VirginiaTech

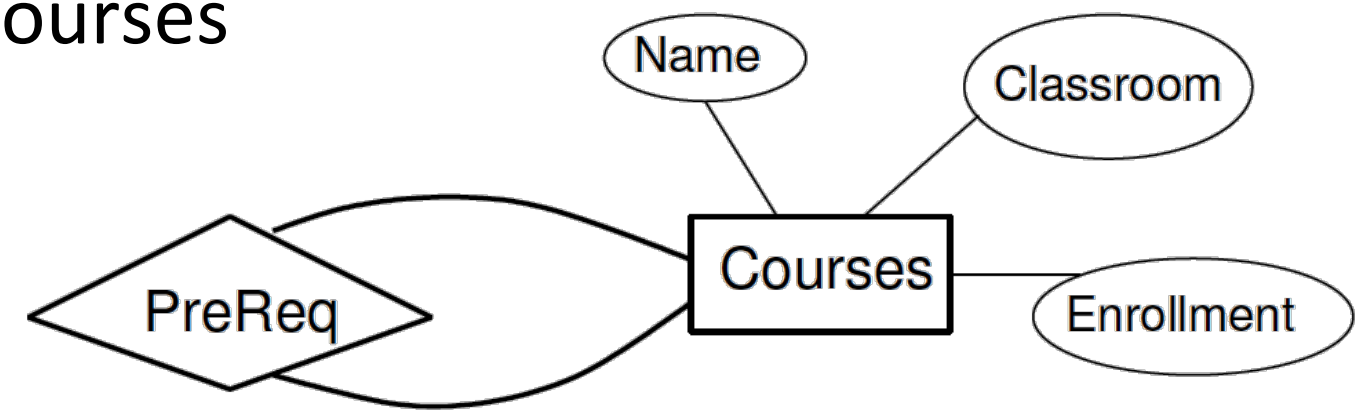
# CS 4604: Introduction to Database Management Systems

*B. Aditya Prakash*

Lecture #9: More E/R Models

# Roles in Relationships

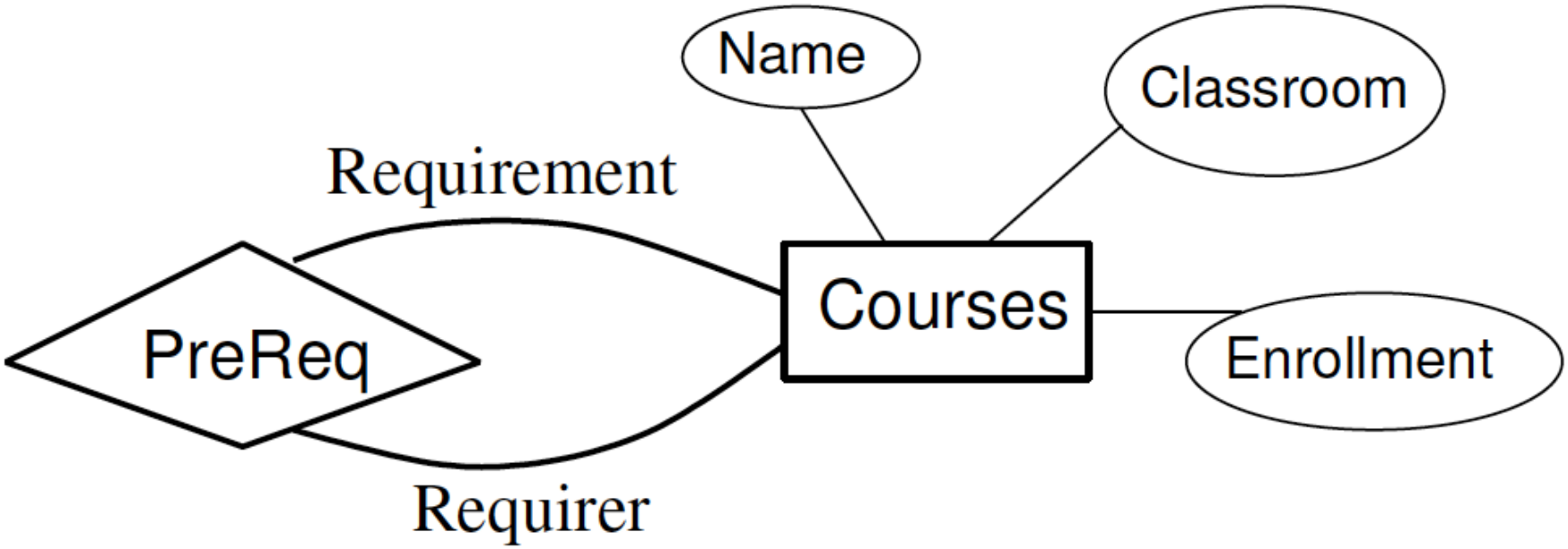
- Can the same entity set appear more than once in the same relationship?
- Prerequisite relationship between two Courses




- But which course is the pre-req?

