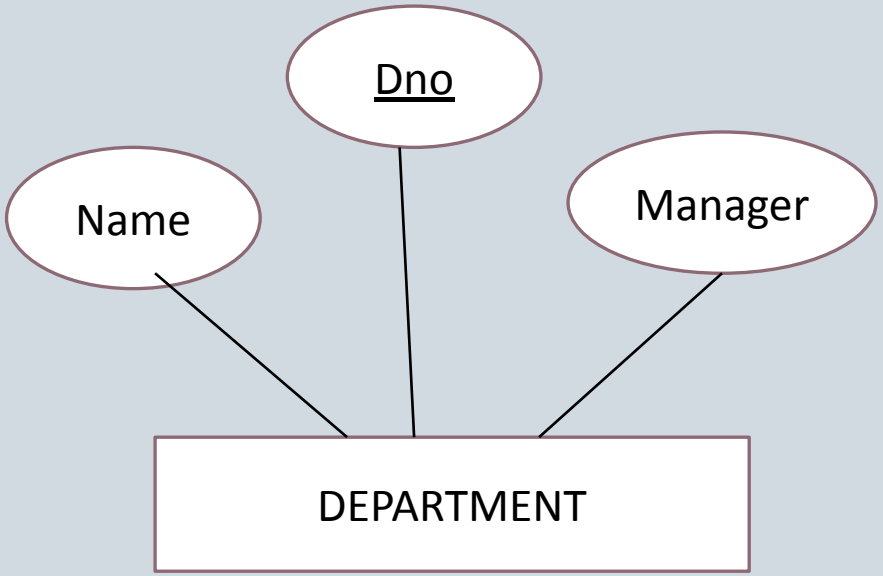
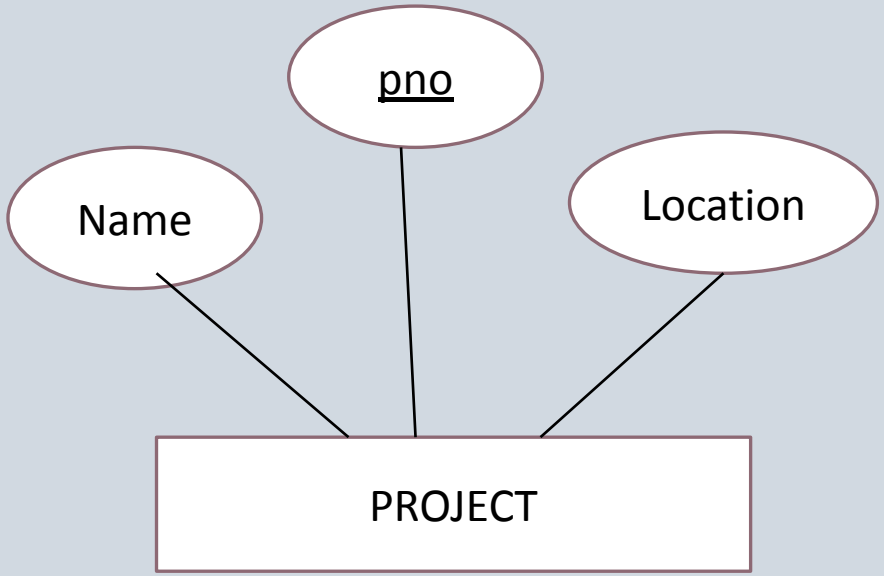
The E-R Model

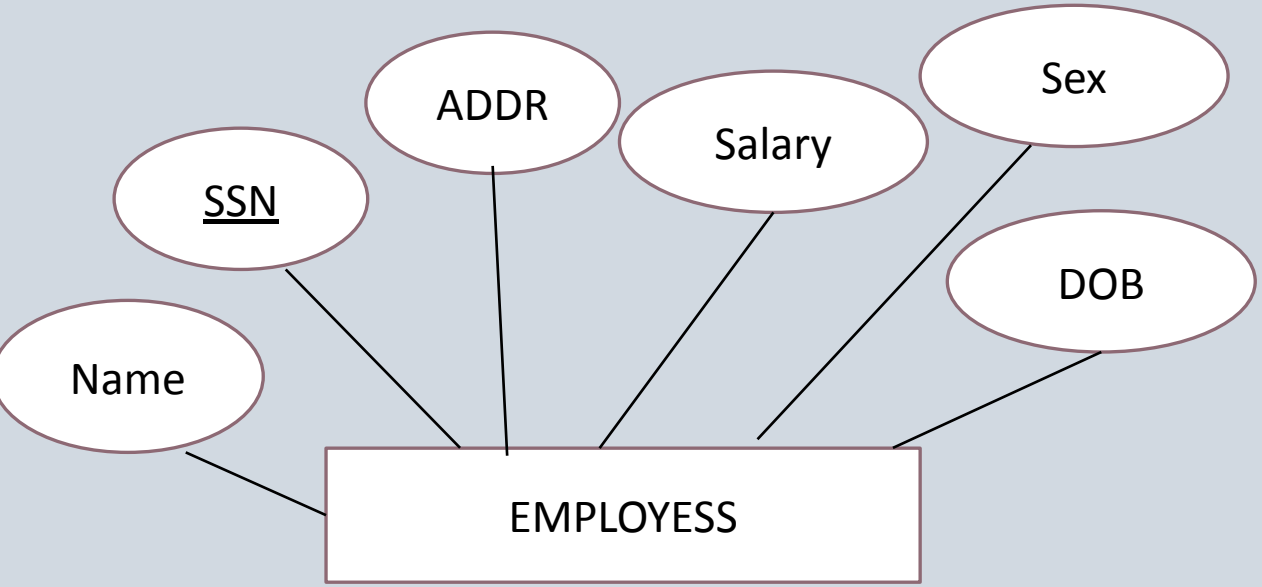
EXAMPLE

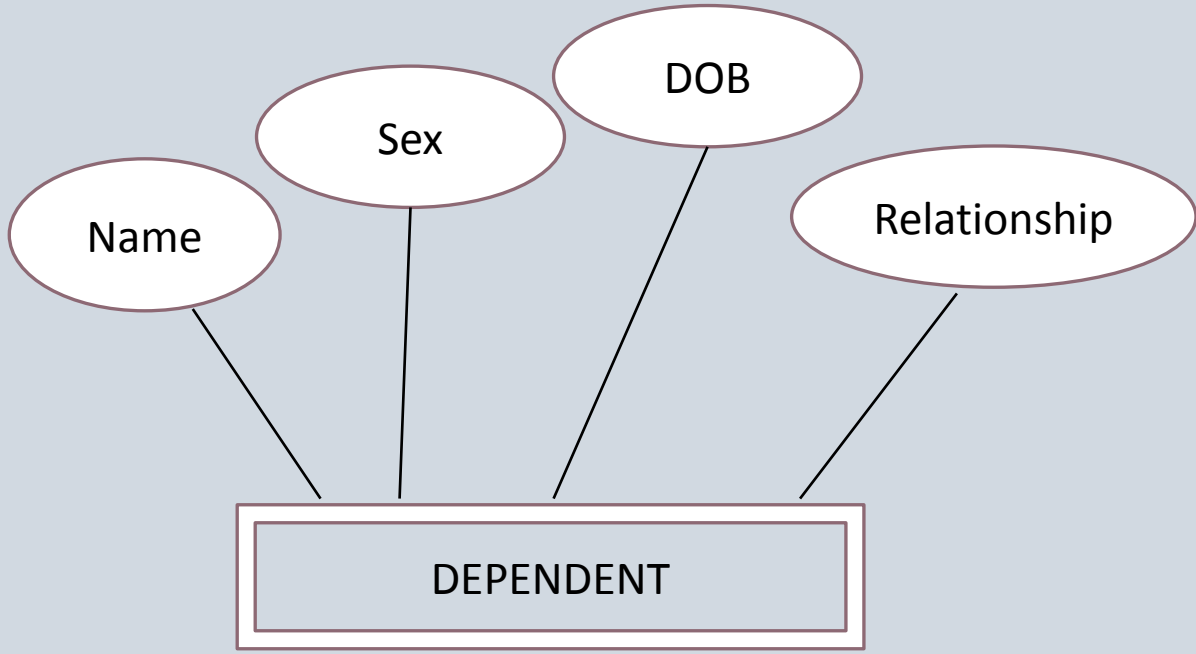
Requirements of the Company

- The company is organized into DEPARTMENTs. Each department has a name, number and an employee who *manages* the department. We keep track of the start date of the department manager.
- Each department *controls* a number of PROJECTs. Each project has a name, number and is located at a single location.
- We store each EMPLOYEE's social security number, address, salary, sex, and birthdate. Each employee *works for* one department but may *work on* several projects. We keep track of the number of hours per week that an employee currently works on each project. We also keep track of the *direct supervisor* of each employee.
- Each employee may *have* a number of DEPENDENTs. For each dependent, we keep track of their name, sex, birthdate, and relationship to employee.

