# DATABASE ESSENTIALS

*Lecture 3*

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# DATABASE DESIGN

- Creating a database application involves the following activities:-
  - ✓designing of the database schema
    - o is the logical design of the database
  - ✓designing of the programs that access and update the data
  - ✓designing of a security scheme to control access to data
- The needs of the users always play a central role in the design process.

# DATABASE DESIGN…

**Design Phases**

The database design phases are as follows:-

- Initial phase
- Conceptual design phase
- Logical design phase
- Physical design phase

# DATABASE DESIGN…

**Design Phases**

Initial phase

- This phase characterize fully the data needs of the prospective database users.
- The database designer interacts extensively with domain experts and users to carry out this task.
- The outcome of this phase is a specification of user requirements.

# DATABASE DESIGN…

**Design Phases**

Conceptual design phase

- This phase involves using a Entity-Relationship (E-R) model to translate user requirements into a conceptual schema of the database.

- This schema provides a detailed overview of the enterprise.

- This phase results in the creation of an E-R diagram that provides a graphic representation of the schema.

# DATABASE DESIGN…

**Design Phases**

Conceptual design phase

- The designer has to review the schema to confirm that all data requirements are satisfied and are not in conflict with one another.

- The designer also, has to examine the design to remove any redundant features.

- The E-R diagram focuses on describing the data and their relationships, rather than on specifying physical storage details.

# DATABASE DESIGN…

**Design Phases**

Conceptual design phase

- A fully developed conceptual schema also indicates:-
  - ✓*the functional requirements*
    - operations (or transactions) that will be performed on the data.
    - Example
      - modifying or updating data
      - searching for and retrieving specific data
      - deleting data

# DATABASE DESIGN…

**Design Phases**

Conceptual design phase

- A fully developed conceptual schema also indicates:-
  - ✓*the attributes of the entities*
  - ✓*the relationships among the entities*
  - ✓*constraints on the entities*
  - ✓*relationships*

# DATABASE DESIGN…

**Design Phases**

Logical design phase

- This phase involves mapping the conceptual schema onto the relational data model.

Physical design phase

- This phase involves specifying the physical features of the database.
- This include the physical storage media.

# DATABASE DESIGN…

- The physical schema of a database can be changed easily after an application has been built.
- Logical schema are harder to change after an application has been built.
- Changes to the logical schema may affect a number of queries and updates scattered across application code.

# DATABASE DESIGN…

When designing a database schema, always avoid the following pitfalls:

- Redundancy
  - ✓caused by repeated information
  - ✓leads to inconsistency
    - information is updated without taking precautions to update all copies of the information.

# DATABASE DESIGN…

When designing a database schema, always avoid the following pitfalls:

- Incompleteness
  - ✓this happens when some data are missing
  - ✓this might make certain aspects of the enterprise difficult or impossible to model

# DATA MODELS

- Data model refers to a collection of conceptual tools for describing data, data relationships, data semantics, and consistency constraints.

- Data models include but not limited to:-
  - ✓Entity-Relationship (E-R) model
  - ✓Relational model

# ENTITY-RELATIONSHIP (E-R) MODEL

- E-R model is a graphical approach to database design that shows how entities are related to each other.

- It maps the meanings and interactions of real world enterprises onto a conceptual schema.

# ENTITY-RELATIONSHIP (E-R) MODEL

- It provides a means of identifying entities to be represented in the database and how those entities are related.

- The E-R data model employs three basic concepts:
  - ✓entity sets
  - ✓relationship sets
  - ✓attributes

# ENTITY-RELATIONSHIP (E-R) MODEL

**Terminologies**

**Enterprise**

- Enterprise refers to any kind of organization.
- Example: colleges, schools, banks, company

# ENTITY-RELATIONSHIP (E-R) MODEL

## Terminologies

### Entity

- Entity refers to an object or thing in real world.

- An entity may be concrete, such as a person or a book, or it may be abstract, such as a course, or a flight reservation.

- Example:
  - ✓students of colleges and schools
  - ✓loans in banks
  - ✓employees in a company

# ENTITY-RELATIONSHIP (E-R) MODEL

## Terminologies

### Attributes/properties

- These are the characteristics of any entity.

- *Example:*
  1. A student can be described by his/her student id, name, age, address, height, class
  2. Loans can be described by their types such as house loan, car loan
  3. Employees in a company can be described by their Employee ID, name, department, designation

# ENTITY-RELATIONSHIP (E-R) MODEL

## Terminologies

### Value

- Value is the information or data which is stored in attributes of any entity.

- *Example:*

| attribute | value |
|---|---|
| student_id | *0001* |
| name | *Clatous* |
| age | *30* |
| address | *Mbezi* |

