# Client/Server Databases and the Oracle 10*g* Relational Database

**Wednesday 1/14/2015**

 MIS 4200 - Spring 2015

## Objectives

- Understand the purpose of database systems
- Describe the differences between personal and client/server databases
- Understand entity-relationship (ER) model
- Explain the steps in DB tables' normalization
- Understand:
  - the Northwoods University student registration database and
  - the Clearwater Traders sales order database



## File-based data processing

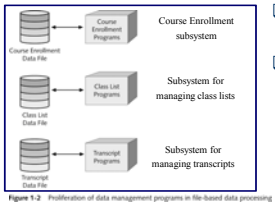


Figure 1-2 Proliferation of data management programs in file-based data processing
Student Registration System (using file-based data processing)

- Each subsystem has its own data file(s)
- Programmers have to write and maintain separate programs for:
  - Inserting data
  - Updating data
  - Deleting data
  - Retrieving data

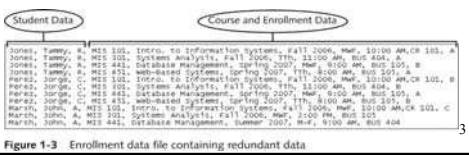


Figure 1-3 Enrollment data file containing redundant data

## File-based data processing (cont.)

- Problems with storing data in files:
  - Redundancy
    - Example: same student data or course data in different files
  - Inconsistency
    - May have different info about students or courses in different files if not updated everywhere
  - Proliferation of data management programs (retrieving, updating, inserting, deleting data)
  - Waste of disk space due to redundancy and proliferation of data management programs.

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## Database systems

- Created in the 1980s to solve problems associated with file-based data processing
- Store all organizational data in central location (a database)
- A single application called Database Management System (DBMS) performs all data-handling operations (retrieving, updating, inserting, deleting data values)
- All programs interface with the DBMS to access the database data.
- Complex database systems require a database administrator (DBA)

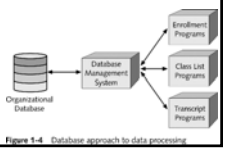


Figure 1-4 Database approach to data processing

## Overview of Relational Databases

- Most databases are relational
- Store data in tables
- A table is a matrix with columns and rows
- **Columns** represent different data **fields** (i.e. the characteristics or **attributes** about entity)
- **Rows** contain individual **records**
  - A record is all attributes about a specific instance of an entity

6th column/field

**FACULTY table**

| F_ID | F_LAST | F_FIRST | F_MI | F_PHONE | F_RANK |
|---|---|---|---|---|---|
| 1 | Marx | Teresa | J | 4075921695 | Associate |
| 2 | Zhulin | Mark | M | 4073975682 | Full |
| 3 | Langley | Colin | A | 4075928719 | Assistant |
| 4 | Brown | Jonnel | D | 4078101155 | Full |

1st Row/record
2nd Row/record
3rd Row/record
4th Row/record

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## Relational Databases' terminology

- Entity
  - Object about which you want to store data (e.g. students, faculty, courses, staff, supplies, etc.)
  - Different tables store data about each different entity
- Relationships
  - Used to connect information about different entities
  - Links that show how different records are related


- Key fields
  - Fields with unique values used to identify individual rows or to link data from different tables.

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## Key fields

- Main types of key fields
  - Primary
  - Candidate
  - Surrogate
  - Foreign
  - Composite

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## Primary Key

- Column in relational database table whose value must be unique for each row
- Serves to identify individual occurrence of entity
- Every row must have a primary key
- Cannot be NULL
- NULL means
  - Value is absent or unknown

## Candidate Key

- Any column that could be used as the primary key
- Should be a column that is unique for each record and does not change

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## Surrogate Keys

- Some table may not have a candidate key
- Surrogate keys are created to be the primary key identifier
- Have no real relationship to row to which it is assigned other than to identify it uniquely
- Surrogate key values automatically generated using a sequence

FACULTY

| F_LAST | F_FIRST | F_MI | F_PHONE | F_RANK |
|---|---|---|---|---|
| Marx | Teresa | J | 4075921695 | Associate |
| Zhulin | Mark | M | 4073875682 | Full |
| Langley | Colin | A | 4075928719 | Assistant |
| Brown | Jonnel | D | 4078101155 | Full |

Figure 1-6 Table lacking suitable candidate keys

FACULTY

| F_ID | F_LAST | F_FIRST | F_MI | F_PHONE | F_RANK |
|---|---|---|---|---|---|
| 1 | Marx | Teresa | J | 4075921695 | Associate |
| 2 | Zhulin | Mark | M | 4073975682 | Full |
| 3 | Langley | Colin | A | 4075928719 | Assistant |
| 4 | Brown | Jonnel | D | 4078101155 | Full |

