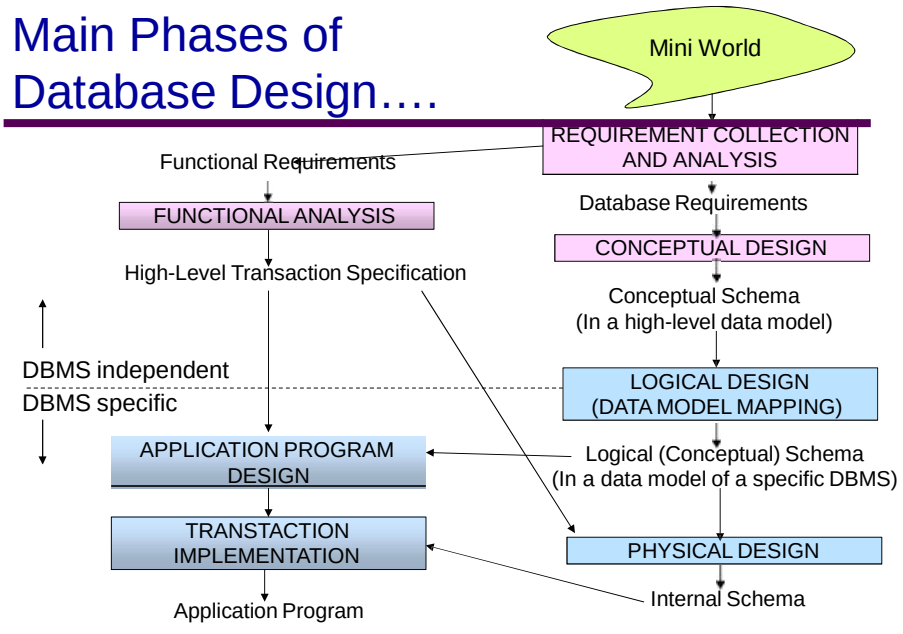
Database Design: Data Modeling using ER Diagram

S. K. Ghosh

CSE, SNU

Main Phases of Database Design….



Steps of Database Design

- Requirement collection and analysis – *database designers interview* prospective database users to understand and document their **data requirements**
- Functional Requirement analysis – *DFD, Sequence Diagram*
- Conceptual Design using **HIGH LEVEL CONCEPTUAL MODEL** – *concise description of the data requirements of the users and includes detailed descriptions of entity, relation and constraints*
- Logical Design and Data model mapping
- Physical Design

Entity- Relationship Modeling

ER Diagram

EER Diagram

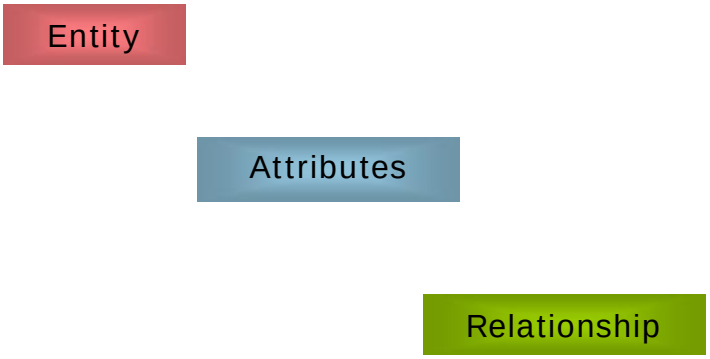
Overview of Database Design

- What are the Entities and Relation ?
- What information about these entities and relationship should we store?
- What are the integrity constraints or business rules that hold?
- A database schema represented pictorially……. ER Diagram
- Can map an ER model into a relational schema…….

ER Diagram

- Originally proposed by Peter Chen (1976)
- Views the real world as entities and relationships
- Key component is the E-R Diagram
- Most common model used for designing relational databases

Some Important terms related to ER Diagram



Entity

- An **entity** is an object that exists and is distinguishable from other objects…. "thing" in the real world with independent existence
- Entity
  - May be an object with Physical existence –
    a particular *person, car, house, employee….*
  - May be an object with Conceptual existence-
    a company, a job or a university course

Entity

contd..

