E-R

2.1 INTRODUCTION

The entity-relationship (E-R) model was introduced by Chen in 1976. He described the main constructs of the E-R model *i.e.*, entities, relationships and their associated attributes. The E-R model continues to evolve but there is not yet a standard notation for E-R modeling. E-R model is mainly used for conceptual data modeling. It is popular due to the factors such as relative ease of use, CASE tool support, and the belief that entities and relationships are natural modeling concepts in the real world.

The E-R model is mainly used for communication between database designers and end users during the analysis phase of database development. This E-R model is a representation of the structure and constraints of a database that is independent of the DBMS and its associated data model that will be used to implement the database.

In 1980's many new database applications like Computer Aided Manufacturing (CAM), Computer Aided Design (CAD), Computer Aided Software Engineering (CASE), Digital publishing, World Wide Web (WWW), Telecommunication applications etc., were introduced. The basic E-R modeling concepts were no longer sufficient to represent the requirement of these newer and complex applications. Basic E-R model was not capable to represent additional semantic modeling concepts. Database designers and practitioners introduced a new model named as *Enhanced Entity-Relationship Model (EER)* which includes the basic E-R model concepts with additional semantic concepts like:

- Specialization
- Generalization
- Categorization.

The chapter describes the basic E-R model and in later sections it describes EER model.

2.2 BASIC CONCEPTS

1 Enterprise

Enterprise refers to any kind of organization.

Ex. Colleges, schools, banks, any company etc.

2 Entity

Entity refers to an "object" or "thing" in real world. Object may be any person, place, event etc.

Ex. Students of colleges and schools, loans in banks, employees in any company etc.

3 Attributes

These are the characteristics of any entity.

Ex., (*i*) A student can be described by his name, age, address, height, class etc.

(*ii*) Loans can be described by their types such as house loan, car loan etc.

(*iii*) Employees in any company can be described by their Employee ID, name, department, designation etc.

(*iv*) A car can be described by his color, model, company etc.

4 Value

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

5 Entity Sets

All the entities having same attributes make an entity set.

6 Domain

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

Ex. Consider the *student* table shown in Figure 2.1. It describes the basic concepts.

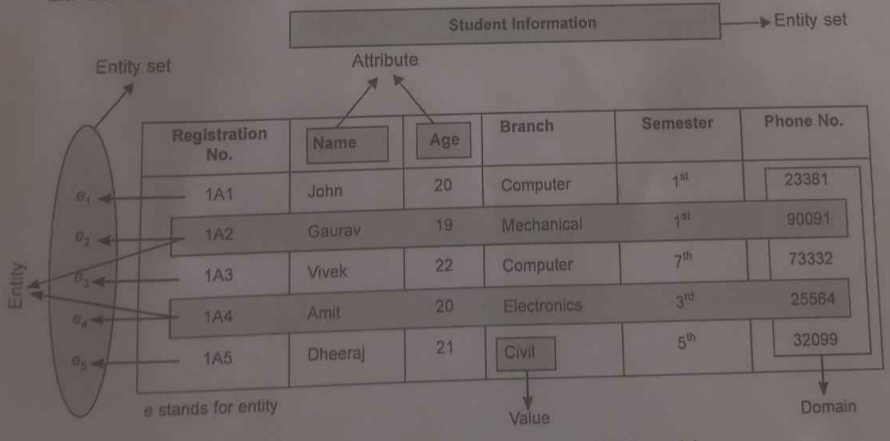


FIGURE 2.1. Table showing basic concepts of E-R model.

(*a*) *Enterprise* : Here, enterprise is college where students are studied.

(*b*) *Entity* : Here, entity refers to any single student with all his values.

Ex.

1A1	John	20	Computer	1st	23381

(*c*) *Attributes* : The students are described by Registration No., Name, Age, Branch, Semester, Phone No. These are the attributes of students.

(*d*) *Value* : The values are 1A1, 21, Civil, Gaurav, 90091, 5th etc.

(*e*) *Entity Set* : All students are described by same set of attributes. So, all these students combine together to make an entity set "Student Information".

(*f*) *Domain* : (Value set) for, attribute, *Name* it is John, Gaurav, Vivek, Amit, Dheeraj and for *Age*, it is 20, 19, 21, 22.

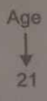
2.3 TYPES OF ATTRIBUTES

Attributes can be characterized by the following **Three** major types :

2.3.1 Simple and Composite Attributes

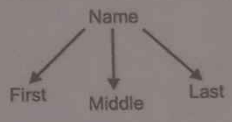
Simple Attributes are those which cannot be divided into subparts.

Ex. Age of student



Composite Attributes are those which can be divided into subparts.

Ex. Name of a student can be divided into First Name, Middle Name, and Last Name.



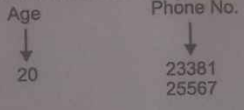
2.3.2 Single Valued and Multi-valued Attributes

Single Valued Attribute : An attribute having only single value for a particular entity is known as single value attribute.

Ex. Age of student.

Multi-Valued Attributes : An attribute having more than one possible value for a particular entity is known as multi-valued attribute.

Ex. Phone number of a student. A student may have more than one phone.



2.3.3 Derived Attributes and Stored Attributes

Derived Attributes : An attribute that can be derived from other known attributes is known as derived attribute.

Ex. Age of employees can be derived if you know date of birth and system date.

Age = System date – Date of birth

Stored Attributes : An attribute which cannot be derived by other known attributes is known as stored attribute.