FACULTY table with surrogate key

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## Foreign Key

- Column in table that is a primary key in another table
- Used to create relationship between two tables
- Value must exist in table where it is the primary key

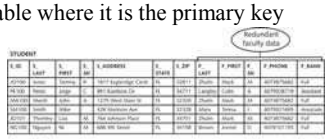


Figure 1-7 Creating relationships by repeating data


Figure 1-8 Creating relationships using foreign keys

- By using foreign keys to create relationships, you repeat only the foreign key values

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## Composite Key

- Alternate to adding a surrogate column for primary key
- Unique key that is created by combining two or more columns
- Usually comprises fields that are primary keys in other tables

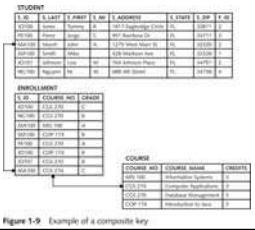


Figure 1-9 Example of a composite key

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## Database Design

- Main tasks involved with design of database:
  - Developing entity-relationship (ER) model
  - Normalizing database tables

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## Entity-Relationship (ER) Model

- Designed to help you …
  - identify which entities need to be included in database
  - Determine he relationships between identified entities
- ER model is composed of
  - Squares representing entities
  - Lines representing relationships
- Types of relationships:
  - One to one (1:1)
  - One to many (1:M)
  - Many to many (N:M)


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## Entity-Relationship Model (continued)

- One to one (1:1)
  - Each occurrence of a specific entity is found only once in each set of data
  - Rare in relational databases


- One to many (1:M)
  - Instance can only appear once in one entity, but one or more times in the other entity


Figure 1-11 Example of a one-to-many relationship

* Crow's foot is used to represent the "many" side of the relationship

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## Entity-Relationship Model (continued)

- Many to many (N:M)
  - Instance can occur multiple times in each entity
  - Cannot be represented in physical database
  - Broken down into series of two or more 1:M relationships through use of linking table in process of normalization


**Figure 1-12** Example of a many-to-many relationship

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## Normalization

- Step-by-step process used to determine which data elements should be stored in which tables
- Purpose
  - Eliminate data redundancy
- Normalization process include:
  - Beginning with unnormalized data/table
  - Applying techniques to convert unnormalized data into 1st Normal Form (1NF) 2NF, 3NF
- Having all tables in 3NF is the objective

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## Normalization (continued)

- Unnormalized data
  - Does not have a primary key identified, and/or
  - Contains repeating groups
- Repeating group = multiple entries for some fields in a record. Example: COURSE_NO, COURSE_NAME, CREDITS, GRADE.

STUDENT

| S_ID | S_LAST | S_ADDRESS | S_STATE | S_ZIP | COURSE_NO | COURSE_NAME | CREDITS | GRADE | F_ID | F_LAST |
|---|---|---|---|---|---|---|---|---|---|---|
| JO100 | Jones | 1817 Eaglerdge Circle | FL | 32811 | CGS 270<br>COP174 | Database Management<br>Introduction to Java | 3<br>3 | C<br>B | 1 | Marx |
| PE100 | Perez | 951 Rainbow Dr | FL | 34711 | CGS 270 | Database Management | 3 | A | 3 | Langley |
| MA100 | Marsh | 1275 West Main St | FL | 32320 | MIS 100<br>CGS 210 | InformationSystems<br>Computer Applications | 3<br>3 | A<br>C | 4 | Brown |
| SM100 | Smith | 428 Markson Ave | FL | 32328 | COP 174 | Introduction to Java | 3 | B | 2 | Zhulin |
| JO101 | Johnson | 764 Johnson Place | FL | 34751 | CGS 210 | Computer Applications | 3 | B | 4 | Brown |
| NG100 | Nguyen | 688 4th Street | FL | 34158 | CGS 270 | Database Management | 3 | B | 3 | Langley |

**Figure 1-13** Example of unnormalized data

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## First Normal Form

- To convert an unnormalized table into 1NF:
  - Repeating groups must be removed
  - Primary key field must be identified
- Easiest way to remove repeating groups is
  - To create a separate record for each value in the repeating group

