DATABASE DESIGN AND DEVELOPMENT (IT 2140)

LECTURE 04- CONCEPTUAL DATABASE MODELING - ER MODEL

LECTURE CONTENT

- Conceptual modelling using ER diagrams

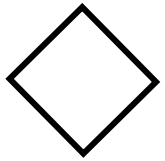
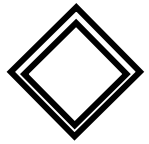
LEARNING OUTCOMES

- Draw an ER diagram for a given scenario

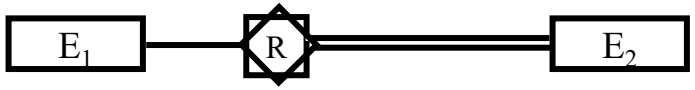
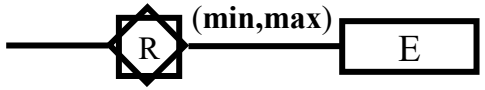
CONCEPTUAL DATABASE DESIGN

- The result of the requirement analysis step is a concisely written set of users' requirements.
- Once, this step is completed, the next step is to create a **conceptual database schema** for the database, using a high-level conceptual data model.
- This step is called **conceptual database design**.
- **Entity-Relationship (ER) model** is a high-level conceptual data model.

E-R NOTATION

SYMBOL	MEANING
	ENTITY
	WEAK ENTITY
	RELATIONSHIP
	IDENTIFYING RELATIONSHIP
	ATTRIBUTE
	KEY ATTRIBUTE

E-R NOTATION

SYMBOL	MEANING
	MULTIVALUED ATTRIBUTE
	COMPOSITE ATTRIBUTE
	DERIVED ATTRIBUTE
	TOTAL PARTICIPATION OF E_2 IN R
	CARDINALITY RATIO 1:N FOR E_1:E_2 IN R
	STRUCTURAL CONSTRAINT (min, max) ON PARTICIPATION OF E IN R

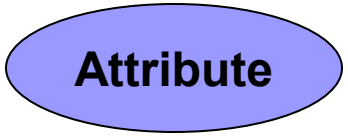
ENTITY

- An **entity** is an object in the real world with an independent existence (place, person, car, house, company, job, university, etc).
- A collection of similar entities is called an **entity set**.
- Graphically,

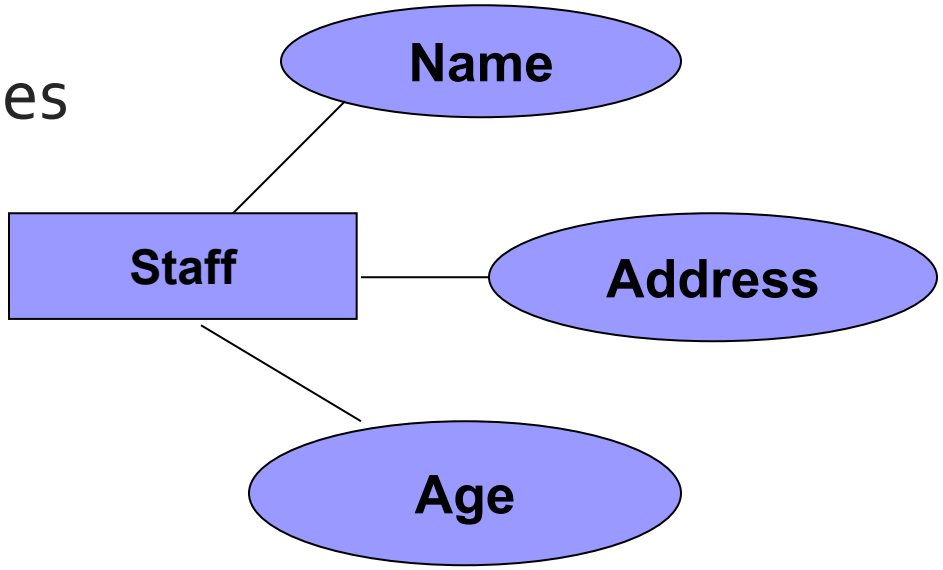
  - First letter of each word in the entity name is uppercase
    - E.g., Student
  - Normally an entity is named using a '**noun**' or 'noun phrase'

ATTRIBUTES

- An entity is described using a set of **attributes**
- Graphically, **Oval**.



- For example staff has 3 attributes
  - Name
  - Position
  - Salary



BOC NETWORK

- BOC is the largest bank network having over 5,000 branches and over 500,000 customers. Customers can open accounts in any bank branch.
- Identify
  - Entities
  - At least 3 attributes /entity

SLIIT STUDENT REGISTRATION

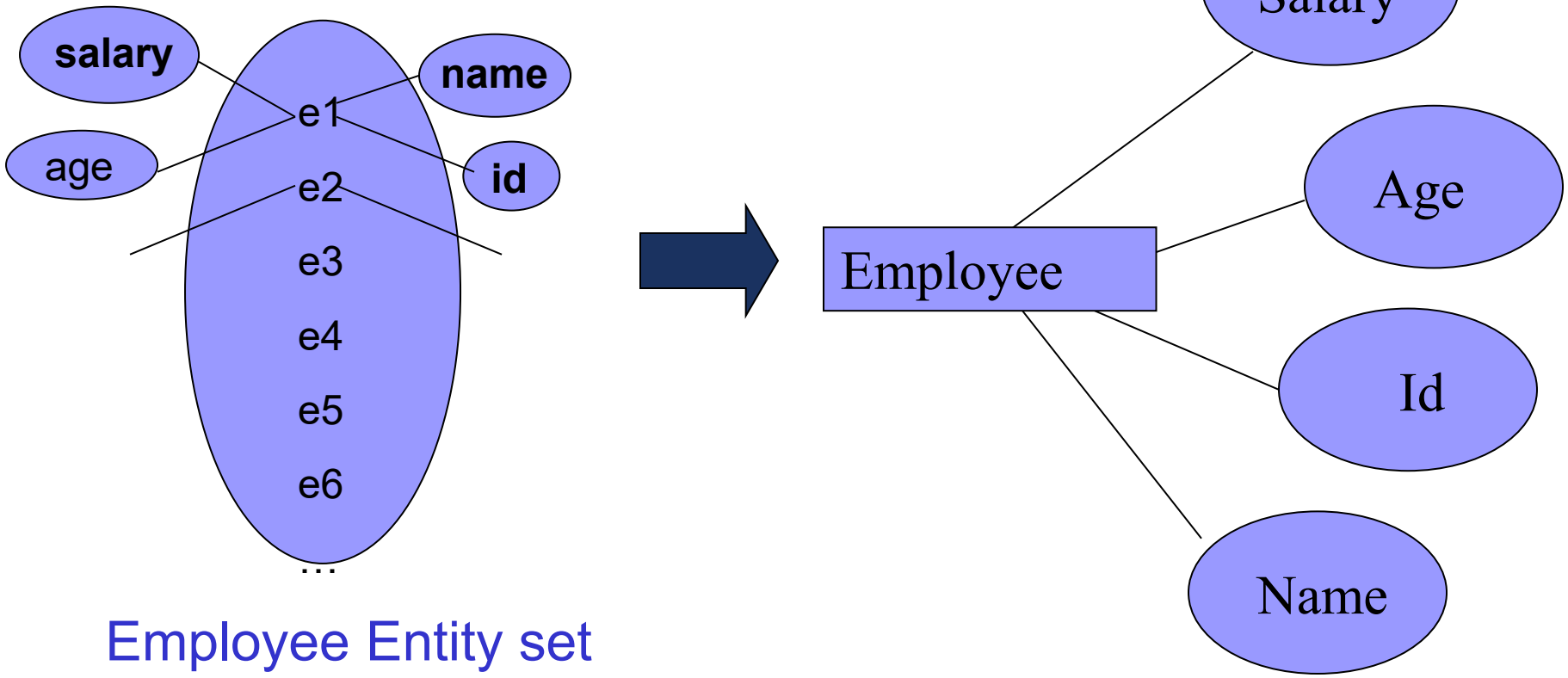
New students are required to produce their national ID card number, name, address, age, date of birth and gender during the registration process. they are also required to select the degree program of their choice.

The programs are selected based on the entry criteria, specialty, duration, fees etc.

- Entity ?
- Attributes ?

ENTITY SET

Example: *name*, *id*, *age* & *salary* are attributes in Employee entity



Employee Entity set

DOMAIN OF AN ATTRIBUTE

The **domain** of an attribute specifies the set of possible values that the attribute can have.

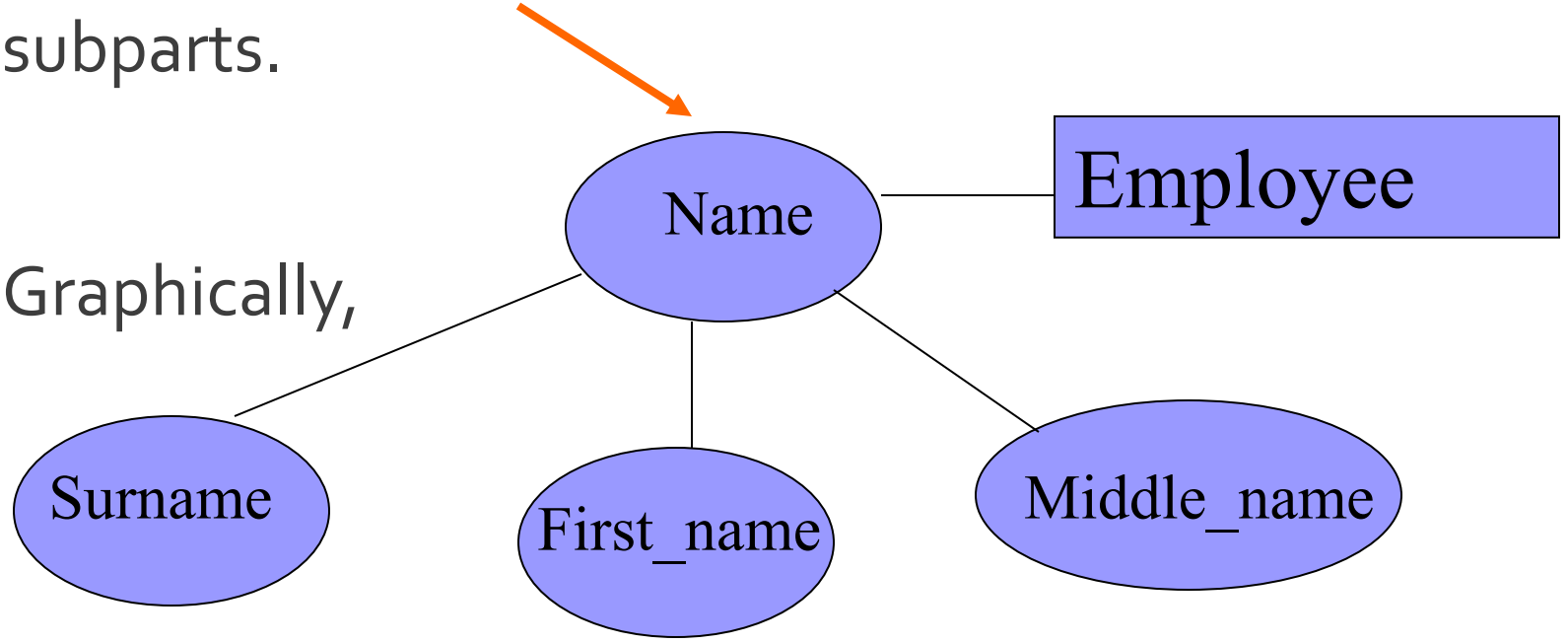
age : integer values from 0 - 120

name: 20 character string

COMPOSITE ATTRIBUTES

- **Composite attributes** can be divided into smaller subparts.