- Each entity must be uniquely identifiable
- Each instance (occurrence) of an entity must be separate and distinctly identifiable from all other instances of that type of entity
- Entity sets do not need to be disjoint. [employee, customer of a bank, a person entity may an employee entity, a customer entity, both or neither]

Attributes

- The particular properties that describe entity
- Say "employee" entity e_1 has four attributes- name, address, age, phone_no
- The values are
  - "John", "Houston", "35", "2350911 5"
- Attributes are the descriptive properties possessed by each member of the entity set
- A particular instance of an attribute is a value
- Domain- the set of permitted values of the attribute

ENTITY TYPE NAME

CUSTOMER

customer_id	customer name	customer street	customer city
019-28-3746	Smith	North	Rye
677-89-9011	Hayes	Main	Harrison
555-55-5555	Jackson	Dupont	Woodside
244-66-8800	Curry	North	Rye
963-96-3963	Williams	Nassau	Princeton
335-57-7991	Adams	Spring	Pittsfield

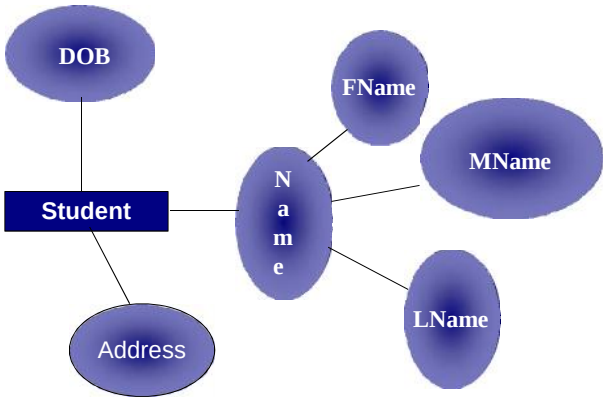
ENTITY SET:

(EXTENSION)

Entity Type defines collection of Entities that have same Attributes

The collection of all entities of a particular entity type in the database at any point is called an entity set

Symbolic Representation in ER Diagram



Types of Attributes

- Simple versus Composite
- Single Valued versus Multi valued
- Stored versus Derived
- Complex Attributes
- NULL Valued

Types of Attributes

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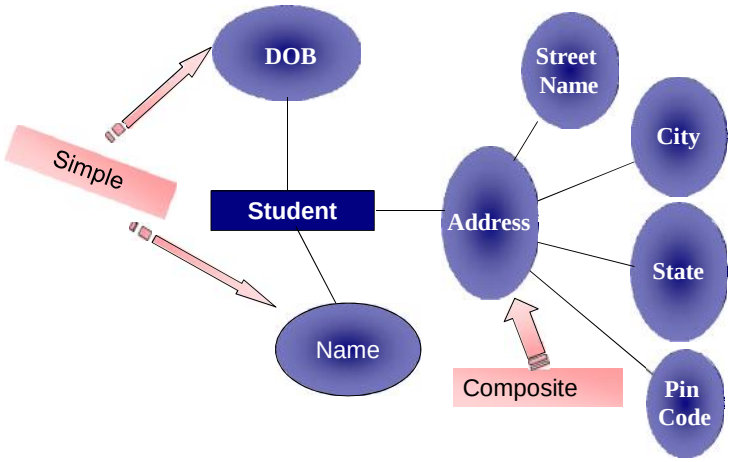
Simple versus Composite Composite attributes can be divided into some sububparts