STUDENT

| S_ID | S_LAST | S_ADDRESS | S_STATE | S_ZIP | COURSE_NO | COURSE_NAME | CREDITS | GRADE | P_ID | P_LAST |
|---|---|---|---|---|---|---|---|---|---|---|
| IO100 | Jones | 1817 Eaglebridge Circle | FL | 32811 | CGS 270 | Database Management | 3 | C | 1 | Mara |
| JO100 | Jones | 1817 Eaglebridge Circle | FL | 32811 | COP174 | Introduction to Java | 3 | B | 1 | Mara |
| PE100 | Perez | 951 Rainbow Dr | FL | 34711 | CGS 270 | Database Management | 3 | A | 3 | Langley |
| MA100 | Marsh | 1275 West Main St | FL | 32320 | MIS 100 | InformationSystems | 3 | A | 4 | Brown |
| MA100 | Marsh | 1275 West Main St | FL | 32320 | CGS 210 | Computer Applications | 3 | C | 4 | Brown |
| SM100 | Smith | 428 Marlissom Ave | FL | 32328 | COP 174 | Introduction to Java | 3 | B | 2 | Zhulin |
| JO101 | Johnson | 764 Johnson Place | FL | 34751 | CGS 210 | Computer Applications | 3 | B | 4 | Brown |
| NG100 | Nguyen | 688 4th Street | FL | 34158 | CG 2370 | Database Management | 3 | B | 3 | Langley |

**Figure 1-14** Example of unnormalized data with repeating groups removed

Q: What kind of problem does the table in Figure 1-14 have?



## First Normal Form (cont.)

- After repeating groups are removed, …
  - A primary key field must be identified
- Is there any candidate key for the STUDENT table below?
- What field(s) could be used as a primary key in the STUDENT table below?

Answer: _____

STUDENT

| S_ID | S_LAST | S_ADDRESS | S_STATE | S_ZIP | COURSE_NO | COURSE_NAME | CREDITS | GRADE | P_ID | P_LAST |
|---|---|---|---|---|---|---|---|---|---|---|
| IO100 | Jones | 1817 Eaglebridge Circle | FL | 32811 | CGS 270 | Database Management | 3 | C | 1 | Mara |
| JO100 | Jones | 1817 Eaglebridge Circle | FL | 32811 | COP174 | Introduction to Java | 3 | B | 1 | Mara |
| PE100 | Perez | 951 Rainbow Dr | FL | 34711 | CGS 270 | Database Management | 3 | A | 3 | Langley |
| MA100 | Marsh | 1275 West Main St | FL | 32320 | MIS 100 | InformationSystems | 3 | A | 4 | Brown |
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| SM100 | Smith | 428 Marlissom Ave | FL | 32328 | COP 174 | Introduction to Java | 3 | B | 2 | Zhulin |
| JO101 | Johnson | 764 Johnson Place | FL | 34751 | CGS 210 | Computer Applications | 3 | B | 4 | Brown |
| NG100 | Nguyen | 688 4th Street | FL | 34158 | CG 2370 | Database Management | 3 | B | 3 | Langley |

**Figure 1-14** Example of unnormalized data with repeating groups removed

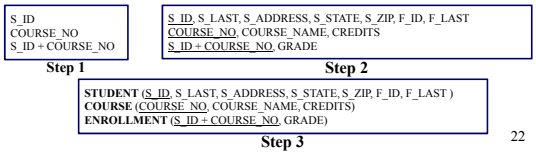


## Second Normal Form (2NF)

- A table is in 2NF if …
  - It is in 1NF
  - It has no partial dependencies
- Partial dependency
  - Means that (some) fields within the table are dependent only on part of the primary key
  - Exists only if the table has a composite key
- Procedure for identifying partial dependencies
  - Look at each field that is not part of the composite key
  - Determine if the field is dependent only on part of the composite key
  - Example: is COURSE_NAME dependent on both S_ID and COURSE_NO? Answer: _____

## Second Normal Form (continued)

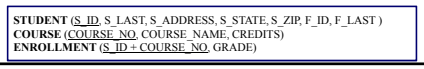
- To remove partial dependency from a table
  - List each part of the composite key, as well as the entire composite key as separate entries as shown in Step1 below.
  - Examine the remaining fields to figure out which ones are determined by each portion of the composite key (Step 2)
  - Give each table a name that reflects its content (Step 3)





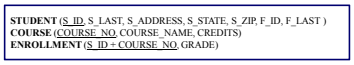

## Third Normal Form (3NF)

- A table is in Third normal form (3NF) if …
  - In 2NF
  - No transitive dependencies
- Transitive dependency
  - Means a field is dependent on another field within the table that is not the primary key field
- Does the ENROLLMENT table have a transitive dependency? Answer: ___
- Does the COURSE table have a transitive dependency? Answer: ___

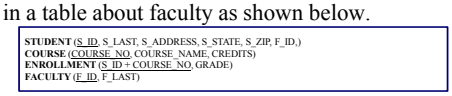





## Third Normal Form (cont.)




- Consider the tables above. Does the STUDENT table have a transitive dependency? Answer: ___
- What field of the STUDENT table is dependent on a field other than S_ID? Answer: _____. What field is it dependent on? Answer: _____.
- To resolve the transitive dependency issue, F_LAST must be removed from the STUDENT table and placed in a table about faculty as shown below.



