CMSC 127

Introduction: Databases and Database Users

Reginald Neil C. Recario
Institute of Computer Science
University of the Philippines Los Baños

Overview

- Database, example, its properties
- Database System and Database Management System
- Characteristics and Advantages of a Database System
- Database Users

But wait! A quiz…

- In a sheet of paper provided, write your FULL NAME (LN, FN MI), STUD NO and signature
- QUESTION:
  - In your opinion, what is a DATABASE?

Basic Definitions

- ***Database***:
  - A collection of related data.
- ***Data***:
  - Known facts that can be recorded and have an implicit meaning.

Example of a Database

- Sample Database:
  - UNIVERSITY environment
- Some database objects:
  - STUDENTs
  - COURSEs
  - SECTIONs (of COURSEs)
  - (academic) DEPARTMENTs
  - INSTRUCTORs

Example of a Simple Database

COURSE

Course_name	Course_number	Credit_hours	Department
Intro to Computer Science	CS1310	4	CS
Data Structures	CS3320	4	CS
Discrete Mathematics	MATH2410	3	MATH
Database	CS3380	3	CS

SECTION

Section_identifier	Course_number	Semester	Year	Instructor
85	MATH2410	Fall	04	King
92	CS1310	Fall	04	Anderson
102	CS3320	Spring	05	Knuth
112	MATH2410	Fall	05	Chang
119	CS1310	Fall	05	Anderson
135	CS3380	Fall	05	Stone

GRADE_REPORT

Student_number	Section_identifier	Grade
17	112	B
17	119	C
8	85	A
8	92	A
8	102	B
8	135	A

PREREQUISITE

Course_number	Prerequisite_number
CS3380	CS3320
CS3380	MATH2410
CS3320	CS1310

Example of a Database

- Sample Database:
  - AIRPORT environment
- Some database objects are?

Example of a Database

- Some involved relationships:
  - SECTIONs are of specific COURSEs
  - STUDENTs take SECTIONs
  - COURSEs have prerequisite COURSEs
  - INSTRUCTORs teach SECTIONs
  - COURSEs are offered by DEPARTMENTs
  - STUDENTs major in DEPARTMENTs

Example of a Database

- How about the relationships in an AIRPORT environment?

Implicit Properties

- A ***database***:
  - represents some aspect of the real world, sometimes called the ***miniworld***.
  - is a logically coherent collection of data with some inherent meaning.
  - is designed, built, and populated with data for a specific purpose.

Database Applications

- **Banking**: customer information, accounts, loans, banking transactions
- **Airlines**: reservations, schedules
- **Universities**: student, registration, grades, faculty

Database Applications

- **Telecommunications:** records of calls, monthly bills, balances on prepaid loads
- **Sales:** customers, products, purchases
- **Human resources:** employee records, salaries, tax, benefits, deductions, paychecks

New Database Applications

- Scientific Applications
- XML (eXtensible Markup Language)
- Image Storage and Management
- Audio and Video Data Management

New Database Applications

- Data Warehousing and Data Mining
- Spatial Data Management
- Time Series and Historical Data Management

Basic Definitions

- ***Database Management System (DBMS)***:
  - A software package/system to facilitate the creation and maintenance of a computerized database
  - Provides an environment that is both convenient and efficient to use

