Entity Relationship Diagram – ER Diagram in DBMS

An **Entity–relationship model (ER model)** describes the structure of a database with the help of a diagram, which is known as **Entity Relationship Diagram (ER Diagram)**. An ER model is a design or blueprint of a database that can later be implemented as a database. The main components of E-R model are: entity set and relationship set.

What is an Entity Relationship Diagram (ER Diagram)?

An ER diagram shows the relationship among entity sets. An entity set is a group of similar entities and these entities can have attributes. In terms of DBMS, an entity is a table or attribute of a table in database, so by showing relationship among tables and their attributes, ER diagram shows the complete logical structure of a database. Lets have a look at a simple ER diagram to understand this concept.

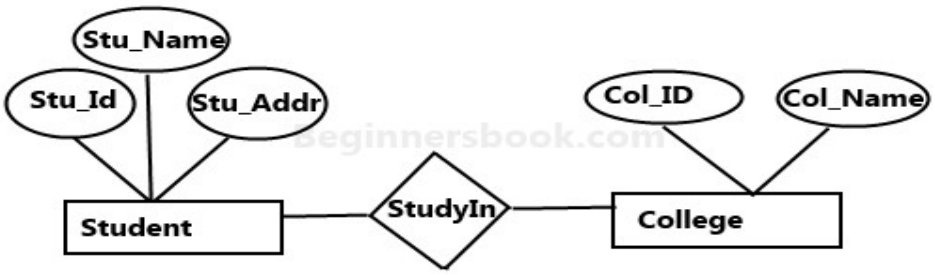
Facts about ER Diagram Model:
ER model allows you to draw Database Design
It is an easy to use graphical tool for modeling data
Widely used in Database Design
It is a GUI representation of the logical structure of a Database
It helps you to identifies the entities which exist in a system and the relationships between those entities

Why use ER Diagrams?

Here, are prime reasons for using the ER Diagram
Helps you to define terms related to entity relationship modeling
Provide a preview of how all your tables should connect, what fields are going to be on each table
Helps to describe entities, attributes, relationships
ER diagrams are translatable into relational tables which allows you to build databases quickly
ER diagrams can be used by database designers as a blueprint for implementing data in specific software applications

A simple ER Diagram:

In the following diagram we have two entities Student and College and their relationship. The relationship between Student and College is many to one as a college can have many students however a student cannot study in multiple colleges at the same time. Student entity has attributes such as Stu_Id, Stu_Name & Stu_Addr and College entity has attributes such as Col_ID & Col_Name.

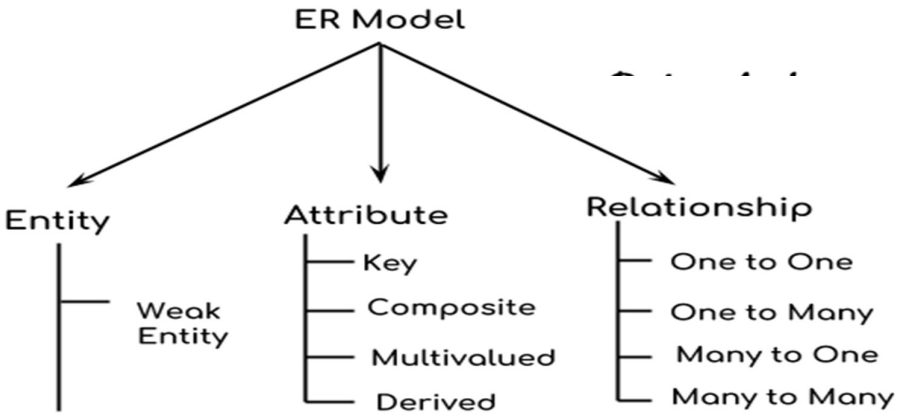


Sample E-R Diagram

Here are the geometric shapes and their meaning in an E-R Diagram. We will discuss these terms in detail in the next section (Components of a ER Diagram) of this guide so don't worry too much about these terms now, just go through them once.

