VirginiaTech

CS 4604: Introduction to Database Management Systems

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Lecture #6: Entity/Relational Model---Part 2

How to design E/R models?

Guidelines

- Be faithful to the specification of the application.
- Avoid redundancy.
- Keep the entities and relationship simple.
- Select the right relationships.
- Select the right type of element.

Be Faithful to the Specification

- Do not use meaningless or unnecessary attributes
- Define the multiplicity of a relationship appropriately
  - What is the multiplicity of the relationship Take between Students and Courses?
  - What is the multiplicity of the relationship Teach between Professors and Courses?

Avoid Redundancy

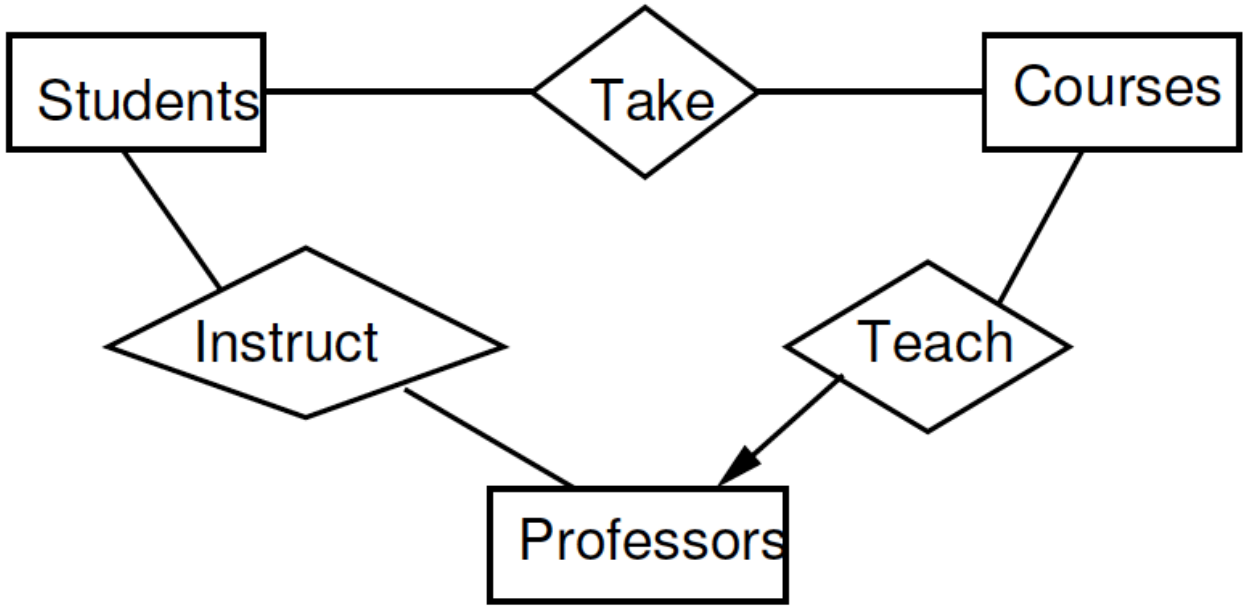
- Redundancy occurs when we express the same fact in two or more ways
- Redundancy wastes space
- Redundancy can lead to inconsistency if we change one instance but not the other

Select the Right Relationships

- Do not add unnecessary relationships.
- It may be possible to deduce one relationship from another.

