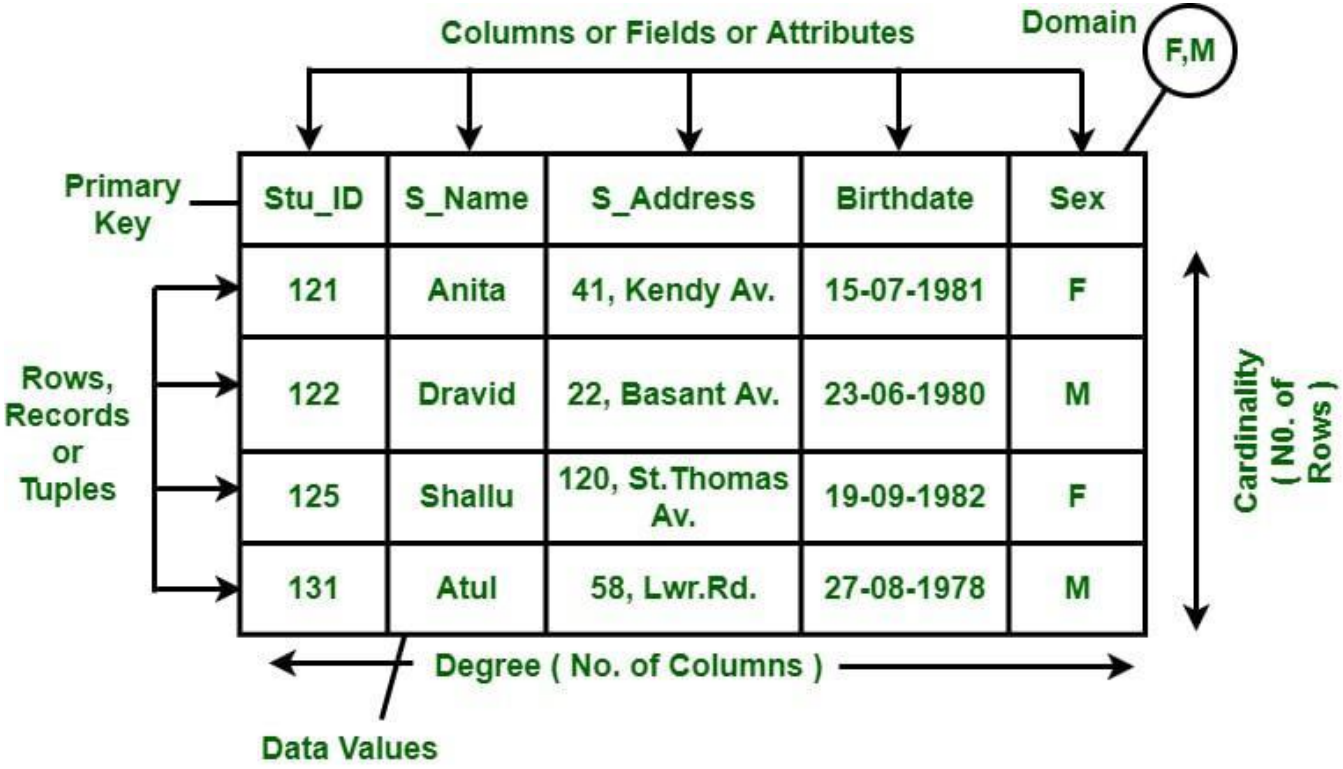
Lebanese University **Faculty of Media and Documentation** **- Section 1 -**		**الجامعة اللبنانية** **كلية الإعلام والتوثيق** **- الفرع الأول -**
Computer Science		
First Year - Semester 1		
Database 1		**Chapter 2: Relational Model of data**





1. Data Model

A data model is the main concept in the study of Database Systems

Is a set of concepts utilized for organizing data of interest and describing its structure in a way that is understood by a computer.

It is a set of concepts to describe data or information. This description includes:

1. To describe the structure of a database (DB).

DB structure: data type, relationships and constraint.