Rectangle: Represents Entity sets.
Ellipses: Attributes
Diamonds: Relationship Set
Lines: They link attributes to Entity Sets and Entity sets to Relationship Set
Double Ellipses: Multivalued Attributes
Dashed Ellipses: Derived Attributes
Double Rectangles: Weak Entity Sets
Double Lines: Total participation of an entity in a relationship set

Components of a ER Diagram

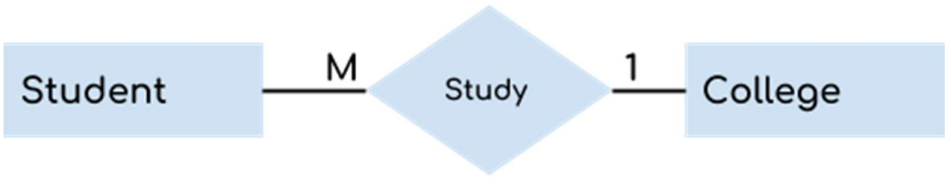


Components of ER Diagram

As shown in the above diagram, an ER diagram has three main components:
1. Entity
2. Attribute
3. Relationship

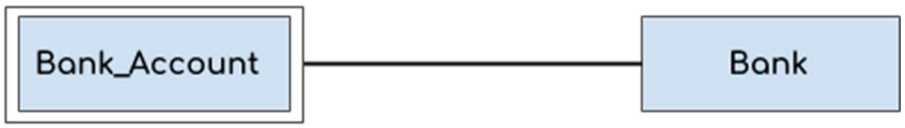
1. Entity

An entity is an object or component of data. An entity is represented as rectangle in an ER diagram.
For example: In the following ER diagram we have two entities Student and College and these two entities have many to one relationship as many students study in a single college. We will read more about relationships later, for now focus on entities.



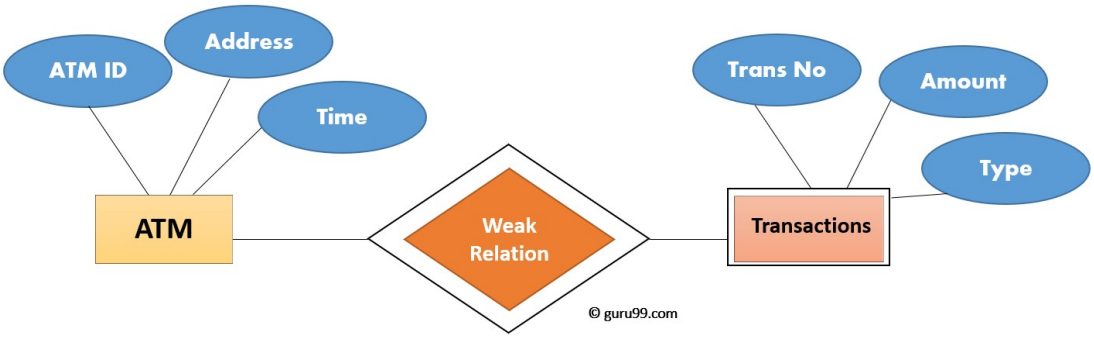
Weak Entity:

An entity that cannot be uniquely identified by its own attributes and relies on the relationship with other entity is called weak entity. The weak entity is represented by a double rectangle. For example – a bank account cannot be uniquely identified without knowing the bank to which the account belongs, so bank account is a weak entity.



Weak Entities

A weak entity is a type of entity which doesn't have its key attribute. It can be identified uniquely by considering the primary key of another entity. For that, weak entity sets need to have participation.



In above example, "Trans No" is a discriminator within a group of transactions in an ATM.Let's learn more about a weak entity by comparing it with a Strong Entity

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.