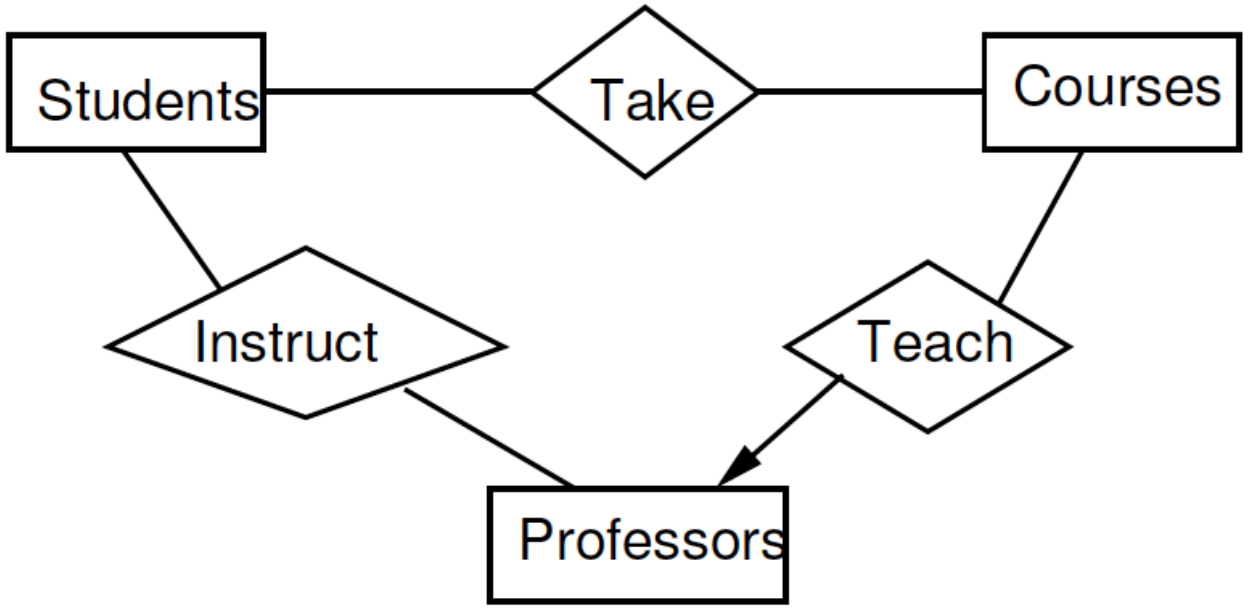
Select the Right Relationships

- Do we need the relationship Instruct between Professors and Students?



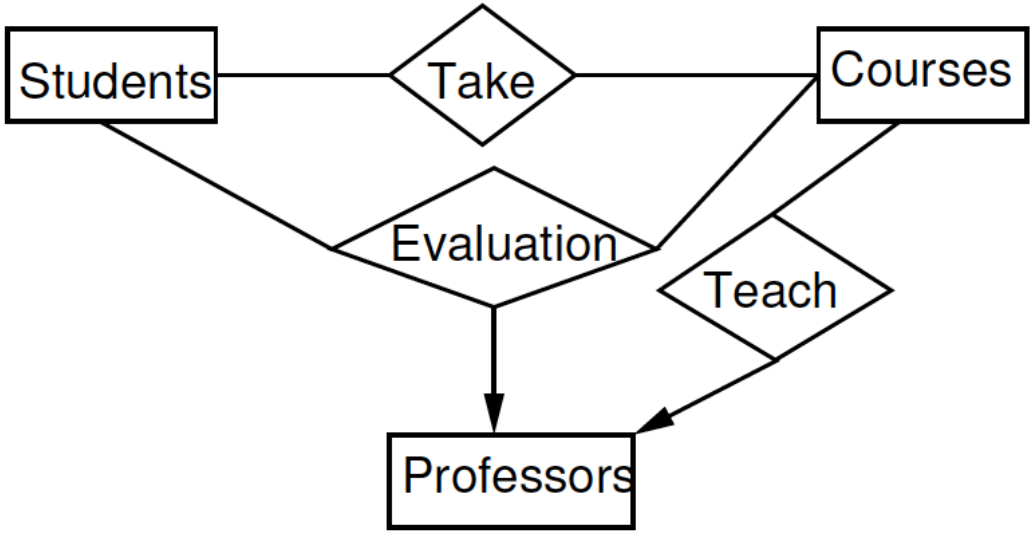
Select the Right Relationships

- Do we need the relationship Instruct between Professors and Students?
  - No! We can deduce it from Take and Teach



