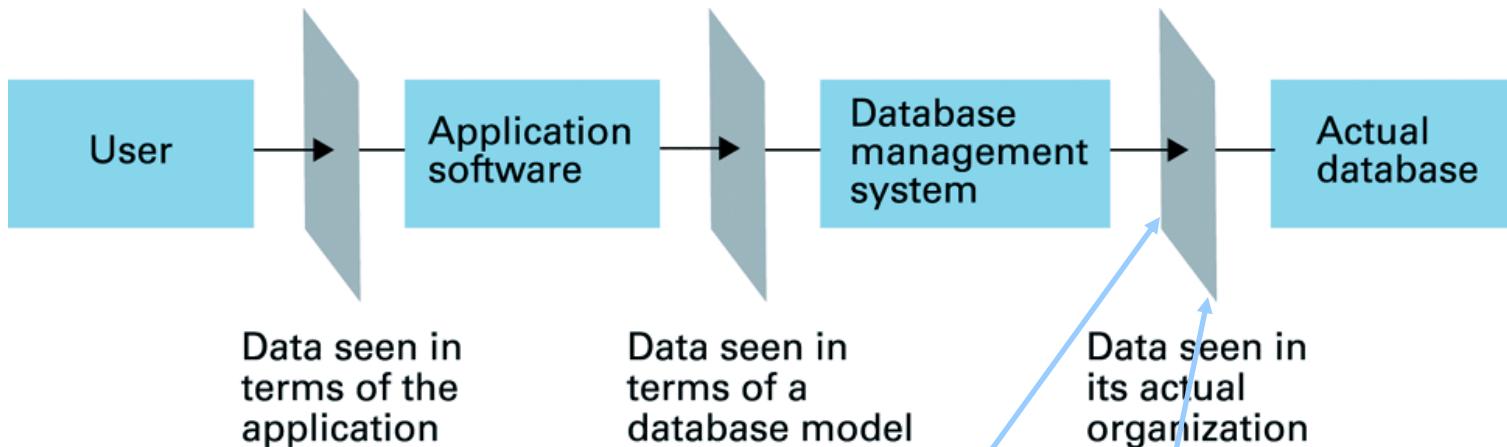
b. Database-oriented information system



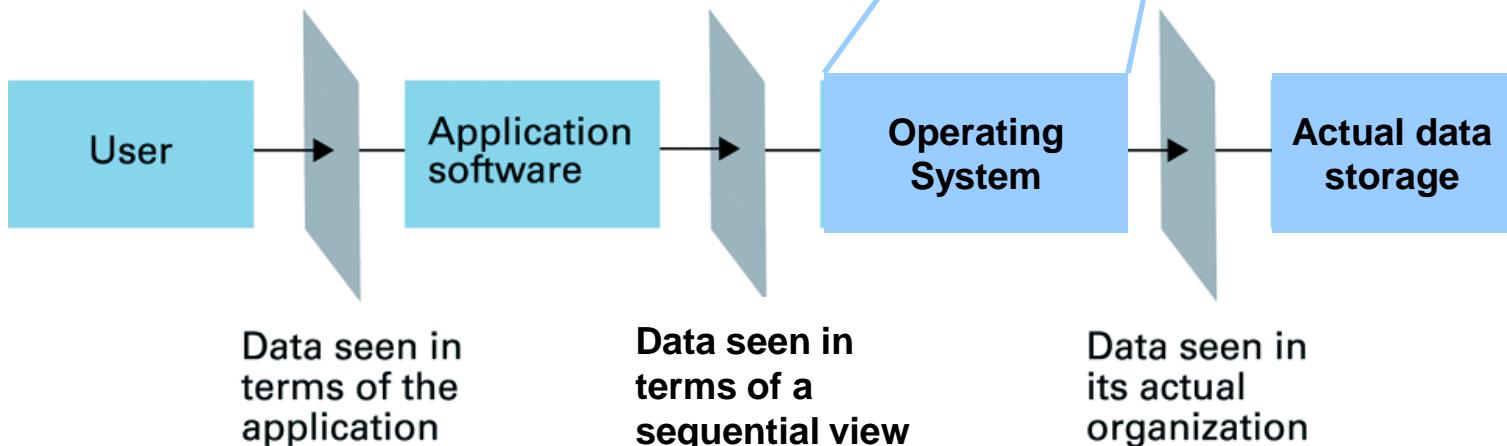
9.1: Disadvantages of Data Integration

- Control of access to sensitive data?
- Misinterpretation of integrated data? 
- What about the **right** to hold/collect/interpret data?

9.2: Conceptual Database Layers



- Compare:



9.3: The Relational Model

- Relational Model
 - shows data as being stored in rectangular tables, called *relations*, e.g.:

Empl Id	Name	Address	SSN
25X15	Joe E. Baker	33 Nowhere St.	111223333
34Y70	Cheryl H. Clark	563 Downtown Ave.	999009999
23Y34	G. Jerry Smith	1555 Circle Dr.	111005555
•	•	•	•
•	•	•	•
•	•	•	•

- row in a relation is called ‘*tuple*’
- column in a relation is called ‘*attribute*’

9.3: Issues of Relational Design

- So, *relations* make up a relational database...
- ... but this is not so straightforward:

Empl Id	Name	Address	SSN	Job Id	Job Title	Skill Code	Dept	Start Date	Term Date
25X15	Joe E. Baker	33 Nowhere St.	111223333	F5	Floor manager	FM3	Sales	9-1-2001	9-30-2002
25X15	Joe E. Baker	33 Nowhere St.	111223333	D7	Dept. head	K2	Sales	10-1-2002	*
34Y70	Cheryl H. Clark	563 Downtown Ave.	999009999	F5	Floor manager	FM3	Sales	10-1-2001	*
23Y34	G. Jerry Smith	1555 Circle Dr.	111005555	S25X	Secretary	T5	Personnel	3-1-1999	4-30-2001
23Y34	G. Jerry Smith	1555 Circle Dr.	111005555	S25Z	Secretary	T6	Accounting	5-1-2001	*
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

- Problem: more than one concept combined in single relation

9.3: Redesign by extraction of 3 concepts

EMPLOYEE relation

Empl Id	Name	Address	SSN
25X15	Joe E. Baker	33 Nowhere St.	111223333
34Y70	Cheryl H. Clark	563 Downtown Ave.	999009999
23Y34	G. Jerry Smith	1555 Circle Dr.	111005555
•	•	•	•
•	•	•	•
•	•	•	•

JOB relation

Job Id	Job Title	Skill Code	Dept
S25X	Secretary	T5	Personnel
S26Z	Secretary	T6	Accounting
F5	Floor manager	FM3	Sales
•	•	•	•
•	•	•	•
•	•	•	•

ASSIGNMENT relation

Empl Id	Job Id	Start Date	Term Date
23Y34	S25X	3-1-1999	4-30-2001
34Y70	F5	10-1-2001	*
25X15	S26Z	5-1-2001	*
•	•	•	•
•	•	•	•
•	•	•	•

Any information obtained
by combining information
from multiple relations

9.3: Example:

- Finding all departments in which employee 23Y34 has worked:

JOB relation			
Job Id	JobTitle	Skill Code	Dept
S25X	Secretary	T5	Personnel
S26Z	Secretary	T6	Accounting
F5	Floor manager	FM3	Sales
•	•	•	•
•	•	•	•
•	•	•	•

Are contained in the personnel and accounting departments.