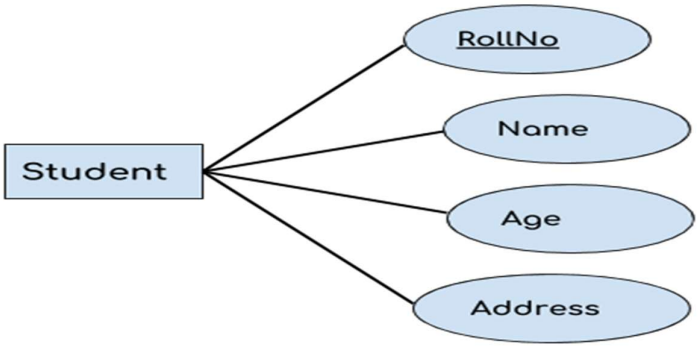
2. Attribute

An attribute describes the property of an entity. An attribute is represented as Oval in an ER diagram. There are four types of attributes:

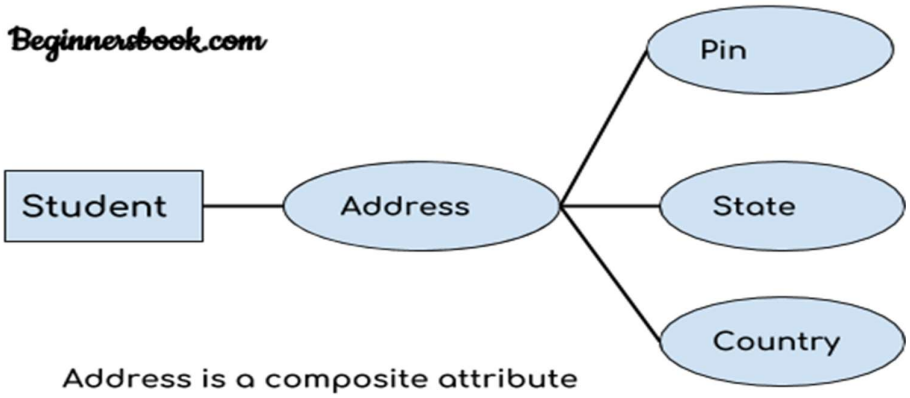
1. Key attribute
2. Composite attribute
3. Multivalued attribute
4. Derived attribute

1. Key attribute:

A key attribute can uniquely identify an entity from an entity set. For example, student roll number can uniquely identify a student from a set of students. Key attribute is represented by oval same as other attributes however the **text of key attribute is underlined**.



2. Composite attribute: An attribute that is a combination of other attributes is known as composite attribute. For example, In student entity, the student address is a composite attribute as an address is composed of other attributes such as pin code, state, country.



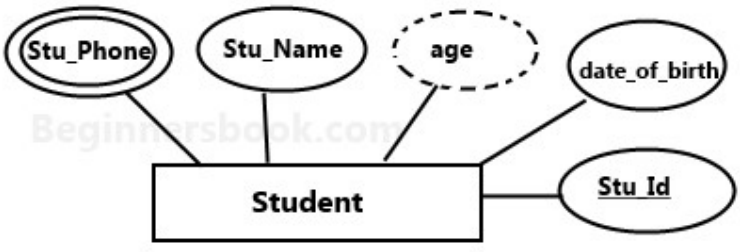
3. Multivalued attribute:

An attribute that can hold multiple values is known as multivalued attribute. It is represented with **double ovals** in an ER Diagram. For example – A person can have more than one phone numbers so the phone number attribute is multivalued.

4. Derived attribute:

A derived attribute is one whose value is dynamic and derived from another attribute. It is represented by **dashed oval** in an ER Diagram. For example – Person age is a derived attribute as it changes over time and can be derived from another attribute (Date of birth).