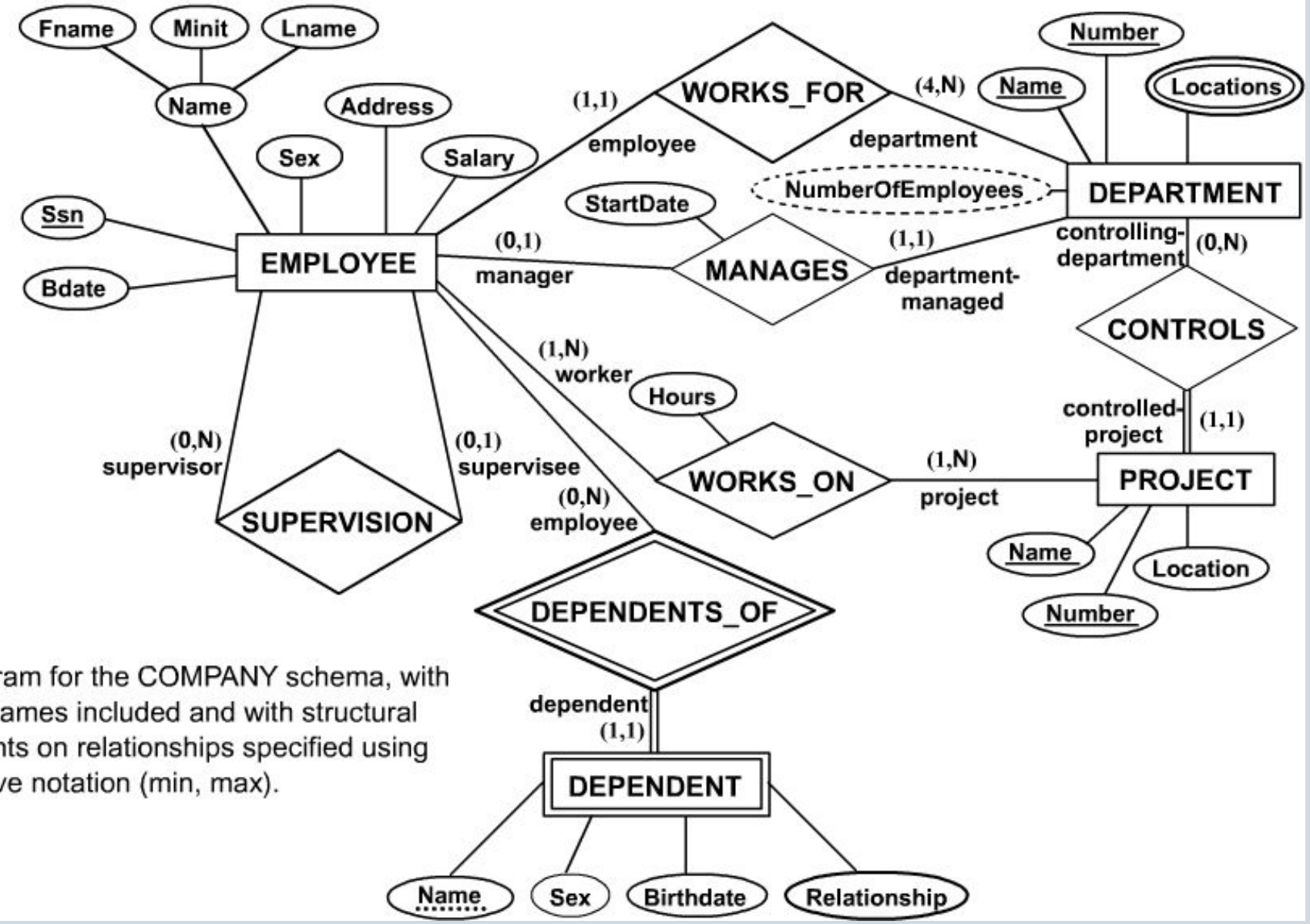

Dno
Name
Manager
DEPARTMENT


pno
Name
Location
PROJECT


ADDR
Sex
SSN
Salary
DOB
Name
EMPLOYESS


DOB
Sex
Name
Relationship
DEPENDENT

Alternative ER Notations



ER diagram for the COMPANY schema, with all role names included and with structural constraints on relationships specified using alternative notation (min, max).

Key Attribute & Non-Key Attribute

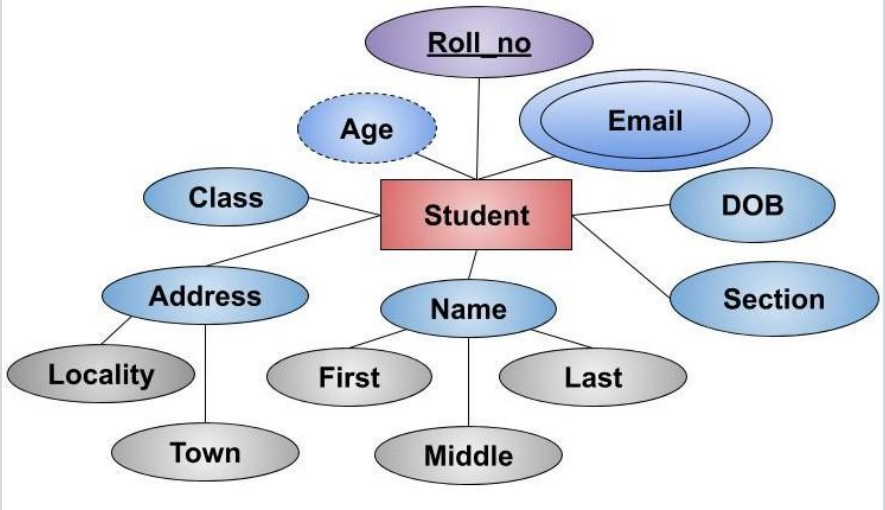
- This classification is made on the basis that if the attribute can uniquely identify the entities or not.
- As the name suggests key attribute will uniquely identify the entities whereas the non-key attributes would not be able to uniquely identify the entities.

Key Attribute

- **A key attribute is used to uniquely identify the entities of an entity type**. In a relational table, it represents the **primary key** of the table.
- Even if all the other attributes of an entity are the same but the key attribute will always be different.
- It is represented by oval and the text in it is underlined.

Non-Key Attribute

- All the other attributes other than the key attribute are the non-key attributes.
- Two or more entities can have the same value for this attribute.



Example: We have Roll_no as the key attribute of the ‘Student’ because two students can never has same roll number.

Example: Class, Section, Age, Name etc, are the non-key attributes.

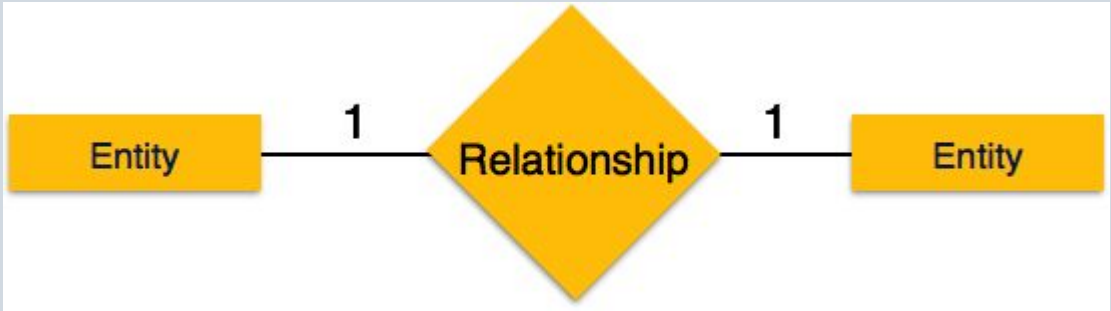
For example, the Class attribute would have the same value for all those students who are studying in the same class..

RELATIONSHIP

- **Relationships are associations between one or more entity types.**
- Are the "*glue*" that holds together components of an E-R model.
- **Entities take part in relationships.**
- Typically, a relationship is identified with verbs or verb phrases.
- ***The degree of a relationship*** - is the number of entity types that participate in a relationship.
- There are 3 common relationships:
  - **Unary (degree one)**
  - **Binary (degree two)**
  - **Ternary (degree three)**

RELATIONSHIPS

- Relationships between more than two entity sets are rare. **Most relationships are binary.**
- **<u>Relationships are represented by diamond-shaped box.</u>**
  - Name of the relationship is written inside the diamond-box.
  - All the entities (rectangles) participating in a relationship, are connected to it by a line.



