UCS310
Database Management System

E-R Model

Lecture-11

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Recap

- Nested Subqueries
  - Set Membership – *where*
    in, not in
  - Set Comparisons – *where*
    some, all, exists, unique
  - Subqueries in *from* and *select* clause
  - *with* clause
- Modification of database – delete, insert, update
- Join operation: natural, inner, outer
- Constraints

Design Phase

- Initial phase -- characterize fully the data needs of the prospective database users.
- Second phase -- choosing a data model
  - Applying the concepts of the chosen data model
  - Translating these requirements into a conceptual schema of the database.
  - A fully developed conceptual schema indicates the functional requirements of the enterprise.
    - Describe the kinds of operations (or transactions) that will be performed on the data

Design Phase

- Final Phase -- Moving from an abstract data model to the implementation of the database
  - Logical Design – Deciding on the database schema.
    - Database design requires that we find a "good" collection of relation schemas.
    - Business decision – What attributes should we record in the database?
    - Computer Science decision – What relation schemas should we have and how should the attributes be distributed among the various relation schemas?
  - Physical Design – Deciding on the physical layout of the database

Design Alternatives

- In designing a database schema, we must ensure that we avoid two major pitfalls:
  - Redundancy: a bad design may result in repeat information.
    - Redundant representation of information may lead to data inconsistency among the various copies of information
  - Incompleteness: a bad design may make certain aspects of the enterprise difficult or impossible to model.
- Avoiding bad designs is not enough. There may be a large number of good designs from which we must choose.

Design Approaches

- Entity Relationship Model (covered in this chapter)
  - Models an enterprise as a collection of *entities* and *relationships*
    - Entity: a "thing" or "object" in the enterprise that is distinguishable from other objects
      - Described by a set of *attributes*
    - Relationship: an association among several entities
  - Represented diagrammatically by an *entity-relationship diagram:*
- Normalization Theory
  - Formalize what designs are bad, and test for them

ER Model

- The Entity-Relationship (ER) model was originally proposed by Peter in 1976
- The ER model is a conceptual data model that views the real world as entities and relationships.A basic component of the model is the Entity-Relationship diagram, which is used to visually represent data objects

ER Model – Database Modeling

- The ER data mode was developed to facilitate database design by allowing specification of an **enterprise schema** that represents the overall logical structure of a database

- The ER data model employs three basic concepts:
  - entity sets,
  - relationship sets,
  - Attributes

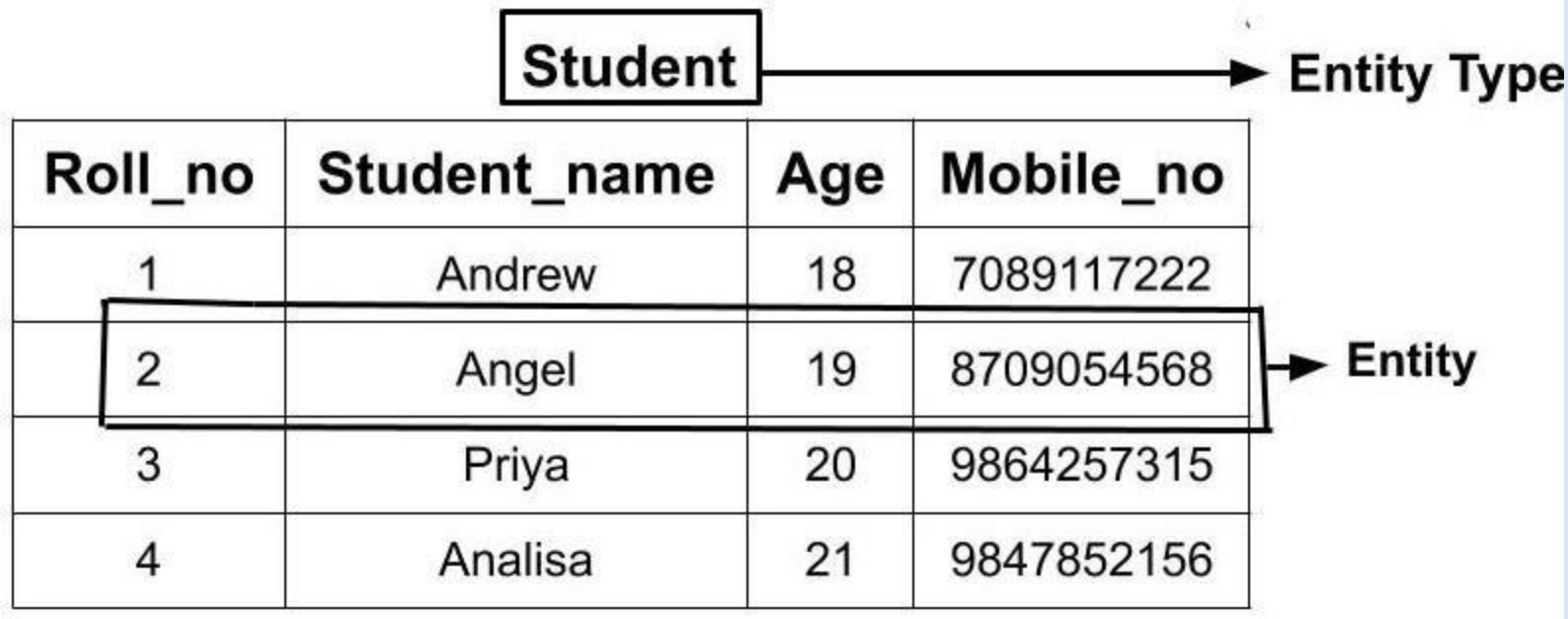
- The ER model also has an associated diagrammatic representation, the **ER diagram**, which can express the overall logical structure of a database graphically

Entity Sets

- An **entity** is an object that exists and is distinguishable from other objects.
  - Example: specific person, company, event, plant
- An **entity set** is a set of entities of the same type that share the same properties.
  - Example: set of all persons, companies, trees, holidays
- An entity is represented by a set of attributes; i.e., descriptive properties possessed by all members of an entity set.
  - Example:

    instructor = (*ID, name, salary*)
    course= (*course_id, title, credits*)
- A subset of the attributes form a **primary key** of the entity set; i.e., uniquely identifying each member of the set.