E-R diagram with multivalued and derived attributes:



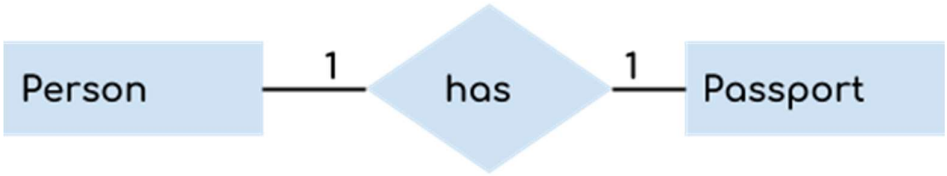
3. Relationship

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

A relationship is represented by diamond shape in ER diagram, it shows the relationship among entities. There are four types of cardinal relationships:
1. One to One
2. One to Many
3. Many to One
4. Many to Many

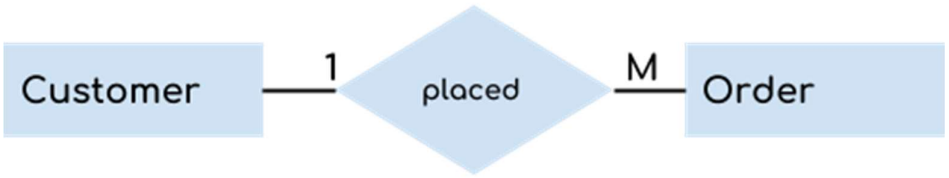
1. One to One Relationship

When a single instance of an entity is associated with a single instance of another entity then it is called one to one relationship. For example, a person has only one passport and a passport is given to one person.



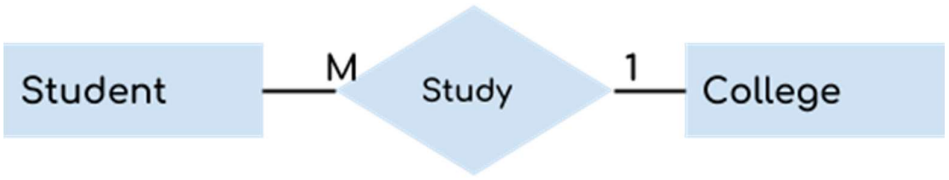
2. One to Many Relationship

When a single instance of an entity is associated with more than one instances of another entity then it is called one to many relationship. For example – a customer can place many orders but a order cannot be placed by many customers.



3. Many to One Relationship

When more than one instances of an entity is associated with a single instance of another entity then it is called many to one relationship. For example – many students can study in a single college but a student cannot study in many colleges at the same time.

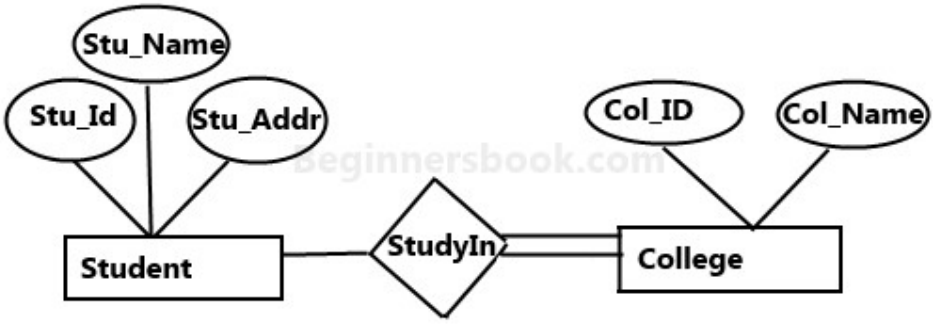


4. Many to Many Relationship

When more than one instances of an entity is associated with more than one instances of another entity then it is called many to many relationship. For example, a can be assigned to many projects and a project can be assigned to many students.

Total Participation of an Entity set

A Total participation of an entity set represents that each entity in entity set must have at least one relationship in a relationship set. For example: In the below diagram each college must have at-least one associated Student.



E-R Digram with total participation of College entity set in StudyIn relationship Set - This indicates that each college must have atleast one associated Student.

Steps to Create an ERD (E-R Digram)

Following are the steps to create an ERD.

