Topic1

An overview of database and DBMS

From

Chapters 1 and 2 of Fundamentals of Database Systems, Authors: Elmasri and Navathe

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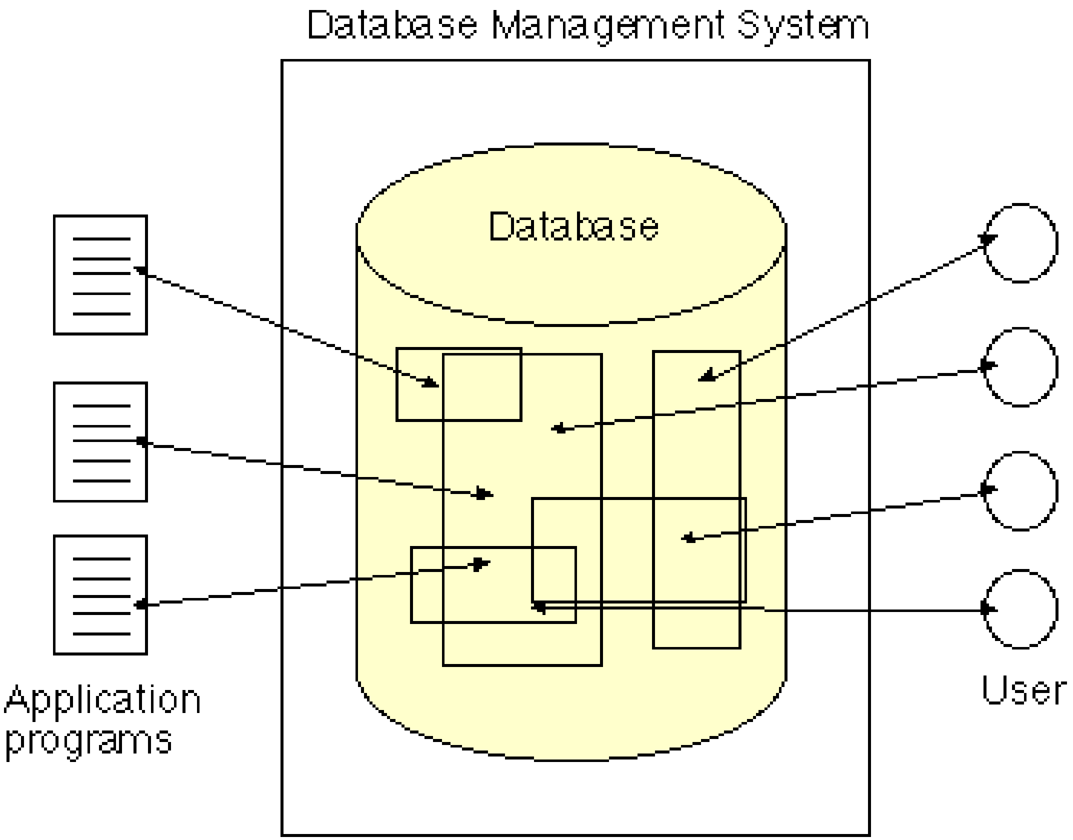
Topics in this Section

- What is a Database System?
- What is a Database?
- Why Database?
- Data Independence
- Relational Systems, and Others

Database System

- Computerized record-keeping system
- A collection of programs to create and maintain database
- Supports operations
  - Add or delete files to the database
  - Insert, retrieve, remove, or change data in database
- Components
  - Data, hardware, software, users

A Simplified Database System



Database System - Data

- Database system may support single user (for small machines) or many users
- When there are many users in organizations:
  - Data is integrated: database is unification of distinct files. Any redundancy among these files partly or wholly is eliminated.
  - Data is shared: Different users can have access to the same data
- Different users will require different views

Database System - Data

- For example a given database can have EMPLOYEE file that shows the information of employees. Also this database can contain an ENROLLMENT file that shows the enrollment of employees in training courses.
- Personnel department uses EMPLOYEE and educational department uses ENROLLMENT files.

EMPLOYEE

NAME	ADDRESS	DEPARTMENT	SALARY	…

ENROLLMENT

NAME	COURSE	…

Database System - Data

- ENROLMENT file does not need the department of employees who took a course because it will be redundant information (integrity).
- DEPARTMENT of employees can be used by the users in personnel and education departments (sharing)
- Although users in personnel and education departments share DEPARTMENT portion but they have different views on database.