Entity



Roll_no	Student_name	Age	Mobile_no
1	Andrew	18	7089117222
2	Angel	19	8709054568
3	Priya	20	9864257315
4	Analisa	21	9847852156

Entity Sets - instructor and student

76766	Crick
45565	Katz
10101	Srinivasan
98345	Kim
76543	Singh
22222	Einstein

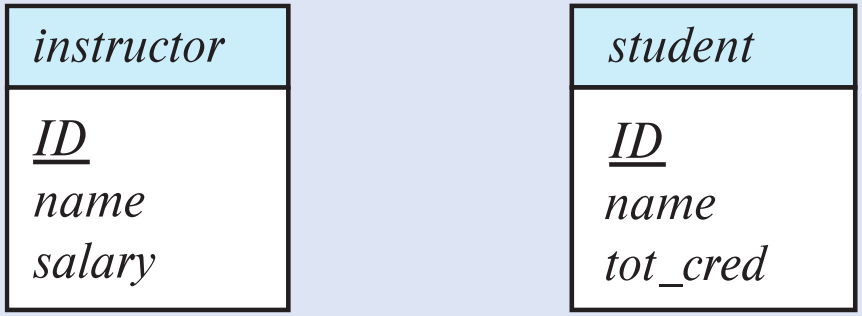
instructor

98988	Tanaka
12345	Shankar
00128	Zhang
76543	Brown
76653	Aoi
23121	Chavez
44553	Peltier

student

Representing Entity sets in ER Diagram

- Entity sets can be represented graphically as follows:
  - Rectangles represent entity sets.
  - Attributes listed inside entity rectangle
  - Underline indicates primary key attributes



Entity

- Tangible Entity: Tangible Entities are those entities which exist in the real world physically
  - Example: Person, car, etc.
- Intangible Entity: Intangible Entities are those entities which exist only logically and have no physical existence.
  - Example: Bank Account, etc
- Strong Entity: has a primary key
- Weak Entity:
  - Do not a primary key
  - Dependent on parent entity

Relationship Sets

- A **relationship** is an association among several entities

  Example:

  44553 (Peltier) — *advisor* — 22222 (Einstein)

  student entity — relationship set — *instructor* entity

- A **relationship set** is a mathematical relation among $n \geq 2$ entities, each taken from entity sets

$$\{(e_1, e_2, \ldots e_n) \mid e_1 \in E_1, e_2 \in E_2, \ldots, e_n \in E_n\}$$

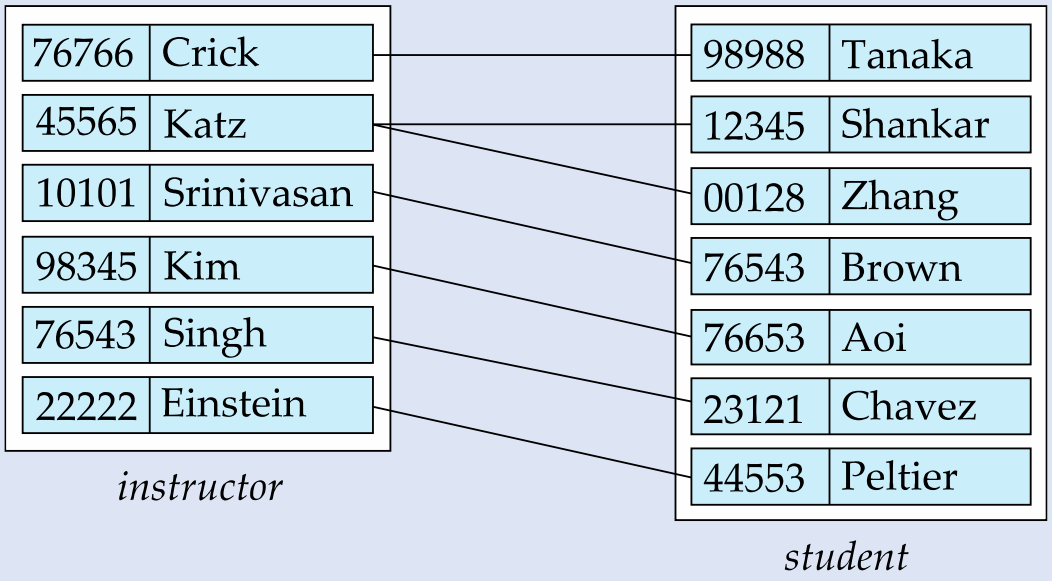
  where $(e_1, e_2, \ldots, e_n)$ is a relationship

  - Example:

$$(44553,22222) \in advisor$$

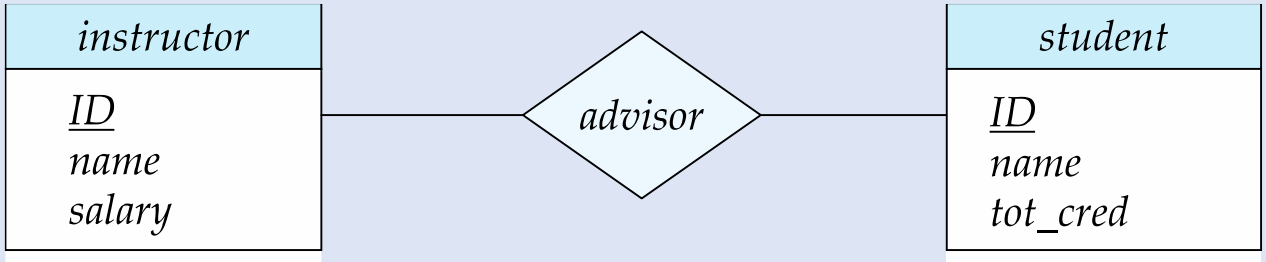
Relationship Sets

- Example: we define the relationship set *advisor* to denote the associations between students and the instructors who act as their advisors.
- Pictorially, we draw a line between related entities