Graphically,



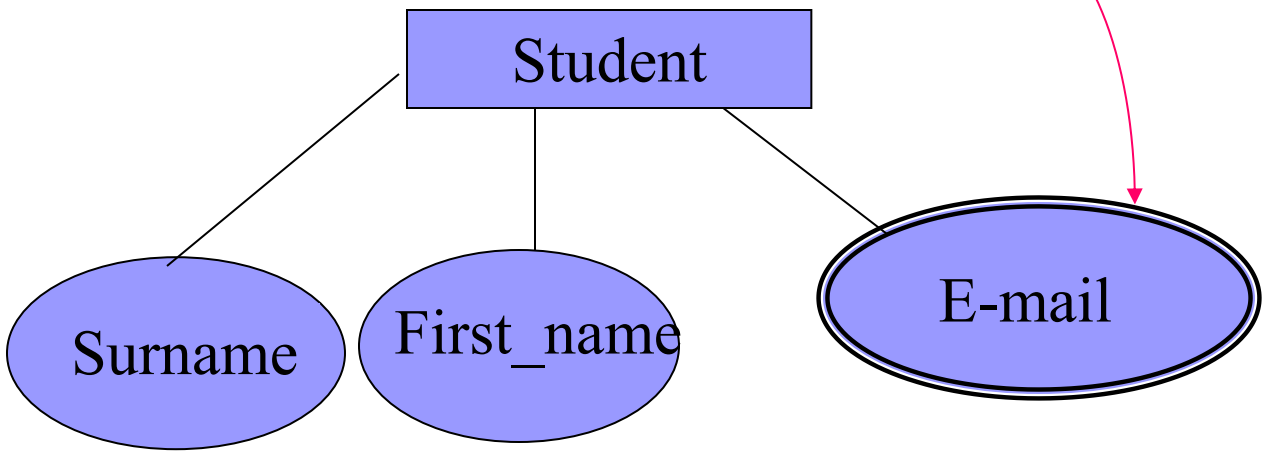
YOUR TURN!!

Think about the library database.

- Identify entities , attributes and domain of attributes

MULTI VALUED ATTRIBUTES

- Attributes containing multiple values are called **multivalued attributes**. Double lines



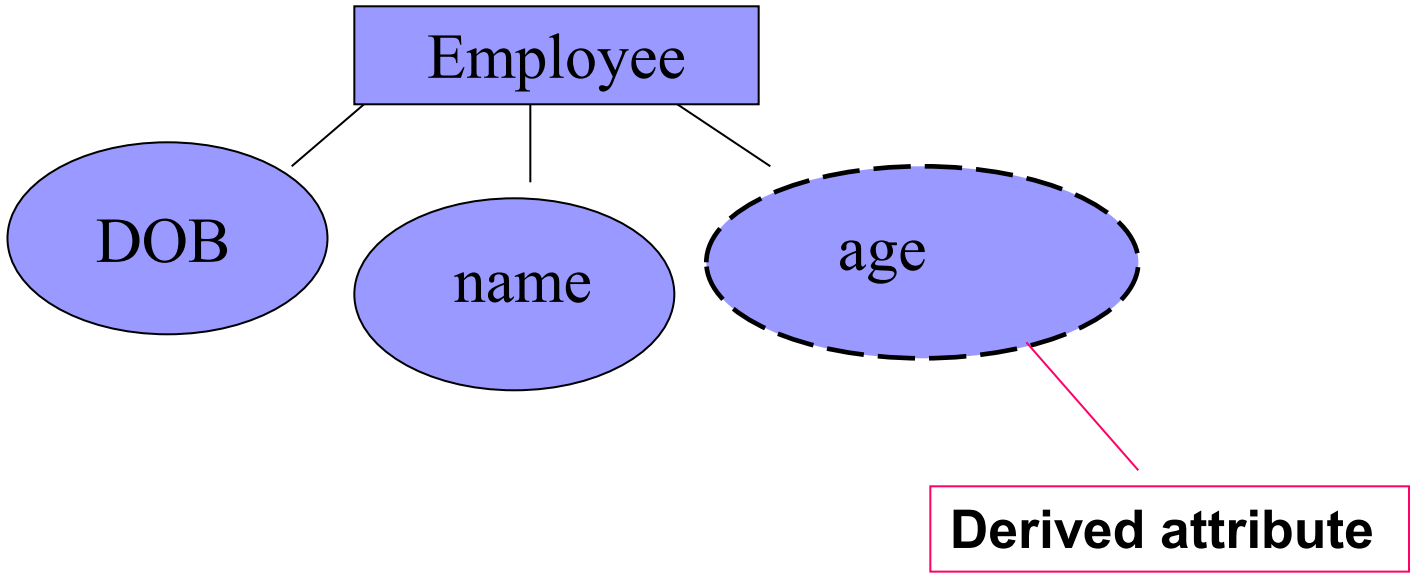
gmail , yahoo, SLIIT e-mail address

YOUR TURN!!

- Give an example for a multi valued attribute in library database

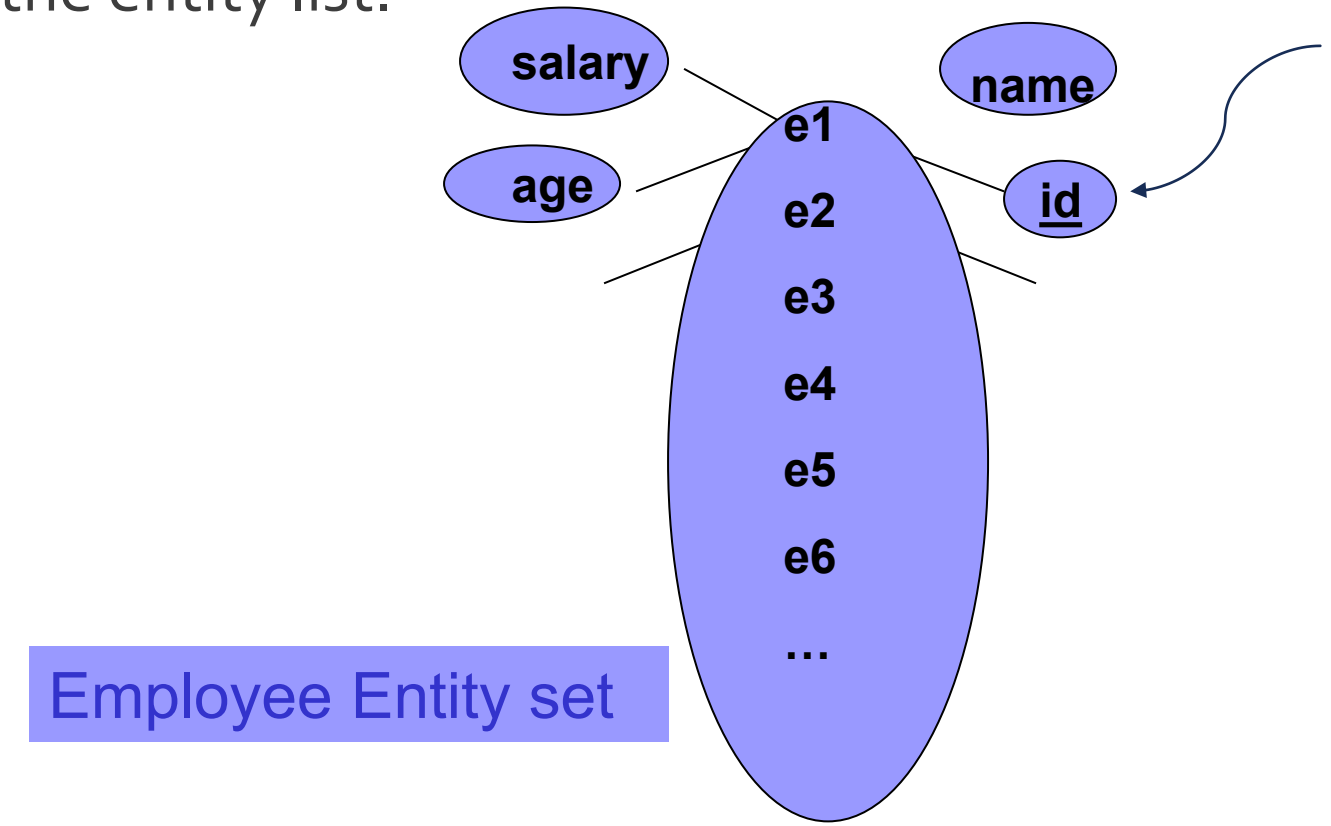
DERIVED ATTRIBUTES

- Some attributes can be derived - called **derived attributes**. Dotted line
- For example, *age* is derived from date of birth & current date.



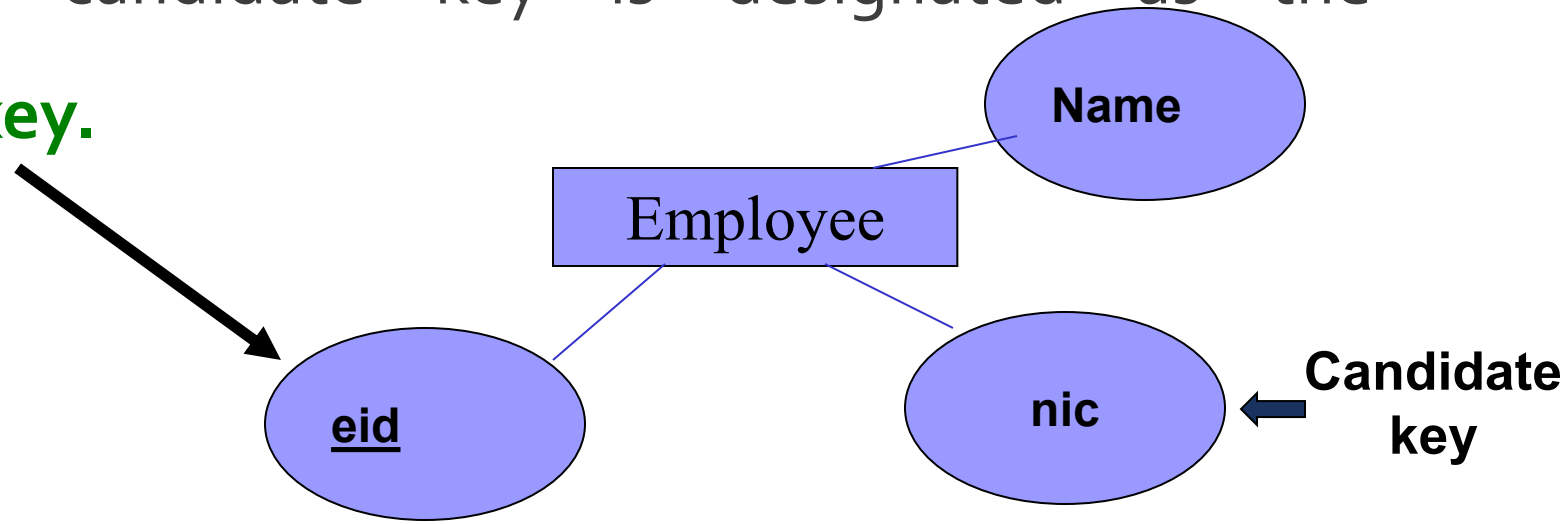
KEY ATTRIBUTES

- **Key attribute** - Minimal set of attributes which uniquely identify an entity in the entity list.



PRIMARY KEY

- There can be multiple key attributes called **candidate keys** in a single entity.
- A single candidate key is designated as the **primary key.**



COMPOSITE KEY

- Sometimes, a group of attributes make up the key. This is called a **composite key**.

