Database Management System – 1 Introduction, basic definitions, characteristics of DBMS

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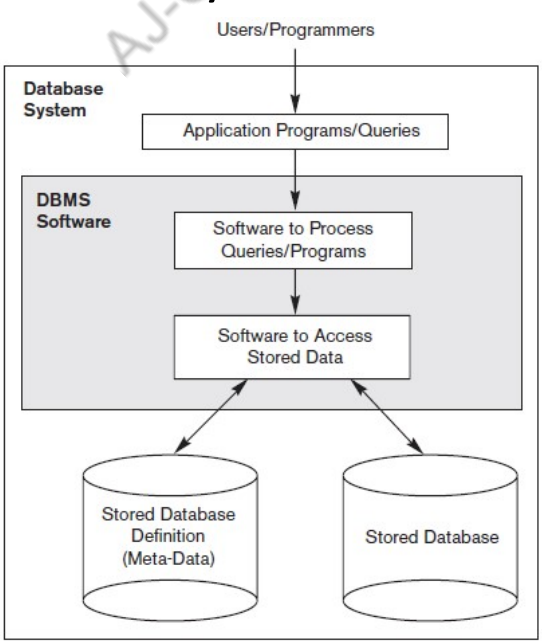
Introduction

- Traditional Applications
  - Numeric and Textual Databases
- Recent Applications
  - Non-traditional data, such as posts, tweets, images, and video clips
- Big data storage systems, or NOSQL systems
  - created to manage data for social media applications
  - Cloud storage - programs, images, videos and emails
- Multimedia databases
- Geographic information systems (GISs)
- Data warehouses and online analytical processing (OLAP) systems
- Real-time and active database technology

Definitions

- **Database:**
  - Collection of related data
- **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
  - Example – data of college students
- **Database Management System (DBMS):**
  - Software package/ system to facilitate the creation and maintenance of a computerized database
- **Database System:**
  - DBMS software + data

Database system environment



Definitions

- **Database management system (DBMS**)
  - a collection of programs that enables users to create and maintain a database
  - *general-purpose software system* that facilitates the processes of ***defining, constructing, manipulating,*** *and* ***sharing*** databases
  - **Defining** - specifying the data types, structures, and constraints of the data to be stored
  - **meta-data** - database definition or descriptive (database catalog or dictionary)
  - **Constructing** - process of storing the data on some storage medium
  - **Manipulating** – querying the database to retrieve specific data, updating the database
  - **Sharing - allows multiple users and programs to access the database** simultaneously

DBMS

- Other features:
  - Protection or Security measures to prevent unauthorized access
  - “Active” processing to take internal actions on data
  - Presentation and Visualization of data
  - Maintaining the database and associated programs over the lifetime of the database application

Example of a Database

- **Mini-world for the example:**
  - Part of a UNIVERSITY environment.
- **Some mini-world *entities*:**
  - STUDENTs
  - COURSEs
  - SECTIONs (of COURSEs)
  - (academic) DEPARTMENTs
  - INSTRUCTORs

Example of a Database

- **Some mini-world *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

STUDENT

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

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	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