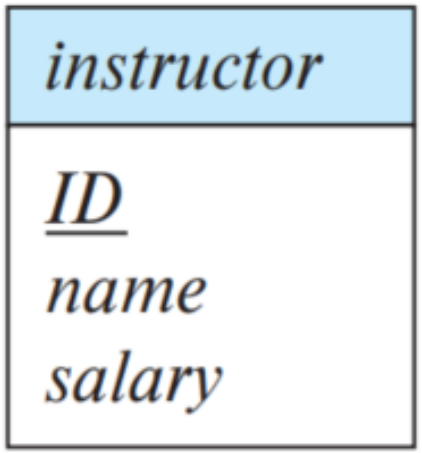
# ENTITY-RELATIONSHIP (E-R) MODEL

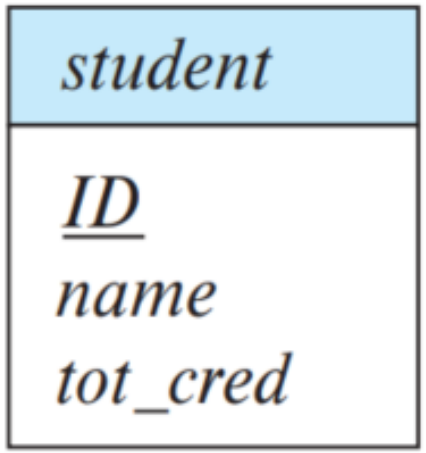
## Terminologies

### Entity Sets

- All the entities having same attributes make an entity set.

- An entity set is represented in an E-R diagram by a **rectangle**, which is divided into two parts
  - ✓First part contains the name of the entity set, the second part contains the names of all the attributes of the entity set.



# ENTITY-RELATIONSHIP (E-R) MODEL

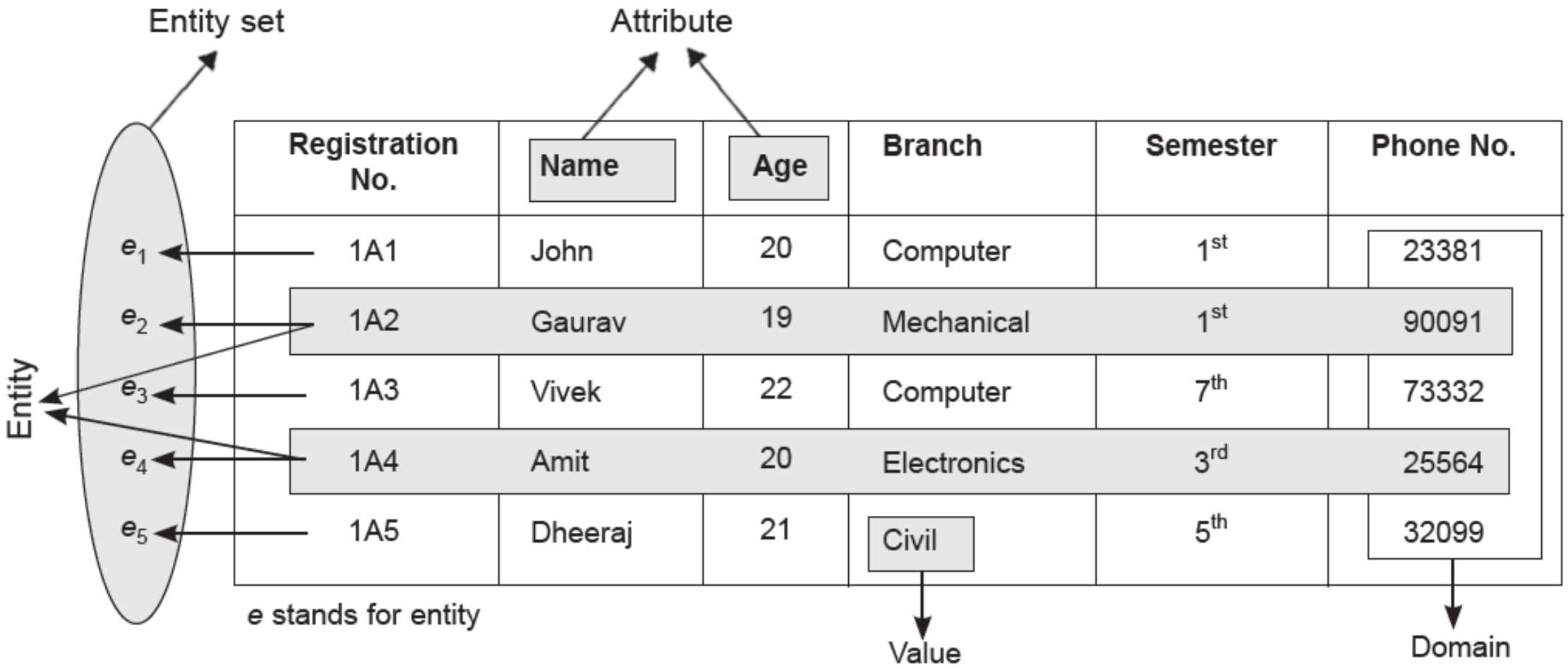
## Terminologies

### Domain

- Domain or value set is the set of all values or information about any attribute.

# ENTITY-RELATIONSHIP (E-R) MODEL

## Terminologies

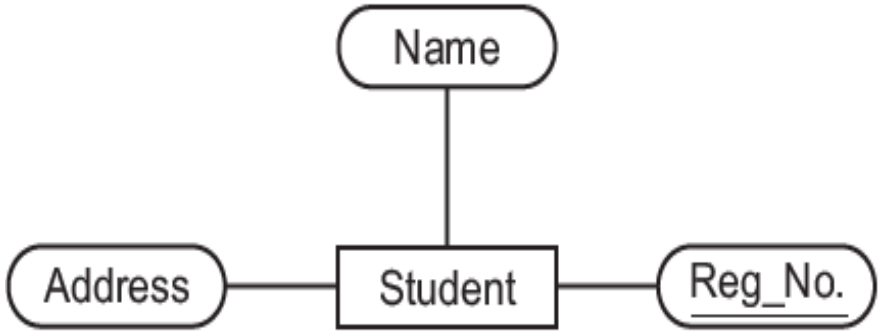



| Registration No. | Name | Age | Branch | Semester | Phone No. |
|---|---|---|---|---|---|
| 1A1 | John | 20 | Computer | 1st | 23381 |
| 1A2 | Gaurav | 19 | Mechanical | 1st | 90091 |
| 1A3 | Vivek | 22 | Computer | 7th | 73332 |
| 1A4 | Amit | 20 | Electronics | 3rd | 25564 |
| 1A5 | Dheeraj | 21 | Civil | 5th | 32099 |