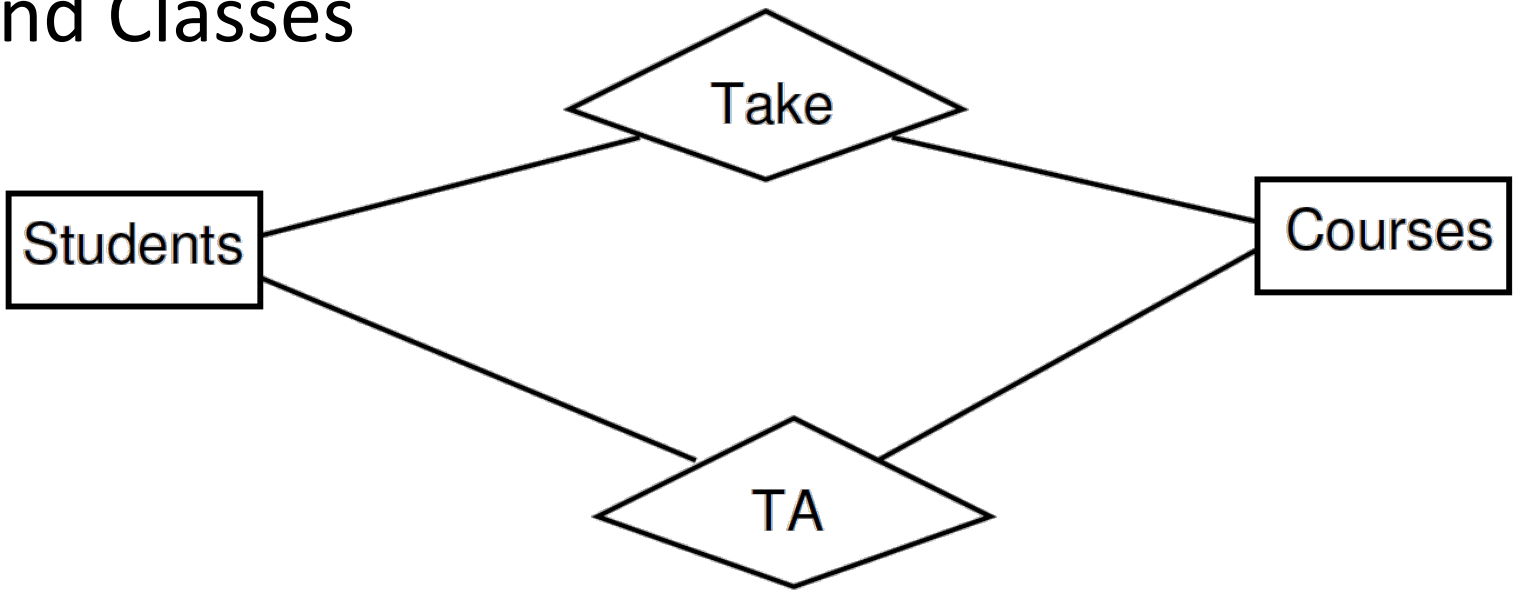
# Roles in Relationships

- Label the connecting lines with the *role* of the entity

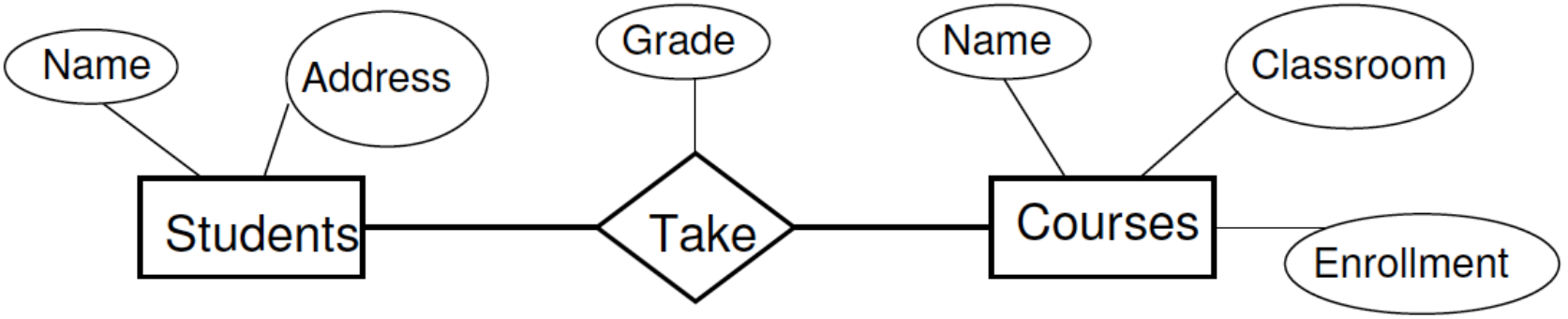


# Parallel Relationships

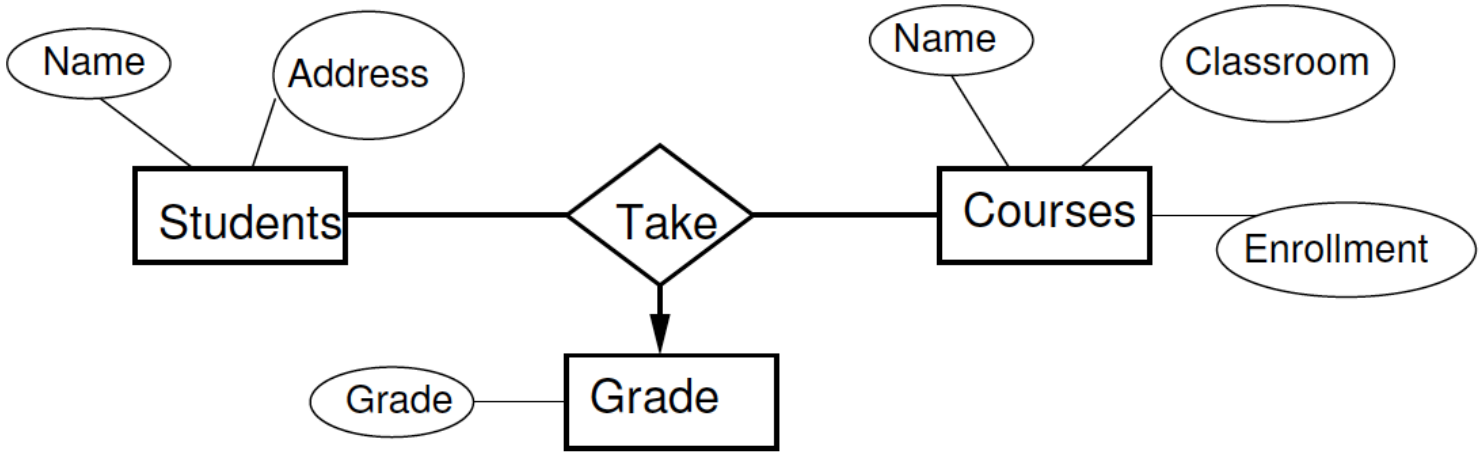