- Example :

Composite key = (ST_ID+ Unit_ID)

ST ID	Unit ID	Marks
IT1601	IT103	85
IT1601	IT104	78
IT1602	IT103	72
IT1603	IT104	82

ST_ID	Unit_ID	Marks
IT1601	IT103	85
IT1601	IT104	78
IT1602	IT103	72
IT1603	IT104	82

SUPER KEY

- Any other set of attributes that uniquely identify a tuple is called the **superkey** of a relation

  Student (SID, Name, Address, Contact, GPA)

- What is the minimal set of attributes that uniquely identify the relation ?
  - SID =Referred to as Primary Key

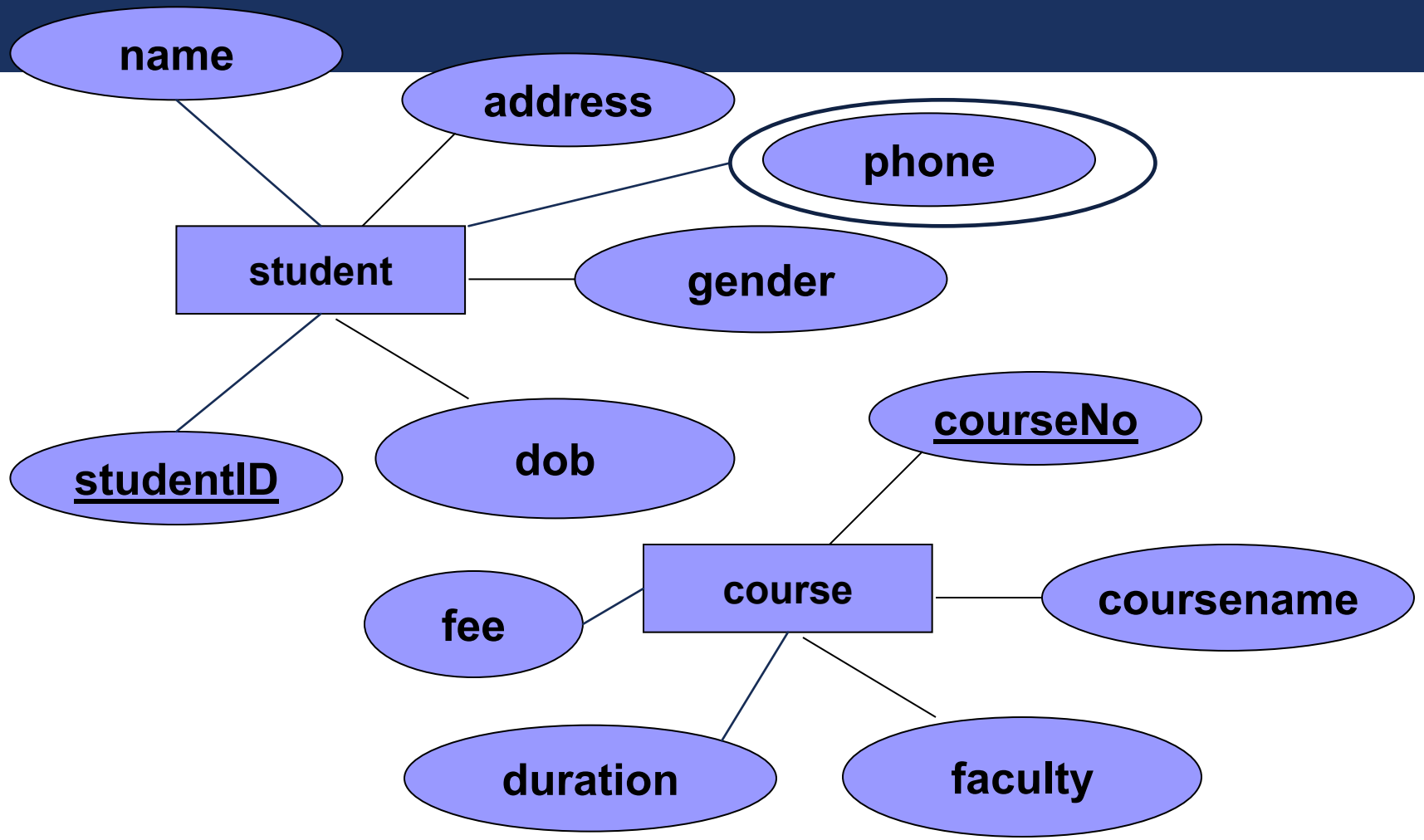
- (SID + Name) Is this unique?
  - Yes, but NOT the minimal set
- Referred to as Super Key

YOUR TURN!!

Students should enroll for courses. Student need to provide studentID number, name, address , date of birth, gender, contact number when he/she is going to register for a course. University keeps track of course number , course name , offering faculty ,duration and course fee of each course.

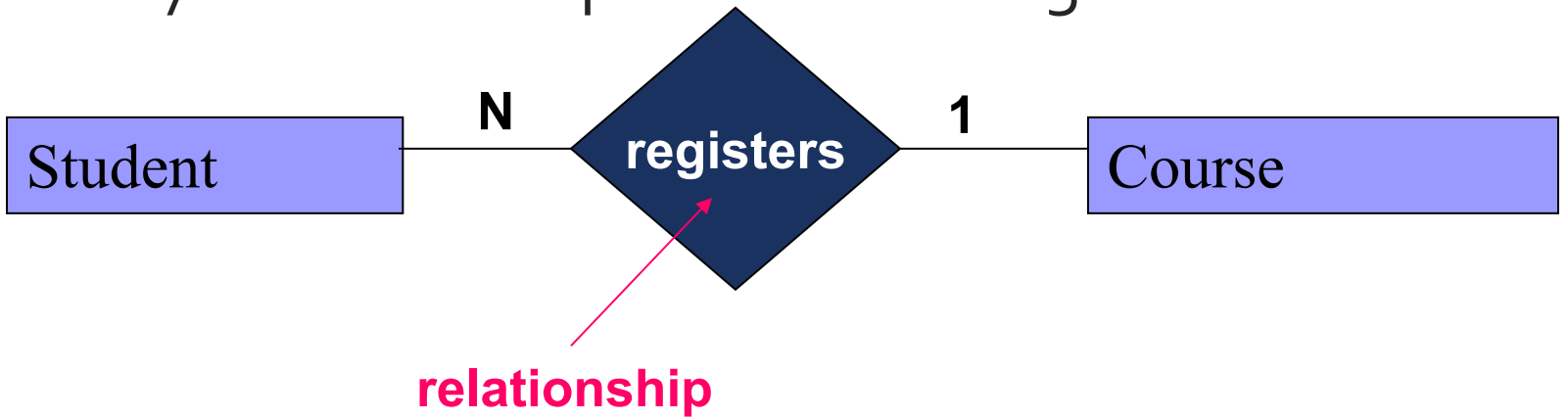
How do you represent this scenario ?

How do we find the course name of the student IT160001



RELATIONSHIP

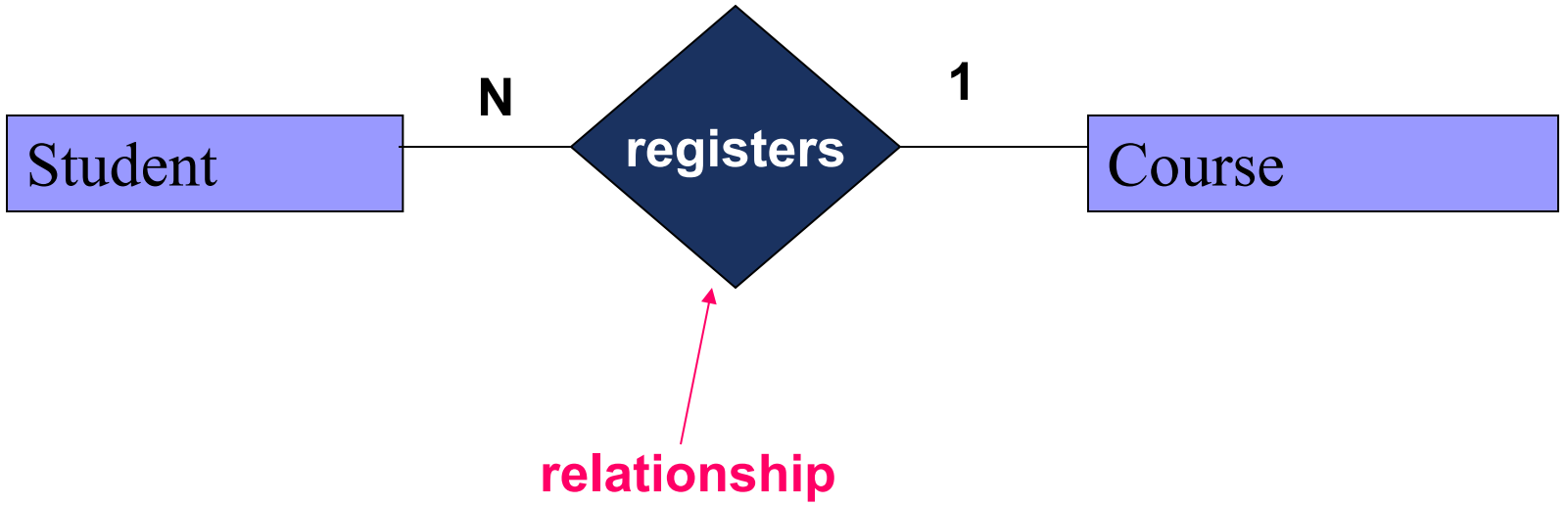
- **Relationship** is an association among two or more entities.
- Collection of similar relationships - **relationship set** .
- Shown as a line connecting the associated entities, labelled with the name of the relationship.
  - Normally a relationship is named using a 'verb' or 'verb group'.



DEGREE OF A RELATIONSHIP

Degree of a relationship is the number of participating entities in the relationship.