2. To do Operations on the data for manipulation these structures.

   - **Query**: Operations that retrieve information
   - **Modifications**: Operations that change the Data

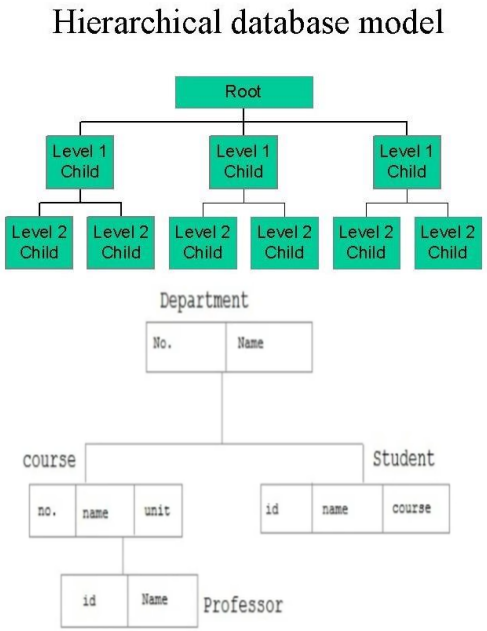
3. To put Constraints on the data that the DB should obey: A way to describe limitation on what the data can be. Example: day of the week is an integer between 1 and 7
4. Hide details of data storage.

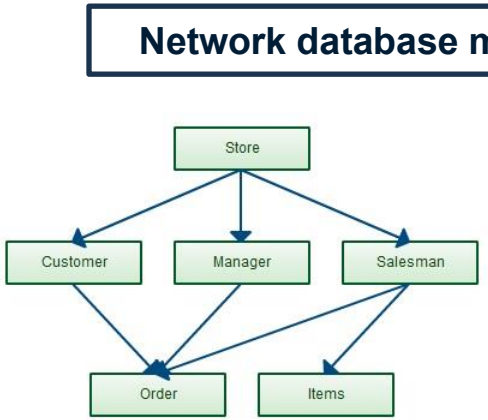
Why Data Modeling?

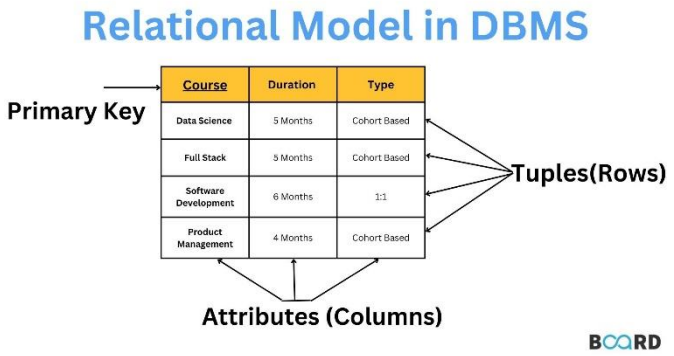
1. **Clearer Understanding of the System**
2. **Establishing a Strong Database**
3. **Reducing Programming Errors**
4. **Ease of Development and Expansion**
5. **System Documentation**
6. **Improving Future Performance**

2. Types of Data Model

- **Before the relational model, other models closer to the physical structures of storing were used:**
  - **Hierarchical Model**
  - **network Model**
- **Relational Model**
- **Entity-relationship Model**
- **Semi-structured model: Object-Oriented Model, XML, database NOSQL**









Each table is a relational model? Each relation model is a table?

Table is a relational model if:

1. **Rows contain data about instances of an entity.**
2. **Cells contain (hold) a single value**
3. **All values in a column are the same kind (data type)**
4. **The order of the columns and rows does not matter.**
5. **Each column on a table has a unique name.**
6. **No 2 rows can be identical.**