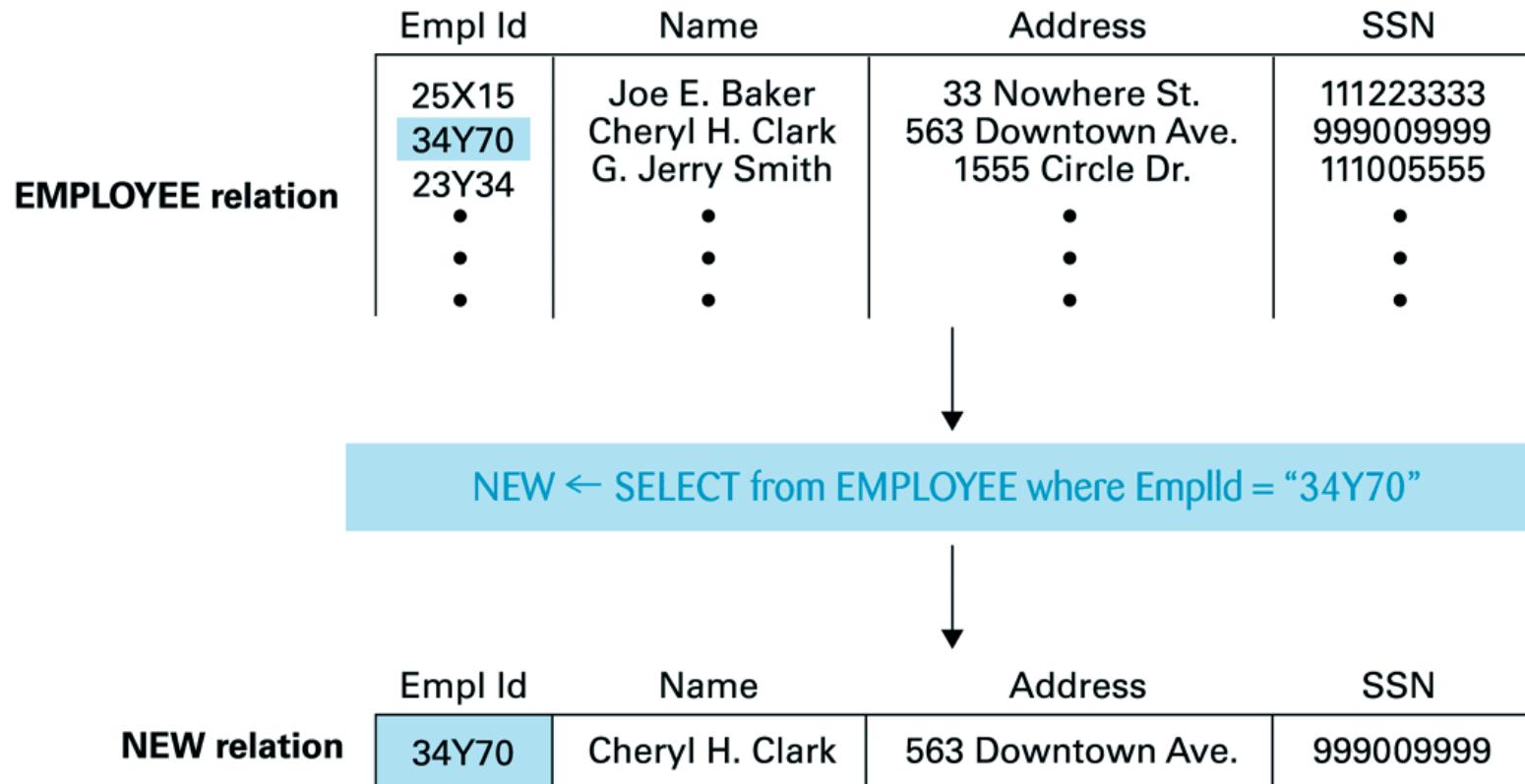
ASSIGNMENT relation			
Empl Id	Job Id	Start Date	Term Date
23Y34	S25X	3-1-1999	4-30-2001
34Y70	F5	10-1-2001	*
23Y34	S26Z	5-1-2001	*
•	•	•	•
•	•	•	•
•	•	•	•

The jobs held by employee 23Y34

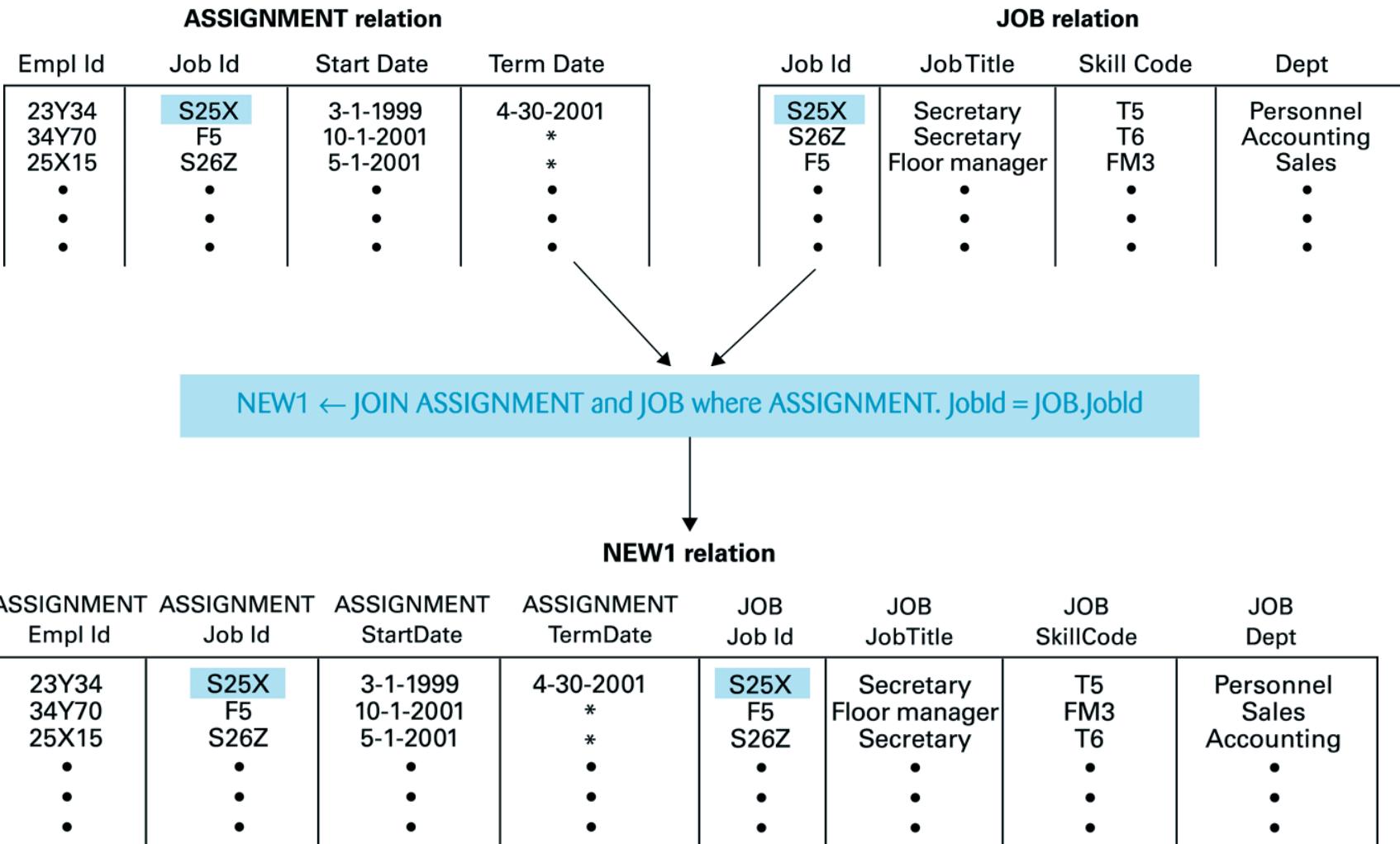
9.3: Relational Operations

- Extracting information from a relational database by way of *relational operations*
 - Most important ones:
 - (1) extract tuples (rows) : SELECT
 - (2) extract attributes (columns) : PROJECT
 - (3) combine relations : JOIN
- Such operations on relations produce other relations
 - so: they can be used in combination, to create complex database requests (or ‘*queries*’)

9.3: The SELECT operation



9.3: The JOIN operation



Chapter 9 - Database Structures: Conclusions

- Database Structures:
 - (large) integrated collections of data that can be accessed quickly
- Database Management System
 - provides high-level view of actual data storage (database model)
- Relational Model most often used
 - relational operations: SELECT, PROJECT, JOIN, ...
 - high-level language for database access: SQL

Discovering Computers 2009



Chapter 10 Database Management

Chapter 10 Objectives

Define the term, database

Differentiate between a file processing system approach and the database approach

Identify the qualities of valuable information

Discuss the functions common to most DBMSs

Explain why data is important to an organization

Describe characteristics of relational, object-oriented, and multidimensional databases