Example of a Database

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

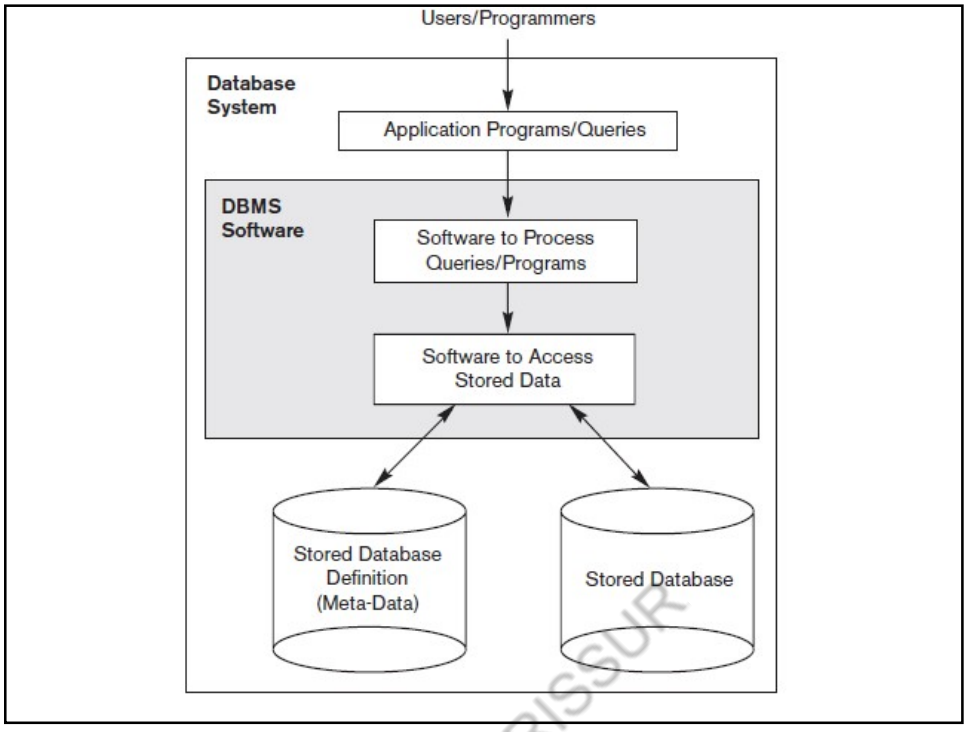
Course_number	Prerequisite_number
CS3380	CS3320
CS3380	MATH2410
CS3320	CS1310

Characteristics of the Database Approach

1. Self-describing nature of a database system
2. Insulation between programs and data, and data abstraction
3. Support of multiple views of the data
4. Sharing of data and multiuser transaction processing

1. Self-describing nature of a database system

- Database system contains not only the database itself
  - but also a complete ***definition or description of the database structure and constraints***
- **DBMS catalog**
  - contains information such as the structure of each file
  - type and storage format of each data item
  - constraints on the data
- Information stored in the catalog is called **meta-data**
  - describes the structure of the primary database
  - used by the DBMS software and also by database users
  - to know the structure of the files in a specific



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
....	....	.....
....	....	.....
....	....	.....
Prerequisite_number	XXXXNNNN	PREREQUISITE

Note: Major_type is defined as an enumerated type with all known majors.
XXXXNNNN is used to define a type with four alpha characters followed by four digits.

2. Insulation between programs and data, and data abstraction

- Allows changing data structures and storage organization without having to change the DBMS access programs
- Structure of data files is stored in the DBMS catalog separately
- **Program-data independence**
- **Program-operation independence**
- **Data abstraction**
  - Program-data independence + Program-operation independence

3. Support of Multiple Views of the Data

- Users may require a different perspective or **view** of the database
- A **view** may be a ***subset of the database*** or it may contain ***virtual data that is derived from the database files*** but is not explicitly stored
- Must provide facilities for defining multiple views

Views

TRANSCRIPT

Student_name	Student_transcript				
	Course_number	Grade	Semester	Year	Section_id
Smith	CS1310	C	Fall	08	119
	MATH2410	B	Fall	08	112
Brown	MATH2410	A	Fall	07	85
	CS1310	A	Fall	07	92
	CS3320	B	Spring	08	102
	CS3380	A	Fall	08	135

COURSE_PREREQUISITES

Course_name	Course_number	Prerequisites
Database	CS3380	CS3320
		MATH2410
Data Structures	CS3320	CS1310

4. Sharing of Data and Multiuser Transaction Processing

- Must **allow multiple users** to access the database at the same time
- Must include **concurrency control software**
- **Online transaction processing (OLTP) applications**
- Transaction
  - an *executing program or process that includes one or more database* accesses, such as reading or updating of database records

Reference

- Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education 6th edition and 7th edition

Thank you