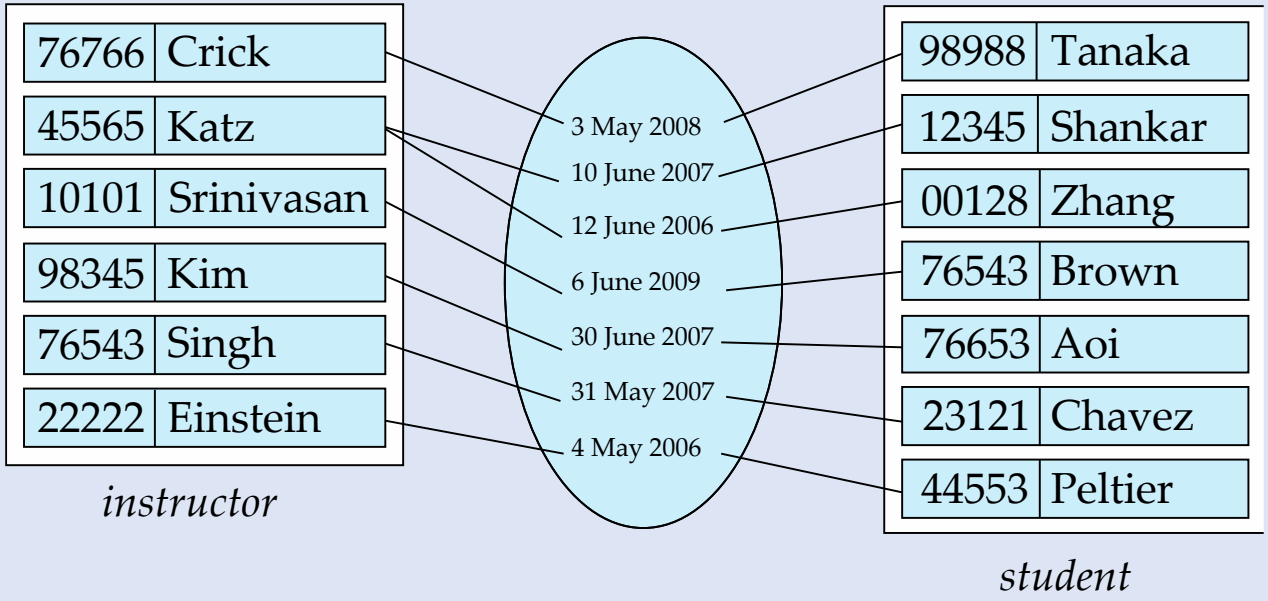
Representing Relationship Sets via ER Diagrams

- Diamonds represent relationship sets.

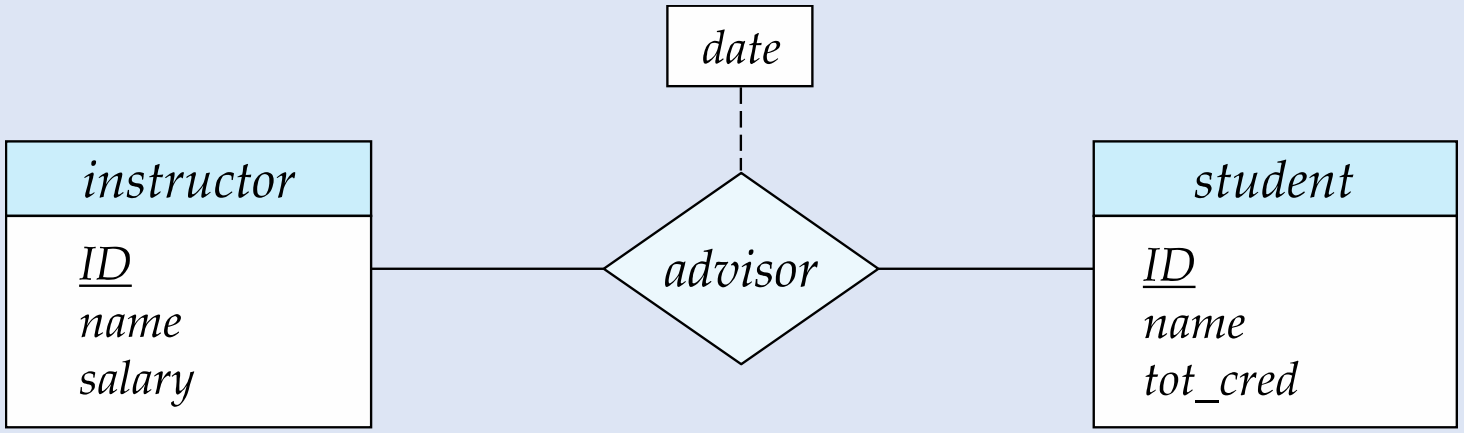


Relationship Sets

- An attribute can also be associated with a relationship set
- For instance, the *advisor* relationship set between entity sets *instructor* and *student* may have the attribute *date* which tracks when the student started being associated with the advisor