Discuss the terms character, field, record, and file

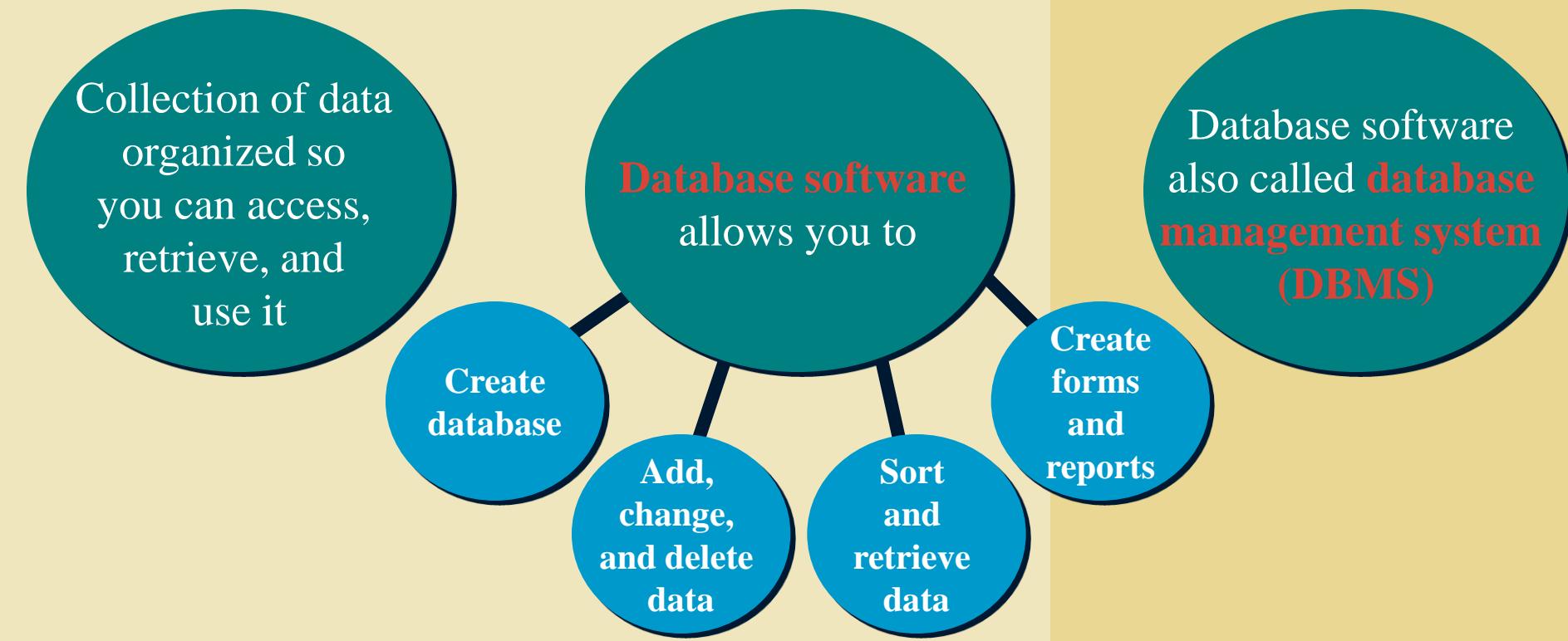
Explain how to interact with Web databases

Identify file maintenance techniques

Discuss the responsibilities of database analysts and administrators

Data and Information

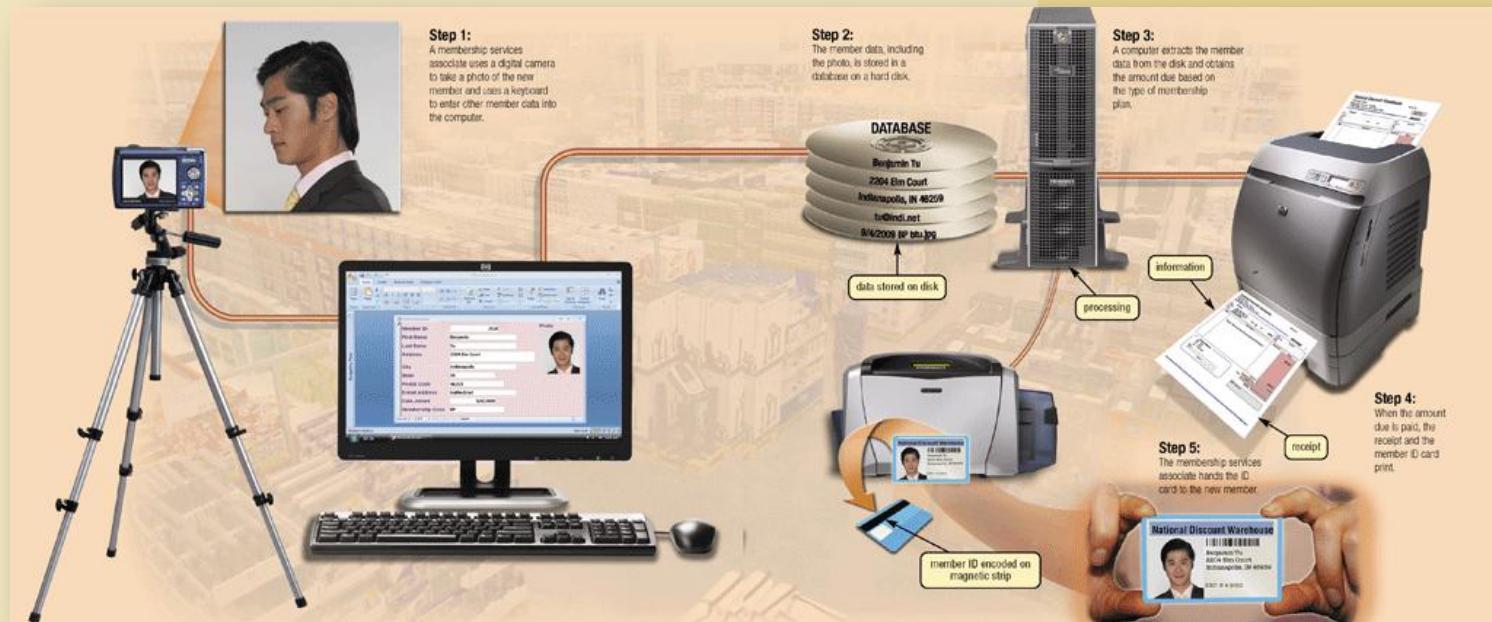
What is a **database**?



Data and Information

How are **data** and **information** related?

- Data is a collection of unprocessed items
- Information is data that is organized and meaningful
- Computers process data into information



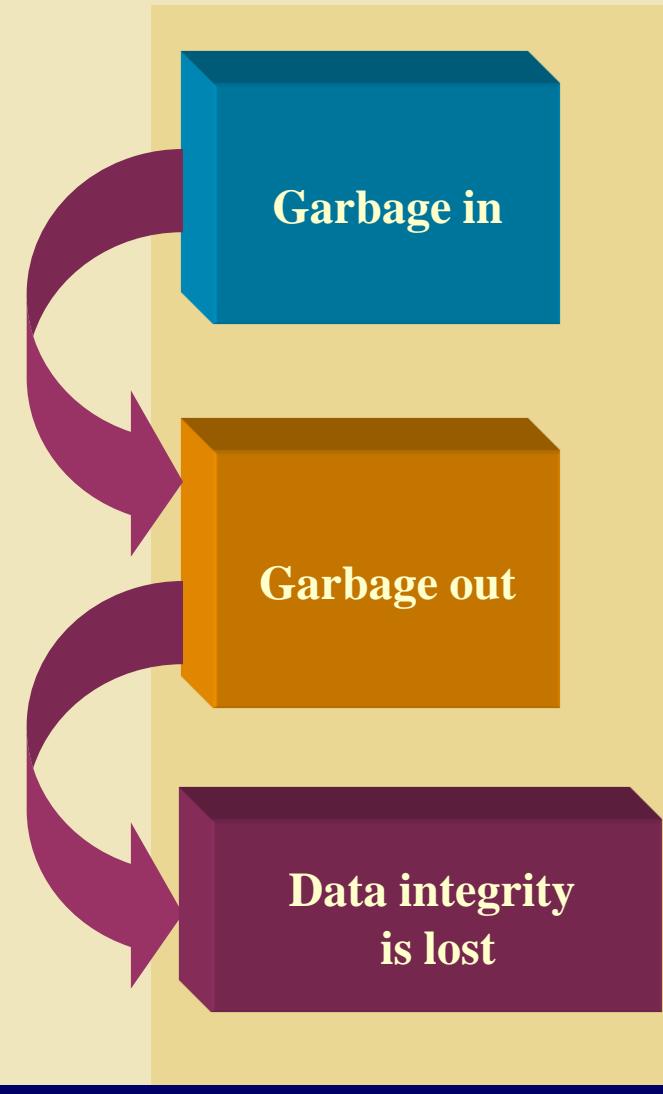
Data and Information

What is data integrity?

- Degree to which data is correct
 - Garbage in, garbage out (GIGO)—computer phrase that means you cannot create correct information from incorrect data



Answer of the Group
Joining Question



Data and Information

What are the qualities of valuable information?