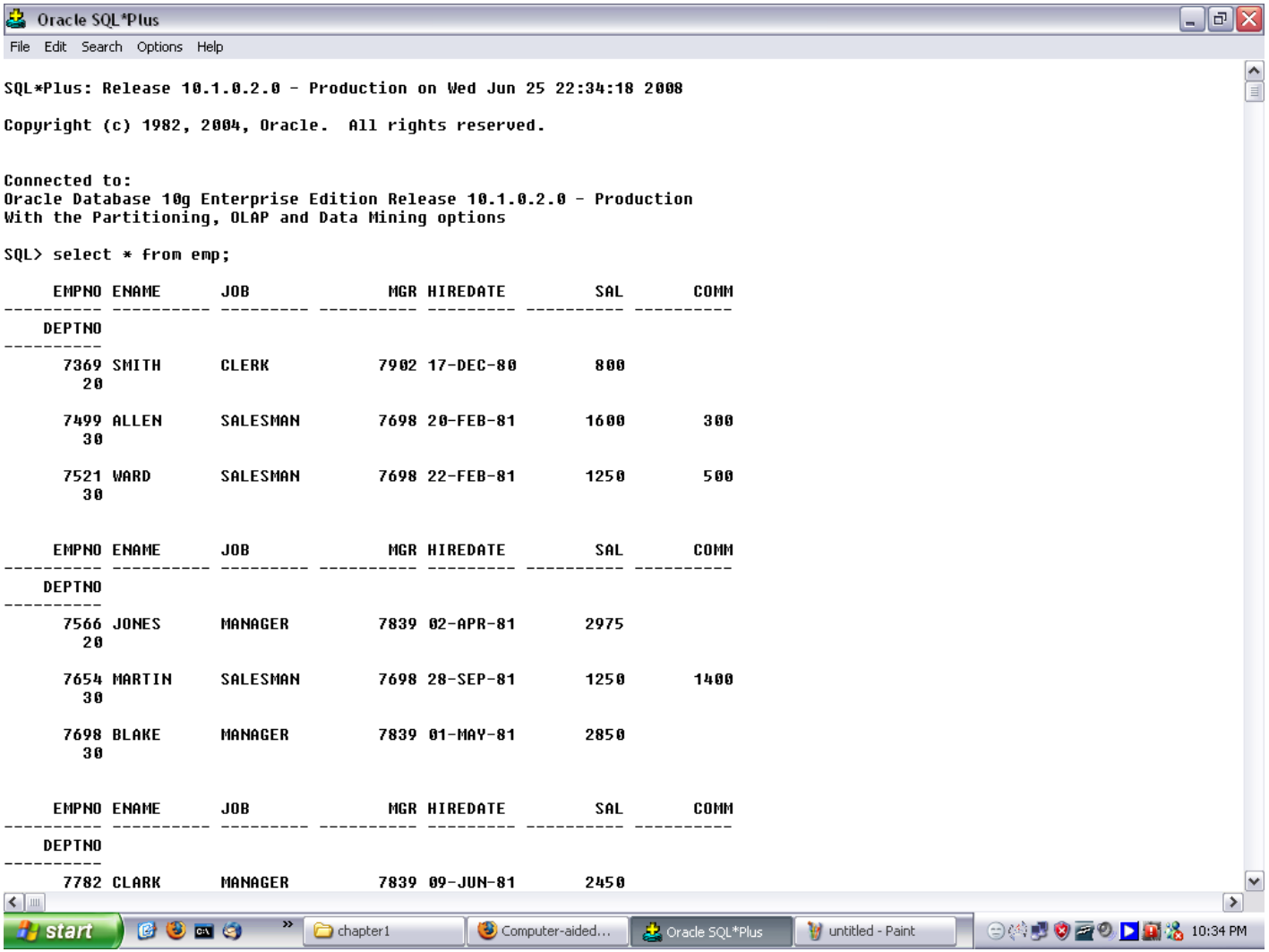
Basic Definitions

- ***Application Program*:**
  - A program used to interact with the database
  - Accesses the database by sending queries or requests for data to the DBMS

Typical DBMS Functionality

- ***Define*** a particular database in terms of its data types, structures, and constraints
- ***Construct*** or Load the initial database contents on a secondary storage medium
- ***Manipulating*** the database for data retrieval, updates and generations of reports