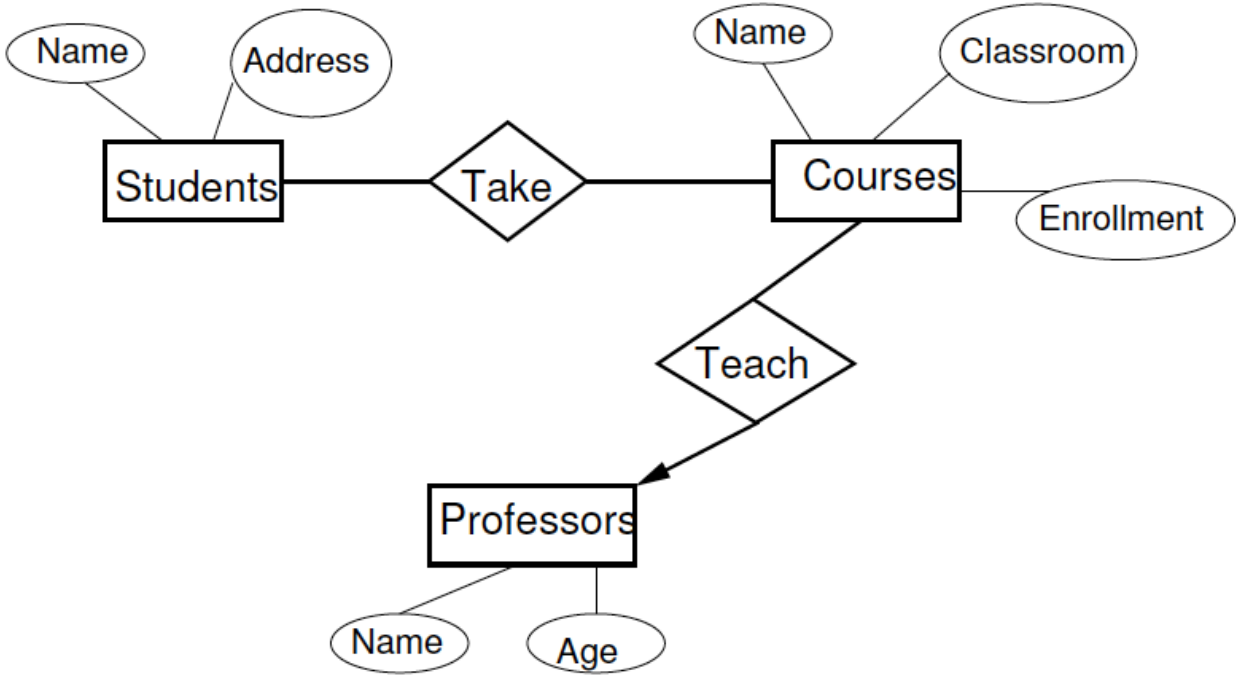
Select the Right Relationships

- Do we need the relationships Take and Teach?
  - Yes actually. Why?



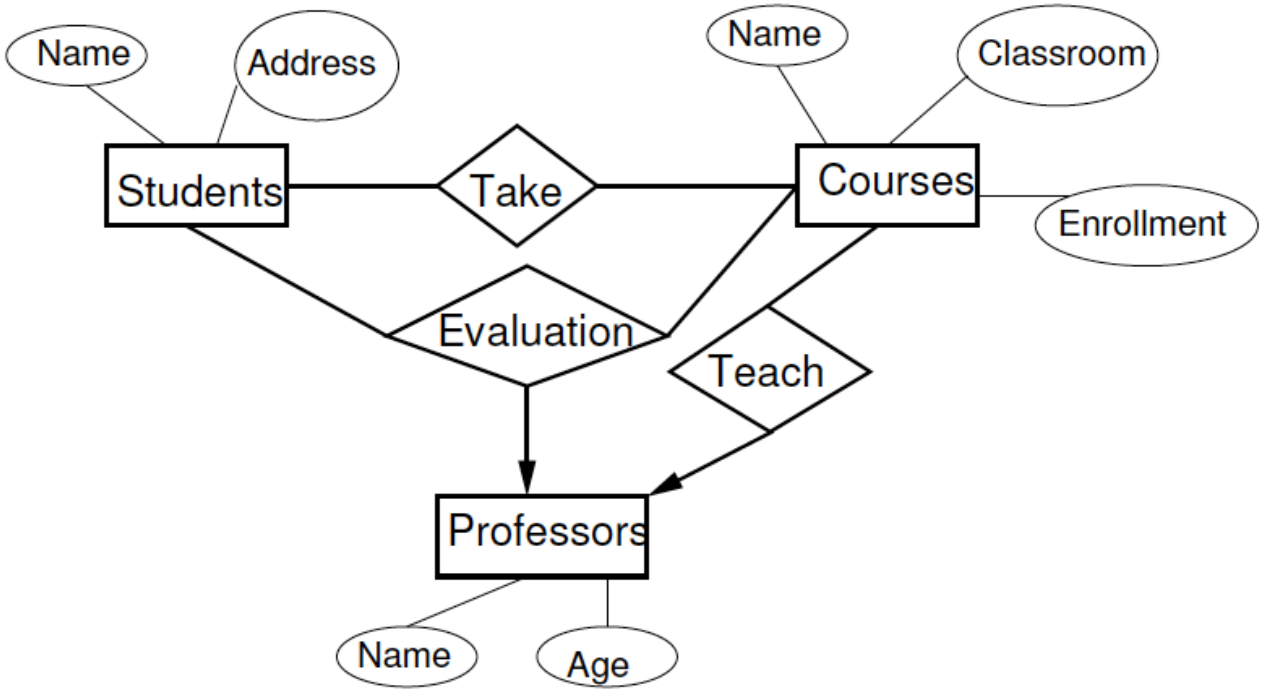
Select the right kind of element

- Attribute or Entity or Relationship
- Can we make Professor an attribute of Courses and remove the relationship Teach?



Select the right kind of element

- Attribute or Entity or Relationship
- What about now?



