UNIT-1

Introduction: Database System, Characteristics (Database Vs File System), Advantages of Database Systems, Database Applications, Database Users, Brief Introduction of Different Data Models; Concepts of Schema, Instance and Data Independence; Three Tier Schema Architecture for Data Independence; Database System Structure, Centralized and Client Server Architecture for Database Systems.

Entity Relationship Model: Introduction, Concept of Entities, Attributes, Entity Sets, Relationships, Relationship Sets, Key and Participation Constraints, Class Hierarchies, and Aggregation, Developing E-R diagrams for Databases.

Entity Relationship Model

ER model

- ER model stands for an Entity-Relationship model. It is a high-level data model. This model is used to define the data elements and relationship for a specified system.

- It develops a conceptual design for the database. It also develops a very simple and easy to design view of data.

- In ER modeling, the database structure is portrayed as a diagram called an entity-relationship diagram.

ER model

- ER model helps to systematically analyze data requirements to produce a well-designed database. The ER Model represents real-world entities and the relationships between them. Creating an ER Model in DBMS is considered as a best practice before implementing your database.

ER Diagrams Symbols & Notations

- **Entity Relationship Diagram Symbols & Notations** mainly contains three basic symbols which are rectangle, oval and diamond to represent relationships between elements, entities and attributes.

- ER Diagram is a visual representation of data that describes how data is related to each other using different ERD Symbols and Notations.

Main components and its symbols in ER Diagrams

- **Rectangles:** This Entity Relationship Diagram symbol represents entity types

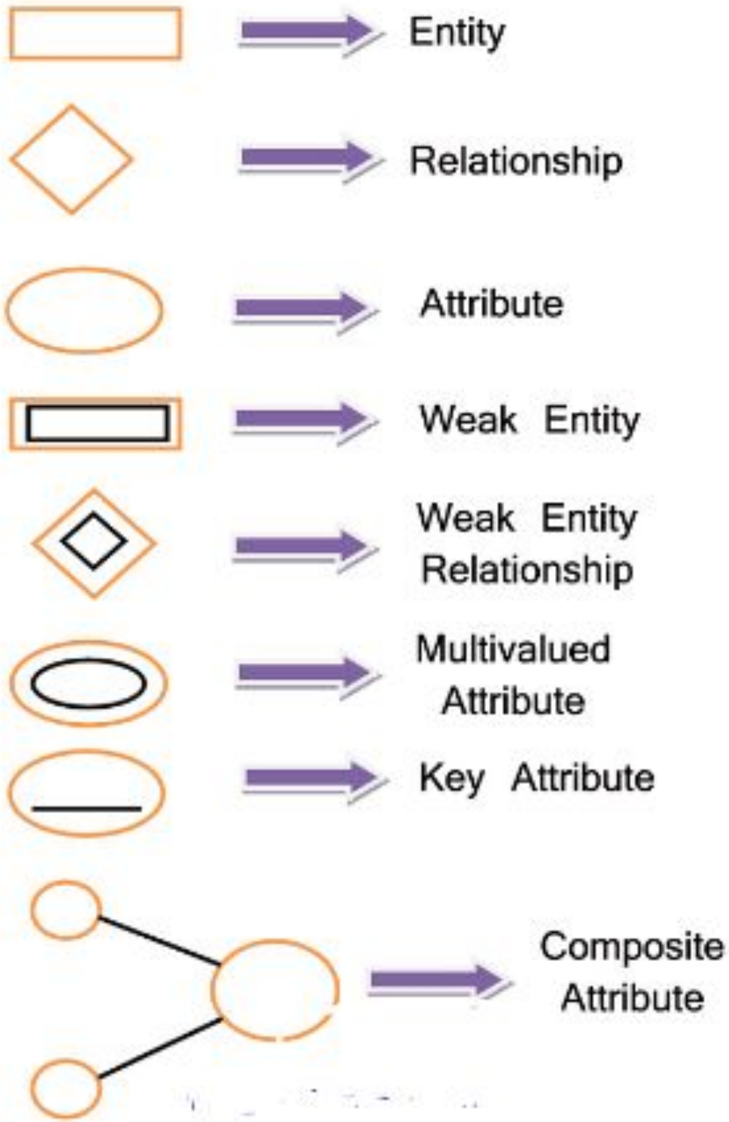
- **Ellipses :** Symbol represent attributes

- **Diamonds:** This symbol represents relationship types

- **Lines:** It links attributes to entity types and entity types with other relationship types

- **Primary key:** attributes are underlined

- **Double Ellipses:** Represent multi-valued attributes



Entity

Relationship

Attribute

Weak Entity

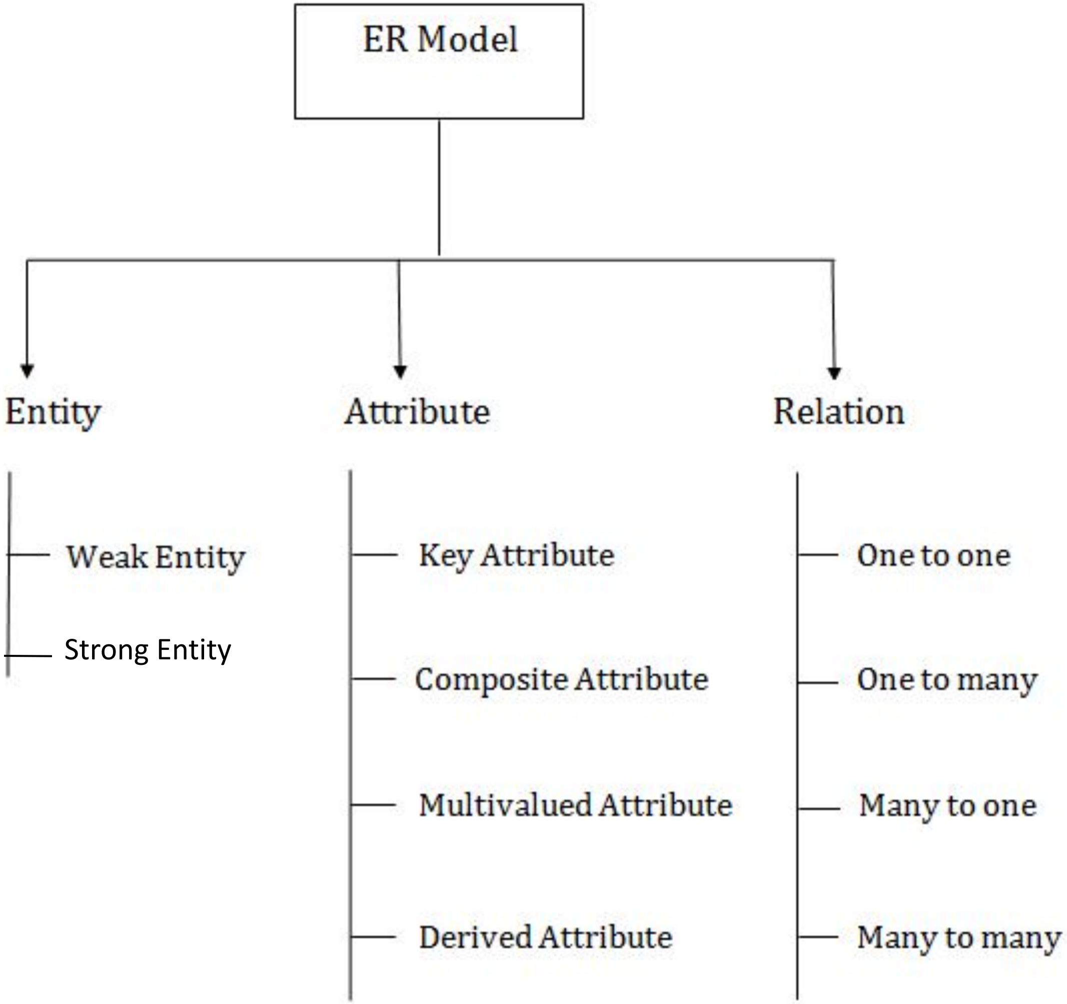
Weak Entity Relationship

Multivalued Attribute

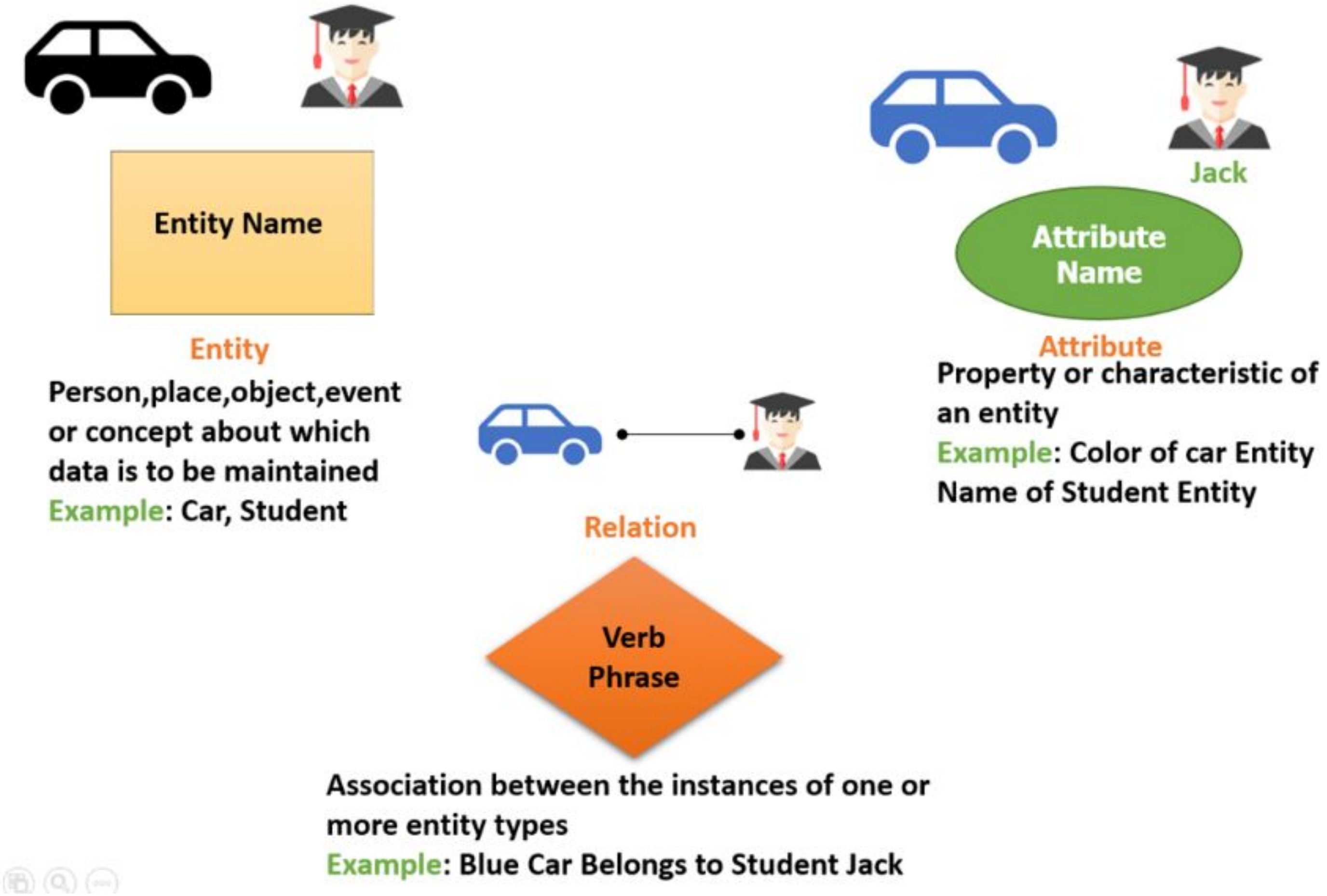
Key Attribute

Composite Attribute

Component of ER Diagram



Component of ER Diagram



Entity

Person,place,object,event or concept about which data is to be maintained

Example: Car, Student

Attribute

Property or characteristic of an entity

Example: Color of car Entity Name of Student Entity

Relation

Association between the instances of one or more entity types

Example: Blue Car Belongs to Student Jack

WHAT IS ENTITY?

- An entity can be place, person, object, event or a concept, which stores data in the database. The characteristics of entities must have an attribute, and a unique key. Every entity is made up of some ‘attributes’ which represent that entity.

Examples of entities

- **Person:** Employee, Student, Patient
- **Place:** Store, Building
- **Object:** Machine, product, and Car
- **Event:** Sale, Registration, Renewal
- **Concept:** Account, Course

Entity set

- Student

An entity set is a group of similar kind of entities. It may contain entities with attribute sharing similar values.

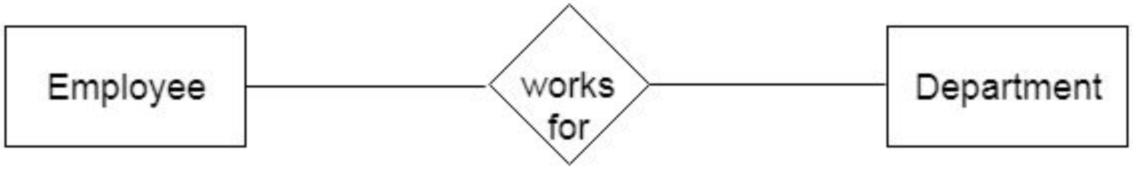
Entities are represented by their properties, which also called attributes.

All attributes have their separate values. For example, a student entity may have a name, age, class, as attributes.

1. Entity

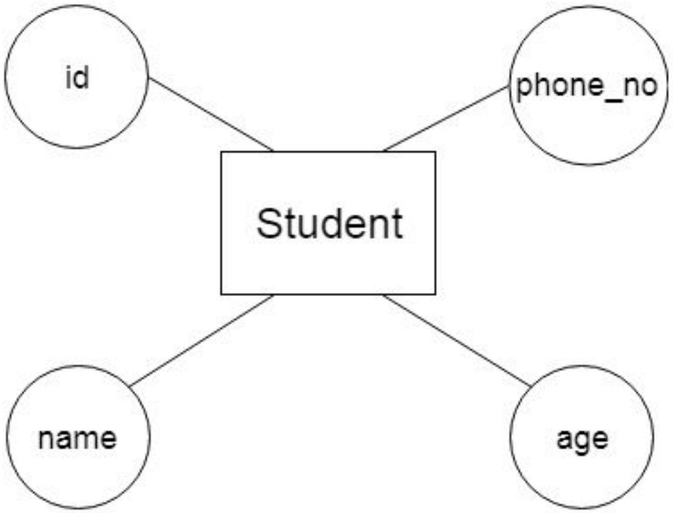
- An entity may be any object, class, person or place. In the ER diagram, an entity can be represented as rectangles.

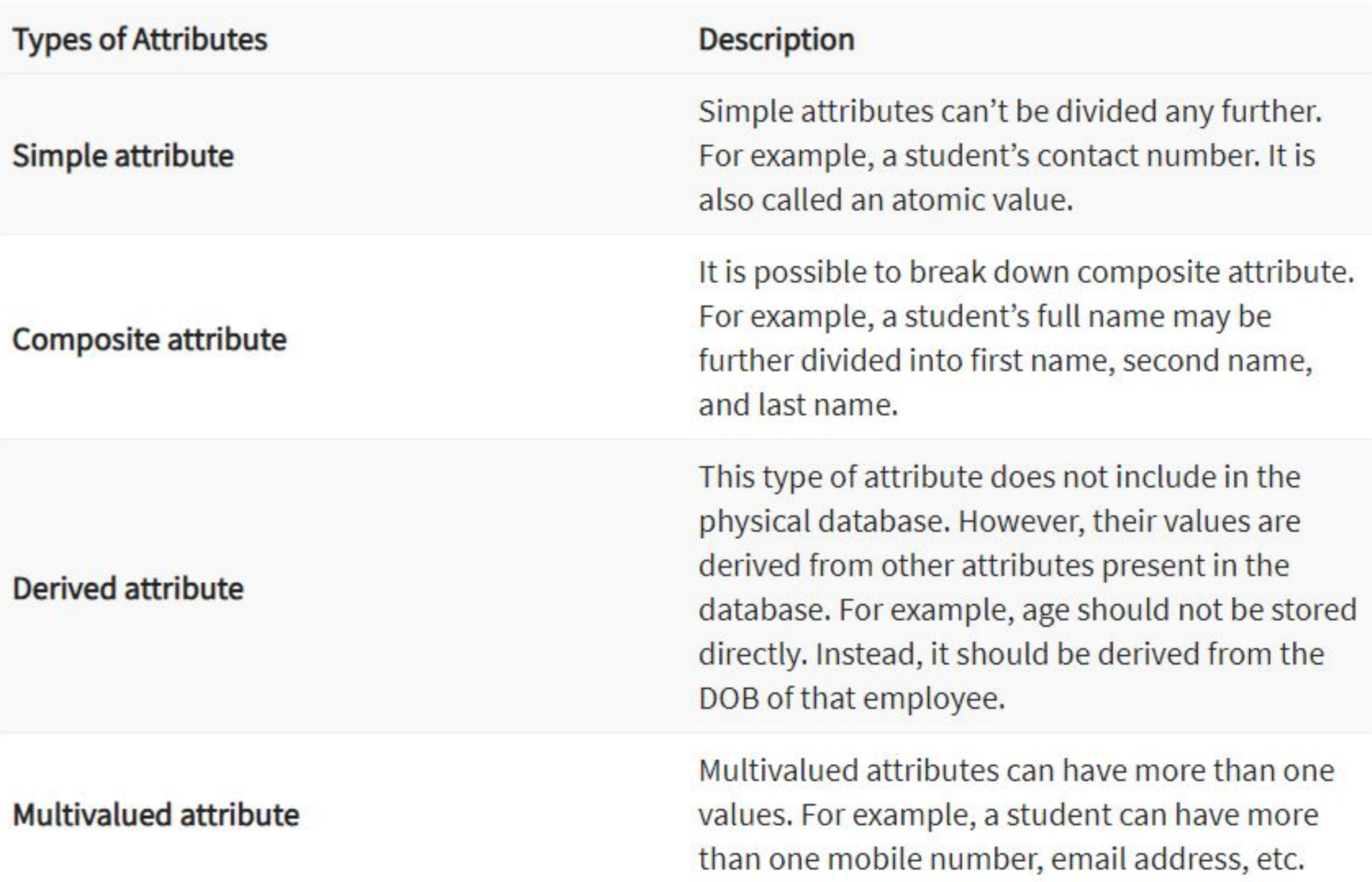
- Consider an organization as an example- manager, product, employee, department etc. can be taken as an entity.



2. Attribute

- The attribute is used to describe the property of an entity. Eclipse is used to represent an attribute.
- **For example,** id, age, contact number, name, etc. can be attributes of a student.

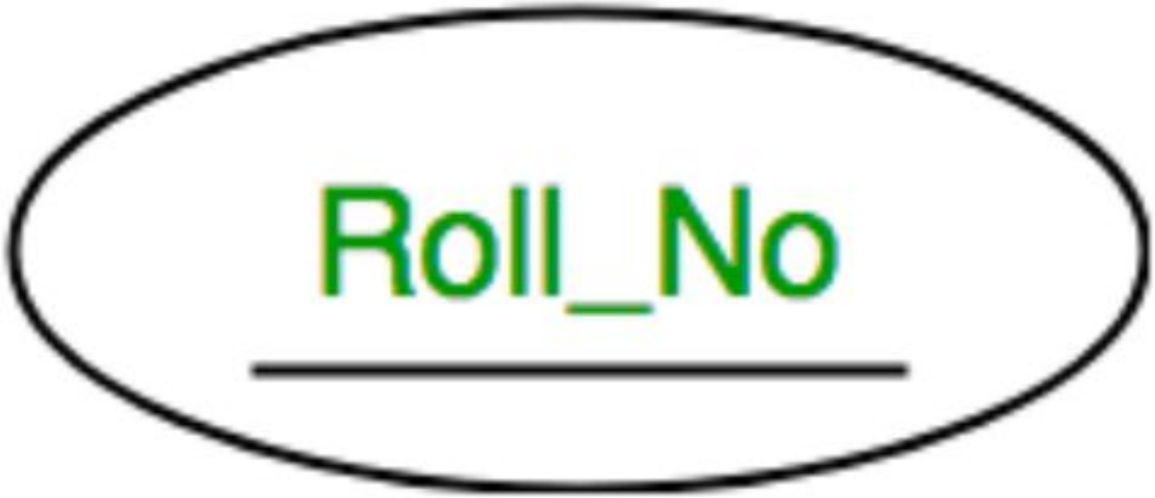




Types of Attributes	Description
Simple attribute	Simple attributes can't be divided any further. For example, a student's contact number. It is also called an atomic value.
Composite attribute	It is possible to break down composite attribute. For example, a student's full name may be further divided into first name, second name, and last name.
Derived attribute	This type of attribute does not include in the physical database. However, their values are derived from other attributes present in the database. For example, age should not be stored directly. Instead, it should be derived from the DOB of that employee.
Multivalued attribute	Multivalued attributes can have more than one values. For example, a student can have more than one mobile number, email address, etc.

