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Case Study on Entity-Relationship (E-R) Diagram

What is an ER Diagram (Entity-Relationship Diagram) ?

An ER Diagram (Entity-Relationship Diagram) is a visual representation of data and its relationships in a system.

- **Entities** → objects or things in the system **(e.g., Customer, Product).**

- **Attributes** → details about entities **(e.g., CustomerName, Price).**

- **Relationships** → how entities are connected **(e.g., Customer *places* Order).**
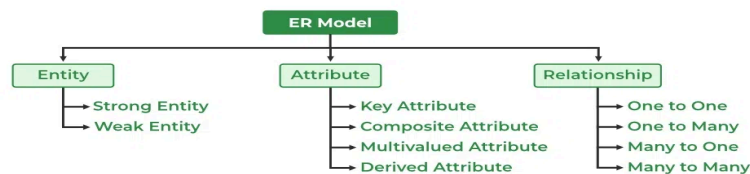

## ER Model in Database Design Process ?

1. Identifies entities, attributes, and relationships in the system.

2. Represents them visually using an ER diagram.

3. Converts the ER model into relational schema (tables).

4. Helps ensure clarity, accuracy, and efficiency in database design.

Symbols Used in ER Model :-
ER Model is used to model the logical view of the system from a data perspective which consists of these symbols:

- **Rectangles:** Rectangles represent entities in the ER Model.

- **Ellipses:** Ellipses represent attributes in the ER Model.

- **Diamond:** Diamonds represent relationships among Entities.
- **Lines:** Lines represent attributes to entities and entity sets with other relationship types.
- **Double Ellipse:** Double ellipses represent multi-valued Attributes, such as a student's multiple phone numbers
- **Double Rectangle:** Represents weak entities, which depend on other entities for identification.

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

What is an Entity ?

An Entity represents a real-world object, concept or thing about which data is stored in a database. It act as a building block of a database. Tables in relational database represent these entities.

Example of entities:

- **Real-World Objects:** Person, Car, Employee etc.
- **Concepts:** Course, Event, Reservation etc.
- **Things:** Product, Document, Device etc.

Types of Entity :-

There are two main types of entities:

1. **Strong Entity** → Has its own primary key and can be uniquely identified independently.

2. **Weak Entity** → Cannot be uniquely identified without a strong entity; depends on it.

What is Attribute ?

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

Types of Attributes :-

1. Key Attribute :- The attribute which **uniquely identifies** each entity in the entity set is called the key attribute. **For example, Roll_No** will be unique for each student.

2. Composite Attribute :- An attribute composed of many other attributes is called a composite attribute. **For example,** the **Address** attribute of the student Entity type consists of **Street, City, State, and Country.**
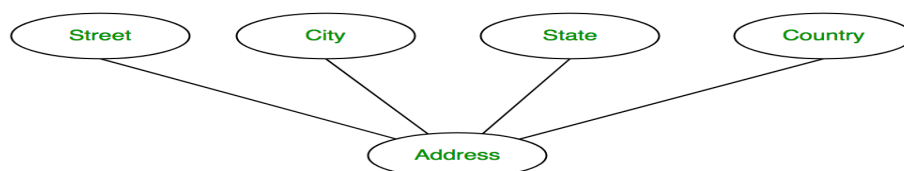
3. Multivalued Attribute :- An attribute consisting of more than one value for a given entity. **For example, Phone_No** (can be more than one for a given student).

4. Derived Attribute :- An attribute that can be derived from other attributes of the entity type is known as a derived attribute. **e.g.; Age** (can be derived from DOB).

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, the relationship type is represented by a diamond and connecting the entities with lines.

A set of relationships of the same type is known as a relationship set. The following relationship set depicts S1 as enrolled in C2, S2 as enrolled in C1, and S3 as registered in C3.
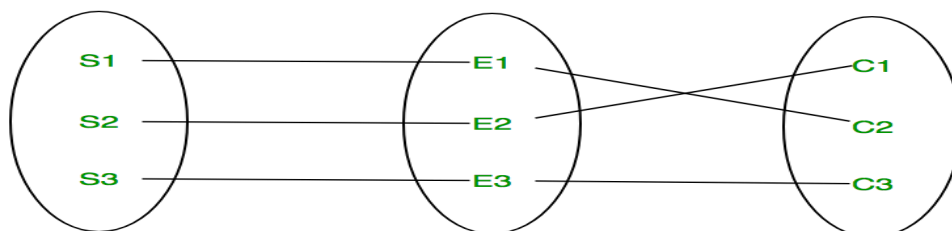
Degree of a Relationship Set :-

1. Unary (Degree 1) → Relationship between entities of the **same set**.

For example, one person is married to only one person.
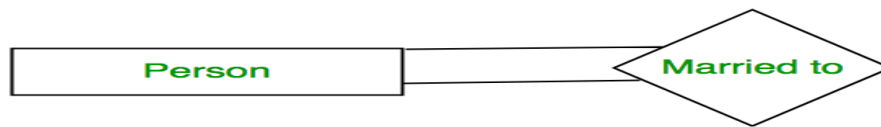
```
┌────────────────────┐      ╱◇──────────────╲
│     Person         ├─────╱   Married to     ╲
└────────────────────┘     ╲                  ╱
                            ╲────────────────╱
```

2. Binary (Degree 2) → Relationship between **two different entities**.
        For example, a Student is **enrolled in a Course.**

```
┌──────────────┐       ◇──────────◇       ┌──────────────┐
│   Student    ├──────< Enrolled in >──────┤   Course     │
└──────────────┘       ◇──────────◇       └──────────────┘
```

3. Ternary (Degree 3) → Relationship between **three entities.**

4. N-ary Relationship: When there are n entities set participating in a relationship, the relationship is **called an n-ary relationship.**

Cardinality in ER Model :-

In an **ER Model**, **Cardinality** defines the **number of instances of one entity that can be associated with instances of another entity** in a relationship.

Types of Cardinality :-

1. One-to-One (1:1) :- One entity relates to only one entity.

```
┌──────────────┐   1   ◇──────────◇   1   ┌──────────────┐
│   Surgeon    ├──────< Headed by  >──────┤    HOD       │
└──────────────┘       ◇──────────◇       └──────────────┘
```

2. One-to-Many (1:N) :- In one-to-many mapping as well where each entity can be related to more than one entity. Let us **assume** that one surgeon department can accommodate **many doctors.** So the Cardinality will be 1 to M. It means one department has many Doctors.

3. Many-to-One (N:1) :- When entities in one entity set can take part only once in the relationship set and entities in other entity sets can take part more than once in the relationship set, cardinality is many to one.

4. Many-to-Many (M:N):- 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.

How to Draw an ER Diagram

1. Identify Entities: The very first step is to identify all the Entities. Represent these entities in a Rectangle and label them accordingly.

2. Identify Relationships: The next step is to identify the relationship between them and represent them accordingly using the Diamond shape. Ensure that relationships are not directly connected to each other.

3. Add Attributes: Attach attributes to the entities by using ovals. Each entity can have multiple attributes (such as name, age, etc.), which are connected to the respective entity.

4. Define Primary Keys: Assign primary keys to each entity. These are unique identifiers that help distinguish each instance of the entity. Represent them with underlined attributes.

5. Remove Redundancies: Review the diagram and eliminate unnecessary or repetitive entities and relationships.

6. Review for Clarity: Review the diagram make sure it is clear and effectively conveys the relationships between the entities.

ER Diagram For Student Enrollment System :-