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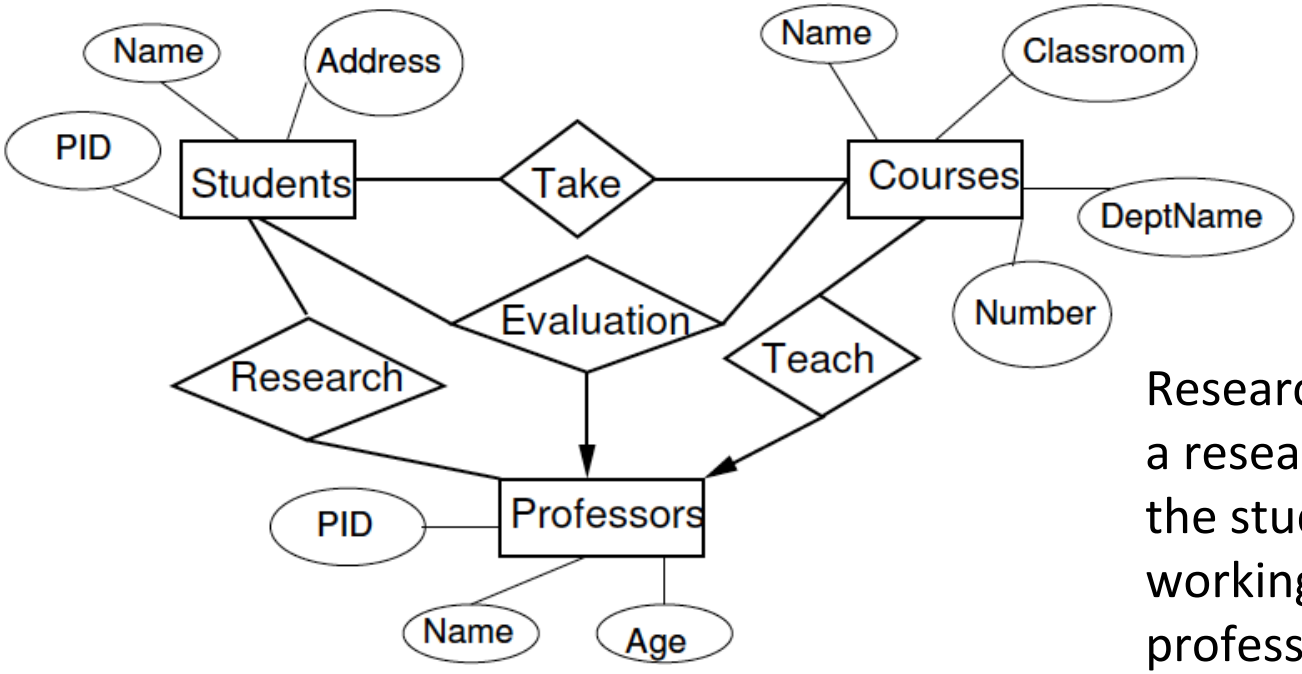


Research signifies a research project the student is working on with a professor

Converting an Entity Set into an Attribute

- **If** an entity set E satisfies the following properties:
  - All relationships involving E have arrows entering E
  - The attributes of E collectively identify an entity (i.e., no attribute depends on another)
  - No relationship involves E more than once
- **Then** we can replace E as follows:
  - If there is a many-one relationship R from an entity set F to E, remove R and make the attributes of E be attributes of F
  - If there is a multiway relationship R with an arrow to E, make E's attributes be new attributes of R and remove the arrow from R to E