- Can there be more than one relationship between the same pair of entities?
- TA and Take relationship between Students and Classes



# Are Attributes on Relationships Needed

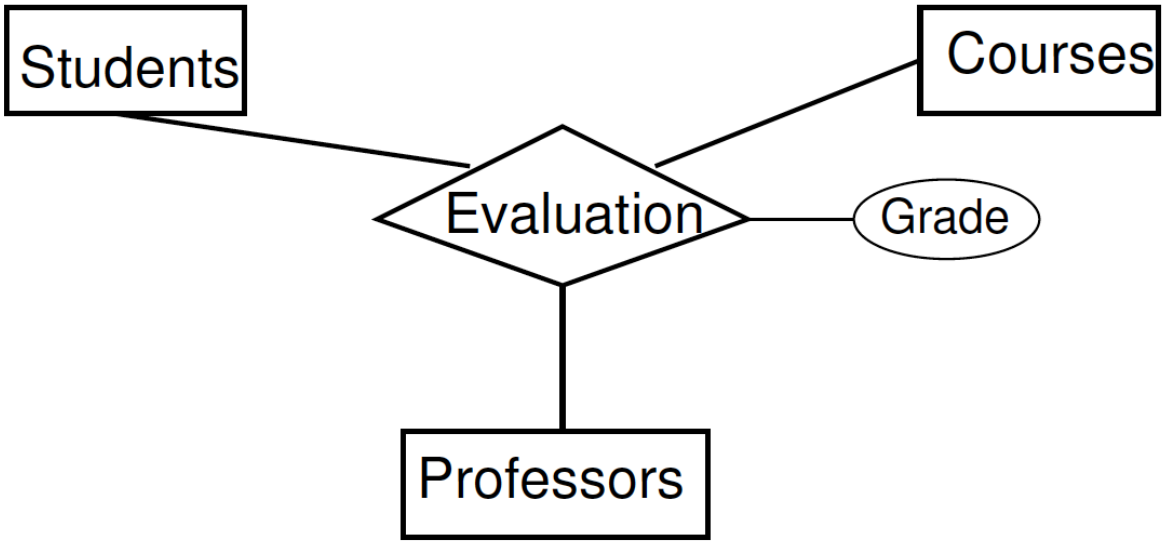



- Attribute on relationship → Attribute to an entity and make relationship multi-way



