Unit 3- Data Models

Subject Code: 303105203

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CHAPTER-3

Data Models

DATA MODELS

Data Models

- Data models re how the logical structure of a database is designed.
- Data Models are fundamental entities to introduce abstraction in a DBMS.
- Data models define how data is connected to each other and how they are processed and stored inside the system.
- It defines how data can be stored, accessed and updated in database management systems.

Data Models

- There are different types of data models in DBMS:-
  - ER(Entity-Relationship)- Model
  - Relational Model
  - Network Model
  - Object Oriented Model

ER Model

Basic Concepts:-

- **What is E-R diagram?**
  - E-R diagram means Entity-Relationship diagram
  - It is a visual tool for **graphical (pictorial) representation** of database.
  - ER Model was proposed by Peter Chen in 1970’s to use it for a conceptual modelling/designing of database.

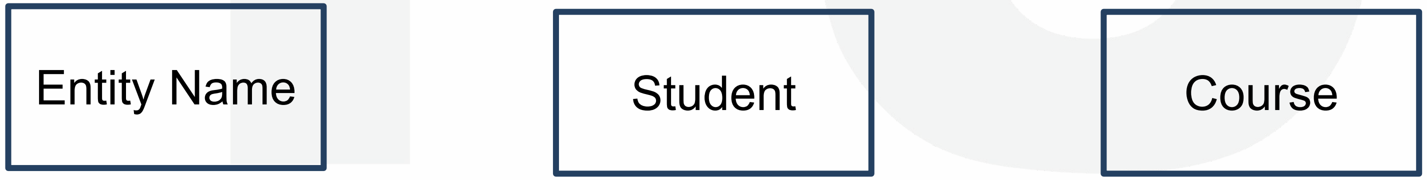
ER Model

Basic Concepts:-

- **What is E-R diagram?**
  - It is based on the view of real-world entities and relationships among them.
  - While expressing real-world scenario into the database model, the ER Model creates **entity set, relationship set, general attributes and constraints**.
  - ER Model mainly focuses on **Entities and their attributes** and **Relationships** among entities.
  - It uses various types of symbols to represent objects of database.

Entity

- Entity is real-world objects, place, person about which we collect data
- Example: For University database entity can be Student, Teacher, Department, Course, Result, Class, etc.
- Entity is denoted by a **Rectangle** containing name of entity.



Entity Name

Student

Course

Figure: 1.25 Entity

Attributes

- Attribute represent **properties or details** about an entity.
- Example: For student entity, attributes can be name, enrollment no, address, date of birth, result, etc.
- It is denoted by an **oval** symbol having name of an attribute.

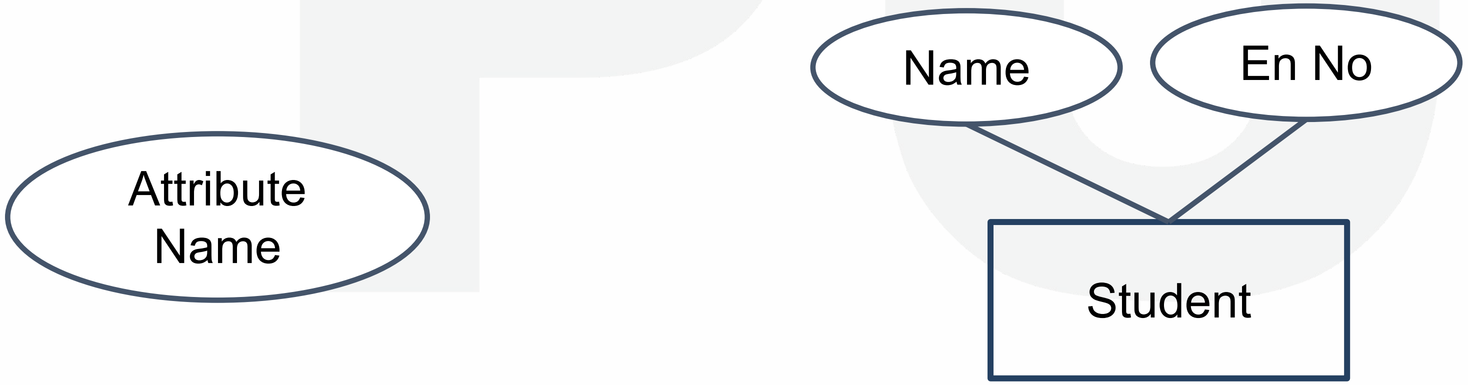


Figure: 1.26 Attributes

Relationship

- Relationship is an association/connection between several entities.
- It defines how entities are related to each other.
- It is denoted by a **diamond** containing relationship's name.
- Diamond should be placed between two entities and a line connecting to both entity.
- Example: Book from library is issued by student, here book & student are entities and issue is relationship.

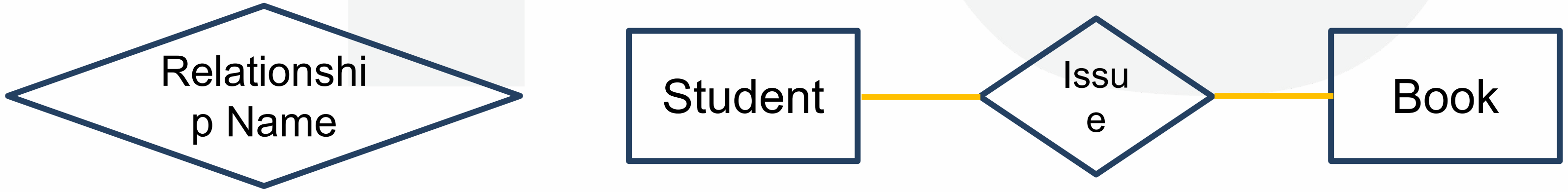


Figure:1.27 Relationship

Entity Set

- Entity Set is a set of entities of the same type having same properties or attributes.
- Example: set of all persons, companies, trees, holidays, all students studying in a university

- **Relationship Set:** When there are set of relationships of a same type is called Relationship set

E-R Diagram of Library Management System

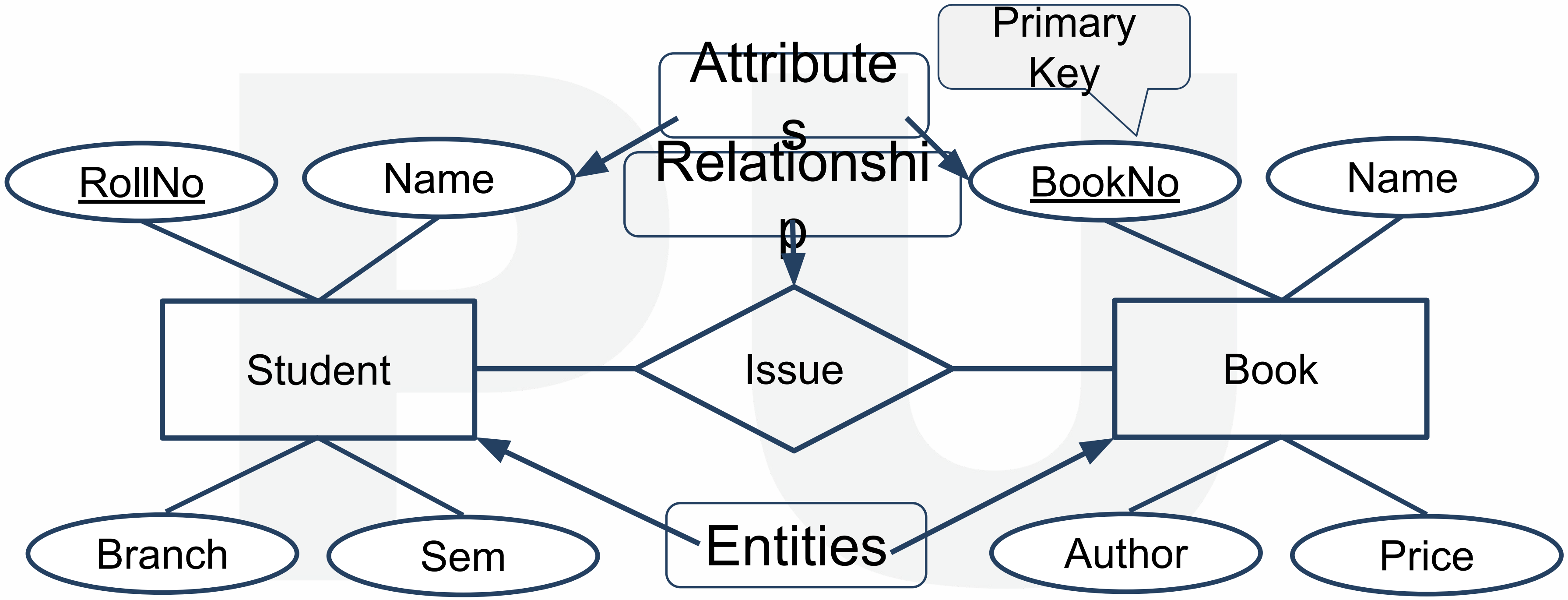


Figure: 1.28 An example of E-R Diagram

Types of Attributes

- Let’s understand different types of attributes
    1. Simple and composite attributes.
    2. Single-valued and multi-valued attributes
    3. Stored attribute and Derived attributes
    4. Complex Attribute
    5. Key Attribute

1. Simple and composite attributes

Simple Attribute:

- It cannot be divided further in more subparts.
- It is like undivided atomic value.
- Example: Price, Year, Enno, CPI

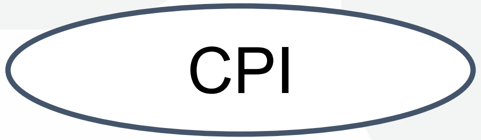


Figure: 1.29 Simple Attribute

1. Simple and composite attributes

▯ **Composite Attribute:**

- It can be divided further in more subparts.
- It is an attribute composed of many other attributes.
- Example: Name
  (first name, middle name, last name)
  Address
  (street, road, city)

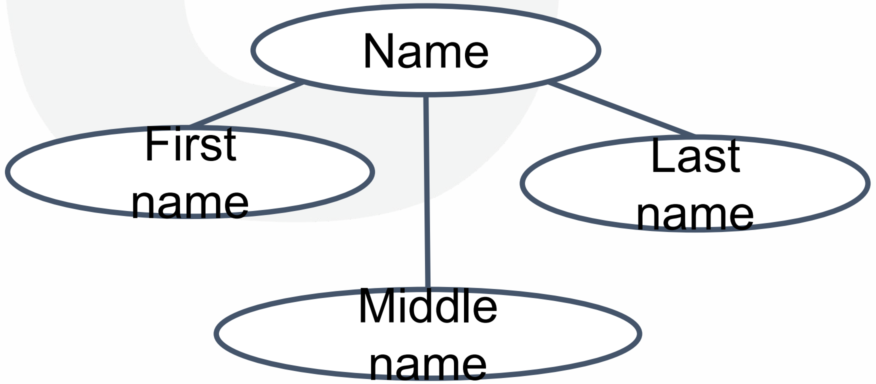


Figure: 1.30 Composite Attribute

2. Single-valued and multi-valued attributes

▯ **Single-Valued Attribute:**

- As name suggests it has single value only.
- Example: Enno, Birthdate

Birthdate

Figure: 1.31 Single-valued Attribute

2. Single-valued and multi-valued attributes

□ **Multi-Valued Attribute:**

- It has multiple/more than one values.
- Example: PhoneNo

  (person may have multiple phone nos)

  EmailID

  (person may have multiple emails)

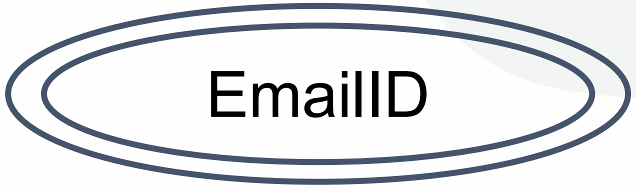


Figure: 1.32 Multi-valued Attribute

3. Stored attribute and Derived attributes

□ Stored Attribute:

- In this attribute value needs to be stored/defined manually.
- Example: Birthdate, Height, Weight

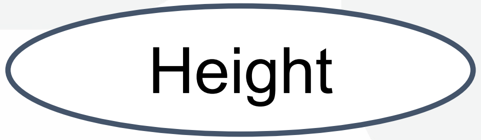


Figure: 1.33 Stored Attribute

3. Stored attribute and Derived attributes

▯ **Derived Attribute:**

- Derived attribute value can be calculated or derived from other attributes.
- Example: Age (Can be derived from current date and birth date)

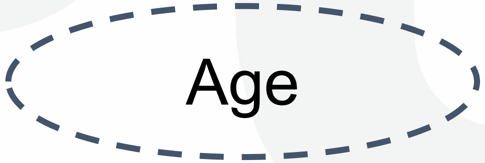


Figure: 1.34 Derived Attribute

4. Complex Attribute

- Attribute that are derived by nesting the composite and multivalued attributes are called complex attributes.