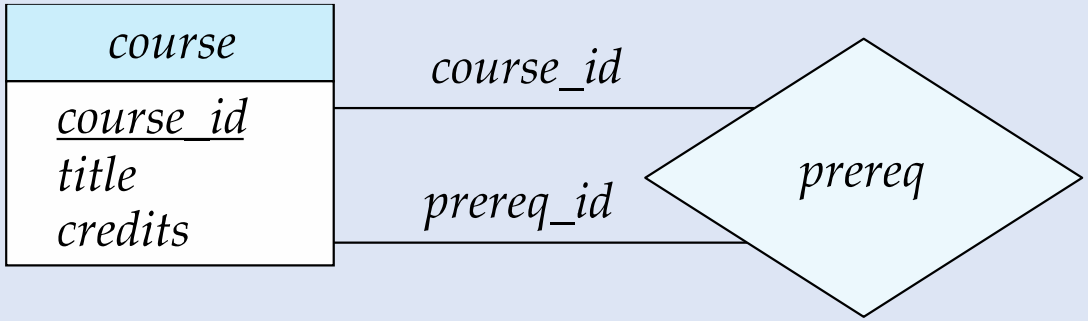


Relationship Sets with Attributes



Design Phase

- Entity sets of a relationship need not be distinct
  - Each occurrence of an entity set plays a "role" in the relationship
- The labels "*course_id*" and "*prereq_id*" are called **roles**.



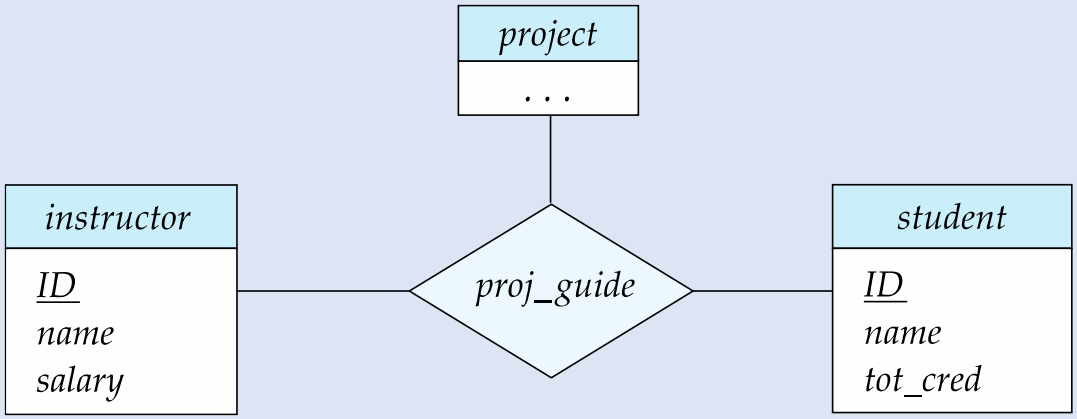
Degree of a Relationship Set

- Binary relationship
  - involve two entity sets (or degree two).
  - most relationship sets in a database system are binary

- Relationships between more than two entity sets are rare. Most relationships are binary. (More on this later.)
  - Example: *students* work on research *projects* under the guidance of an *instructor*
  - relationship *proj_guide* is a ternary relationship between *instructor*, *student*, and *project*

Non-binary Relationship Sets

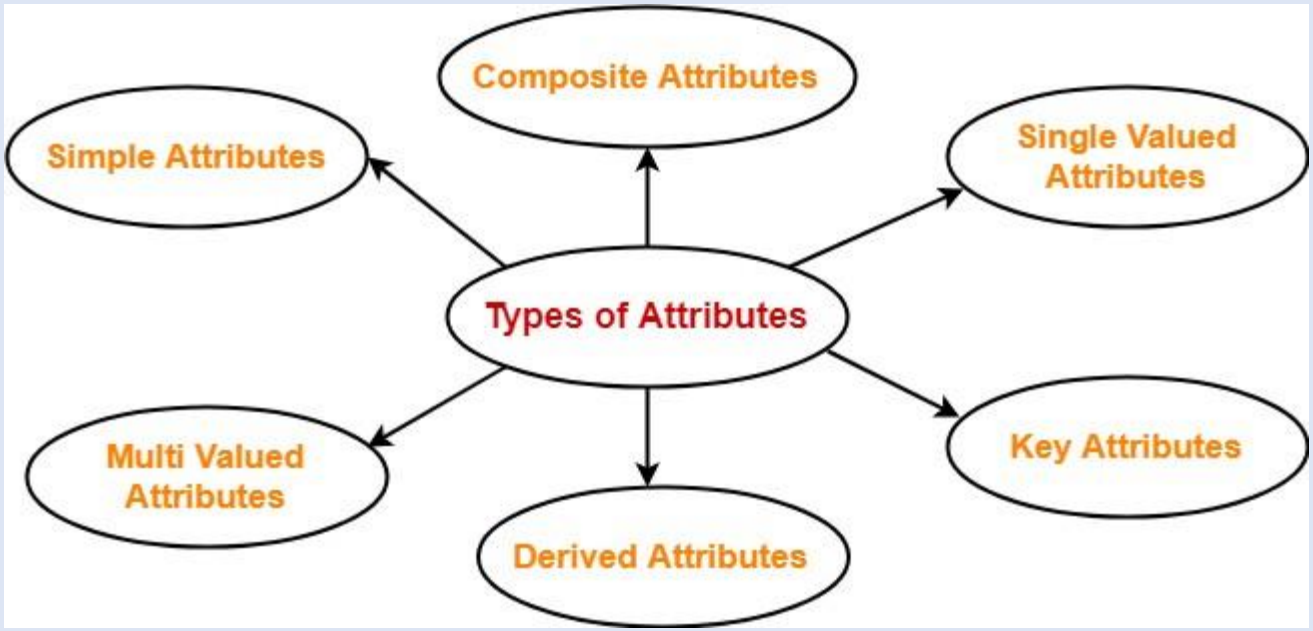
- Most relationship sets are binary
- There are occasions when it is more convenient to represent relationships as non-binary
- E-R Diagram with a Ternary Relationship