SIMPLE EXAMPLE

A company has several departments. Each department has a supervisor and at least one employee. Employees must be assigned to at least one, but possibly more departments. At least one employee is assigned to a project, but an employee may be on vacation and not assigned to any projects. The important data fields are the names of the departments, projects, supervisors and employees, as well as the supervisor and employee number and a unique project number.

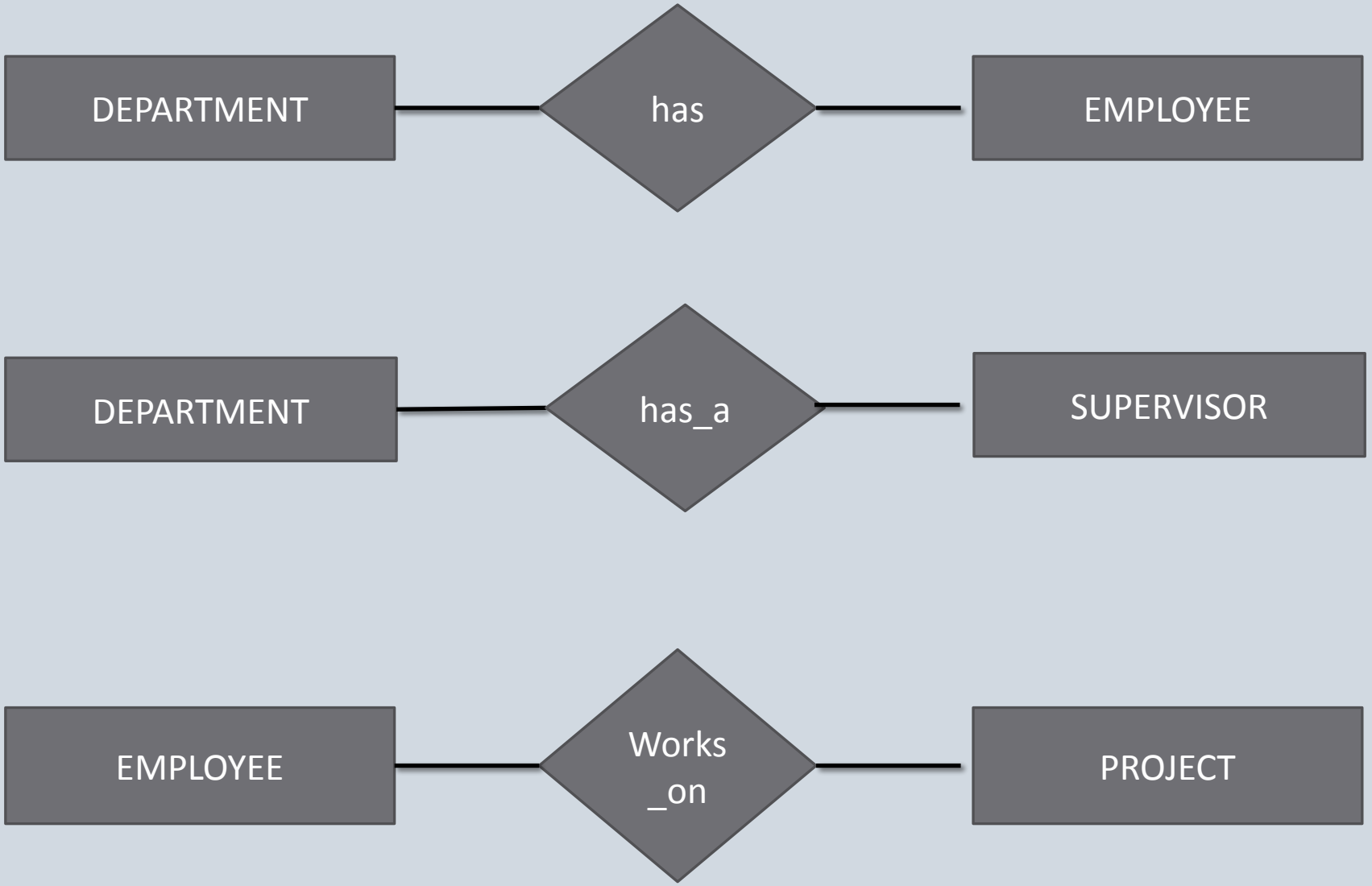
Step 1 : Identify Entities - The entities are :

- Department, Employee, Supervisor and Project.
- One is tempted to make Company an entity, but it is a false entity because it has only one instance in this problem. True entities must have more than one instance.

A company has several departments. Each department has a supervisor and at least one employee. Employees must be assigned to at least one, but possibly more departments. At least one employee is assigned to a project, but an employee may be on vacation and not assigned to any projects. The important data fields are the names of the departments, projects, supervisors and employees, as well as the supervisor and employee number and a unique project number.

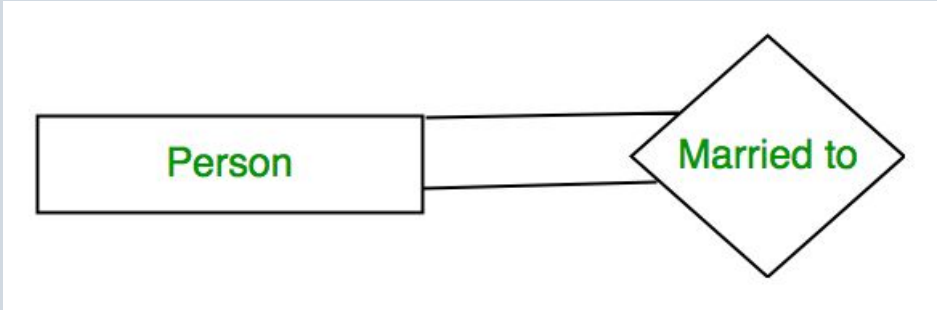
Step 2: Identify Relationships :- construct the following Entity Relationship Matrix:

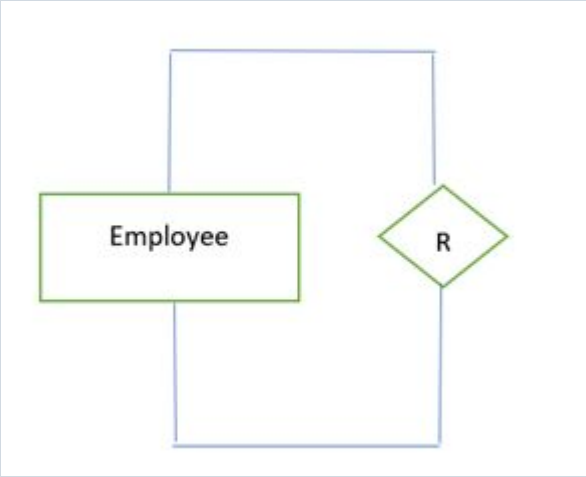
	DEPARTMENT	EMPLOYEE	SUPERVISOR	PROJECT
DEPARTMENT		has	has_a	
EMPLOYEE	works_for			assigned_to
SUPERVISOR	supervises			
PROJECT		hires		


DEPARTMENT
has
EMPLOYEE
DEPARTMENT
has_a
SUPERVISOR
EMPLOYEE
Works
_on
PROJECT

UNARY RELATIONSHIPS

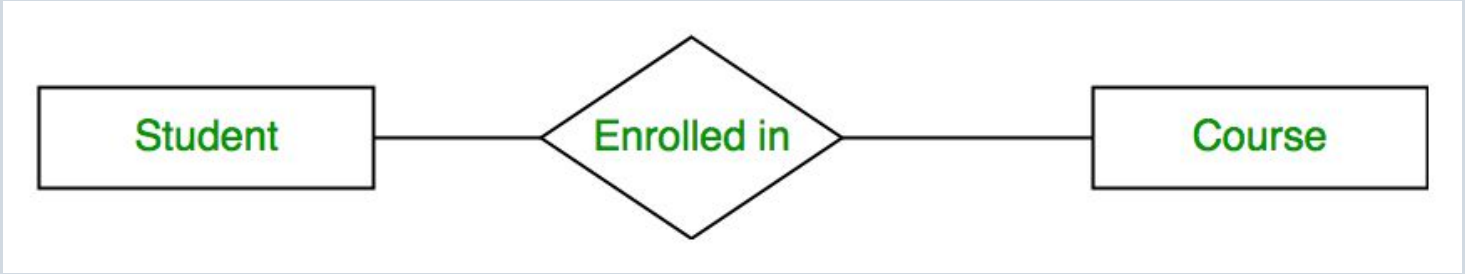
- **Recursive Relationships**.
- Relationship between the instances of one entity type.