Accurate

Verifiable

Timely

Organized

Accessible

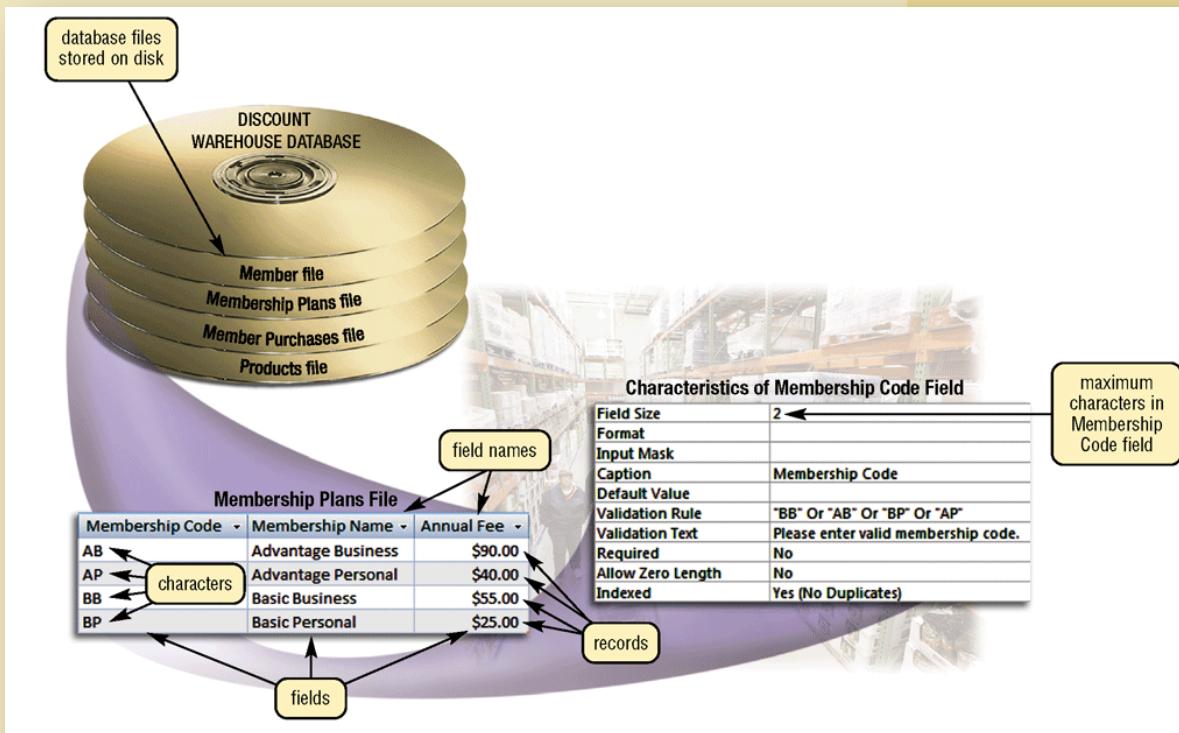
Useful

Cost-effective

The Hierarchy of Data

What is a hierarchy?

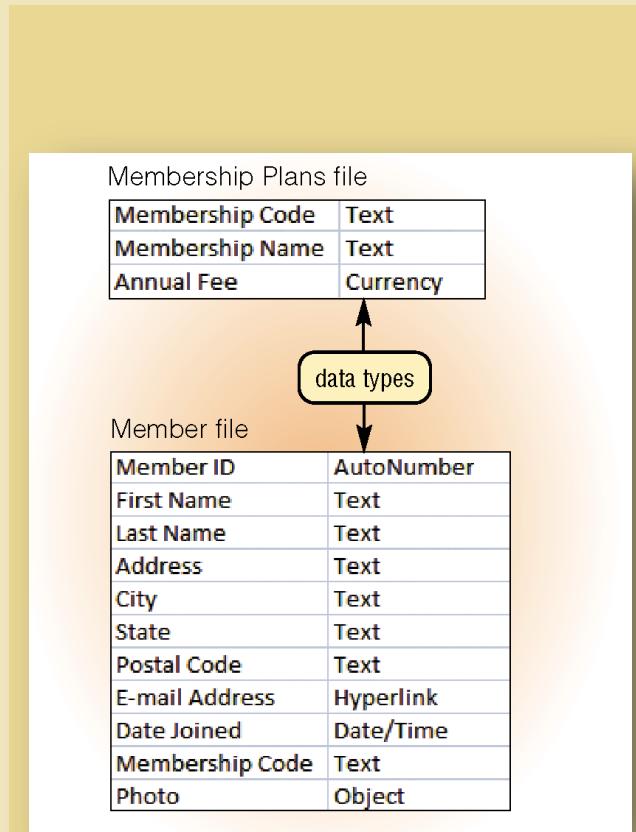
- Database contains files, file contains records, record contains fields, field contains characters



The Hierarchy of Data

What is a **field**?

- **Combination of one or more characters**
- **Smallest unit of data user accesses**
 - **Field name** uniquely identifies each field
 - **Field size** defines the maximum number of characters a field can contain
 - **Data type** specifies kind of data field contains



The Hierarchy of Data

What are common data types?

Text

(also called **alphanumeric**)—letters, numbers, or special characters

Numeric

numbers only

AutoNumber

unique number automatically assigned to each new record

Currency

dollar and cent amounts or numbers containing decimal values

Date

month, day, year, and sometimes time

Memo

lengthy text entries

Yes/No

(also called **Boolean**)—only the values Yes or No (or True or False)

Hyperlink

Web address that links to document or Web page

Object

(also called **BLOB** for binary large object)—photograph, audio, video, or document created in other application such as word processing or spreadsheet

The Hierarchy of Data

What is a **record**?

Group of
related fields

Key field, or primary key,
uniquely identifies each record

The Hierarchy of Data

What is a **data file**?

- Collection of related records stored on disk

Maintaining Data

What is file maintenance?

- Procedures that keep data current

Adding records

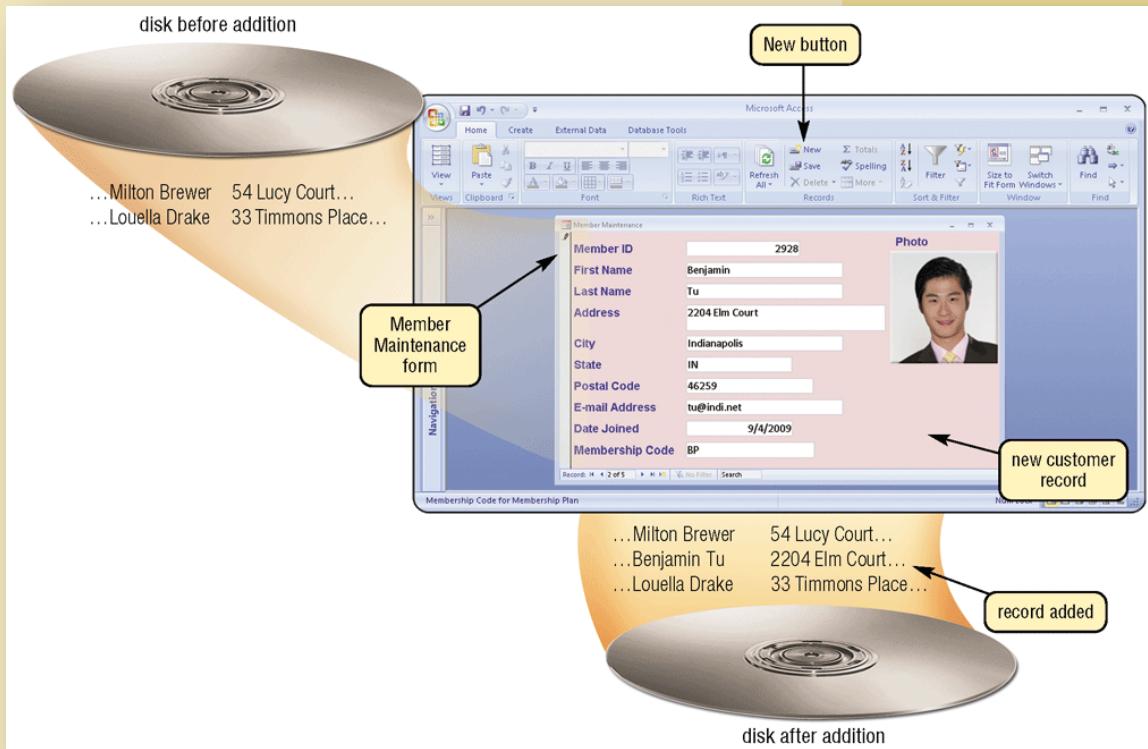
Changing records

Deleting records

Maintaining Data

Why do you add records?

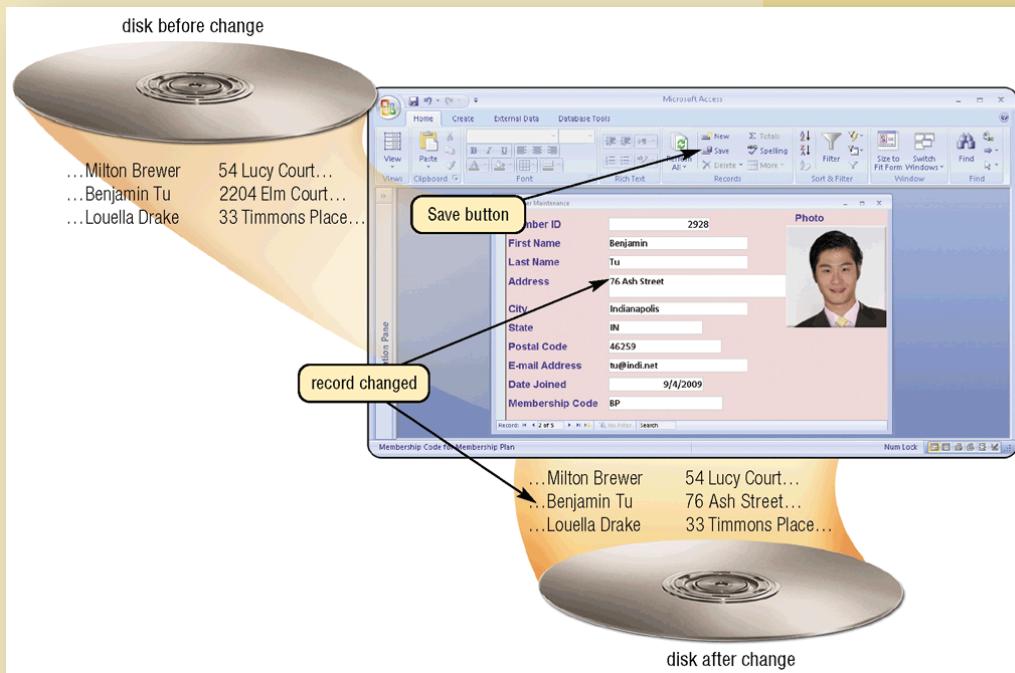
- Add new record when you obtain new data



Maintaining Data

Why do you change records?