Database System - Hardware

- The hardware components of database system consist of the disks in which data are stored thus database system can perform
  - Direct access to subset portions of data
  - Rapid I/O
- Data operated on in the main memory

Database System - Software

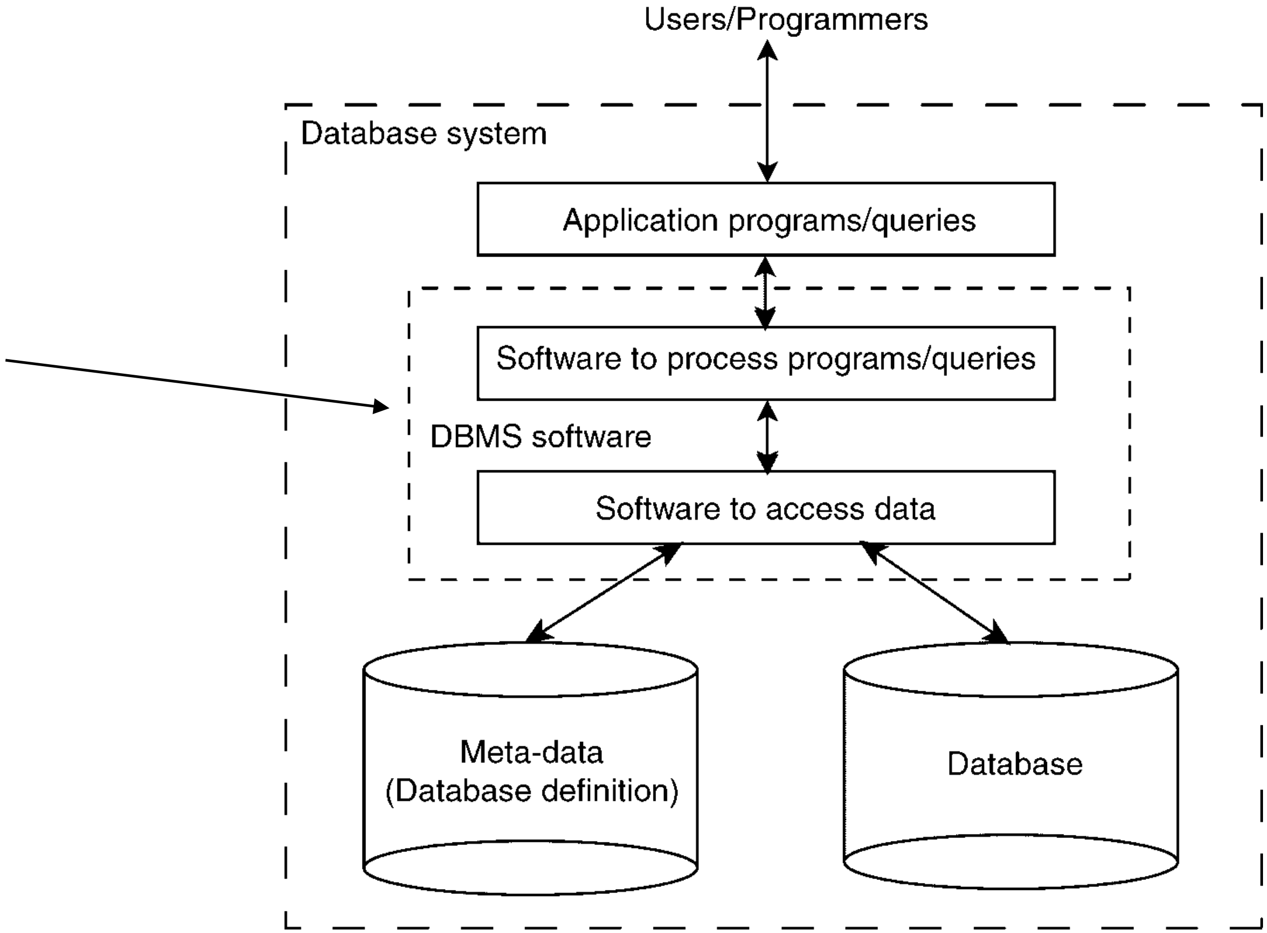
Between physically stored data and users of the systems there is a layer of software referred to as:

- Database manager
- Database server
- Database management system (DBMS)

DBMS shields database users from hardware details

- Note that DBMS is also referred to some products provided by specific vendor. For example DB2

DBMS in a Database System Environment



Database System - Software

- DBMS is not (but may come with)
  - Application Development Tools
  - Application Software
  - Transaction Manager (TP Monitor)
  - Report Writer
  - System utilities
- Note that people often use the term *database* when they really mean *DBMS*. For example “Vendor X’s database” is wrong, it should be “Vendor X’s DBMS”

Database System - Users

- Application programmers
- End users
- Database Administrators (DBA). DBA is a person or team of IT professional/s whose job is to create the database and put in place the technical controls needed to enforce the various policy decisions made by data administrator. Note that DBA is different from Data administrator (DA). DA's job is to decide what data should be stored and who can perform what operations on data (i.e., data security)

What is a Database?

- Collection of persistent data that is used by the application systems of some given enterprise (enterprise is a self contained commercial, scientific, technical or other organization).
- Collection of true propositions: For example the fact "Supplier S1 is located in London" might be such a true proposition
- Made up of entities, relationships, properties

(we will talk about it later)

What is a Database? (persistent data)

- Persistent data is different from the data that last for a short time. For example the intermediate results are transient data that last for a short time.
- When persistent data has been accepted by DBMS for entry in database it can be removed from database only by some explicit request to DBMS.
- The earlier term for persistent data was operational data which reflected the original emphasis in database systems for production or operational databases. However databases are now increasingly used for other kind of applications too. For example database can offers decision support via operational data and data warehouse (i.e., summary information)

What is a Database?