- Degree / Number of Entities = 2 Or binary



DEGREE OF RELATIONSHIP

- = no of participating entities
- Relationships can be classified based on their degree into
  - **Binary – relationship with <u>two</u> participants-**

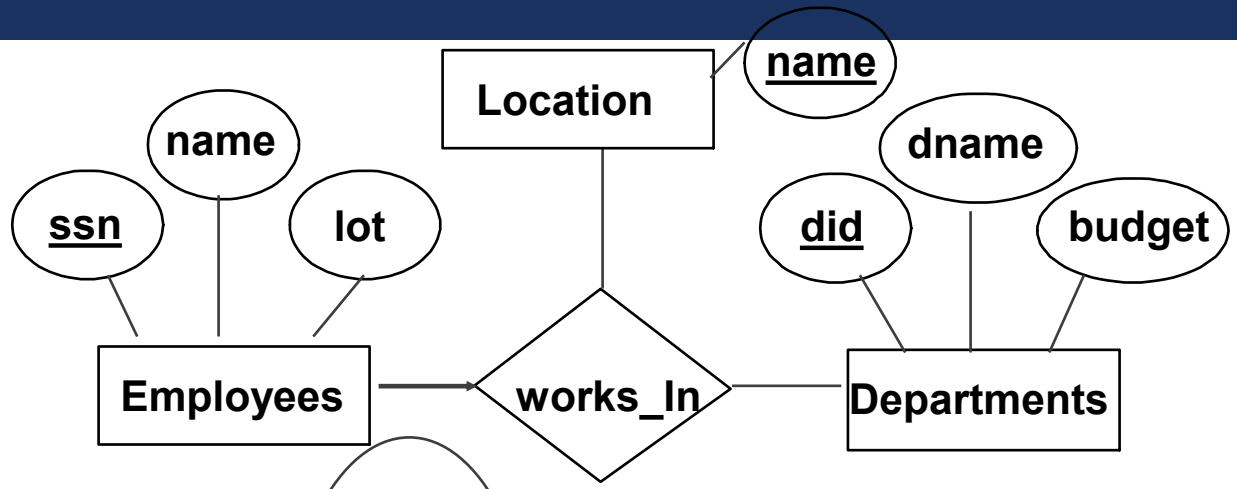
    Degree/No of Entities = 2
  - **Ternary – relationship with <u>three</u> participants**

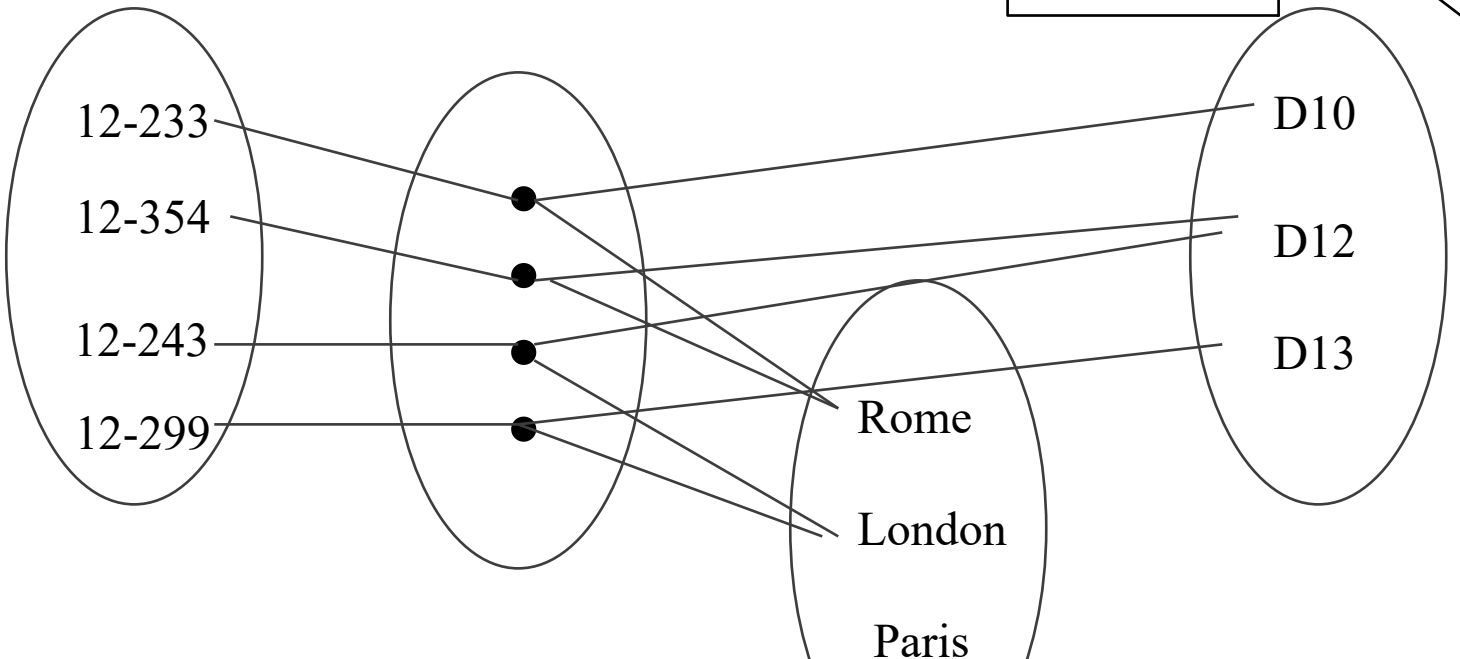
    Degree/No of Entities = 3
  - **Quaternary – relationship with <u>four</u> participants**

    Degree/No of Entities = 4

TERNARY RELATIONSHIPS

Each employee can work at most in one department at a single location





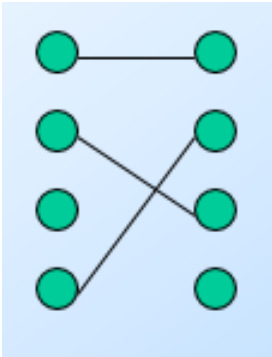
CARDINALITY

The **cardinality ratio** for a binary relationship specifies the number of relationship instances that an entity can participate in.

- There are three types of cardinality ratios for binary relationships.

  - **one-to-one (1: 1)**
  - **one-to-many (1 : N)**
  - **many-to-many. (N : M)**

ONE-TO-ONE RELATIONSHIP

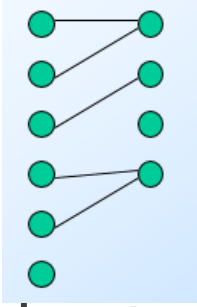


An employee manages at most one department. A department can have only one manager managing it.

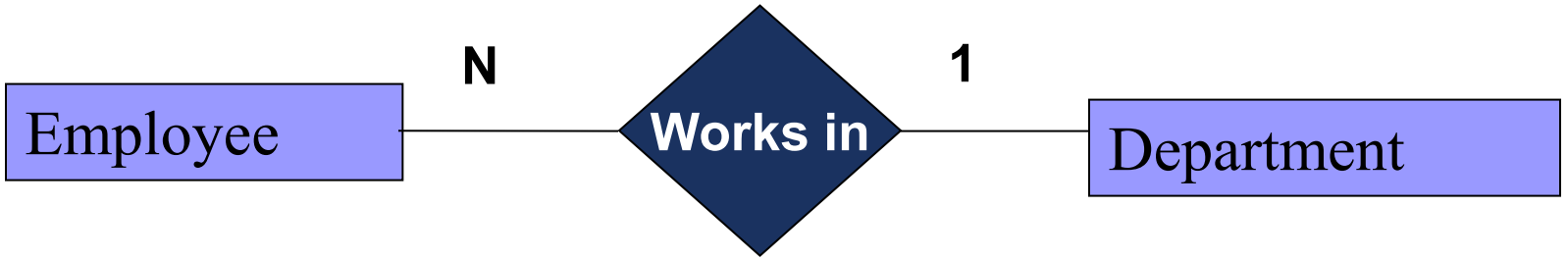
YOUR TURN !!

- Think about the Library database and give an example of a 1:1 relationship

ONE-TO-MANY RELATIONSHIP



- An employee works in at most one department.

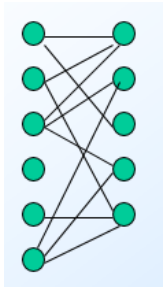


- This is a **one-to-many** (or **many-to-one**) relationship

YOUR TURN !!

- Think about the Library database and give an example of a 1:N relationship

MANY-TO-MANY RELATIONSHIP



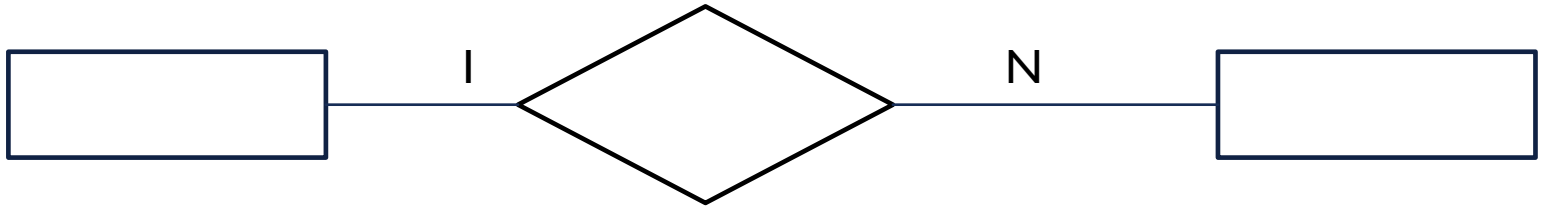
- An employee can work on several projects. A project can have many employees working on it.

YOUR TURN !!

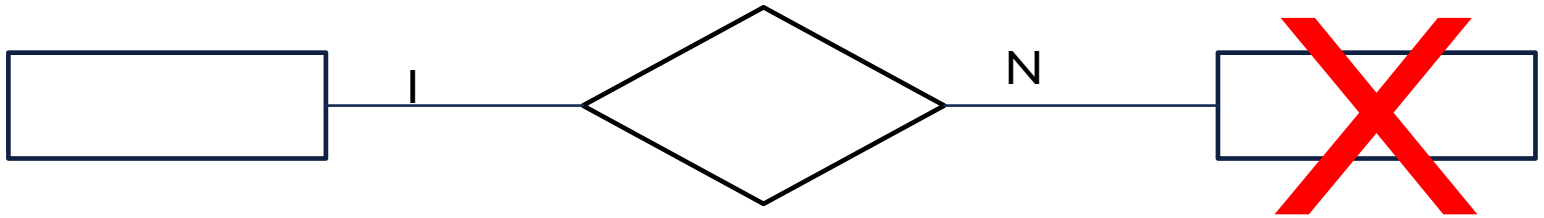
- Think about the Library database and give an example of a N:M relationship

RECURSIVE RELATIONSHIP

- Have you formed your project groups
- What is the structure?
  - Leader and members