Complex Attributes

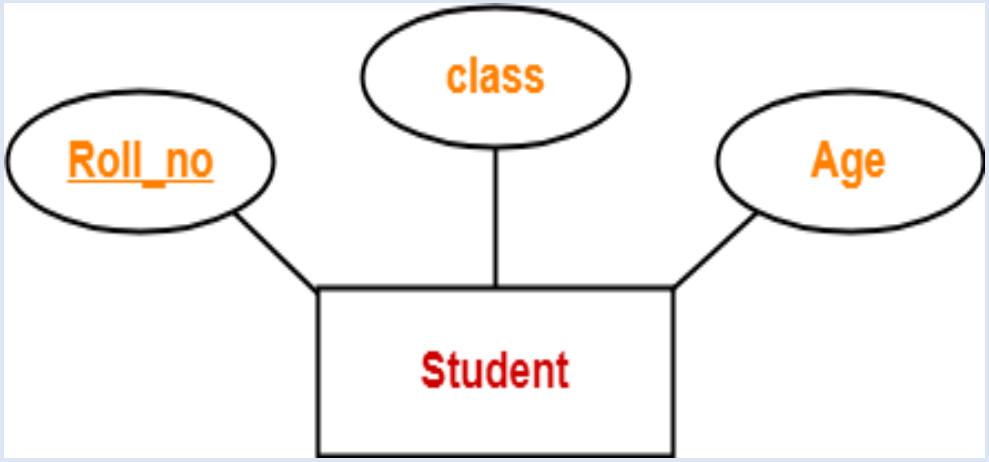
- Attribute types:
  - **Simple** and **composite** attributes.
  - **Single-valued** and **multivalued** attributes
    - Example: multivalued attribute: *phone_numbers*
  - **Derived** attributes
    - Can be computed from other attributes
    - Example: age, given date_of_birth
- **Domain** – the set of permitted values for each attribute

Attributes


Composite Attributes
Simple Attributes
Single Valued Attributes
Types of Attributes
Multi Valued Attributes
Key Attributes
Derived Attributes

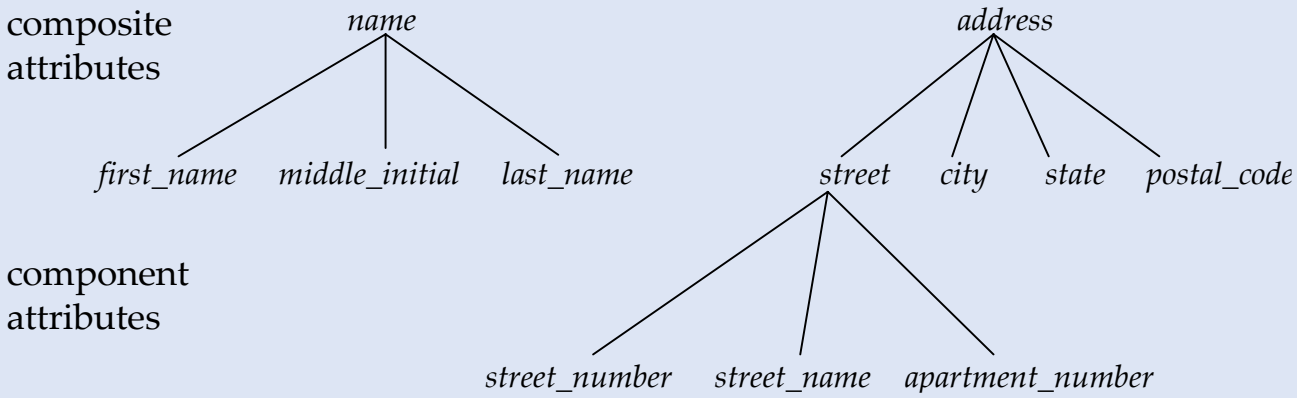
Simple Attributes

- Simple attributes are those attributes which can not be divided further



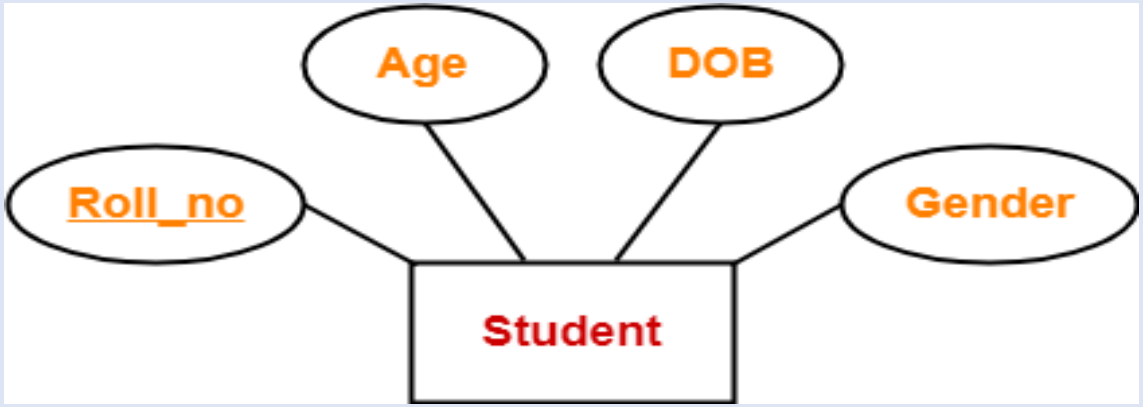
Composite Attributes

- Composite attributes allow us to divided attributes into subparts (other attributes).