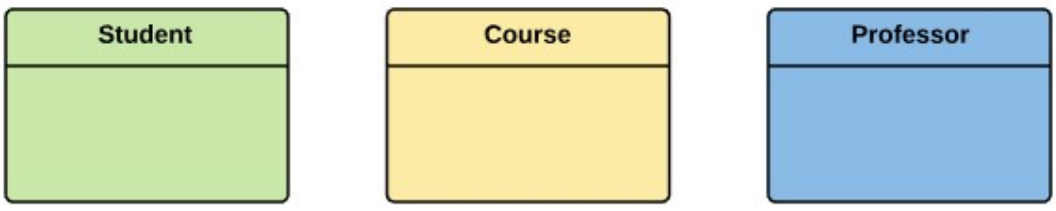
Let's study them with an example:

In a university, a Student enrolls in Courses. A student must be assigned to at least one or more Courses. Each course is taught by a single Professor. To maintain instruction quality, a Professor can deliver only one course

Step 1) Entity Identification

We have three entities

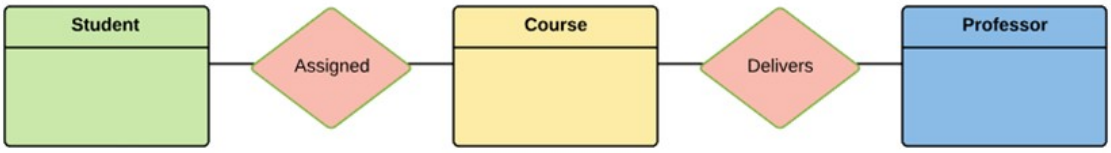
- Student
- Course
- Professor



Step 2) Relationship Identification

We have the following two relationships

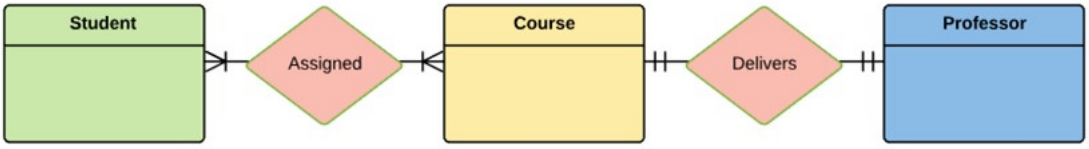
- The student is **assigned** a course
- Professor **delivers** a course



Step 3) Cardinality Identification

For them problem statement we know that,

- A student can be assigned **multiple** courses
- A Professor can deliver only **one** course



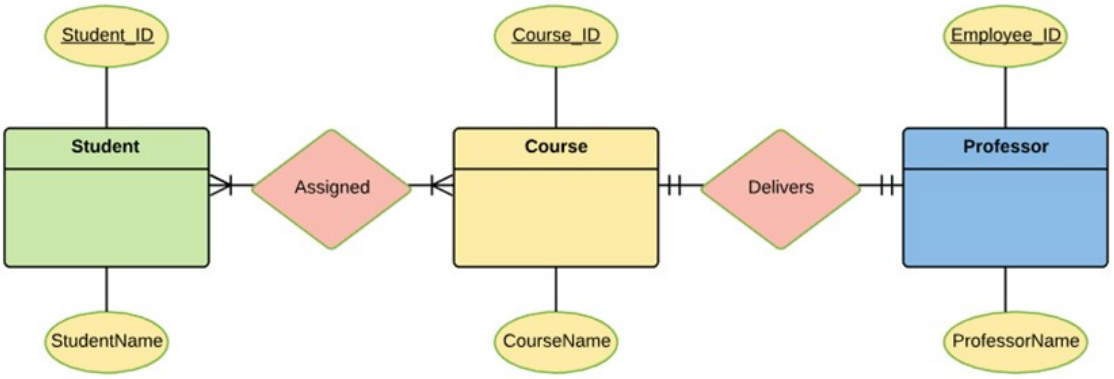
Step 4) Identify Attributes

You need to study the files, forms, reports, data currently maintained by the organization to identify attributes. You can also conduct interviews with various stakeholders to identify entities. Initially, it's important to identify the attributes without mapping them to a particular entity.