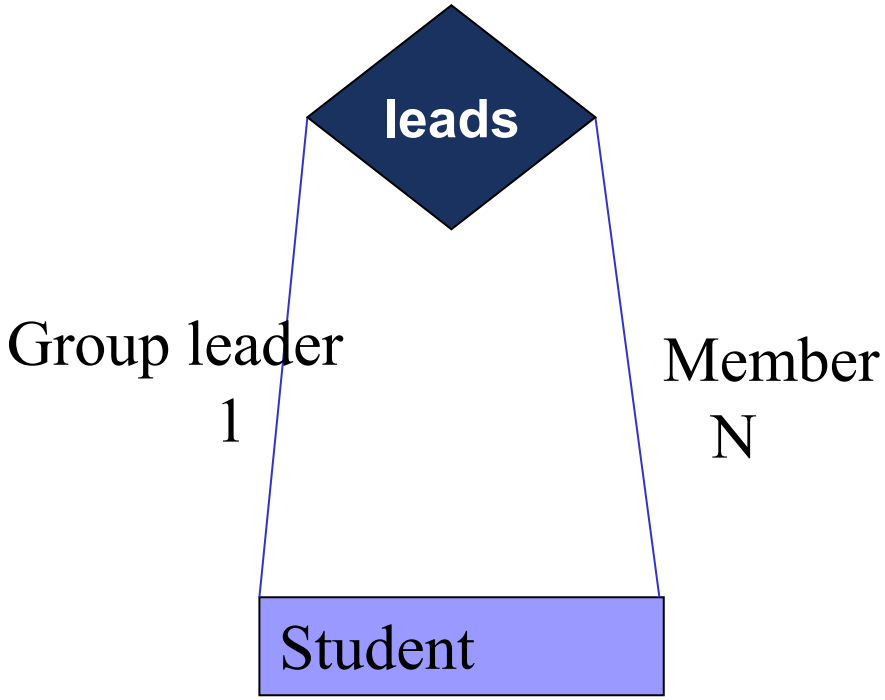


  - Both leader and members are students

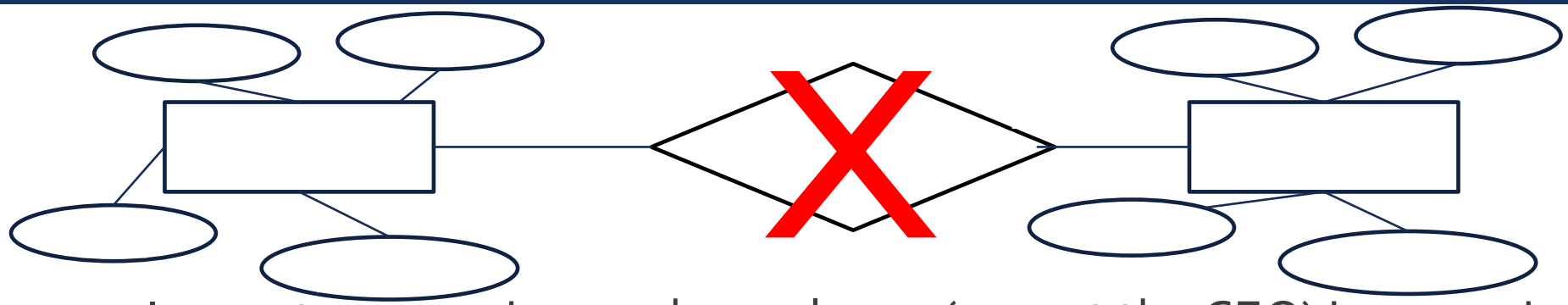


RECURSIVE RELATIONSHIPS

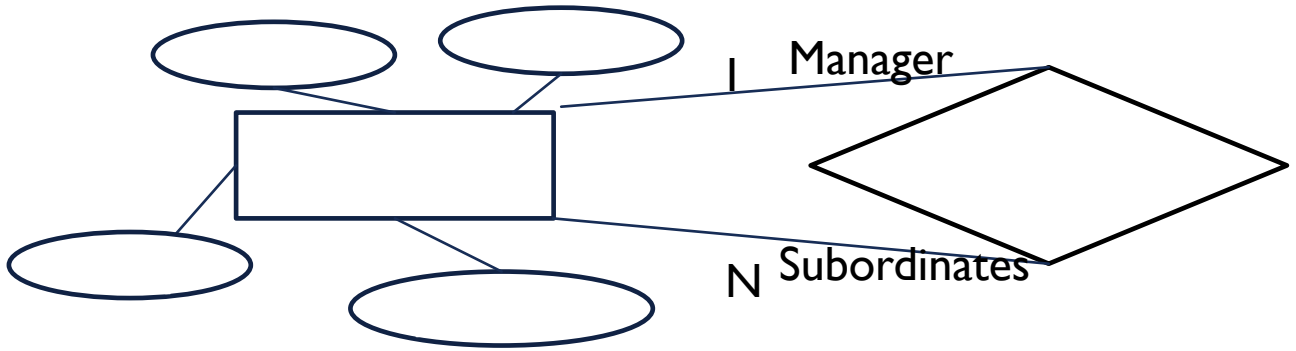
Student leads set of students in group assignments.



RECURSIVE RELATIONSHIPS



- In most companies, each employee (except the CEO) is supervised by one manager. Of course, not all employees are managers.



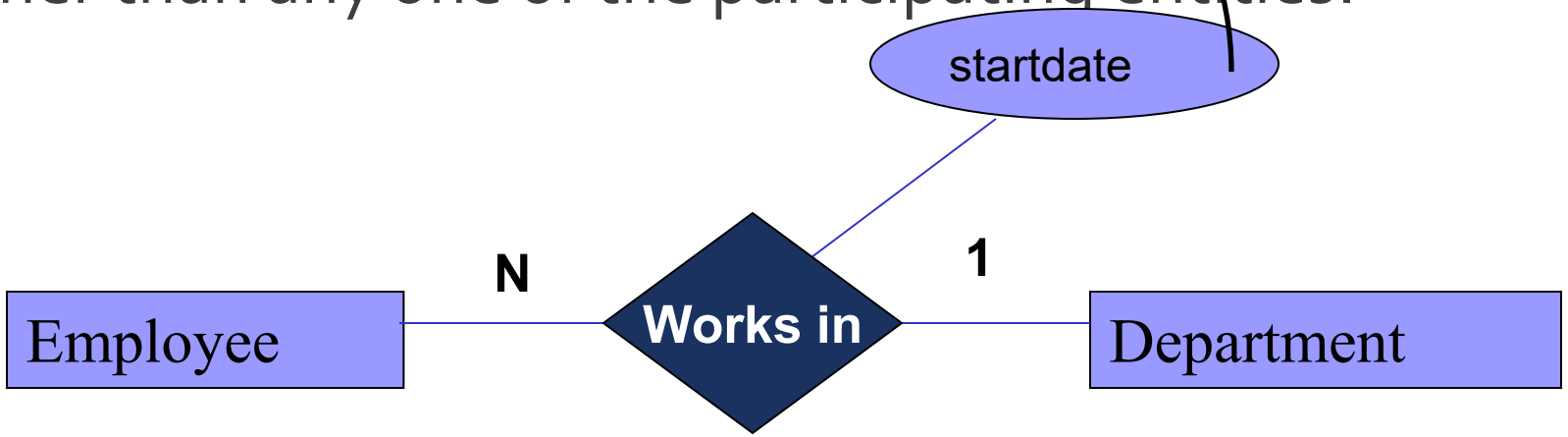
YOUR TURN !!

Rosell, 23 years old, a diploma holder joined the 'ABC' company as a *management trainee*. She joined the ***Production department*** on 01/01/2005. When Rosell successfully completed her Commerce degree, she was promoted as *Finance Executive* and transferred to the ***Finance department*** from 02/02/2006.

Considering her MBA qualification, the management of the company promoted her as *Assistant Manager - Business Development* and transferred to the ***Business Development department*** with effect from 03/03/2008.

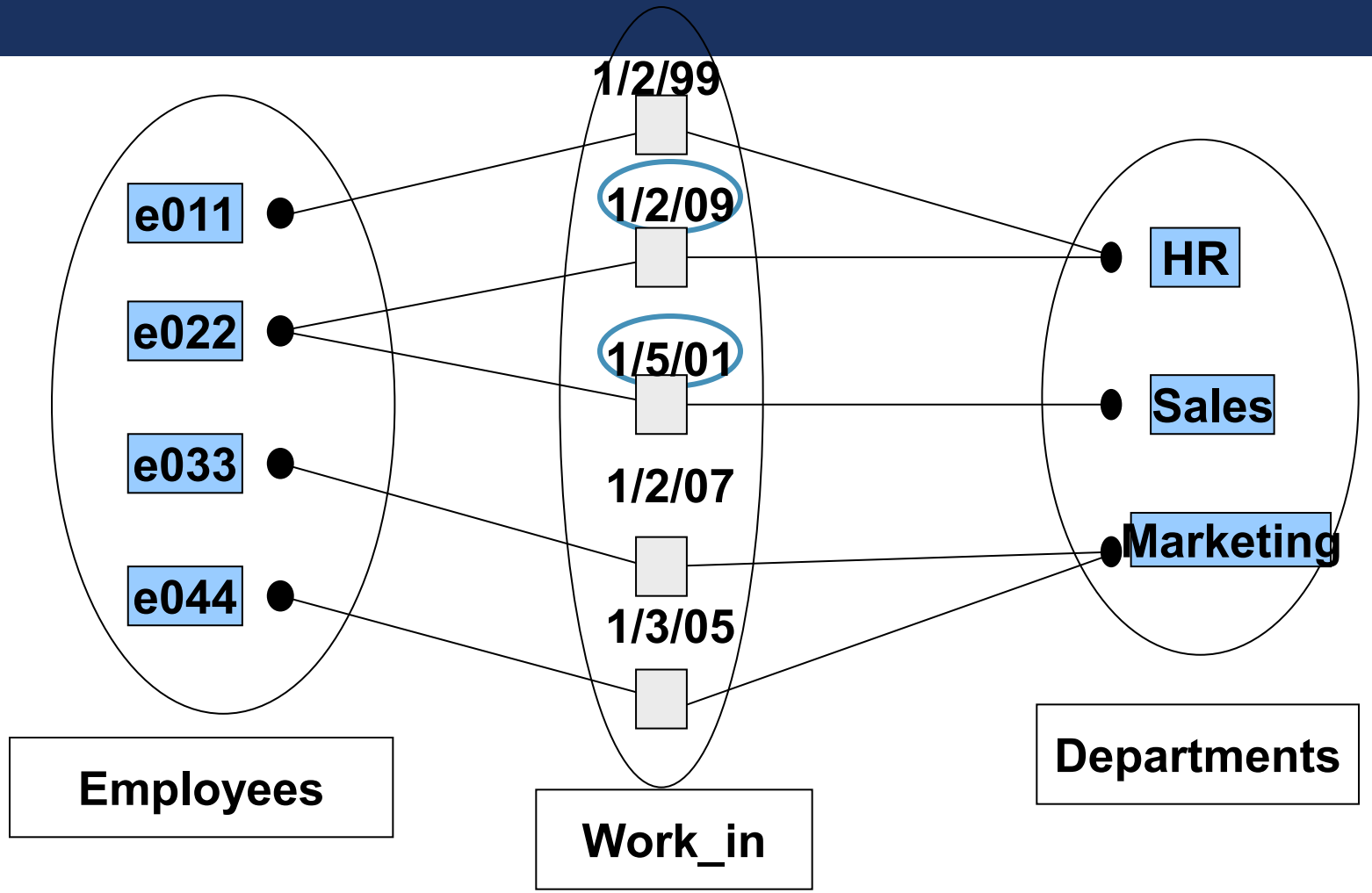
DESCRIPTIVE ATTRIBUTES

A relationships can also have **descriptive attributes .**
Used to record information about the relationship rather than any one of the participating entities.

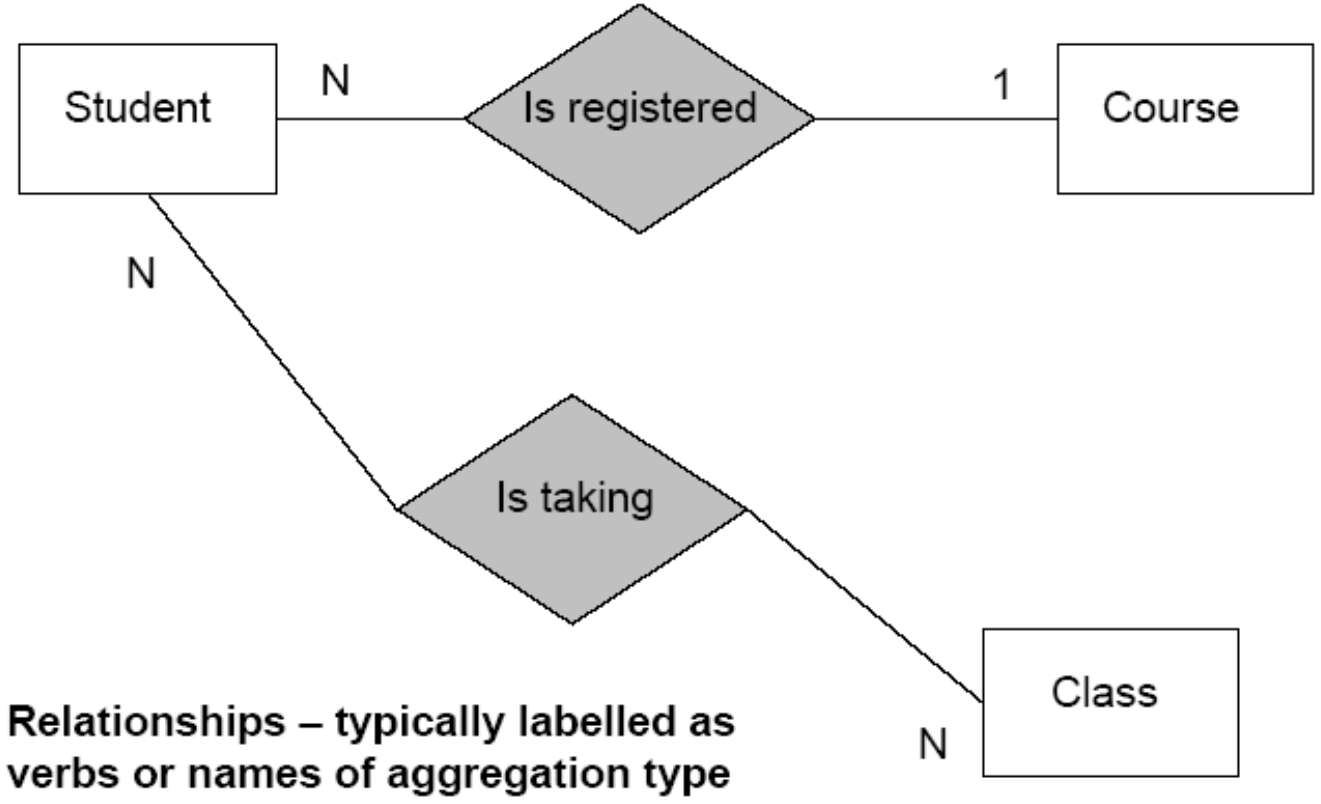


Nimal works in accounts dept since 2008

DESCRIPTIVE ATTRIBUTES



ER DIAGRAM



Relationships – typically labelled as verbs or names of aggregation type

YOUR TURN !!!

