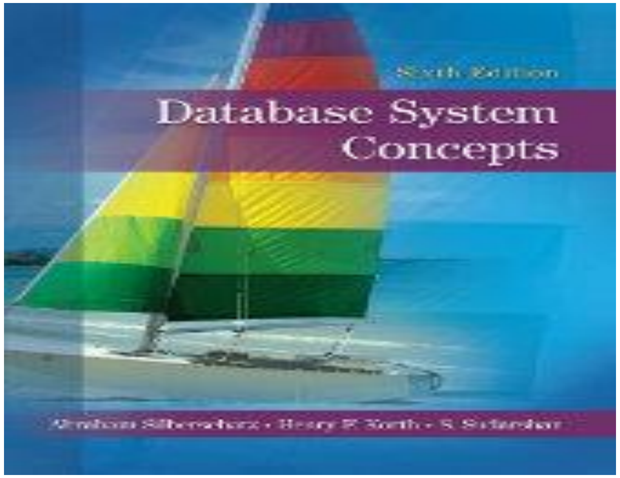
# CSE 4304
# Database Systems

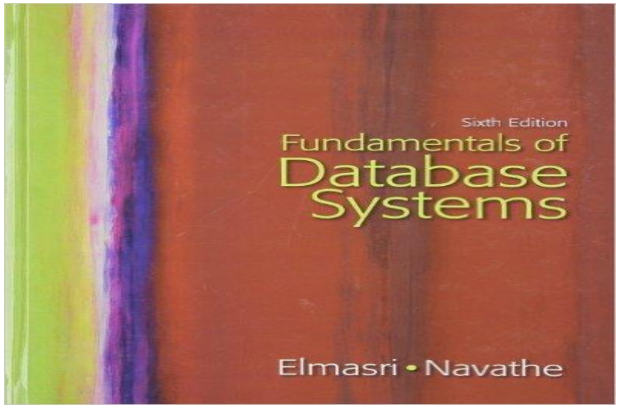
## Text Book:

Database System Concepts, 6th Edition,
Silberschatz, Korth and Sudarshan



## Reference:

“Fundamentals of Database Systems”, 6th Edition,
Ramez Elmasri and Shamkant Navathe, Pearson
Education