Types of Attributes

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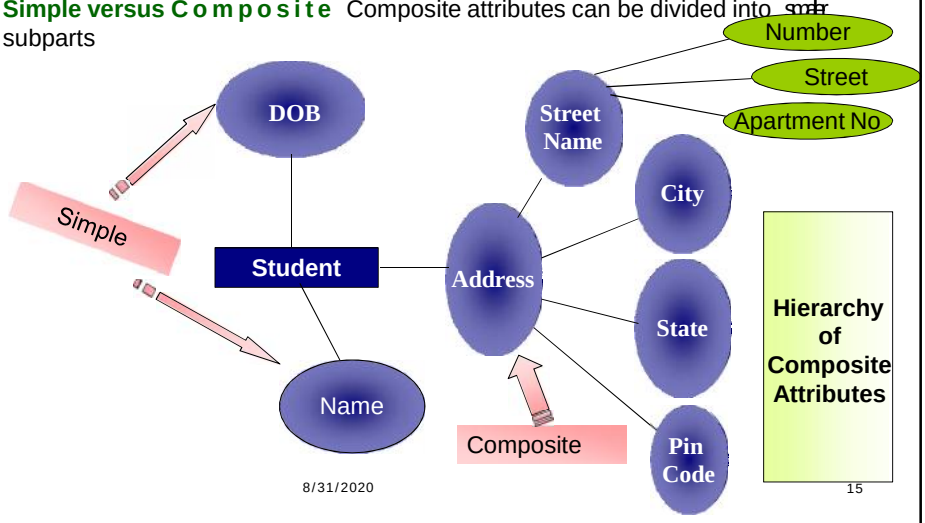
Simple versus C o m p o s i t e Composite attributes can be divided into smaller subparts



Types of Attributes

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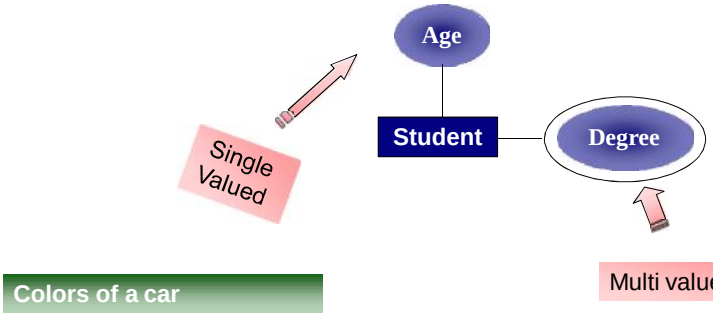
Single Valued versus Multi valued:

Most attributes have single value for a particular entity

Attributes may have multiple values Multi-Valued attribute



Types of Attributes

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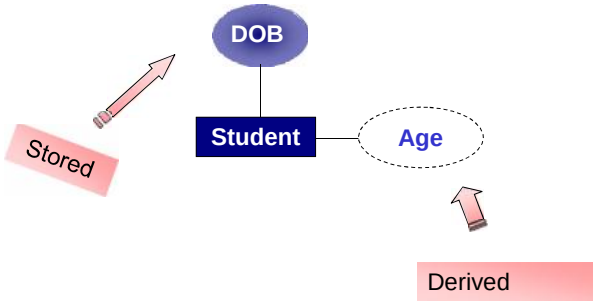
Stored versus Derived:

Derived from DOB and the Current Date



Types of Attributes

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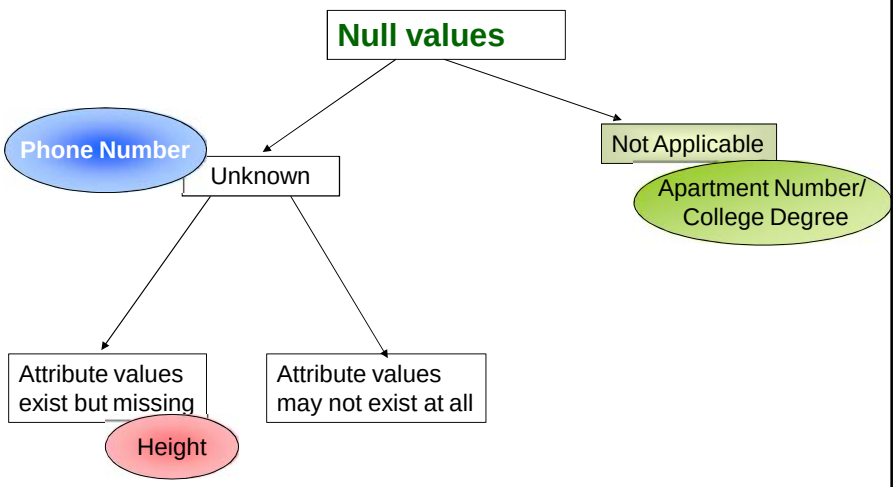


