Introduction to Database Systems
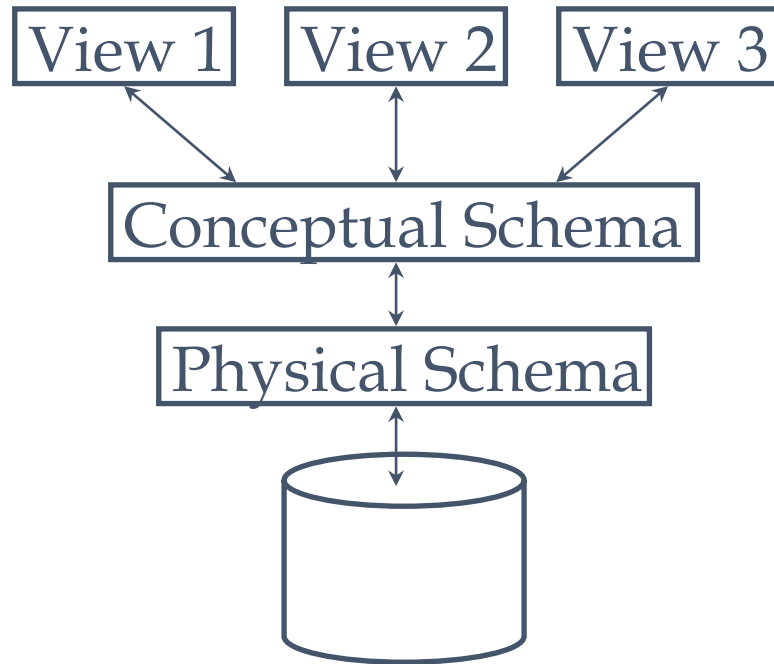
2023-Fall

Data Model

- Hierarchical Data Model

- Network Data Model

- Relational Data Model

- Entity-relationship Data Model

- ……

Data Schema

- A *__schema__* is a description of a particular collection of data, using a given data model.

Example: University Database

Conceptual schema:
- *Students(sid: string, name: string, login: string, age: integer, gpa:real)*
- *Courses(cid: string, cname:string, credits:integer)*
- *Enrolled(sid:string, cid:string, grade:string)*

Physical schema:
- Relations stored as unordered files.
- Index on first column of Students.

External Schema (View):
- *Course_info(cid:string,enrollment:integer)*

View 1   View 2   View 3

Conceptual Schema

Physical Schema

History of Database Systems

- 1950s and early 1960s:
    - Data processing using magnetic tapes for storage
        - Tapes provided only sequential access
    - Punched cards for input

- Late 1960s and 1970s:
    - Hard disks allowed direct access to data
    - Network and hierarchical data models in widespread use
    - Ted Codd defines the relational data model
        - Would win the ACM Turing Award for this work
        - IBM Research begins System R prototype
        - UC Berkeley (Michael Stonebraker) begins Ingres prototype
        - Oracle releases first commercial relational database
    - High-performance (for the era) transaction processing

History of Database Systems (Cont.)

- 1980s:
    - Research relational prototypes evolve into commercial systems
        - SQL becomes industrial standard
    - Parallel and distributed database systems
        - Wisconsin, IBM, Teradata
    - Object-oriented database systems
- 1990s:
    - Large decision support and data-mining applications
    - Large multi-terabyte data warehouses
    - Emergence of Web commerce

History of Database Systems (Cont.)

- 2000s
  - Big data storage systems
    - Google BigTable, Yahoo PNuts, Amazon,
    - "NoSQL" systems.
  - Big data analysis: beyond SQL
    - Map reduce and friends
- 2010s
  - SQL reloaded
    - SQL front end to Map Reduce systems
    - Massively parallel database systems
    - Multi-core main-memory databases

