# Chapter 1. Introduction

**Def.** Database-management system (DBMS).

A collection of interrelated data (database) and a set of programs to access those.

* Primary goal : Store & retrieve in a convenient & efficient manner.

## 1.1 Database system applications.

**Remark.** Although user interfaces hide details of access to databases, it is now an essential part of almost everybody.

## 1.2 Purpose of database systems

**Remark.** Before DBMS, file processing system, which is supported by conventional OS, is used.

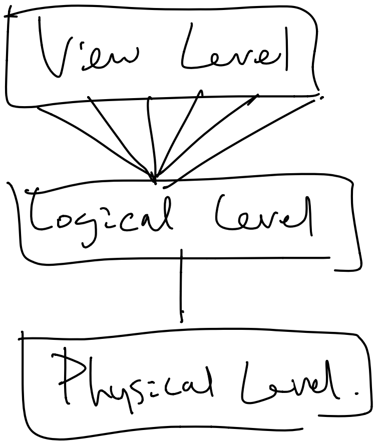
* Disadvantages (= advantages of DBMS).

- Data redundancy : Duplicates & different formats.
- Data inconsistency : Various inconsistent copies.
- Data isolation : Scattered data.
- Difficulties in accessing data : one code per function.
- Integrity problems : Consistency constraints.
  ex) Bank balance always positive.
- Concurrent access anomalies
- Security problems : Different access boundaries per user.

# 1.3 . View of Data.

Remark. Providing abstract view of the data is a major purpose of DBMS.

* Three levels of Data Abstraction.



: Simplifying user interaction with multiple views.

: What data are stored, what relationships exist among them?

↕ Physical data independence.

: How data are actually stored?

Remark. Each level has its own schema which describes the overall design.

Def. Instance of a database is a collection of information stored in the database at a particular moment.

Def. Data model is a collection of conceptual tools for describing data, data relationships, data semantics and consistency constraints.

i) Relational Model uses a collection of tables (relations) to represent both data and relationships between data.

ii) Entity-Relationship (E-R) Model uses a collection of basic objects (entities) and relationship among entities.

iii) object-based data model extends E-R model. with notions of encapsulation, methods (functions) and object identity.

iv) Semistructured data model permits specification of data — individual items of same type may have different attributes. ex) XML.

## 1.4 Database Languages.

i) Data - Manipulation Language (DML).

: Enables access or manipulation as organized by the data model.

Namely, ① Retrieval. ② Insertion. ③ Deletion. ④ Modification.

- Procedual DML require a user to specify
  What data are needed and how to get those data.
- Declarative DML only require what data are needed.
  So, the system has to figure out how to retrieve data efficiently.

Def. A query is a statement requesting a retrieval of info.

Query language is a portion of DML that involves retrieval of info.

ii) Data - Definition Language. (DDL)

: Conveys specifications of a database schema with a set of definitions,

as database has to satisfy certain consistency constraints.

i) Assertions (Consistency of data).

Special cases: Domain constraints & Referential integrity.
↳ type checking. ↳ foreign key. cascade deletion.

ii) Authorizations (Consistency of user)

on read / insert / update / delete. (operations expressed by DML)

Def Data storage & definition language specifies implementation details.

Remark. Output of DDL is a metadata (data about data).

Resules are stored in a special table (Data dictionary)

## 1.5 Relational Databases.

Remark. Record-based models are structured in fixed-format records of several types.

Each table contains records of a particular type.

Each record type defines a fixed number of fields (attributes).

Remark. SQL is not a universal turing machine, so it needs a host language for additional actions.

## 1.6 Database Design.

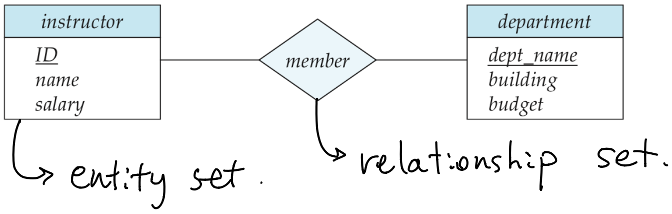
* Database design process.

Data model provides conceptual framework on requirements.

Designer translates requirements to a conceptual schema.

- What attributes we want to capture? ⇒ Business decision
- How to group these attributes? ⇒ CS problem.

* Unified Modelling Language (UML).



: A way to express E-R model graphically.