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# DBS: Syllabus

1. Introduction

2. DB Design and ER Model

3. SQL

4. Normalization

5. Data Storage & Indexing

6. Transactions, Concurrency Control & Recovery

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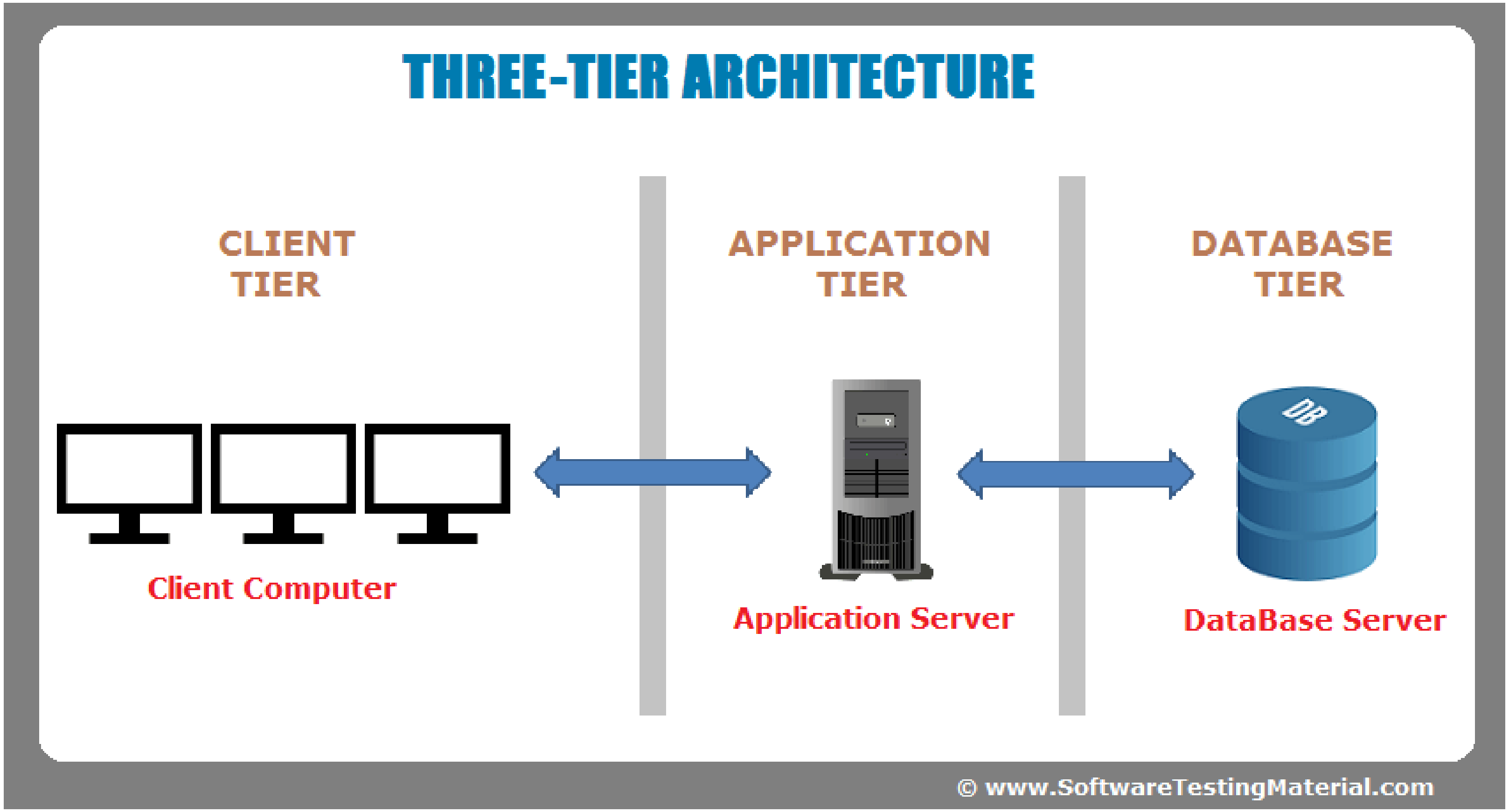
# Introduction

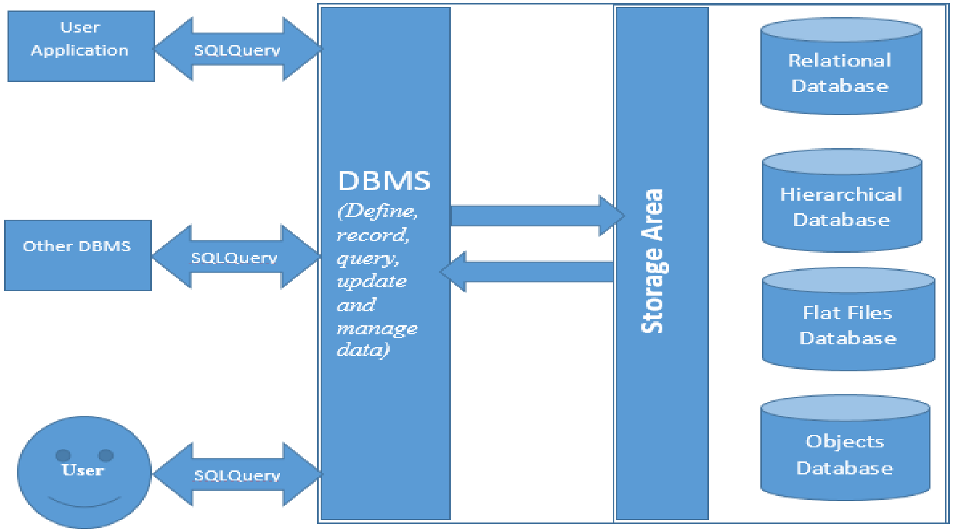
Database System Concepts, 6th Ed.