Ex. Date of birth of any employee.

NULL Value : Null stands for nothing. An attribute have a null value if either the value of that attribute is not known or the value is not applicable.

Caution : NULL is not equal to Zero (0). But you can say that NULL is blank as shown in Figure 2.2.

Ex.

Name	Subject	Marks
abc	Maths	92
def	Science	– → This is null
ghi	Maths	0

FIGURE 2.2. Showing null value.

2.4 RELATIONSHIP SETS

1. **Relationship :** A relationship is the association among several entities. It connects different entities through a meaningful relation.
2. **Relationship Set :** A relationship set is a set of relationships of the same type.

Consider an example, employees work in different departments. Then relationship exists between employees and departments because each employee must belongs to some department. Relation of all employees with department when combined makes the relationship set because each employee has same kind of relation with departments.

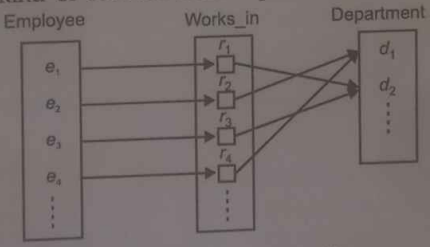


FIGURE 2.3. Binary relationship set.

Here, Employee and Department are two entity sets. *r* stands for relationship between Employee and Department. Works_in is the *relationship set* as shown in Figure 2.3.

- **Descriptive Attributes :** Attributes of any relationship set are known as descriptive attributes.

2.4.1 Degree of Relationship Sets

Total number of entity sets participate in a relationship set is known as degree of that relationship set.

1. **Binary Relationship Set**

A relationship set in which only two entity sets are involved is known as binary relationship set.

Ex. The Figure 2.3 shows the Binary relationship set.

2. Ternary Relationship Set

A relationship set in which three entity sets are involved is known as ternary relationship set or a relationship set having degree three.

Ex. The Figure 2.4 shows the relationship set works_in, which is a ternary relationship set.

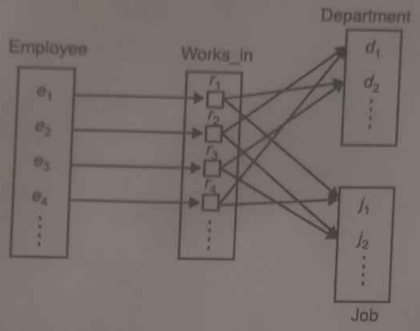


FIGURE 2.4. Ternary relationship set.

2.4.2 Role and Recursive Relationship Set

- **Role :** The function of any entity which it plays in relationship set is called that entity's role. *e.g.,* employee plays the role of worker in his department in Figure 2.4.
- **Recursive Relationship Set :** When the same entity sets participate in same relationship set more than once with different roles each time, then this type of recursive relationship set is known as Recursive Relationship set. *e.g.,* consider an example of relationship set works_in and two entity set student and college. A student who attends weekend classes in college as student may also be lecturer in that college. Then this person plays two roles (student, faculty) in same relationship set work_in.

2.5 MAPPING CONSTRAINTS

There are certain constraints in E-R model. Data in the database must follow the constraints. Constraints act as rules to which the contents of database must conform. There are *two types* of mapping constraints : (*a*) *Mapping cardinalities,* (*b*) *Participation constraints.*

2.5.1 Mapping Cardinalities (Cardinality Ratios)

It specifies the number of entities of an entity set that are associated with entities of another entity set through a relationship set.

Mapping Cardinalities are helpful in describing *binary relationship sets.*

Two entity sets X and Y having binary relationship set R must have one of the following mapping cardinality :

1. **One to One (1 : 1) :** An entity in X is associated with at most one entity in Y and an entity in Y is associated with at most one entity in X.

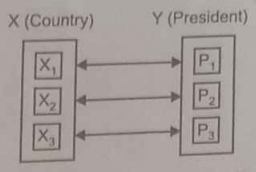


FIGURE 2.5. One to one cardinality ratio.

A country has only one president. Any person may be the president of at most one country.

2. One to Many (1 : N) : An entity in X is associated with any number of entities in Y. An entity in Y is associated with at most one entity in X.

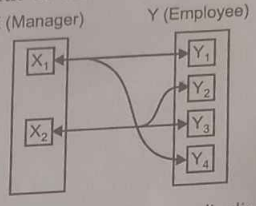


FIGURE 2.6. One to many cardinality ratio.

A manager has many employees under it but an employee works under only one manager.

3. Many to One (N : 1) : An entity in X is associated with at most one entity in Y. An entity in Y is associated with any number of entities in X.

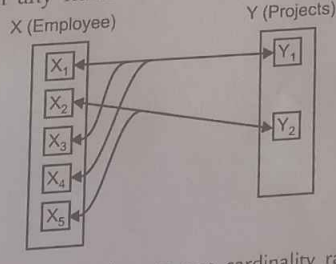


FIGURE 2.7. Many to one cardinality ratio.

A employee can work on single project while any project can be assigned to more than one employee.

4. Many to Many (M : N) : An entity in X is associated with any number (zero or more) of entities in Y and vice versa.

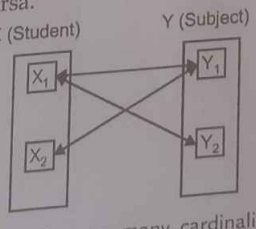


FIGURE 2.8. Many to many cardinality ratio.