Introduction to Database Systems – Part 1

General Concepts

What is a Database?

- Have you designed a database?
- Have you worked with a database?

Definition of Databases

- A **database** is a collection of related data.
- Implicit properties:
  - represents some **aspects of the real world**;
  - a **logically coherent collection** of data;
  - designed and built for a **specific purpose**.

Examples (Huge):

Amazon: – It has 244 million active customers, over 60 million items occupying many terabytes of data (clothing, sports, videos, office products).

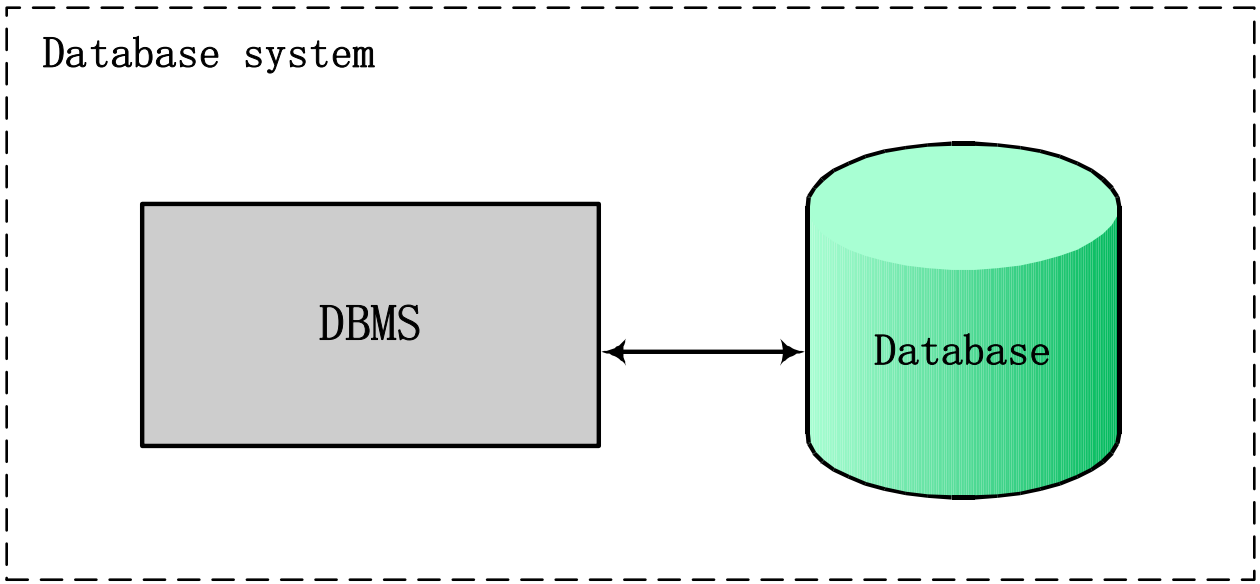
YouTube: – Over 1.3 billion users, 300 hours of videos added every minute, average of one billion mobile YouTube views per day

What is a Database Management System?

- A **database management system** (DBMS) is a collection of programs that enable users to create and maintain a database.
- It is a general-purpose software system that facilitates the process of
  - **defining:** specifying data types, structures and constraints;
  - **constructing:** storing data on some storage medium;
  - **manipulating:** retrieving and manipulating data;
  - **sharing:** using data by multiple users/programs simultaneously.
- Well-known relational DBMSs include Oracle, IBM DB2, Microsoft's Access, Microsoft's SQL Server, MySQL, postgreSQL, etc.

What is a Database System?