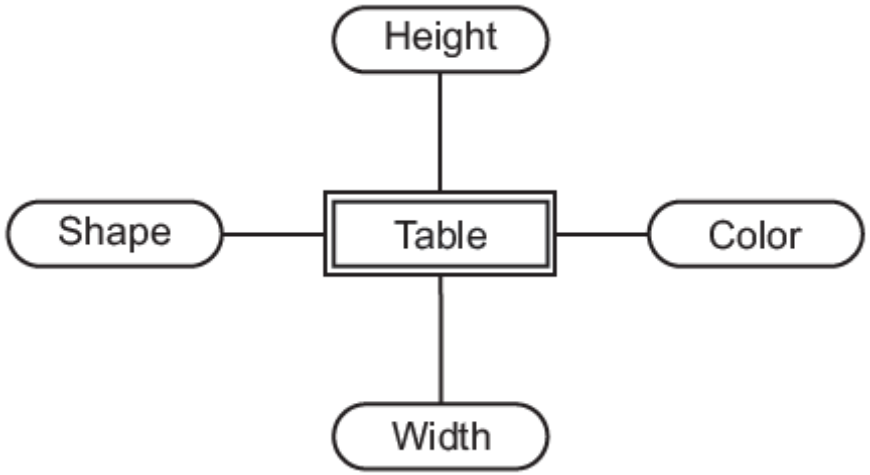
# ENTITY-RELATIONSHIP (E-R) MODEL

Entity sets are categorized as follows:

1. Strong entity set
   - Refers to an entity set having any key attributes.




2. Weak entity set
   - Refers to an entity set having no key attributes.



# TYPES OF ATTRIBUTES

Attributes can be characterized by the following types:

1. **Simple and Composite Attributes**
   - Simple attribute
     - An attribute that cannot be divided into subparts.
     - Example: age of a student
   - Composite attribute
     - An attribute that can be divided into subparts.
     - Example: name of a student can be divided into first name, middle name and last name.

# TYPES OF ATTRIBUTES

Attributes can be characterized by the following types:

2. **Single Valued and Multi-valued Attributes**
   - Single valued attribute
     - An attribute having only single value for a particular entity.
     - Example: age of a student.
   - Multi-valued attribute
     - An attribute having more than one possible value for a particular entity is known as multi-valued attribute.
     - Example: phone number of a student. A student may have more than one phone number.

# TYPES OF ATTRIBUTES

Attributes can be characterized by the following types:

3. **Derived Attributes and Stored Attributes**
   - *Derived Attribute*
     - An attribute that can be derived from other known attributes.
     - The value of a derived attribute is not stored but is computed when required.
     - Example: Age of an employee can be derived if you know date of birth and system date.

