DATABASE SYSTEMS

Course: DE4, Course Teacher: D. M. Akbar Hussain
Department of Electronic Systems

KROENKE and AUER - DATABASE CONCEPTS (4rd Edition) © 2010 2008 Pearson Prentice Hall

Book by

DAVID M. KROENKE and DAVID J. AUER

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Course Web Page

http://www.aue.auc.dk/~akbar/2011/database-2011.html

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F4-2: Database Design

Objectives:
To enable students to **apply principles for design of simple relational database systems**

Contents:
Basic concepts and principles of database systems
- o ER-models
- o Converting to relational models
- o 1st-3rd normal forms
- o SQL

Prerequisites:
Level of knowledge following the 3rd semester and OO programming from the same semester

Weight:
1 ECTS

Type:
SE

Examination:
The form of examination is determined by the study board before semester starts, or is chosen by the course-responsible in consultation with the students at latest at the second lecture of the course (in accordance with the framework provision)

Key Topics of the Course

- ❑ **Design of simple relational database systems**
- ❑ **Database processing**
- ❑ **Basic SQL for database definition and manipulation**
- ❑ **Entity-relationship model and illustration of data modelling**
- ❑ **Transformation of E-R data models to relational designs**

Chapter Objectives

- Potential problems with lists
- Understand the reasons for using a database
- Understand how related tables avoid the problems of lists
- Learn the components of a database system
- Learn the elements of a database
- Learn the purpose of the database management system (DBMS)
- Understand the functions of a database application

Purpose of a Database

- To keep track of things
- Unlike a list or spreadsheet, a database may store information that is more complicated than a simple list

Some Key Questions About Database

- The purpose of a database is to help people track things of interest to them.
- Data is stored in tables, which have rows and columns like a spreadsheet.
- Database typically have multiple tables, where each table stores data about different things.
- Each row in a table stores data about an occurrence or instance of the thing of interest.
- A database stores data and relationships
- Simple question What is a database ?
- What is data ?
- What is information ? What is Knowledge ?

Problems with Lists

	A	B
1	**Name**	**Email**
2	Andrews, Matthew	MattA@ourcampus.edu
3	Brisbon, Lisa	LisaB@ourcampus.edu
4	Fischer, Douglas	DougF@ourcampus.edu
5	Hwang, Terry	TerryH@ourcampus.edu
6	Marino, Chip	ChipM@myserver.com
7	Lai, Tzu	TzuL@ourcampus.edu
8	Thompson, James	JamesT@myserver.com

Do you see any Problem with this list ?

Problems with Lists

	A	B	C	D
1	**Name**	**Email**	**Adviser**	**AdviserEmail**
2	Andrews, Matthew	MattA@ourcampus.edu	Baker	Baker@ourcampus.edu
3	Brisbon, Lisa	LisaB@ourcampus.edu	Valdez	Valdez@ourcampus.edu
4	Fischer, Douglas	DougF@ourcampus.edu	Baker	Baker@ourcampus.edu
5	Hwang, Terry	TerryH@ourcampus.edu	Taing	Taing@ourcampus.edu
6	Marino, Chip	ChipM@myserver.com	Tran	Tran@ourcampus.edu
7	Lai, Tzu	TzuL@ourcampus.edu	Valdez	Valdez@ourcampus.edu
8	Thompson, James	JamesT@myserver.com	Taing	Taing@ourcampus.edu

Do you see any Problem with this list ?

Problems with Lists

	A	B	C	D
1	**Name**	**Email**	**Adviser**	**AdviserEmail**
2	Andrews, Matthew	MattA@ourcampus.edu	Baker	Baker@ourcampus.edu
3	Brisbon, Lisa	LisaB@ourcampus.edu	Valdez	Valdez@ourcampus.edu
4	Fischer, Douglas	DougF@ourcampus.edu	Baker	Baker@ourcampus.edu
5	Hwang, Terry	TerryH@ourcampus.edu	Taing	Taing@ourcampus.edu
6	Marino, Chip	ChipM@myserver.com	Tran	Tran@ourcampus.edu
7	Lai, Tzu	TzuL@ourcampus.edu	Valdez	Valdez@ourcampus.edu
8	Thompson, James	JamesT@myserver.com	Taing	Taing2@ourcampus.edu
9	??	??	Greene	Greene@ourcampus.edu

Deleted row—Too much lost

Changed row—Inconsistent data

Inserted row—Data missing

Do you see any problem if you remove student Marino from the list ?