- Correct inaccurate data
- Update old data



Maintaining Data

Why do you delete records?

- When record no longer is needed
- Some programs remove record immediately, others flag record



Maintaining Data

What is validation?

- Process of comparing data with a set of rules to find out if data is correct
- Reduce data entry errors and enhance data integrity before program writes data on disk

SAMPLE VALID AND INVALID DATA

Validity Check	Field(s) Being Checked	Valid Data	Invalid Data
Alphabetic Check	First Name	Karen	Ka24n
Numeric Check	Postal Code	46322	4tr22
Range Check	Annual Fee	\$30.00	\$120.00
Consistency Check	Date Joined and Birth Date	9/20/2008 8/27/1984	9/20/2008 8/27/2009
Completeness Check	Last Name	Tu	

Maintaining Data

What are the types of validity checks?

Check Digit
number(s) or
character(s)
appended to or
inserted into a
primary key value
to confirm
accuracy of
primary key value

**Alphabetic/
Numeric Check**
ensures correct
type of data
entered

**Completeness
Check**
verifies that a
required field
contains data

Range Check
determines
whether number is
within specified
range

**Consistency
Check**
tests for logical
relationship
between two or
more fields

File Processing Versus Databases

What is a **file processing system**?

Each department or area within organization has own set of files

Records in one file may not relate to records in any other file

May have weaknesses

Data redundancy—same fields stored in multiple files

Isolated data—data stored in separate files so it is difficult to access

File Processing Versus Databases

What is the database approach?

- Many programs and users can share data in database
- Secures data so only authorized users can access certain data



File Processing Versus Databases

What are the strengths of the database approach?

Reduced
data
redundancy

Improved
data
integrity

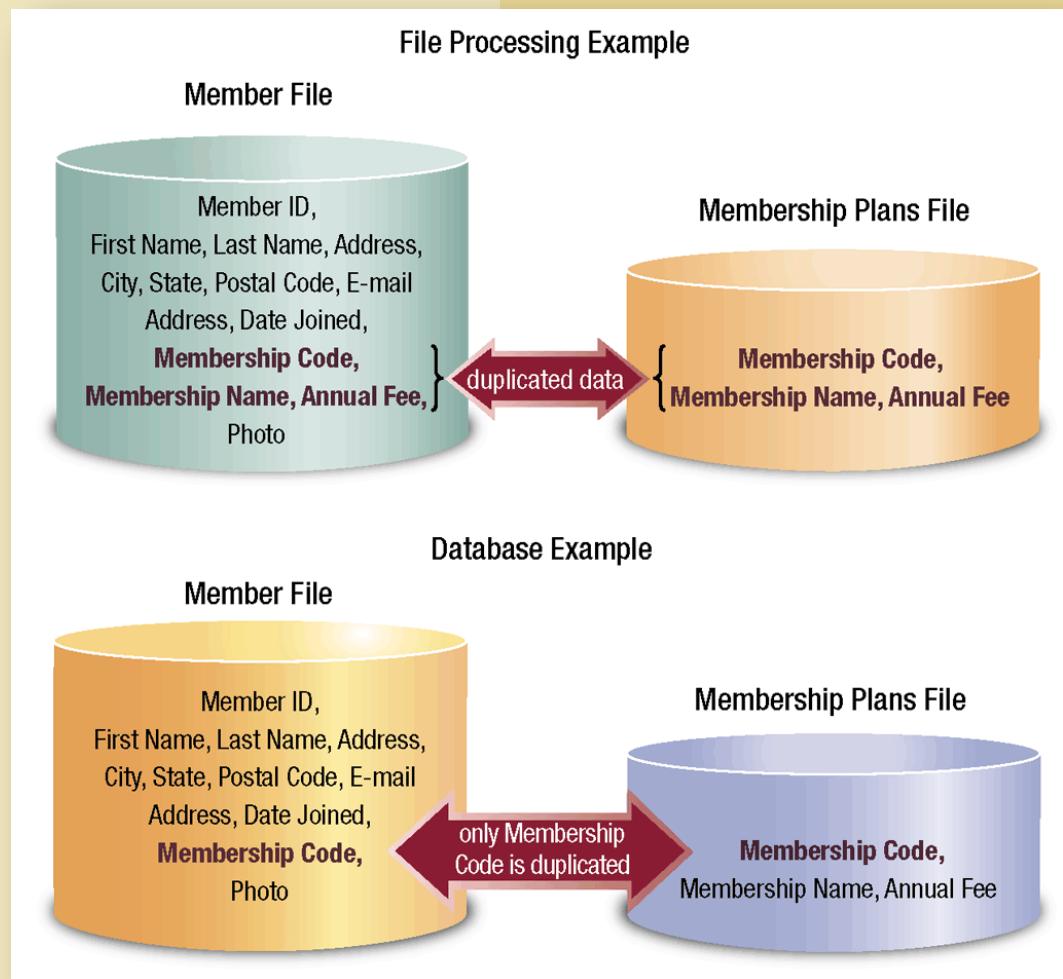
Shared
data

Easier
access

Reduced
development
time

File Processing Versus Databases

How do a database application and a file processing application differ in the way they store data?



Database Management Systems

What are popular database management systems (DBMSs)?

POPULAR DATABASE MANAGEMENT SYSTEMS

Database	Manufacturer	Computer Type
Access	Microsoft Corporation	Personal computer, server, mobile devices
Adabas	Software AG	Server, mainframe
D ³	Raining Data	Personal computer, server
DB2	IBM Corporation	Personal computer, server, mainframe
Essbase	Oracle Corporation	Personal computer, server, mobile devices
FastObjects	Versant Corporation	Personal computer, server
GemFire	GemStone Systems	Server
Informix	IBM Corporation	Personal computer, server, mainframe
Ingres	Ingres Corporation	Personal computer, server, mainframe
InterBase	Borland Software Corporation	Personal computer, server
KE Texpress	KE Software, Inc.	Personal computer, server
MySQL	MySQL AB	Personal computer, server
ObjectStore	Progress Software Corporation	Personal computer, server
Oracle Database	Oracle Corporation	Personal computer, server, mainframe, mobile devices
SQL Server	Microsoft Corporation	Server, personal computer
SQL Server Compact Edition	Microsoft Corporation	Mobile devices
Sybase	Sybase Inc.	Personal computer, server, mobile devices
Teradata Database	Teradata	Server
Versant	Versant Corporation	Personal computer, server
Visual FoxPro	Microsoft Corporation	Personal computer, server

Database Management Systems

What is a **data dictionary**?

- Contains data about each file in database and each field within those files

The screenshot shows the Microsoft Access 'Field Properties' dialog for the 'State' field of the 'Member' table. The main table lists fields like Member ID, First Name, Last Name, Address, City, State, Postal Code, E-mail Address, Date Joined, Membership Code, and Photo. The 'State' field is selected. Below the table, the 'General' tab of the 'Field Properties' dialog is open, showing properties such as Field Size (2), Format, Input Mask, Caption (State), Default Value ("IN"), Validation Rule, Validation Text, Required (Yes), Allow Zero Length (No), Indexed (No), and Unicode Compression (No). A callout box points to the 'Caption' property with the text 'metadata about State field'. Another callout box points to the right pane with the text 'A field name can be up to 64 characters long, including spaces. Press F1 for help on field names.'

Field Name	Data Type	Description
Member ID	AutoNumber	Member's ID Number
First Name	Text	Member's First Name
Last Name	Text	Member's Last Name
Address	Text	Member's Address
City	Text	City Member Lives
State	Text	State Member Lives
Postal Code	Text	Member's Postal Code
E-mail Address	Hyperlink	Member's E-Mail Address
Date Joined	Date/Time	Date Member Joined Center
Membership Code	Text	Membership Code for Membership Plan
Photo	Object	Digital Photo of Member

Database Management Systems

What is a **query**?

- Request for specific data from a database
- Query language consists of simple, English-like statements that allow users to specify data to display, print, or store

Step 1: Select the fields from the Available Fields list you want to be displayed in the resulting query.

Step 2: Assign a name to the query, so that you can open it later.

Step 3: View the query results on the screen.

Simple Query Wizard

Available Fields list

Selected Fields: First Name, Last Name, E-mail Address

Member ID, Address, City, State, Postal Code, Date Joined, Membership Code, Photo

Simple Query Wizard

What title do you want for your query? Member E-mail Addresses

That's all the information the wizard needs to create your query.