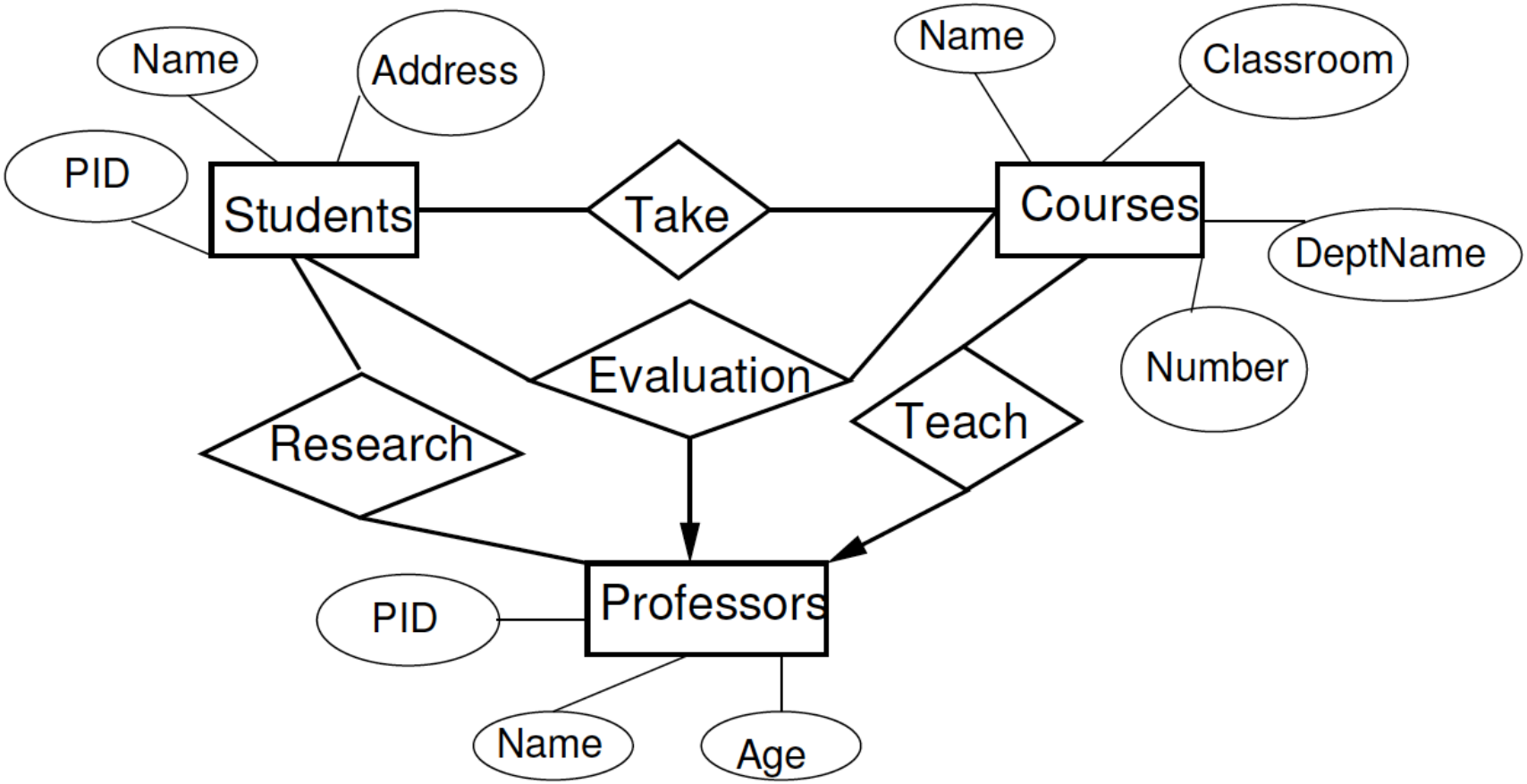
Types of Constraints

- **Keys** are attributes or sets of attributes that uniquely identify an entity within its entity set.
- **Single-value constraints** require that a value be unique in certain contexts.
- **Referential integrity constraints** require that a value referred to actually exists in the database.
- **Degree constraints** specify what set of values an attribute can take.
- **General constraints** are arbitrary constraints that should hold in the database.
- **Constraints are part of the schema of a database.**