Problems with Lists

	A	B	C	D
1	**Name**	**Email**	**Phone**	**Dorm**
2	Andrews, Matthew	MattA@ourcampus.edu	301.555.1234	McKinley
3	Brisbon, Lisa	LisaB@ourcampus.edu	301.555.3335	Dorsett
4	Fischer, Douglas	DougF@ourcampus.edu	301.555.1688	McKinley
5	Hwang, Terry	TerryH@ourcampus.edu	301.555.1837	McKinley
6	Ingrum, Garret	GarretI@somewhere.com	301.555.3880	Dorsett
7	Marino, Chip	ChipM@myspovar.com	301.555.9665	Johnson
8	Lai, Tzu	TzuL@ourcampus.edu	301.555.4139	McKinley
9	Thompson, James	JamesT@myserver.com	301.555.3240	Johnson

Inserted row

Deleted row

Changed row

Do you see any problem if you remove student Marino from the list ?

Theme ?

List Modification Issues

If Adviser **Baker** is changed to **Taing**, need to change *AdviserEmail* as well—if changed to **Valdez**, need to change *AdviserEmail*, *Department* and *Admin*

	A	B	C	D	E	F	G
1	**LastName**	**FirstName**	**Email**	**AdviserName**	**AdviserEmail**	**Department**	**AdminName**
2	Andrews	Matthew	Andrews@ourcampus.edu	Baker	Baker@ourcampus.edu	Accounting	Smith
3	Brisbon	Lisa	Brisbon@ourcampus.edu	Valdez	Valdez@ourcampus.edu	Chemistry	Chaplin
4	Fischer	Douglas	Fischer@ourcampus.edu	Baker	Baker@ourcampus.edu	Accounting	Smith
5	Hwang	Terry	Hwang@ourcampus.edu	Taing	Taing@ourcampus.edu	Accounting	Smith
6	Lai	Tzu	Lai@ourcampus.edu	Valdez	Valdez@ourcampus.edu	Chemistry	Chaplin
7	~~Marino~~	~~Chip~~	~~Marino@ourcampus.edu~~	~~Taing~~	~~Taing@ourcampus.edu~~	~~Info Systems~~	~~Rogers~~
8	Thompson	James	Thompson@ourcampus.edu	Taing	Taing@ourcampus.edu	Accounting	Smith
9	???	???	???	???	???	Biology	Kelly

Deleted row—Student, Adviser and Department data lost

Inserted row—both Student and Adviser data missing

Problems with Lists: Redundancy

- In a list, each row is intended to stand on its own. As a result, the same information may be entered several times
  - For Example:
    A list of Projects may include the Project Manager's Name, ID, and Phone Extension.
  - If a particular person is managing 10 projects, his/her information would have to be entered 10 times

Problems with Lists: Multiple Themes

- In a list, each row may contain information on more than one theme. As a result, needed information may appear in the lists only if information on other themes is also present
  - **For Example:**
    A list of Projects may include Project Manager information (Name, ID, and Phone Extension) and Project information (Name, ID, StartDate, Budget) in the same row.

List Modification Issues

- Redundancy and multiple themes create modification problems
  - Deletion problems
  - Update problems
  - Insertion problems

Addressing the Information Complexities

- Relational databases are designed to address many of the information complexity issues

Relational Databases

- A **relational database** stores information in tables. Each informational topic is stored in its own table.
- In essence, a relational database will break-up a list into several parts. **One part for each theme in the list.**
- A Project List would be divided into a CUSTOMER Table, a PROJECT Table, and a PROJECT_MANAGER Table.