- Identify the entities -> nouns
- Identify the relationships -> verbs
- Determine
  - Cardinality
  - Participation (total / partial)

RESTRICTIONS- CONSTRAINTS

What is the criteria to become a student at SLIIT?

Register for a degree

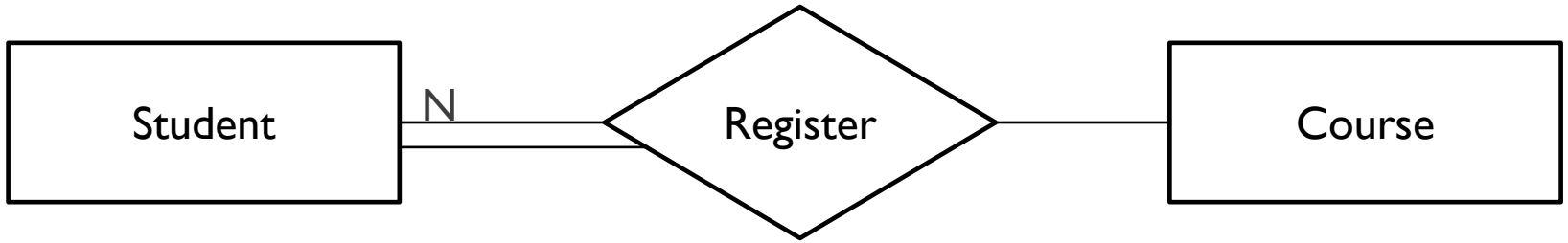
Mandatory /compulsory

Student MUST be registered in a degree

Restriction - Constraint

How do we present this information in the data base??

- Student must be registered in a degree.

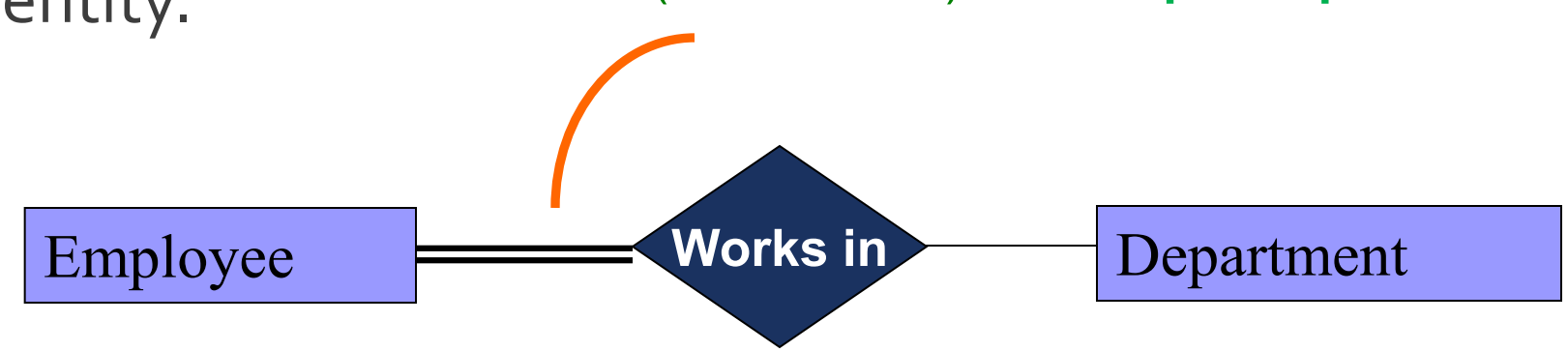


PARTICIPATING CONSTRAINTS

- **Participating constraint** specifies whether the existence of an entity depends on its being related to another entity via the relationship type.

PARTICIPATION CONSTRAINTS

- For example, if we specify that an employee **must** always work for a department.
- Then we say that the relationship "works in" is in **total participation** from employee entity to department entity.

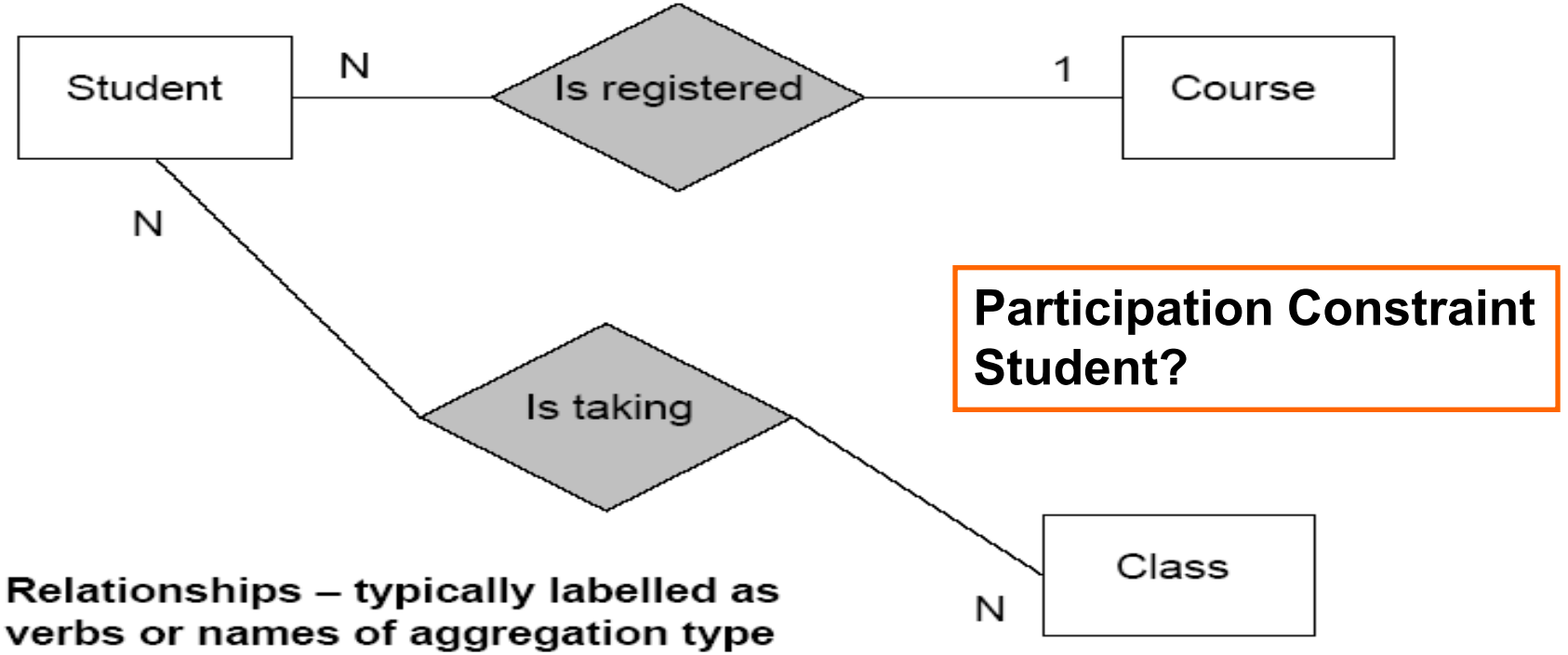


Employee must work in a department
Department may or may not have employees

E-R MODEL (CONTD.)

- If the relationship is not in total participation, then it is known as in **partial**.
- For example, from Department to Employee
- Department may or may not have Employees

PARTICIPATION CONSTRAINTS



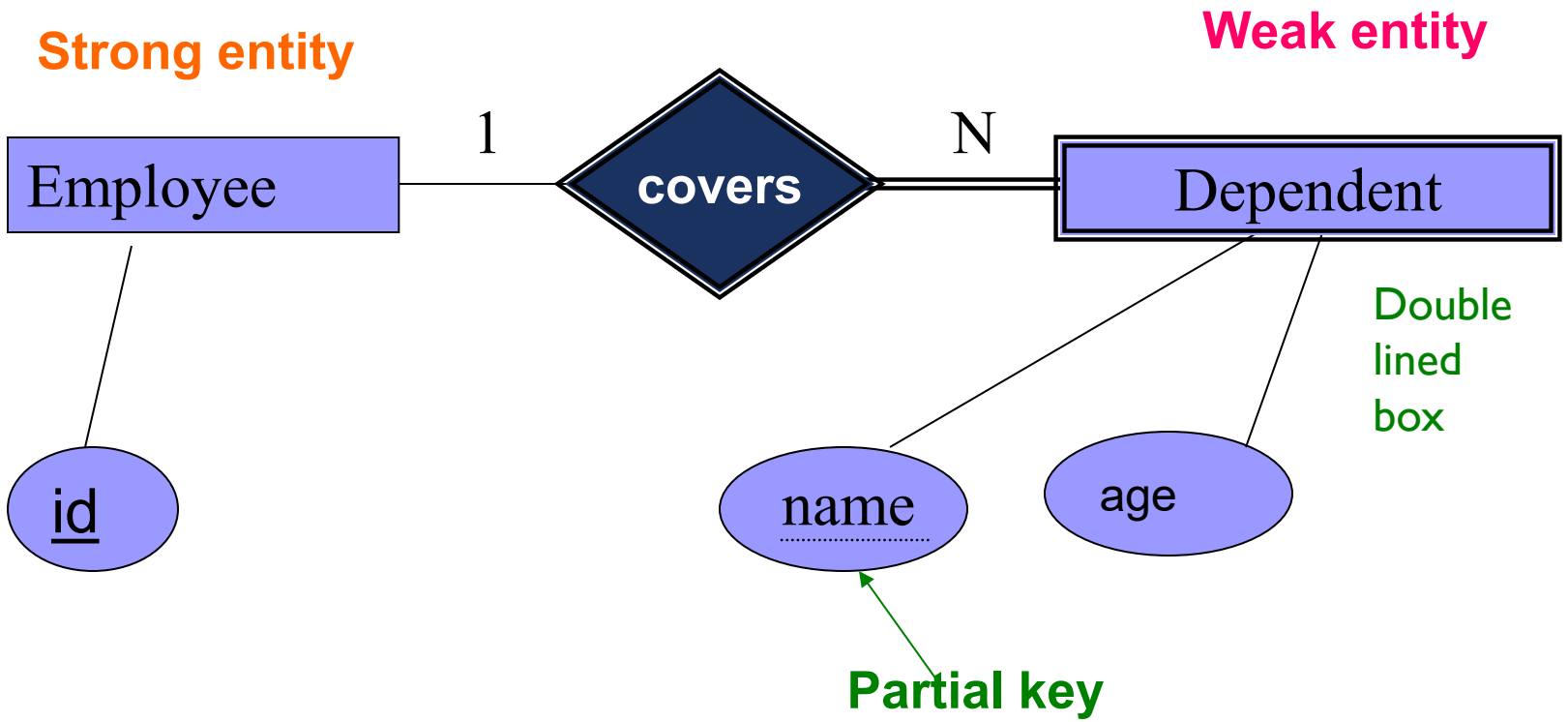
Participation Constraint
Student?