Do you want to open the query or modify the query's design?

Open the query to view information.
 Modify the query design.

Member E-mail Addresses

First Name	Last Name	E-mail Address
Milton	Brewer	tu@indi.net
Benjamin	Tu	tu@world.com
Louella	Drake	lou@world.com
Adelbert	Ruiz	
Elena	Gupta	eg@earth.net

SELECT First Name, Last Name, E-mail Address
FROM Member

query language statement generated by wizard

Database Management Systems

What is a query by example (QBE)?

- Program retrieves records that match criteria entered in form fields
- Has a graphical user interface that assists users with retrieving data

The figure consists of three windows illustrating the QBE process:

- Main Data Grid:** A table titled "Member" showing six records. The columns are Last Name, Address, City, State, Postal Code, E-mail Address, Date Joined, and Membership Code. The "Membership Code" column contains values like AB, BP, AP, and BB.
- Filter Dialog:** A "Member: Filter by Form" dialog. It has input fields for Last Name, Address, City, State, Postal Code, E-mail Address, Date Joined, and Membership Code. The "Membership Code" field is highlighted and contains the value "BP". Below the input fields are buttons for "Look for" and "Or".
- Results Grid:** A table titled "Member" showing two filtered records. The "Membership Code" column shows "BP" for both entries. The "Record" status bar indicates "1 of 2".

Annotations with arrows point from the "Membership Code" field in the main grid to the "Membership Code" field in the filter dialog, and from the "Membership Code" field in the filter dialog to the "Membership Code" column in the results grid. A yellow callout labeled "Membership Code field" points to the main grid's column header, and another labeled "criteria" points to the "BP" entry in the filter dialog's input field.

Database Management Systems

What is a **form**?

- Window on screen that provides areas for entering or changing data in database
- Used to retrieve and maintain data in a database
- Form that sends data across network or Internet is called e-form, short for electronic form

The screenshot shows a web browser window titled "Club - New Member Registration - Windows Internet Explorer". The URL is "http://www.ion.com/". The page has a green header bar with the title "New Member Registration" and a sub-header "Select a Username and Password". Below this, there are two input fields: "USERNAME" and "PASSWORD", with a note below stating "Note: Username and password must be between 4 and 40 characters long." The main content area is titled "Contact Information" and contains fields for "FIRST NAME" and "LAST NAME", "ADDRESS" with a "Private?" checkbox, "CITY", "STATE" (set to "Alabama"), "COUNTRY" (set to "United States"), "ZIP CODE", "PHONE" (with fields for "Home", "Work", and "Cell"), and another "Private?" checkbox. At the bottom is a "Submit Form" section with a "Submit" button.

Database Management Systems

What is a **report generator**?

- Allows user to design a report on screen, retrieve data into report design, then display or print reports
- Also called report writer

Member List by Membership Plan				
Membership Name		Advantage Business		
Last Name	First Name	Address	City	Date Joined
Brewer	Milton	54 Lucy Court	Shelbyville	6/10/2008
Membership Name Advantage Personal				
Last Name	First Name	Address	City	Date Joined
Drake	Louella	33 Timmons Place	Cincinnati	8/9/2008
Membership Name Basic Business				
Last Name	First Name	Address	City	Date Joined
Gupta	Elena	2 East Penn Drive	Pittsboro	11/6/2008
Membership Name Basic Personal				
Last Name	First Name	Address	City	Date Joined
Ruiz	Adelbert	99 Tenth Street	Carmel	10/8/2008
Tu	Benjamin	76 Ash Street	Indianapolis	9/4/2009

Database Management Systems

What is data security?

DBMS provides means to ensure only authorized users can access data

Access privileges define activities that specific user or group of users can perform

Read-only privileges - user can view data, but cannot change it

Full-update privileges - user can view and change data

Database Management Systems

What are **backup** and **log**?

- **Backup** is a copy of the entire database
- **Log** is a listing of activities that change database contents
 - DBMS places three items in log: before image, actual change, and after image

Member ID	2928	Photo
First Name	Benjamin	
Last Name	Tu	
Address	2204 Elm Court	
City	Indianapolis	
State	IN	
Postal Code	46259	
E-mail Address	tu@indi.net	
Date Joined	9/4/2009	
Membership Code	BP	

Address	76 Ash Street
---------	---------------

Member ID	2928	Photo
First Name	Benjamin	
Last Name	Tu	
Address	76 Ash Street	
City	Indianapolis	
State	IN	
Postal Code	46259	
E-mail Address	tu@indi.net	
Date Joined	9/4/2009	
Membership Code	BP	

Database Management Systems

What is a **recovery utility**?

Uses logs and/or backups to restore database when it is damaged or destroyed

Rollforward—DBMS uses log to re-enter changes made to database since last save or backup

- Also called **forward recovery**

Rollback—DBMS uses log to undo any changes made to database during a certain period of time

- Also called **backward recovery**

Relational, Object-Oriented, and Multidimensional Databases

What is a **data model**?

- Rules and standards that define how database organizes data
- Defines how users view organization of data
- Four popular data models
 - Relational
 - Object-oriented
 - Object-relational
 - Multidimensional

DATA MODELS FOR POPULAR DBMSs

Data Model	Popular DBMSs
Relational	Access Adabas Informix Ingres InterBase MySQL SQL Server Sybase Teradata
Object-oriented	FastObjects GemFire KE Texpress ObjectStore Versant
Object-relational	DB2 Oracle Polyhedra PostgreSQL Visual FoxPro Teradata
Multidimensional	D ³ Essbase Oracle Express Edition

What is a **relational database**?

- Stores data in tables that consist of **rows** and **columns**
 - Each row has primary key
 - Each column has unique name
- Stores data relationships
- Uses specialized terminology

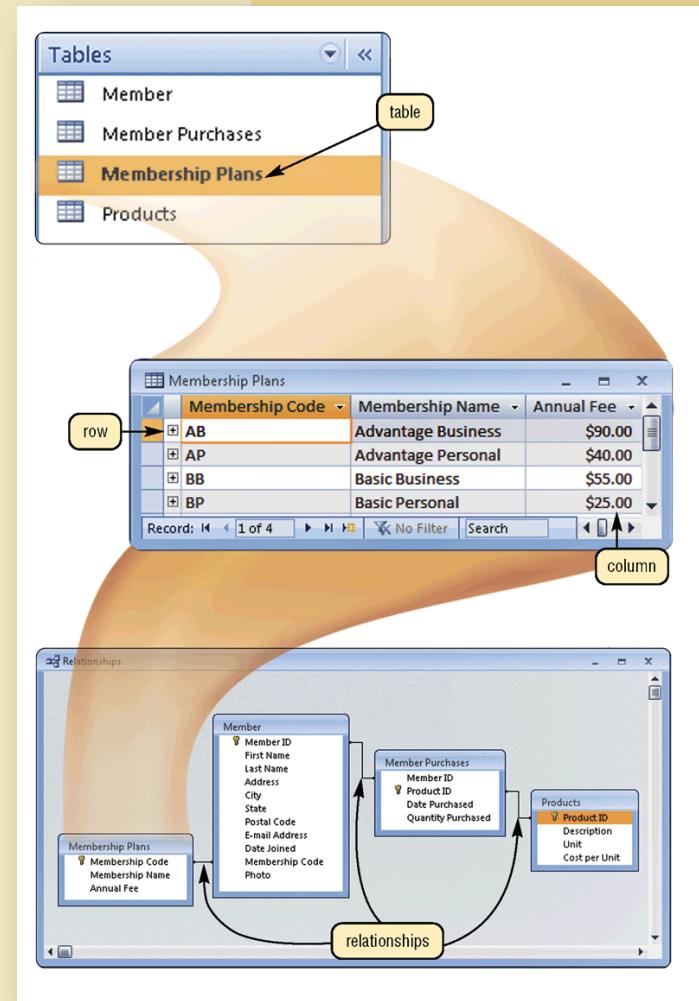
DATA TERMINOLOGY

File Processing Environment	Relational Database Developer	Relational Database User
File	Relation	Table
Record	Tuple	Row
Field	Attribute	Column

Relational, Object-Oriented, and Multidimensional Databases

What is a relationship?

- Connection within data



What is Structured Query Language (SQL)?

- Allows you to manage, update, and retrieve data
- Has special keywords and rules included in SQL statements

```
SELECT FIRST NAME, LAST NAME, ANNUAL FEE, ANNUAL FEE * .05  
      AS EARLY PAY DISCOUNT  
  FROM MEMBER, MEMBERSHIP PLANS  
 WHERE MEMBER.MEMBERSHIP CODE =  
       MEMBERSHIP PLANS.MEMBERSHIP CODE  
 ORDER BY LAST NAME
```

First Name	Last Name	Annual Fee	EarlyPayDiscount
Milton	Brewer	\$90.00	\$4.50
Louella	Drake	\$40.00	\$2.00
Elena	Gupta	\$55.00	\$2.75
Adelbert	Ruiz	\$25.00	\$1.25
Benjamin	Tu	\$25.00	\$1.25

What is an object-oriented database (OODB)?