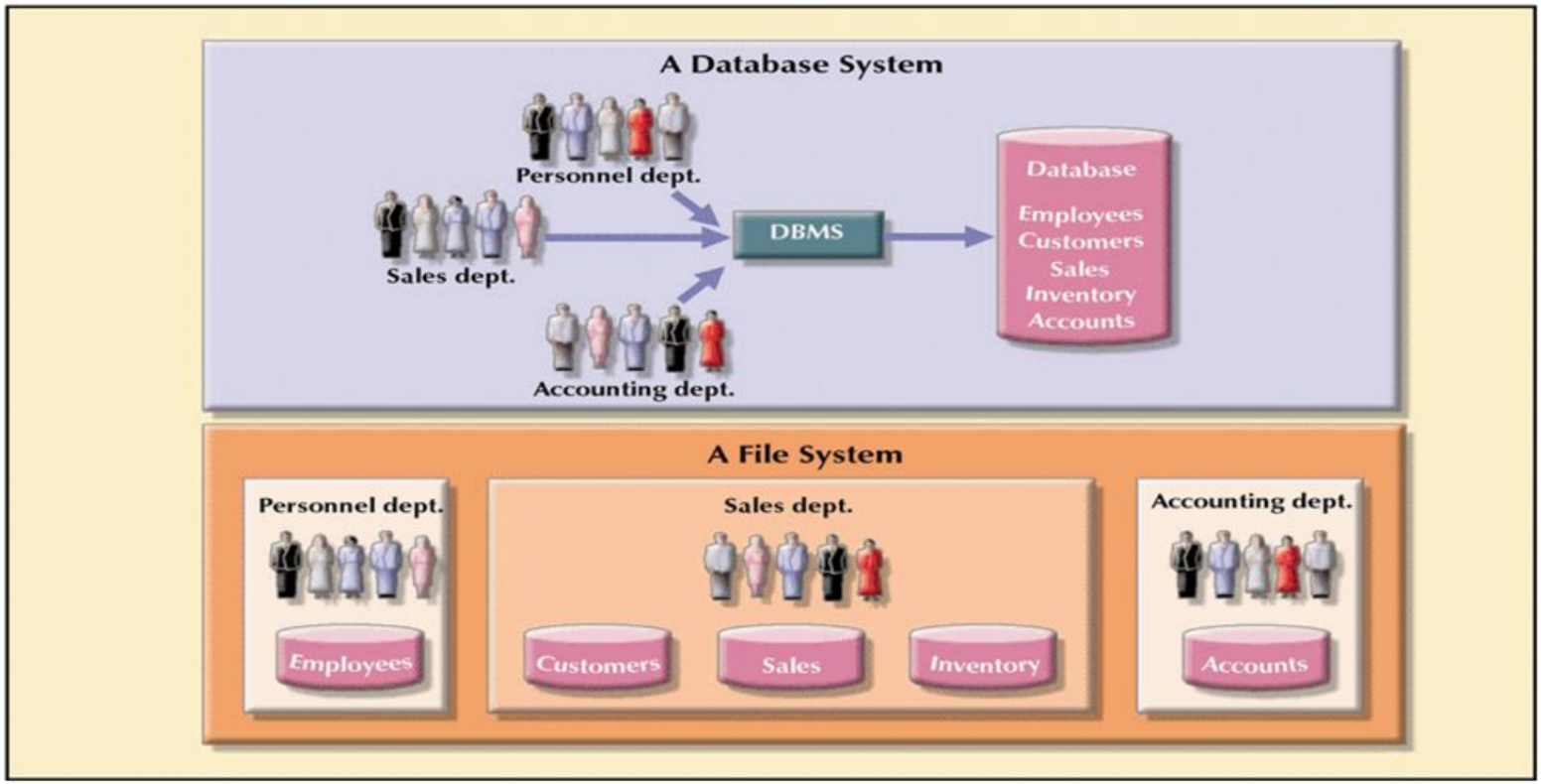
- A **database system** is part of information systems dealing with data retrieval and manipulation.
- It often refers to a DBMS plus a database.



- Main services a database system provides:
  - answer queries efficiently;
  - execute updates efficiently.

Why is a Database System Needed?

- Database system: an integrated collection of logically related data
- File system: many separate and unrelated files



Database Systems: Design, Implementation, & Management, 6th Edition, Rob & Coronel