# Database Application



# Database Management System (DBMS)

- **DBMS contains information about a particular enterprise**
  - Collection of interrelated data
  - Set of programs to access the data
  - An environment that is both *convenient* and *efficient* to use



# Database Management System (DBMS)

- **Database Applications:**
  - Banking: transactions
  - Airlines: reservations, schedules
  - Universities:  registration, grades
  - Sales: customers, products, purchases
  - Online retailers: order tracking, customized recommendations
  - Manufacturing: production, inventory, orders, supply chain
  - Human resources:  employee records, salaries, tax deductions
- **Databases can be very large.**
- **Databases touch all aspects of our lives**

# University Database Example

- **Application program** examples
  - Add new students, instructors, and courses
  - Register students for courses, and generate class rosters
  - Assign grades to students, compute grade point averages (GPA) and generate transcripts

- In the early days, database applications were built directly on top of **file systems**
  - Set of files and application programs
  - For every new requirement, new files and new application programs were added

# Drawbacks of using file systems to store data

- **Data redundancy and inconsistency**
  - Multiple file formats, duplication of information in different files
- **Difficulty in accessing data**
  - Need to write a new program to carry out each new task
- **Data isolation** — multiple files and formats
- **Integrity problems**
  - Integrity constraints (e.g., account balance > 0) become “buried” in program code rather than being stated explicitly
  - Hard to add new constraints or change existing ones

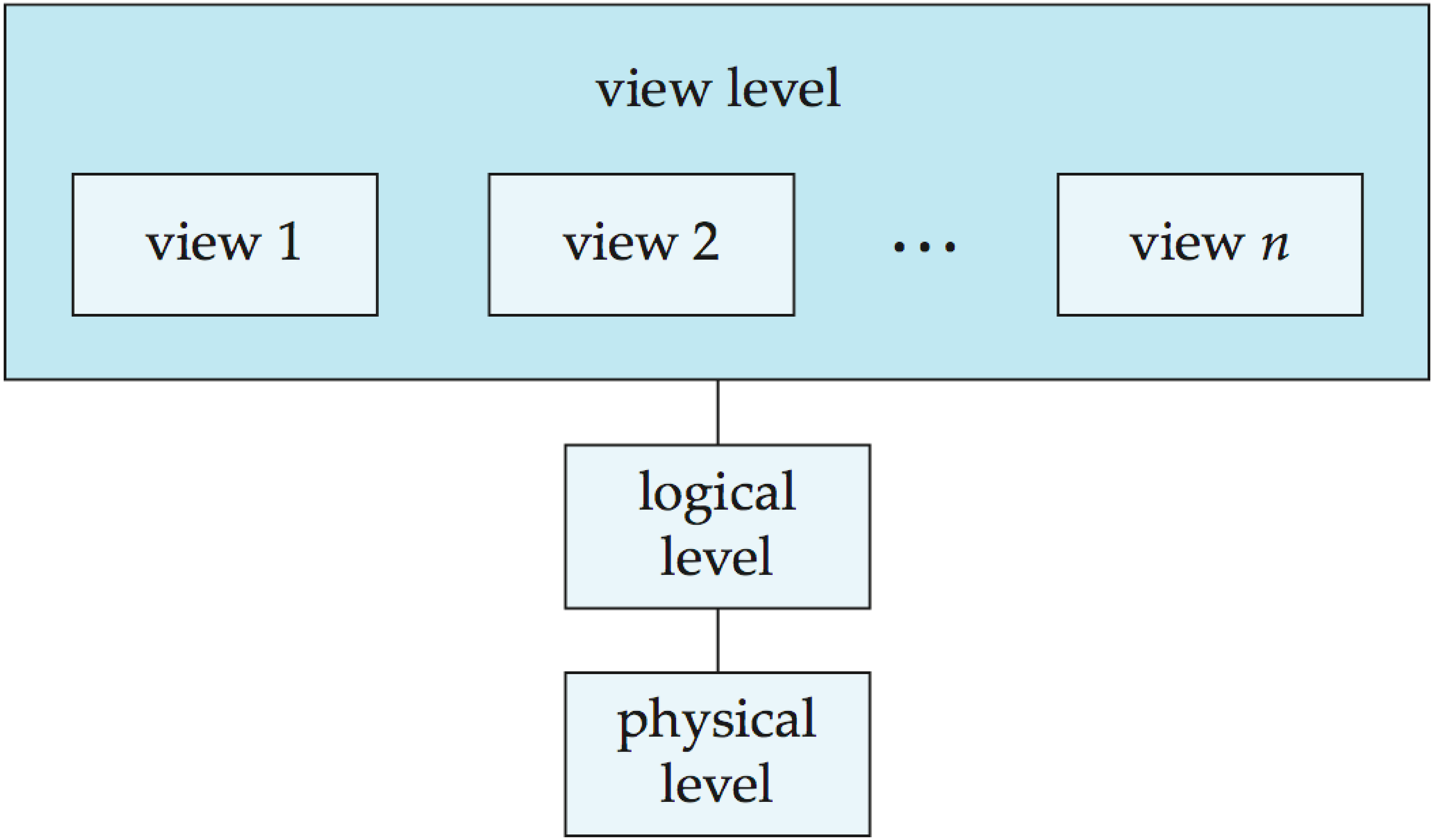
# Drawbacks of using file systems to store data (Cont.)