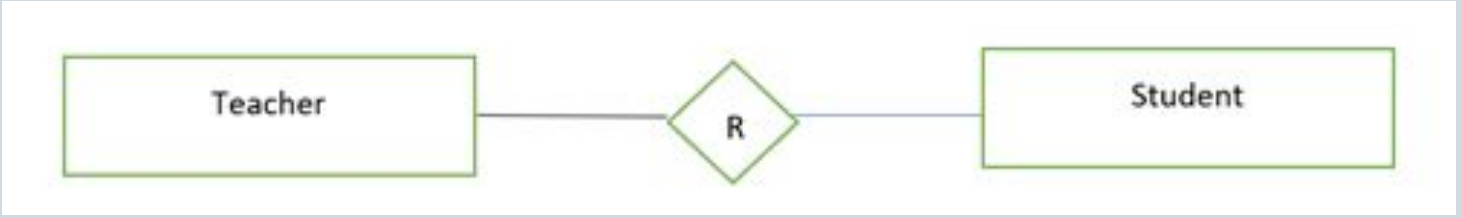




BINARY RELATIONSHIPS

- Relationship between the instances of two entity type.

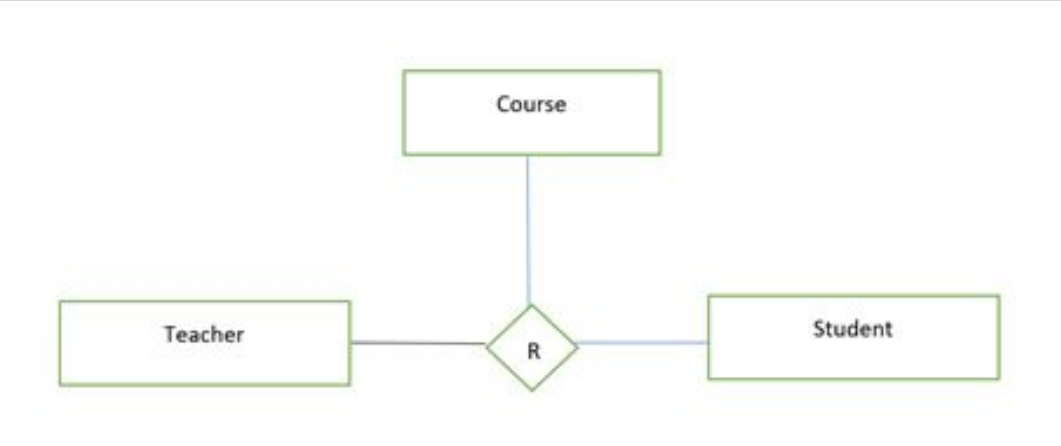




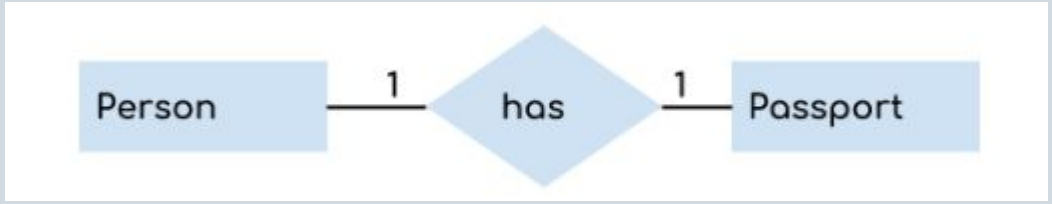
TERNARY RELATIONSHIPS

- Three entities sets in a relationship are ternary relationships.

For example, the relationship among *Teacher*, *Student,* and *Course*.



RELATIONSHIPS



Structural Constraints of a Relationship type

- Relationship types usually have certain constraints that limit the possible combinations of entities that may participate in the corresponding relationship set - these constraints are determined from the miniworld situation that the relationships represent.
- For example :
  - **In a company** - each employee must work for exactly one department.
  - **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

Structural Constraints of a Relationship type

- We would like to describe all such constraints in the schema.
- We can distinguish two main types of binary relationship constraints:
  - **cardinality ratio and**
  - **participation constraint**
- **Cardinality ratio : one-to-one, one-to-many, many-to-one and many-to-many.**
- **Participation ratio : total participation and partial participation.**

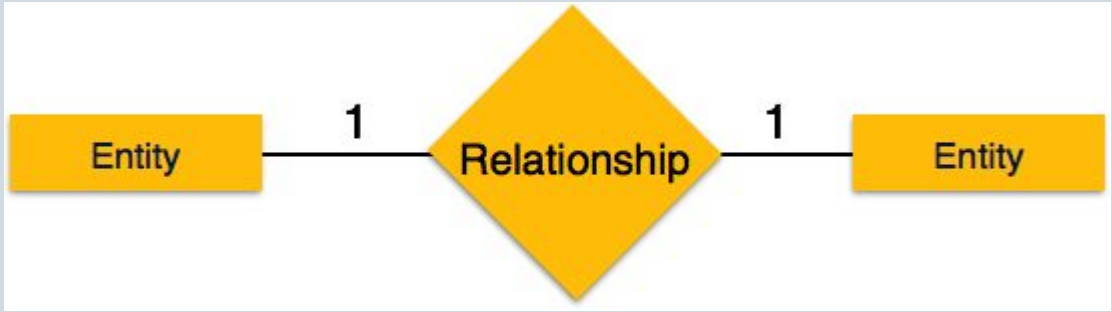
Cardinality Ratios for Binary Relationships

Cardinality:

- Most useful in describing binary relationship sets.
- Is the number of occurrences in one entity which are associated to the number of occurrences in another via a relationship set.
- For a binary relationship set the mapping cardinality must be one of the following types:
  - **One to one (1:1)** **One to many (1:M)**
  - **Many to one (M:1)** **Many to many (M:N)**

One-to-one (1:1)

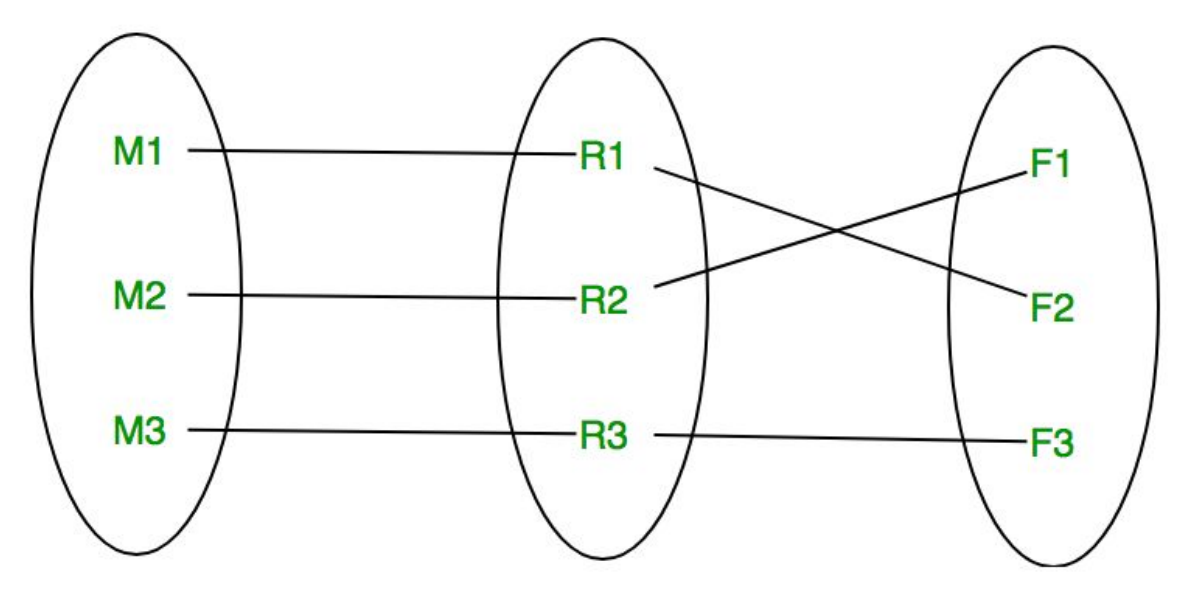
An entity in A is associated with **at most one entity** in B, and an entity in B is associated with **at most one entity** in A.



The above image reflects that only one instance of each entity should be associated with the relationship. It depicts one-to-one relationship.