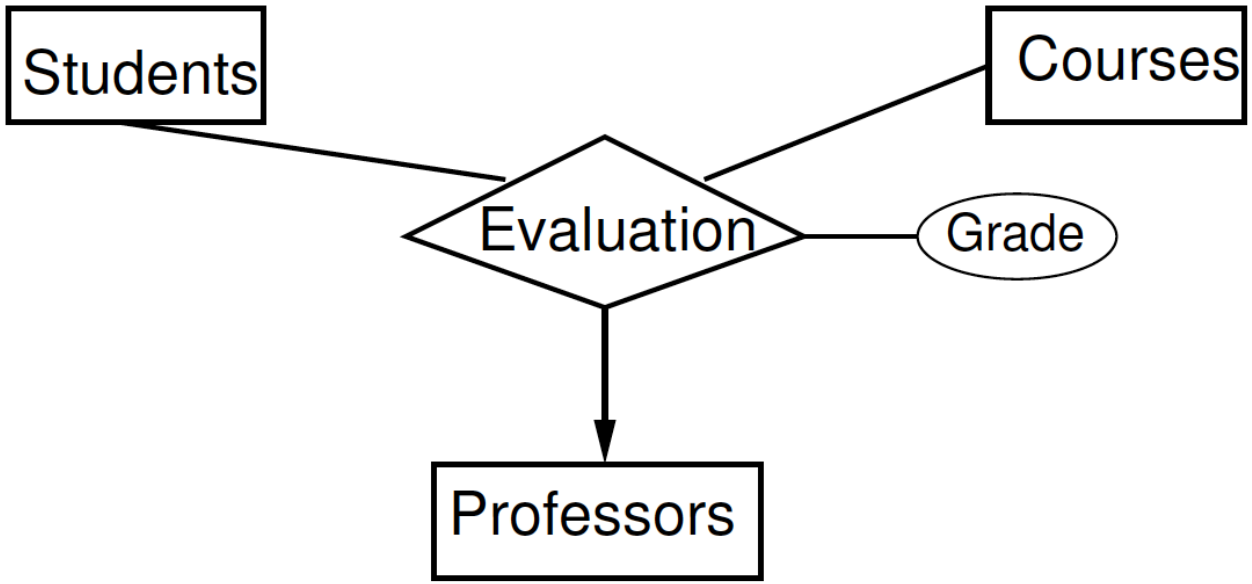
# Multi-way Relationships

- Relationships may connect more than 2 entity sets
- >= 1 professor can teach a course but each student evaluates each professor separately
- Three-way Evaluation relationship between Students, Professors, and Classes



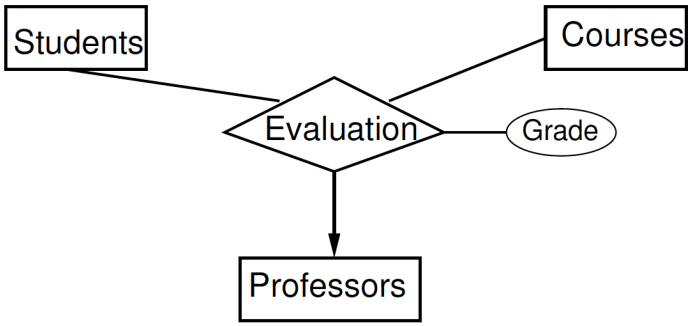
# Multi-way Relationships

- >= 1 professor can teach a course but each student taught by at most one professor, and each student only evaluates that professor
- Add arrow directed towards Professors



# Multiplicity in Multiway Relationships

- An arrow pointing to an entity set E => if we select an entity from each of the other entity sets, the selected entities are related to at most one entity in E



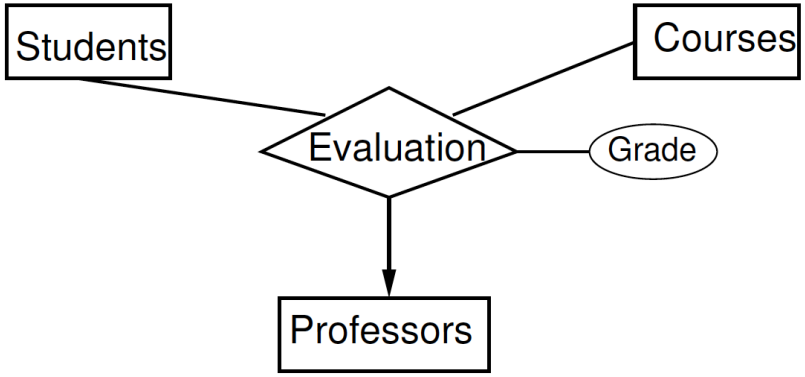

| *Student* | *Course* | *Professor* | *Grade* |
|---|---|---|---|
| Hermione Grainger | Potions | Snape | F- |
| Draco Malfoy | Potions | Snape | A* |
| Harry Potter | Potions | Lupin | A+ |
| Ron Weasley | Potions | Lupin | B+ |