- **Atomicity of updates**
  - Failures may leave database in an inconsistent state with partial updates carried out
  - Example: Transfer of funds from one account to another should either complete or not happen at all
- **Concurrent access by multiple users**
  - Concurrent access needed for performance
  - Uncontrolled concurrent accesses can lead to inconsistencies
    - Example: Two people reading a balance (say 100) and updating it by withdrawing money (say 50 each) at the same time
- **Security problems**
  - Hard to provide user access to some, but not all, data

**Database systems offer solutions to all the above problems**

# View of Data

Data Abstraction



# Levels of Abstraction

- **Physical level:** describes how a record (e.g., customer) is stored.
- **Logical level:** describes data stored in database, and the relationships among the data.

```
    type instructor = record
            ID : string;
            name : string;
            dept_name : string;
            salary : integer;
        end;
```

- **View level:** application programs hide details of data types. Views can also hide information (such as an employee's salary) for security purposes.

# Instances and Schemas

- Similar to types and variables in programming languages
- **Schema** – the logical structure of the database
  - Example: The database consists of information about a set of customers and accounts and the relationship between them
  - Analogous to type information of a variable in a program
  - **Physical schema**: database design at the physical level
  - **Logical schema**: database design at the logical level
- **Instance** – the actual content of the database at a particular point in time
  - Analogous to the value of a variable
- **Physical Data Independence** – the ability to modify the physical schema without changing the logical schema
  - Applications depend on the logical schema
  - In general, the interfaces between the various levels and components should be well defined so that changes in some parts do not seriously influence others.