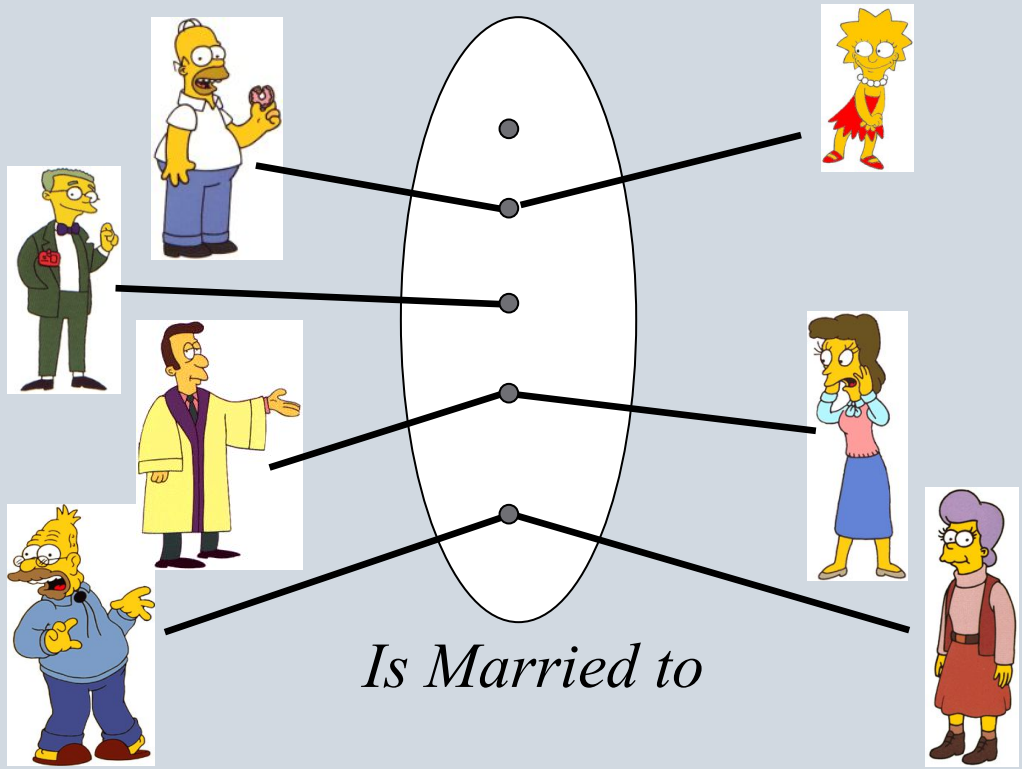
One-to-one (1:1)

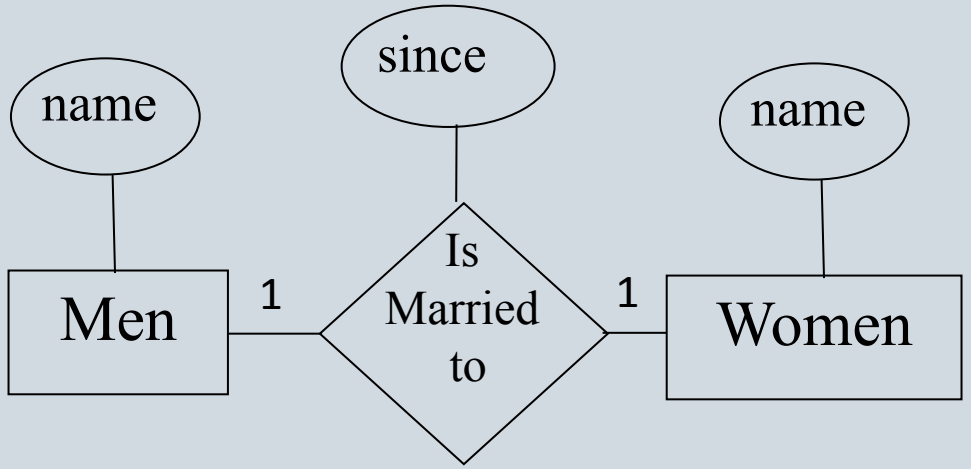
Using Sets, it can be represented as:



Example :

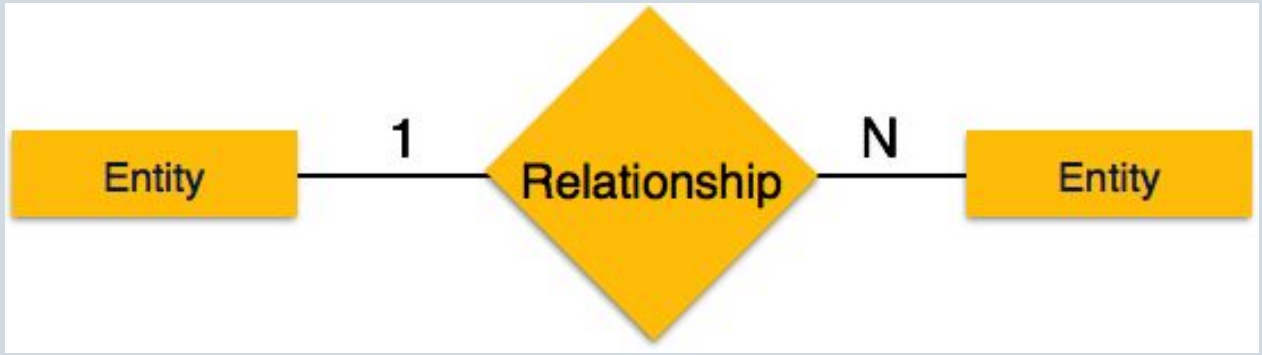
A man may be married to at most one women, and woman may be married to at most one man (both men and women can be unmarried)





One-to-Many (1:N)

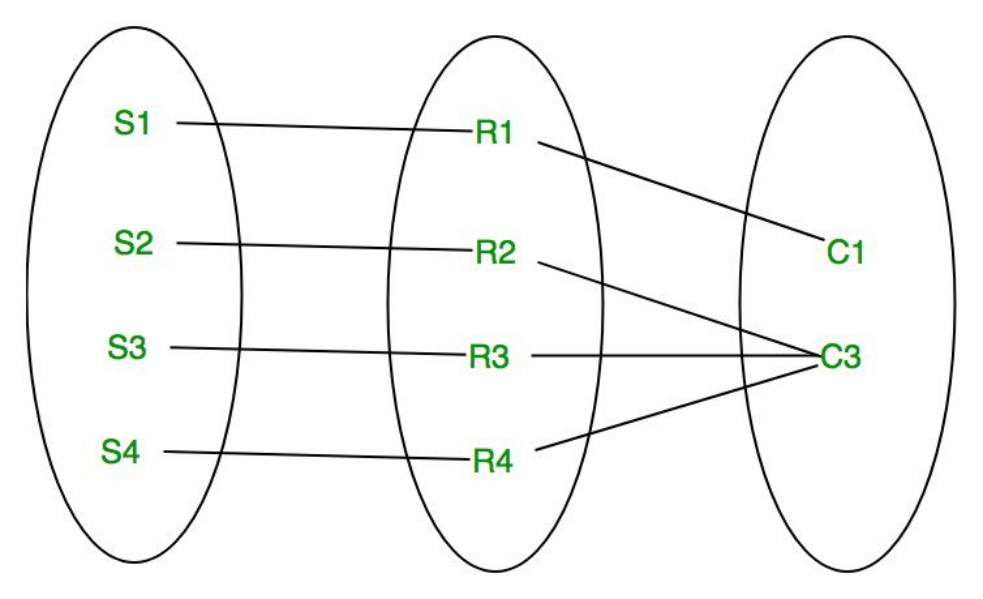
An entity in A is associated **with any number** in B. An entity in B is associated with **at most one entity** in A.



The above image reflects that only one instance of entity on the left and more than one instance of an entity on the right can be associated with the relationship. It depicts one-to-many relationship.