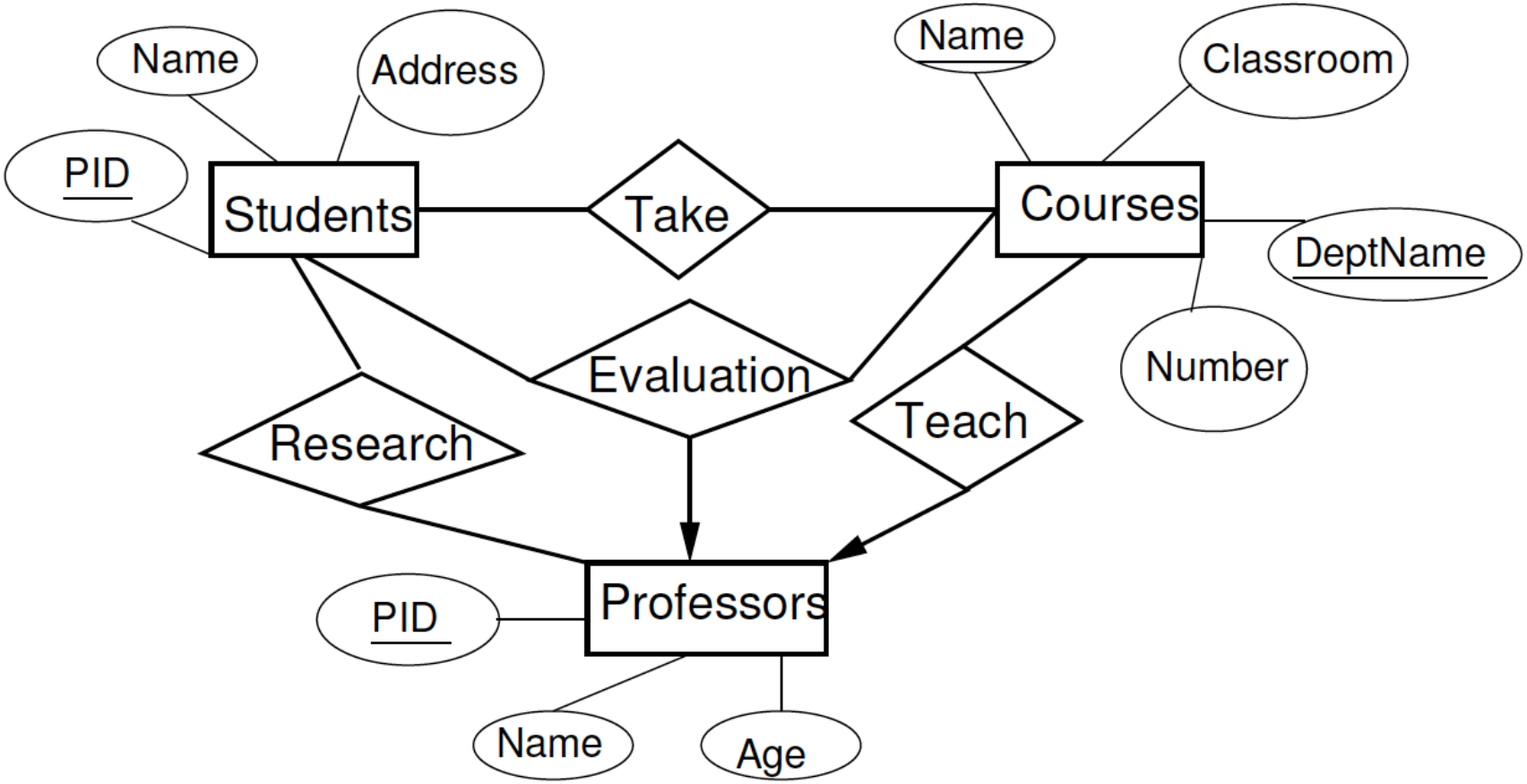
Keys in the E/R Model

- A key for an entity set E is a set K of one or more attributes such that given any two entities e1 and e2 in E, e1 and e2 cannot have identical values for all the attributes in K.
- E can have multiple keys. We designate one as the primary key.
- In an isa-hierarchy?
  - the root entity set must have all the attributes needed for a key.
- In an E/R diagram, underline the attributes that form the primary key

Keys: Example



Keys: Example



Single Value Constraints

- There is at most one value in a given context
- Each attribute of an entity set has a single value
  - If the value is missing, we can invent a “null" value
  - E/R models cannot represent the requirement that an attribute cannot have a null value
- A many-one relationship implies a single value constraint

Referential Integrity Constraint

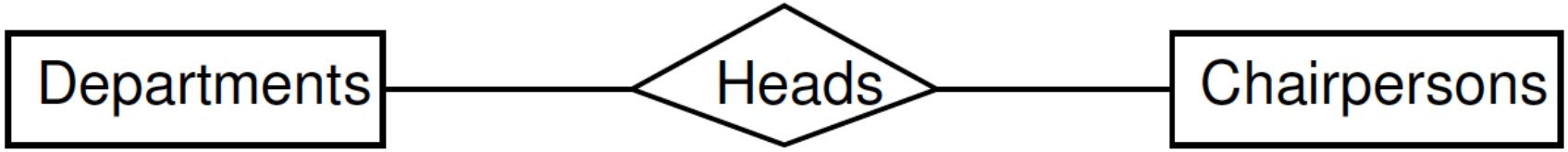
- Asserts that exactly one value exists in a given context
  - Usually used in the context of relationships
- Example: Many-one Advises relationship between Students and Professors
  - Many-one requirement says that no student may have more than one advising professor
  - Referential integrity constraint says that each student must have exactly one advising professor and that professor must be present in the database

Referential Integrity Constraint

- Asserts that exactly one value exists in a given context
  - Usually used in the context of relationships
- If R is a (many-to-one or one-to-one) relationship from E to F, we use a rounded arrowhead pointing to F to indicate that we require that the entity in F related by R to an entity in E must exist

Example: Referential Integrity Constraint

- Each department has at most one chairperson who is its head (there are times when a department may not have a chairperson)
- Each chairperson can be the head of at most one department and this department must exist in the database
- Where do we put arrows?