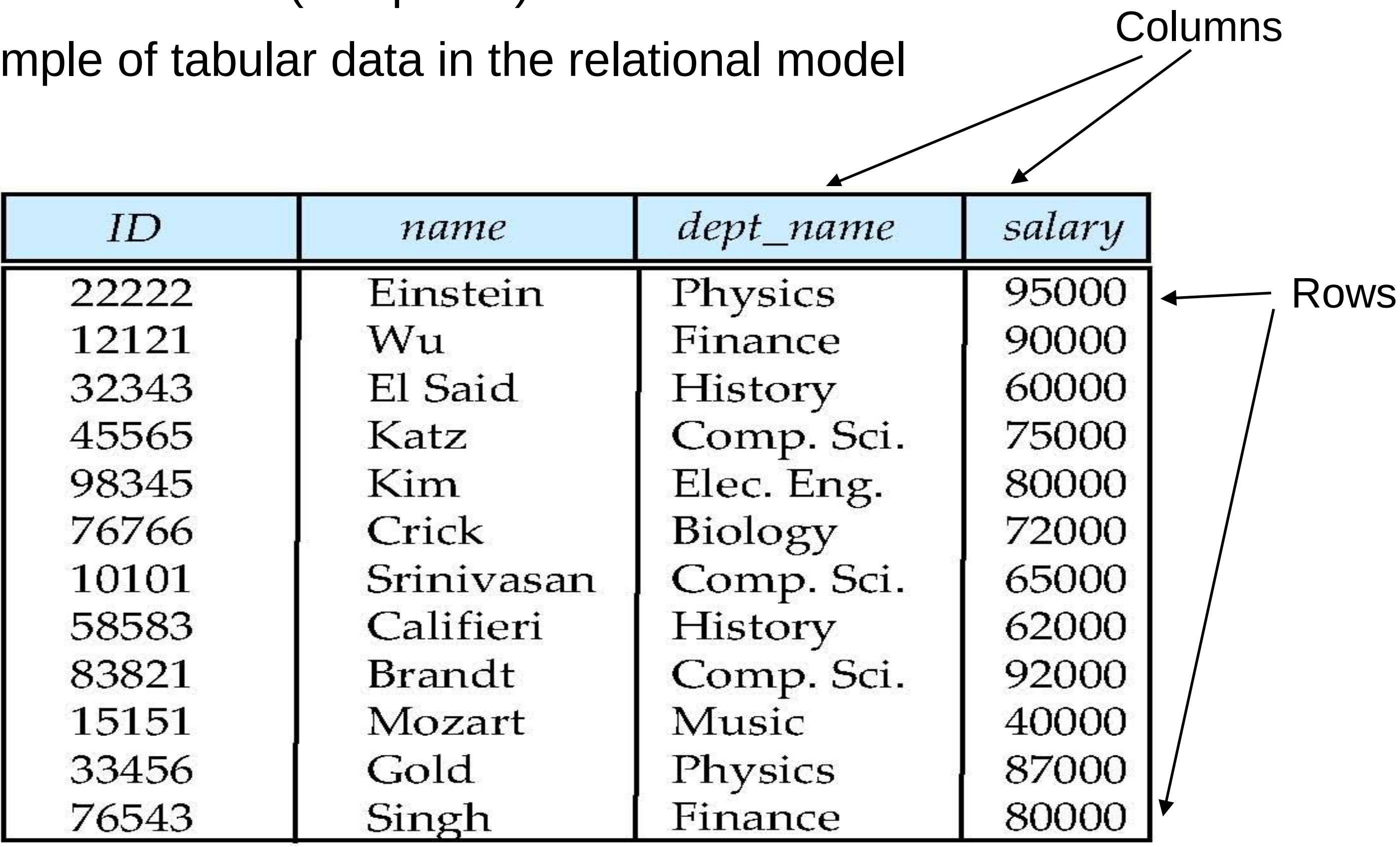
# Data Models

- A collection of conceptual tools for describing
  - Data
  - Data relationships
  - Data semantics
  - Data constraints

- Relational model
- Entity-Relationship data model (mainly for database design)
- Object-based data models (Object-oriented and Object-relational)
- Semistructured data model  (XML)
- Other older models:
  - Network model
  - Hierarchical model