Sample Querying



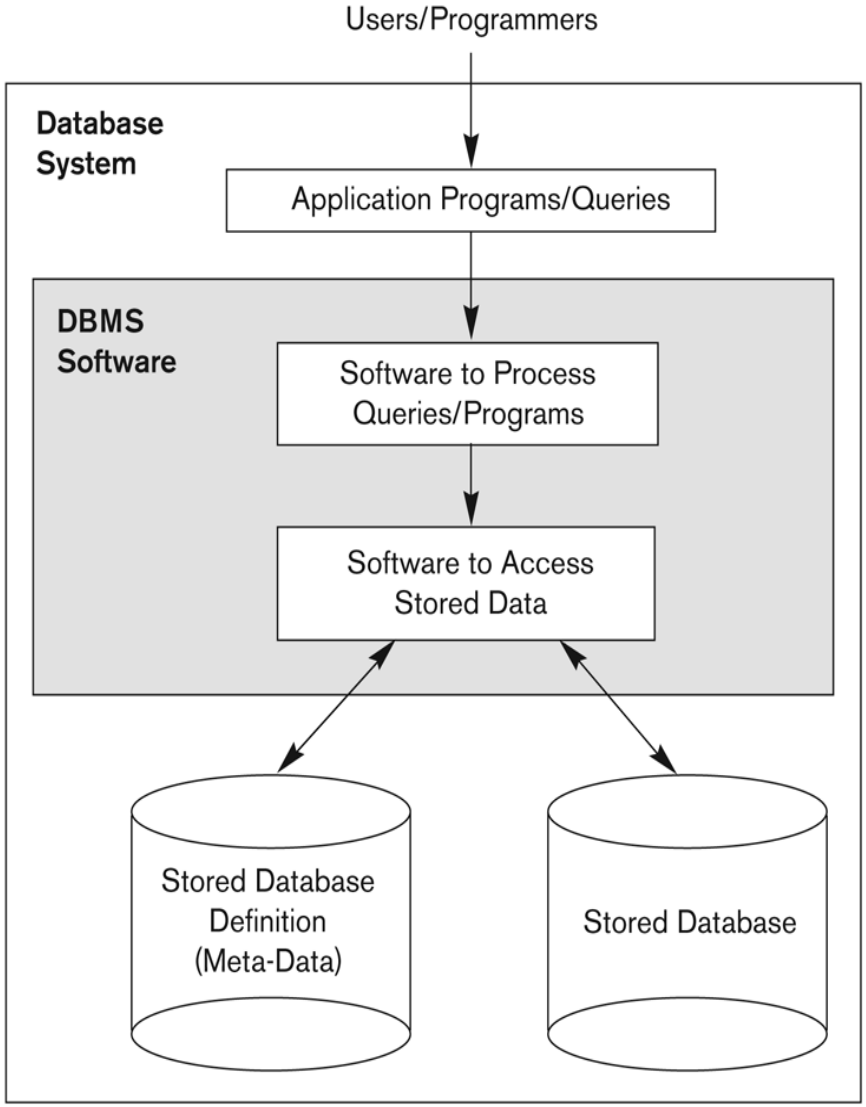
Typical DBMS Functionality

- ***Processing*** *and* ***Sharing***
- ***Protection*** *or* ***Security***
- ***"Active" processing*** to take internal actions on data
- ***Presentation*** *and* ***Visualization*** of data
- ***Maintaining*** *the database* and associated programs

Basic Definitions

- ***Database:***
  - A collection of related data
- ***Database Management System(DBMS):***
  - A software package/system to facilitate the creation and maintenance of a computerized database
- ***Database System:***
  - The DBMS together with the database

Simplified Database System Environment



Main Characteristics of the Database System

- Self-describing nature:
  - A DBMS **catalog** stores the description of a particular database (e.g. data structures, types, and constraints)
  - The description is called ***meta-data***.
  - This allows the DBMS software to work with different database applications.

Example of a simple database catalog

RELATIONS

Relation_name	No_of_columns
STUDENT	4
COURSE	4
SECTION	5
GRADE_REPORT	3
PREREQUISITE	2

COLUMNS

Column_name	Data_type	Belongs_to_relation
Name	Character (30)	STUDENT
Student_number	Character (4)	STUDENT
Class	Integer (1)	STUDENT
Major	Major_type	STUDENT
Course_name	Character (10)	COURSE
Course_number	XXXXNNNN	COURSE

Main Characteristics of the Database System

- Insulation between programs and data:
  - Called ***program-data independence***.
  - Allows changing data structures and storage organization without having to change the DBMS access programs.