One-to-Many (1:1)

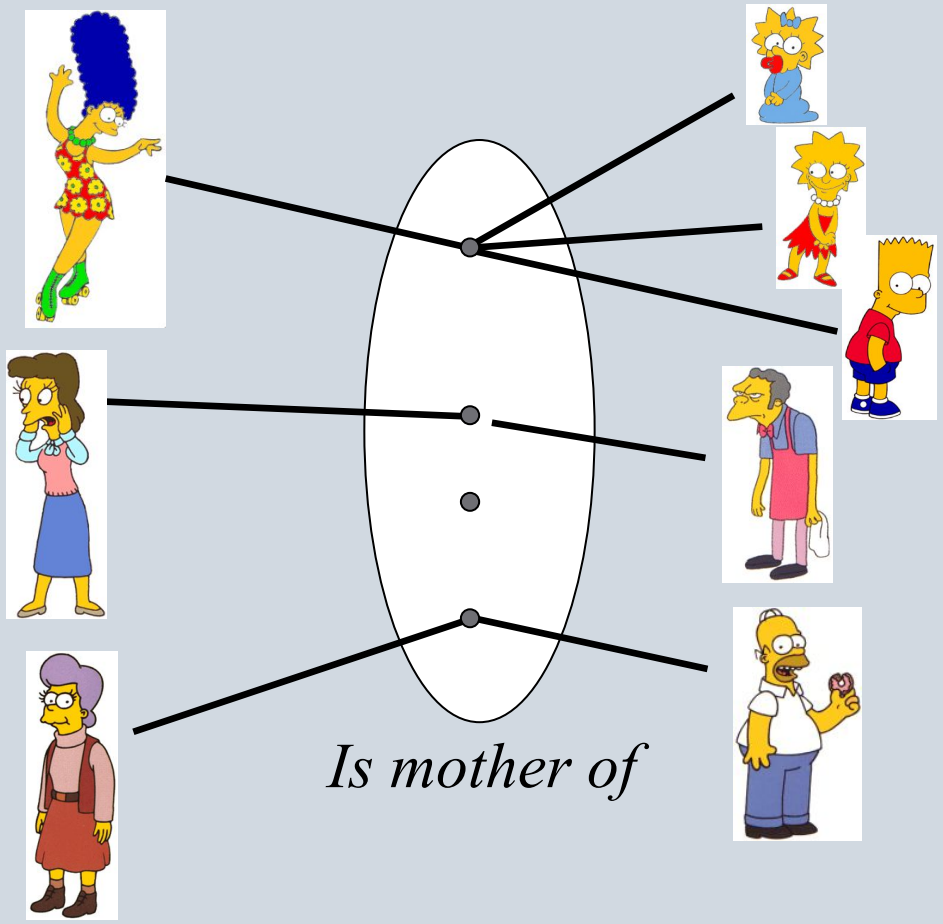
Using Sets, it can be represented as:

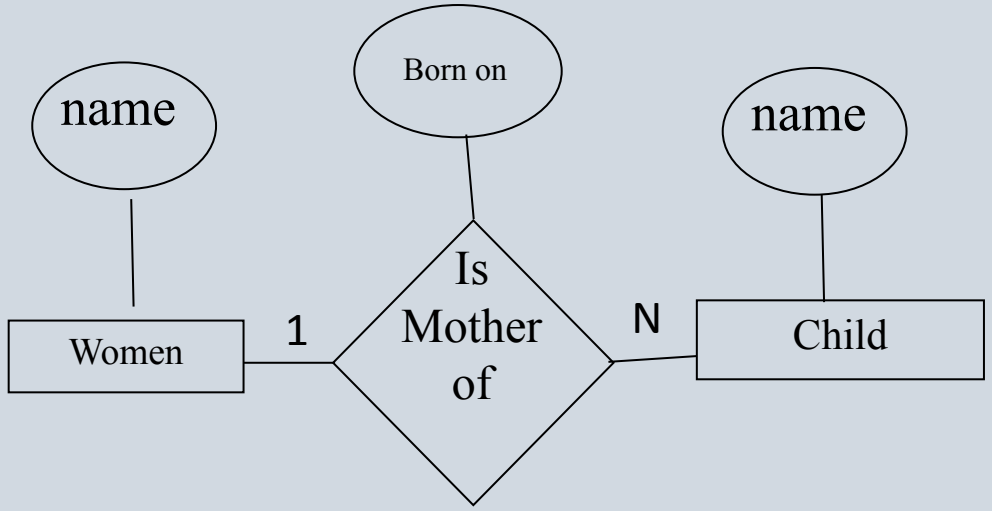


In this case, each student is taking only 1 course but 1 course has been taken by many students

Example :

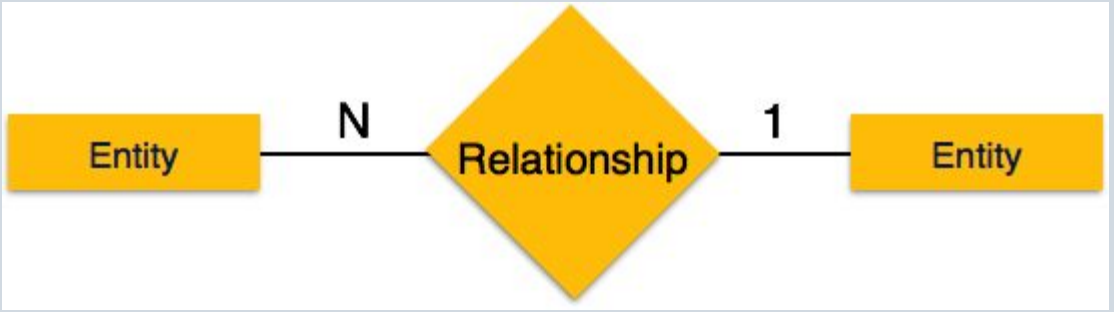
A woman may be the mother of many (or no) children. A person may have at most one mother.





Many-to-One (N:1)

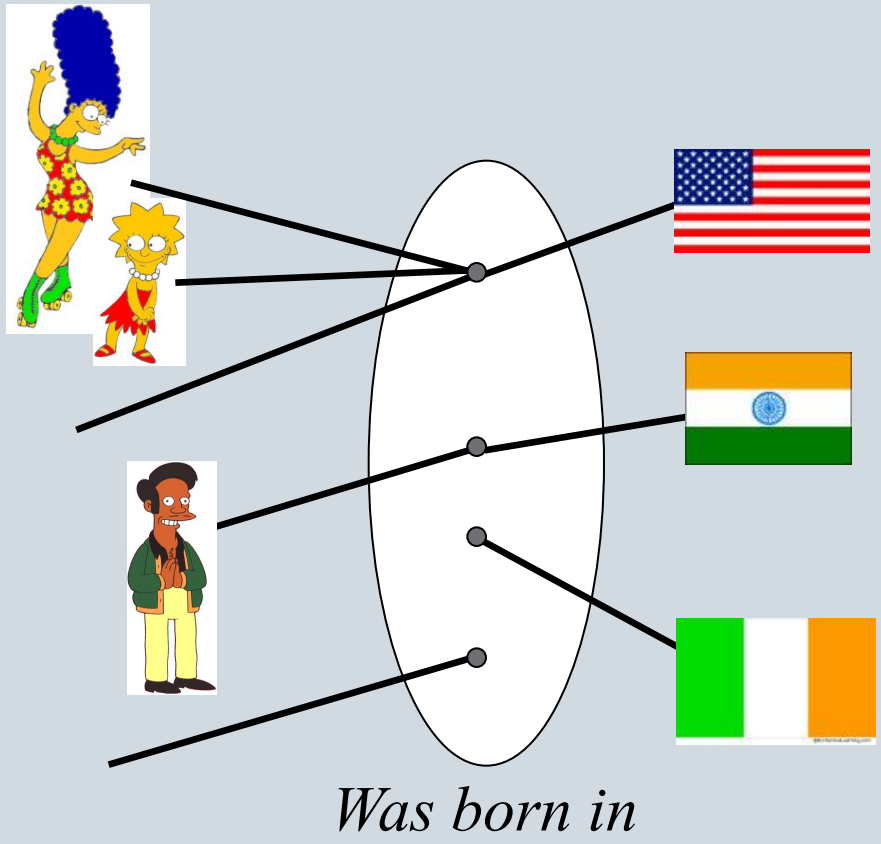
An entity in A is associated with at most one entity in B. An entity in B is associated with any number in A

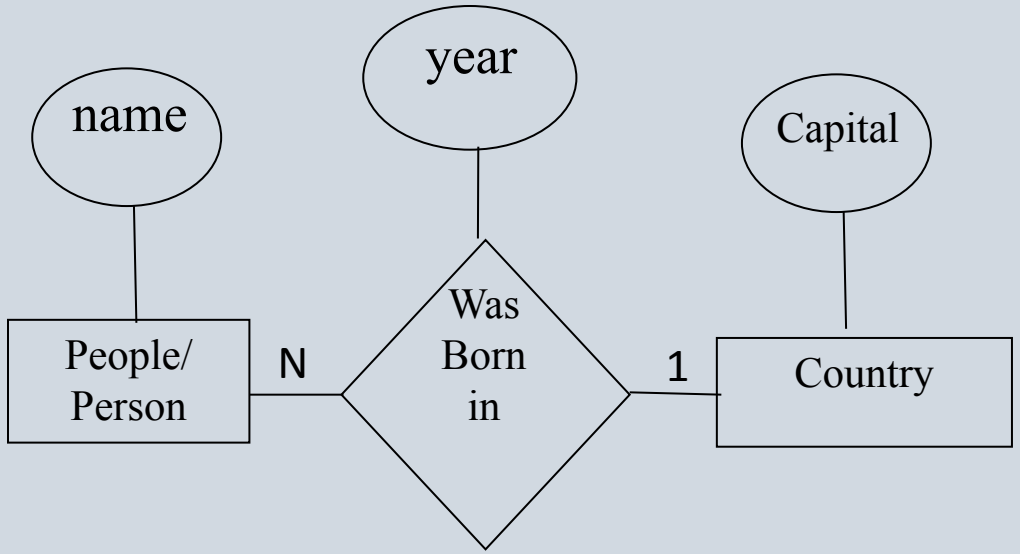


The above image reflects that more than one instance of an entity on the left and only one instance of an entity on the right can be associated with the relationship. It depicts many-to-one relationship..