Stores data in objects

Object is item that contains data, as well as actions that read or process data

Advantages

- Can store more types of data
- Can access data faster
- Programmers can reuse objects

Often uses object query language (OQL)

Relational, Object-Oriented, and Multidimensional Databases

What are examples of applications appropriate for an object-oriented database?

Multimedia databases

Store images, audio clips,
and/or video clips

Computer-aided design
(CAD) databases

Store data about
engineering, architectural,
and scientific designs

Web databases

Link to e-form on Web page

Groupware databases

Store documents such as
schedules, calendars, manuals,
memos, and reports

Hypertext databases

Contain text links
to other documents

What is a **data warehouse**?

Huge database system that stores and manages data required to analyze historical and current transactions

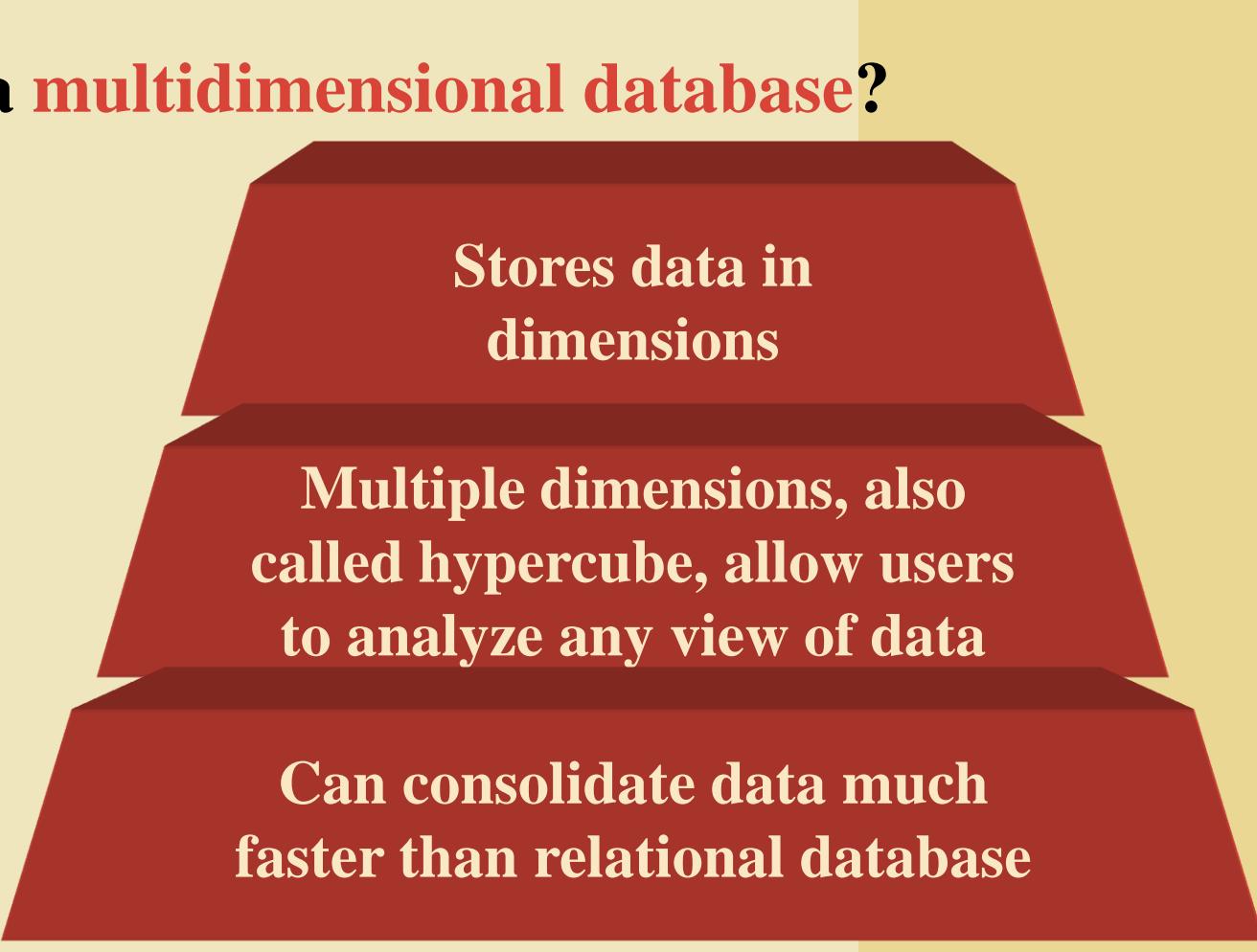
Quick and efficient way to access large amounts of data

Often uses a process called data mining to find patterns and relationships among data

Uses multidimensional databases

Data mart is smaller version of data warehouse

What is a multidimensional database?