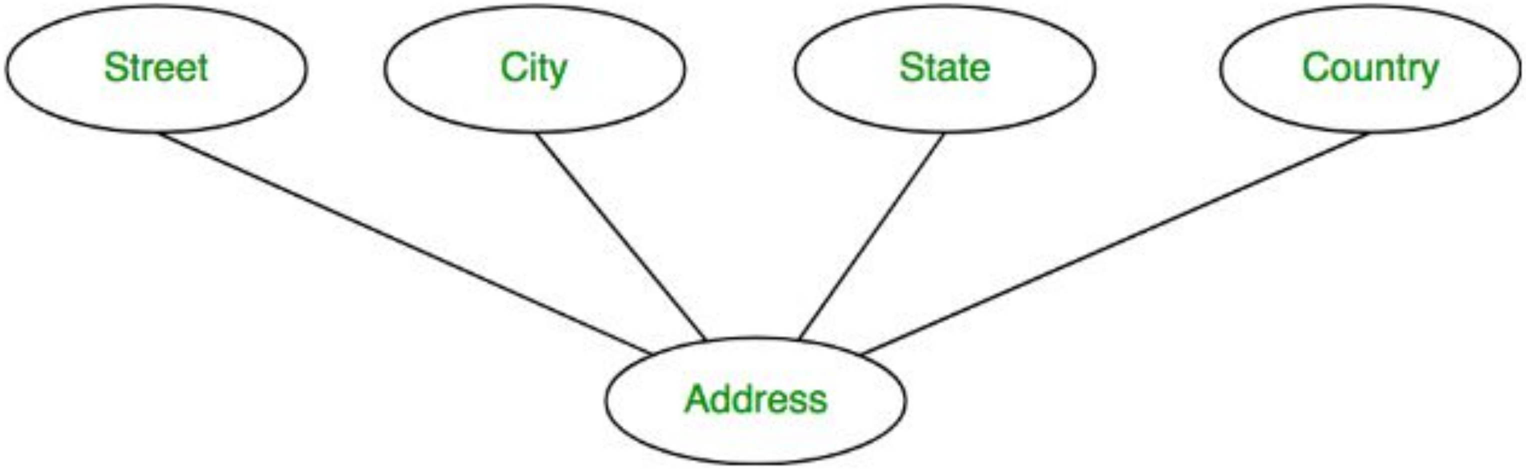
1. Key Attribute –

The attribute which **uniquely identifies each entity** in the entity set is called key attribute.For example, Roll_No will be unique for each student. In ER diagram, key attribute is represented by an oval with underlying lines.



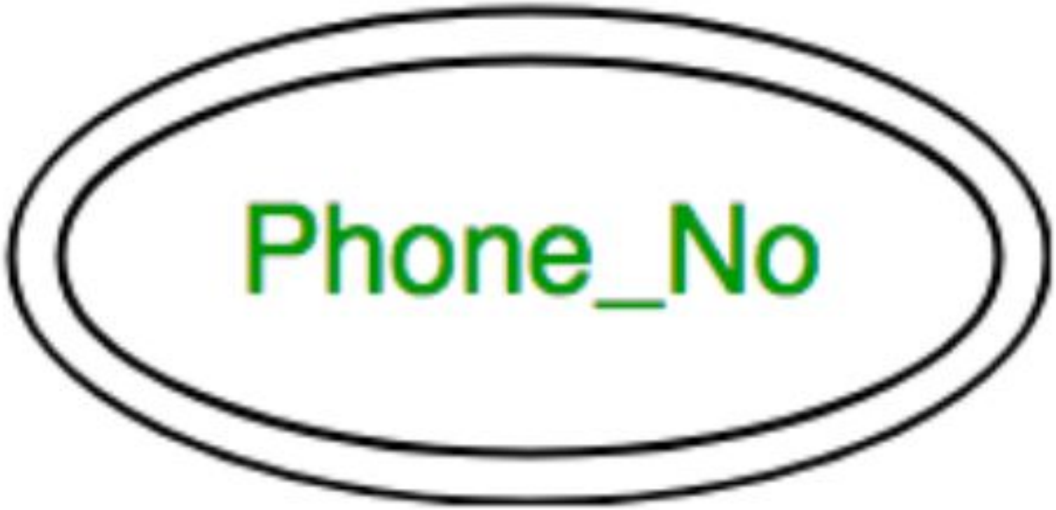
2. Composite Attribute –

An attribute **composed of many other attribute** is called as composite attribute. For example, Address attribute of student Entity type consists of Street, City, State, and Country. In ER diagram, composite attribute is represented by an oval comprising of ovals.



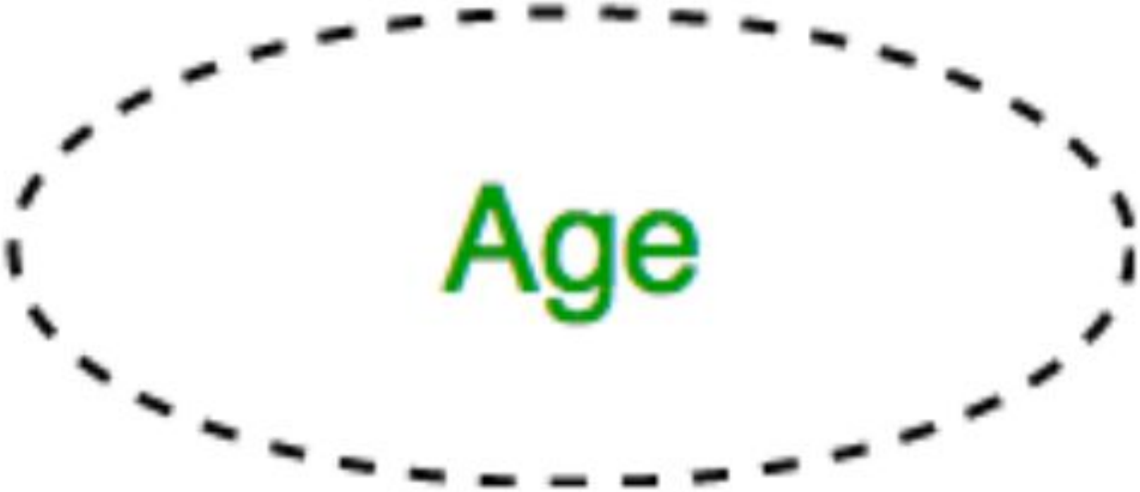
3. Multivalued Attribute –

An attribute consisting **more than one value** for a given entity. For example, Phone_No (can be more than one for a given student). In ER diagram, multivalued attribute is represented by double oval.



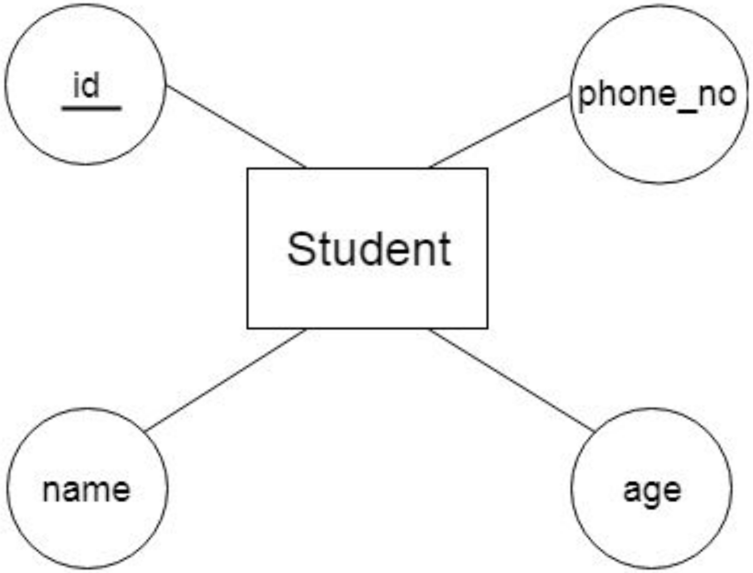
4. Derived Attribute –

An attribute which can be **derived from other attributes** of the entity type is known as derived attribute. e.g.; Age (can be derived from DOB). In ER diagram, derived attribute is represented by dashed oval.



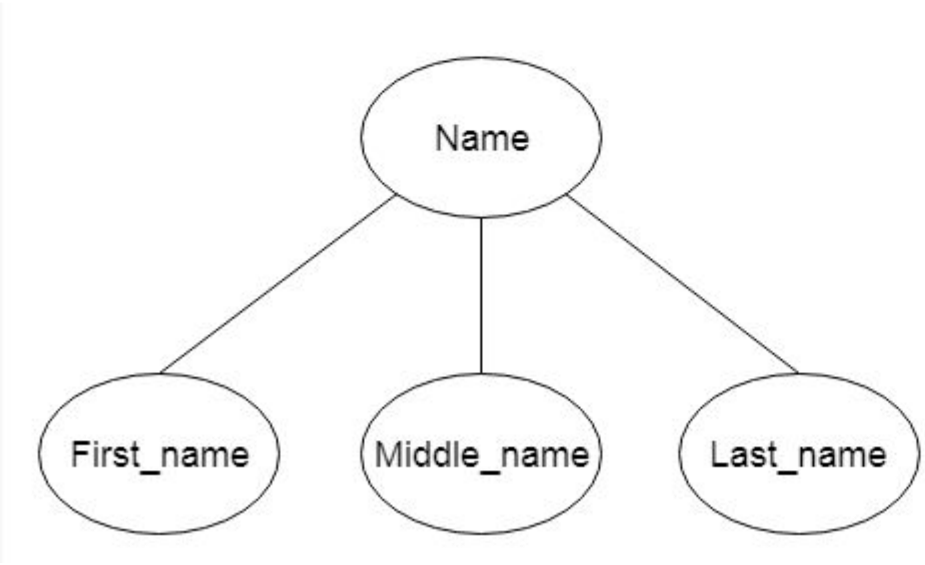
Key Attribute

- The key attribute is used to represent the main characteristics of an entity. It represents a primary key. The key attribute is represented by an ellipse with the text underlined.



Composite Attribute

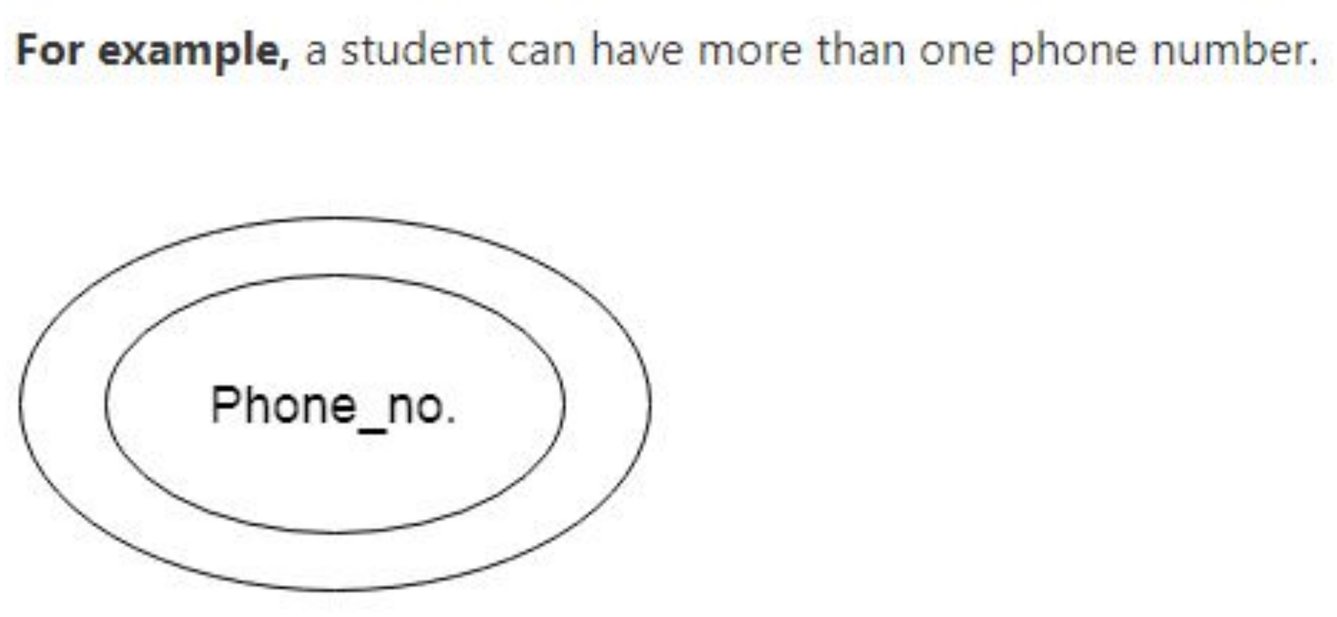
- An attribute that composed of many other attributes is known as a composite attribute. The composite attribute is represented by an ellipse, and those ellipses are connected with an ellipse.



Multi valued Attribute

- An attribute can have more than one value. These attributes are known as a multivalued attribute. The double oval is used to represent multi valued attribute.

Multi-value attributes may contain more than one values. For example, a person can have more than one phone number, email_address, etc.

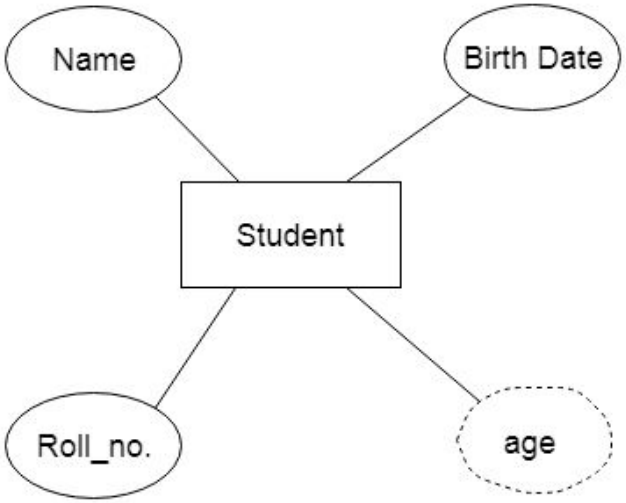


For example, a student can have more than one phone number.

Derived Attribute

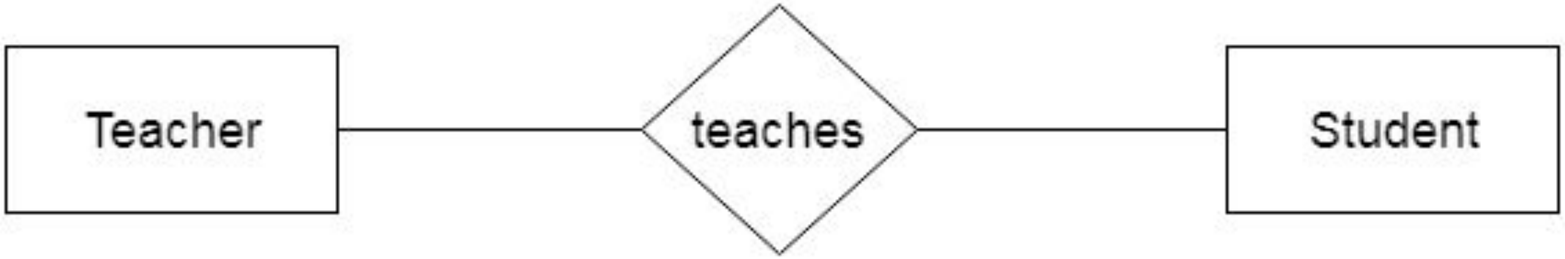
- An attribute that can be derived from other attribute is known as a derived attribute. It can be represented by a dashed ellipse.

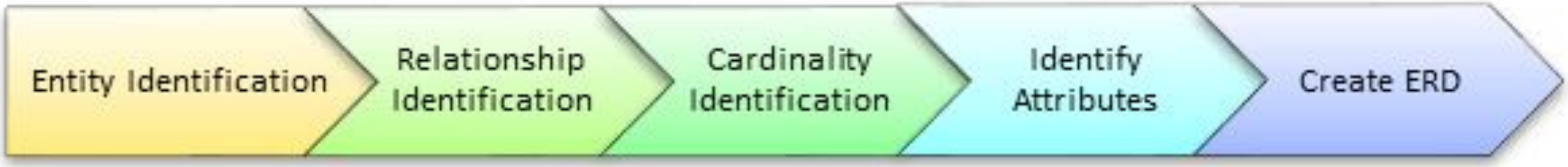
For example, A person's age changes over time and can be derived from another attribute like Date of birth.



3. Relationship

- A relationship is used to describe the relation between entities. Diamond or rhombus is used to represent the relationship.





Steps to Create an ER Diagram

ER Model

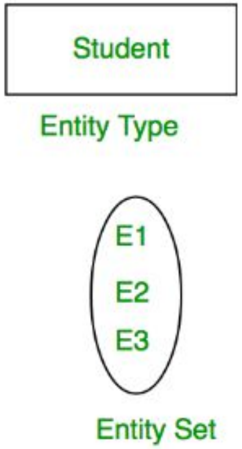
- ER Model is used to model the logical view of the system from data perspective which consists of these components:

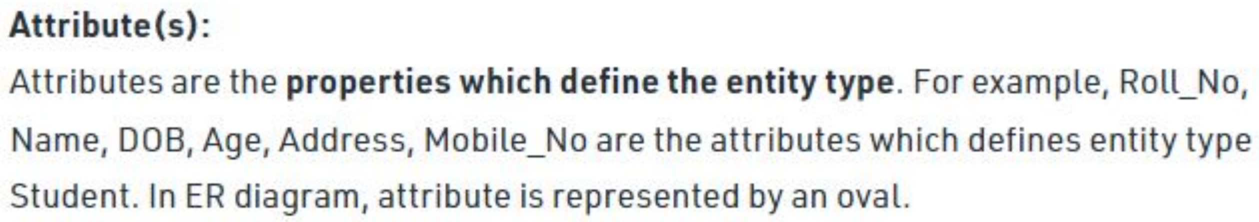
- **Entity, Entity Type, Entity Set –**

- An Entity may be an object with a physical existence – a particular person, car, house, or employee – or it may be an object with a conceptual existence – a company, a job, or a university course.

- An Entity is an object of Entity Type and set of all entities is called as entity set. e.g.; E1 is an entity having Entity Type Student and set of all students is called Entity Set.