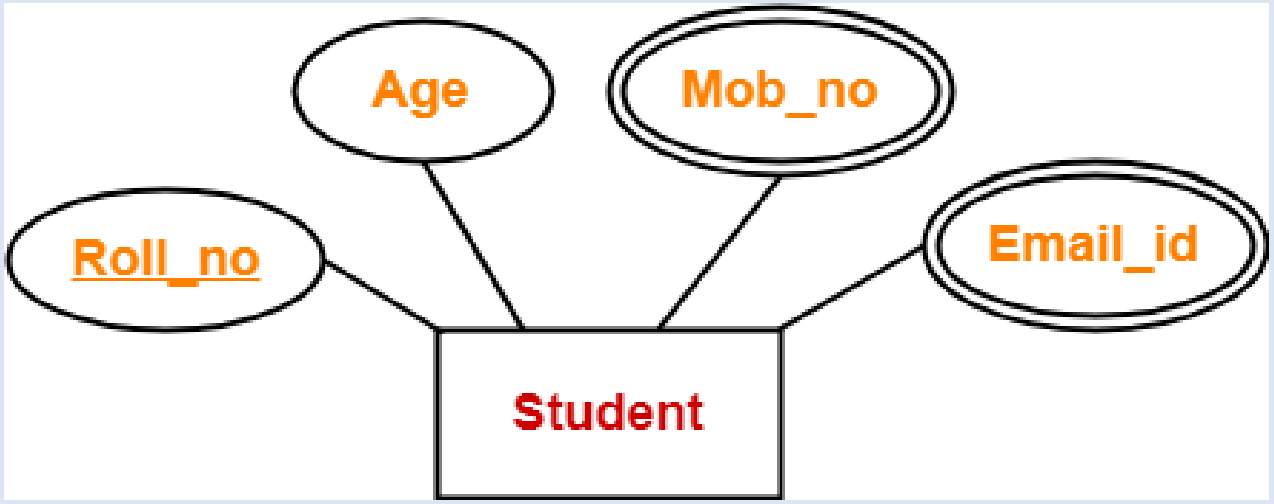
Single Valued Attributes

- Single valued attributes are those attributes which can take only one value for the given entity from an entity set



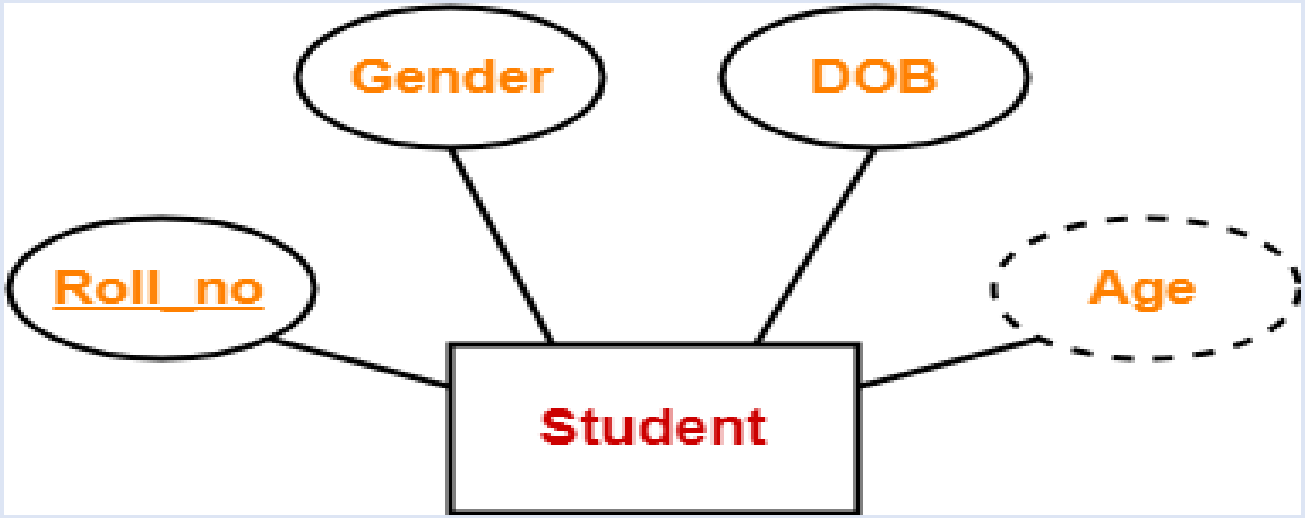
Multi Valued Attributes

- Multi valued attributes are those attributes which can take more than one value for the given entity from an entity set



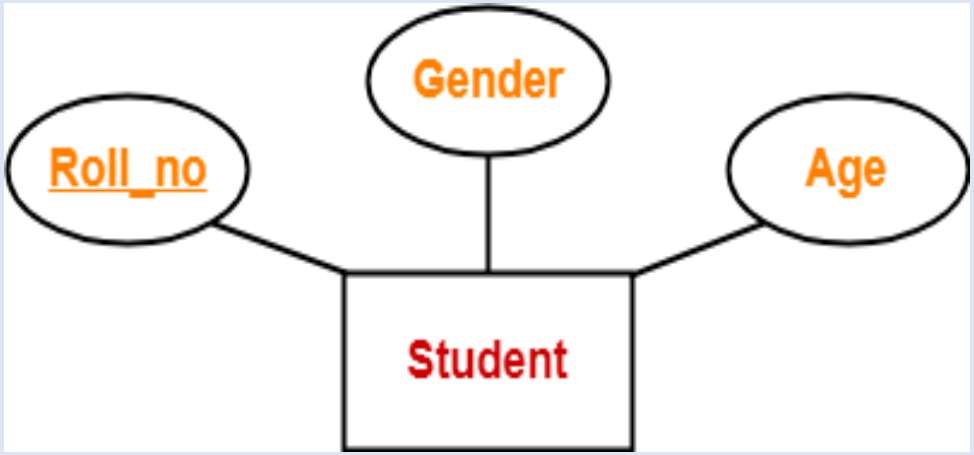
Derived Attributes

- Derived attributes are those attributes which can be derived from other attribute(s)