Address_ phone((phone), address (H.no., city, state))

Complex Attribute MV Attribute Composite Attribute

5. Key Attribute

- Attribute which uniquely identifies each entity in the entity set is called key attribute.
- For example, RollNo will be unique for each student.
- It is denoted by an oval with underlying lines.

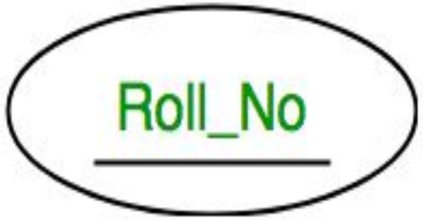


Figure: 1.35 Key Attribute

Example of All Attributes

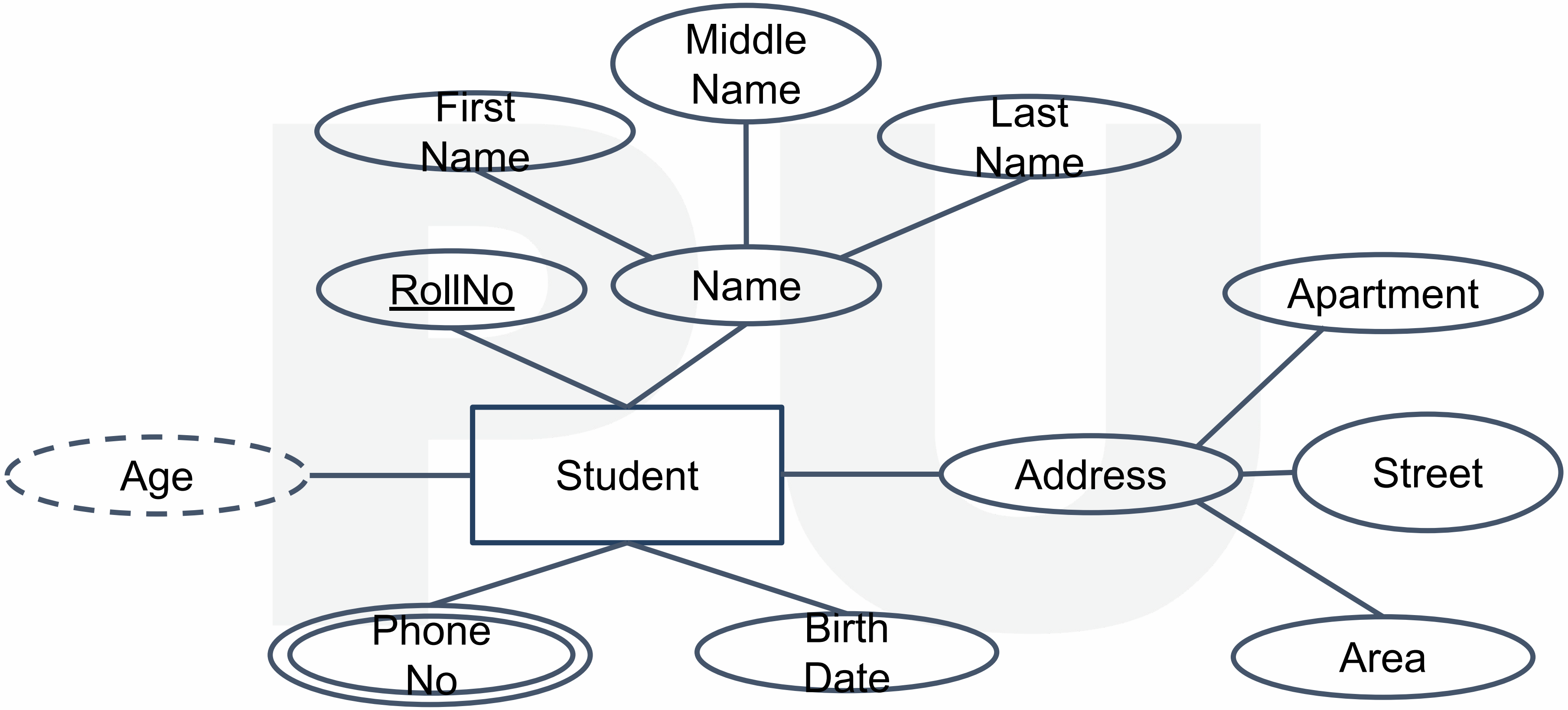


Figure: 1.36 An example of all Attributes

Descriptive Attributes

- If any relationship has a attribute like entity then its known as Descriptive Attributes.
- Example: Student had been issued degree certificate on 25/5/2020. Certificate date is an attribute of relationship.

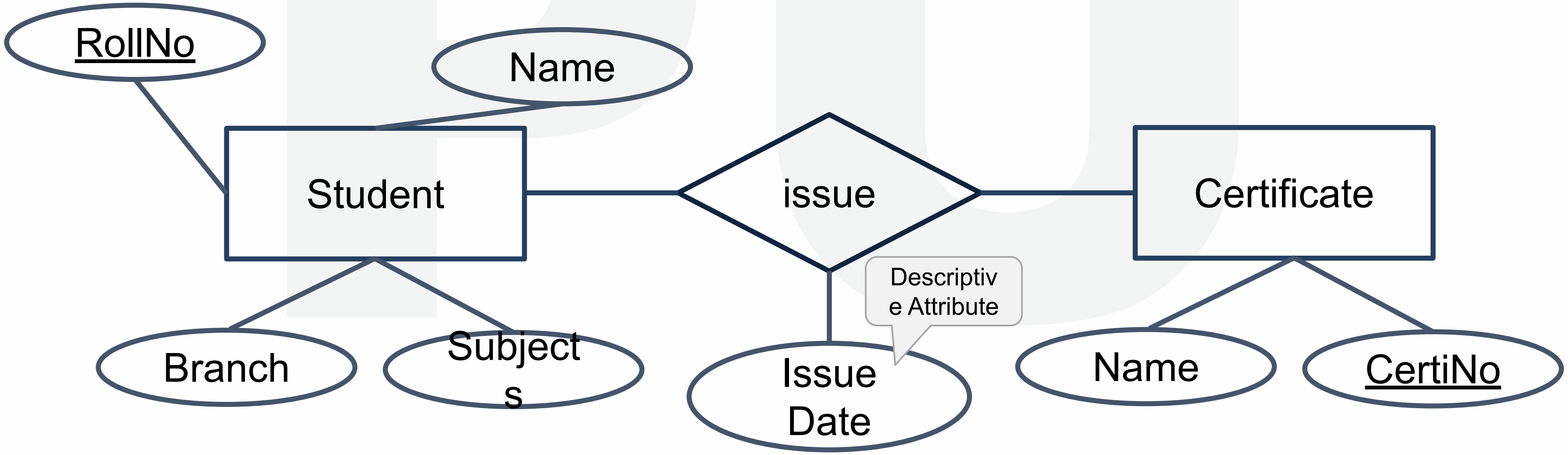
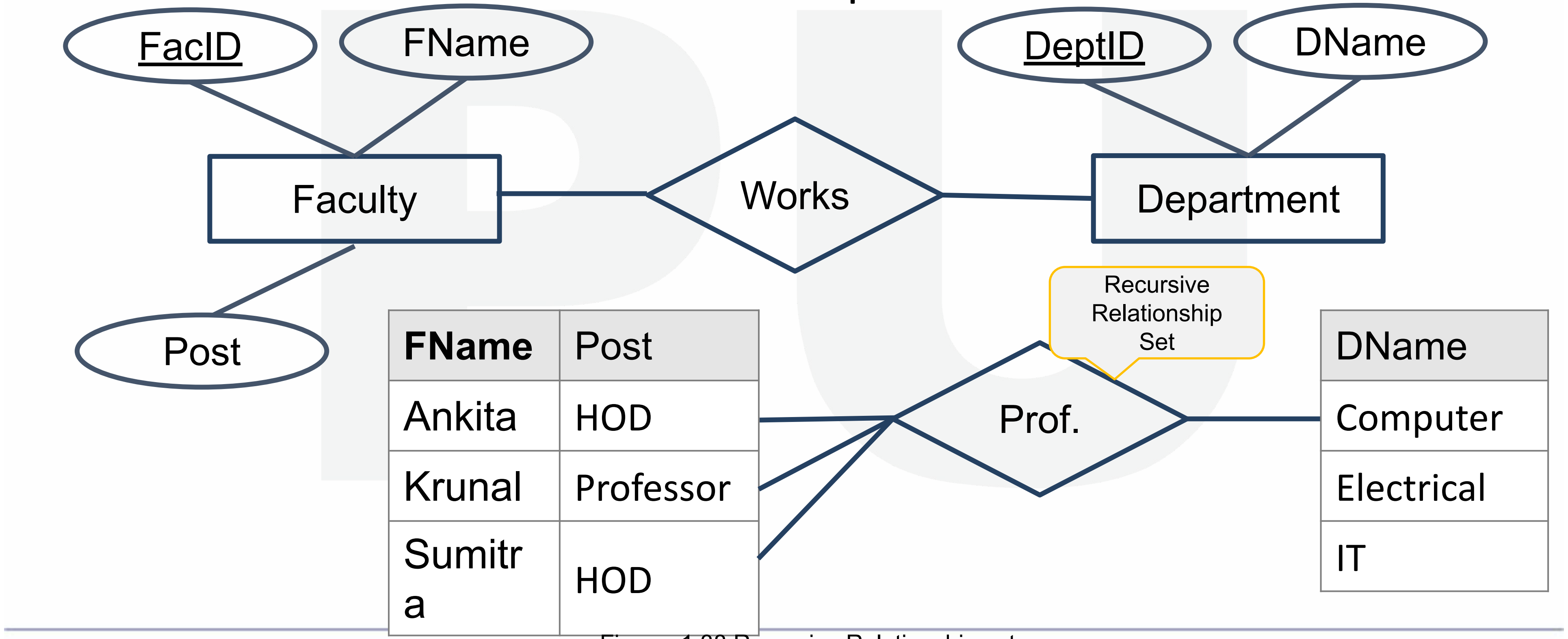


Figure: 1.37 Descriptive Attributes

Recursive Relationship Set

- When one entity set participate in a relationship for more than once then it is called recursive relationship set.