Example :

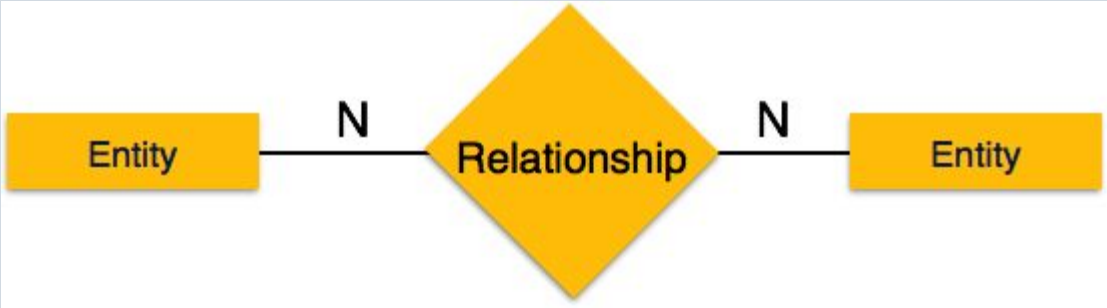
Many people can be born in any county, but any individual is born in at most one country.





Many-to-Many (M:N)

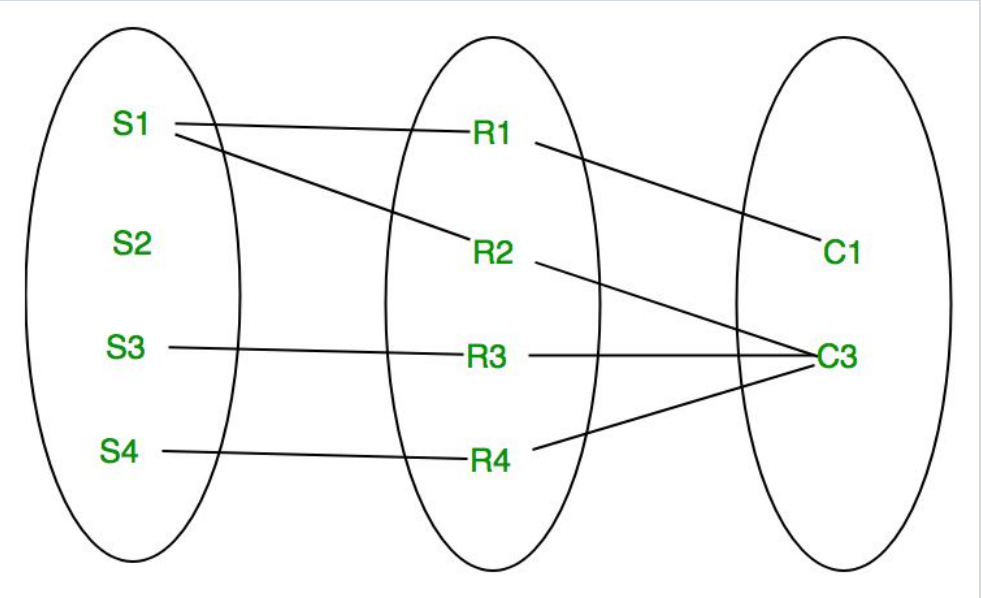
Entities in A and B are associated with any number from each other.



The following image reflects that more than one instance of an entity on the left and more than one instance of an entity on the right can be associated with the relationship. It depicts many-to-many relationship.

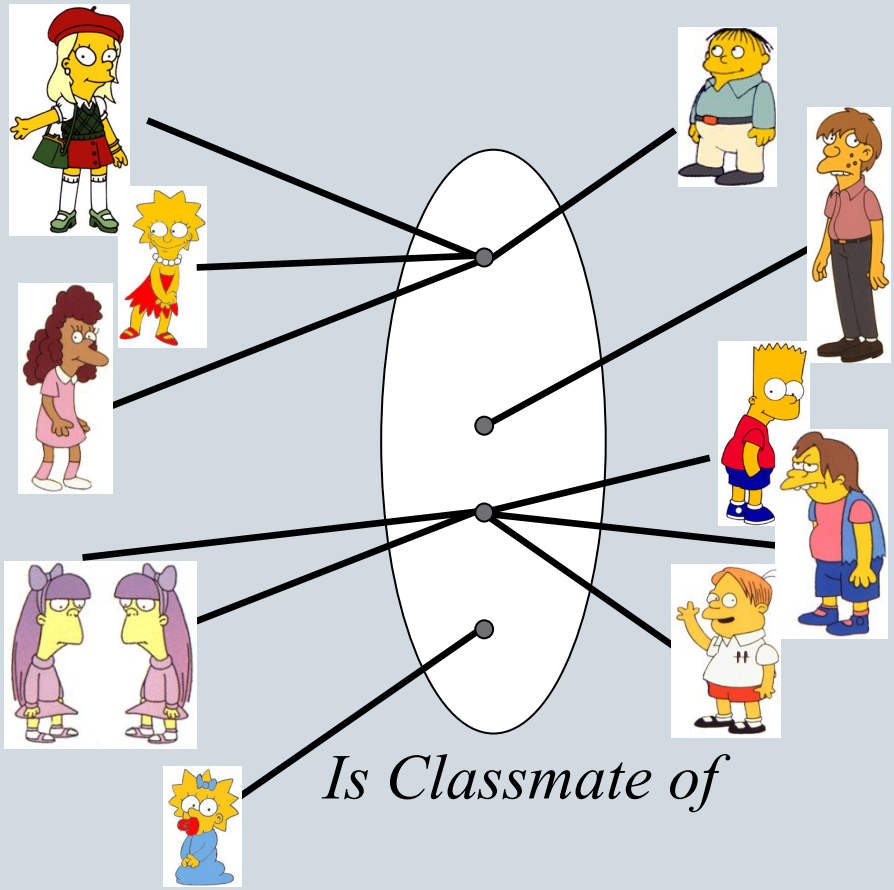
Many-to-Many (M:N)

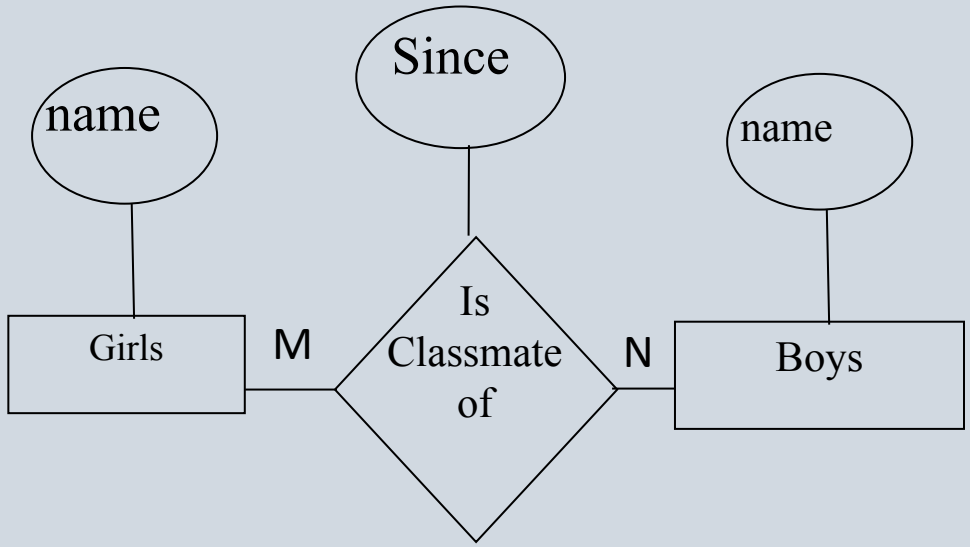
Using Sets, it can be represented as:



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.