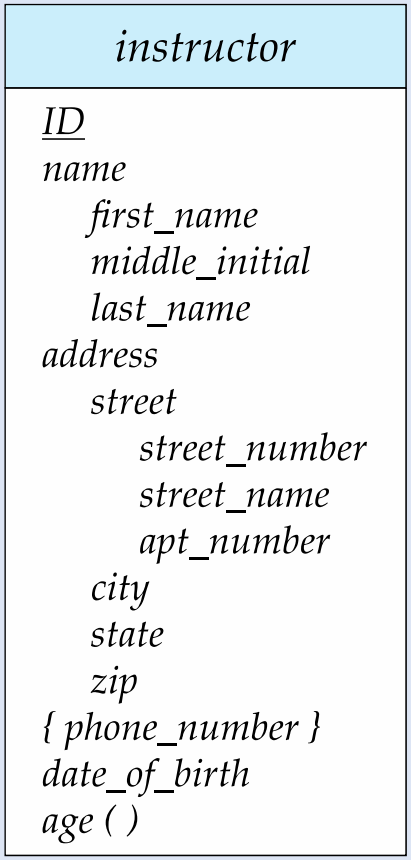


Key Attributes

- Key attributes are those attributes which can identify an entity uniquely in the entity set



Representing Complex Attributes in ER Diagram

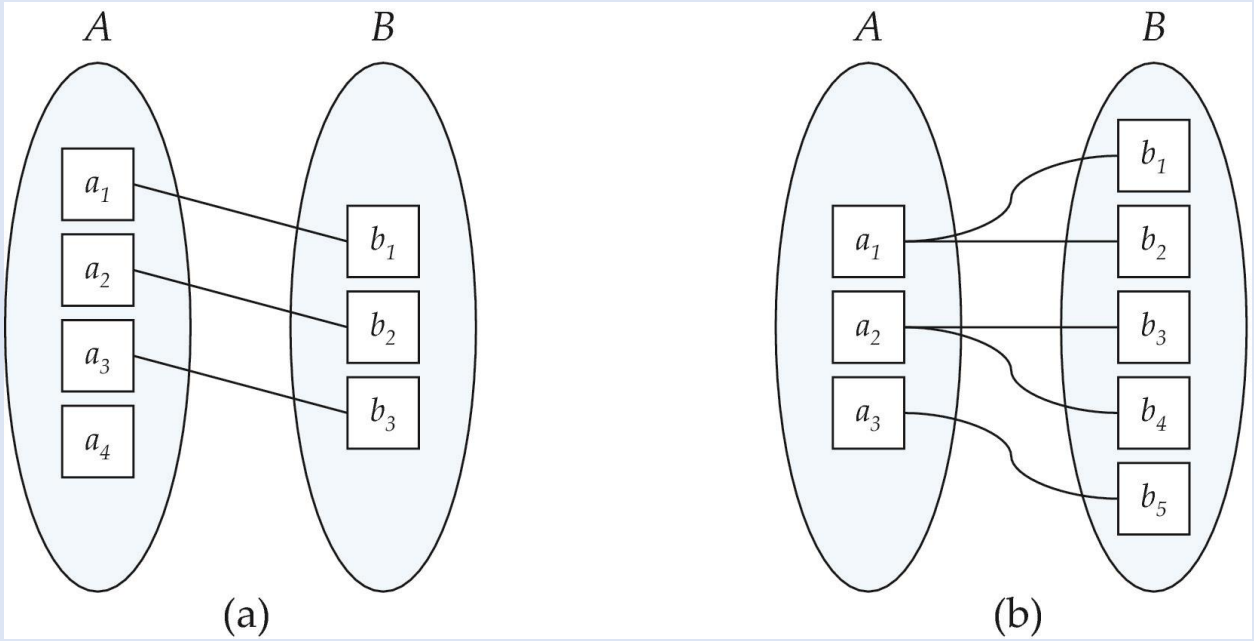


Mapping Cardinality Constraints

- Express the number of entities to which another entity can be associated via a relationship set.
- Most useful in describing binary relationship sets

- For a binary relationship set the mapping cardinality must be one of the following types:
  - One to one
  - One to many
  - Many to one
  - Many to many