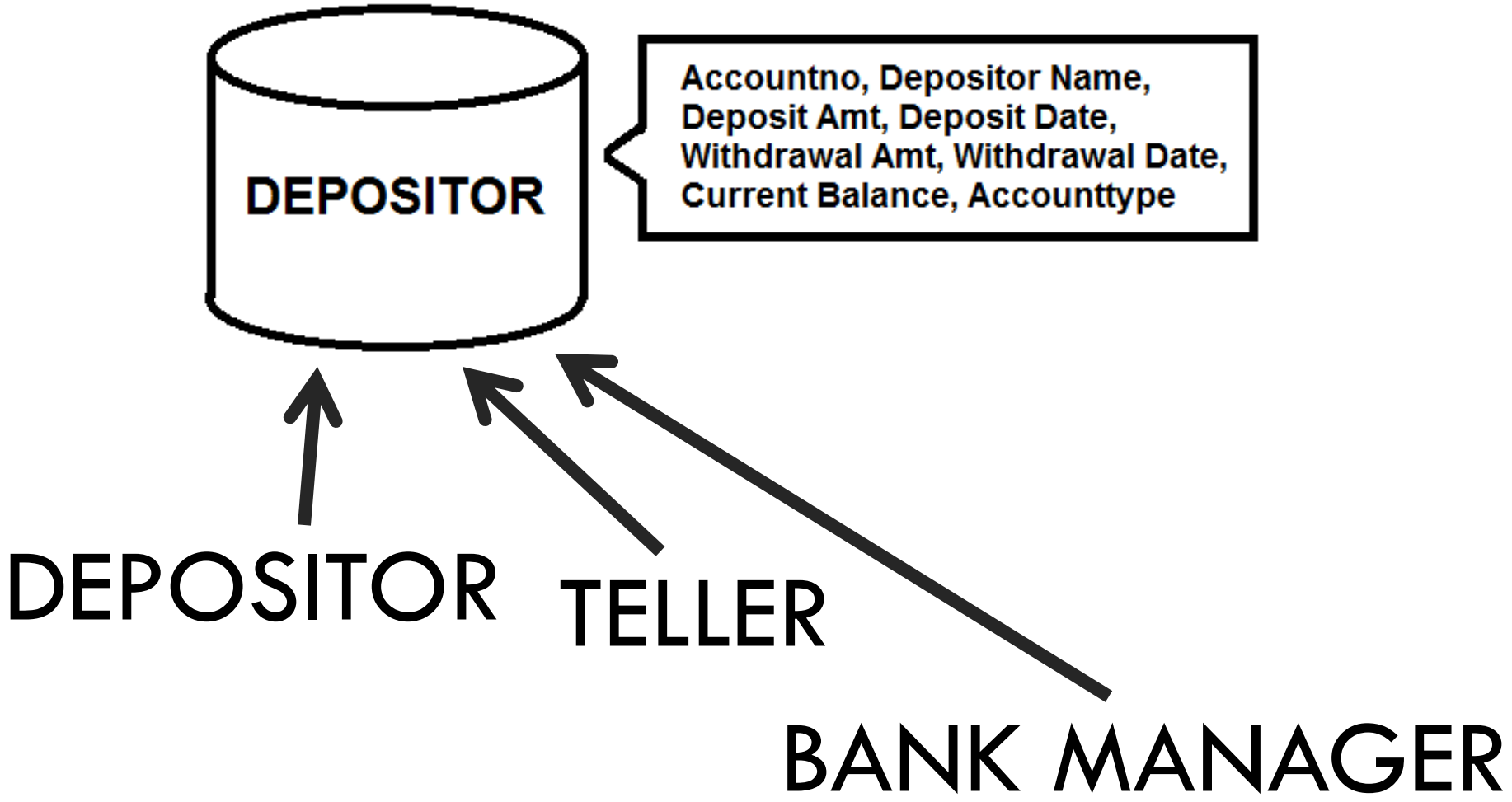
Main Characteristics of the Database System

- ***Data Abstraction*:**
  - A data model is used to hide storage details and present the users with a conceptual view of the database.
  - Programs refer to the data model constructs rather than data storage details

Main Characteristics of the Database System

- Support of multiple views of the data:
  - Each user may see a different view of the database, which describes only the data of interest to that user.