Def. Mapping Cardinality is a type of constraint that expresses number of entities to which another can be associated via a relationship set.

Def. Normalization is a process to remove redundant info, yet allow easy retrieval of info.

## (1.1) Data Storage and Querying.

Def. The storage manager is a component of DBMS that provides the interface between low-level data & queries submitted.

The storage manager component includes:

- Authorizations and Integrity (assertions)
- Transaction
- File & Buffer.

which implements several data structures for physical implementation:

- Data files ( data itself )
- Data dictionary (metadata)
- Indices ( provides fast access ) .

Def. The query processor is a component of DBMS that simplify and facilitate access to data.

the query processor component includes:

- DDL intepreter
- DML compiler & query optimizer
- Query evaluation engine

## 1.8 Transaction Management.

Def. A transaction is a collection of operations that performs a single logical function in a database app.

Def. A transaction manager manages:

Recovery manager ←( - Consistency (correctness of data)
- Atomiticity (all-or-none operations applied)
- Durability (persistence after a transaction)

Concurrency Control manager ← - Isolation (among multiple transactions)

## 1.9 Database Architecture

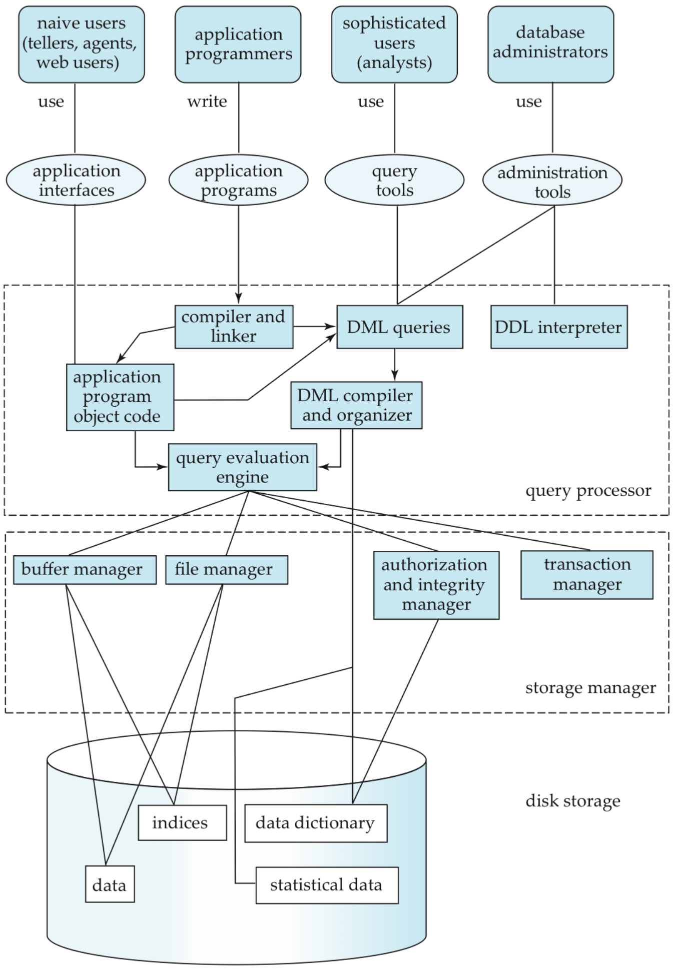


**Figure 1.5** System structure.

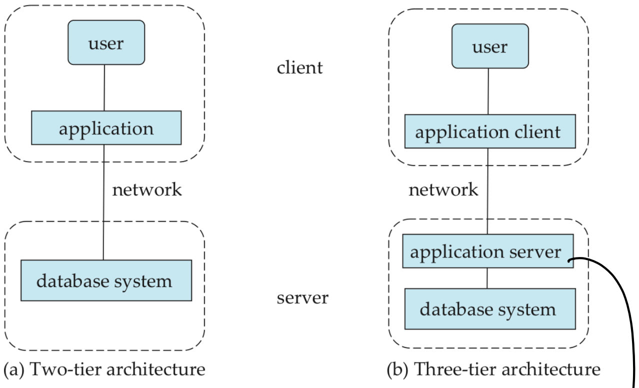


**Figure 1.6** Two-tier and three-tier architectures.

API server.
eg RESTful.

Remark. The business logic (What actions to do under what conditions) is embedded in the app server, making 3-tier app more appropriate for larger apps, or apps on www.