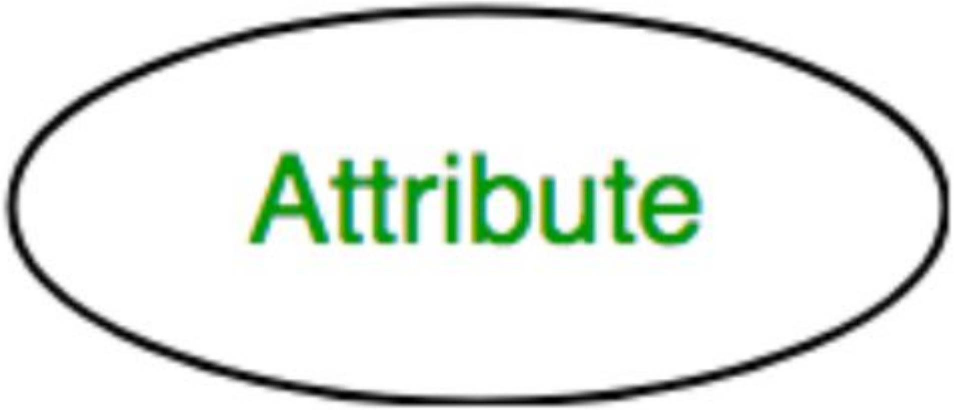
In ER diagram, Entity Type is represented as:



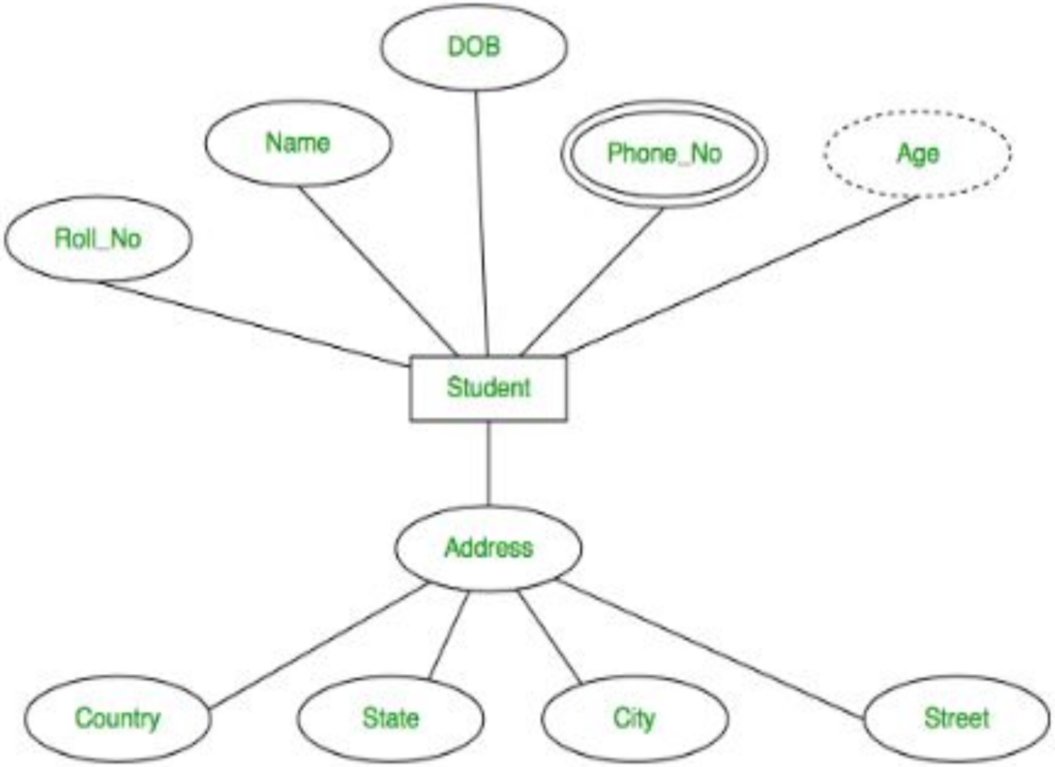


Attribute(s):

Attributes are the **properties which define the entity type**. For example, Roll_No, Name, DOB, Age, Address, Mobile_No are the attributes which defines entity type Student. In ER diagram, attribute is represented by an oval.

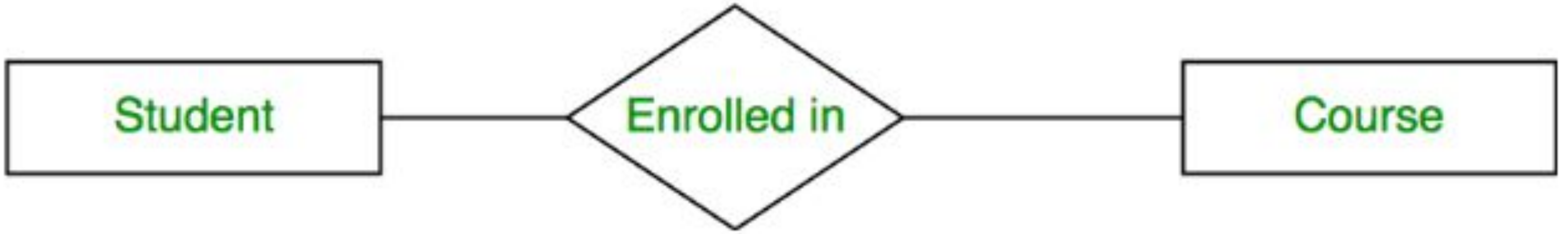


The complete entity type **Student** with its attributes can be represented as:

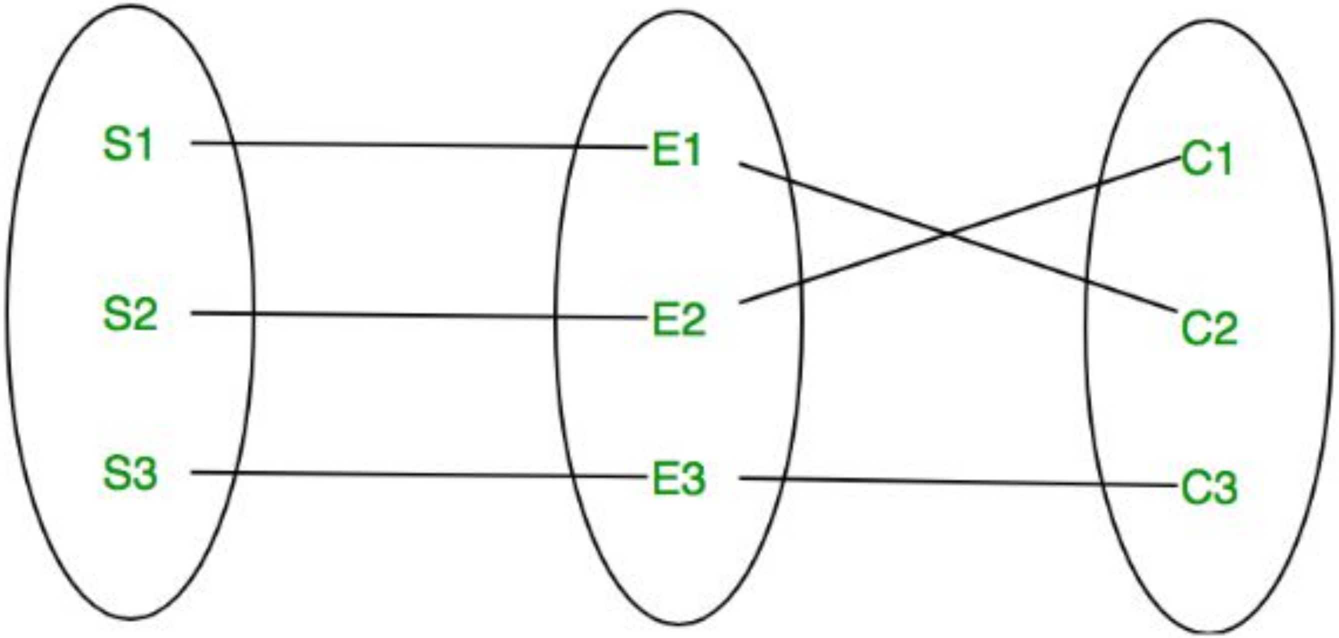


Relationship Type and Relationship Set:

A relationship type represents the **association between entity types**. For example,'Enrolled in' is a relationship type that exists between entity type Student and Course. In ER diagram, relationship type is represented by a diamond and connecting the entities with lines.



A set of relationships of same type is known as relationship set. The following relationship set depicts S1 is enrolled in C2, S2 is enrolled in C1 and S3 is enrolled in C3.

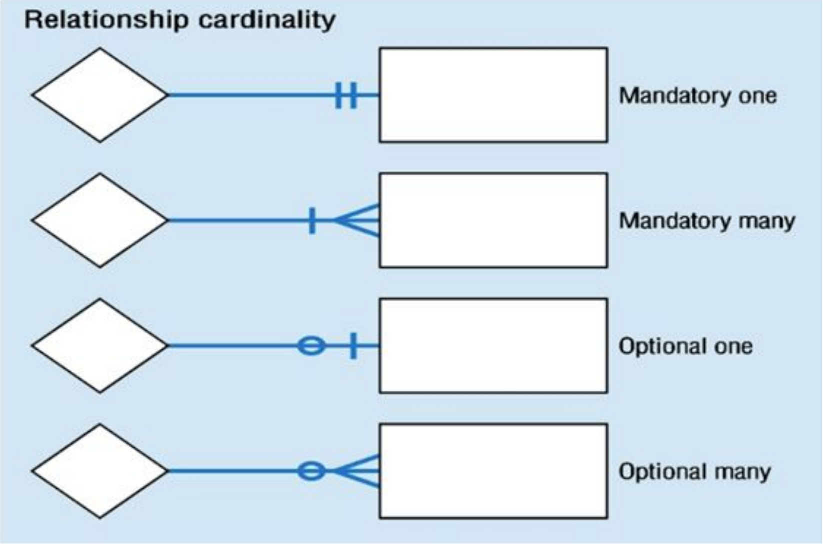


Cardinality

Defines the numerical attributes of the relationship between two entities or entity sets.

Different types of cardinal relationships are:

- One-to-One Relationships
- One-to-Many Relationships
- May to One Relationships
- Many-to-Many Relationships



One-to-One Relationship

- When only one instance of an entity is associated with the relationship, then it is known as one to one relationship.

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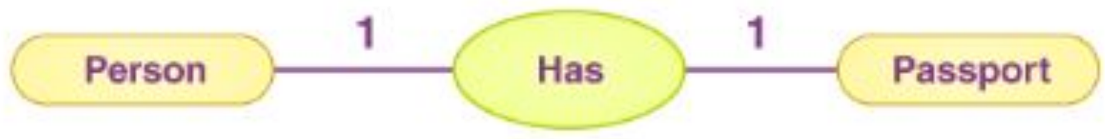
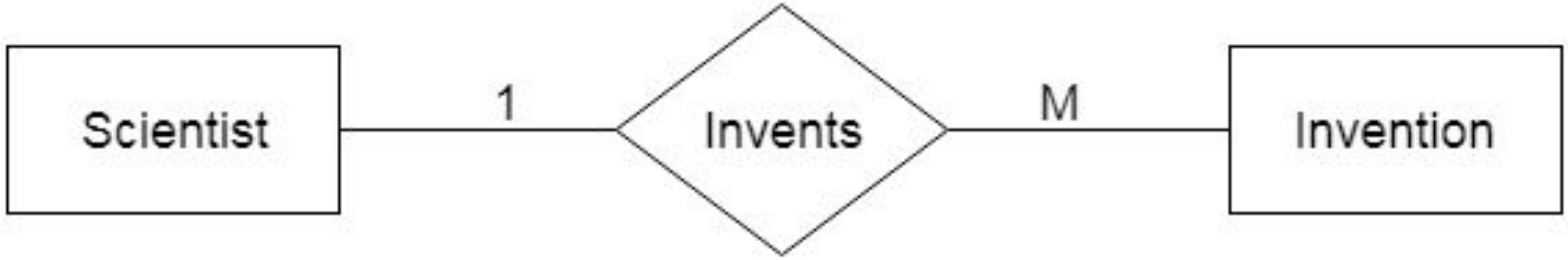
For example,



One-to-many relationship

- When only one instance of the entity on the left, and more than one instance of an entity on the right associates with the relationship then this is known as a one-to-many relationship.

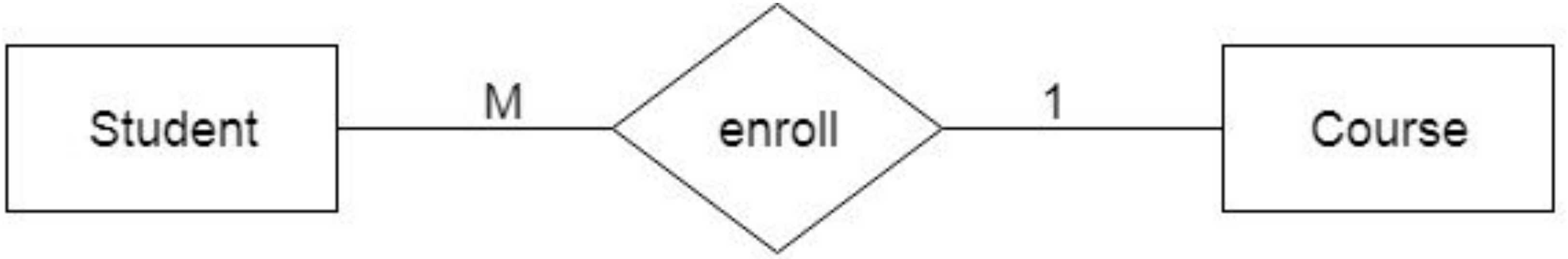
- **For example,** Scientist can invent many inventions, but the invention is done by the only specific scientist.



Many-to-one relationship

- When more than one instance of the entity on the left, and only one instance of an entity on the right associates with the relationship then it is known as a many-to-one relationship.

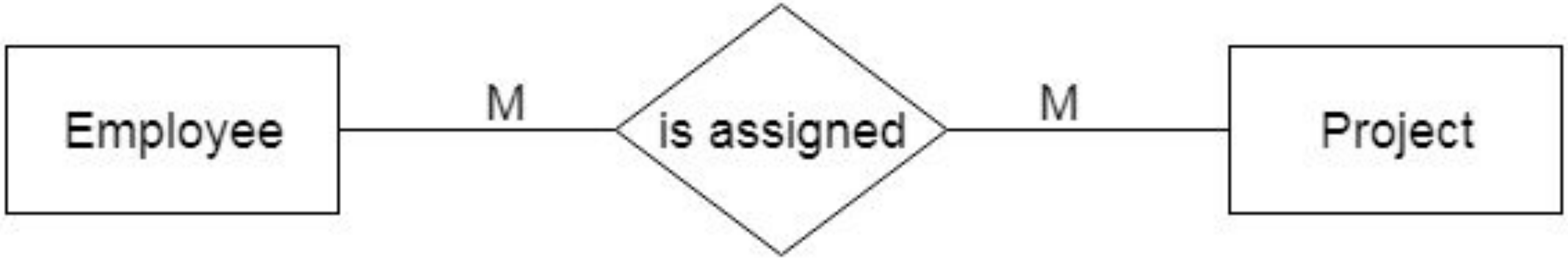
For example, Student enrolls for only one course, but a course can have many students.



Many-to-many relationship

- When more than one instance of the entity on the left, and more than one instance of an entity on the right associates with the relationship then it is known as a many-to-many relationship.

For example, Employee can assign by many projects and project can have many employees.

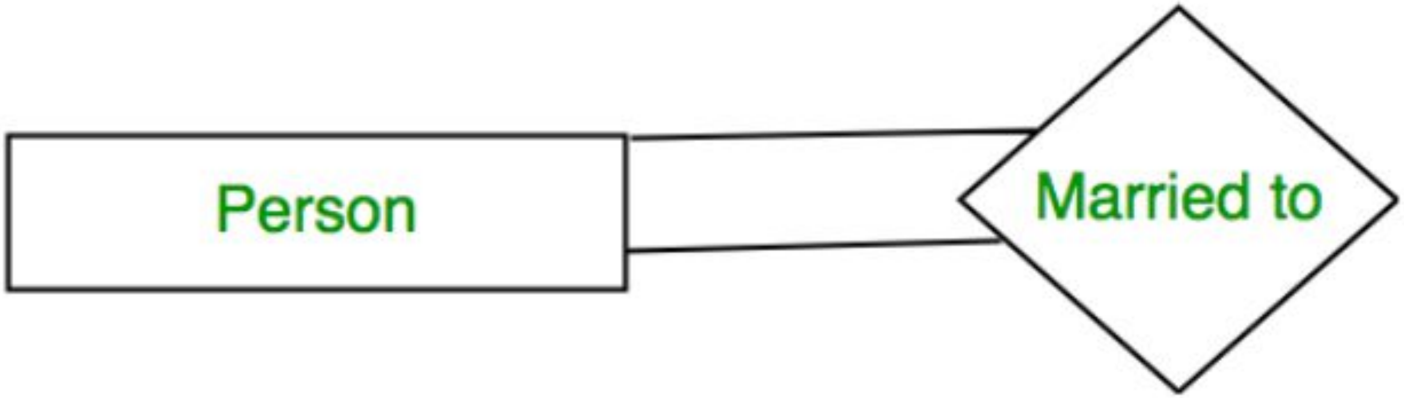


Degree of a relationship set:

The number of different entity sets **participating in a relationship** set is called as degree of a relationship set.

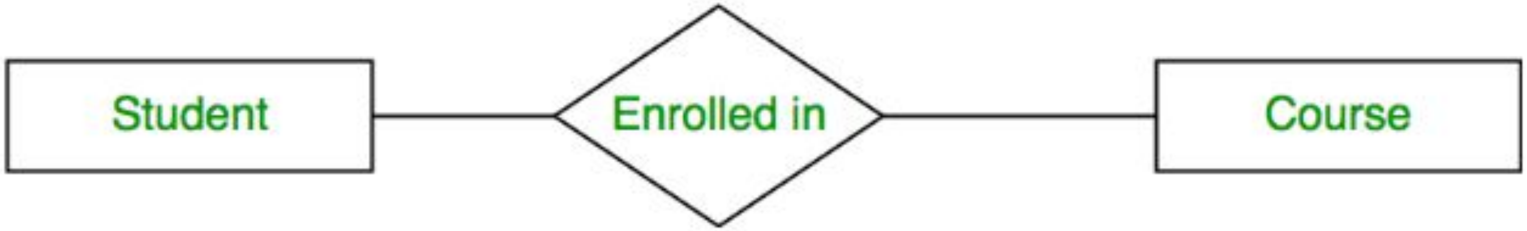
1. Unary Relationship –

When there is **only ONE entity set participating in a relation**, the relationship is called as unary relationship. For example, one person is married to only one person.

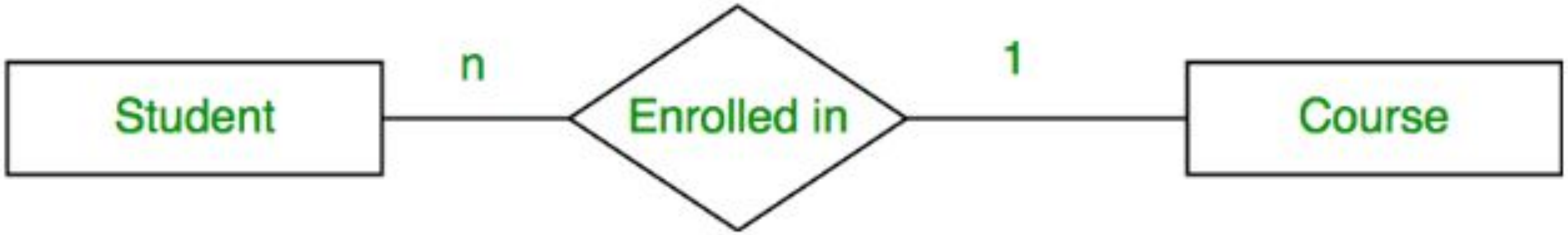


2. Binary Relationship –

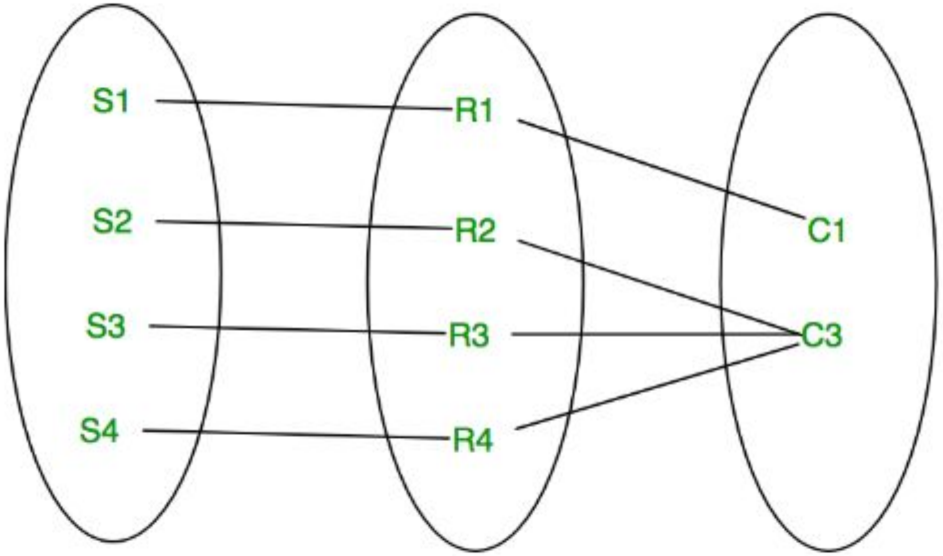
When there are **TWO entities set participating in a relation**, the relationship is called as binary relationship.For example, Student is enrolled in Course.



2. Many to one – When entities in one entity set **can take part only once in the relationship set and entities in other entity set can take part more than once in the relationship set,** cardinality is many to one. Let us assume that a student can take only one course but one course can be taken by many students. So the cardinality will be n to 1. It means that for one course there can be n students but for one student, there will be only one course.