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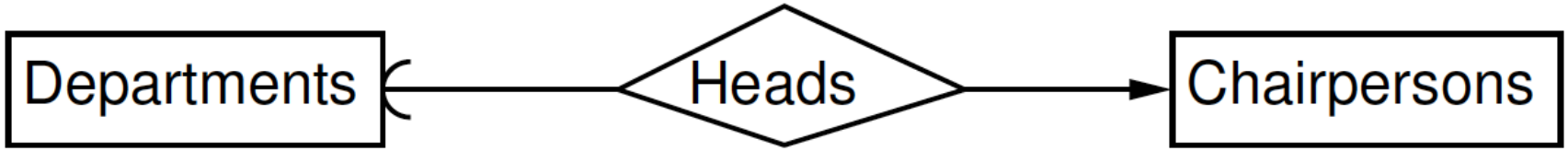
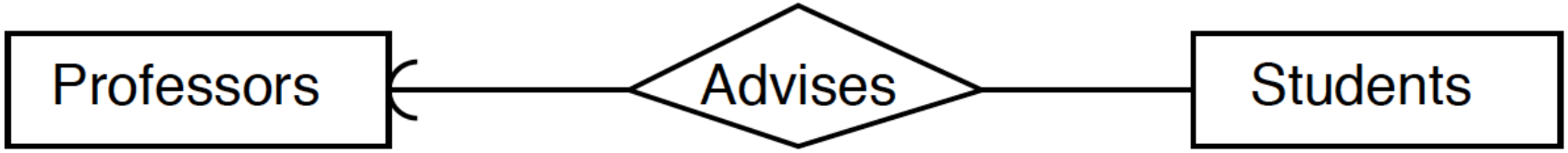


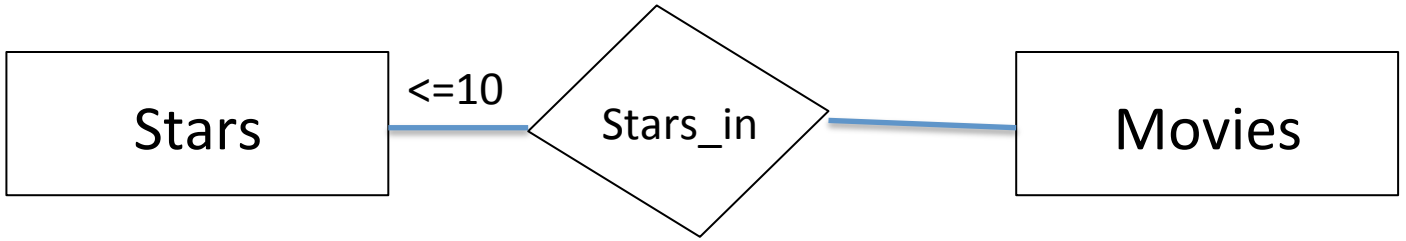
Enforcing Referential Integrity Constraints



- We forbid the deletion of a referenced entity (e.g., a professor) until the professor advises no students
- We require that if we delete a referenced entity, we delete all entities that reference it
- When we insert a (student, professor) pair into the Advises relationship, the professor must exist in the Professors entity set

Degree Constraints

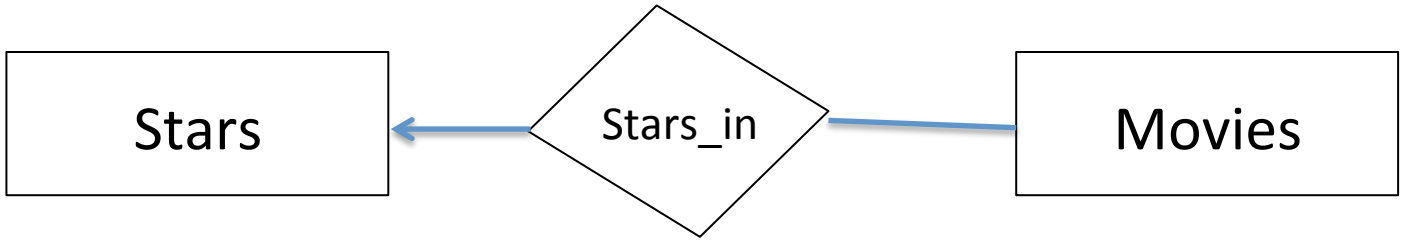
- Indicates limits on the # of entities that can be connected
- For example,



- Limits number of stars in each move to <=10

Degree Constraints

- Indicates limits on the # of entities that can be connected
- So you can think of