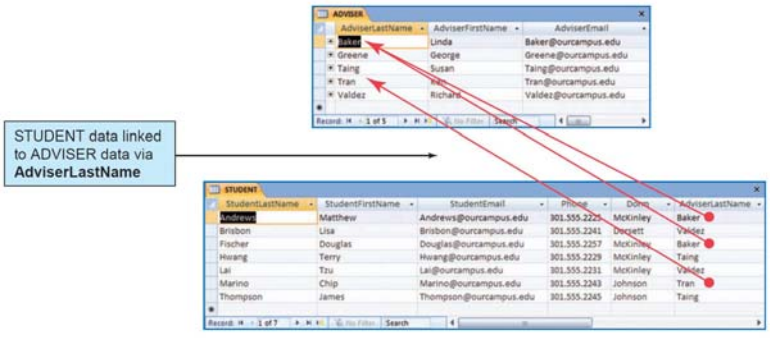
Putting the Pieces Back Together

- In our relational database we broke apart our list into several tables. Somehow the tables must be *joined* back together.
- In a relational database, tables are joined together using the value of the data.
- If a PROJECT has a CUSTOMER, the Customer_ID is stored as a column in the PROJECT table. The value stored in this column can be used to retrieve specific customer information from the CUSTOMER table.

Sounds like More Work, Not Less

- A relational database is more complicated than a list
- However, a relational database minimizes data redundancy, preserves complex relationships among topics, and allows for partial data
- Furthermore, a relational database provides a solid foundation for user forms and reports

Relational Database Example



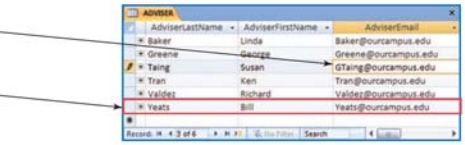
Student & Adviser Relational Design

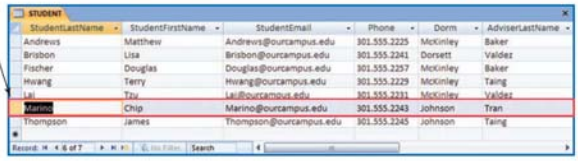
A Relational Database Solves the Problems of Lists

Changed data—data remains consistent

Inserted data—no STUDENT data required

Deleted data—no ADVISOR data lost





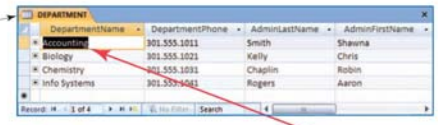
Do you see any Problem ?

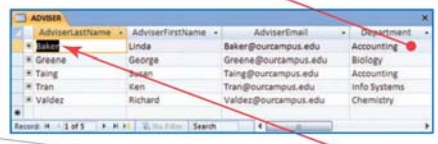
The Department, Advisor and Student Tables

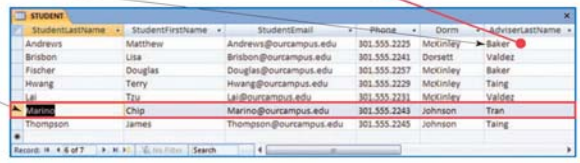
Can insert DEPARTMENT data as needed—no ADVISER or STUDENT data required

Can change STUDENT Adviser name as needed—new value is linked to its own data

Can delete STUDENT data as needed—no DEPARTMENT or ADVISER data lost







Student, Department & Adviser Relational Design

Processing Relational Tables

- So we have used the tables to create a relational database, but now the question is we would like to view the data in the form of original list.
- The answer is SQL (Structured Query Language) which defines data definition and manipulation.