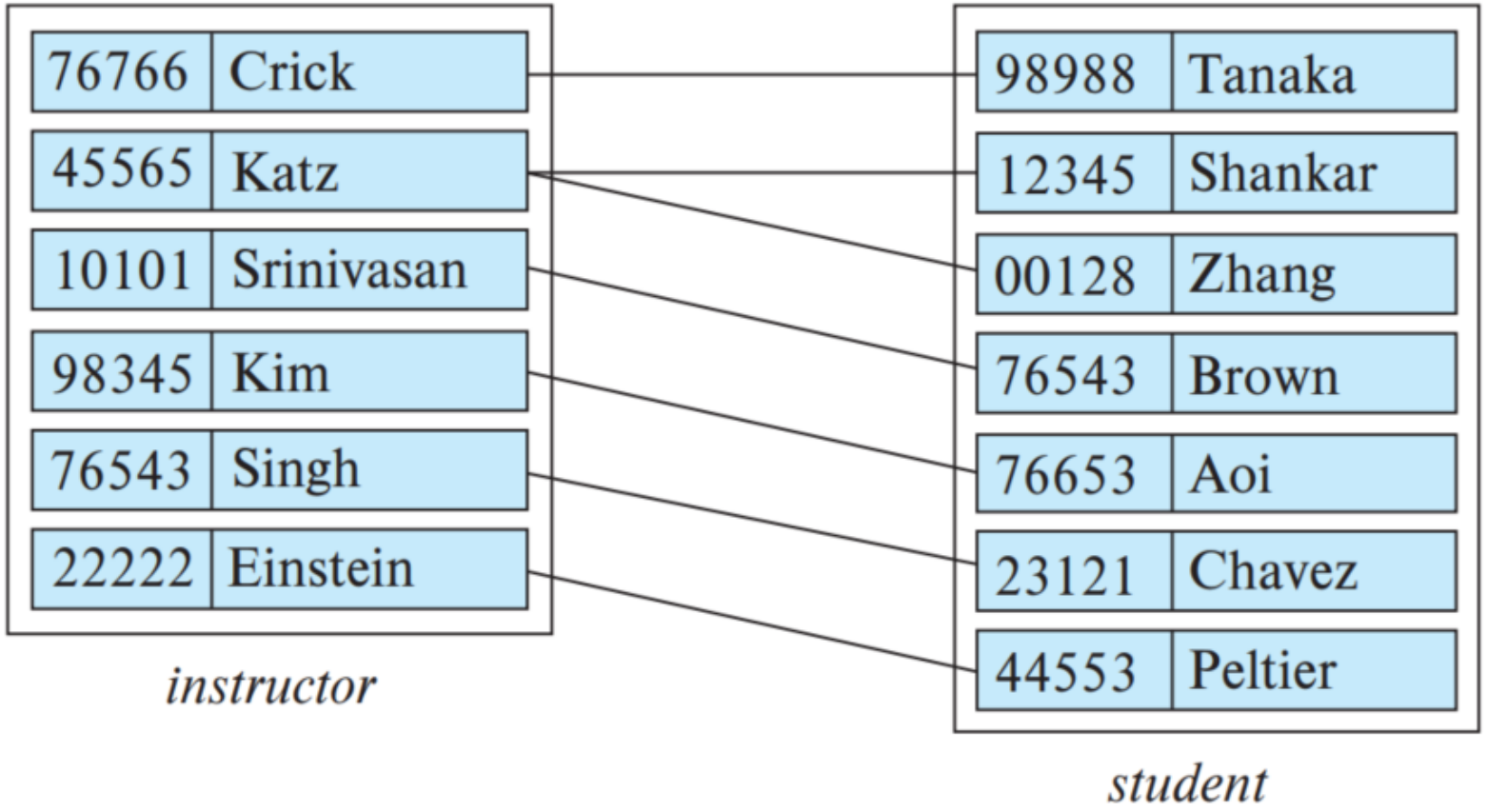
   - *Stored Attribute*
     - An attribute which cannot be derived by other known attributes.
     - Example: Date of birth of any employee.

# RELATIONSHIP

- A relationship refers to the association among several entities.
- Connects different entities through a meaningful relation.
- Example:
  - ✓ a relationship *advisor* that associates instructor Samwel with student Hamida.

# RELATIONSHIP…

- A relationship set is a set of relationships of same type.

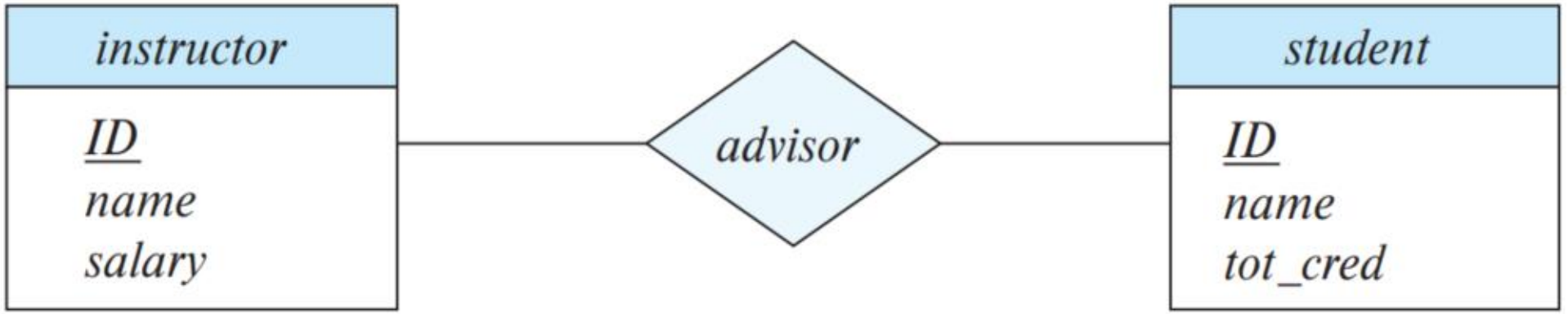



Relationship set *advisor*

# RELATIONSHIP…

- A relationship instance represents an association between the named entities in the real-world enterprise.

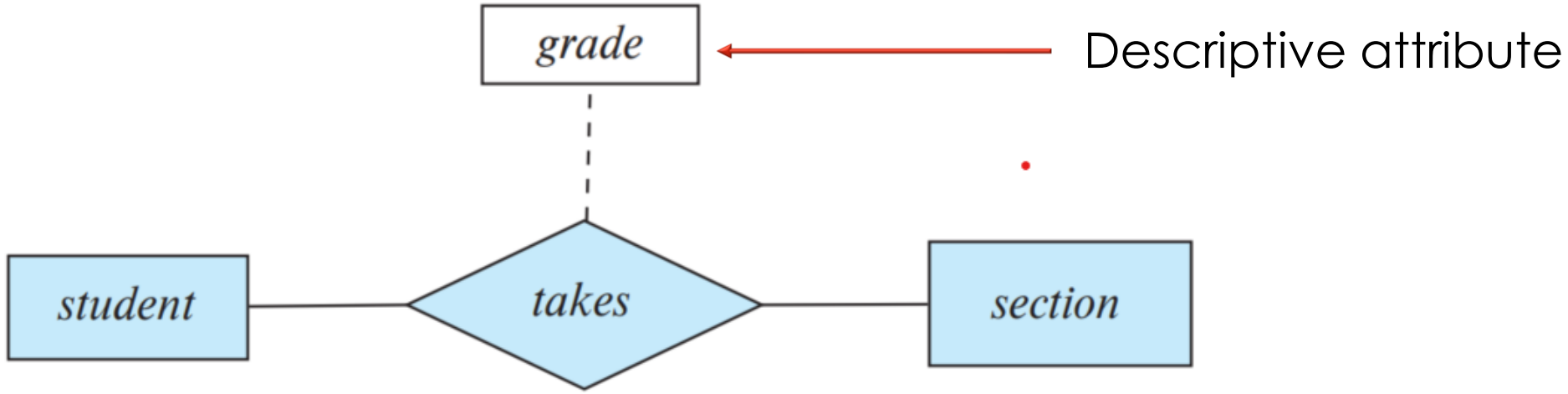
- A relationship set is represented in an E-R diagram by a **diamond**, which is linked via **lines** to a number of different entity sets (rectangles).