# Relational Model

- Relational model (Chapter 2)
- Example of tabular data in the relational model



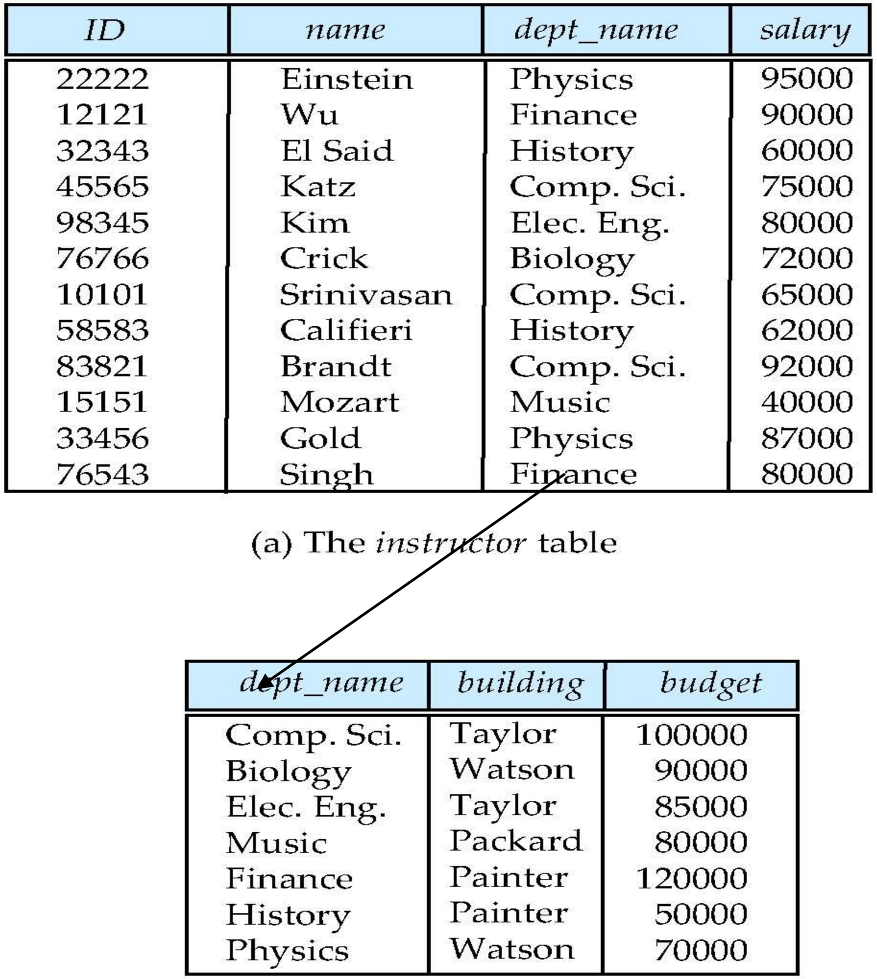
| *ID* | *name* | *dept_name* | *salary* |
|---|---|---|---|
| 22222 | Einstein | Physics | 95000 |
| 12121 | Wu | Finance | 90000 |
| 32343 | El Said | History | 60000 |
| 45565 | Katz | Comp. Sci. | 75000 |
| 98345 | Kim | Elec. Eng. | 80000 |
| 76766 | Crick | Biology | 72000 |
| 10101 | Srinivasan | Comp. Sci. | 65000 |
| 58583 | Califieri | History | 62000 |
| 83821 | Brandt | Comp. Sci. | 92000 |
| 15151 | Mozart | Music | 40000 |
| 33456 | Gold | Physics | 87000 |
| 76543 | Singh | Finance | 80000 |

Columns

Rows

(a) The *instructor* table

# A Sample Relational Database



| *ID* | *name* | *dept_name* | *salary* |
|---|---|---|---|
| 22222 | Einstein | Physics | 95000 |
| 12121 | Wu | Finance | 90000 |
| 32343 | El Said | History | 60000 |
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| 15151 | Mozart | Music | 40000 |
| 33456 | Gold | Physics | 87000 |
| 76543 | Singh | Finance | 80000 |

(a) The *instructor* table

| *dept_name* | *building* | *budget* |
|---|---|---|
| Comp. Sci. | Taylor | 100000 |
| Biology | Watson | 90000 |
| Elec. Eng. | Taylor | 85000 |
| Music | Packard | 80000 |
| Finance | Painter | 120000 |
| History | Painter | 50000 |
| Physics | Watson | 70000 |

(b) The *department* table