FName	Post
Ankita	HOD
Krunal	Professor
Sumitra	HOD

DName
Computer
Electrical
IT

Figure: 1.38 Recursive Relationship set

Degree of a Relationship Set

- Number of entity sets joining in a relationship set is known as a degree of a relationship set.

1. Unary Relationship
2. Binary Relationship
3. n-ary Relationship

Degree of a Relationship Set

1. Unary Relationship:

- When only one entity set participating in a relationship is called Unary Relationship.
- Example: One person is married to only one person.

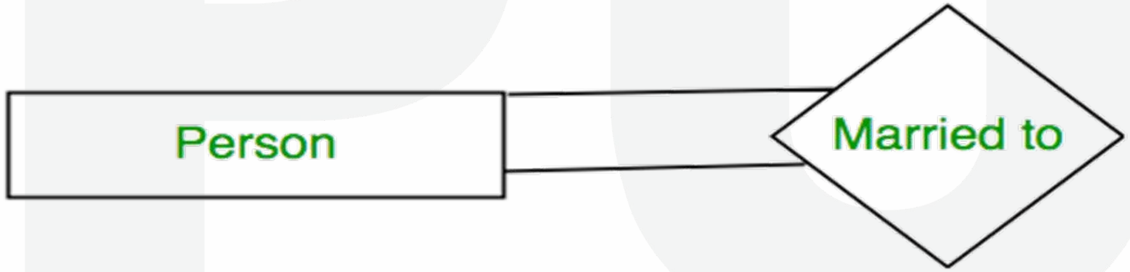


Figure: 1.39 Unary Relationship

Degree of a Relationship Set

2. Binary Relationship:

- When Two entity set participating in a one relationship is called Binary Relationship.
- Example: Student is Enrolled in Course

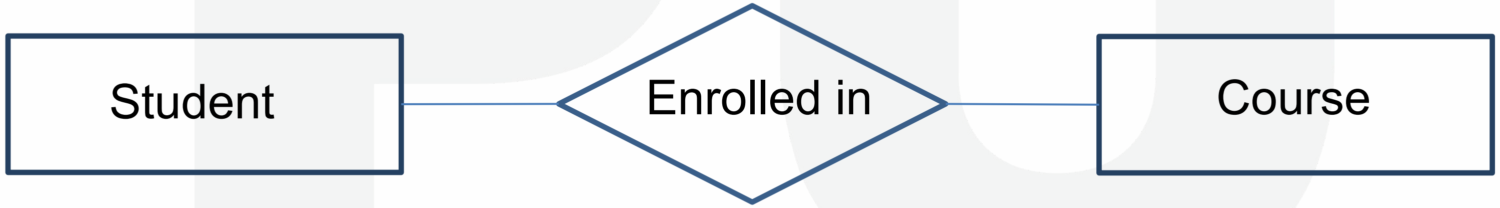


Figure: 1.40 Binary Relationship

Degree of a Relationship Set

3. N-ary / Ternary Relationship:

- When there are 3 or N entity set participating in a relationship is called Ternary / N-ary Relationship.

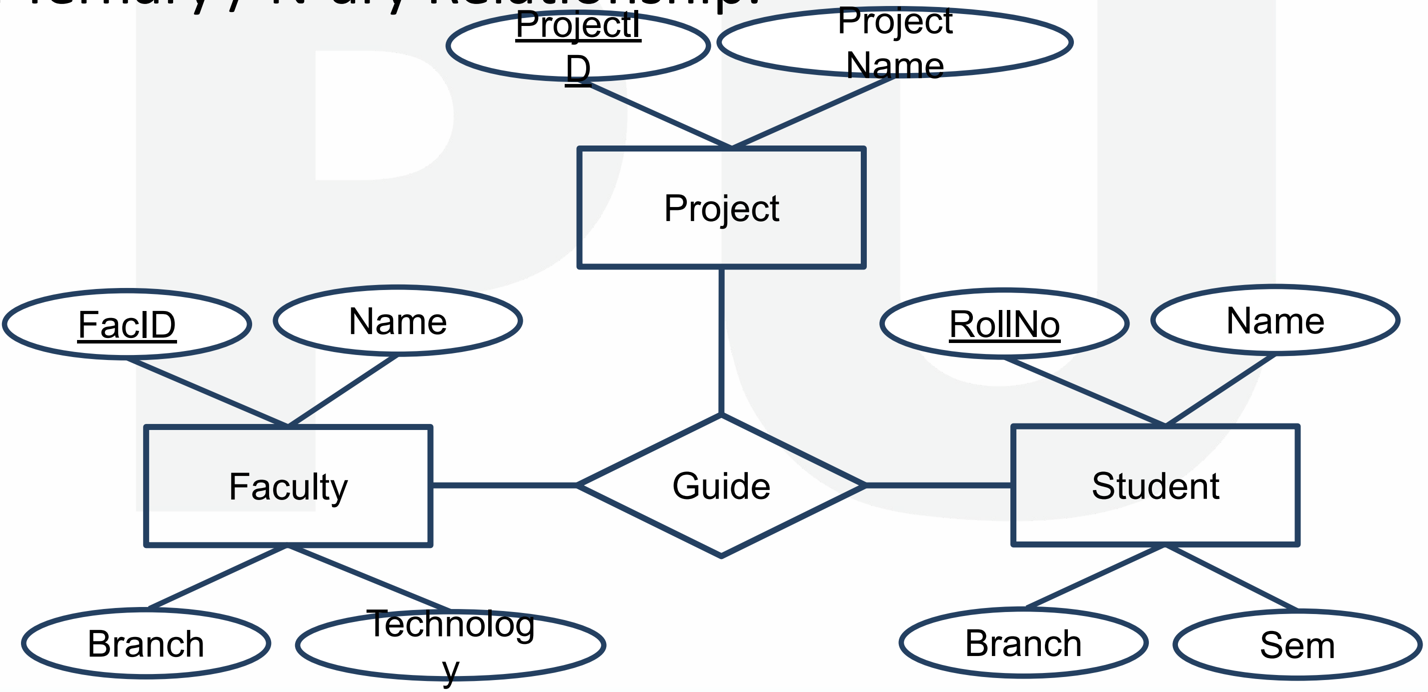


Figure: 1.41 Ternary Relationship

Cardinality Constraints (Mapping Cardinality)

- It defines numbers of times an entity of another entity set participate in a relationship set.
- It helps in defining binary relationship sets.
- Mapping Cardinality for binary relationship can be following types:

  1. One to One
  2. One to Many
  3. Many to One
  4. Many to Many

Cardinality Constraints (Mapping Cardinality)

1. One to One Relationship(1-1):

- An entity in A is associated with only one entity in B and an entity in B is associated with only one entity in A.

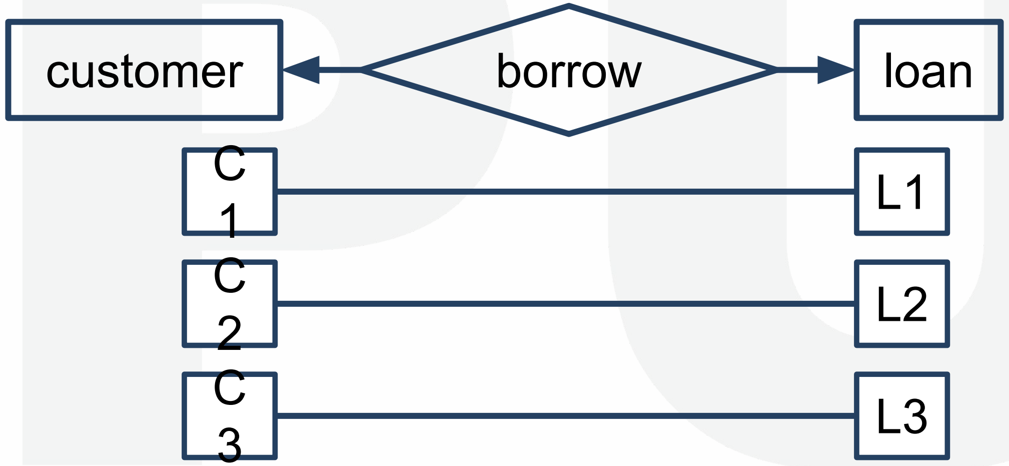


Figure: 1.42 1-1 Relationship

- **Example:** One customer is connected with only one loan through borrower relationship and loan is connected to one customer using borrower.

Cardinality Constraints (Mapping Cardinality)

2. One to Many Relationship(1-M):

- An entity in A is associated with more than one entities in B and an entity in B is associated with only one entity in A.

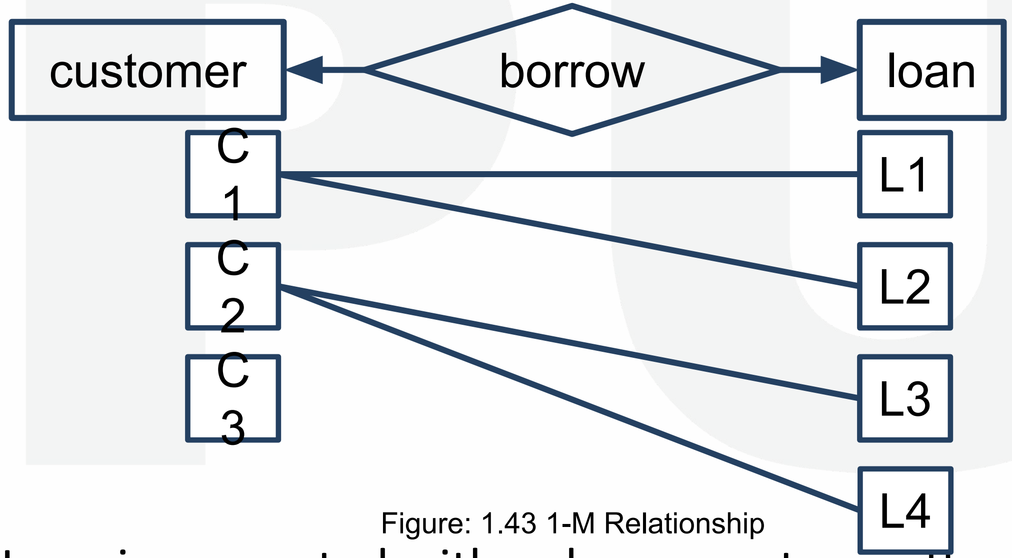


Figure: 1.43 1-M Relationship

- **Example:** Loan is connected with only one customer through borrower relationship and customer is connected with more than one loan.

Cardinality Constraints (Mapping Cardinality)

3. Many to One Relationship(M-1):

- An entity in A is associated with only one entity in B and an entity in B is associated with more than one entities in A.

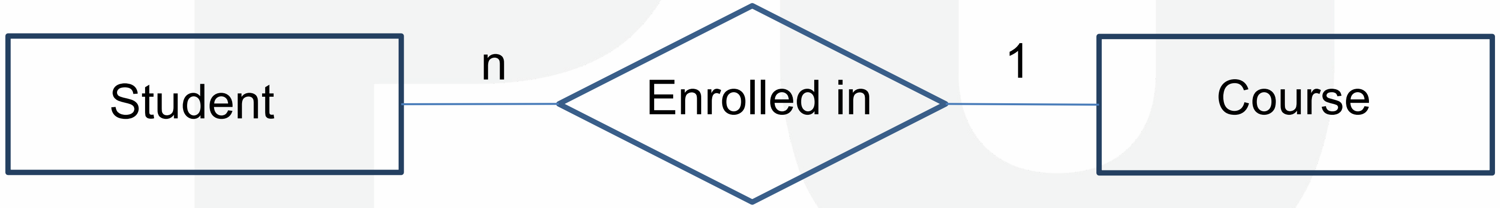


Figure: 1.44 M-1 Relationship

Cardinality Constraints (Mapping Cardinality)

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

- An entity in A is associated with more than one entities in B and an entity in B is associated with more than one entities in A.