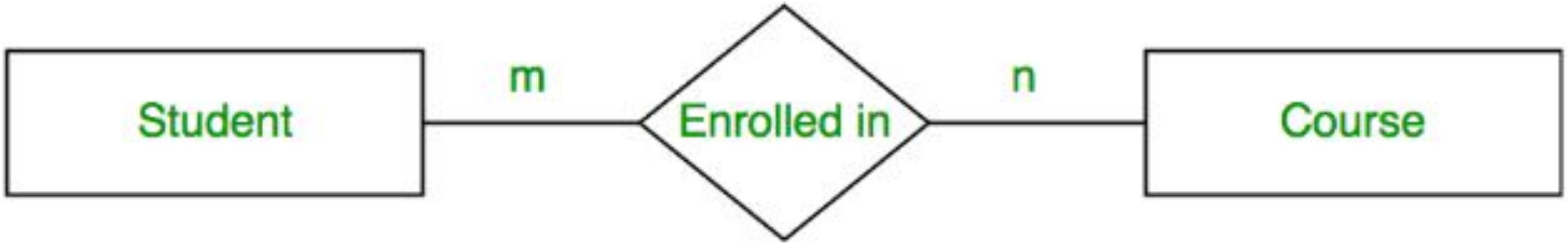


Using Sets, it can be represented as:

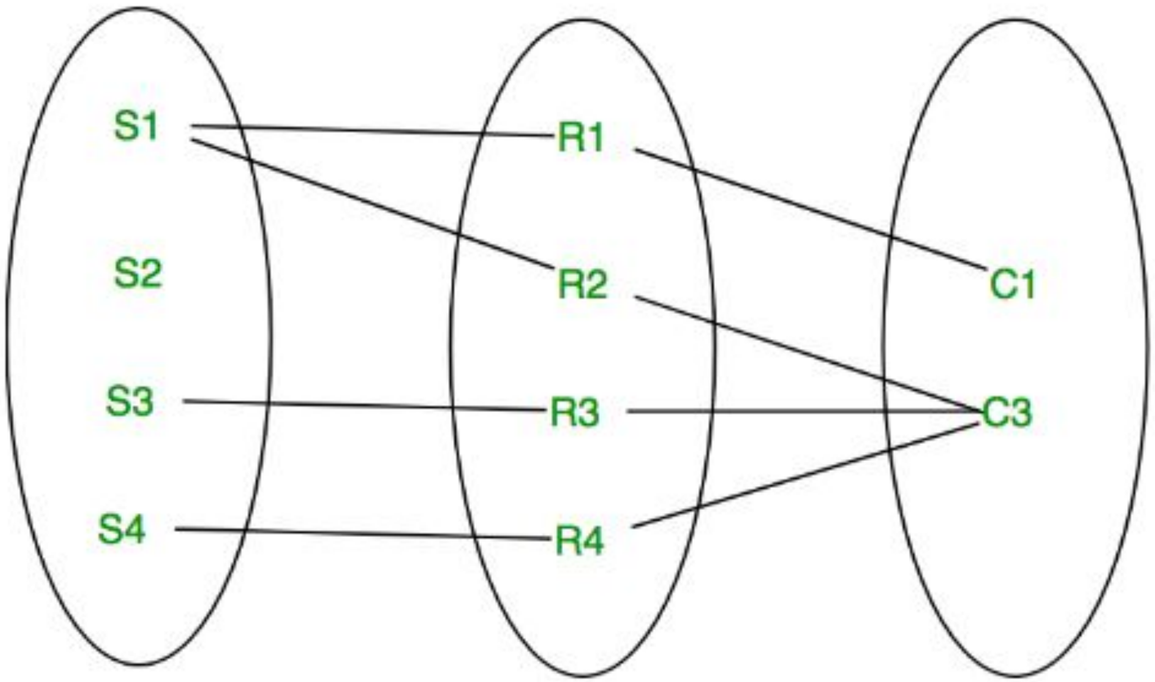


In this case, each student is taking only 1 course but 1 course has been taken by many students.

3. Many to many – When entities in all entity sets can **take part more than once in the relationship** cardinality is many to many. Let us assume that a student can take more than one course and one course can be taken by many students. So the relationship will be many to many.

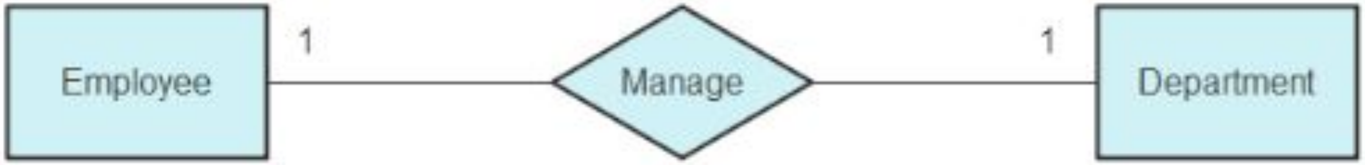


Using sets, it can be represented as:

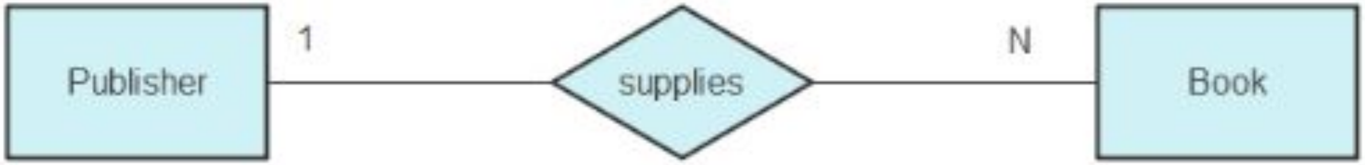


In this example, student S1 is enrolled in C1 and C3 and Course C3 is enrolled by S1, S3 and S4. So it is many to many relationships.

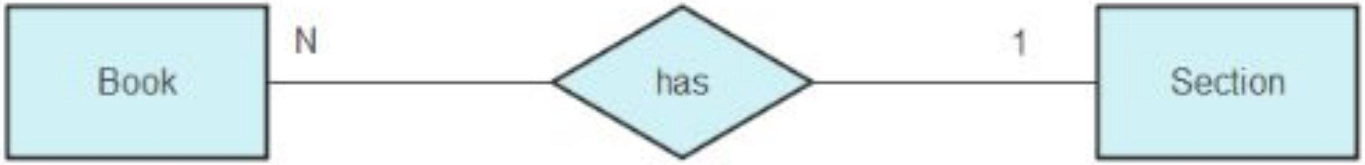
one-to-one (1:1)



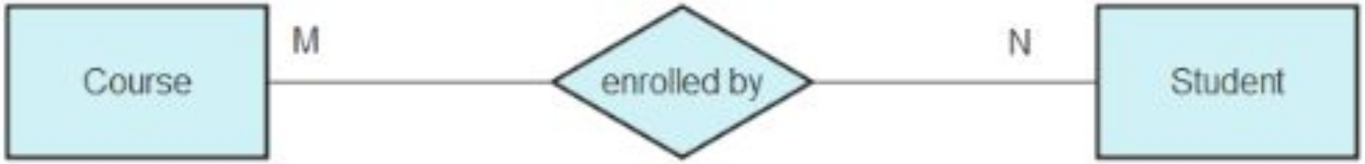
one-to-many (1:N)



many-to-one (N:1)



many-to-many (M:N)



Strong Entity – Weak Entity

- **Strong Entity:**

  A strong entity is not dependent on any other entity in the schema. A strong entity will always have a primary key. Strong entities are represented by a single rectangle.

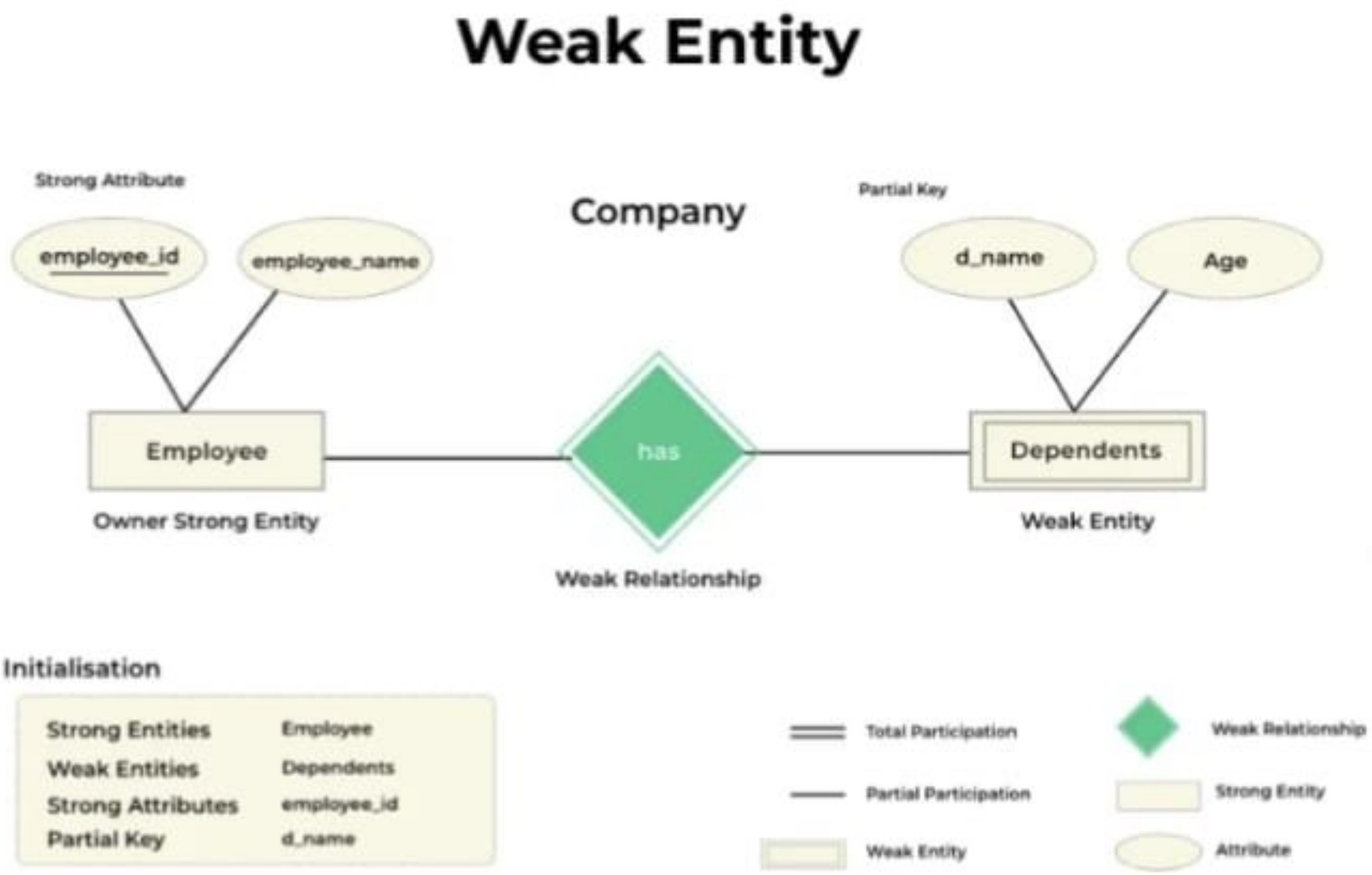
  The relationship of two strong entities is represented by a single diamond. Various strong entities, when combined together, create a strong entity set.

- **Weak Entity:**

  A weak entity is dependent on a strong entity to ensure its existence. Unlike a strong entity, a weak entity does not have any primary key. It instead has a partial discriminator key.

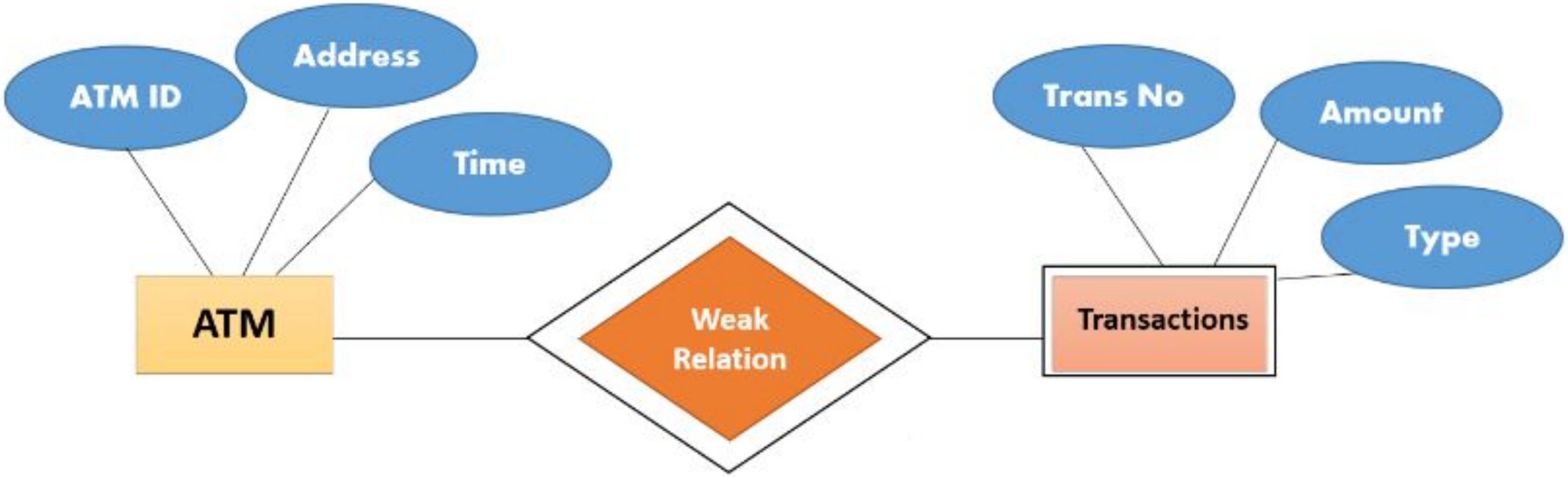
A weak entity is represented by a double rectangle.

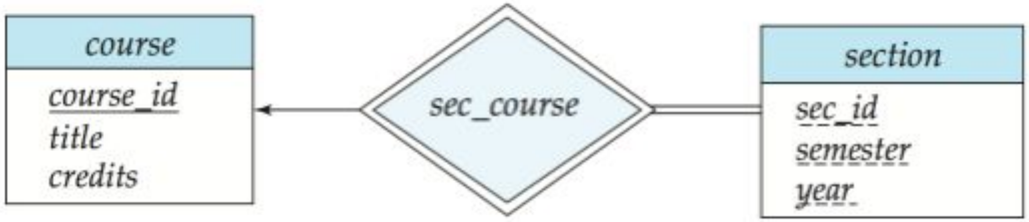
Strong Entity – Weak Entity



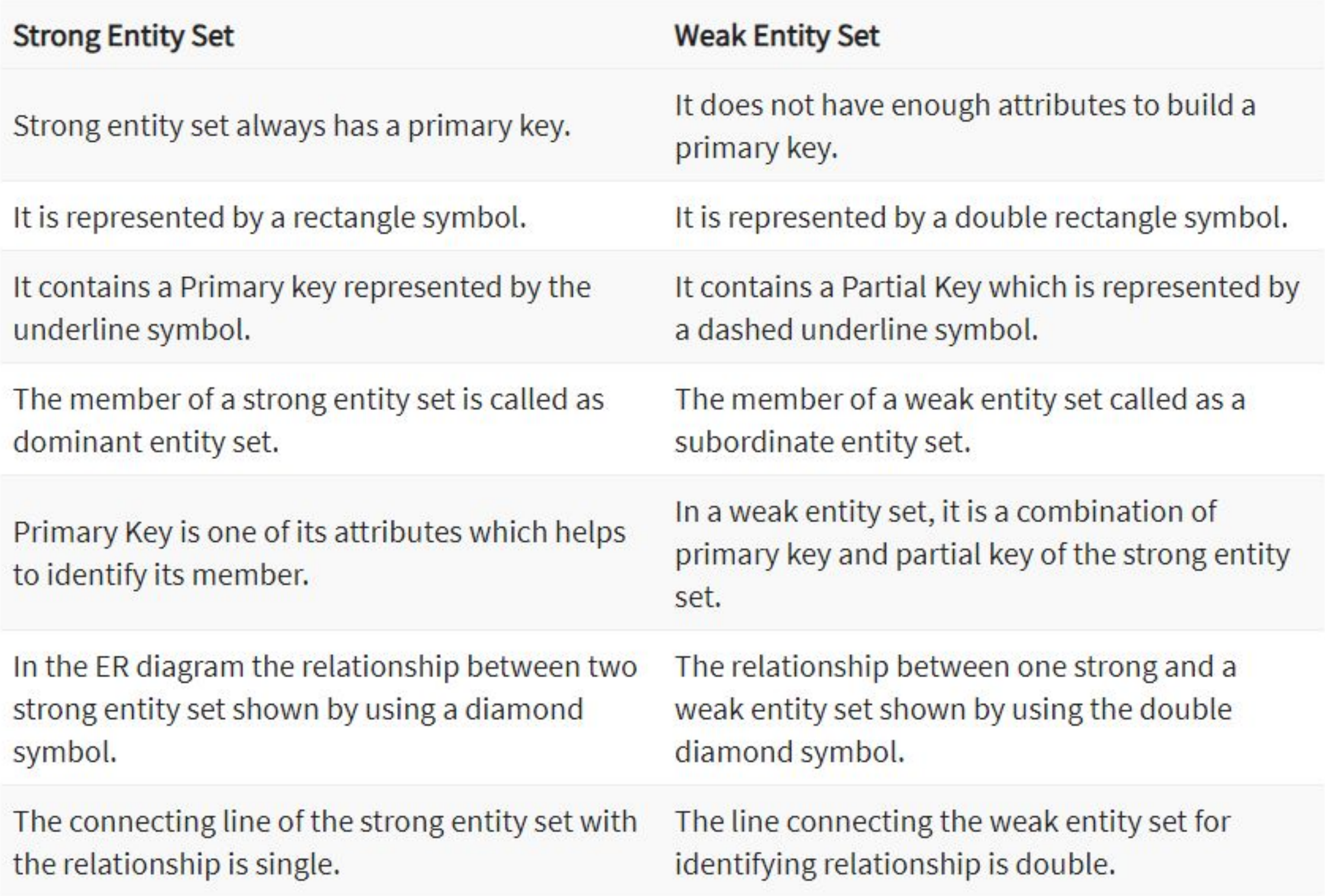
Strong Entities	Employee
Weak Entities	Dependents
Strong Attributes	employee_id
Partial Key	d_name

Strong Entity-Weak Entity Example



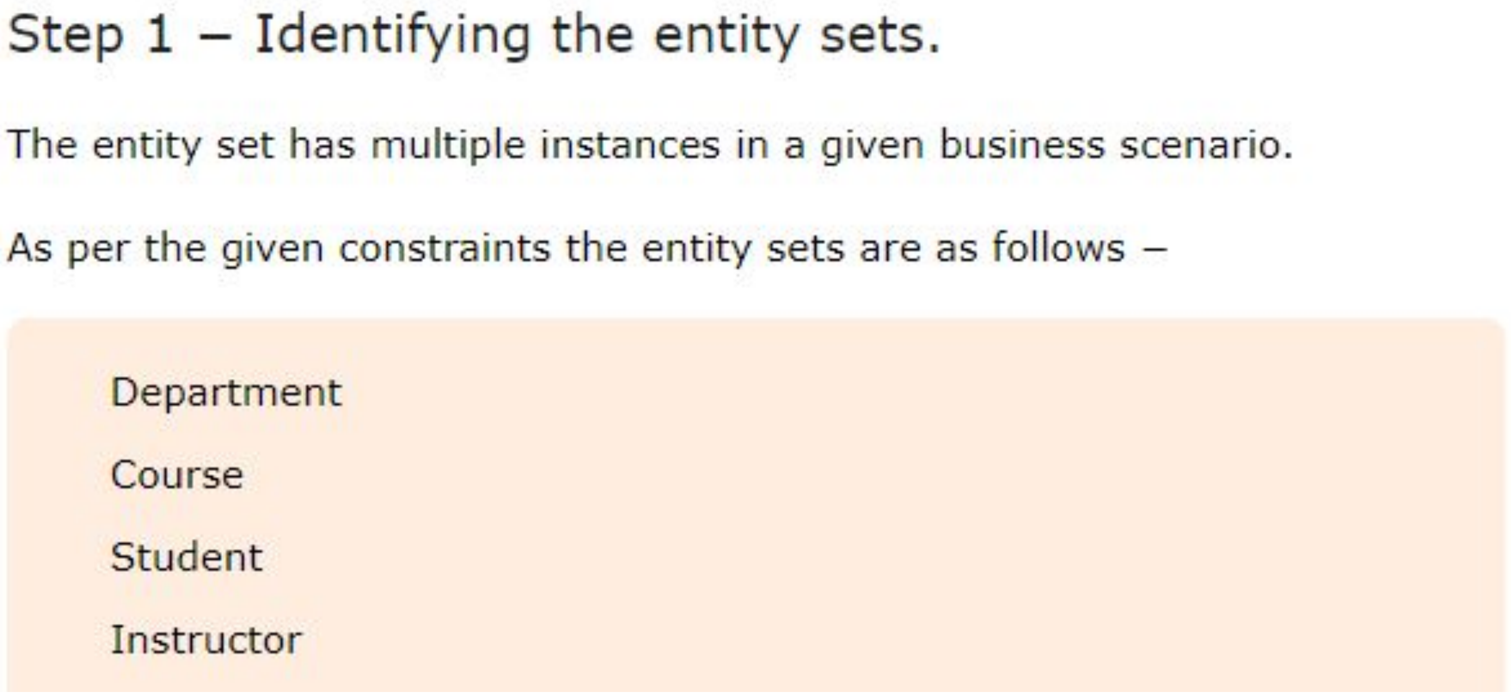


Strong Entity Set Vs Weak Entity Set



Strong Entity Set	Weak Entity Set
Strong entity set always has a primary key.	It does not have enough attributes to build a primary key.
It is represented by a rectangle symbol.	It is represented by a double rectangle symbol.
It contains a Primary key represented by the underline symbol.	It contains a Partial Key which is represented by a dashed underline symbol.
The member of a strong entity set is called as dominant entity set.	The member of a weak entity set called as a subordinate entity set.
Primary Key is one of its attributes which helps to identify its member.	In a weak entity set, it is a combination of primary key and partial key of the strong entity set.
In the ER diagram the relationship between two strong entity set shown by using a diamond symbol.	The relationship between one strong and a weak entity set shown by using the double diamond symbol.
The connecting line of the strong entity set with the relationship is single.	The line connecting the weak entity set for identifying relationship is double.