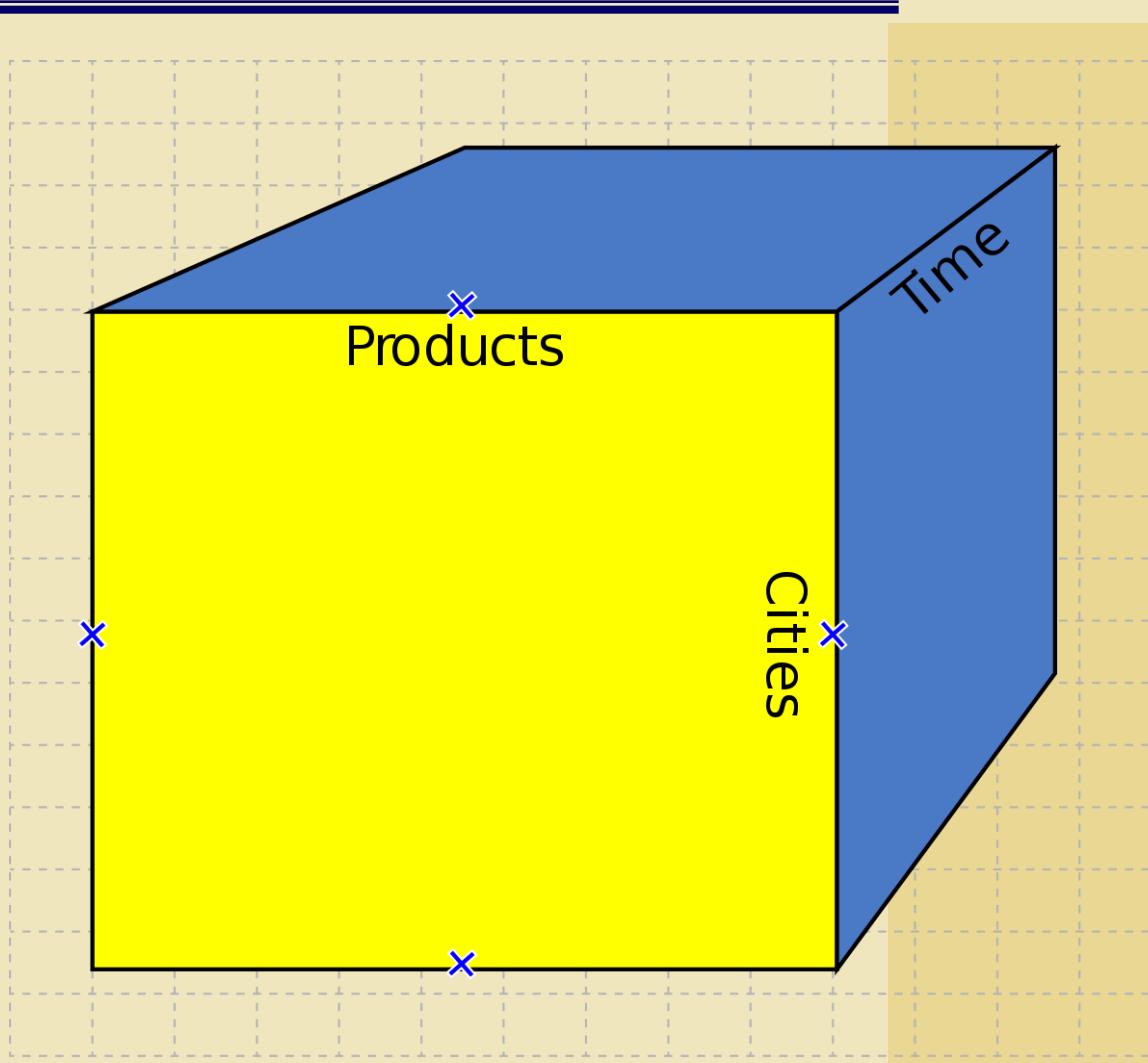


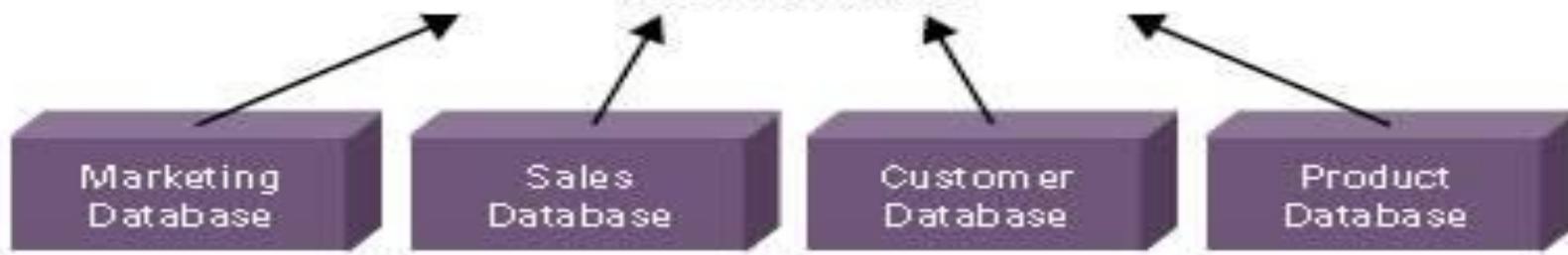
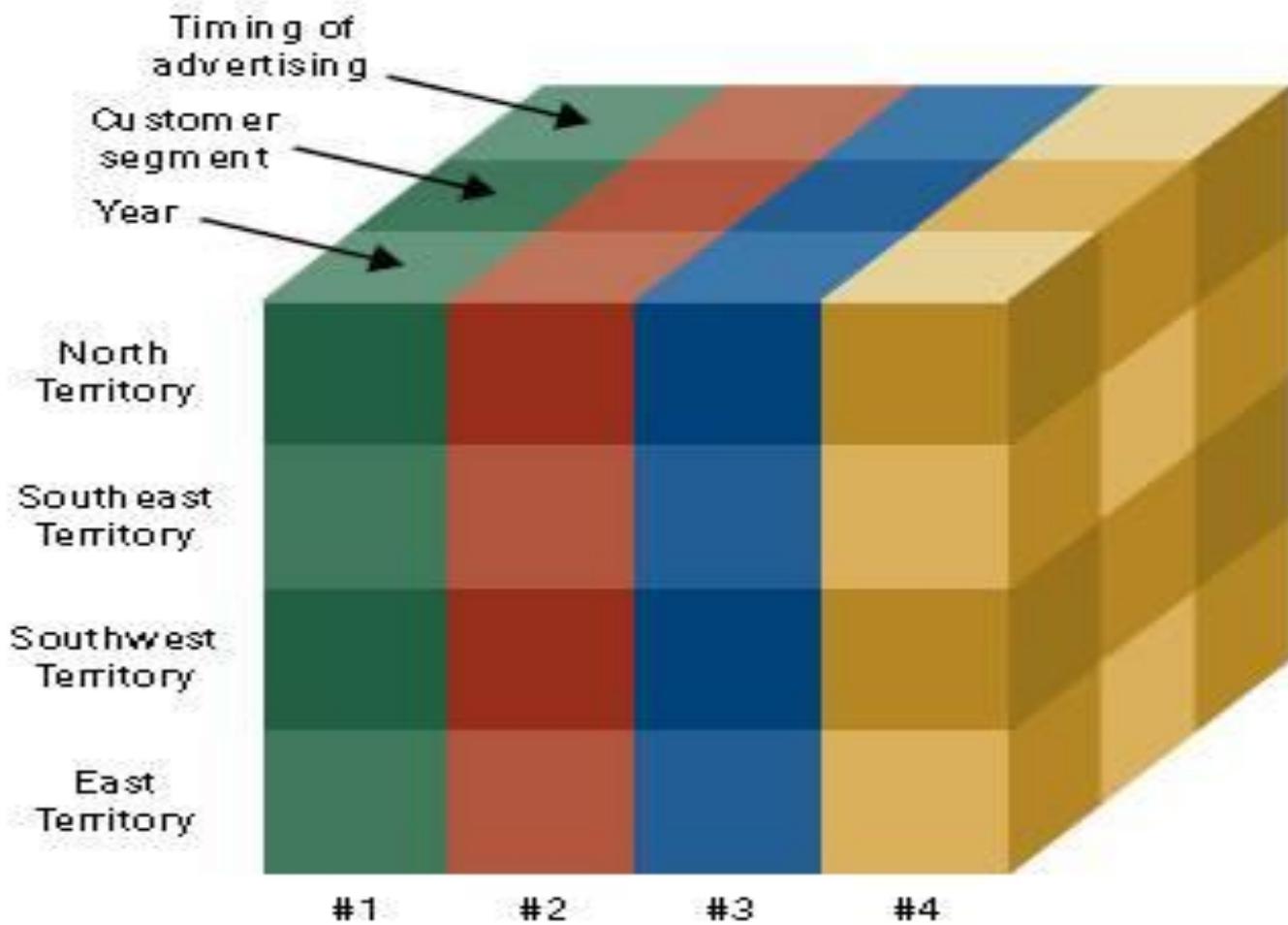
Stores data in dimensions

Multiple dimensions, also called hypercube, allow users to analyze any view of data

Can consolidate data much faster than relational database

Hypercube:

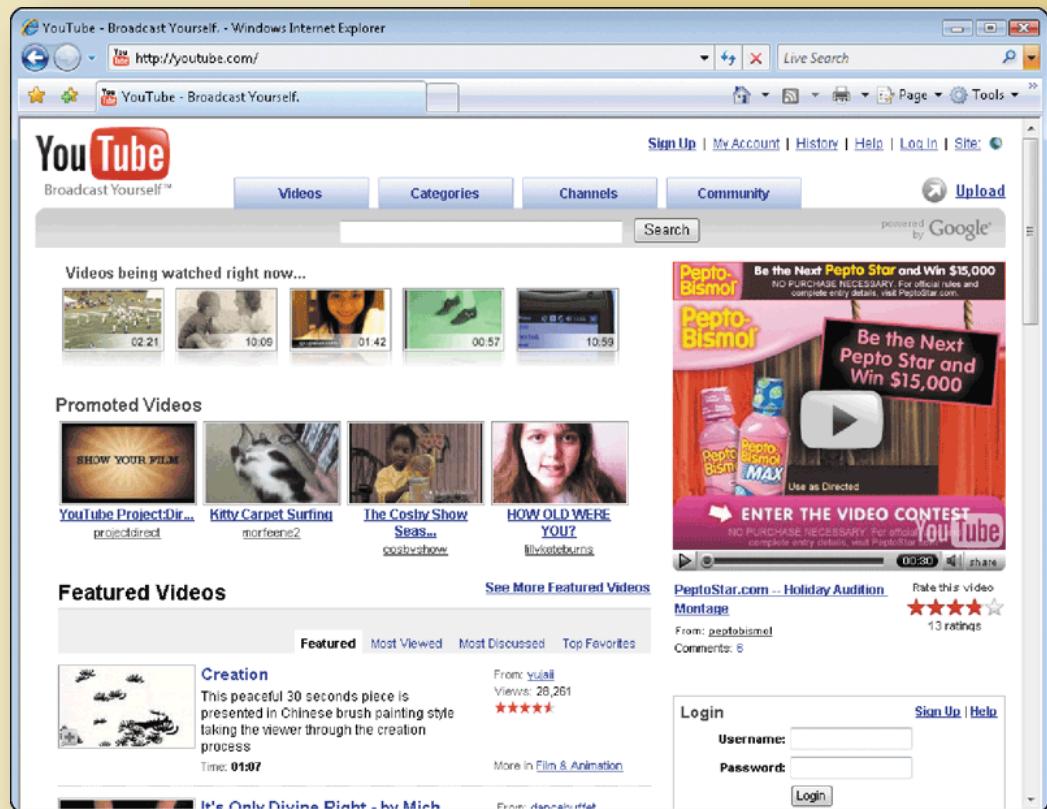




Web Databases

What is a Web database?

- Database you access through the Web by filling in a form on a Web page
- Usually resides on a database server, a computer that stores and provides access to a database



Database Administration

What are guidelines for developing a database?

1. Determine the purpose of the database

2. Design the tables

- Design tables on paper first
- Each table should contain data about one subject

4. Determine the relationships among the tables or files

3. Design the records and fields for each table

- Be sure every record has a unique primary key
- Use separate fields for logically distinct items
- Do not create fields for information that can be derived from entries in other fields
- Allow enough space for each field
- Set default values for frequently entered data

Database Administration

What is the role of the database analyst and administrator?

Database analyst (DA)

- Focuses on meaning and usage of data
- Decides proper placement of fields, defines relationships, and identifies users' access privileges

Database administrator (DBA)

- Creates and maintains data dictionary, manages database security, monitors database performance, and checks backup and recovery procedures

Summary of Database Management

How data and information are valuable assets to an organization

Methods for maintaining high-quality data

Assessing the quality of valuable information

Advantages of organizing data in a database

Various types of databases

Role of the database analysts and administrators

Chapter 10 Complete