Main Characteristics of the Database System



Main Characteristics of the Database System

- Sharing of data and multi-user transaction processing:
  - Allowing a set of ***concurrent users*** to retrieve from and to update the database correctly
  - Concurrency control within the DBMS guarantees that each ***transaction*** is correctly executed or aborted

Advantages of Using the Database System Approach

- Controlling redundancy in data storage and in development and maintenance efforts
- Restricting unauthorized access to data
- Providing backup and recovery services
- Providing multiple interfaces to different classes of users

Advantages of Using the Database System Approach

- Representing complex relationships among data.
- Enforcing integrity constraints on the database.
- Drawing inferences and actions from the stored data using deductive and active rules

Database Users

- ***Actors on the Scene***
  - Those who actually use and control the database content, and those who design, develop and maintain database applications
- ***Workers Behind the Scene***
  - Those who design and develop the DBMS software and related tools, and the computer systems operators

Actors on the Scene

- ***Database Administrators***
  - authorizes access to the database
  - coordinates and monitors the use of the database system
  - acquires software and hardware resources
  - monitors efficiency of operations

Actors on the Scene

- ***Database Designers***
  - defines the content, the structure, the constraints, and functions or transactions against the database
  - must communicate with the end-users and understand their needs.

Actors on the Scene

- ***End-users***: They use the data for queries, reports and some of them update the database content. End-users can be categorized into:
  - ***Casual***: access database occasionally when needed
  - ***Naive or Parametric***: use previously well-defined functions in the form of "canned transactions" against the database

Actors on the Scene

- *Categories of End-users (continued)*
- ***Sophisticated***
  - These include business analysts, scientists, engineers, others thoroughly familiar with the system capabilities.
  - Many use tools in the form of software packages that work closely with the stored database.

Actors on the Scene

- *Categories of End-users (continued)*
- ***Stand-alone***
  - *Mostly maintain personal databases using ready-to-use packaged applications.*

Actors on the Scene

- ***System Analysts***
  - *Determine the requirements of end users and develop specifications for canned transactions that meet these requirements*
- ***Application Programmers***
  - *Implement the specifications as programs*
  - *Test, debug, document, and maintain the canned transactions*

Workers Behind the Scene

- ***Database system designers and implementers***
  - Design and implement the DBMS modules and interfaces as software package

Workers Behind the Scene

- ***Tool developers***
  - Design and implement the software packages that facilitate database modeling and design, database system design and improved performance
  - Examples are DbVisualizer, Easy SQL Data Compare

Workers Behind the Scene

- ***Operators and maintenance personnel***
  - Responsible for the actual running and maintenance of the hardware and software environment for the database system

When not to use DBMS

- ***Main inhibitors (costs) of using a DBMS:***
  - High initial investment and possible need for additional hardware
  - Overhead for providing generality, security, concurrency control, recovery, and integrity functions

When not to use DBMS

- ***When a DBMS may be unnecessary:***
  - If the database and applications are simple, well defined, and not expected to change
  - If there are stringent real-time requirements that may not be met because of DBMS overhead
  - If access to data by multiple users is not required

When not to use DBMS

- ***When no DBMS may suffice:***
  - If the database system is not able to handle the complexity of data because of modeling limitations
  - If the database users need special operations not supported by the DBMS.

Reference(s):

- **Elmasri, R. and S.B. Navathe**. 2010. Fundamentals of Database Systems. 6th Edition. Addition Wesley. ISBN-13: 978-0-136-08620-8
- **Elmasri, R. and S.B. Navathe**. 2007. Fundamentals of Database Systems. 5th Edition. Addition Wesley. ISBN: 981-06-9800-3