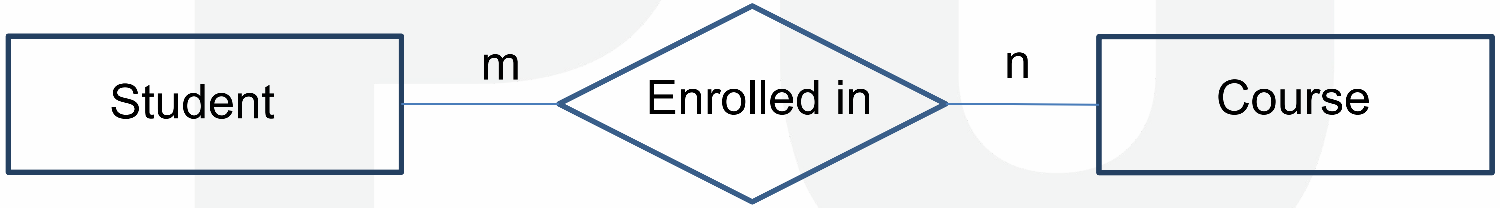


Figure: 1.45 M-M Relationship

Weak Entity Set

- Any Entity set that does not have a primary key of own is known as Weak Entity Set. This entity is known as Dependent Entity.

- Any Entity that has a key attribute is strong entity type and known as a Independent Entity.

- Existence of a weak entity set depends on the existence of a strong entity set.

- Weak Entity set is denoted by double rectangle.
- Weak Entity Relationship set is denoted by double diamond

Weak Entity Set

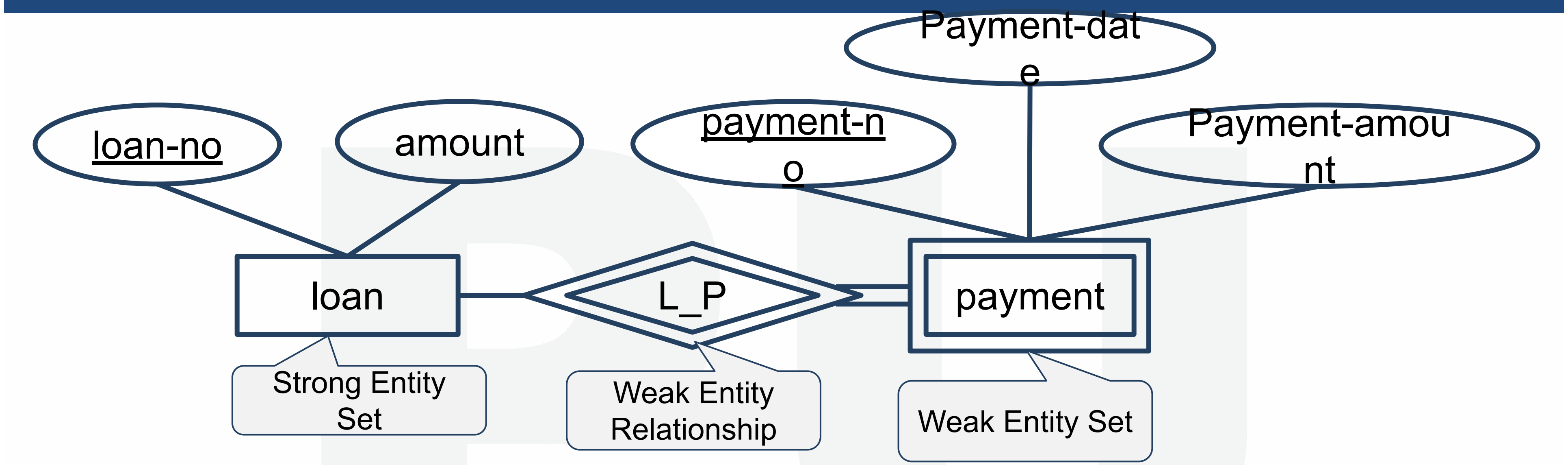


Figure: 1.46 Weak Entity Set

- Primary key of a weak entity set is known as discriminator (partial key), it’s created by combining primary key of strong entity set.

Weak Entity Set

- Here Loan-No is primary key of a Loan entity.
- Payment-no is discriminator of payment entity.
- Primary key for Payment is (loan-no,payment-no)
- Discriminator attribute of weak entity set is denoted with dashed underline.

Super Class & Sub Class

- A **superclass** is an entity from which another entities can be derived.
- Example: an entity person has two subsets employee and teacher
- Here person is superclass.

- A **subclass** is an entity that is derived from another entity.
- employee and teacher entities are derived from entity account.
- Here employee and teacher are subclass.

Super Class & Sub Class

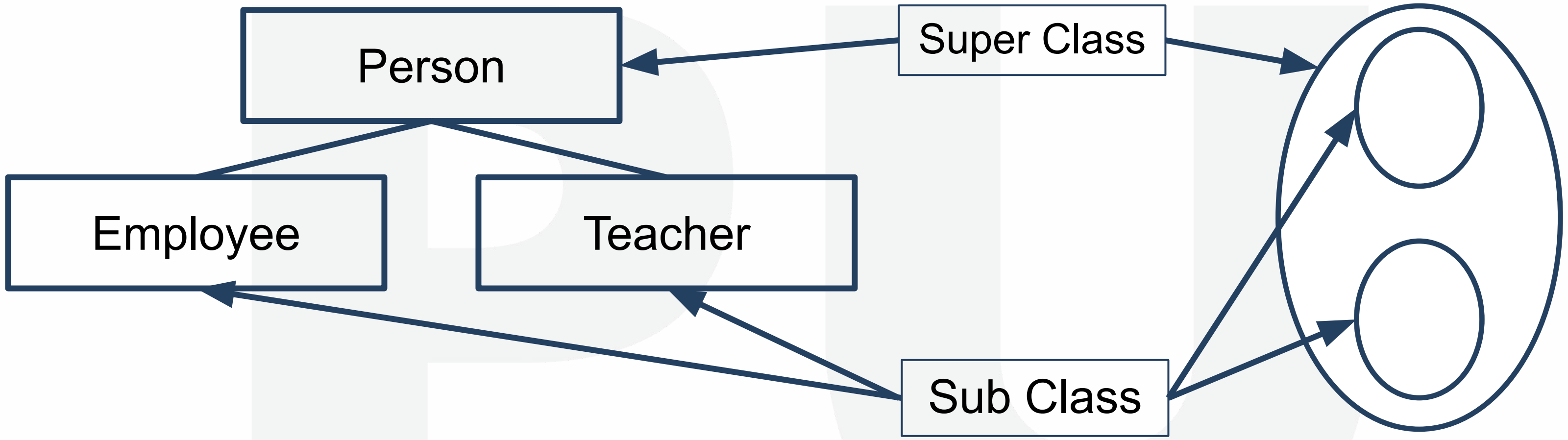


Figure: 1.47 Super & Sub class

Generalization & Specialization

□ **Generalization:**

- It determines the common features of multiple entities to create a new entity.
- Generalization is a process of creating group from several entities.
- It follows a bottom-up approach.
- It’s like union of two or more lower level entity sets to make higher level entity set.

Generalization & Specialization

Generalization:

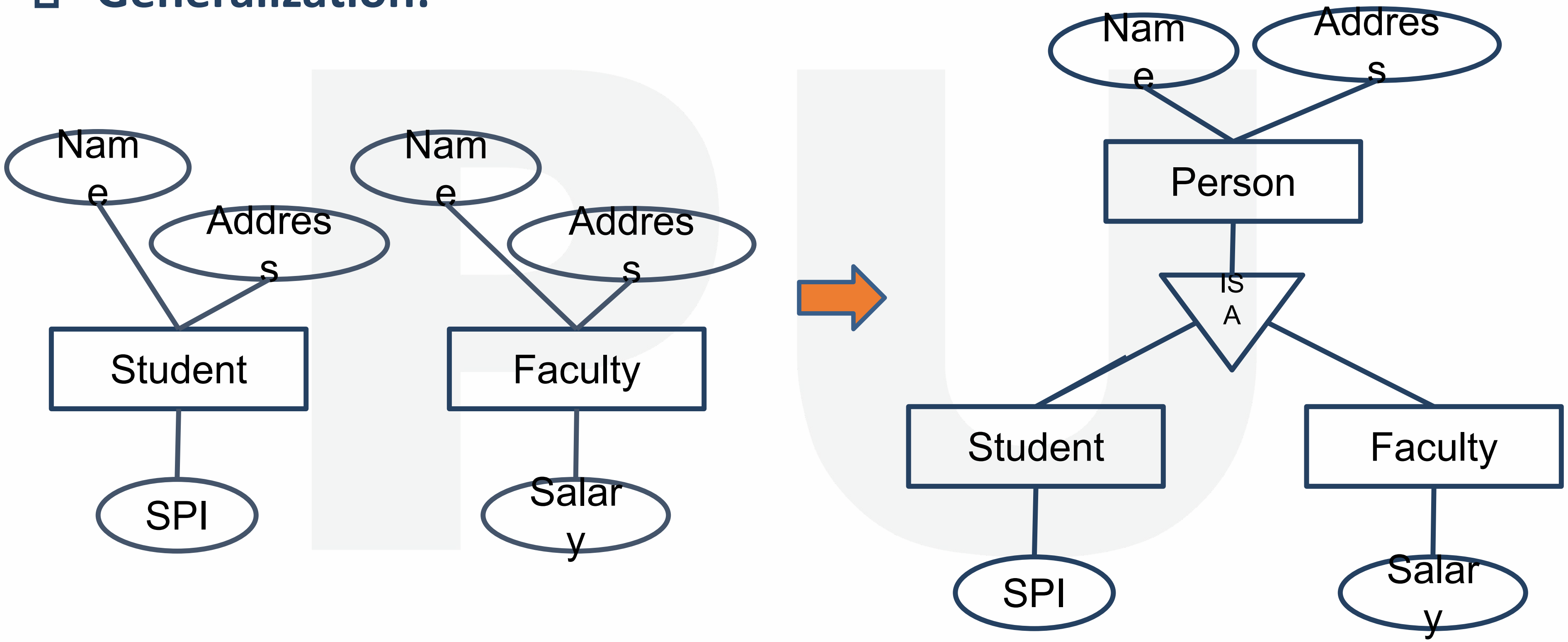


Figure: 1.48 Generalization

Generalization & Specialization

- **Specialization:**
- It divides entity to make multiple entities that inherits some features of splitting entity.
- It is a process of creating subgroups within entities.
- It follows a top-down approach.
- It’s like subset of higher level entity set to form a lower level entity set.