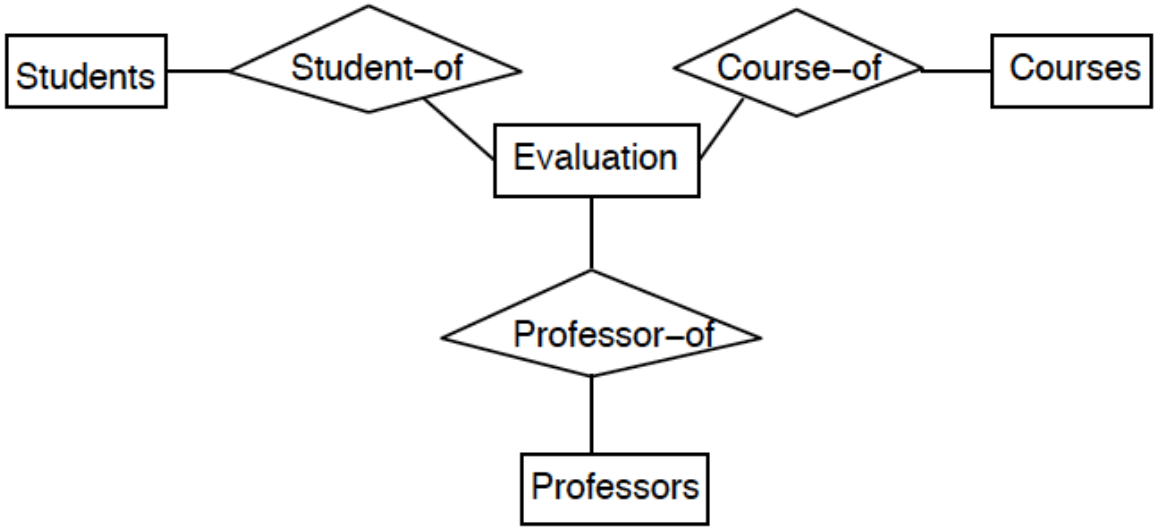
- E/R diagram forbids connections between “Hermione Grainger”, “Potions" and two different professors.

# Converting Multiway to Binary

- It is easy to convert a multiway relationship to multiple binary relationships
  - Create a new connecting entity set. Think of its entities as the tuples in the relationship set for the multiway relationship
  - Introduce relationships from the connecting entity set to each of the entities in the original relationship
  - If an entity set plays > 1 role, create a relationship for each role

# Converting Multiway to Binary




What is the multiplicity of the relationships?

# Example of the Conversion

- Instance of Evaluation (ternary) relationship before conversion:

| *Student* | *Course* | *Professor* | *Grade* |
|---|---|---|---|
| Hermione Grainger | Potions | Snape | F- |
| Draco Malfoy | Potions | Snape | A* |
| Harry Potter | Potions | Lupin | A+ |
| Ron Weasley | Potions | Lupin | B+ |

# Example of the Conversion

- Instance of Evaluation (ternary) relationship **before** conversion:

| *Student* | *Course* | *Professor* | *Grade* |
|---|---|---|---|
| Hermione Grainger | Potions | Snape | F- |
| Draco Malfoy | Potions | Snape | A* |
| Harry Potter | Potions | Lupin | A+ |
| Ron Weasley | Potions | Lupin | B+ |

- **After**

Evaluation entity set

| *Eval_Id* | *Grade* |
|---|---|
| e1 | F- |
| e2 | A* |
| e3 | A+ |
| e4 | B+ |