Classification

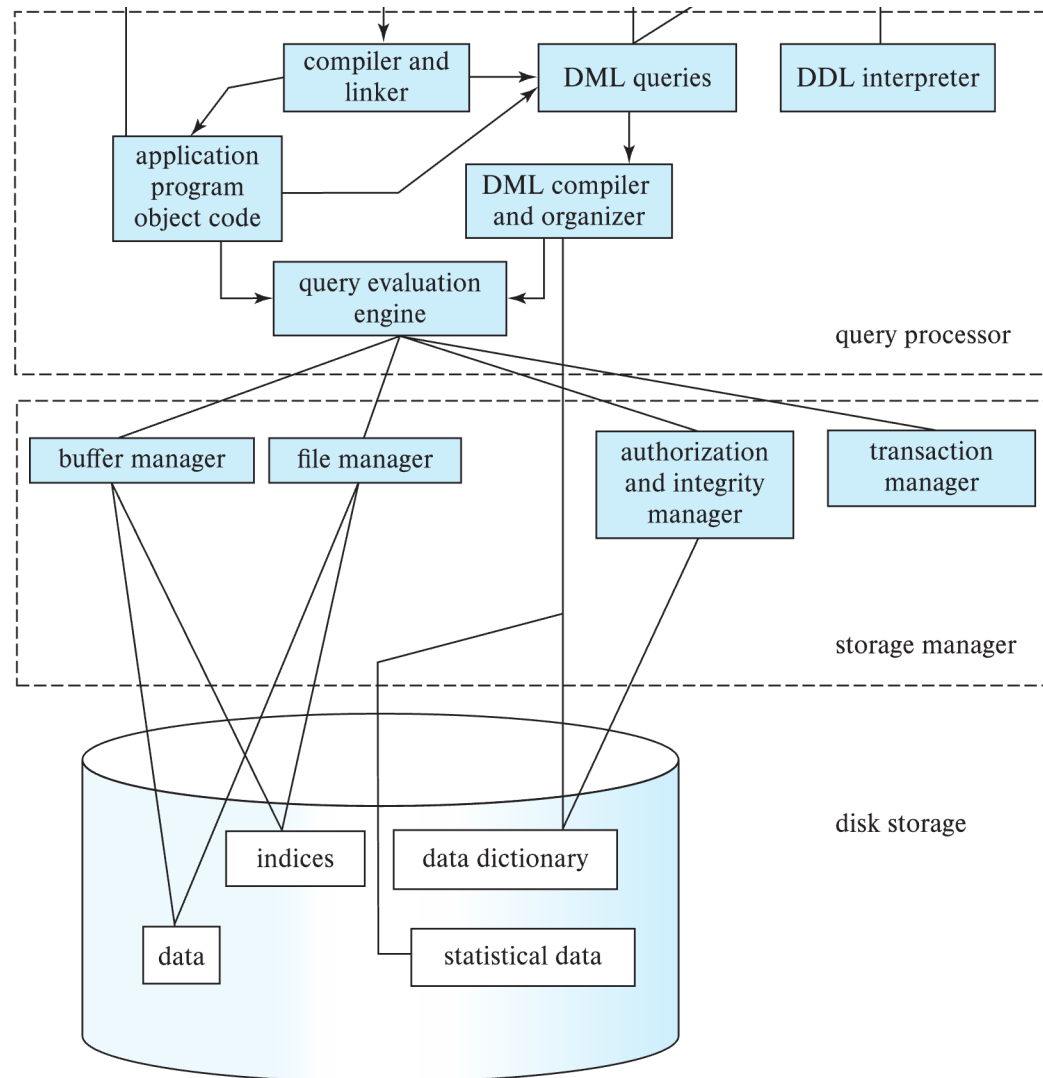**(1) According to the development of data model**

- No management (before 1960'): Scientific computing

- File system: Simple data management

- Demand of data management growing continuously, DBMS emerged.

    - 1964, the first DBMS (American): IDS, network
    - 1969, the first commercial DBMS of IBM, hierarchical
    - 1970, E.F.Codd(IBM) bring forward relational data model
    - Other data model: Object Oriented, deductive, ER, …

Classification

2) **According to the development of DBMS architectures**

- Centralized database systems

- Parallel database systems

- Distributed database systems

- Mobile database systems

Database Architecture (Centralized/Shared-Memory)

Classification

(3) According to the development of architectures of application systems based on databases