Generalization & Specialization

- **Specialization:**

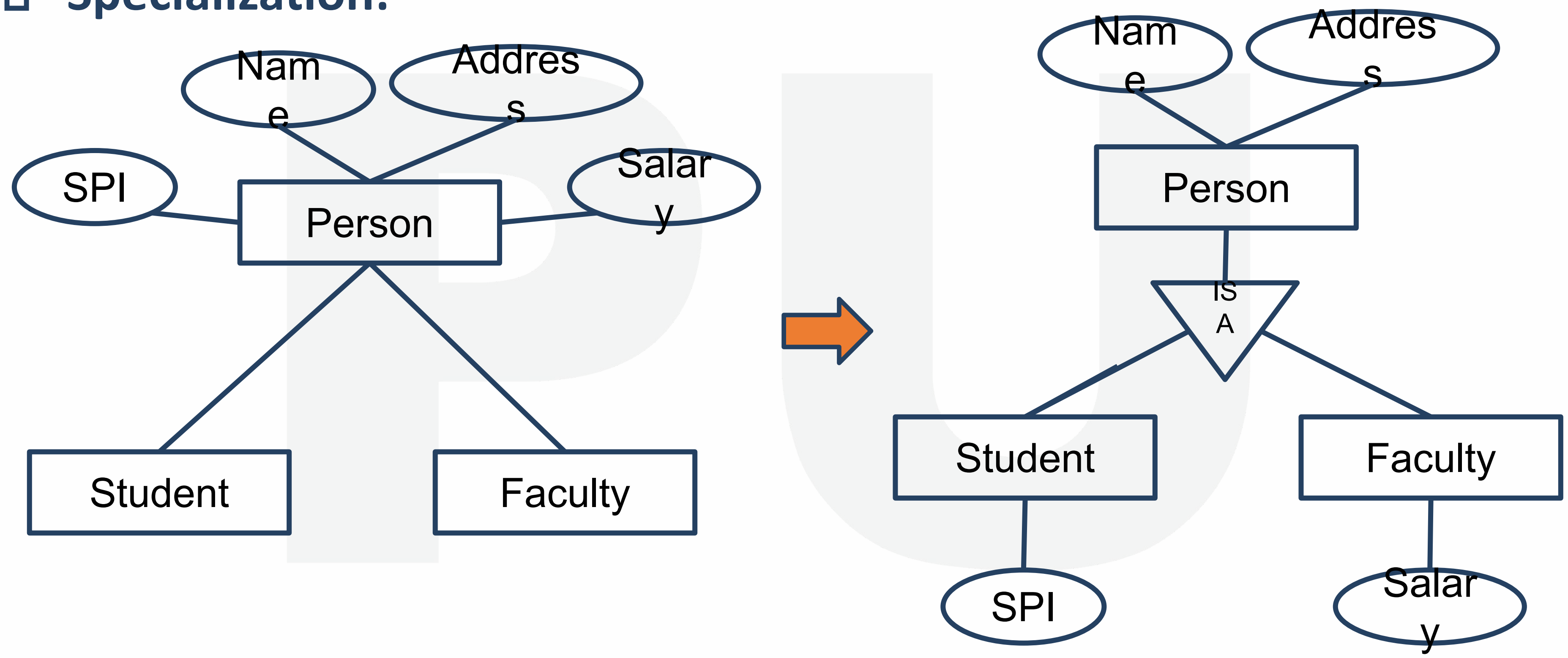


Figure: 1.49 Specialization

Example

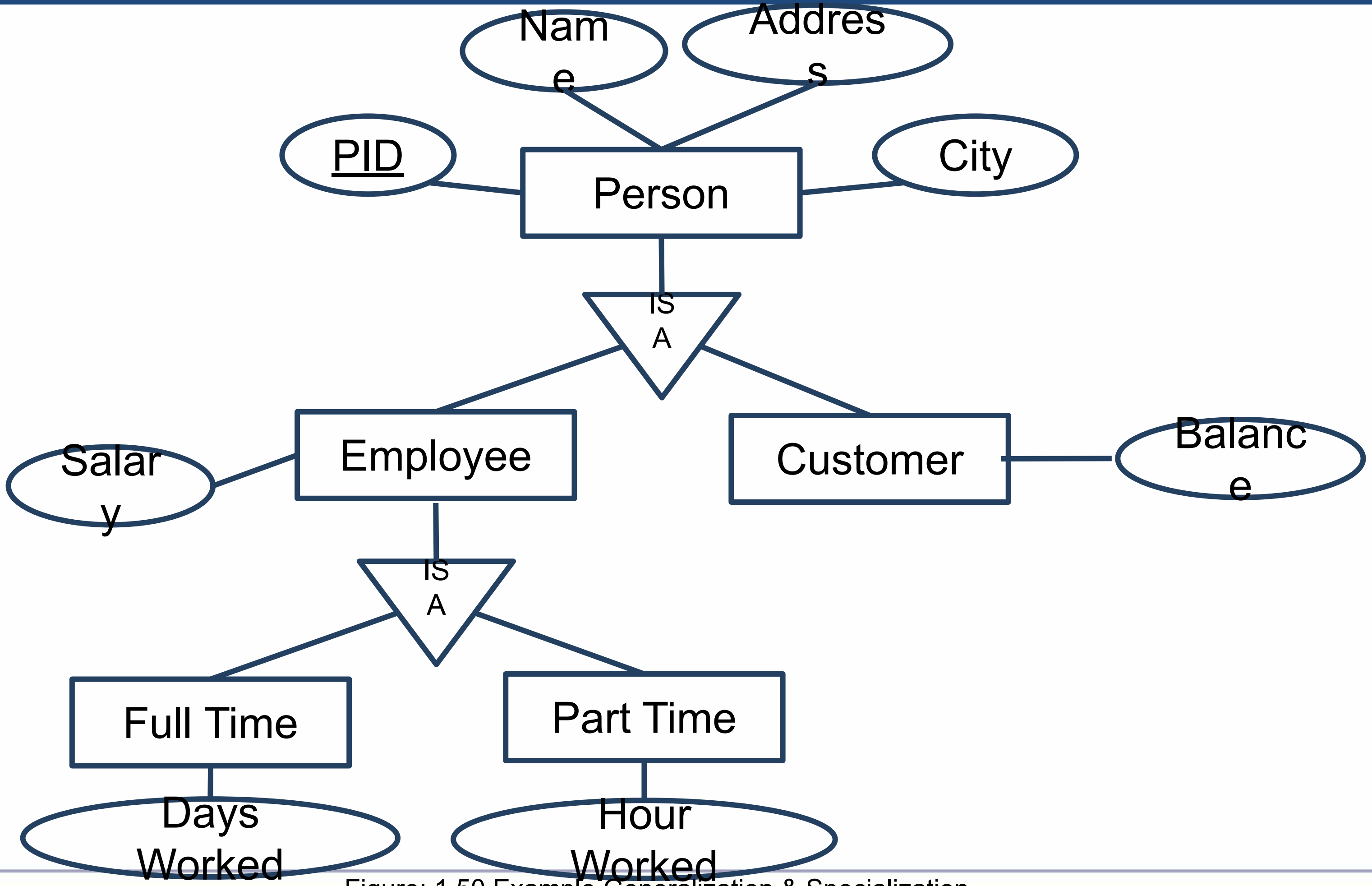


Figure: 1.50 Example Generalization & Specialization

Constraints on Specialization and Generalization

- Constraints are normally divided in two types

1. Disjoint Constraint
2. Participation Constraint

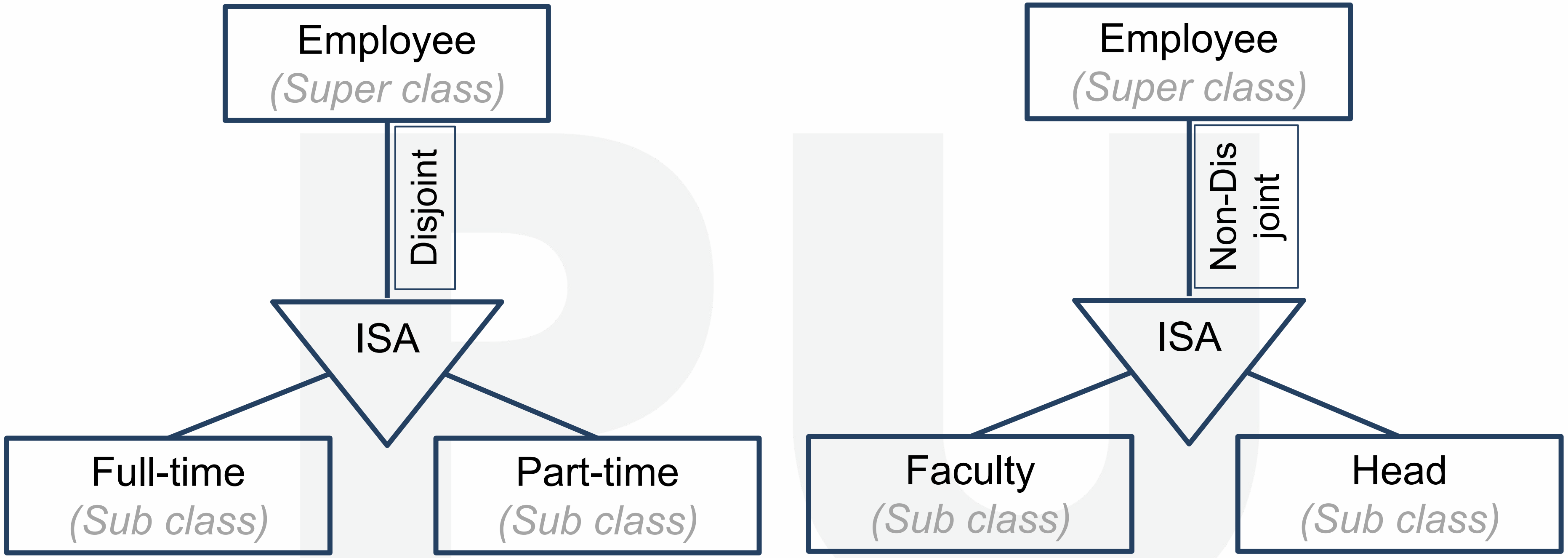
Disjoint Constraints

- It defines relationship of members of superclass and subclass and also indicates member of superclass can be a member of one or more subclass.
  1. Disjoint constraint
  2. Non-disjoint(Overlapping) constraint

Disjoint Constraint

1. **Disjoint Constraint**
   - It defines entity of a super class can belong to only one sub class entity set
   - It is denoted by **d** or **disjoint** near ISA triangle.
2. **Non-Disjoint Constraint:**
   - It defines entity of a super class can belong to more than one sub class entity set.
   - It is denoted by **o** or **non-disjoint** near ISA triangle.

Example



All employees are associated with only one sub class either Full time or Part Time

One Employee can be associated with more than one sub class, like faculty and head.