## Third Normal Form (cont.)

- Final ER model

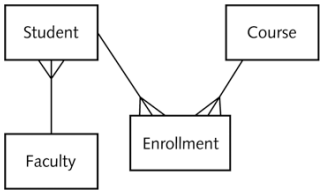



**Figure 1-20** Revised entity-relationship model

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## Database Systems

- Consists of
  - DBMS
    - Manages physical storage and data retrieval
  - Database applications
    - Provide interface that allows users to interact with database
- Server
  - Computer that shares resources with other computers

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## Database Systems (continued)

- Server process
  - Program that listens for requests for resources from clients
  - Responds to requests
- Client
  - Program that requests and uses server resources

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## Personal Database Management Systems

- DBMS and database applications run on same workstation
- Appear to user as a single integrated application
- Used primarily for creating single-user database applications
- Can also be used for some multiuser applications
- Should be used only for applications that are not mission critical

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## Personal Database Management Systems (continued)

- Microsoft Access
  - Stores all data for database in a single file with an .mdb extension
  - Database administrator stores .mdb file on a central file server

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## Using a Personal Database for a Multiuser Application

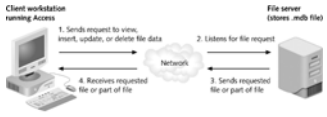


Figure 1-21 Using a personal database for a multiuser application

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## Personal Database Management Systems (continued)

- Transaction processing
  - Grouping related database changes into units of work that must either all succeed or all fail
  - DBMS can use the transaction log to reverse—or roll back—the changes

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## Client/Server Database Management Systems

- DBMS server process runs on one workstation
- Database applications run on separate client workstations across network
- Server sends only requested data back to client rather than entire database

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## Client/Server Database Architecture


Figure 1-22 Client/server database architecture

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## Client/Server Database Management Systems (continued)

- Generate less network traffic than personal databases
- Extra features to minimize chance of failure
- Powerful recovery mechanisms that often operate automatically
- Maintain file-based transaction log on database server

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## Client/Server Database Management Systems (continued)

- Preferred for
  - Database applications that retrieve and manipulate small amounts of data from databases containing large numbers of records
  - Mission-critical applications
  - Web-based database applications that require increased security and fault tolerance

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## The Oracle 10*g* Client/Server Database

- Oracle 10*g*
  - Latest release of Oracle Corporation's relational database
  - Client/server database
- Server side
  - DBMS server process
- Oracle Net
  - Utility that enables network communication between client and server

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## Client/Server Architecture for Oracle 10*g* DBMS

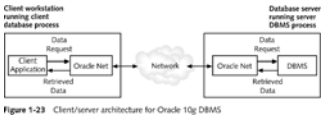


Figure 1-23 Client/server architecture for Oracle 10g DBMS

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## The Oracle 10*g* Client/Server Database (continued)

- Oracle Application Server
  - Used to create World Wide Web pages that allow users to access Oracle databases
- Oracle client products:
  - SQL*Plus
  - Oracle 10g Developer Suite
  - Enterprise Manager

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## The Database Cases

- Fictional organizations:
  - Clearwater Traders
  - Northwoods University

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## The Clearwater Traders Sales Order Database

- Clothing and sporting goods through mail-order catalogs
- Wants to begin accepting orders using Web site
- Required data consists of information for:
  - Customers
  - Orders
  - Items
  - Shipments

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## The Clearwater Traders Sales Order Database (continued)

- Tables:
  - CUSTOMER
  - ORDER_SOURCE
  - ORDERS
  - CATEGORY
  - ITEM

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## The Clearwater Traders Sales Order Database (continued)

- Tables (continued): :
  - ORDER_LINE
  - SHIPMENT
  - INVENTORY
  - SHIPMENT_LINE
  - COLOR

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## Visual Representation of the Clearwater Traders Database

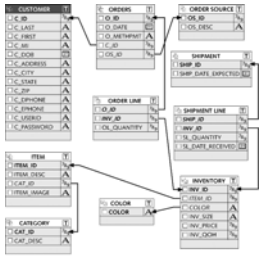

Figure 1-25 Visual representation of the Clearwater Traders database

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## The Northwoods University Student Registration Database

- Student registration system
- Data items consist of information about:
  - Students
  - Courses
  - Instructors
  - Student Enrollment

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## The Northwoods University Student Registration Database (continued)

- Tables:
  - LOCATION
  - FACULTY
  - STUDENT
  - TERM
  - COURSE
  - COURSE_SECTION
  - ENROLLMENT

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## Visual Representation of the Northwoods University Database

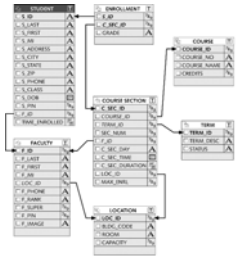

Figure 1-27 Visual representation of the Northwoods University database

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