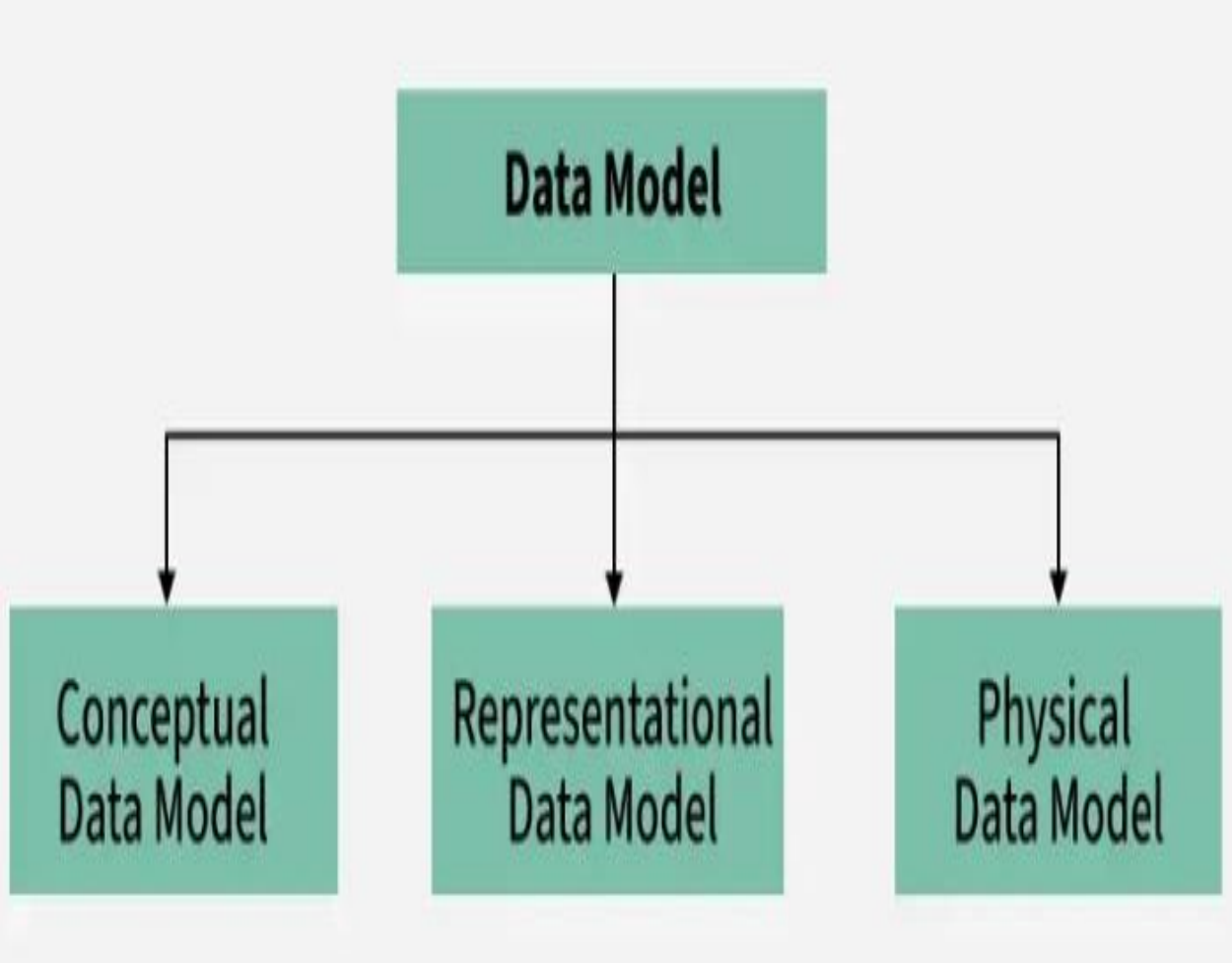
Each relational model is a table but not each table is a relational model