Once, you have a list of Attributes, you need to map them to the identified entities. Ensure an attribute is to be paired with exactly one entity. If you think an attribute should belong to more than one entity, use a modifier to make it unique.

Once the mapping is done, identify the primary Keys. If a unique key is not readily available, create one.

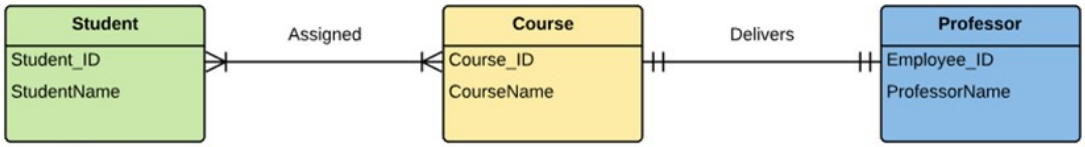
Entity	Primary Key	Attribute
Student	Student_ID	StudentName
Professor	Employee_ID	ProfessorName
Course	Course_ID	CourseName



For Course Entity, attributes could be Duration, Credits, Assignments, etc. For the sake of ease we have considered just one attribute.

Step 5) Create the ERD

A more modern representation of ERD Diagram



Best Practices for Developing Effective ER Diagrams

- Eliminate any redundant entities or relationships
- You need to make sure that all your entities and relationships are properly labeled
- There may be various valid approaches to an ER diagram. You need to make sure that the ER diagram supports all the data you need to store
- You should assure that each entity only appears a single time in the ER diagram
- Name every relationship, entity, and attribute are represented on your diagram
- Never connect relationships to each other
- You should use colors to highlight important portions of the ER diagram

Summary

- The ER model is a high-level data model diagram
- ER diagrams are a visual tool which is helpful to represent the ER model
- Entity relationship diagram displays the relationships of entity set stored in a database
- ER diagrams help you to define terms related to entity relationship modeling
- ER model is based on three basic concepts: Entities, Attributes & Relationships
- An entity can be place, person, object, event or a concept, which stores data in the database

- Relationship is nothing but an association among two or more entities
- A weak entity is a type of entity which doesn't have its key attribute
- It is a single-valued property of either an entity-type or a relationship-type
- It helps you to defines the numerical attributes of the relationship between two entities or entity sets
- ER- Diagram is a visual representation of data that describe how data is related to each other
- While Drawing ER diagram you need to make sure all your entities and relationships are properly labeled.

DBMS Generalization

Generalization is a process in which the common attributes of more than one entities form a new entity. This newly formed entity is called generalized entity.

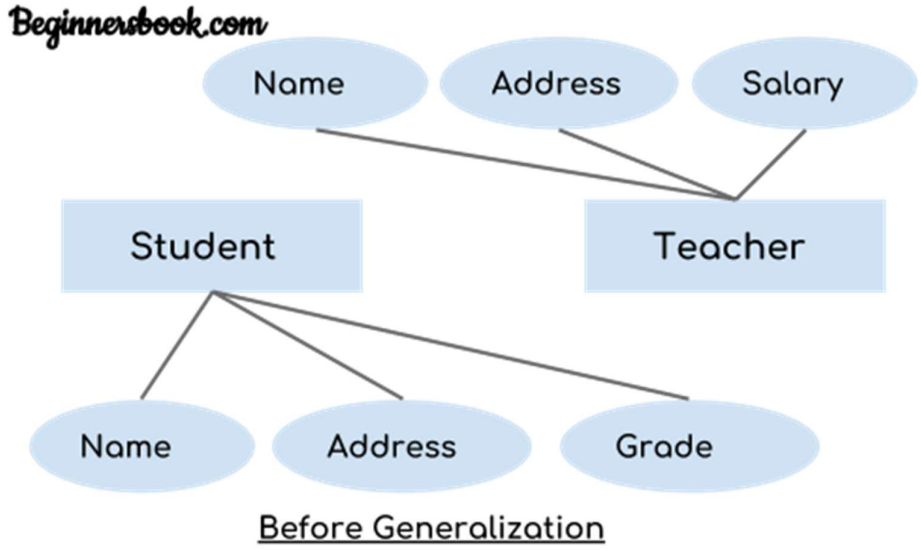
Generalization Example

Lets say we have two entities Student and Teacher.