Mapping Cardinalities

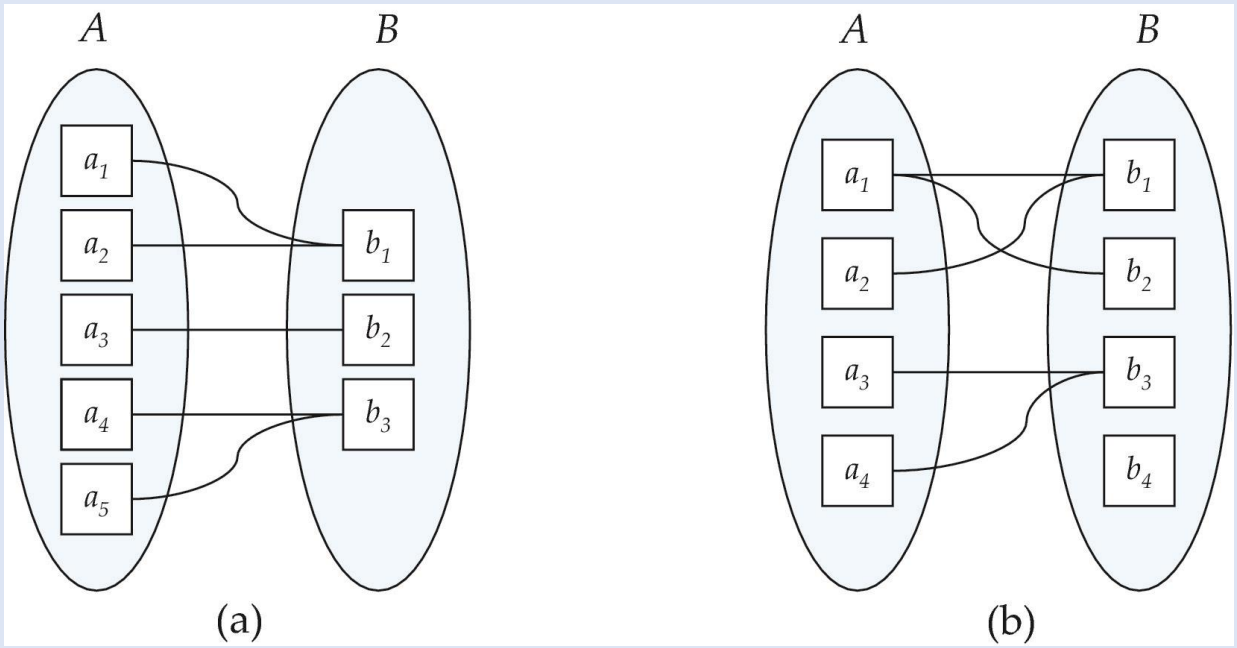


One to one

One to many

Note: Some elements in A and B may not be mapped to any elements in the other set

Mapping Cardinalities



Many to one

Many to many

Note: Some elements in A and B may not be mapped to any elements in the other set

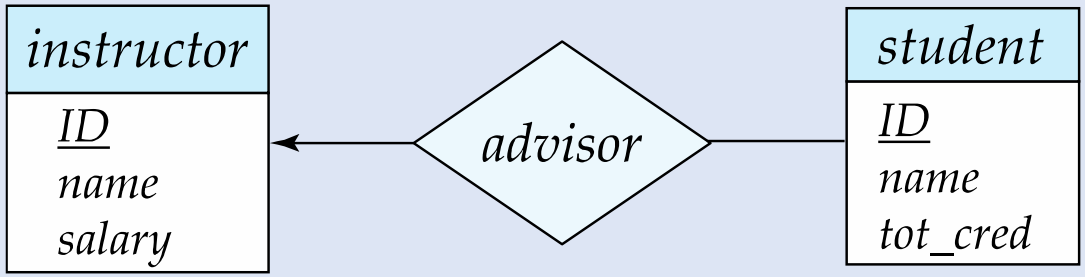
Representing Cardinality Constraints in ER Diagram

- We express cardinality constraints by drawing either a directed line (→), signifying "one," or an undirected line (—), signifying "many," between the relationship set and the entity set.

- One-to-one relationship between an *instructor* and a *student* :
  - A student is associated with at most one *instructor* via the relationship *advisor*
  - A *student* is associated with at most one *department* via *stud_dept*

One-to-Many Relationship

- one-to-many relationship between an *instructor* and a *student*
  - an instructor is associated with several (including 0) students via *advisor*
  - a student is associated with at most one instructor via advisor,

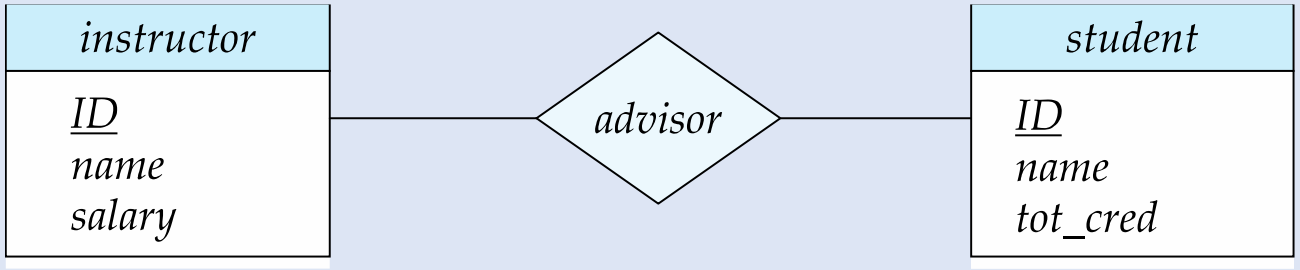


Many-to-One Relationships

- In a many-to-one relationship between an instructor and a student,
  - an instructor is associated with at most one student via advisor,
  - and a student is associated with several (including 0) instructors via advisor

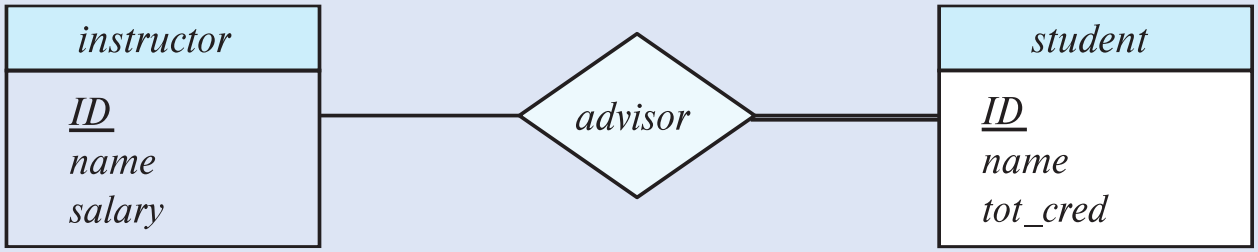
Many-to-Many Relationship

- An instructor is associated with several (possibly 0) students via *advisor*
- A student is associated with several (possibly 0) instructors via *advisor*



Total and Partial Participation

- **Total participation** (indicated by double line): every entity in the entity set participates in at least one relationship in the relationship set



participation of *student* in *advisor* relation is total

  - every *student* must have an associated instructor

- **Partial participation**: some entities may not participate in any relationship in the relationship set
  - Example: participation of *instructor* in *advisor* is partial

Thanks!