Relationships – typically labelled as verbs or names of aggregation type

WEAK ENTITY

- Parents employed?
- Does the company cover THE CHILDRENS medical insurance?
- How do you claim your medical bills
  - Can you get it reimbursed or through your parents
- Is the same coverage given to children after resignation

WEAK ENTITY


Strong entity
Weak entity
Employee
1
covers
N
Dependent
Double lined box
id
name
age
Partial key

WEAK ENTITY

- Some entities can't exist on its own.
- Its' existence-dependent on another entity, i.e., it cannot exist without the entity with which it has a relationship.
- It inherits the part of the primary key from the entity to which it is related.
- Entity types without any key attributes is called **weak entity types**.

WEAK ENTITY

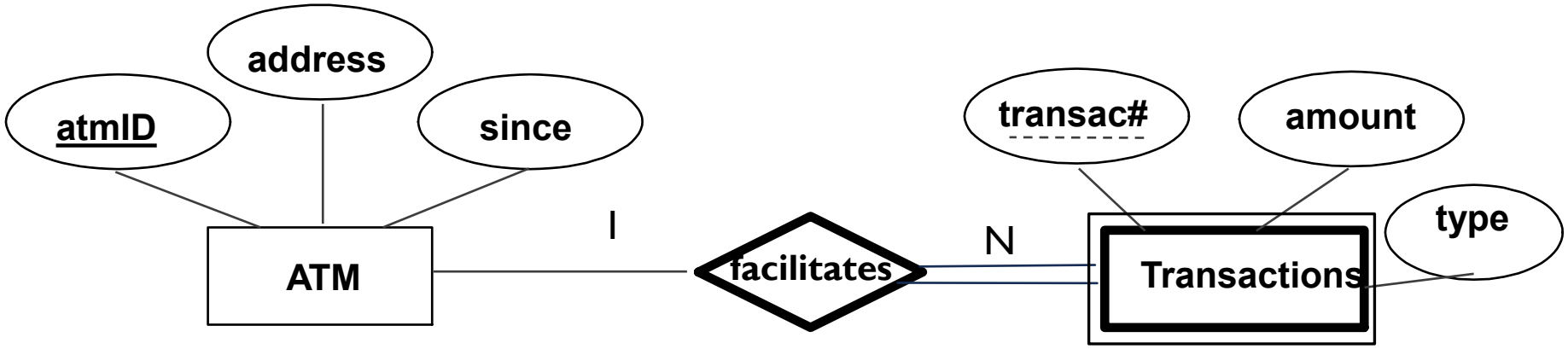
- The attributes in the weak entity participating in the key are called **partial keys**.

- The owner entity and the **weak entity** participates in an **identifying relationship**.

- The cardinality of the identifying relationship is either **one-to-one** or **one-to-many** from owner entity to weak entity.

- The weak entity must have **total participation** in the identifying relationship.

EXAMPLE- WEAK ENTITY



EER MODEL

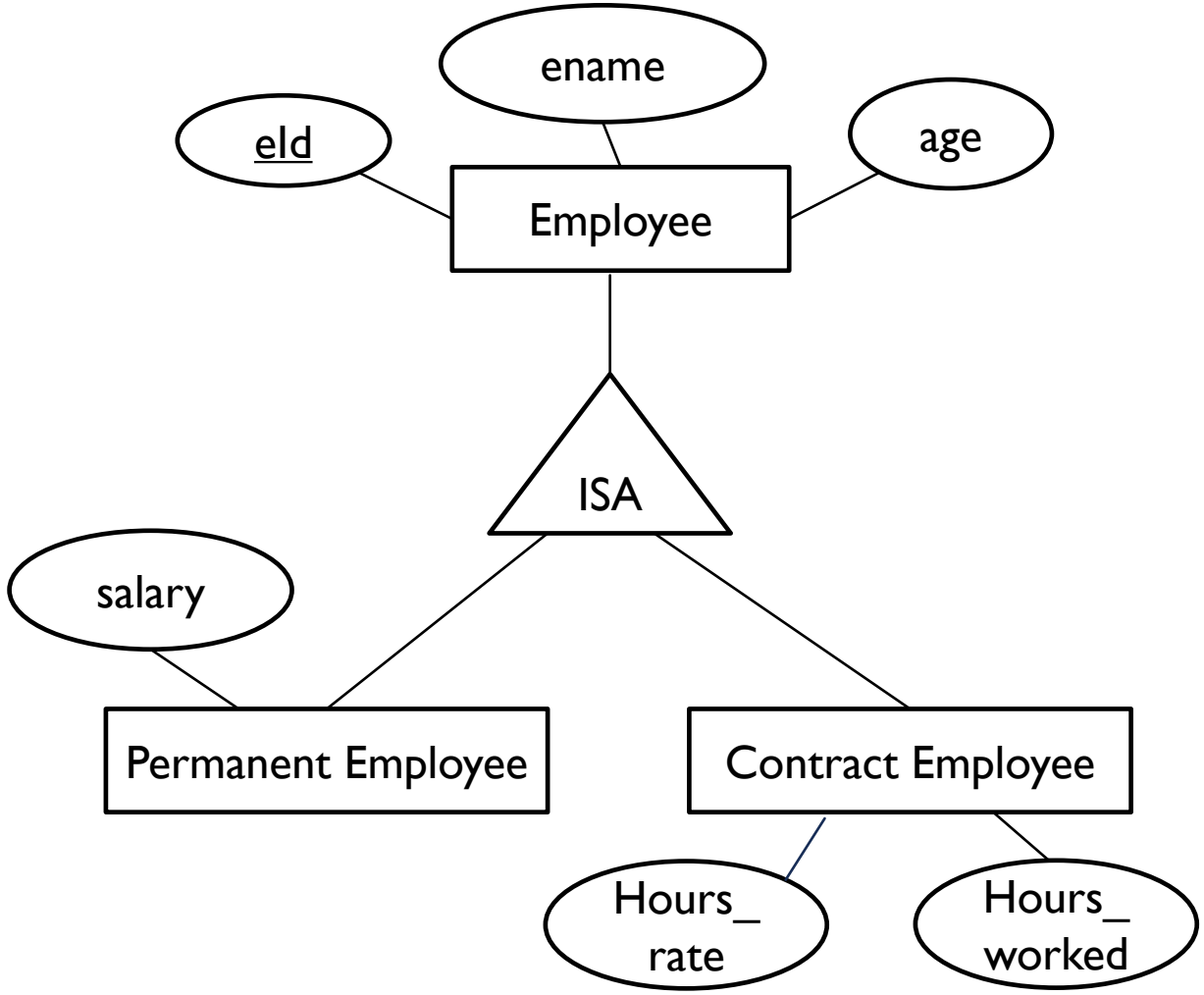
- ER model we discussed so far has been enhanced by adding several new concepts leading to the development of the EER model.
- An important extension included in the EER model is the specialization and generalization concepts.
  - Specialization is the process of defining a set of subclasses of an entity type.
    - Employee & permanent employee
  - Generalization is the process of identifying commonalities between entity types and grouping them as super-classes.

EER MODEL - ISA RELATIONSHIPS

- In many cases an entity type has numerous subgroupings or subtypes of its entities that are meaningful and need to be represented explicitly because of their significance to the database application.
  - Ex: the entities that are members of the EMPLOYEE entity type may be distinguished further into contract employees and permanent employees
- Such subtypes could be represented in EER diagrams using 'ISA' relationships

EER MODEL - ISA RELATIONSHIPS (CONTD.)

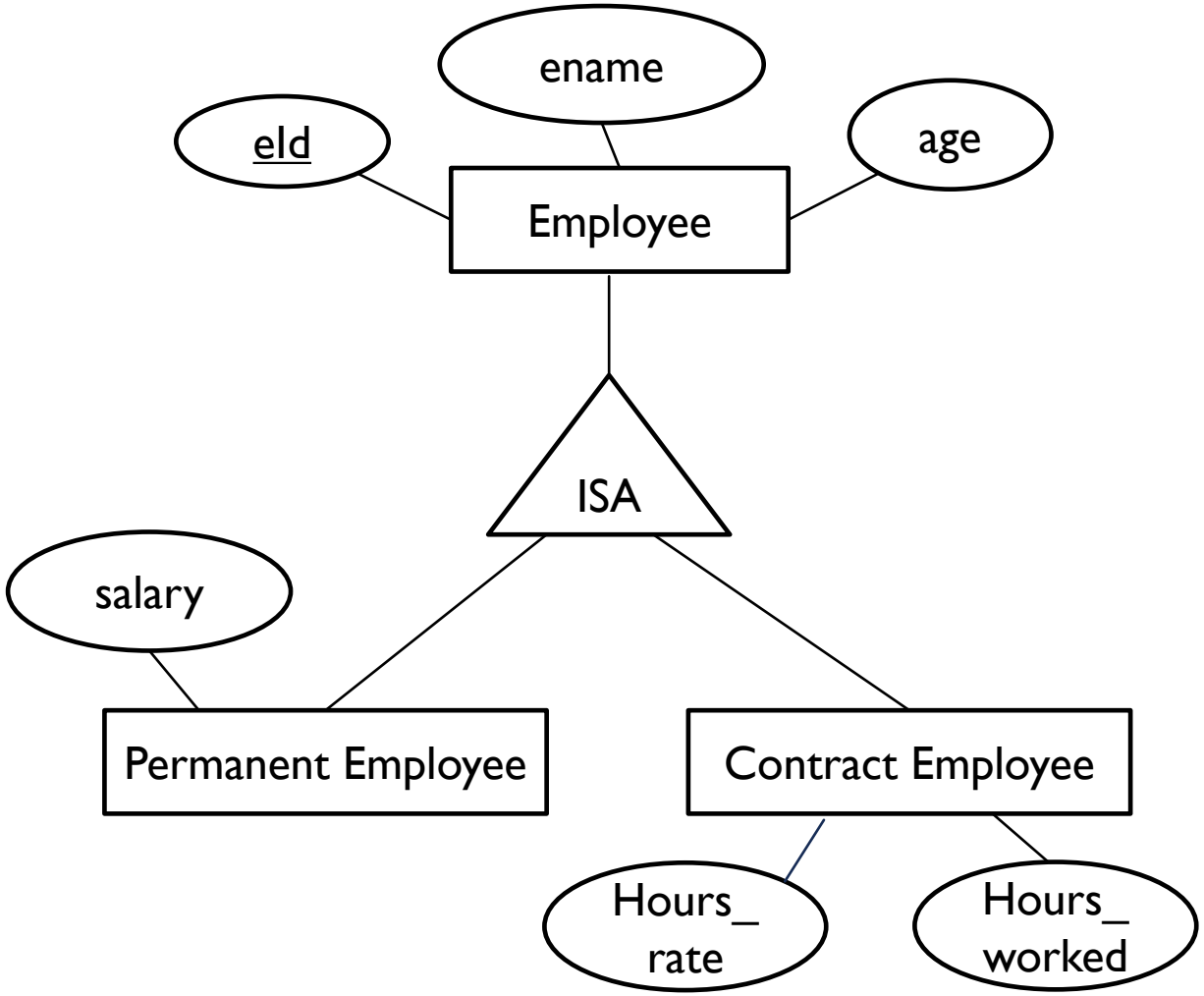
- Note that the subclasses may have their own attributes and relationships.
- Every entity in the subclass is also an employee entity and have all the have all of the attributes of Employees entity.
- Thus attributes of the permanent employee include all attributes of employee entity and those of permanent employee.