- A University has several departments. Each department has several instructors/lectures . Each instructor teaches multiple courses. Each department offers several courses. Each Course have different subjects. A student can enroll for several courses offered by different departments. Considering above description, develop a complete E-R diagram for the University database.



Step 1 – Identifying the entity sets.

The entity set has multiple instances in a given business scenario.

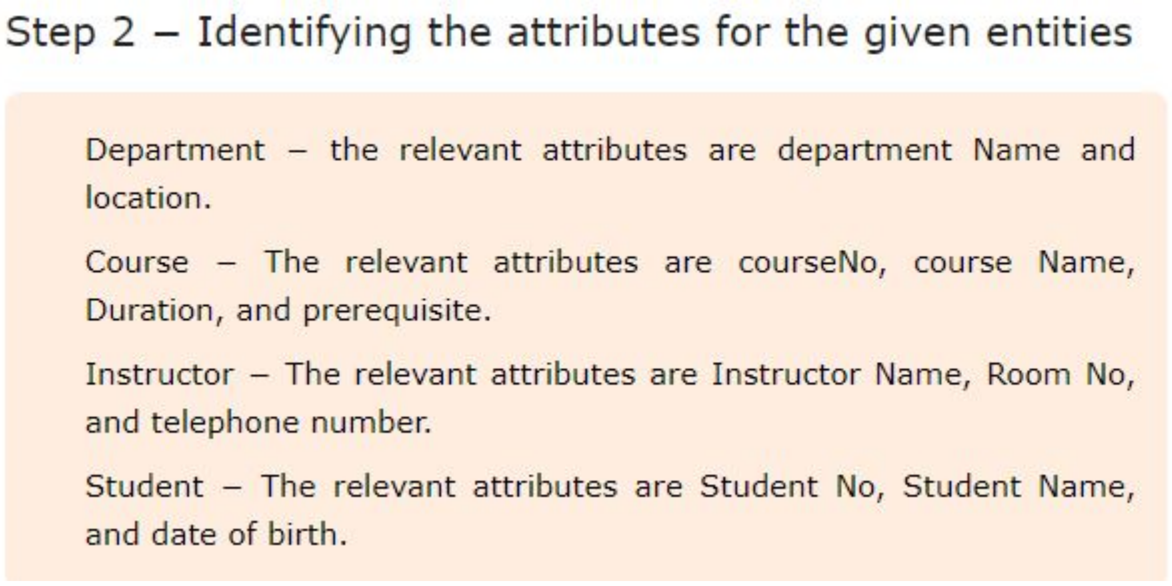
As per the given constraints the entity sets are as follows –

Department

Course

Student

Instructor



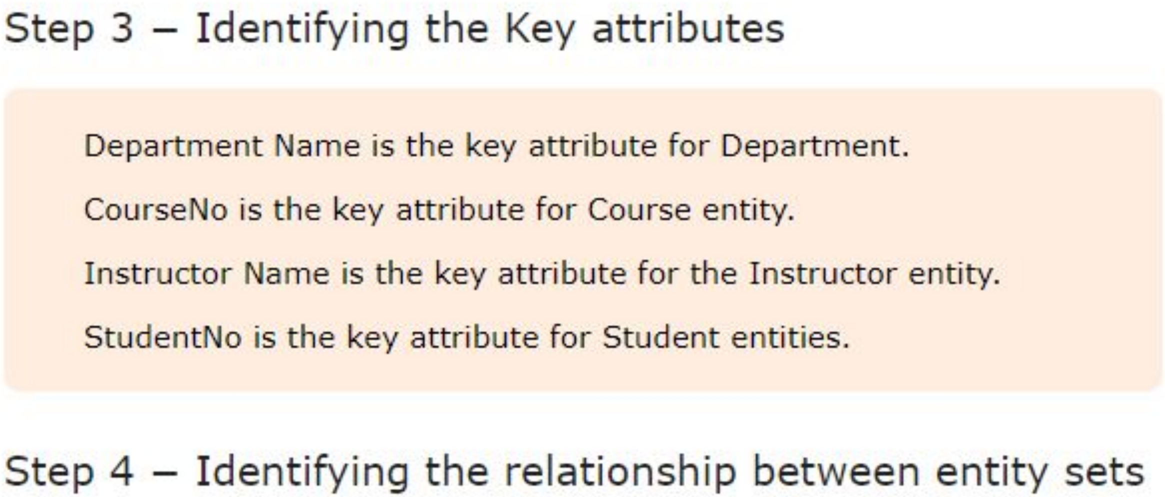
Step 2 – Identifying the attributes for the given entities

Department – the relevant attributes are department Name and location.

Course – The relevant attributes are courseNo, course Name, Duration, and prerequisite.

Instructor – The relevant attributes are Instructor Name, Room No, and telephone number.

Student – The relevant attributes are Student No, Student Name, and date of birth.



Step 3 – Identifying the Key attributes

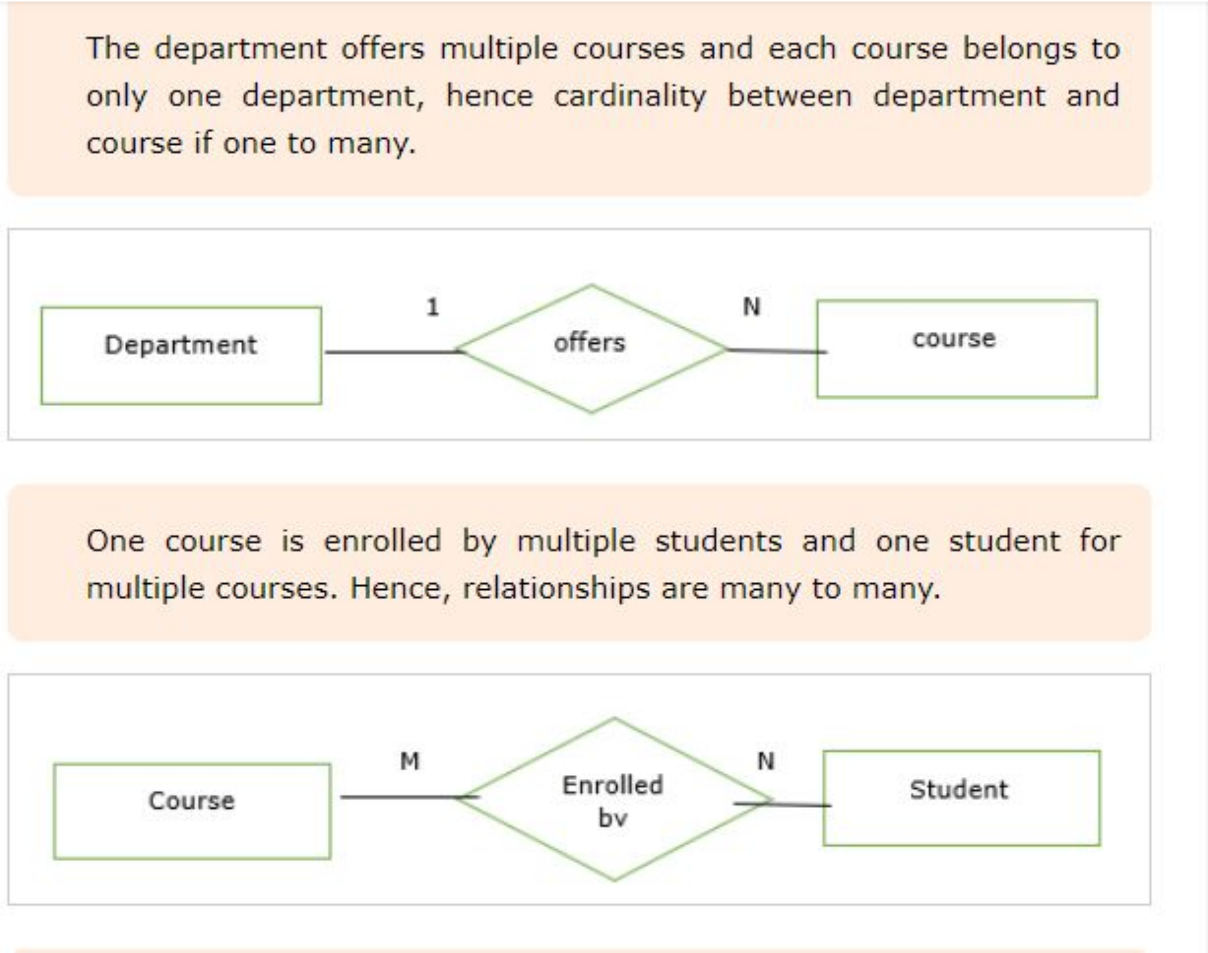
Department Name is the key attribute for Department.

CourseNo is the key attribute for Course entity.

Instructor Name is the key attribute for the Instructor entity.

StudentNo is the key attribute for Student entities.

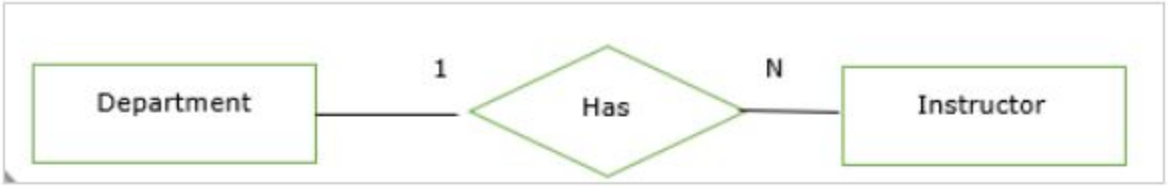
Step 4 – Identifying the relationship between entity sets



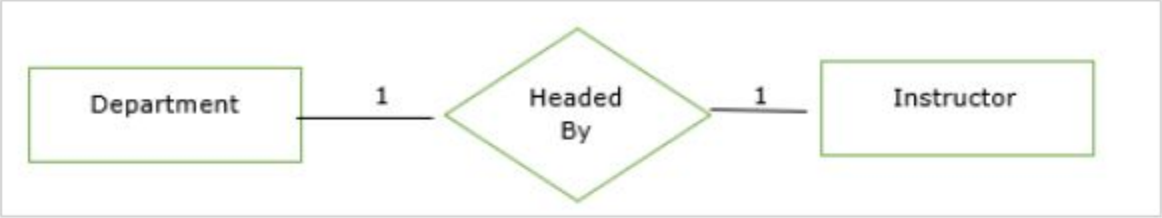
The department offers multiple courses and each course belongs to only one department, hence cardinality between department and course if one to many.

One course is enrolled by multiple students and one student for multiple courses. Hence, relationships are many to many.

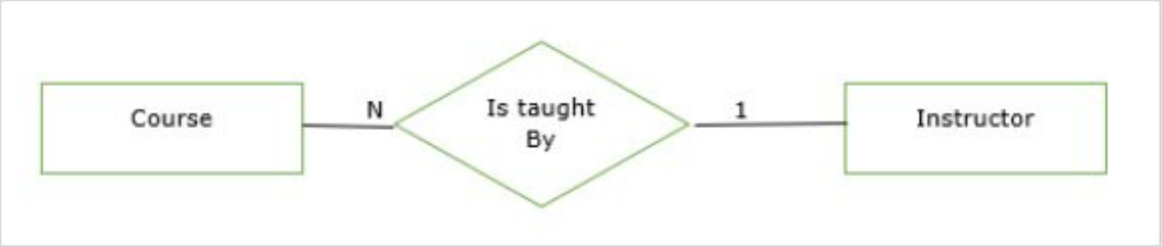
One department has multiple instructors and one instructor belongs to one and only one department, hence the relationship is one to many.



Each department has one "HOD" and one instructor is "HOD" for only one department, hence the relationship is one to one. Here, HOD refers to the head of the department.



> One course is taught by only one instructor but one instructor teaches many courses hence the relationship between course and instructor is many to one.

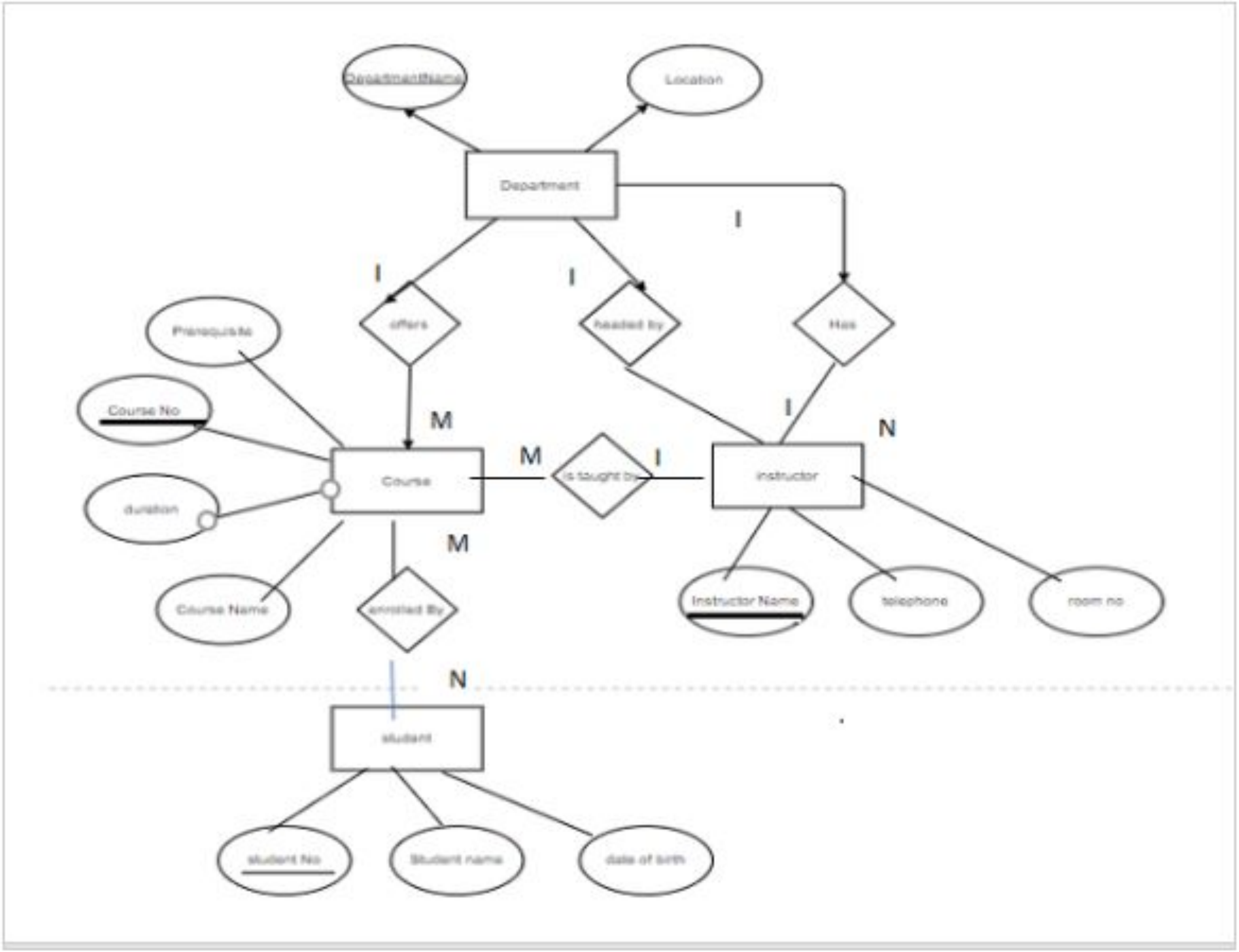


The relationship between instructor and student is not defined because of the following reasons –

> There is no significance in the relationship.
>
> We can always derive this relationship indirectly through course and instructors, and course and student.