Figure: 1.51 Example of Disjoint & Non-Disjoint Constraint

Participation(Completeness) Constraints

- It defines every member of super class must participate as a member of subclass or not.
- It defines how much entity set participates in a relationship set.
    1. Total(Mandatory) Participation
    2. Partial(Optional) Participation

Participation Constraints

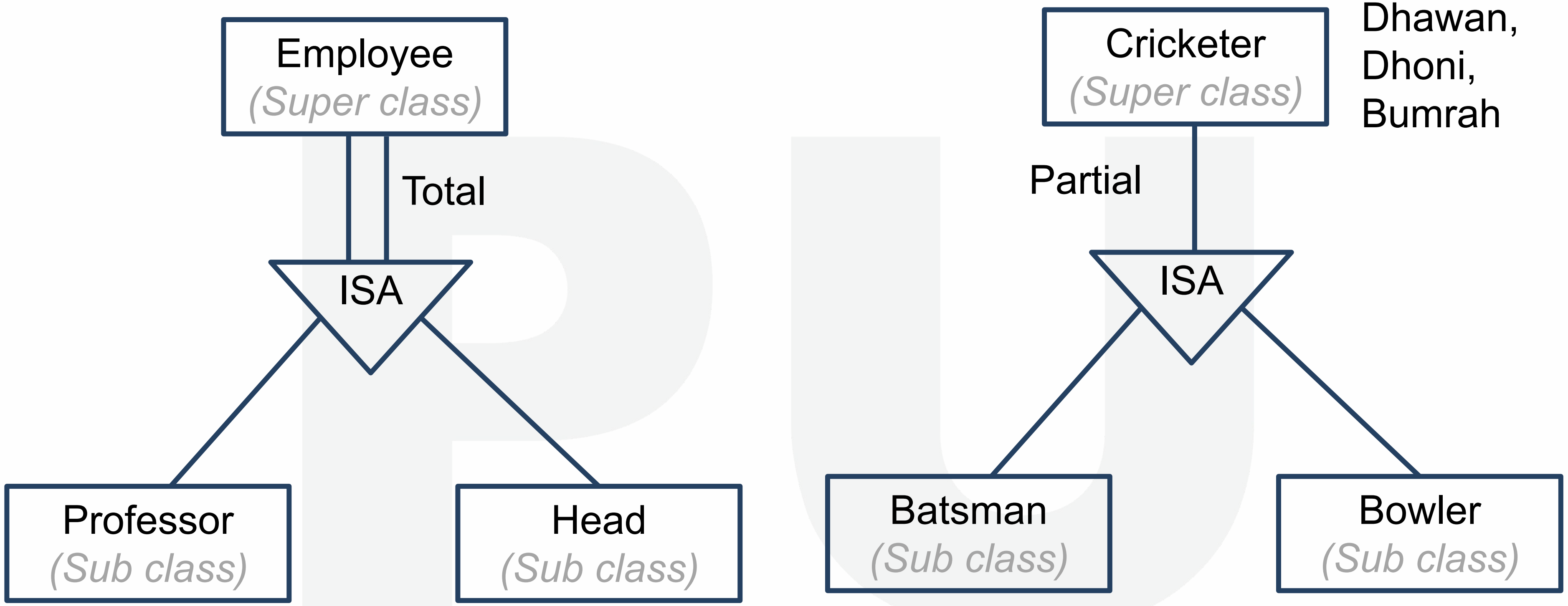
1. **Total Participation:**

- Every entity in the entity set participates in at least one relationship in the relationship set such participation is total.
- Every entity of superclass must be a member of subclass.
- It is denoted by double line connected with relationship

2. **Partial Participation:**

- Some entities in the entity set may not participate in any relationship in the relationship set such participation is partial.
- Every entity in super class does not belong to any of the subclass.
- It is denoted by single line connected with relationship.

Participation Constraints



Dhawan

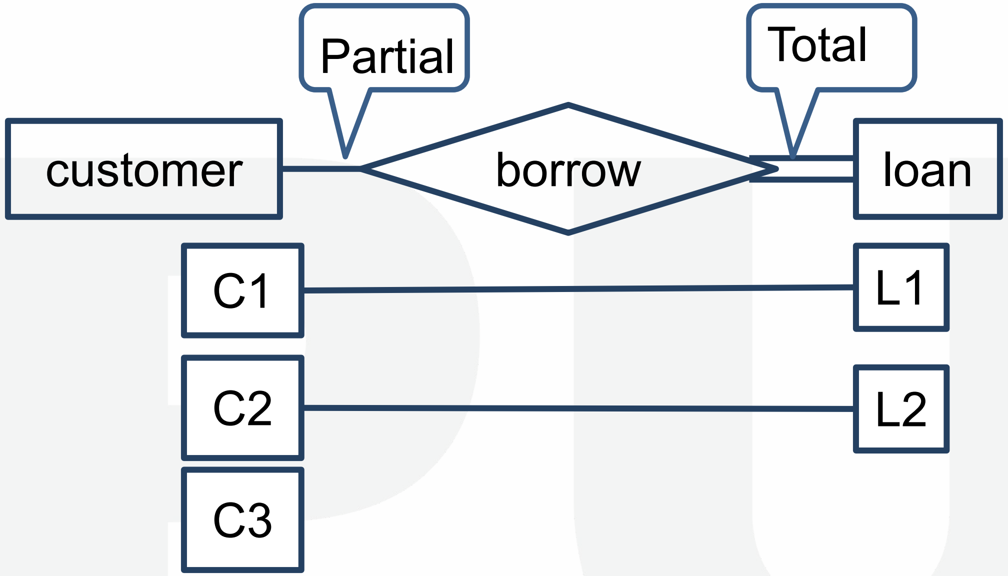
Bumrah

Employee is either Professor or Head

Dhoni is not associated with any subclass

Figure: 1.52 Example of Participation Constraint

Participation Constraints



Each customer has maximum one loan

Figure: 1.53 Example of participation Constraint

Aggregation

- Normally in E-R model relationship between entities are possible to define, but relationships between two relationships defining is not possible, that’s limitation here.

- Aggregation is kind of abstraction which treats relationships as entities.

- Aggregation is process of creating single entity by combining components & relationship between two entity of ER model.

Aggregation

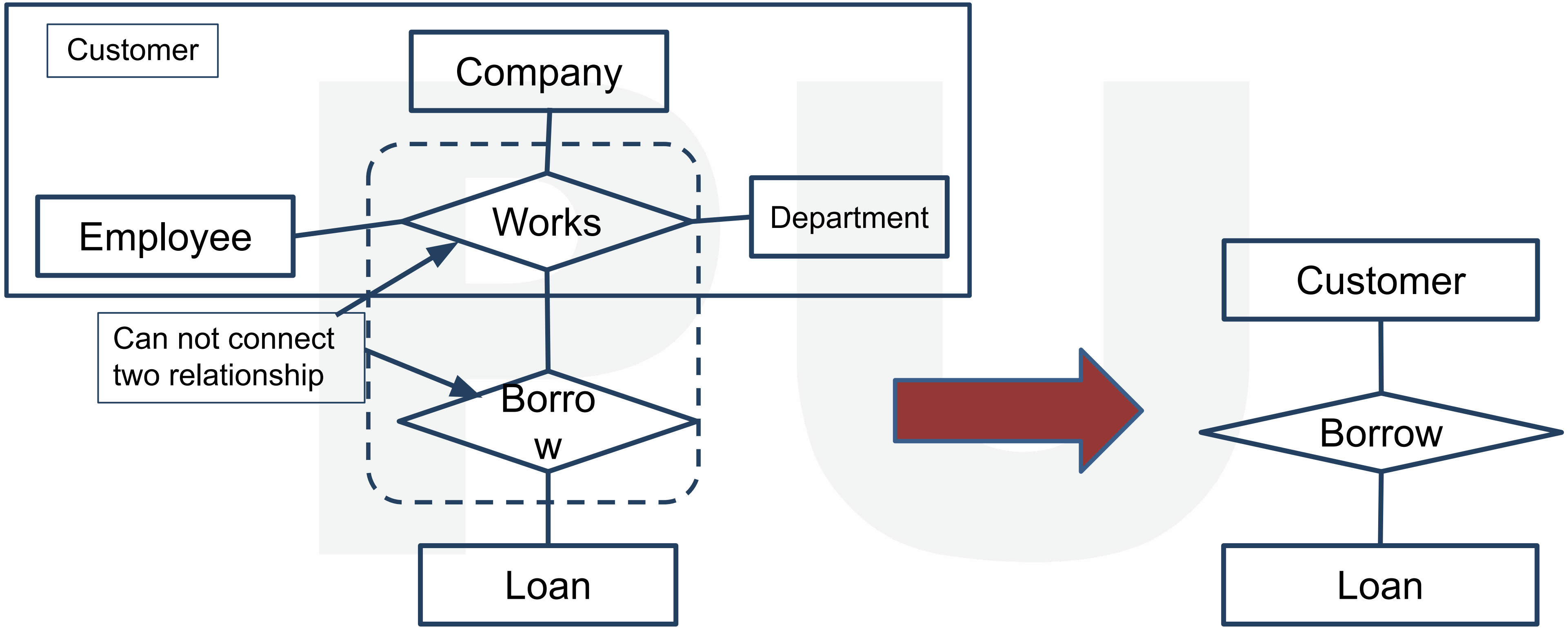
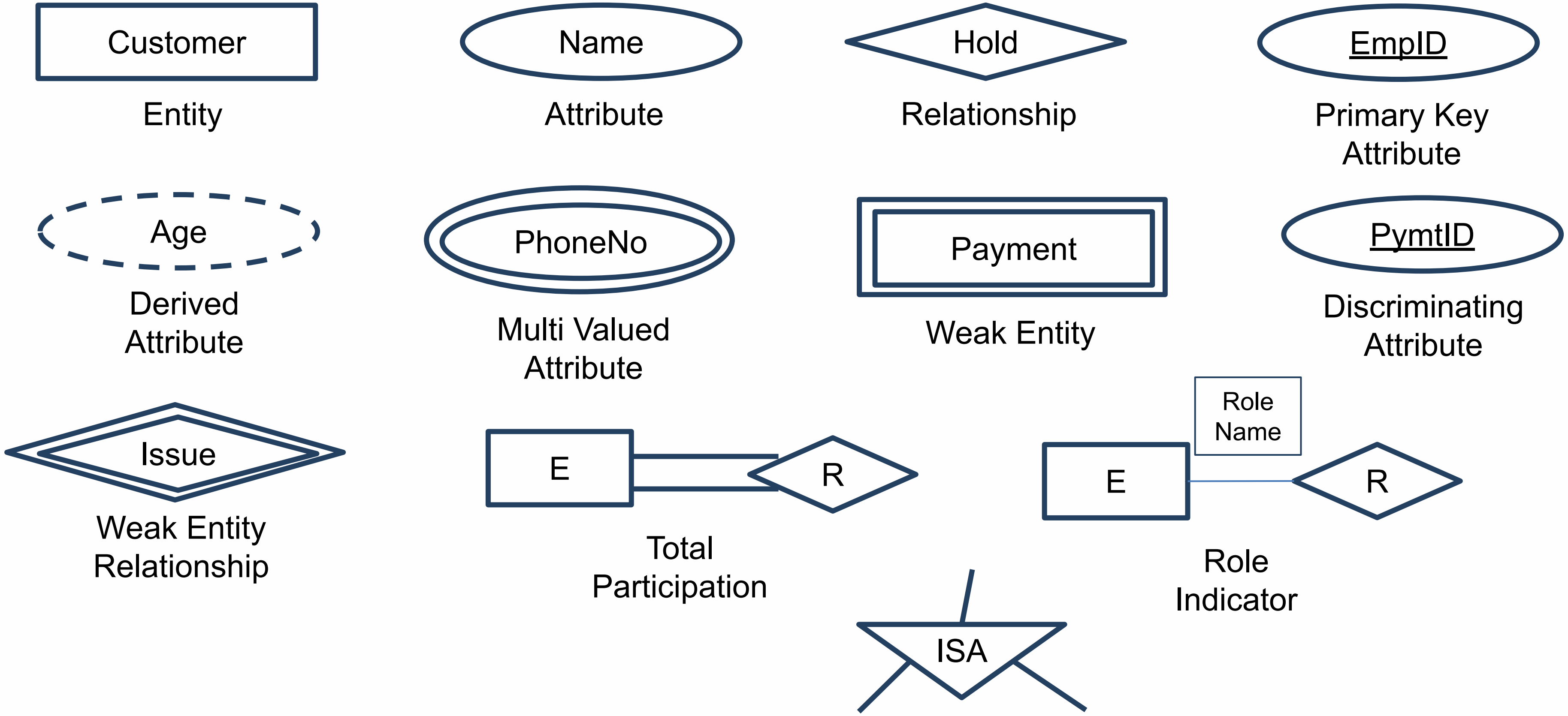


Figure: 1.54 Example of Aggregation

E-R Model Symbols



Specialization/ Generalization

Figure: 1.55 E-R Model Symbols

Hierarchical Model

- It organize data into a tree like structure having one root or parent.
- Here data starts from room with one to many kind of relationship

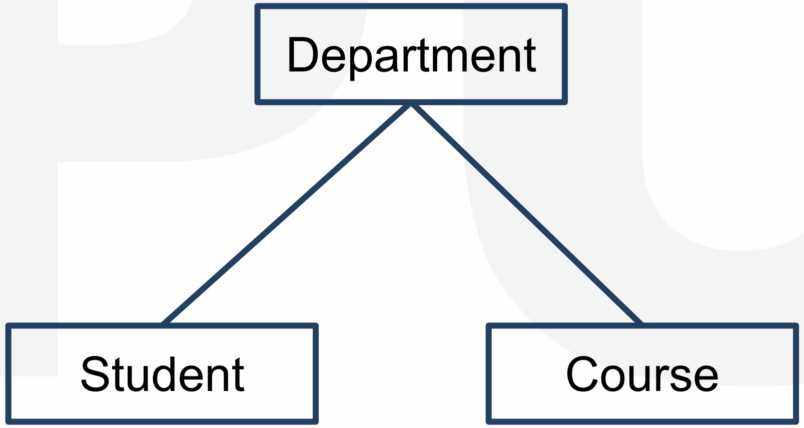


Figure: 1.56 Hierarchical Model

Network Model

- It is an extension of hierarchical model, with many to many kind of relationship in tree structure with multiple parents.