Types of Attributes

contd..

Complex Attributes

{AddressPhone({Phone(Area Code, Phone Number)},
Address(Street Address(Number, street, apartment number),City, State, Zip))}

Person with more than one residence and each residence having multiple phones

Key Attributes

- Key
  - Value of this attribute helps to identify each tuple uniquely: no two tuples of an entity set are allowed to have exactly same values for all attributes

Super Key is a set of attributes that taken from attribute allow us to identify uniquely an entity in the entity set

Emp (eno, name, vid, address, dob, phone_no)

Key Attributes

- Super Key
  - Contains extraneous attributes
  - If K is a super key then so any subset of K

We need to find out in which
no proper subset is a super key

CANDIDATE KEY

Emp (eno, name, vid, address, dob, phone_no)

CANDIDATE KEY

PRIMARY KEY

Key Attributes

STUDENT (regn no,year, vid, address, dob, phone_no)

CANDIDATE KEY

COMPOSITE CANDIDATE KEY

COMPOSITE PRIMARY KEY

Value Set (Domains) of Attributes

- Each simple attribute of an entity type is associated with a value set
- Range of ages of an employee is between 18 to 70

Relationship

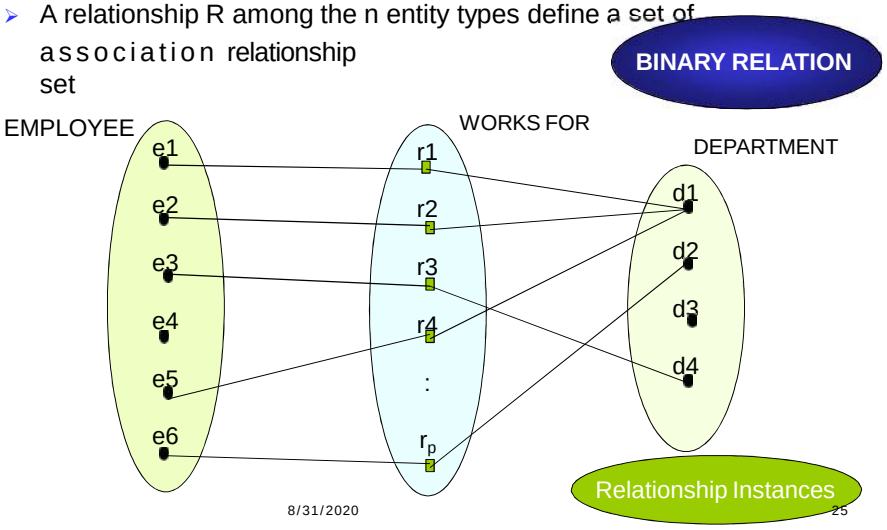
- A relationship is an association among several entities

  Example:

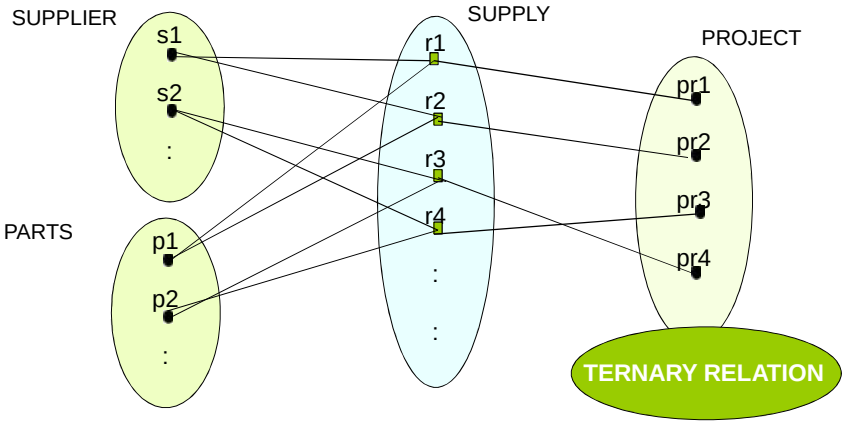
customer entity	relationship set	account entity
Hayes	depositor	A-102

Relationship

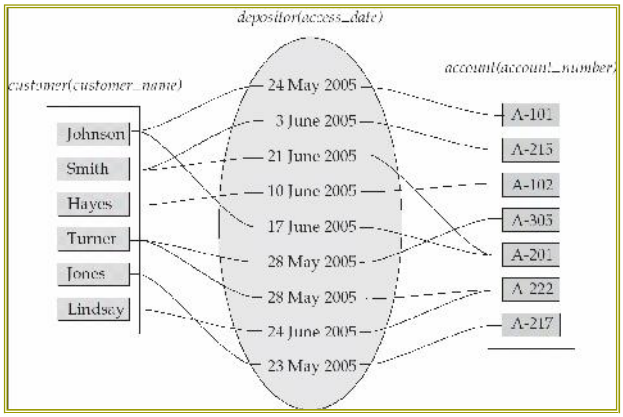
- A relationship R among the n entity types define a set of association relationship set



Relationship



Relationship Set



Relationship Set

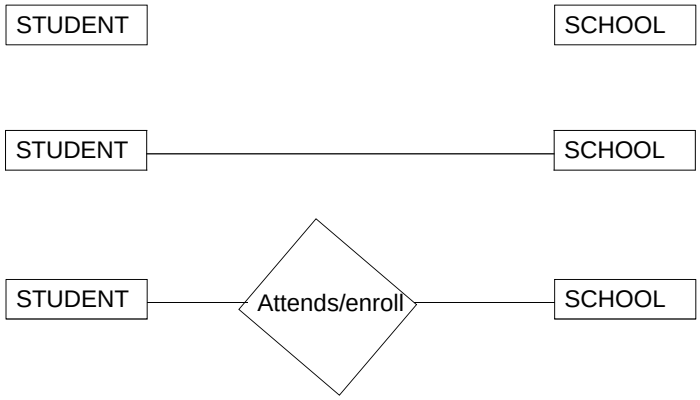
- A **relationship set** is a mathematical relation among $n \geq 2$ entities (possible non-distinct).
- If $E_1, E_2 \ldots E_n$ are entity sets, then a relationship set R is a subset of

  $$\{(e_1, e_2, \ldots e_n) \mid e_1 \in E_1, e_2 \in E_2, \ldots, e_n \in E_n\}$$

  where $(e_1, e_2, \ldots, e_n)$ is a relationship.
  The entity sets $E_1, E_2 \ldots E_n$ participate in the relationship set R.
  - Example:

    (Hayes, A-102) $\in$ *depositor*

Relation in ER Diagram



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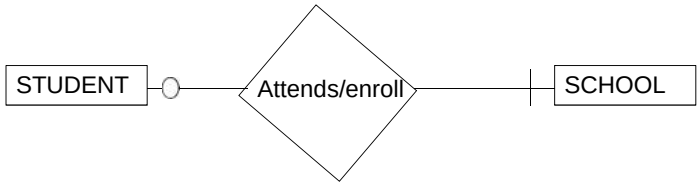
Optionality and Cardinality