Example :


Is Classmate of


name
Since
name
Girls
M
Is
Classmate
of
N
Boys

For binary relationship sets between entity sets A and B, the mapping cardinality must be one of:

1. **One-to-one:** An entity in A is associated with at most one entity in B, and an entity in B is associated with at most one entity in A.
2. **One-to-many**: An entity in A is associated with any number in B. An entity in B is associated with at most one entity in A.
3. **Many-to-one**: An entity in A is associated with at most one entity in B. An entity in B is associated with any number in A.
4. **Many-to-many**: Entities in A and B are associated with any number from each other.

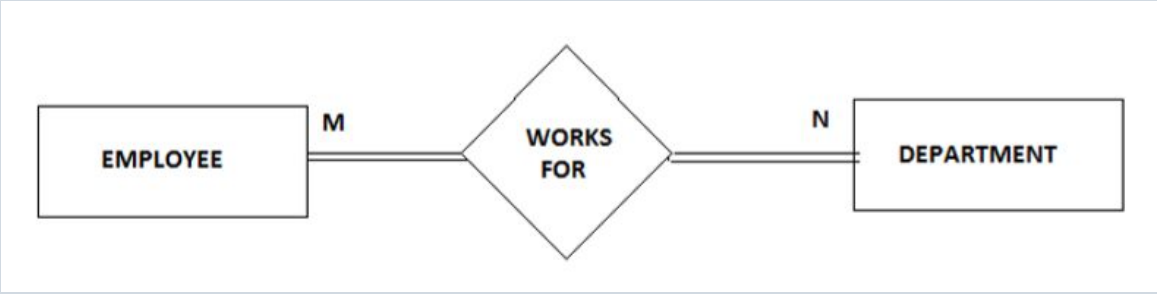
Participation Constraint for Binary Relationships

- In a Relationship, Participation constraint specifies the existence of an entity when it is related to another entity in a relationship type. It is also called minimum cardinality constraint.
- This constraint specifies the number of instances of an entity that can participate in a relationship type.
- There are two types of Participation constraint:
  - **Total Participation**
  - **Partial Participation**

Participation Constraint for Binary Relationships

Total Participation

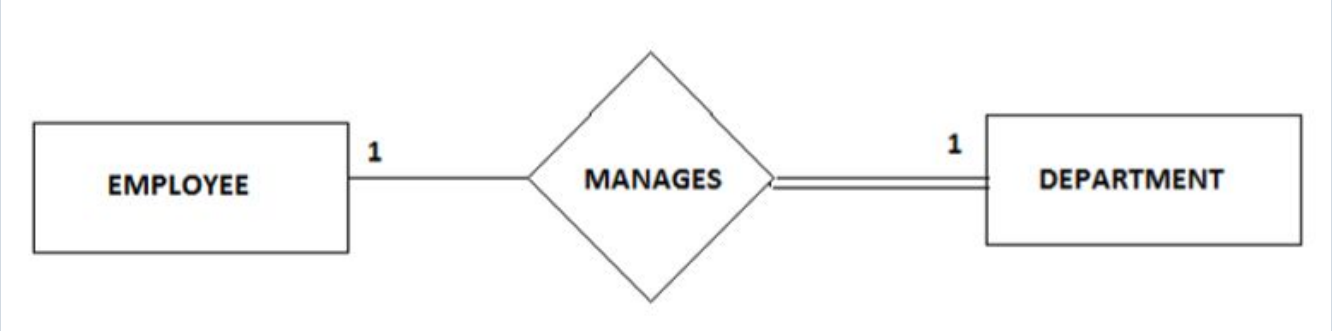
- Each entity in the entity set is involved in at least one relationship in a relationship set i.e. the number of relationship in every entity is involved is greater than 0.
- Each entity is involved in the relationship.
- Total participation is represented by double lines in the ER diagram.



Participation Constraint for Binary Relationships

Partial Participation

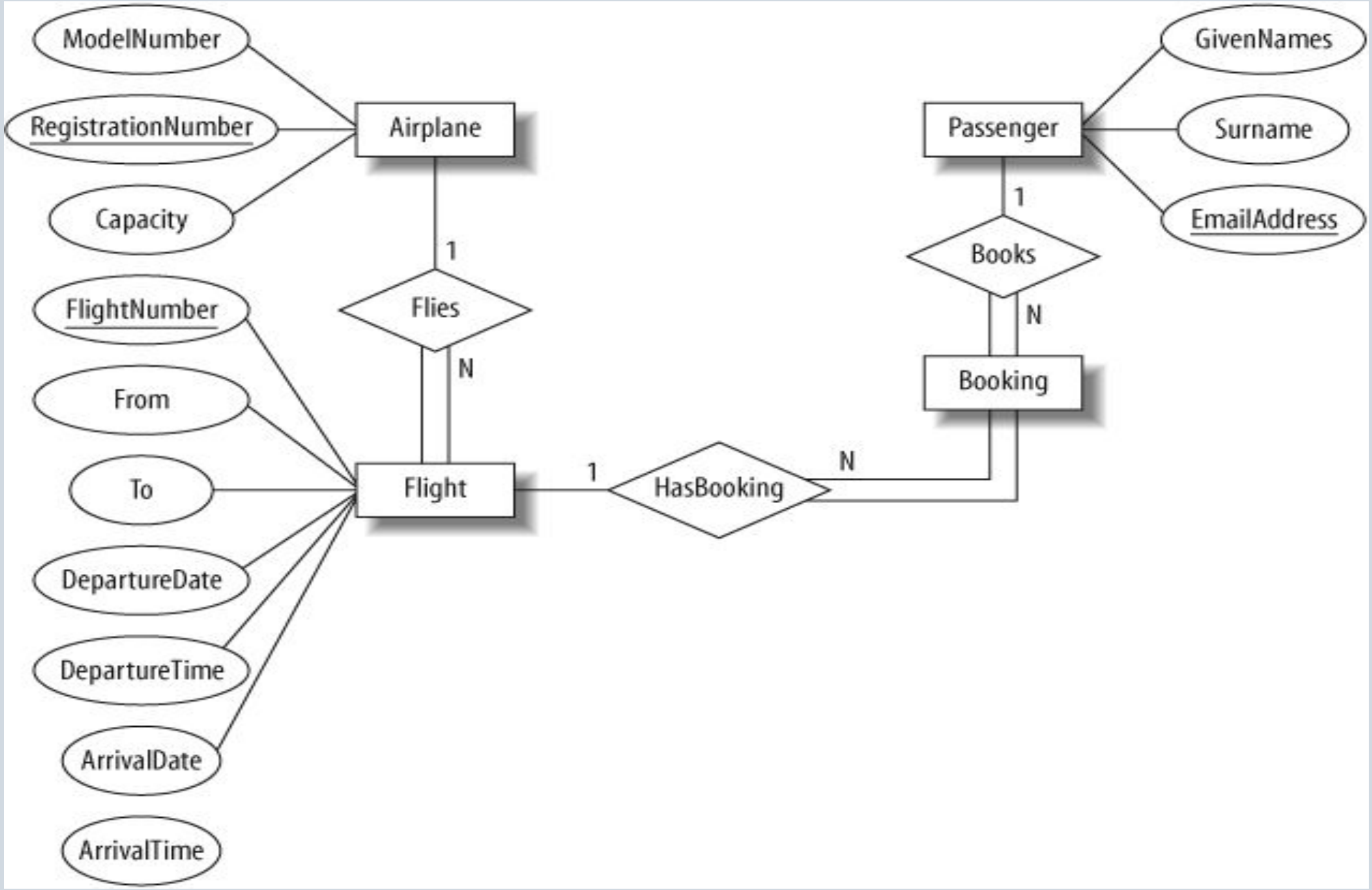
- Each entity in entity set may or may not occur in at least one relationship in a relationship set.
- Not all entities are involved in the relationship.
- Partial participation is represented by single lines.



Example - The Flight Database

Consider the following requirements list:

- The airline has one or more airplanes.
- An airplane has a model number, a unique registration number, and the capacity to take one or more passengers.
- An airplane flight has a unique flight number, a departure airport, a destination airport, a departure date and time, and an arrival date and time.
- Each flight is carried out by a single airplane.
- A passenger has given names, a surname, and a unique email address.
- A passenger can book a seat on a flight.


ModelNumber
RegistrationNumber
Capacity
Airplane
1
Flies
N
FlightNumber
From
To
DepartureDate
DepartureTime
ArrivalDate
ArrivalTime
Flight
1
HasBooking
N
Booking
N
Books
1
Passenger
GivenNames
Surname
EmailAddress

ER MODEL