- Centralized structure : Host + Terminal

- Distributed structure

- Client/Server structure

- Three tier/multi-tier structure

- Mobile computing
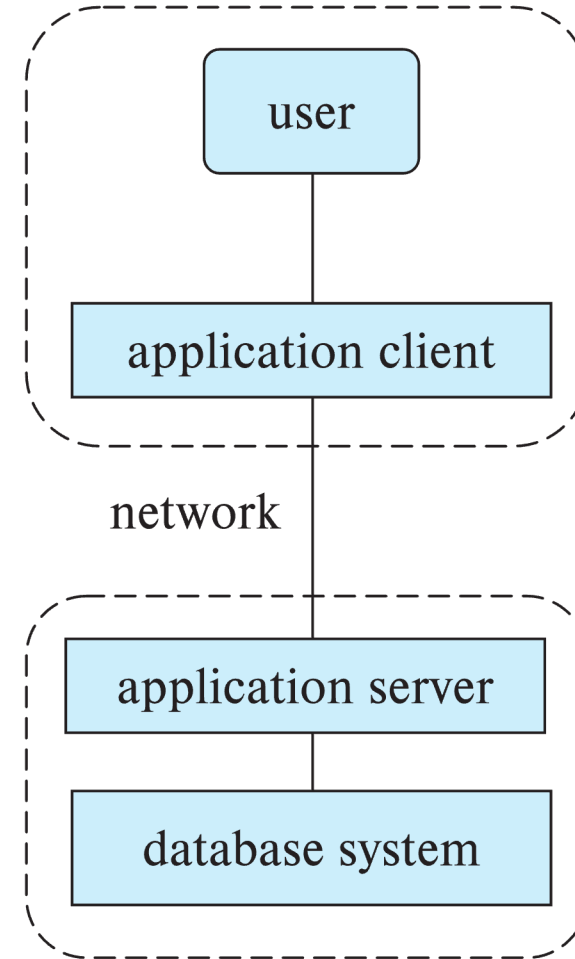
- Grid computing / Cloud computing

