



**WISDOMTECH**  
BRINGS WISDOM TO TECHNOLOGY



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# Introduction to Database Systems

**CSI-406 Database Systems**

 **0345-5922495**

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# What is Database Systems?

- **Databases** and **database systems** are an essential component of life in modern society: most of us encounter **several activities** every day that **involve some interaction with a database**. For example:
  - PPSC, FPSC, NADRA, having large databases
  - BISE, PU, also have strong databases at backend.

# Types of Databases & Database Applications

1. Numeric & Textual Databases/ Online Transaction Processing (**OLTP**)
2. **Multimedia** Databases
3. Geographic Information Systems (**GIS**)
4. Data **Warehouses** & Online Analytical Processing (**OLAP**)
5. **Real-time** and **Active Databases** (industrial and manufacturing)



# Basic Definitions

- **Database:** is an *organized* collection of data, generally stored and accessed *electronically*
- **Data:** *known facts* that can be *recorded* and have an implicit meaning.
- **Mini-world:** Some *part of the real world about which data is stored* in a database, another name for mini-world is *Universe of discourse (UoD)*. For example, student grades and transcripts at a *university*.



# Basic Definitions cont...

- **Database Management System (DBMS):** A software *package/ system* to facilitate the *creation and maintenance* of a computerized database.
- **Database System:** The *DBMS software together with the data* itself (i.e. **DBMS + DATA**). Sometimes, the applications are also included.



# Typical DBMS Functionality

- **Define a database** : in terms of *data types*, *structures* and *constraints*
- **Construct or Load the Database** : on a secondary storage medium
- **Manipulating the database** : *querying*, *generating reports*, *insertions*, *deletions* and *modifications* to its content
- **Concurrent Processing and Sharing** : by a set of users and programs – yet, keeping all data valid and consistent





# Typical DBMS Functionality cont...

- *Protection or Security* measures to prevent unauthorized access
- Presentation and *Visualization of data*
- “Active” processing to take *internal actions* on data

# Example of a Database (with a Conceptual Data Model)

- **Mini-world for the example:** Part of a UNIVERSITY environment.
- **Some mini-world *entities*:** STUDENT, COURSE, SECTION, GRADE\_REPORT, PREREQUISITE

**Note:** The above could be expressed in the **ENTITY-RELATIONSHIP** data model (conceptual data model).



# Example of a Database cont... (with a Conceptual Data Model)



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## SECTION

Section_identifier	Course_number	Semester	Year	Instructor
85	MATH2410	Fall	07	King
92	CS1310	Fall	07	Anderson
102	CS3320	Spring	08	Knuth
112	MATH2410	Fall	08	Chang
119	CS1310	Fall	08	Anderson
135	CS3380	Fall	08	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

## 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

## STUDENT

Name	Student_number	Class	Major
Smith	17	1	CS
Brown	8	2	CS

## PREREQUISITE

Course_number	Prerequisite_number
CS3380	CS3320
CS3380	MATH2410
CS3320	CS1310



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# Main Characteristics of Database Approach

- **Self-describing nature of a database system:** A DBMS catalog stores the *description* of the database. The description is called **meta-data**). This allows the DBMS software to work with different databases.
- **Insulation between programs and data:** Called **program-data independence**. Allows changing data storage structures and operations without having to change the DBMS access programs.
- **Data Abstraction:** A **data model** is used to hide storage details and present the users with a *conceptual view* of the database.



# Main Characteristics of Database Approach cont...

- 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.
- Sharing of data and multiuser transaction processing : allowing a set of concurrent users to retrieve and to update the database. Concurrency control within the DBMS guarantees that each **transaction** is correctly executed or completely aborted. OLTP (Online Transaction Processing) is a major part of database applications.



# Database Users

- Users may be divided into two categories:
- Those who actually use and control the content (called “**Actors on the Scene**”) and
- Those who enable the database to be developed and the DBMS software to be designed and implemented (called “**Workers Behind the Scene**”).



# Database Users cont...

## Actors on the scene

- **Database administrators (DBA):** responsible for authorizing access to the database, for coordinating and monitoring its use, acquiring software, and hardware resources, controlling its use and monitoring efficiency of operations.
- **Database Designers (DBD):** responsible to define the content, the structure, the constraints, and functions or transactions against the database. They must communicate with the end-users and understand their needs.





# Database Users cont...

## Actors on the scene

- **System Analyst and Application Programmers (Software Engineers):** System analysts determine the requirements of end users, especially naive and parametric end users, and develop specifications for standard canned transactions that meet these requirements. Application programmers implement these specifications as programs; then they test, debug, document, and maintain these canned transactions. Such analysts and programmers—commonly referred to as software developers or software engineers
- **End-users:** they use the data for queries, reports and some of them actually update the database content.



# Database Users cont...

## Categories of End-users

- **Casual** : access database occasionally when needed. Casual users learn only a few facilities that they may use repeatedly.
- **Naive or Parametric** : they make up a large section of the end-user population. They use previously well-defined functions in the form of “*canned transactions*” against the database. Examples are **bank-tellers** or **reservation clerks** who do this activity for an entire shift of operations. Naive end users need to learn very little about the facilities provided by the DBMS; they simply have to understand the user interfaces of the standard transactions designed and implemented for their use.





# Database Users cont...

## Categories of End-users

- **Sophisticated:** these include business analysts, scientists, engineers, thoroughly familiar with the system capabilities. Sophisticated users try to learn most of the DBMS facilities in order to achieve their complex requirements.
- **Stand-alone :** maintain personal databases by using ready-made program packages that provide easy-to-use menu-based or graphics-based interfaces. Standalone users typically become very proficient in using a specific software package.



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# Database Users cont...

## Workers behind the scene

- **DBMS system designers and implementers:** design and implement the DBMS modules and interfaces as a software package (DBMS is complex software including: query language processing, interface processing, accessing and buffering data, controlling concurrency, and handling data recovery and security).
- **Tool developers:** design and implement tools—the software packages that facilitate database modeling and design, database system design, and improved performance.
- **Operators and maintenance personnel:** are responsible for the actual running and maintenance of the hardware and software environment for the database system.