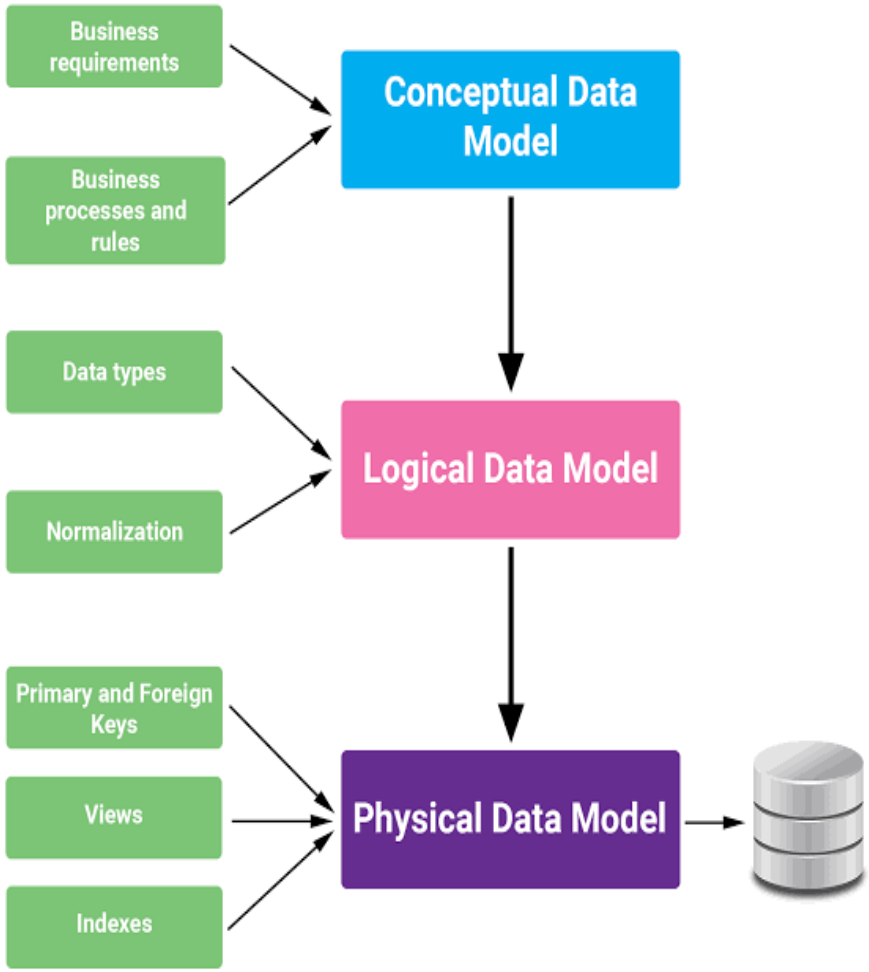
Exercise: Identify which of the following tables is a relational model

EmployeeNumber	FirstName	LastName	Salary
1	Ahmed	Mohamed	28,000
2	Ali	Khalied	31,000
3	Zainab	Mahmoud	24,000
4	Mariam	Abdelrahman	22,800

EmployeeNumber	FirstName	Phone	Salary
1	Ahmed	22334455, 88331199	28,000
2	Ali	55668844	31,000
3	Zainab	23456784	24,000
4	Mariam	11667788	22,800
2	Ali	55668844	31,000

3. Phases of data models (1)





3. Phases of data models (2)

1. Conceptual (High level, semantic) data models.

A high-level view of what needs to be stored and how different entities relate to each other.

ER: Entities (table sor relation)-Attributes (field name or features or columns)-Relationships

In C data are stored as arrays. In java data are stored as objects. In database data are stored as conceptual model.

2. Logical or representational or implementational (mid-level, internal) data models: It is more detailed than conceptual data model specifying attributes and relationships.

ER: Entities (tables or relation)-Attributes (field name)-Relationships- Datatypes