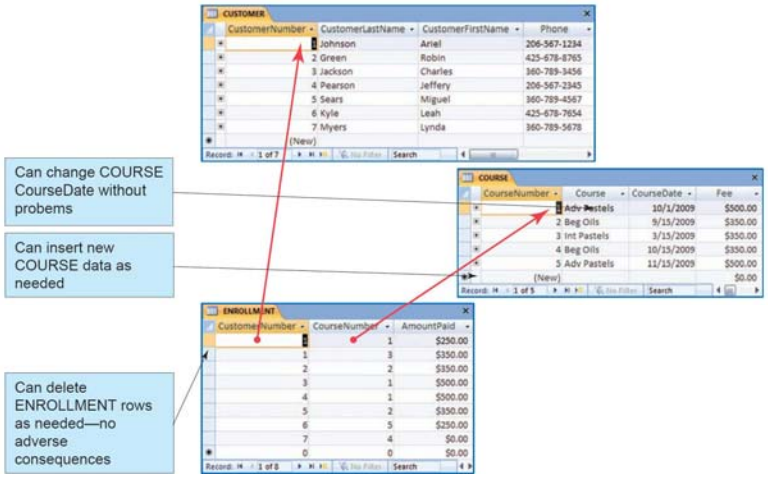
Structured Query Language (SQL)

- **Structured Query Language (SQL)** is an international standard for creating, processing and querying databases and their tables.
- Many database applications use SQL to **retrieve, format, report, insert, delete, and/or modify** data for users.
- One needs to know the core SQL statements.

SQL Example (Continued)

```
SELECT CUSTOMER.CustomerLastName,
       CUSTOMER.CustomerFirstName,
       CUSTOMER.Phone,
       COURSE.CourseDate, ENROLLMENT.AmountPaid,
       COURSE.Course, COURSE.Fee
FROM   CUSTOMER, ENROLLMENT, COURSE
WHERE  CUSTOMER.CustomerNumber
              = ENROLLMENT.CustomerNumber
       AND
       COURSE.CourseNumber
              = ENROLLMENT.CourseNumber;
```


SQL Example



SQL Example Results

Art Course List

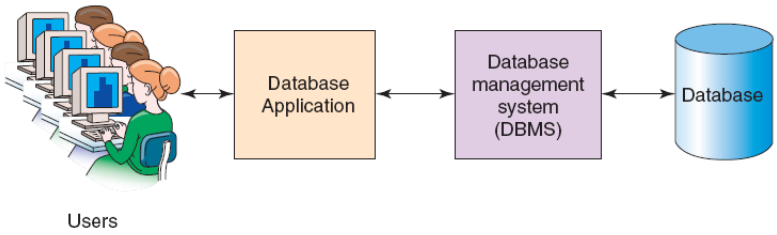
CustomerLastName	CustomerFirstName	Phone	CourseDate	AmountPaid	Course	Fee
Johnson	Ariel	206-567-1234	10/1/2009	$250.00	Adv Pastels	$500.00
Johnson	Ariel	206-567-1234	3/15/2009	$350.00	Int Pastels	$350.00
Green	Robin	425-678-8765	9/15/2009	$350.00	Beg Oils	$350.00
Jackson	Charles	360-789-3456	10/1/2009	$500.00	Adv Pastels	$500.00
Pearson	Jeffery	206-567-2345	10/1/2009	$500.00	Adv Pastels	$500.00
Sears	Miguel	360-789-4567	9/15/2009	$350.00	Beg Oils	$350.00
Kyle	Leah	425-678-7654	11/15/2009	$250.00	Adv Pastels	$500.00
Myers	Lynda	360-789-5678	10/15/2009	$0.00	Beg Oils	$350.00

Record: 1 of 8 Search

Database Systems

- The four components of a database system are:
  1. Users
  2. Database Application
  3. Database Management System (DBMS)
  4. Database

Components of a Database System



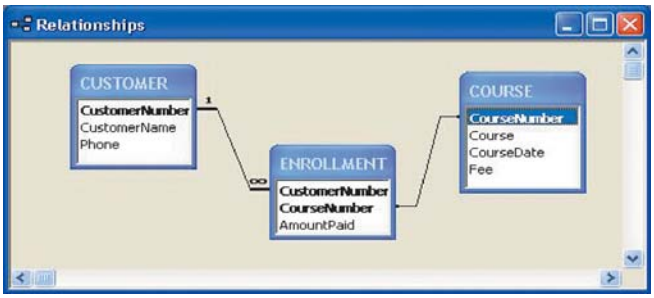
Users

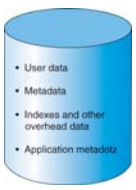
- A **user** of a database system will
  - Use a database application to track things
  - Use forms to enter, read, delete and query data
  - Produce reports

The Database

- A database is a *self-describing* collection of *related* records.
- Self-describing
  - The database itself contains the definition of its structure, the contents of the database can always be determined by looking inside the database itself.
  - Metadata is data describing the structure of the database data
- Tables within a relational database are related to each other.