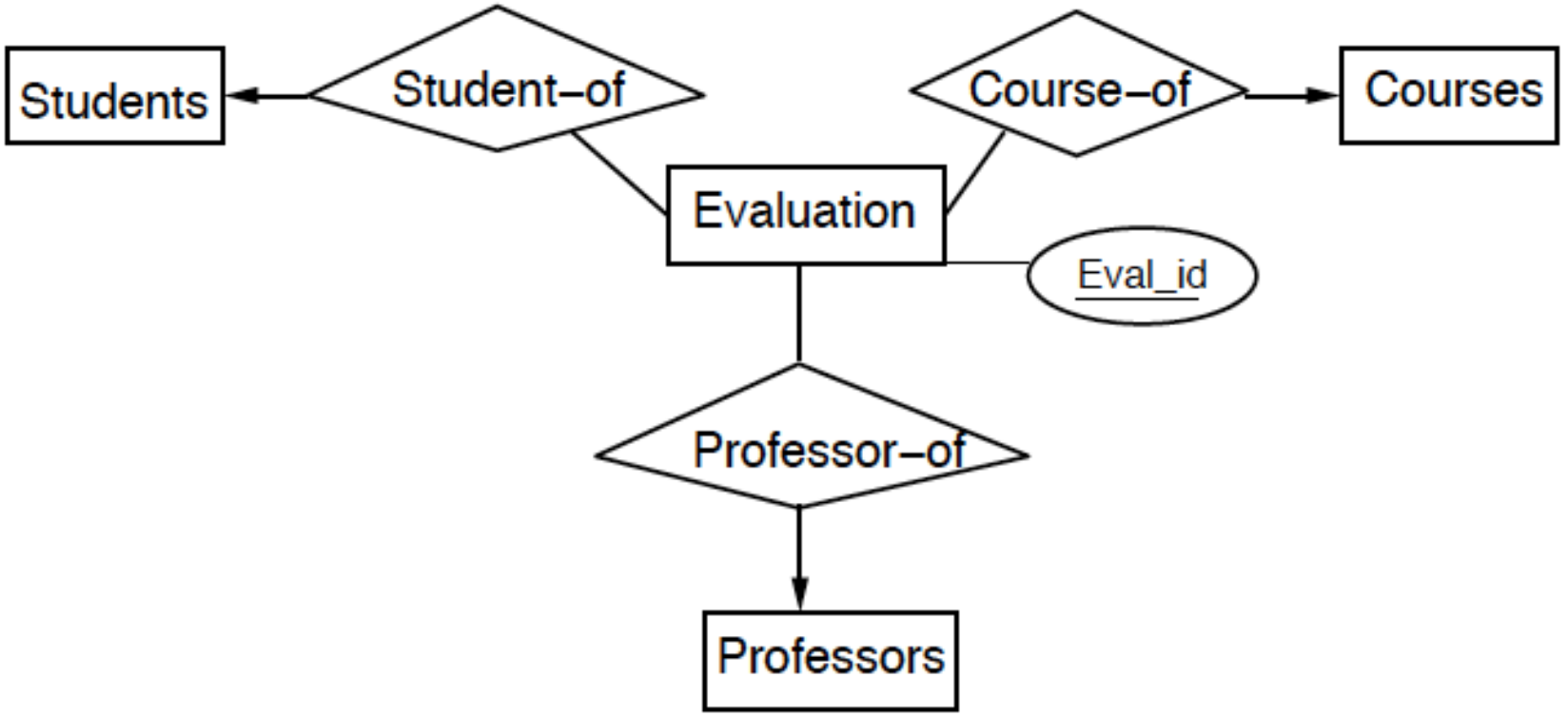
Student_of entity set

| *Eval_Id* | Student |
|---|---|
| e1 | Hermione Grainger |
| e2 | Draco Malfoy |
| e3 | Harry Potter |
| e4 | Ron Weasley |

# Details of the Conversion

- Create an entity in the new Evaluation entity set for each instance (row) in the ternary Evaluation relationship.
- In the Student_of relationship, relate each entity in the Evaluation entity set with the corresponding student entity.
- How many students can the Student_of relationship relate an Evaluation entity to?
  - Only one!
- Therefore, the multiplicity of Student_of is many-to-one from Evaluation to Student.