3. Physical (Low level, internal) data models: conceptual → physical

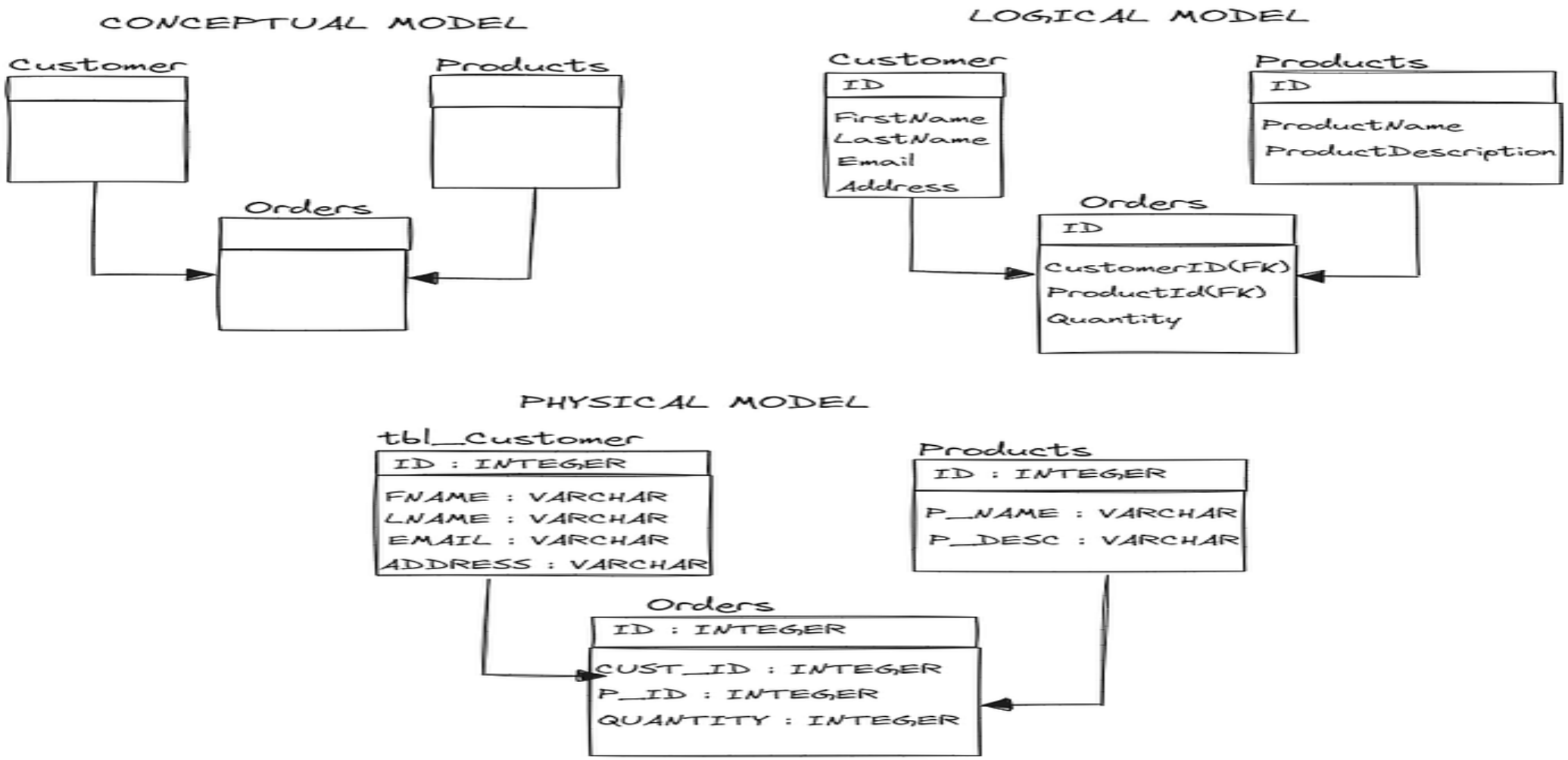
Specifies how the data will be stored considering database technologies and constraints.

ER: Entities (tables-relation)-Attributes (field name)-Relationships- Datatypes- Field size (lengths) – Key Fields



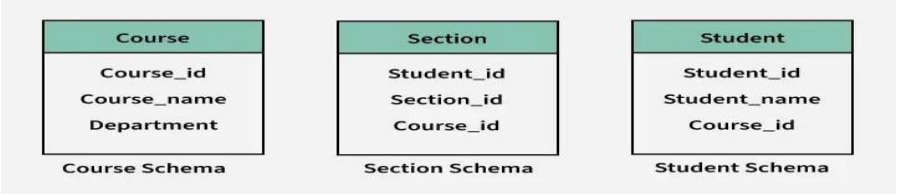
What is the output of each phase?