*E-R diagram showing relationship set advisor*

# RELATIONSHIP…

- Descriptive attributes refers to attributes of a relationship set.
- An attribute of a relationship set is represented in an E-R diagram by an **undivided rectangle**.
- This rectangle is linked to the diamond representing that relationship set with a dashed line.



# RELATIONSHIP…

**Degree of relationship sets**

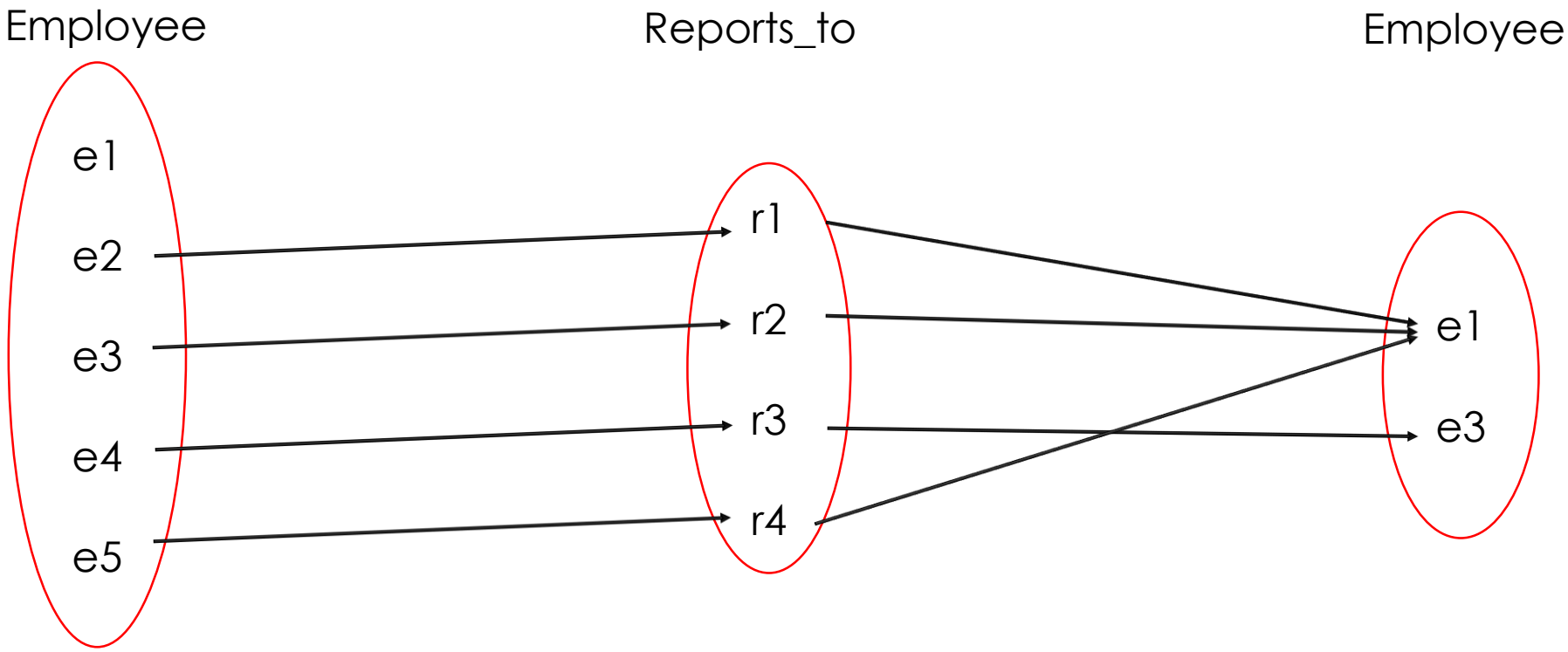
- Refers to the total number of entity sets participating in a relationship set.