# Conversion

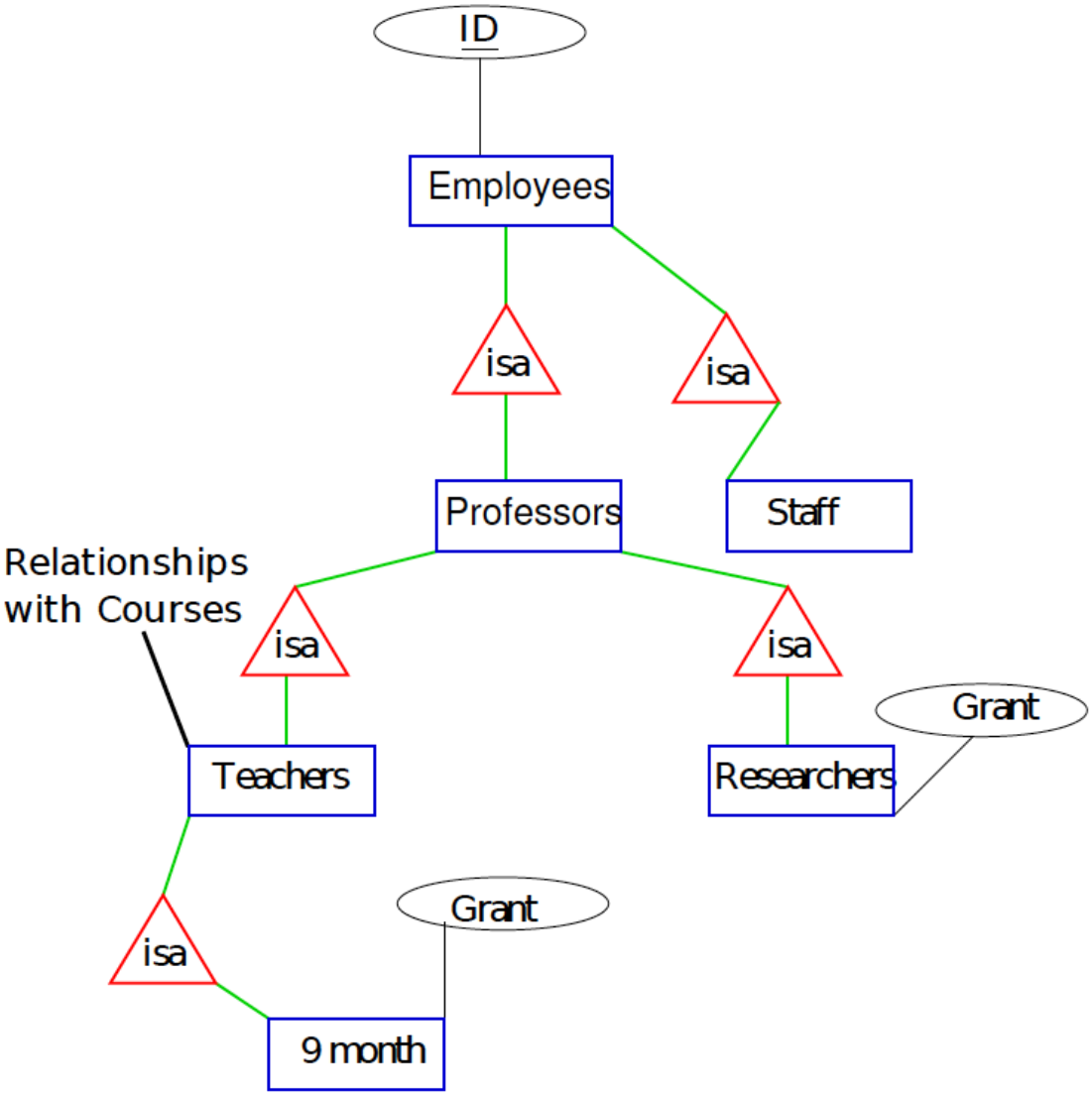

Students
Student–of
Course–of
Courses
Evaluation
Eval_id
Professor–of
Professors

# Subclasses in the E/R Model

- A subclass of an entity set E is an entity set F such that
  - each entity in F is an entity in E
  - the entity set F must have at least one attribute or participate in at least one relationship that E does not
- Connect E to F using an *isa* relationship denoted by a triangle
- Convention is to draw E above F
- Each *isa* relationship is one-one but we do not draw the arrows.
- The set of *isa* relationships must form a tree.