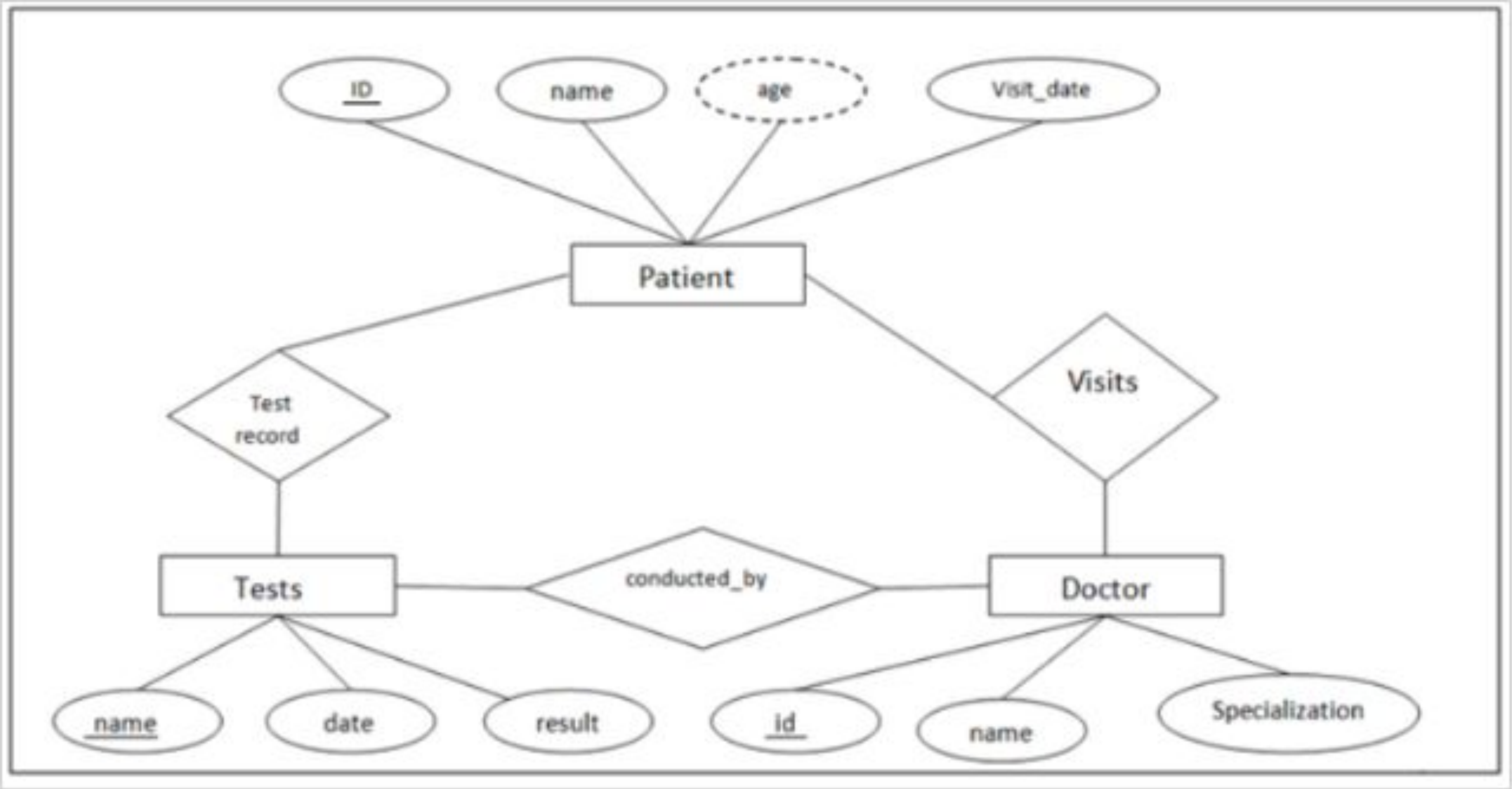
Step 5 – Complete ER model

The complete ER Model is as follows –

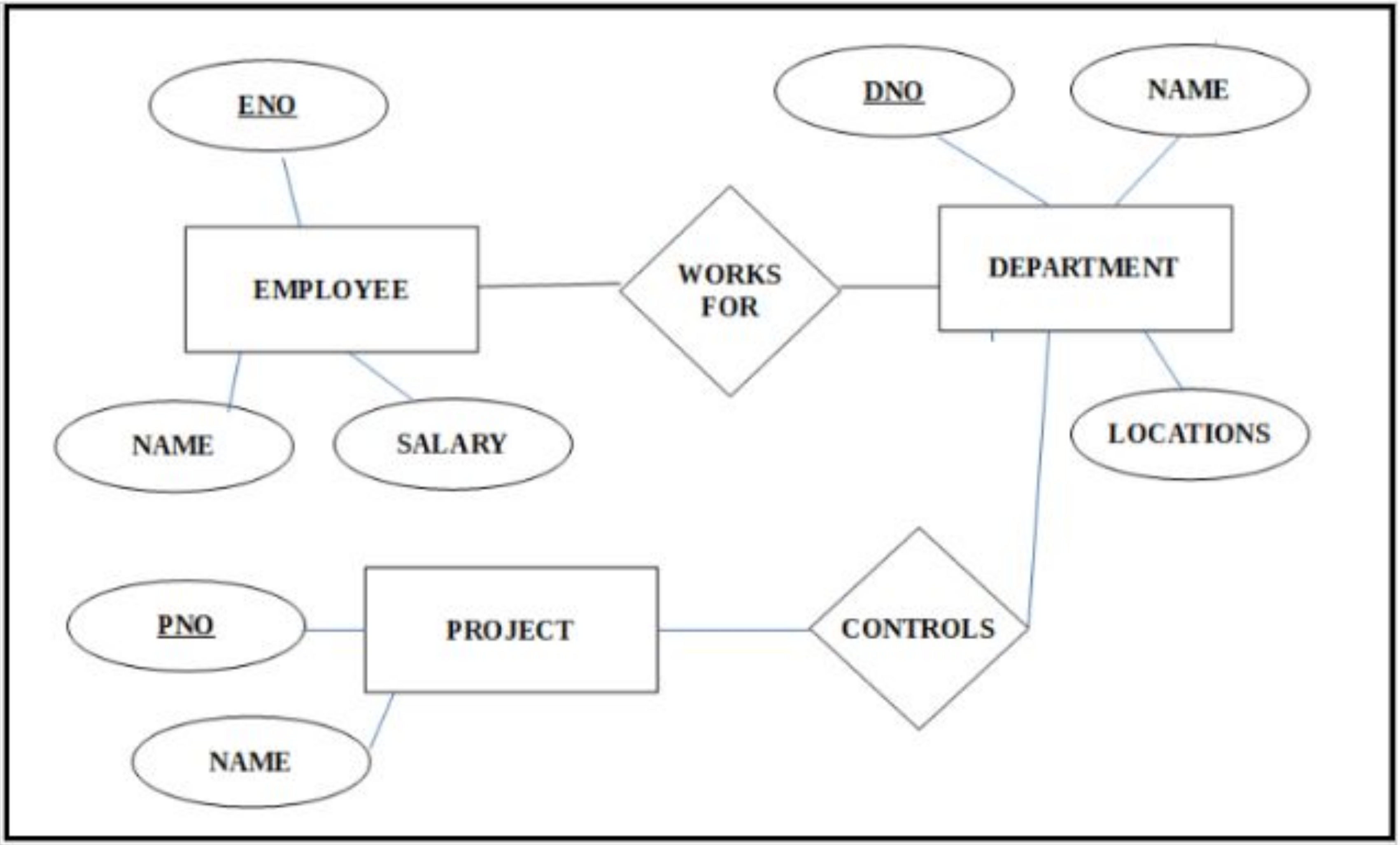


- Construct an ER diagram for a company in DBMS?
- Construct an ER diagram for a Hospital Management Systems in DBMS?
- Construct an ER diagram for the Banking system in DBMS?
- Construct an ER diagram for the Library management system(DBMS)?

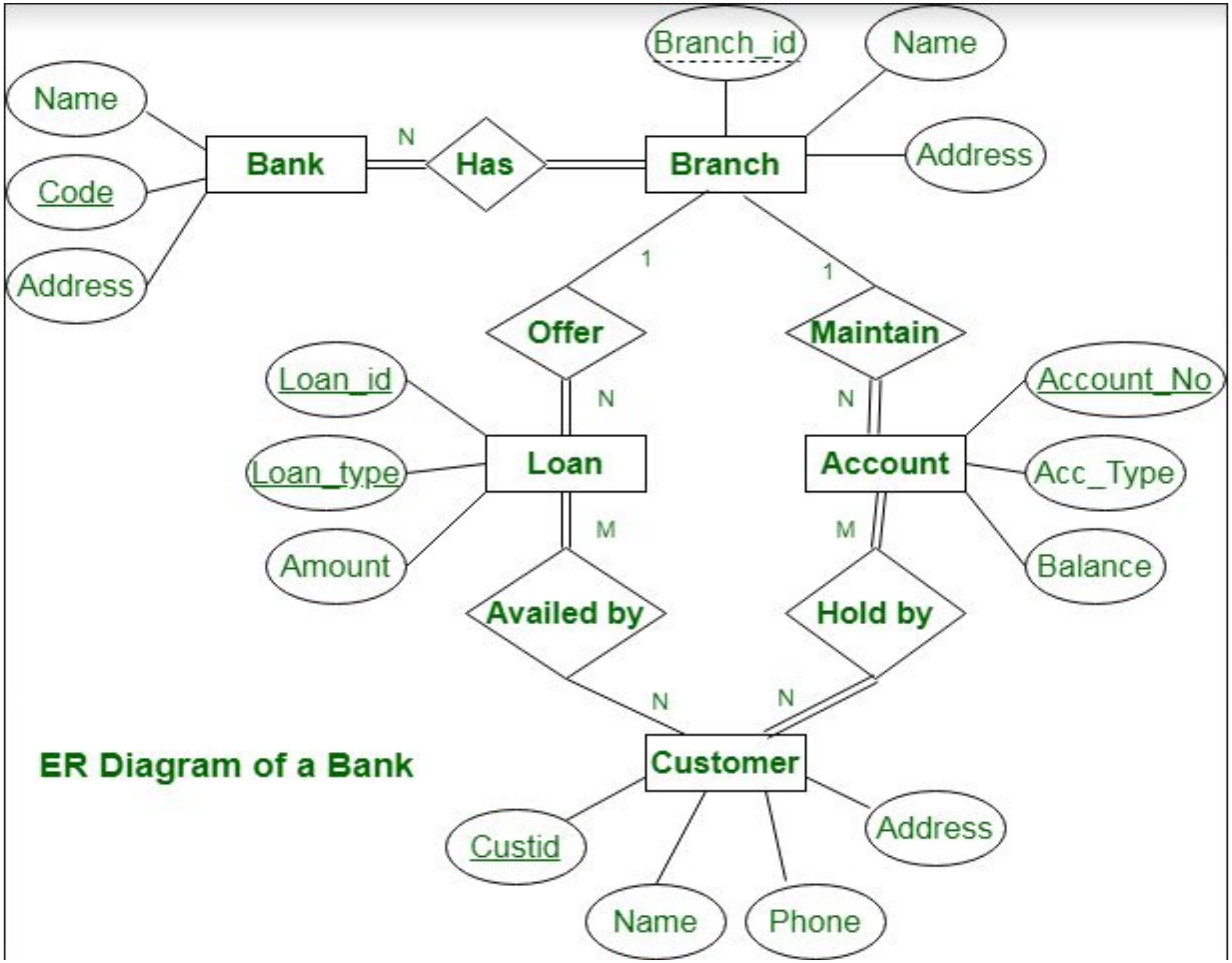
Hospital ER Model



Company ER Model

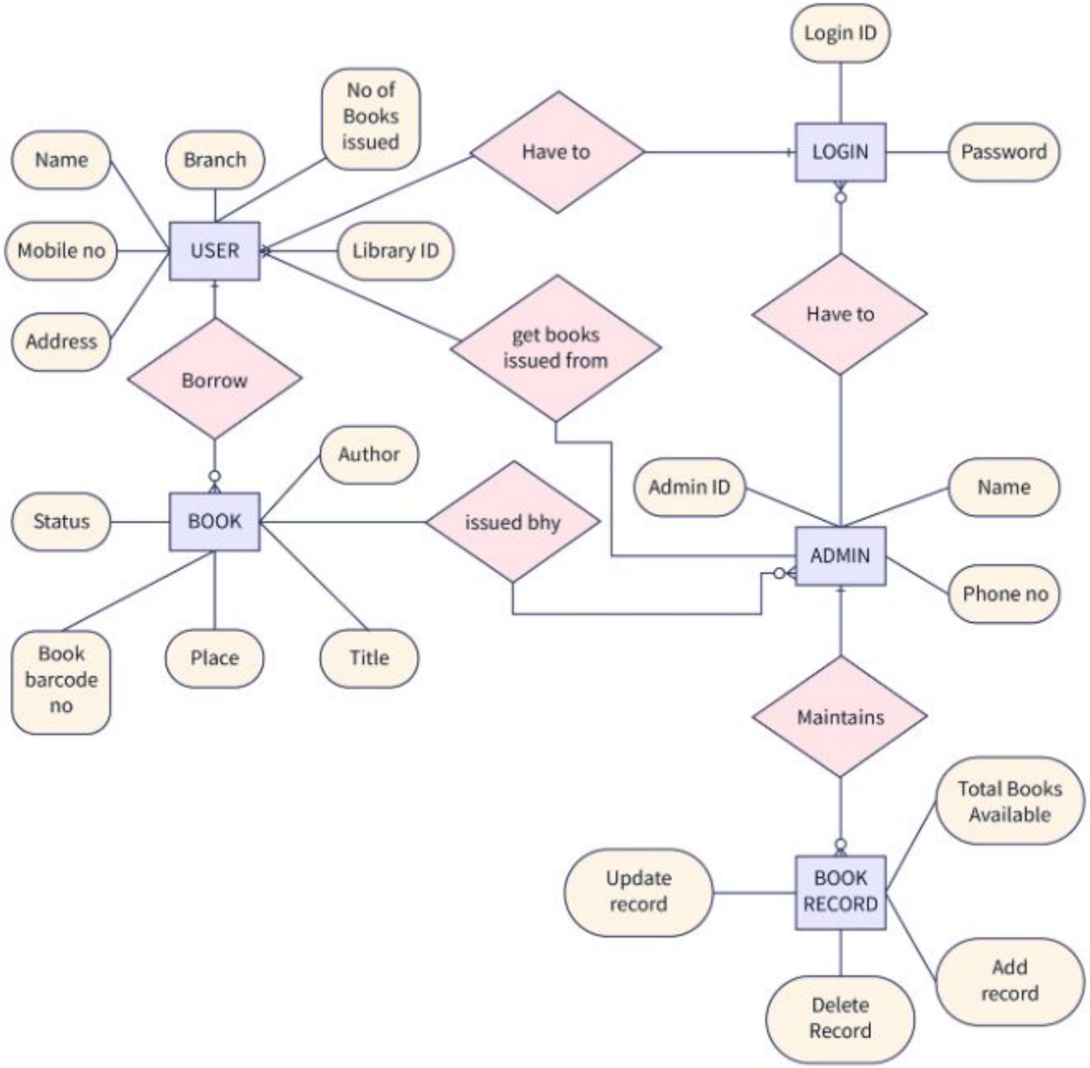


ERD for Banking



In an ER diagram, entities are represented by rectangles, and relationships are represented by diamonds. The double line connecting the diamonds indicates a strong relationship. The entities connected by a double line are considered interdependent, meaning they cannot exist independently of each other in the database.

ERD for LIS

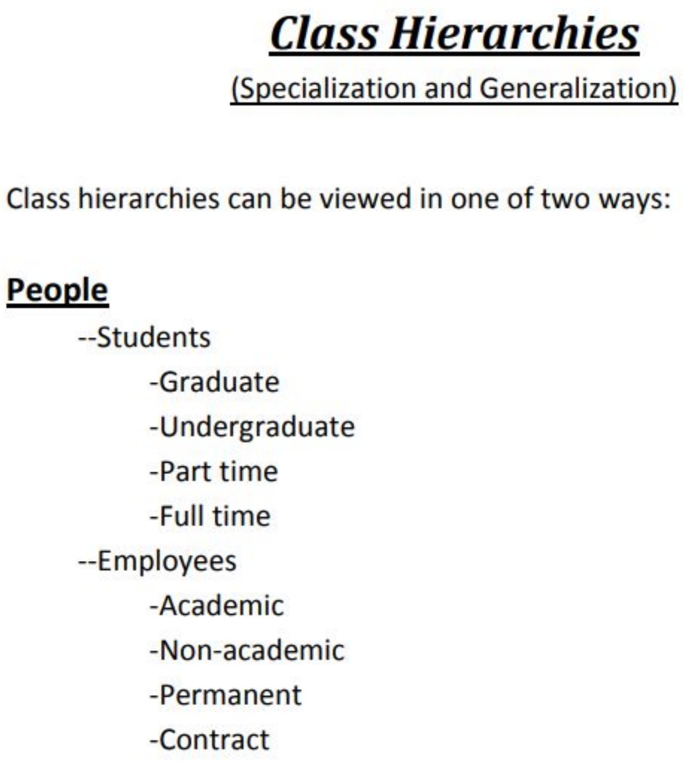

Login ID
No of Books issued
Have to
LOGIN
Password
Name
Branch
USER
Mobile no
Library ID
Address
Have to
Borrow
get books issued from
Author
Admin ID
Name
Status
BOOK
issued bhy
ADMIN
Phone no
Book barcode no
Place
Title
Maintains
Total Books Available
Update record
BOOK RECORD
Add record
Delete Record

- Using the ER model for bigger data creates a lot of complexity while designing a database model.

- In order to minimize the complexity Generalization, Specialization, and Aggregation were introduced

  - Generalization
  - Specialization
  - Aggregation

Class Heirarchies



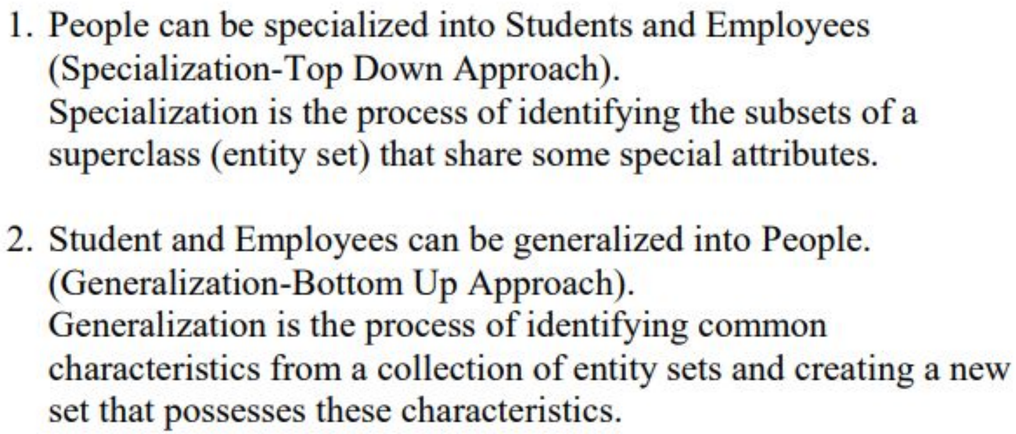
Class Hierarchies

(Specialization and Generalization)

Class hierarchies can be viewed in one of two ways:

People

- --Students
  - -Graduate
  - -Undergraduate
  - -Part time
  - -Full time
- --Employees
  - -Academic
  - -Non-academic
  - -Permanent
  - -Contract



1. People can be specialized into Students and Employees (Specialization-Top Down Approach).
   Specialization is the process of identifying the subsets of a superclass (entity set) that share some special attributes.

2. Student and Employees can be generalized into People. (Generalization-Bottom Up Approach).
   Generalization is the process of identifying common characteristics from a collection of entity sets and creating a new set that possesses these characteristics.

Generalization

- Generalization is the process of extracting common properties from a set of entities and creating a generalized entity from it.

- It is a bottom-up approach in which two or more entities can be generalized to a higher-level entity if they have some attributes in common.

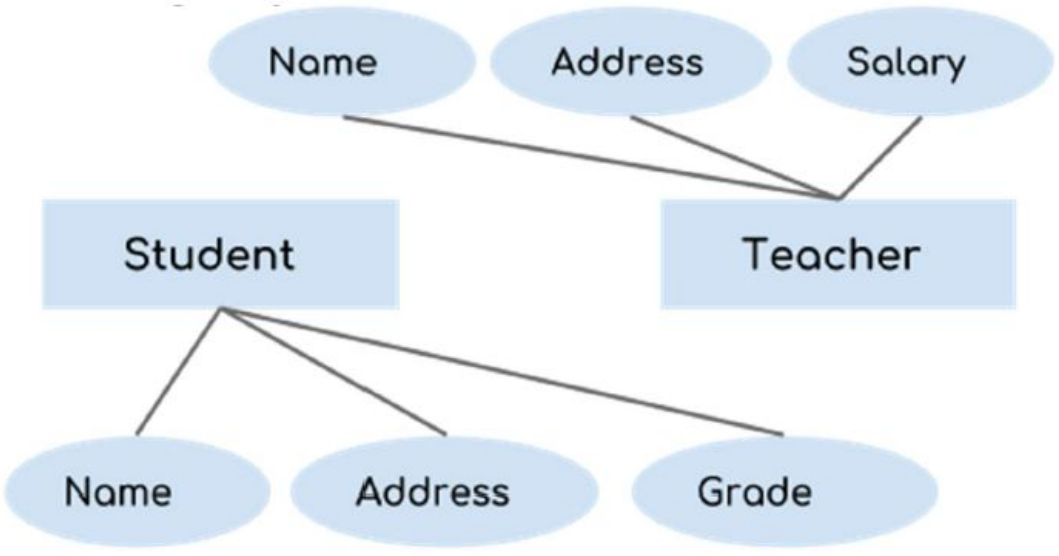
- For Example, STUDENT and FACULTY can be generalized to a higher-level entity called PERSON as shown in Figure 1.

- In this case, common attributes like P_NAME, and P_ADD become part of a higher entity (PERSON), and specialized attributes like S_FEE become part of a specialized entity (STUDENT).