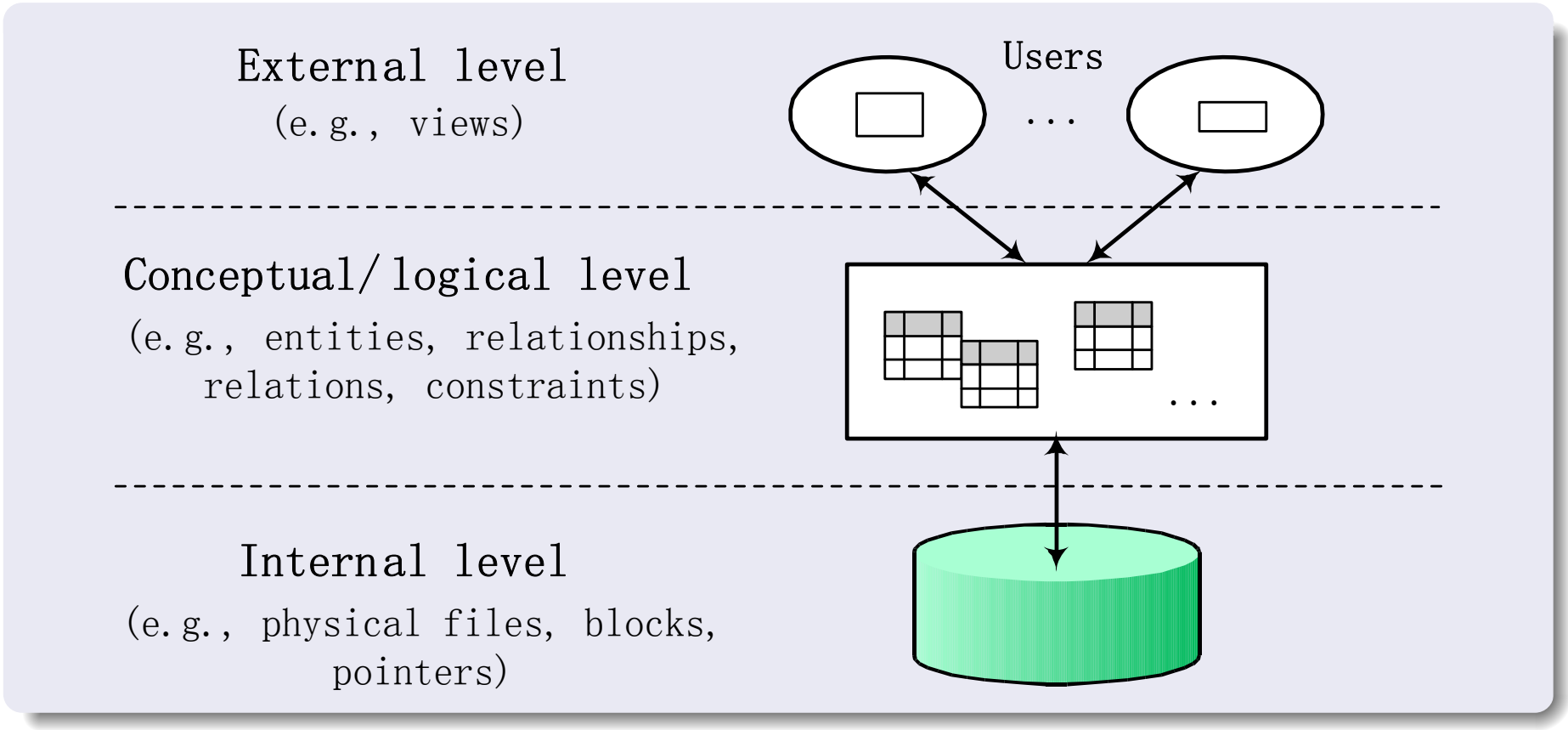
Why is a Database System Needed?

- Advantages of using a database system
  - **Data redundancy:** Data redundancy is controlled to ensure consistency and save the storage space.
  - **Data integrity:** Some integrity constraints can be enforced automatically by the DBMS.
  - **Data security:** Since the data is managed centrally, the DBMS ensures that the database access is through an authorized channel.

    In addition to the above, the database system also facilitates the following:

    Concurrent transactions; backup and recovery services; data independence; etc.

Three-level ANSI/SPARC Architecture



- **Note:** schemas at the three levels are *descriptions* of data; the stored data *actually* exists at the internal level (i.e., physical level) only.

Three-level ANSI/SPARC Architecture

- **External Schema**
  - perspective of the user / application
  - describes restructured parts of the database used in applications
- **Conceptual or Logical Schema**
  - perspective of a community of users
  - describes what data is stored in the database and relationships among data (independent from their physical storage structures).
- **Internal Schema**
  - perspective of the implementation / system realization
  - describes how data is stored in the database (e.g., physical storage structures).