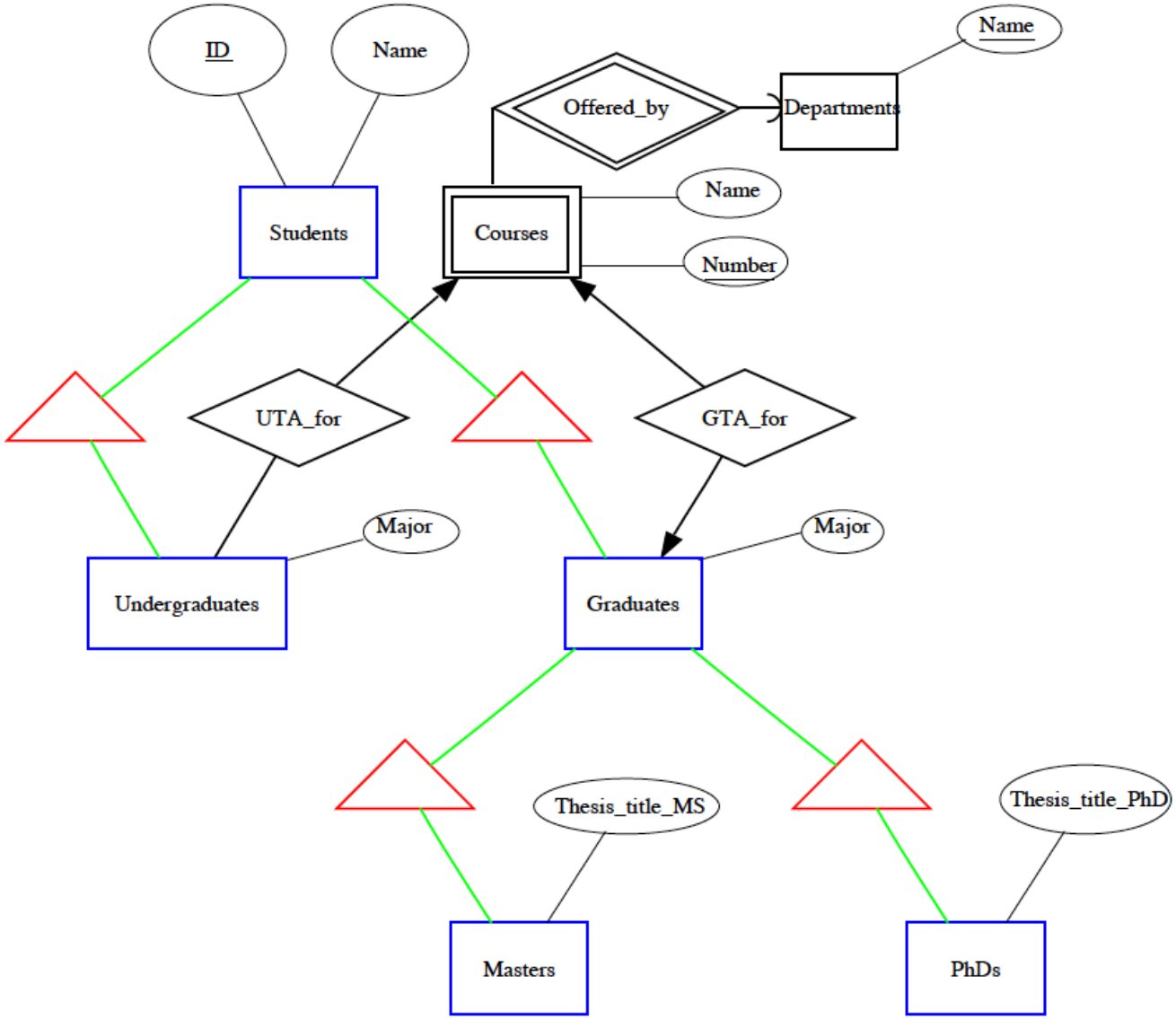
# Subclasses: Example

- University Employees, Handout 2



# Subclasses: Example

- University Students, Handout 2

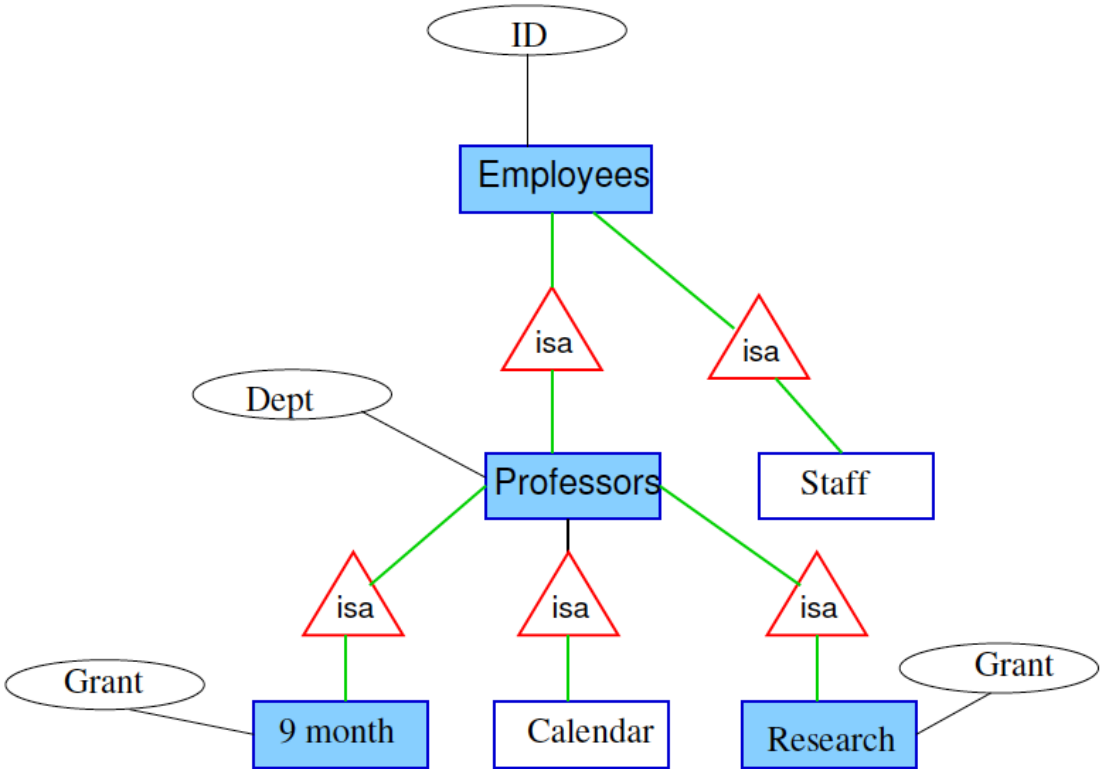


# E/R vs. OO Subclasses

- In object-oriented programming languages, each object is in only one class.
  - A subclass inherits variables and methods from the superclasses.
- In an E/R diagram, an entity has components in all the subclasses to which it belongs
  - If an entity *e* has a component in an subclass, then *e* has a component in the superclass
  - Does *e* have a component in the root?
  - The attributes of *e* are the union of the attributes of its components
  - *e* participates in all the relationships its components participate in

# Components of an Entity

- Prof. Fingers InMany Pies has a 9-month appointment, teaches in one semester every year, and does not teach in the other semester.
- In the other semesters, his research grant pays his salary.
- Which entity sets does he have components in? (using a different *isa* hierarchy)



# Components of an Entity

- How do we represent students enrolled in combined Bachelors-Masters programs?
- Such a student has components in multiple entity sets

# Components of an Entity

- Such a student has components in multiple entity sets