Attributes of Entity Student are: Name, Address & Grade

Attributes of Entity Teacher are: Name, Address & Salary

The ER diagram before generalization looks like this:

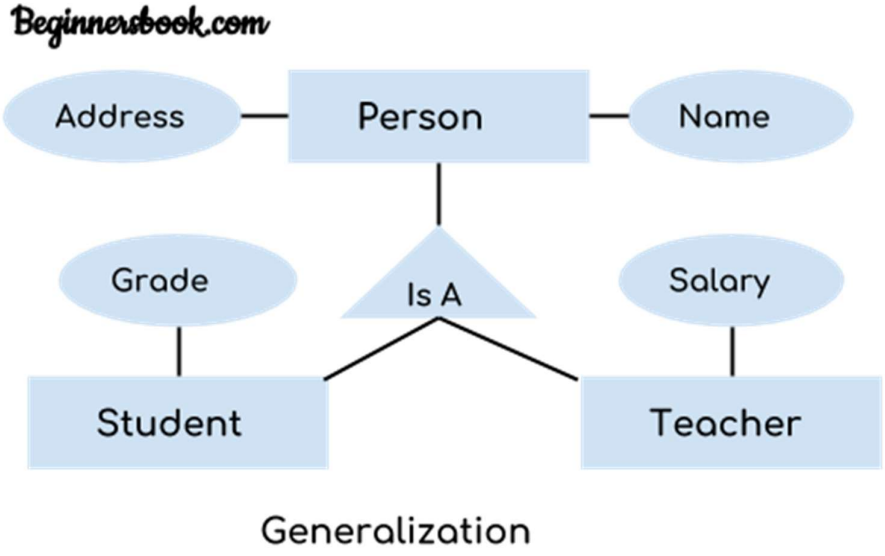


Before Generalization

These two entities have two common attributes: Name and Address, we can make a generalized entity with these common attributes. Lets have a look at the ER model after generalization.

The ER diagram after generalization:

We have created a new generalized entity Person and this entity has the common attributes of both the entities. As you can see in the following ER diagram that after the generalization process the entities Student and Teacher only has the specialized attributes Grade and Salary respectively and their common attributes (Name & Address) are now associated with a new entity Person which is in the relationship with both the entities (Student & Teacher).



Generalization

Note:

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.