- Types of degree of relationship sets
    1. Unary Relationship Set
    2. Binary Relationship Set
    3. Ternary Relationship Set

# RELATIONSHIP…

Unary Relationship Set

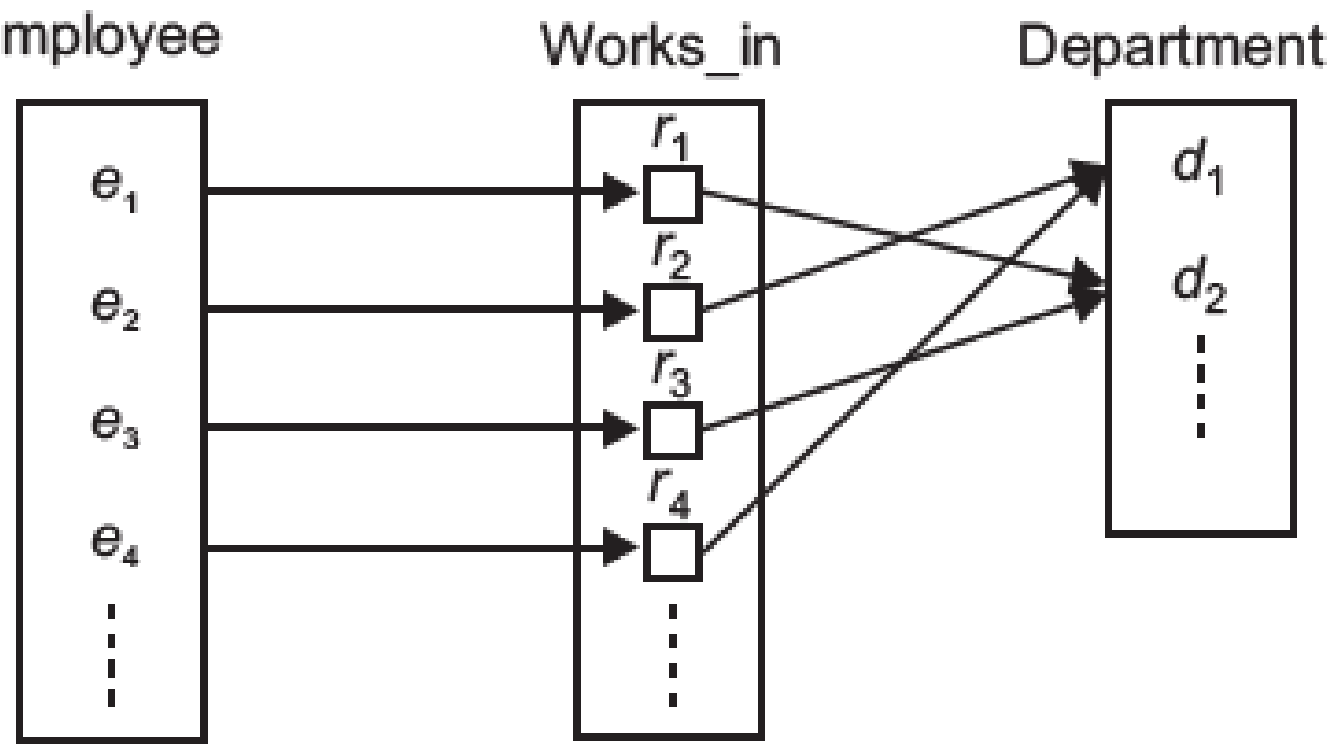
- A relationship set where only one entity set participates in a relationship set (degree 1).



# RELATIONSHIP…

Binary Relationship Set

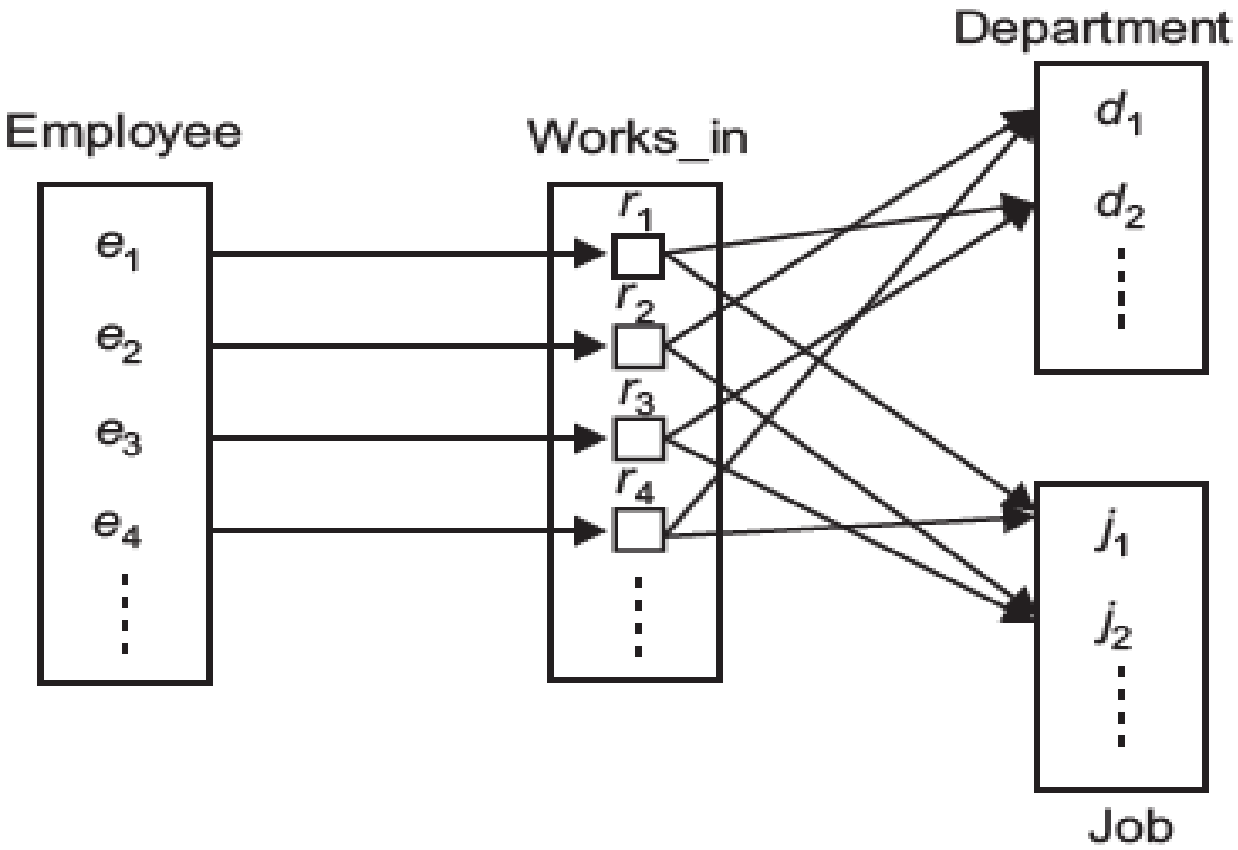
- A relationship set where only two entity sets participates in a relationship set (degree 2).