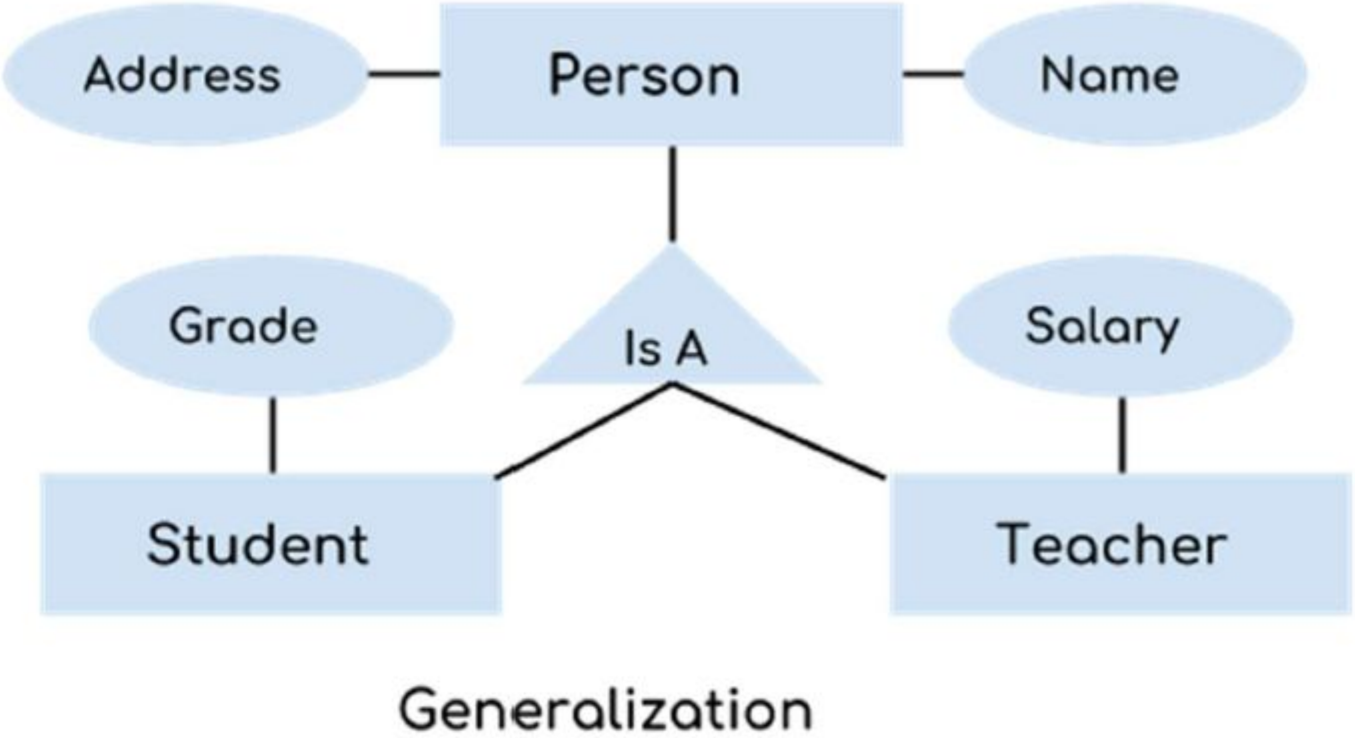
- Generalization is also called as ‘ Bottom-up approach”.

Generalization

- ER Diagram before Generalization looks like this . Two Entities Student & Teacher having common attributes



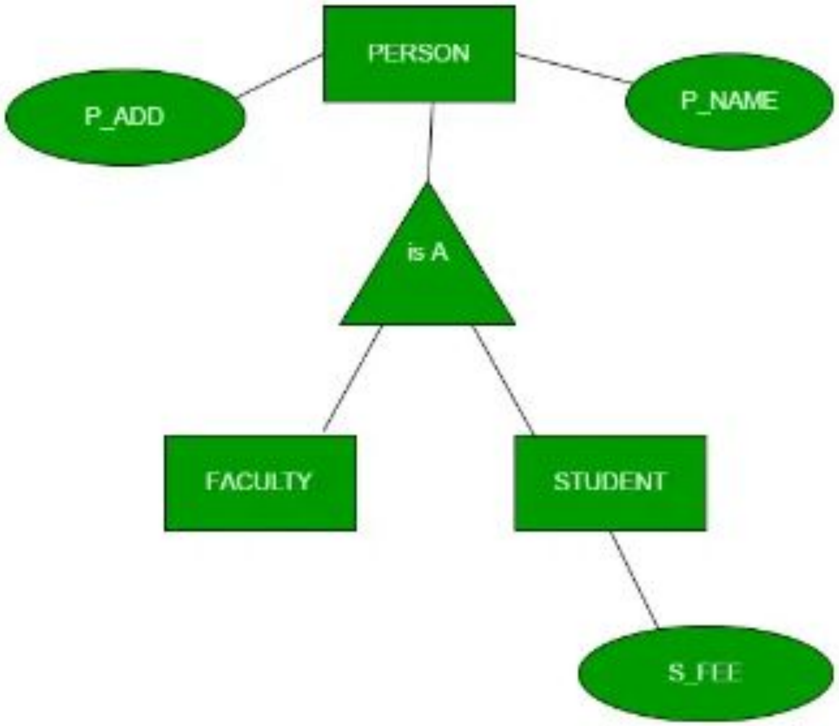
Entities after Generalization



1. Generalization uses bottom-up approach where two or more lower level entities combine together to form a higher level new entity.

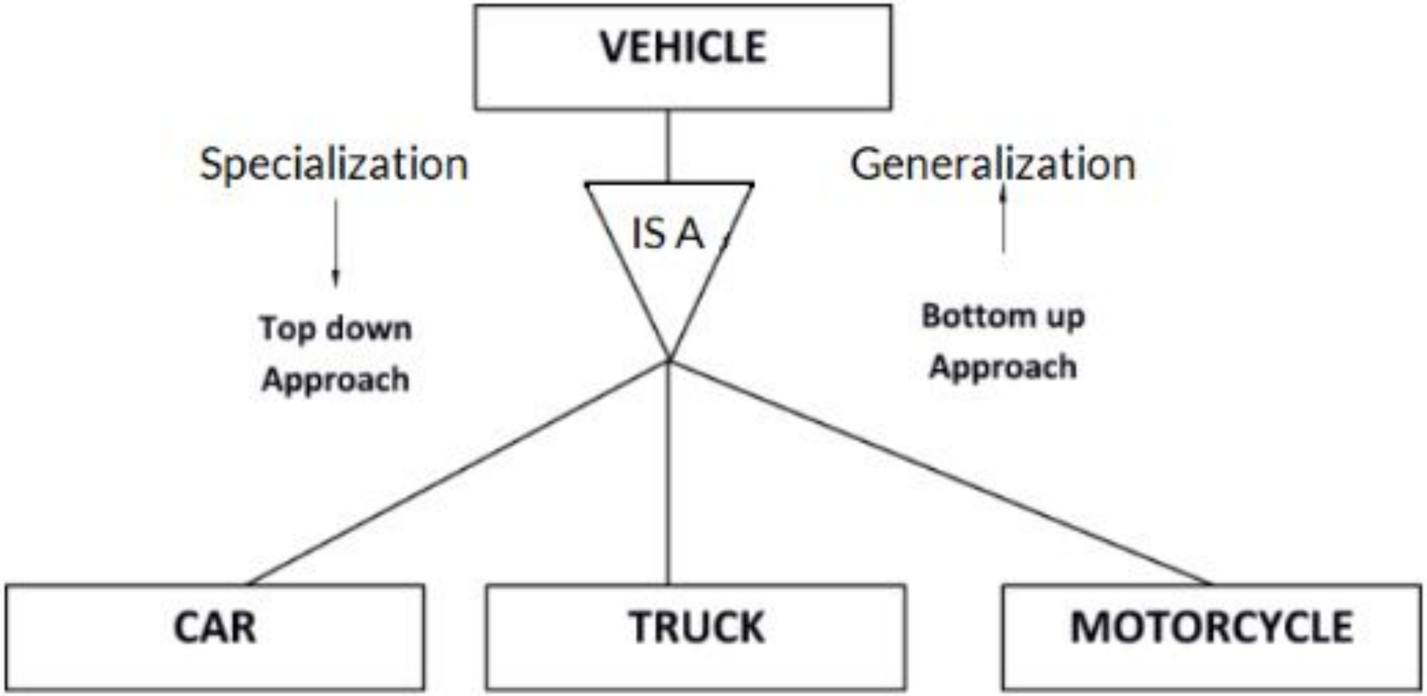
2. The new generalized entity can further combine together with lower level entity to create a further higher level generalized entity.

Generalization



Generalization

Generalization Example



Specialization

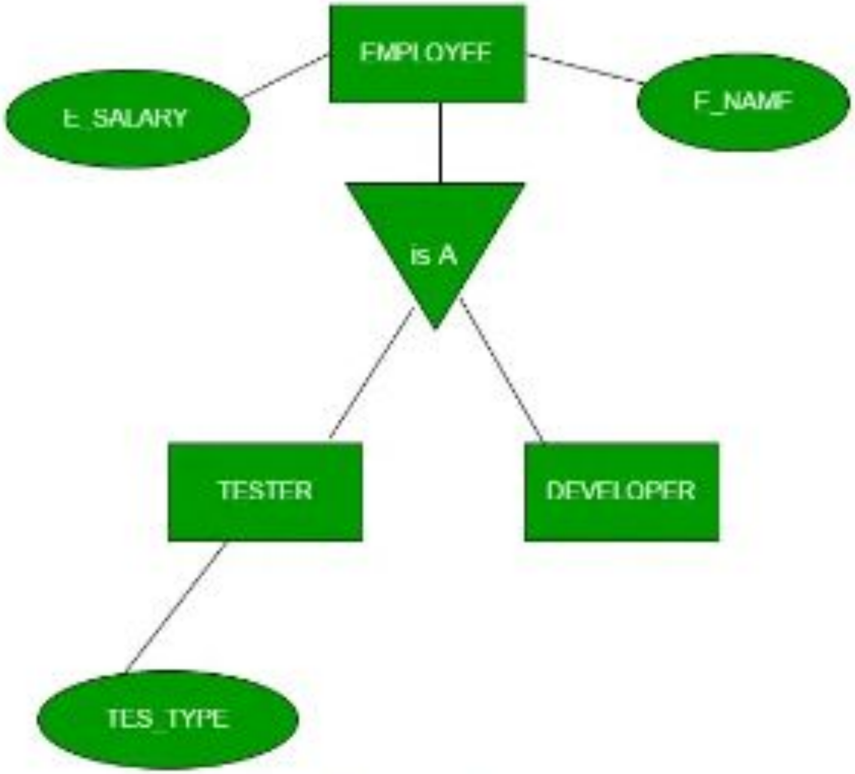
- In specialization, an entity is divided into sub-entities based on its characteristics. It is a top-down approach where the higher-level entity is specialized into two or more lower-level entities.

- For Example, an EMPLOYEE entity in an Employee management system can be specialized into DEVELOPER, TESTER, etc. as shown in Figure 2.

- In this case, common attributes like E_NAME, E_SAL, etc. become part of a higher entity (EMPLOYEE), and specialized attributes like TES_TYPE become part of a specialized entity (TESTER).

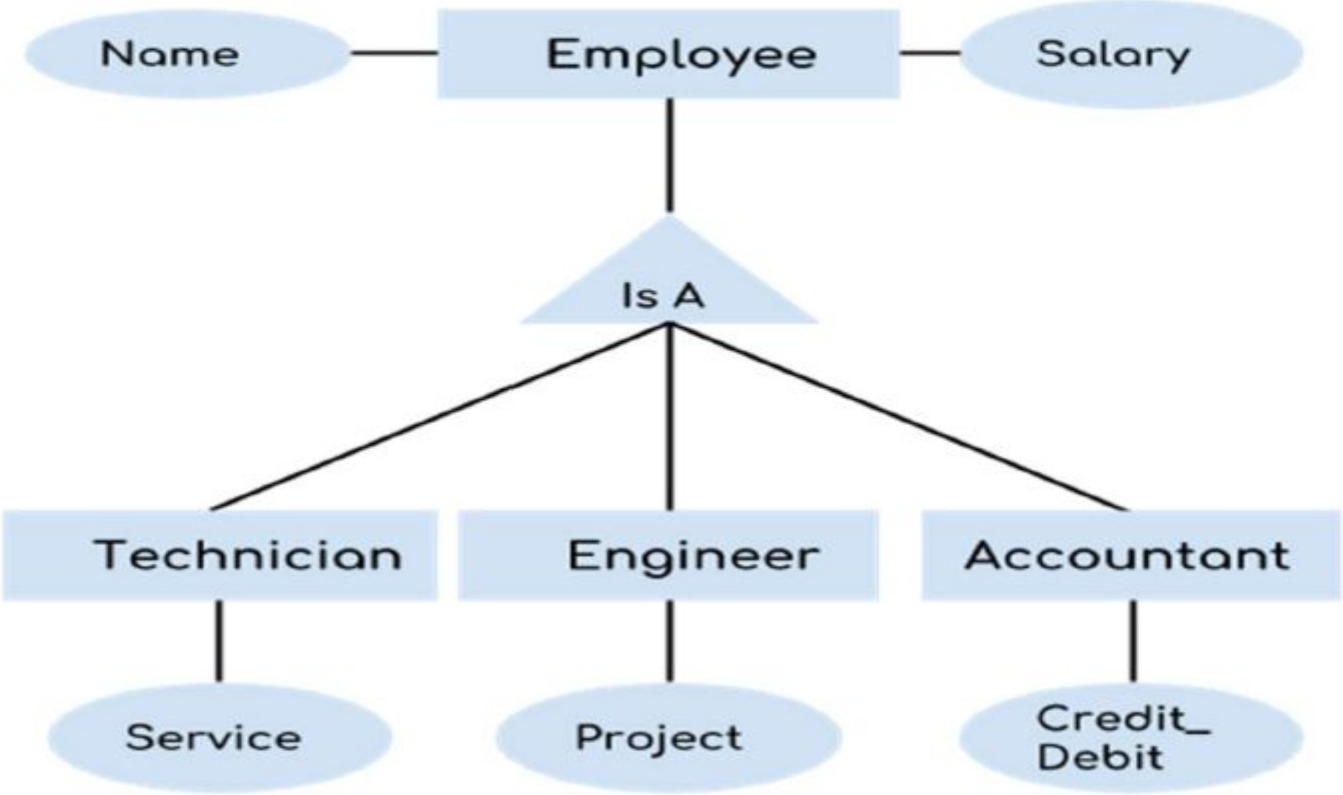
- Specialization is also called as ” Top-Down approch”.

Specialization



Specialization

Specialization Example



Specialization

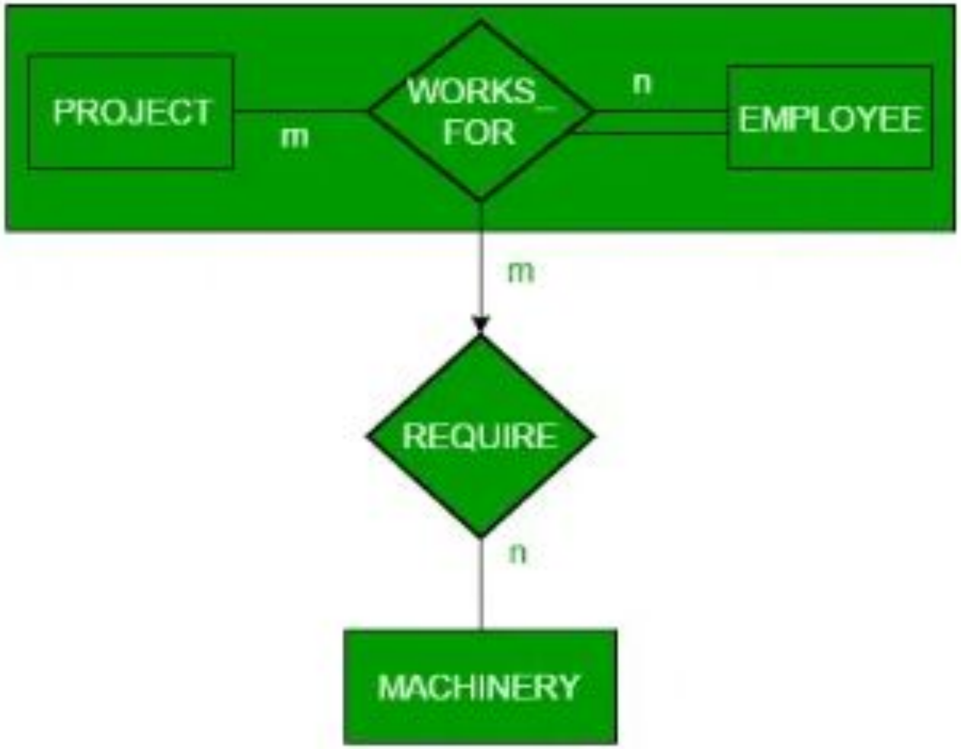
Aggregation

- An ER diagram is not capable of representing the relationship between an entity and a relationship which may be required in some scenarios.

- For Example, an Employee working on a project may require some machinery. So, REQUIRE relationship is needed between the relationship WORKS_FOR and entity MACHINERY.

- Using aggregation, WORKS_FOR relationship with its entities EMPLOYEE and PROJECT is aggregated into a single entity and relationship REQUIRE is created between the aggregated entity and MACHINERY.

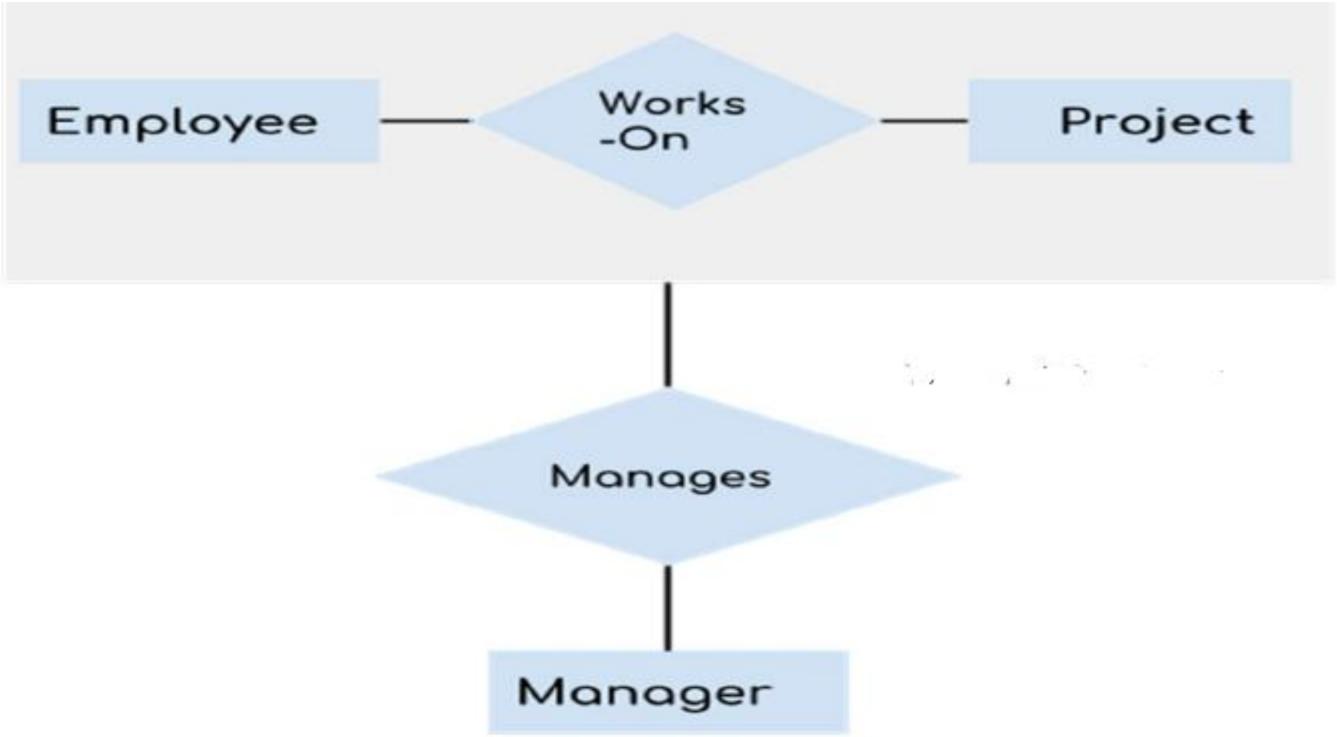
Aggregation



Aggregation

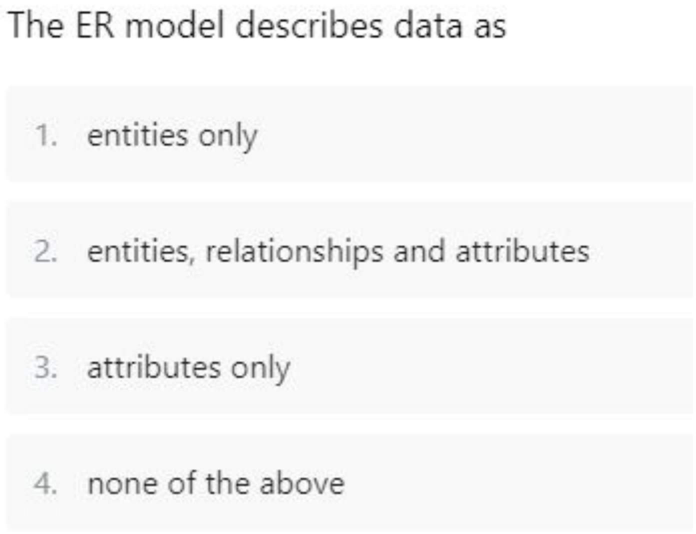
ERD - Aggregation

- Aggregation is a process in which a single entity alone is not able to make sense in relationship so the relationship of two entities acts as one entity.