3. Phases of data models-Example (3)

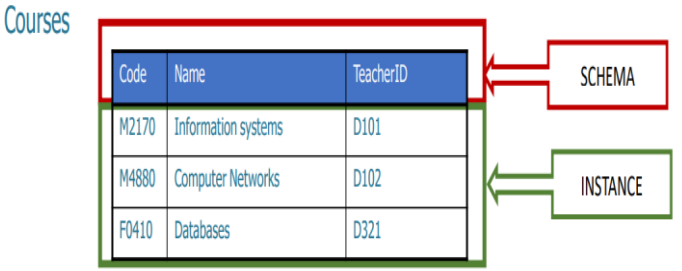


4. ER- Database Schemas (Design)

A database schema is the design or structure of a database that defines how data is organized and how different data elements relate to each other. It acts as a blueprint, outlining tables, fields, relationships, and rules that govern the data.



1. **DB schema:** The description of DB (structure, data types and constraints).
2. **Schema diagram (ER): It is a visual representation of a DB schema.** Data models represent database schemas as diagrams
3. **Schema construct:** Each object in the schema such as student, course,…
4. **DB instance:** consists of the contents of each table (actual Values of the data)



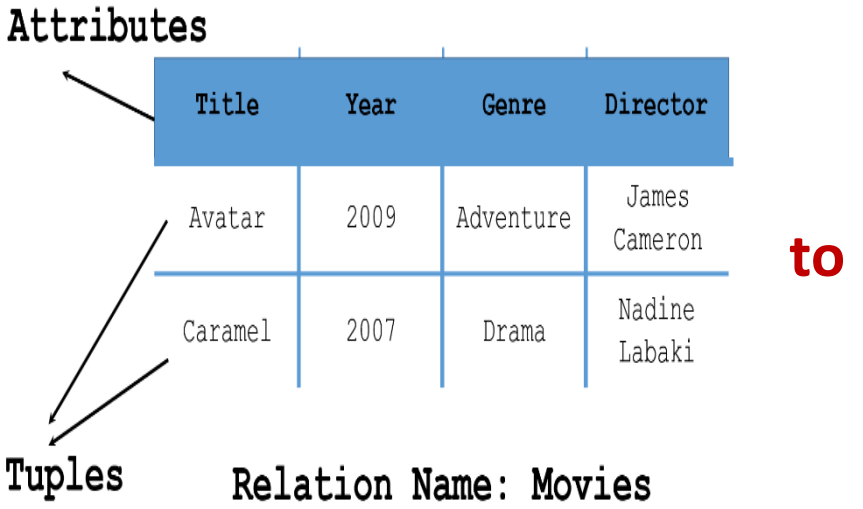
- The actual data in the DB may change quite frequently (add new student, ..)
- **The data in DB at a particular moment in time is called a DB state or DB instances or the current set of occurrences (snapshot).**
- *Schema (= model) is also called intension and state (=real data) is also named extension.*
  The Schema (or description) of a relation is denoted by R(A1,A2,A3,….) where R is the name of the entity and A1,A2,A3,… are the attributes of the relation R
  Schema: Students (id, name, birthDate, email) – State: (1, "Alice", 2000-01-01, "alice@email.com")
- **The DB schema changes very infrequently but the DB state changes every time the DB is updated.**

5. The Relational Model (ER Model concepts)

- It's a conceptual data model based on tables
- ER Model stands for Entity Relationship Model.
- ER Model allows us to sketch DB schema designs.

Designs are pictures called ER diagrams.

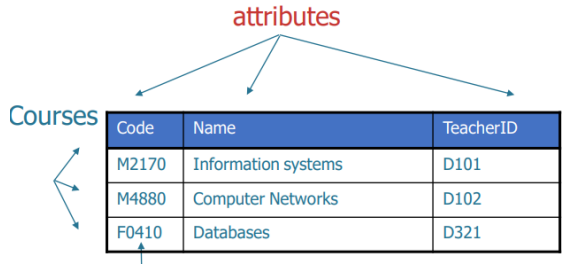
- It's developing a very simple and easy design to view data.
- It's a diagram that presents entities and relationships between entities.