# RELATIONSHIP…

Ternary Relationship Set

- A relationship set in which three entity sets participates in a relationship set (degree 3).



# RELATIONSHIP…

- A role of an entity refers to a function that entity plays in a relationship.

- Example

  An employee plays the role of worker in his/her department

- A recursive relationship set refers to a situation when the same entity sets participate in same relationship set more than once with different roles each time.

- Example

  A manager (employee) supervises a subordinate (employee).

# MAPPING CARDINALITIES (CARDINALITY RATIOS)

- Mapping cardinalities refers to the number of entities to which another entity can be associated via a relationship set.

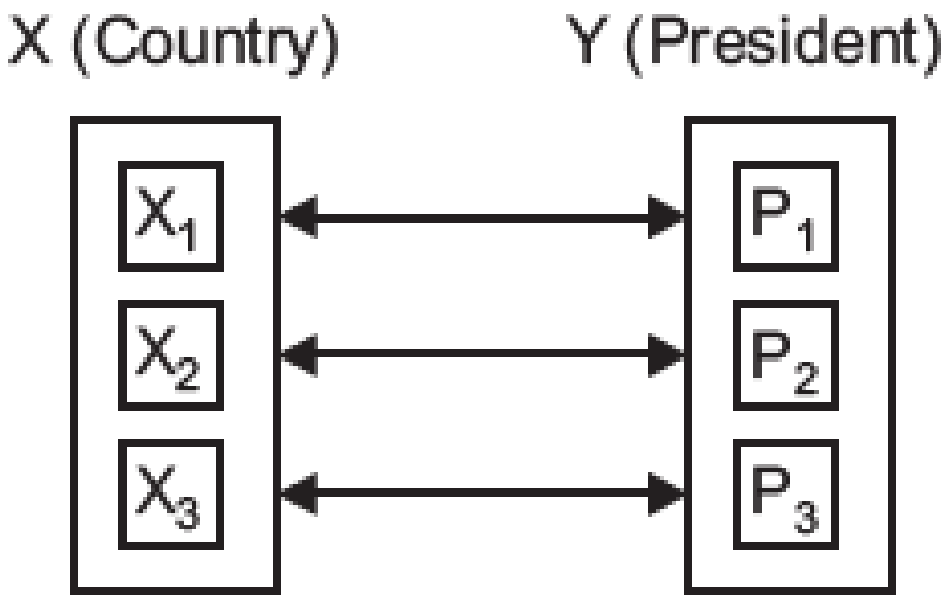
- Types of cardinalities
- One to One (1 : 1)
- One to Many (1 : N)
- Many to One (N : 1)
- Many to Many (M : N)

# MAPPING CARDINALITIES (CARDINALITY RATIOS)

One to One (1 : 1)

- An entity in table X is associated with at most one entity in table Y and an entity in table Y is associated with at most one entity in table X.

- Example

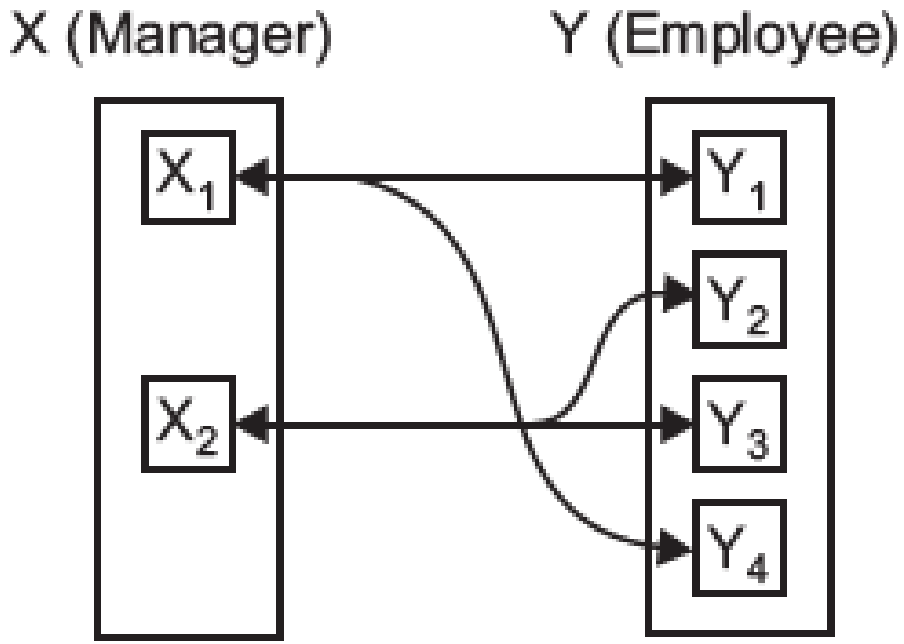


# MAPPING CARDINALITIES (CARDINALITY RATIOS)

One to Many (1 : N)