- For example here are the example of data that are used in database for following enterprises
  - ∗ Student data (for a university)
  - ∗ Patient data (for a hospital)
  - ∗ Product data (for a company)
- Data can be
  - ∗ Static (e.g., part#, SIN)
  - ∗ Dynamic (e.g., quantity, balance)
  - ∗ Quasi-static (e.g., salary)

Why Database?

- **Shared data**: Not only for existing applications but also new ones can be developed to operate against the same data.
- **Reduced redundancy**: If we need to keep some redundancies it should be controlled. For example the updates should be propagated to all redundant data

Why Database?

- Example of a situation in which redundancy is not completely eliminated

Saving account

account#	customer name	address	balance

Chequeing account

account#	customer name	address	balance

Why Database?

- **Reduced inconsistent data**: Inconsistency happens when one of the redundant data has been updated and the other has not. Propagating updates is used to avoid inconsistency
- **Transaction support**: By putting several update operations in one transaction we can guarantee that either all of them are done or none of them are done. For example the operations for transferring cache from account A to account B can be put in one transaction.

Why Database?

- **Support for data integrity**: Ensures that the data in database is accurate.

For example:

- We shouldn’t have an employee working in non exiting department.
- We shouldn’t have number of hours entered as 400 instead of 40
- Inconsistency can lead to the lack of integrity.

Why Database?

Security enforcement: Ensuring that the only means of access to a database is through proper channels: By:

- Restricting unauthorized data
- Different checks (security constraints) can be established for each type of access (retrieve, insert, delete, etc.)
    - Example: Course marks database
        - A student can have access to his/her own mark
            - Should not be able to see other student’s marks
        - TA might have access to enter marks for the current assignment only
            - Should not be allowed to change marks for the other assignments/tests
        - Instructor can have full access to the course database

Why Database?

- **Support for standards**
  - ∗ Due to central control of database.
    - » Example
      - – Address must be two lines
        - ✈Each line 40 characters (maximum)

Why Database?

- **Conflicting requirements can be met**
  - Knowledge of overall enterprise requirements as opposed to individual requirements
    - System can be designed to provide overall service that is best for the enterprise
    - Data representation can be selected that is good for most important applications (at the cost of some other applications).

Data Independence

- Data independence
  - ∗ Traditional file processing is data-dependent
    - » Knowledge of data organization and access technique is built into application logic and code
- **Examples of situations in which the stored representation might be subject to change:**
    - » An application program written to search a student file in which records are sorted in ascending order by **`student#`** fails if the sort order is reversed
    - » Representation of numeric data
      - – binary or decimal or BCD
      - – fixed or floating point
      - – real or complex

Data Independence

- » Representation of characters
  - – ASCII (uses 1 byte)
  - – Unicode (uses 2 bytes)
    - ✈used in JAVA
  - – Universal character set (UCS)
    - ✈UCS-2 (uses 2 bytes – essentially Unicode)
    - ✈UCS-4 (uses 4 bytes)
- » Unit for numeric data
  - – inches or centimeters
  - – pounds or kilograms
- » Data encoding

  Red = 1, Blue = 2, ...

  == changed to ==> Red = 0, Blue = 1, ...

Data Independence

- In database systems DBMS immune applications to such changes
- In database systems the logical and physical representation of data are separated
- Using database allows changes to application programs without changing the structure of the underlying data and *vice versa*. So the database can grow without impairing existing applications. For example without requiring any changes to the existing applications a "unit cost" field can be added to the "part" stored record in the "parts" stored file of the database shown in Fig 1.7 of the text book.

Relational Systems

- Introduction of relational model in 1969-70 was the most important innovation in database history
- Relational systems are based on logic and mathematics. *Relation* is basically a mathematical term for a table.
- In relational systems data is perceived as tables, only and operators derive new tables from existing
- Relational systems are not pointer based (to the user). Although they may use pointers at the level of physical implementation.

Relational Systems-SUPPLIER Table

supplier#	supplier_name	city
1	Acme Supplies	Toronto
2	Sona Systems	Ottawa
3	AtoZ Systems	New York
4	Quality Supplies	London
5	Best Supplies	Saskatoon

Relational Systems-PART Table

part#	part_name	weight
1	Tower case	2.5
2	Sony display	4.5
3	Mother board	0.6
4	Yamaha speakers	2
5	Power supply	3

Relational Systems-PART-SUPPLIER Table

part#	supplier#	quantity
1	1	20
1	2	34
2	2	23
3	3	33
3	5	43
4	5	45
5	4	22

Relational products

They appeared in the market in late 70s and mostly support SQL. Names of some of these products which are based on the relational system are:

- DB2 from IBM Corp.
- Ingres II from Computer Associate International Inc.
- Informix from Informix Software Inc.
- Microsoft SQL Server from Microsoft Corp.
- Oracle 11g from Oracle Corp.
- Sybase Adaptive Server from Sybase Corp.

Not Relational Systems

- Hierarchic
- Network
- Inverted List
- Object
- Object/Relational
- Multi-dimensional

We will talk about them later