Two-tier and three-tier architectures
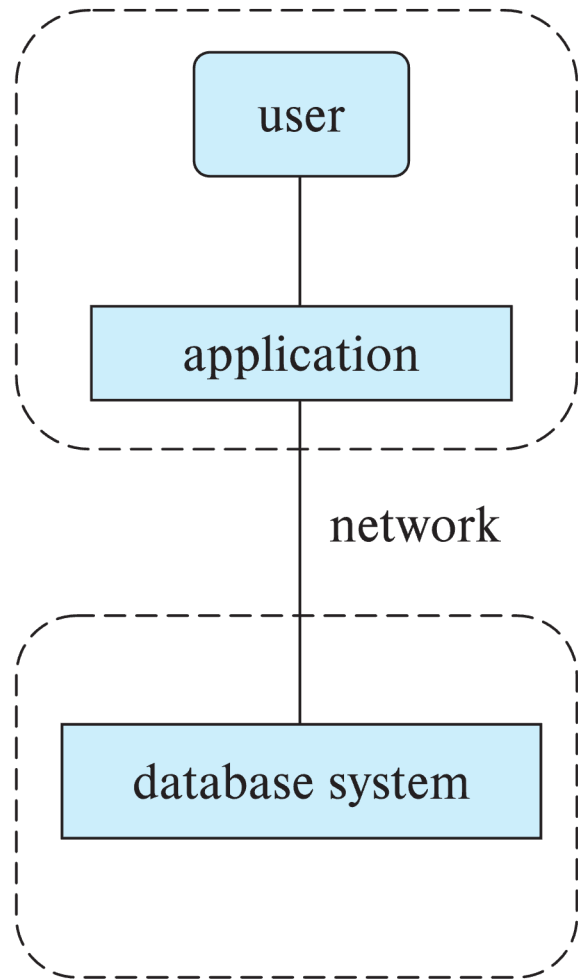

(a) Two-tier architecture

(b) Three-tier architecture

Classification

(4) According to the expanding of application fields

- On-line Transaction Processing (OLTP)
- Engineering Database
- Multimedia Database
- Temporal Database
- Spatial Database
- Data Warehouse, On-line Analytical Processing (OLAP), Data Mining
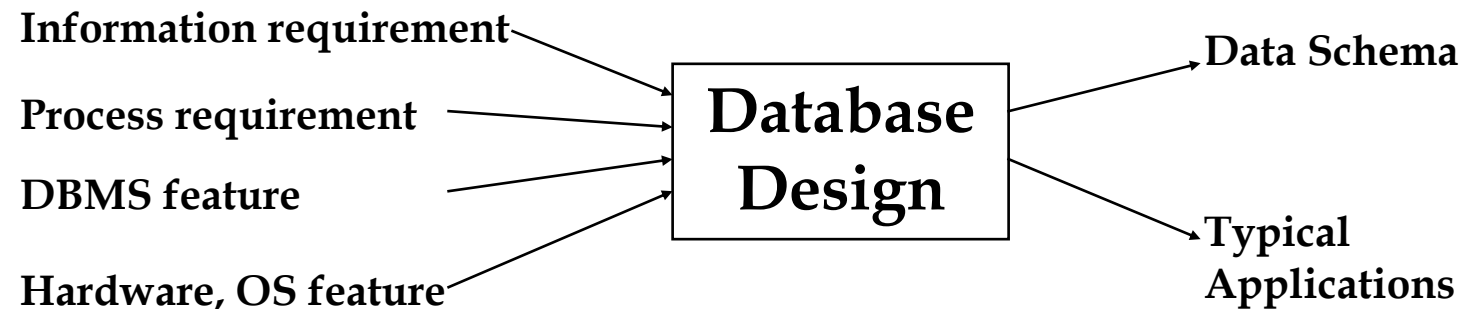- Deductive Database, Knowledge Management
- … …

Database System
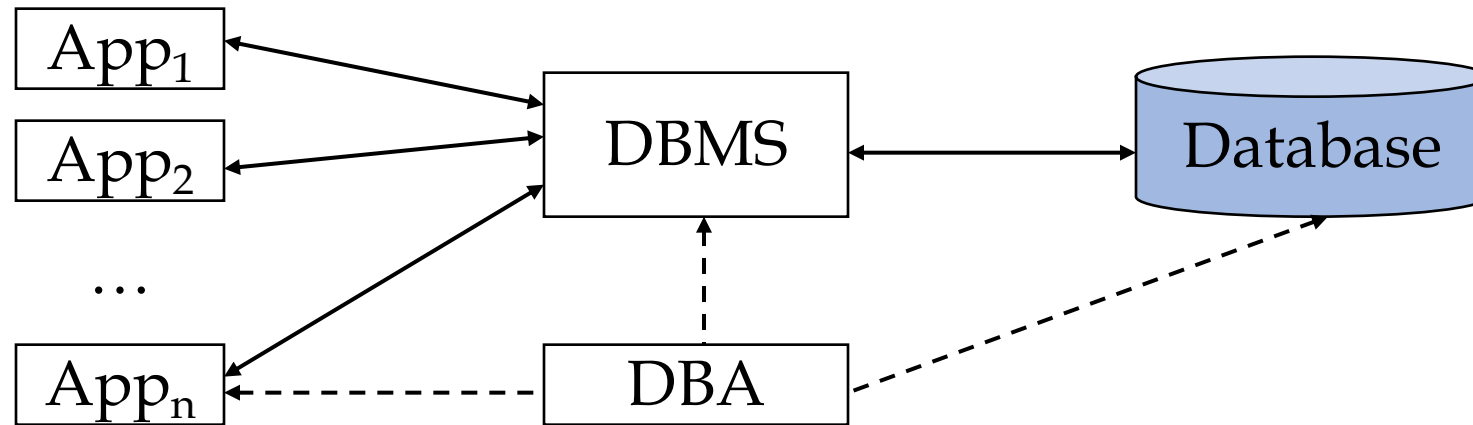
- **Applications + DBMS + Database + DBA**
- **DBMS is the core of database system**
  - High level user interfaces
  - Query processing and optimization
  - Catalog management
  - Concurrency control and Recovery
  - Integrity constraints checking
  - Access control

Life cycle of database systems

- Database system planning

- Database designing

- Database establishing and loading

- Database running, managing and maintaining

- Database extending and restructuring

Information requirement → Database Design → Data Schema

Process requirement →

DBMS feature →

Hardware, OS feature →

→ Typical Applications

Summary

- What Is Database, DBMS, Database System, and relational DBMS?

- Files vs. Databases and why DBMS?

- What's Data, Data Model and Data Schema?

- What's ANSI-SPARC Architecture and how it supports data independence?