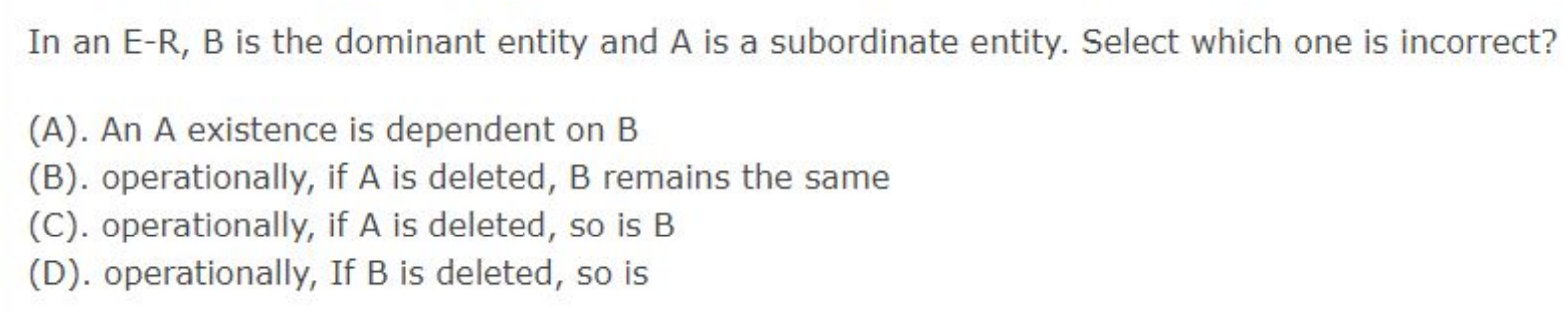
Possible Questions

- Illustrate E-R diagram with different mapping cardinalities
- Describe notations or symbols used to draw ER diagrams with examples
- Illustrate aggregation in ER model with example.
- Explain about Design Issues related to ER Diagrams.
- Define a) Entity b) Attribute c) Relationship with examples.
- State and explain various features of E-R Models.
- A university database contains information about Professors (identified by empid) and Courses (identified by cid). Professors teach courses; each of the following situations describes the Teaches relationship. For each situation draw an ER diagram
- Illustrate Generalization and Specialization in ER model with example.
- Explain differences between Strong entity and Weak entity with examples



The ER model describes data as

1. entities only
2. entities, relationships and attributes
3. attributes only
4. none of the above



In an E-R, B is the dominant entity and A is a subordinate entity. Select which one is incorrect?

(A). An A existence is dependent on B
(B). operationally, if A is deleted, B remains the same
(C). operationally, if A is deleted, so is B
(D). operationally, If B is deleted, so is

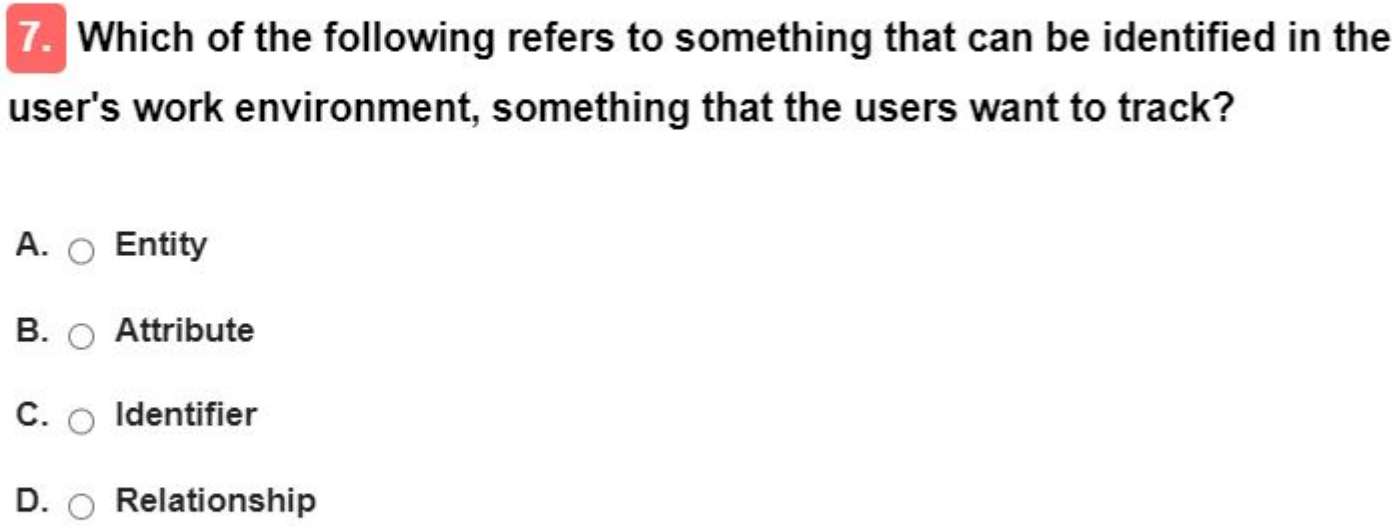
2. Which type of entity cannot exist in the database unless another type of entity also exists in the database, but does not require that the identifier of that other entity be included as part of its own identifier?

A. ○ Weak entity

B. ○ Strong entity

C. ○ ID-dependent entity

D. ○ ID- independent entity



7. Which of the following refers to something that can be identified in the user's work environment, something that the users want to track?

A. ○ Entity

B. ○ Attribute

C. ○ Identifier

D. ○ Relationship

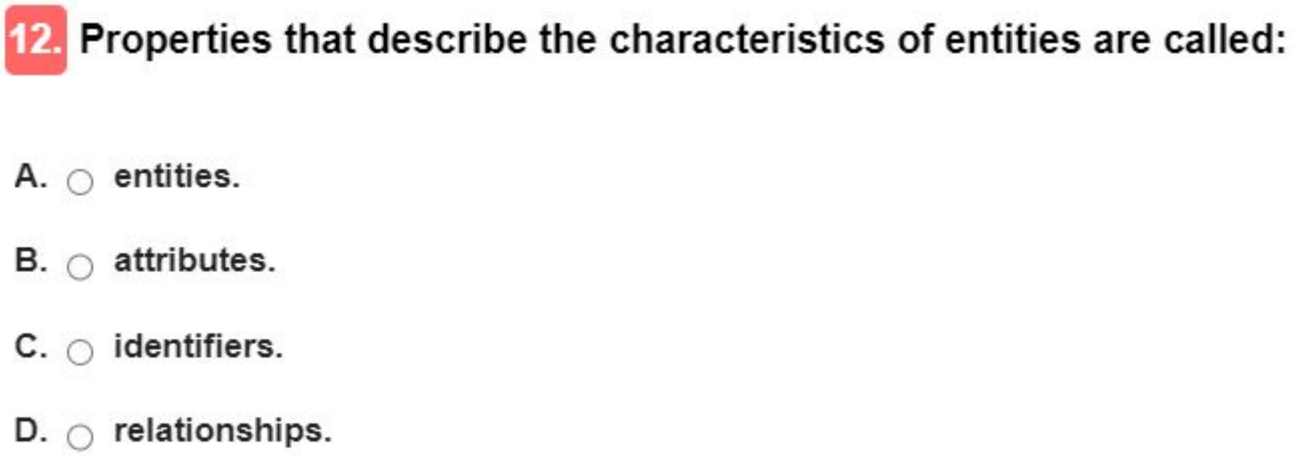
8. In which of the following is a single-entity instance of one type related to many entity instances of another type?

A. ○ One-to-One Relationship

B. ○ One-to-Many Relationship

C. ○ Many-to-Many Relationship

D. ○ Composite Relationship



12. **Properties that describe the characteristics of entities are called:**

A. ○ entities.

B. ○ attributes.

C. ○ identifiers.

D. ○ relationships.

15. **Which of the following is NOT a basic element of all versions of the E-R model?**

A. ○ Entities

B. ○ Attributes

C. ○ Relationships

D. ○ Primary keys

16. In which of the following is a single-entity instance of one type of related to a single-entity instance of another type?

A. ○ One-to-One Relationship

B. ○ One-to-Many Relationship

C. ○ Many-to-Many Relationship

D. ○ Composite Relationship

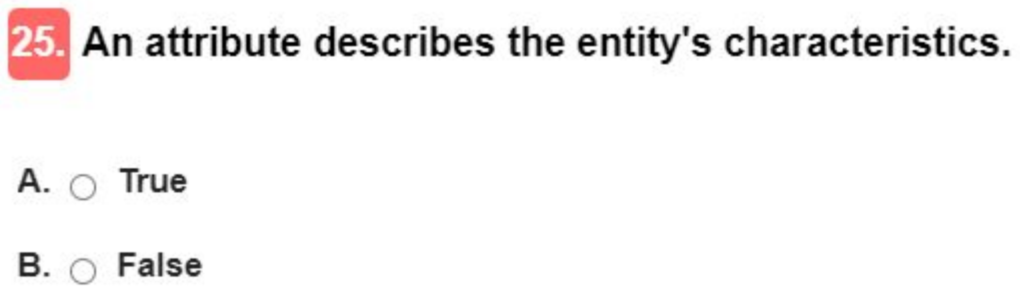
17. **Entities can be associated with one another in which of the following?**

A. ○ Entities

B. ○ Attributes

C. ○ Identifiers

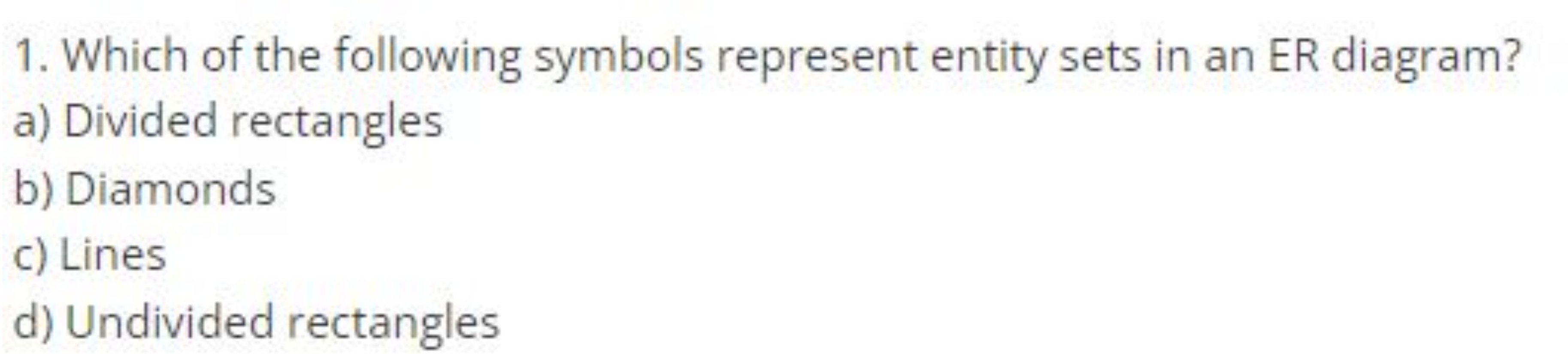
D. ○ Relationships



25. An attribute describes the entity's characteristics.

A. ○ True

B. ○ False



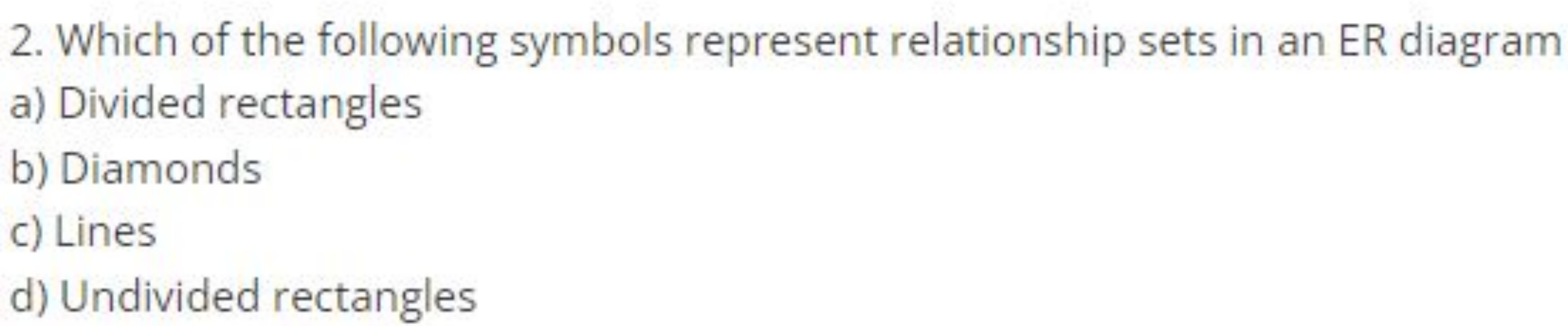
1. Which of the following symbols represent entity sets in an ER diagram?

a) Divided rectangles

b) Diamonds

c) Lines

d) Undivided rectangles



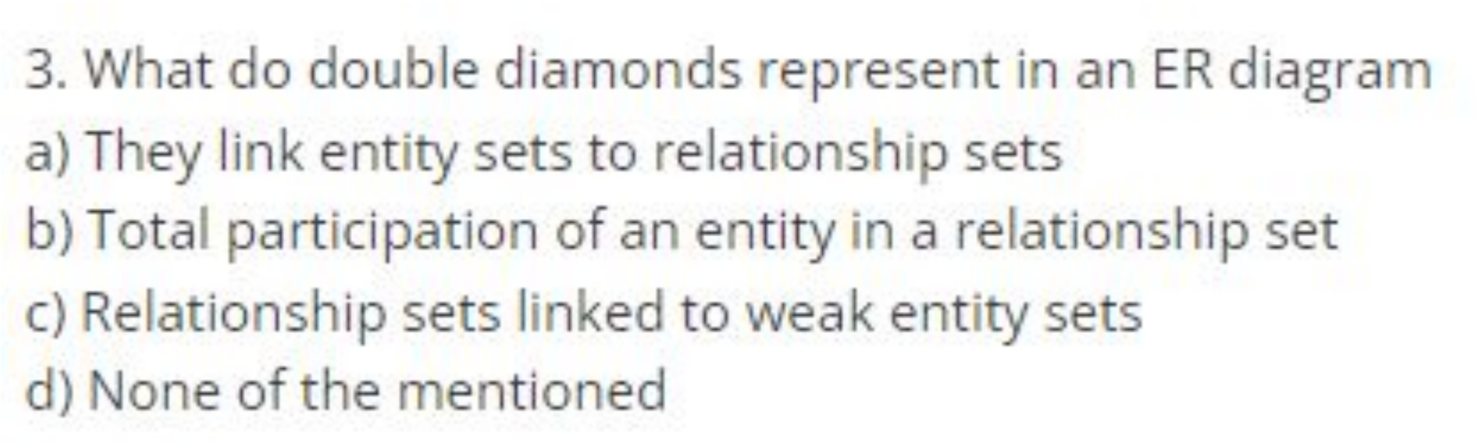
2. Which of the following symbols represent relationship sets in an ER diagram

a) Divided rectangles

b) Diamonds

c) Lines

d) Undivided rectangles



3. What do double diamonds represent in an ER diagram

a) They link entity sets to relationship sets

b) Total participation of an entity in a relationship set

c) Relationship sets linked to weak entity sets

d) None of the mentioned

6. How is the discriminator of a weak entity set specified?

a) Using a solid line

b) Circling it

c) Using a dashed line

d) Drawing a square around it

7. An entity set that has a primary key is called as __________

a) Strong entity set

b) Weak entity set

c) Complete entity set

d) None of the mentioned

9. State true or false: Every weak entity set must be associated with an identifying entity

a) True

b) False

10. State true or false: A weak entity can participate in all the relationships.

a) True

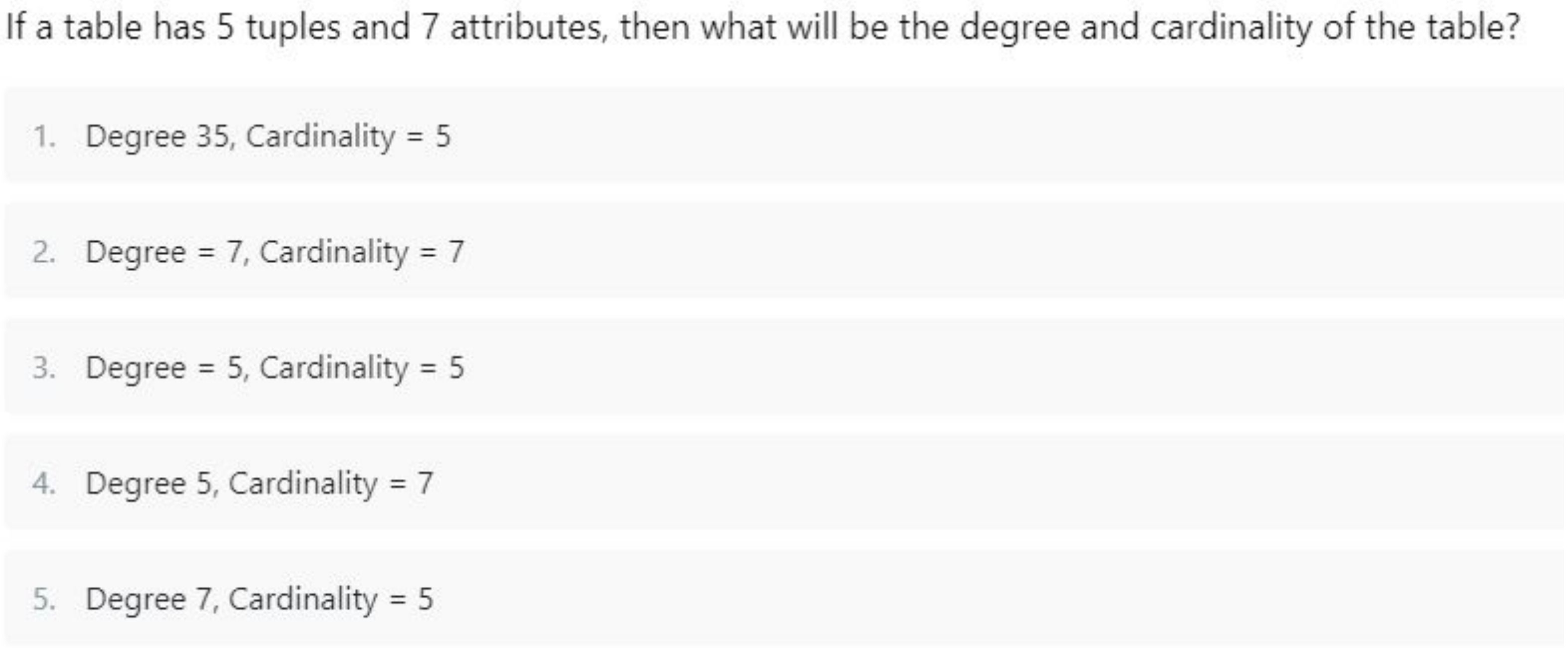
b) False

Which of the following components is not a part of Entity Relationship Diagrams?

1. Ellipse
2. Double rectangle
3. Double lines
4. Hexagons

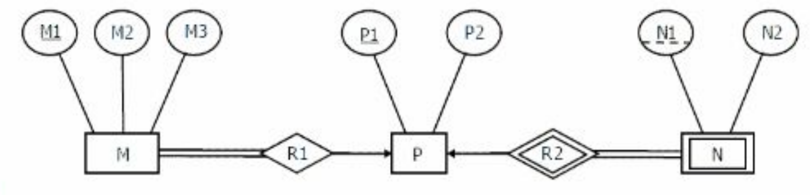
Attributes in Entity-Relationship diagram are represented by:

1. Circle
2. Line
3. Rectangle
4. Ellipse



If a table has 5 tuples and 7 attributes, then what will be the degree and cardinality of the table?

1. Degree 35, Cardinality = 5
2. Degree = 7, Cardinality = 7
3. Degree = 5, Cardinality = 5
4. Degree 5, Cardinality = 7
5. Degree 7, Cardinality = 5



Consider the following ER diagram. The minimum number of tables needed to represent M, N, P, R1, R2 is

- □ 2
- □ 3
- □ 4
- □ 5