Optionality whether relation is optimum

Indicates optionality

Indicates mandatory



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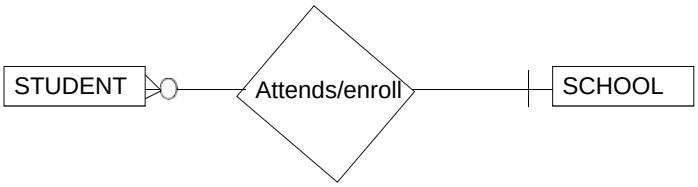
Cardinality

Cardinality ® Number of relationship instances that an entity can participate

— Indicates maximum one relation

Indicates many such relation

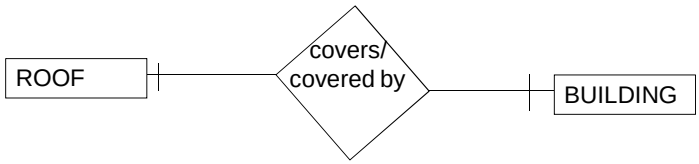


Cardinality

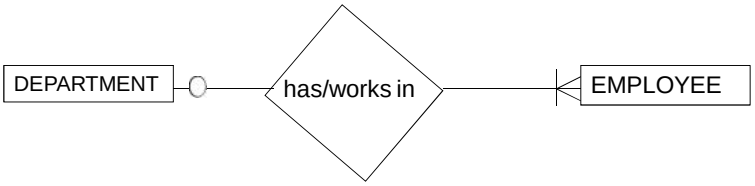
- One- to- One
- One-to-Many
- Many-to-One
- Many-to-Many

Cardinality

One-to-One



One-to-Many



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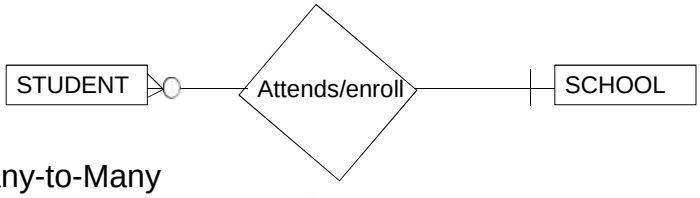
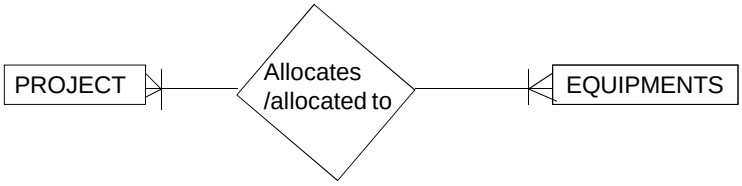
Cardinality

Many-to-One



Many-to-Many



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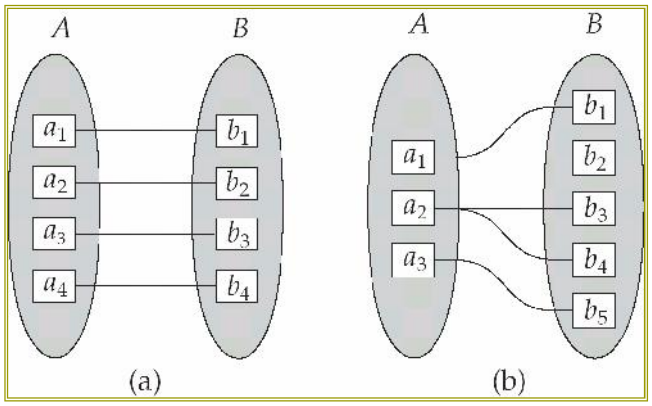
Mapping Cardinality Constraints

- Mapping cardinalities (or cardinality ratio) is the number of entities of an entity set associated with the entities of another entity via a relationship set.
- Most useful in describing binary relationship sets.
- For a binary relationship set the mapping cardinality must be one of the following types:
  - One to One (1:1)
  - One to many (1:N)
  - Many to one(N:1)
  - Many to Many (N:M)