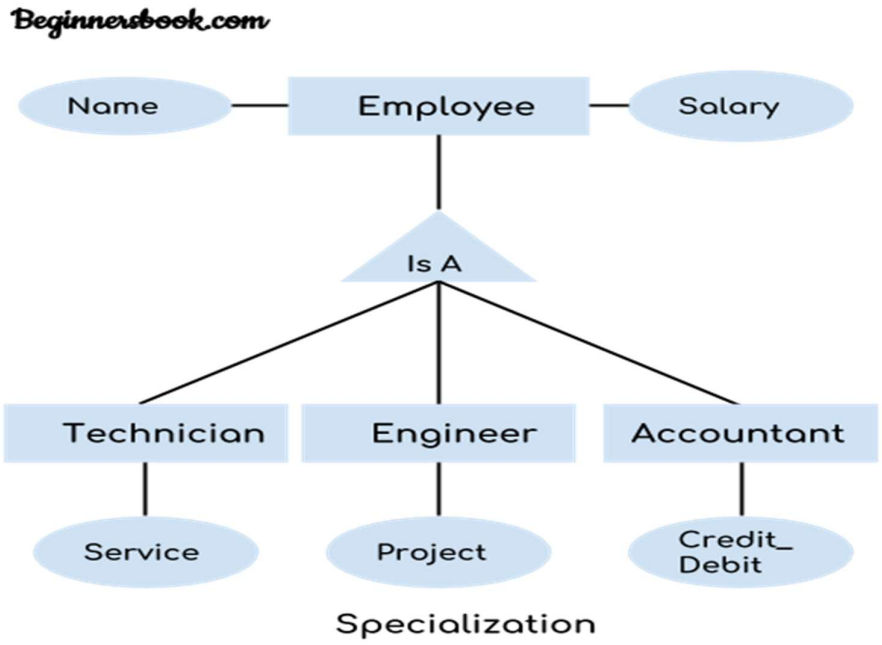
DBMS Specialization

Specialization is a process in which an entity is divided into sub-entities. You can think of it as a reverse process of generalization, in generalization two entities combine together to form a new higher level entity. Specialization is a top-down process.

The idea behind Specialization is to find the subsets of entities that have few distinguish attributes. For example – Consider an entity employee which can be further classified as sub-entities Technician, Engineer & Accountant because these sub entities have some distinguish attributes.

Specialization Example

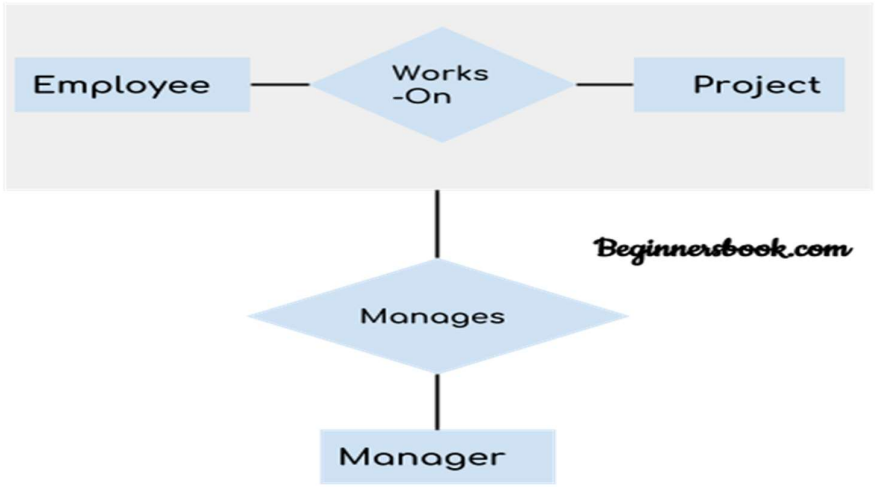
In this diagram, we can see that we have a higher level entity “Employee” which we have divided in sub entities “Technician”, “Engineer” & “Accountant”. All of these are just an employee of a company, however their role is completely different and they have few different attributes. Just for the example, I have shown that Technician handles service requests, Engineer works on a project and Accountant handles the credit & debit details. All of these three employee types have few attributes common such as name & salary which we had left associated with the parent entity “Employee” as shown in the above diagram.



DBMS Aggregration

Aggregation is a process in which a single entity alone is not able to make sense in a relationship so the relationship of two entities acts as one entity. I know it sounds confusing but don't worry the example we will take, will clear all the doubts.

Aggregration Example



In real world, we know that a manager not only manages the employee working under them but he has to manage the project as well. In such scenario if entity "Manager" makes a "manages" relationship with either "Employee" or "Project" entity alone then it will not make

any sense because he has to manage both. In these cases the relationship of two entities acts as one entity. In our example, the relationship “Works-On” between “Employee” & “Project” acts as one entity that has a relationship “Manages” with the entity “Manager”.

Mapping from ER Model to Relational Model

Go to following link

https://www.geeksforgeeks.org/mapping-from-er-model-to-relational-model/