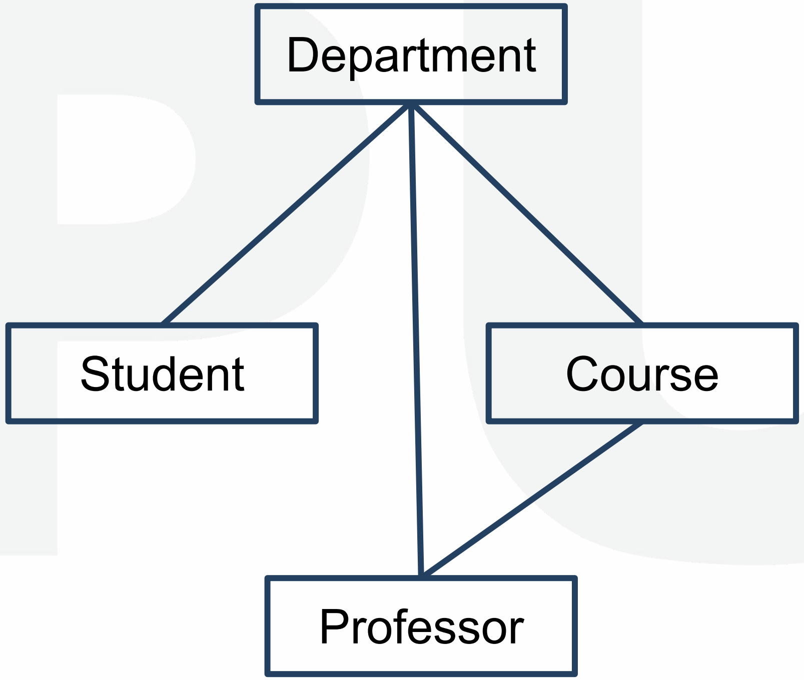


Figure: 1.57 Network Model

Relational Model

- In this model data is organized in two-dimensional tables and relationship is retained by storing a common attribute.
- **Tables:** Relations are saved in the format of tables. Table has rows and columns. Here rows denotes records and columns denotes attributes.
- **Tuple:** A single row of a table which has a single record value is known as tuple .

Relational Model

- **Relation Instance:** It is a finite set of tuples in a relation.
- **Relation schema:** It describes relation name (table name), attributes, and their names.
- **Relation Key:** Each tuple has one more attributes that identifies relation uniquely is known as relation key.
- **Attribute Domain:** It is a predefined value scope of a every attribute.

Relational Model

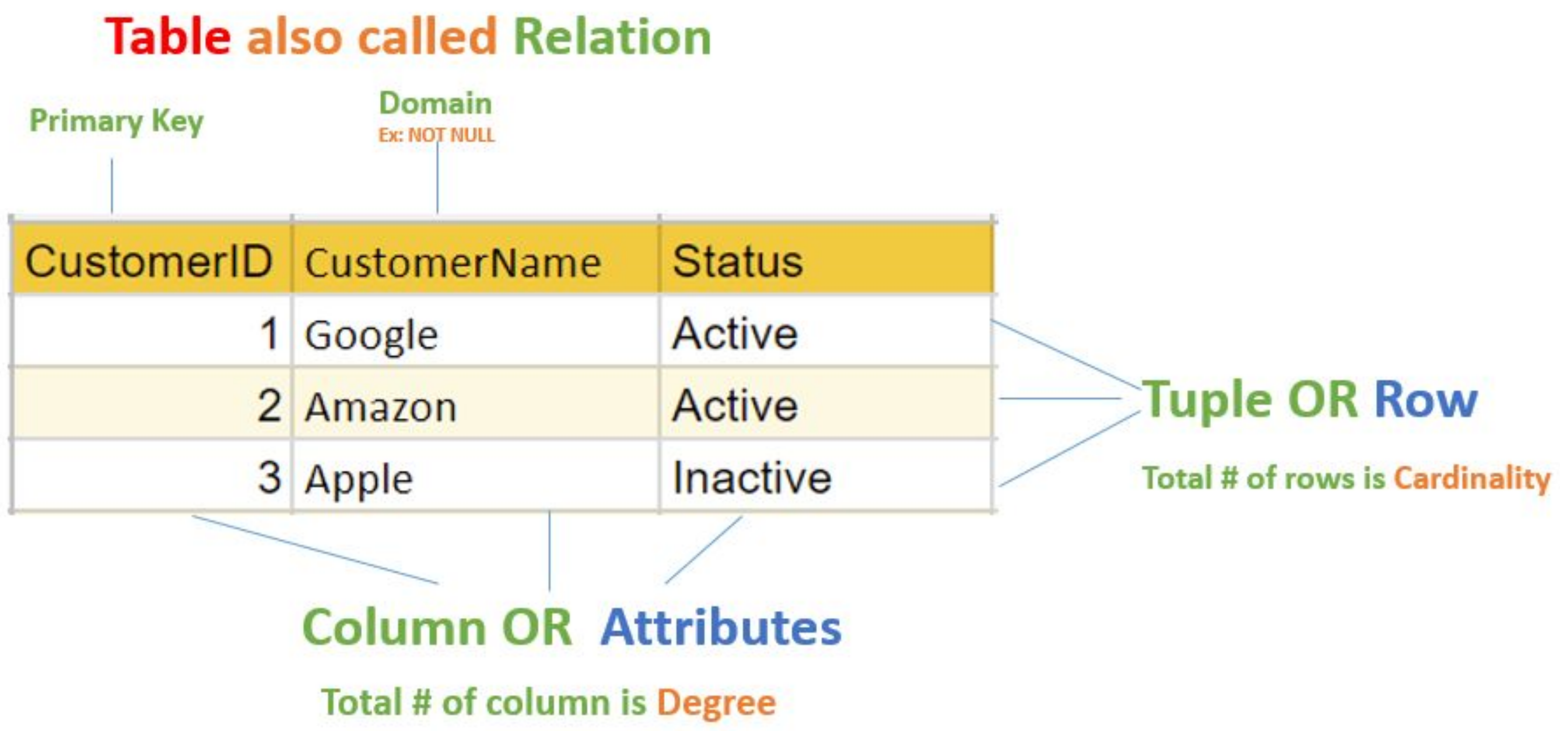


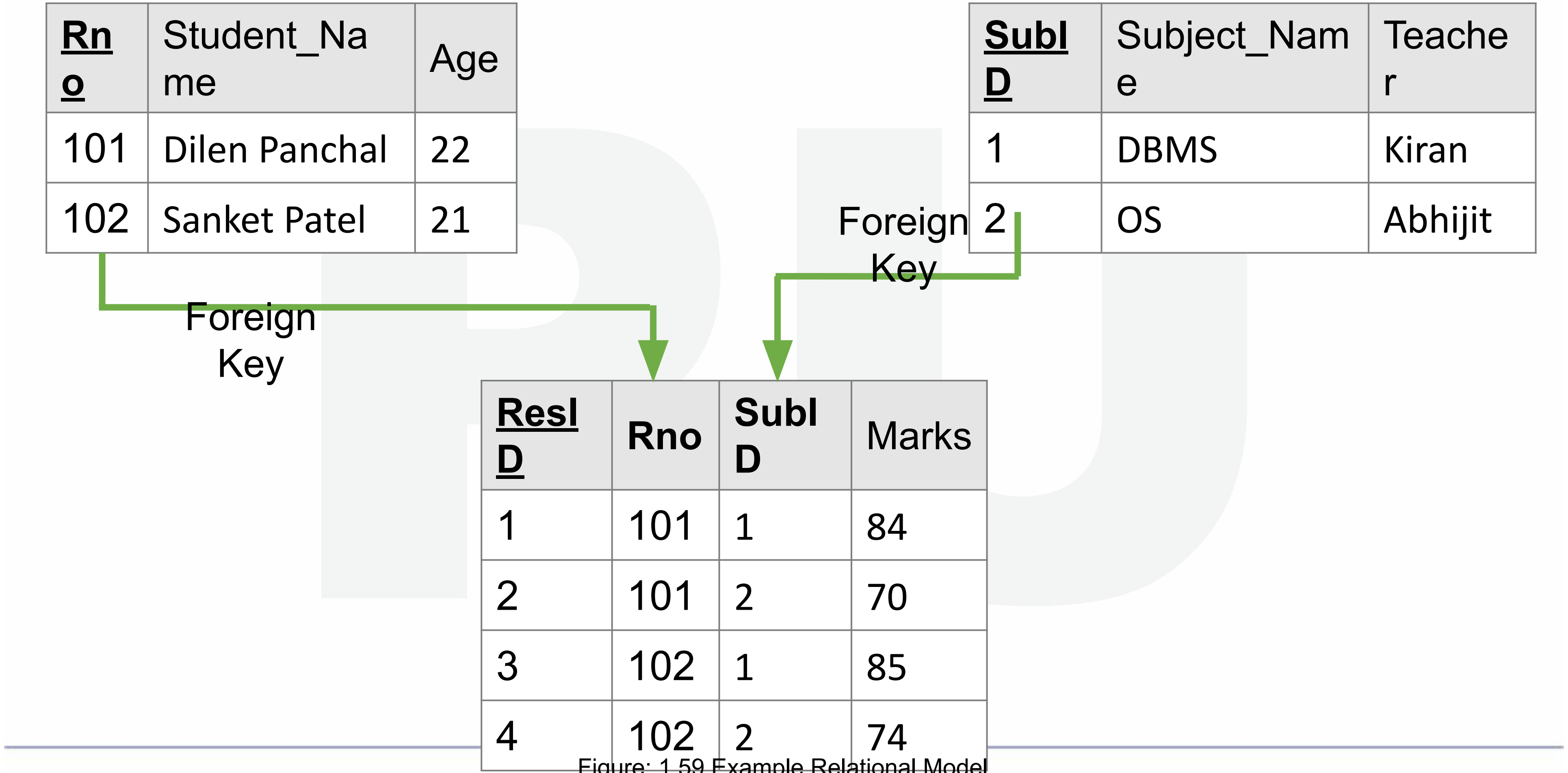
Table also called Relation
Primary Key
Domain
Ex: NOT NULL
Tuple OR Row
Total # of rows is Cardinality
Column OR Attributes
Total # of column is Degree