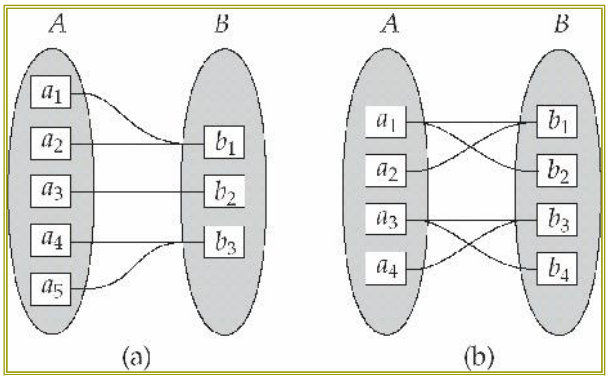
Mapping Cardinalities



One to one One to many

Note: Some elements in *A* and *B* may not be mapped to any elements in the other set

Mapping Cardinalities

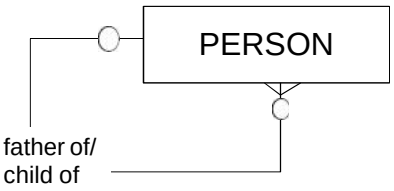


Many to one Many to many

Note: Some elements in A and B may not be mapped to any elements in the other set

Recursive Relation

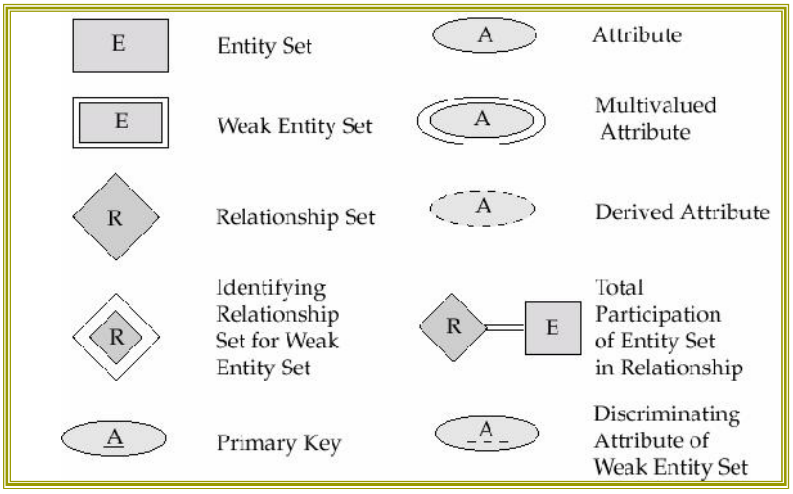
- Instances of entity may have relationships with other instances of the same entity



E-R Diagrams

- Representation of entity sets, relationship sets and their attributes by means of graph.
- Rectangles represent entity sets.
- Diamonds represent relationship sets.
- Lines link attributes to entity sets and entity sets to relationship sets.
- Ellipses represent attributes
  - Double ellipses represent multivalued attributes.
  - Dashed ellipses denote derived attributes.
- Underline indicates primary key attributes.

Symbols Used in E-R Notation



Let us take an Example and

Draw the ER Diagram

Steps of Drawing anER Diagram

- Identify Entities
- Find Relationship (Entity-Relationship Matrix)
- Draw Rough ERD
- Fill in cardinality/ Optionality
- Identify Attributes
- Define Primary key
- Draw key based ERD
- Check Results

Weak Entity

- An entity set that does not have a primary key is referred to as a *weak entity set*
- The existence of a weak entity set depends on the existence of a *identifying entity s e t @ owner entity*
- Regular entities that do have key attributes are sometimes called *strong entity types*
- *A relationship that relates a weak entity type to its owner @ identifying relationship of the weak entity type*
- *A weak entity always has a total participation constraint (existence dependency)*

Thank You

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