Derived Principles – Data Independence

- **Logical data independence**: change the conceptual/logical schemas without having to change external schemas or application programs

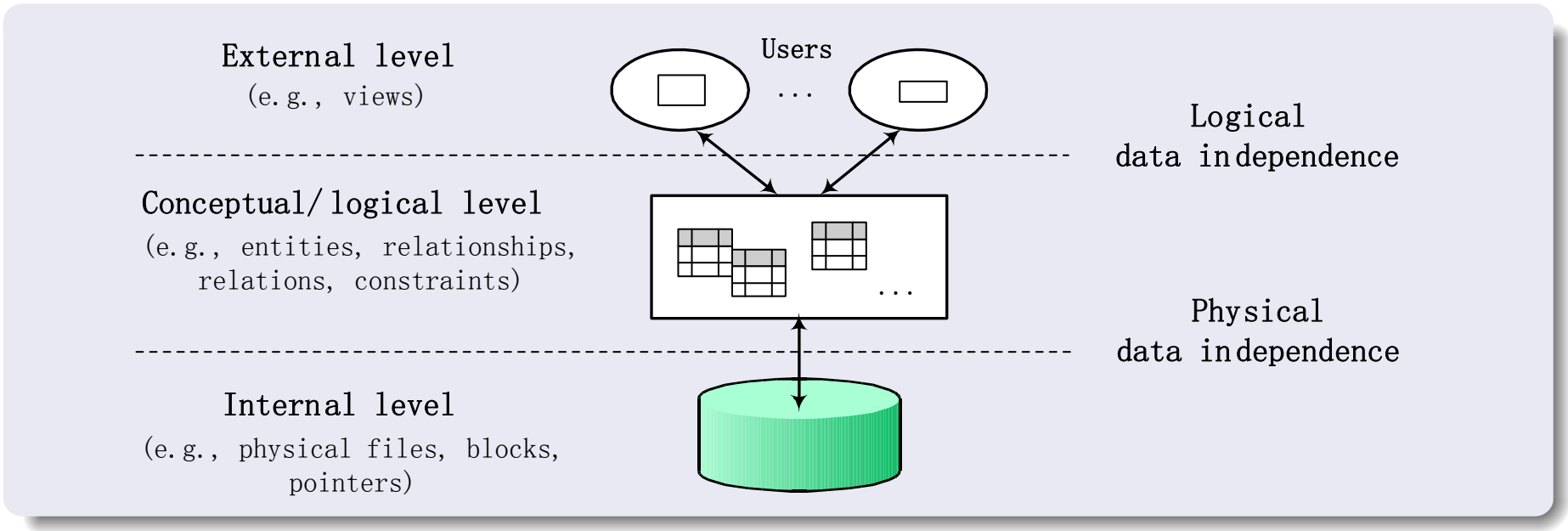
  Example: If adding or removing entities, external schemas that refer only to the remaining data should not be affected.

- **Physical data independence**: change the internal schemas without having to change the conceptual/logical schemas

  Example: If physical files were reorganised, we should not have to change the conceptual/logical schemas.

Derived Principles – Data Independence

- **Key idea**: When the schema is changed at some level,
  - the schema at the next higher level remains unchanged;
  - only the *mapping* between two levels is changed.



Historical Remarks I/II

- **Hierarchical Databases**
  - Oldest data model (1960s);
  - SABRE, a collaboration between IBM and American Airlines;
- **Network Databases**
  - Extension of hierarchical databases, from tree to network (late 1960s);
- **Relational Databases**
  - Edgar F. Codd,
    A Relational Model of Data for Large Shared Data Banks
  - System R and SQL

Historical Remarks II/II

- **Object-Oriented Databases**
  - Driven by object-oriented programming languages (1980s);
  - Designed to store and share complex, structured objects.
- **XML Databases**
  - XML is emerged as the standard for Web data exchange (1990s);
  - Suitable to sparse data, deeply nested data and mixed content.
- **NoSQL Databases**
  - Recent development in industry (since 2009);
  - We will discuss NoSQL databases at the end of this course.