CustomerID	CustomerName	Status
1	Google	Active
2	Amazon	Active
3	Apple	Inactive

Figure: 1.58 Example Relational Model

(**Image Source:** https://www.guru99.com/relational-data-model-dbms.html**)**

Relational Model



Rno	Student_Name	Age
101	Dilen Panchal	22
102	Sanket Patel	21

SubID	Subject_Name	Teacher
1	DBMS	Kiran
2	OS	Abhijit

Foreign Key

Foreign Key

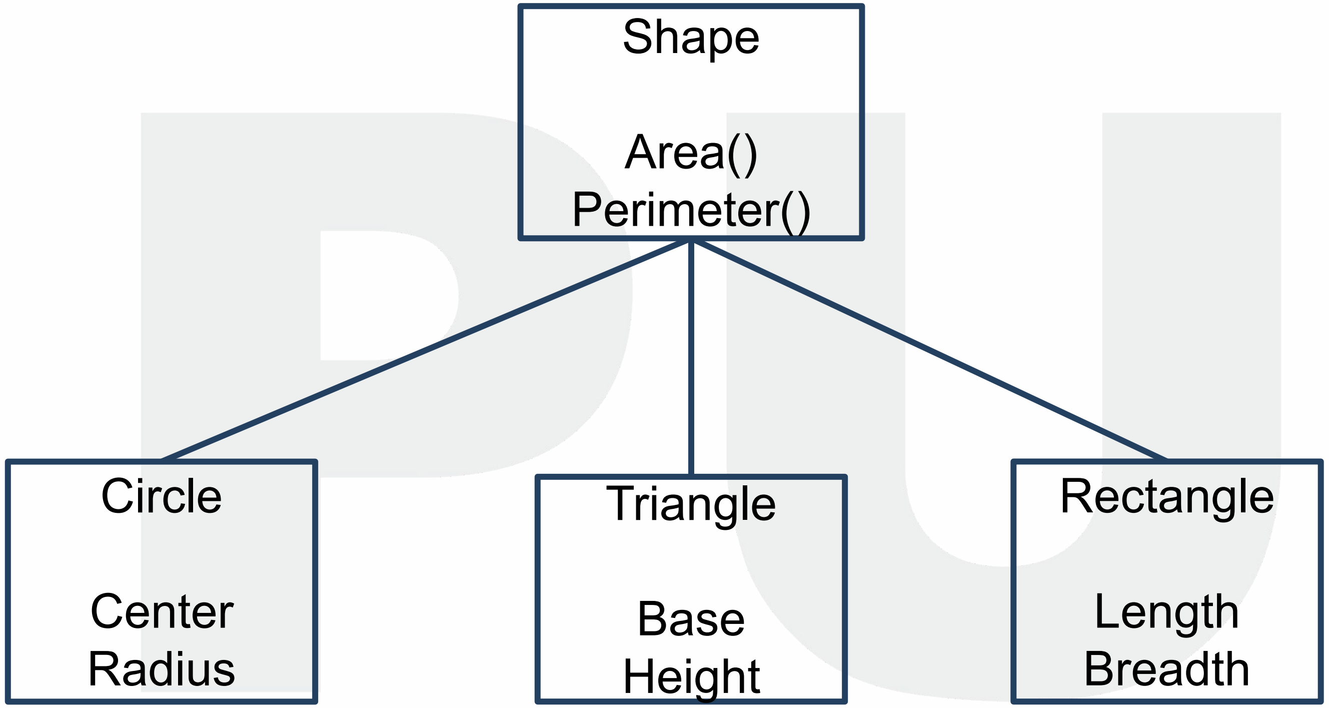
ResID	**Rno**	**SubID**	Marks
1	101	1	84
2	101	2	70
3	102	1	85
4	102	2	74

Figure: 1.59 Example Relational Model

Object-Oriented Model

- This model follows the method of representing real world objects.
- Objects are derived from real world entities and situations.
- Each object has their own properties that are defined as attribute and their behavior is defined as methods.
- Object is like an instance of class. So similar attributes and methods are grouped together as a class.

Object-Oriented Model



Shape

Area()
Perimeter()

Circle

Center
Radius

Triangle

Base
Height

Rectangle

Length
Breadth

Figure: 1.60 Example Object-Oriented Model

Integrity Constraints

- Integrity constraints means set of rules defined in database system. It is used to maintain the quality of information.
- It ensures that any data related operation performed on database like, data insertion, updating does not affect integrity of data.
- It provide protection against any damage to database.
- Following are different types of Integrity Constraints:
    1. Check
    2. Not null
    3. Unique
    4. Primary key
    5. Foreign key

Integrity Constraints

1. **Check:**

- Check integrity constraint defines a specific rule for a column, all the rows of that column must have to satisfy it.
- Check controls the tuple values to some set, range or specific value.
- It can be applied on more than one column of a relation(table).
- Example: Tuple value of CGPA should be between 0 to 10

Integrity Constraints

2. Not Null

- As name suggests all the rows of relation(table) should be some definite value for the column on which Not null is applied.
- Simply when we apply this constraint on any column, it should have some value.
- Example: For relation *Student,* Name column should have some value.

Integrity Constraints

3. Unique

- As name defines it make sure that columns or group of columns in each row of table has unique (distinct) value.
- Columns can have null values, but they can’t be duplicated.
- This constraint sometimes also referred as Unique Key.
- Example: For relation *Student,* Enrollmentno column should have unique value.

Integrity Constraints

4. Primary Key

- Primary key applies to column or combination of columns to uniquely identifies each row in the table.
- Primary Key = Unique key + Not null
- There can be only one primary key per table
- Example: For student relation table, **EnrollmentNo** column should have unique value and can’t be null.

Primary Key

EnrollNo	Student_Name	DeptID
001	Ramesh	1
002	Suresh	2
003	Mahesh	1

Figure: 1.61 Primary Key

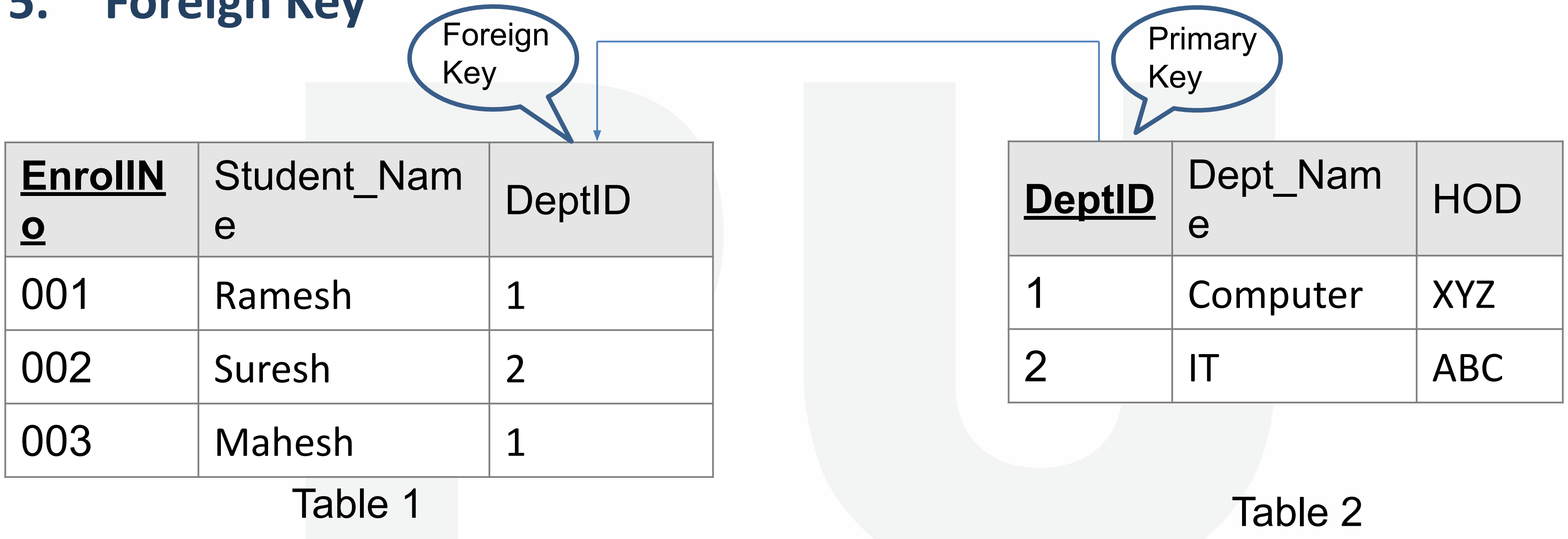
Integrity Constraints

5. Foreign Key

- Foreign key is defined to link two tables(relation).
- Foreign key is set of one or more attributes whose value is derived from the primary key of another relation.
- Foreign key is also known as referential integrity.
- Attribute or column which is declared as foreign key in Table 1 is derived from primary key of Table 2 and every value of foreign key column in table 1 must be null or available in primary key of table 2.

Integrity Constraints

5. Foreign Key



EnrollNo	Student_Name	DeptID
001	Ramesh	1
002	Suresh	2
003	Mahesh	1

Table 1

DeptID	Dept_Name	HOD
1	Computer	XYZ
2	IT	ABC

Table 2

Figure: 1.62 Example Foreign Key

Some other keys

- **Super Key:** It is a set of one or more columns that identifies each tuple record uniquely in a relation.

Employee

Emp_SSN	Emp_Number	Emp_Name
123	101	Ramesh
456	102	Suresh
789	103	Dinesh
791	104	Mahesh

Figure: 1.63 Super Key

- Here entity sets {Emp_SSN}, {Emp_Number}, {Emp_SSN, Emp_Number}, {Emp_SSN, Emp_Name}, {Emp_SSN, Emp_Number, Emp_Name}, {Emp_Number, Emp_Name} are uniquely identifies rows so they all are super keys.

Some other keys

- **Candidate Key:** It is subset or part of the super key.
  - Sometimes they’re also known as minimal super key with no repeated attributes.
  - Each table has minimum one candidate key, but there can be multiple candidate keys also.
  - One Primary key is selected from candidate keys.
  - Example: {Emp_SSN} , {Emp_Number}
- **Alternate Key:** Any candidate key that’s not chosen as a primary key is alternate key.

Data Manipulation Operations

- Data Manipulation Operations are performed by DML commands
- SELECT – retrieve data from a table
- INSERT – insert new records
- UPDATE – update/Modify existing records
- DELETE – delete existing records

Data Manipulation Operations

- SELECT

- **Syntax:**

```
SELECT column_name(s) FROM table_name;
```

Example:

```
Select * from Students;
Select Enroll_no, Student_name from Students;
```

Data Manipulation Operations

- INSERT

- **Syntax:**

INSERT INTO table_name (column, column1, column2..) **VALUES** (value, value1, value2 ...);

Example:

INSERT INTO Students (Enroll_no, Student_name, Phone)

VALUES (1234567890, ’xyz’, 9876543210);

Data Manipulation Operations

❑ UPDATE

- **Syntax:**

```
        UPDATE table_name SET column=value, column1=value1,...
                    WHERE someColumn=someValue;
```

Example:

```
    UPDATE Student SET Phone = 987654321
    WHERE Enroll_No = 123456789;
```

Data Manipulation Operations

- DELETE
- **Syntax:**

  DELETE FROM tableName WHERE someColumn = someValue;

Example:

DELETE FROM Students WHERE Enroll_no=123456789;

References

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