Relationship & Contents of Database





Database Management System (DBMS)

- A **database management system (DBMS)** serves as an **intermediary** between database applications and the database
- The DBMS **manages and controls** database activities
- The DBMS **creates, processes and administers** the databases it controls

Functions of a DBMS

1. Create databases
2. Create tables
3. Create supporting structures
4. Read database data
5. Modify database data (insert, update, delete)
6. Maintain database structures
7. Enforce rules
8. Control concurrency
9. Provide security
10. Perform backup and recovery

Referential Integrity Constraints

- The DBMS will enforce many constraints
- **Referential integrity constraints** ensure that the values of a column in one table are valid based on the values in another table
  - **If a 5 was entered as a CustomerID in the PROJECT table, a Customer having a CustomerID value of 5 must exist in the CUSTOMER table**

Database Applications

- A **database application** is a set of one or more computer programs that serves as an intermediary between the user and the DBMS

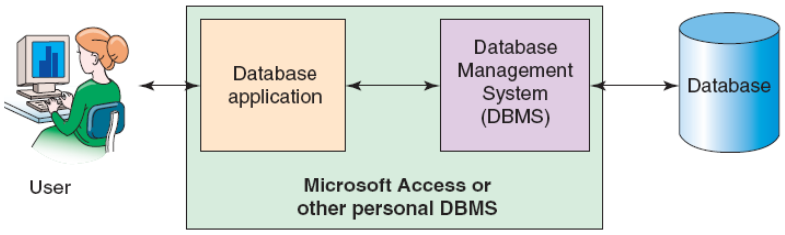
Functions of Database Applications

1. Create and process forms
2. Process user queries
3. Create and process reports
4. Execute application logic
5. Control database applications

Personal Database Systems

- Personal database systems typically consist:
  - One application
  - Only a few tables
  - Simple in design
  - Involve only one computer
  - Support one user at a time

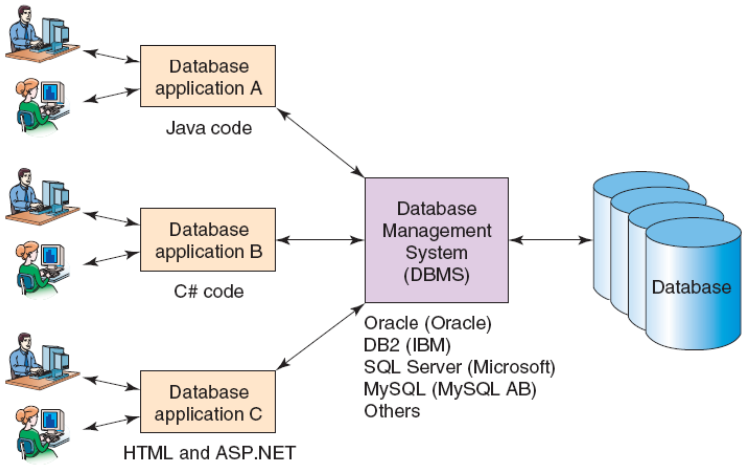
Personal Database Systems



Enterprise-class Database Systems

- Enterprise-Class database systems typically:
  - Support several users simultaneously
  - Include more than one application
  - Involve multiple computers
  - Are complex in design
  - Have many tables
  - Have many databases

Organizational Database Systems



Commercial DBMS Products

- Example Desktop DBMS Products
  - Microsoft Access
- Example Organizational DBMS Products
  - Microsoft's SQL Server
  - Oracle's Oracle
  - Sun Microsystem's MySQL
  - IBM's DB2