- An entity in table X is associated with any number of entities in table Y. An entity in table Y is associated with at most one entity in table X.

- Example

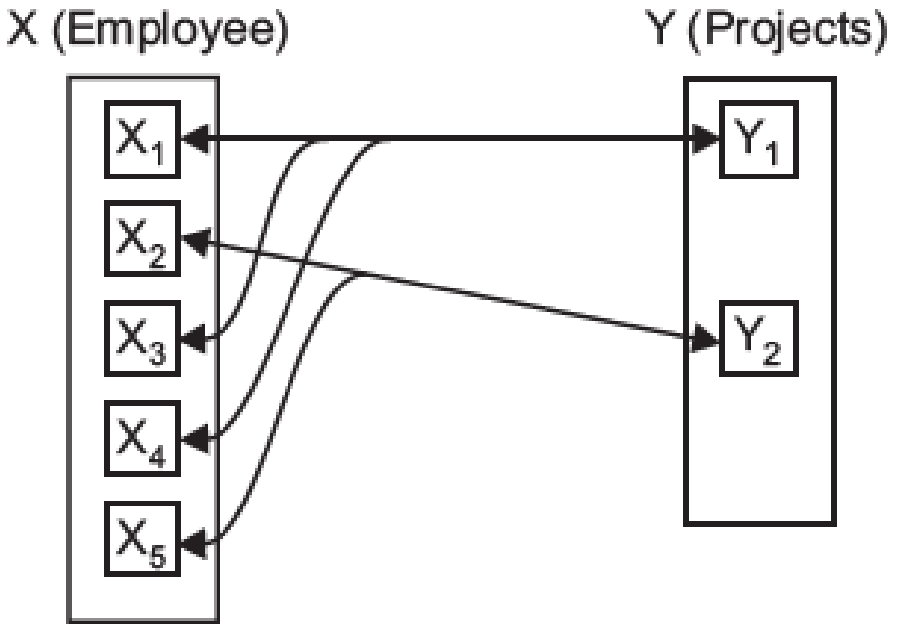


# MAPPING CARDINALITIES (CARDINALITY RATIOS)

Many to One (N : 1)

- An entity in table X is associated with at most one entity in table Y. An entity in table Y is associated with any number of entities in table X.

- Example

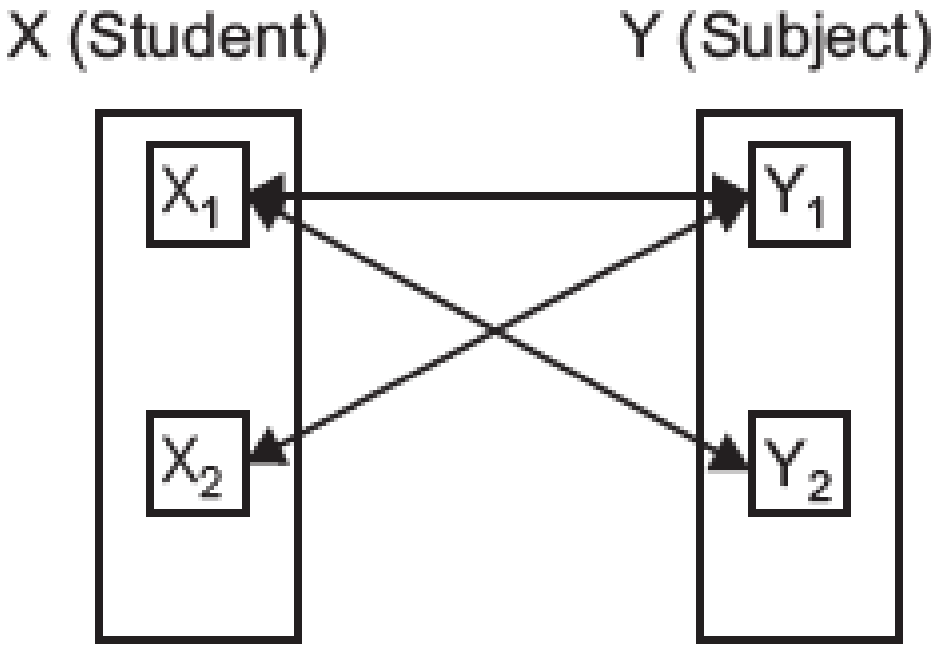


# MAPPING CARDINALITIES (CARDINALITY RATIOS)

Many to Many (M : N)

- An entity in table X is associated with any number of entities in table Y and vice versa.

- Example



Successful and unsuccessful people do not vary greatly in their abilities. They vary in their desires to reach their potential. –

John Maxwell