6. Basics of relational models

The ER model includes:

- **Entities:** Real world objects (Person- car) or Thing (document) or concepts (Course). ex.: Courses
- **Attributes:** Name of a table column: properties used to describe an entity. ex.: Code, Name,TeacherID
- **Domains:** Each attribute has a domain or a set of valid values. The domain is a set of values that can be assumed by an attribute. Ex: The domain of teacherID(D101+D102-D321)



The domain is defined by a type. A type is the class of atomic values (Attributes are simple values, e.g. integers or character strings, not structures, lists, etc.)

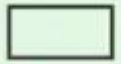
- **Relationships:** relate 2 or more entities with a specific meaning.
- **Schemas:** Movies(title, year, genre, director)
- **Tuples: Table rows**
- **Relation Instance**
- **Keys: An attribute (or set of attributes) that we don't allow two tuples to have the same value for. (underline it/ them in relation schema)**

Example

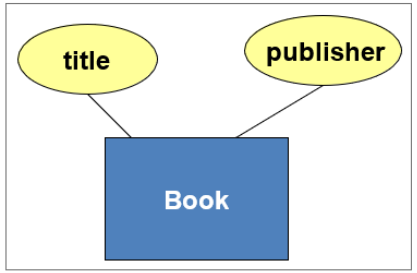
Movies(<u>title</u>, year, genre, director)

Cardinality = number of tuples in a relation (table) – Degree = number of attributes in a tables

7. Symbols used in ER diagram

Figures	Symbols	Represents
Rectangle		Entities in ER Model
Ellipse		Attributes in ER Model
Diamond		Relationships among Entities
Line		Attributes to Entities and Entity Sets with Other Relationship Types
Double Ellipse		Multi-Valued Attributes
Double Rectangle		Weak Entity

Example of E/R diagram



https://designerdb.io/

8. Database Schema

- A database consists of one ore more relations.
- The set of schemas in the database is called a relational database schema, or just a database schema.

```
Movies(
    title:string,
    year:integer,
    length:integer,
    genre:string,
    studioName:string,
    producerC#:integer
)
MovieStar(
    name:string,
    address:string,
    gender:char,
    birthdate:date
)
```

```
StarsIn(
    movieTitle:string,
    movieYear:integer,
    starName:string
)
MovieExec(
    name:string,
    address:string,
    cert#:integer,
    netWorth:integer
)
Studio(
    name:string,
    address:string,
    presC#:integer
)
```

For more information

Entity-Relationship (ER) Model	Relational Model
• A **conceptual model** used to **design and visualize** the structure of a database before it is created. • Focuses on **entities**, **relationships**, and **attributes**. • Typically represented using **ER diagrams**. • Key concepts: Entity- Attribute – Relationship- Cardinality	• A **logical model** used to **implement** the database using tables (relations). • Focuses on relations (tables), tuples (rows), and attributes (columns). • Key concepts: Relation (Entity) - Attribute –Tuplre- Relationship- Keys

After designing the conceptual model of the Database using an ER diagram, we need to convert the conceptual model into a relational model that can be implemented using any RDBMS language like Oracle, SQL, MySQL,

https://www.geeksforgeeks.org/dbms/databse-schemas/

Difference between Logical and Physical Database Schema

Physical Schema	Logical Schema
Physical schema describes the way of storage of data in the disk.	Logical schema provides the conceptual view that defines the relationship between the data entities.
Having Low level of abstraction.	Having a high level of abstraction.
The design of database is independent to any database management system.	The design of a database must work with a specific database management system or hardware platform.
Changes in Physical schema effects the logical schema	Any changes made in logical schema have minimal effect in the physical schema
Physical schema does not include attributes.	Logical schema includes attributes.
Physical schema contains the attributes and their data types.	Logical schema does not contain any attributes or data types.
Examples: Data definition language(DDL), storage structures, indexes.	**Examples:** Entity Relationship diagram, Unified Modeling Language, class diagram.

Database schema versus database instance

Aspect	Database Schema	Database Instance
Definition	Blueprint or design of the database structure	Actual data stored in the database at a given time
Nature	Static (does not change frequently)	Dynamic (changes with every data modification)
Represents	Structure (tables, columns, data types, relationships)	State of the data in the database
Example	Table definitions, data types, constraints	Actual rows of data in the tables
Change Frequency	Changes infrequently (e.g., during schema design changes)	Changes frequently with transactions