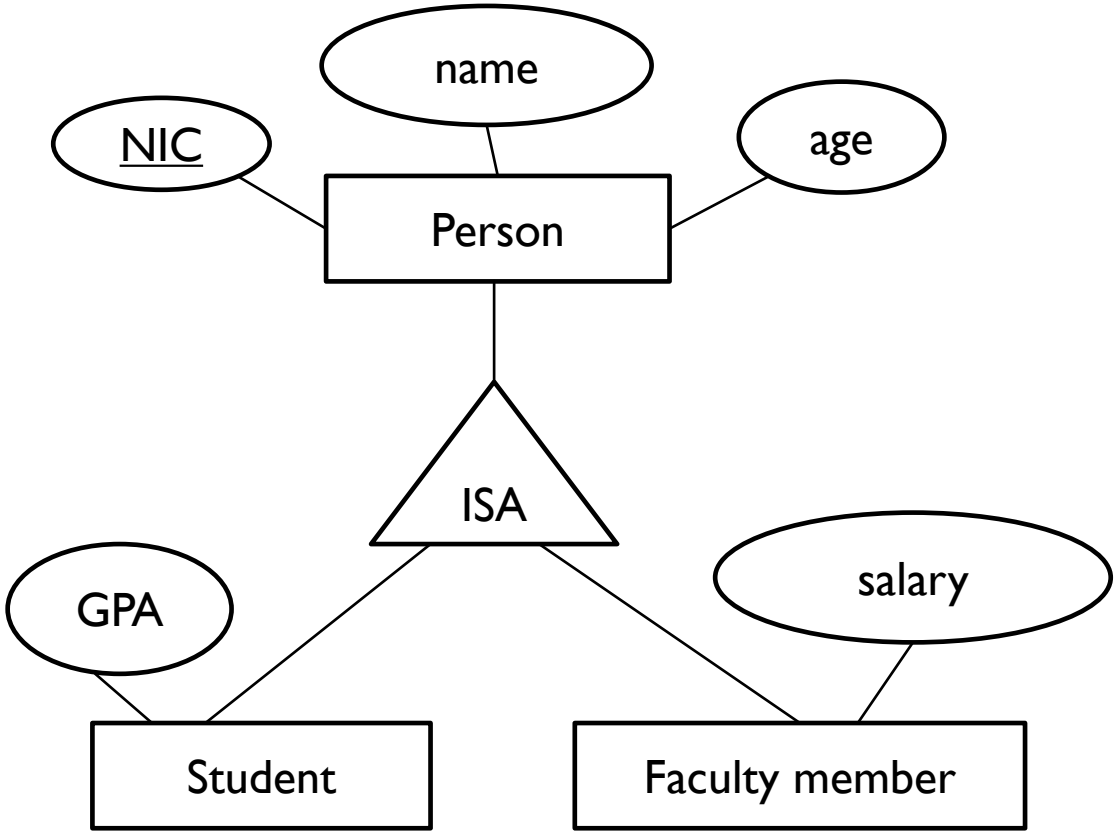


OVERLAPPING CONSTRAINT

- **Overlapping constraint** determine whether two subclasses are allowed to contain the same entity.
  - For example can an employee E be a permanent employee and a contract employee? Probably not. Therefore, the permanent employee subclass and the contract employee subclass are disjoint.
  - Can a person P in a university environment be a student and a faculty member at the same time. If it is so, we denote this by writing student overlaps faculty member. In absence on such a statement we assume that the sub classes are disjoint.

OVERLAPPING CONSTRAINT (CONTD.)



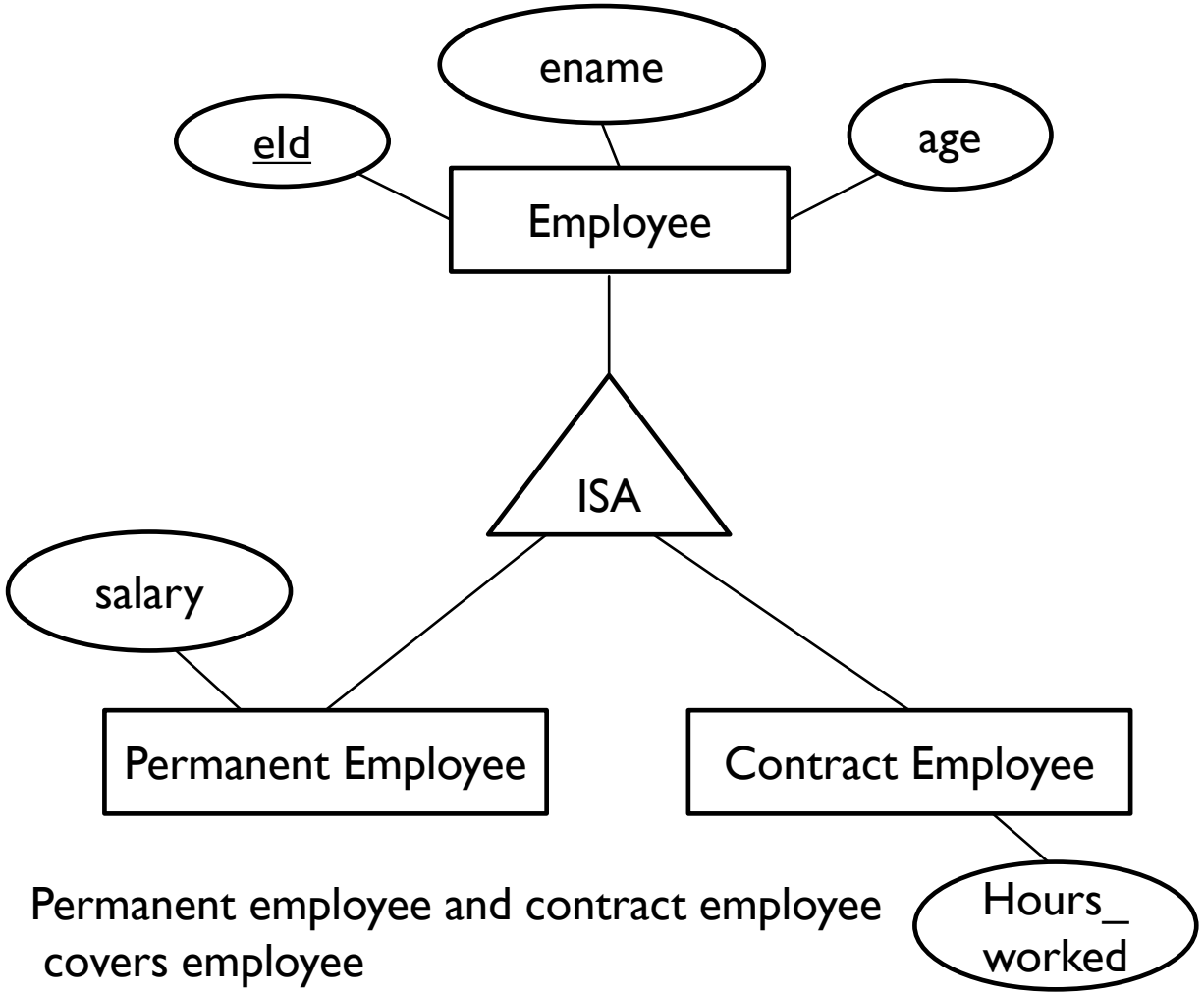


Student overlaps faculty member

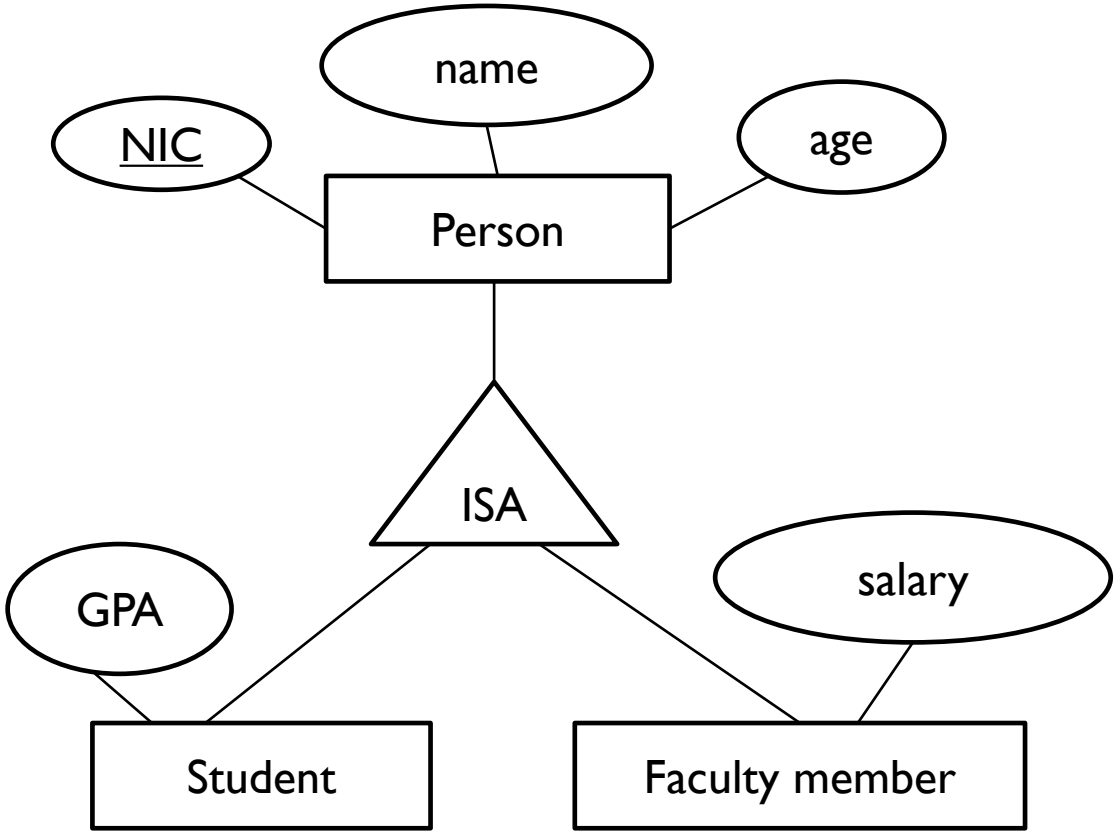
COVERING CONSTRAINT

- **Covering constraints** determine whether the entities in the subclasses collectively include all entities in the super class.
  - For example, does every employee entity e, belong to one of its subclasses (i.e. permanent employee or contract employee)? If so we denote this by writing permanent employee and contract employee covers employee.
  - Does every person p in a university environment belong to either student sub class or the faculty member sub class? Probably not. Therefore, there is no covering constraint associated with the hierarchy.
- Existence of a covering constraint is also know as having a total specialization.
- Absence of a covering constraint in a class hierarchy is known as partial specialization.

COVERING CONSTRAINT (CONTD.)



Permanent employee and contract employee covers employee



WHAT YOU HAVE TO DO BY NEXT WEEK

- Try out the self-test questions on the course web.
- Try out tutorial and bring the answers to the class.