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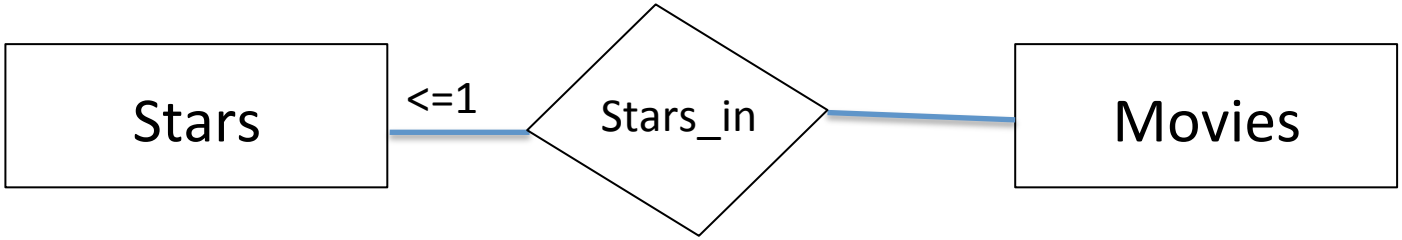
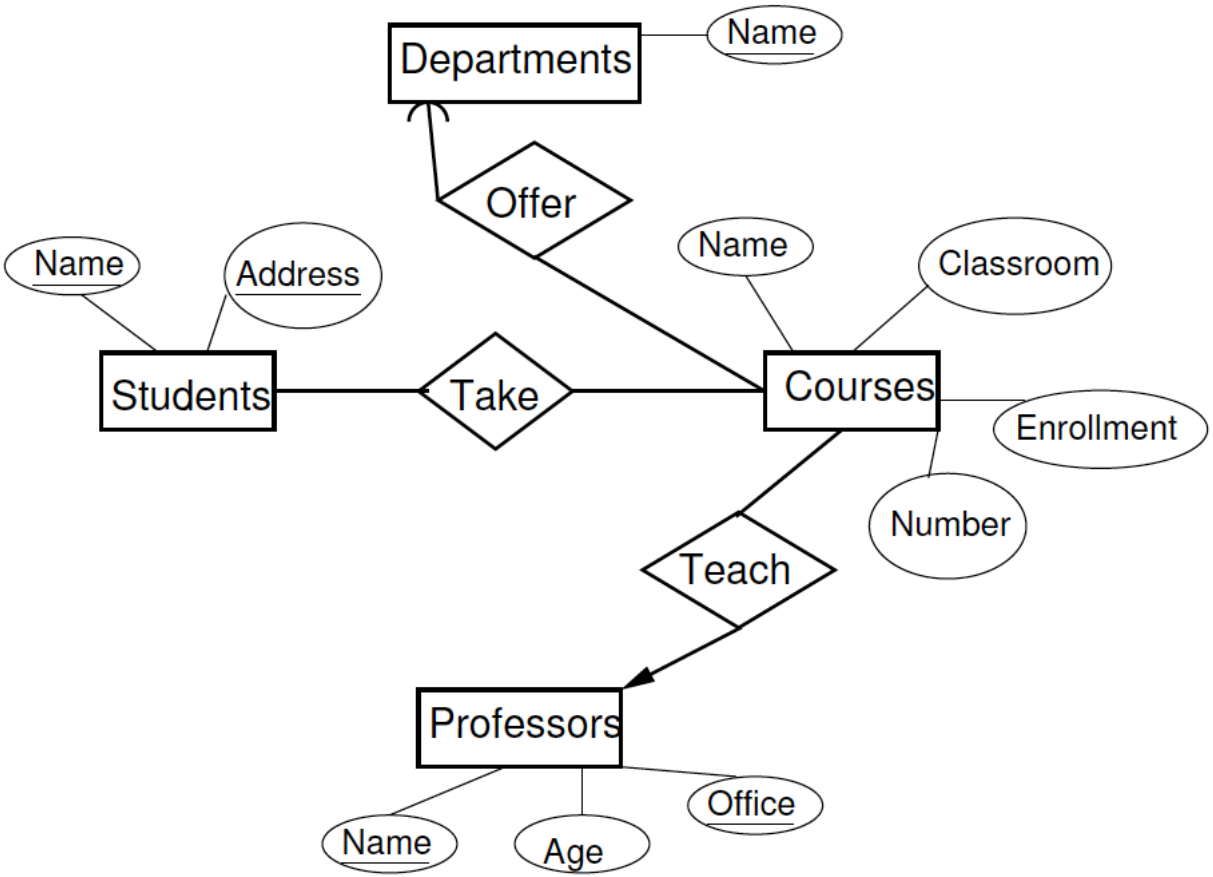


Weak Entity Sets

- A weak entity set is an entity set whose key contains attributes from one or more other entity sets.
- It is possible that all attributes in a weak entity set's key come from other entity sets.
- Primary causes for weak entity sets:
  - Hierarchy of entity sets (not caused by inheritance).

Example of Weak Entity Set

- Each department teaches multiple courses. Each course has a number. What is the key for the entity set Courses?



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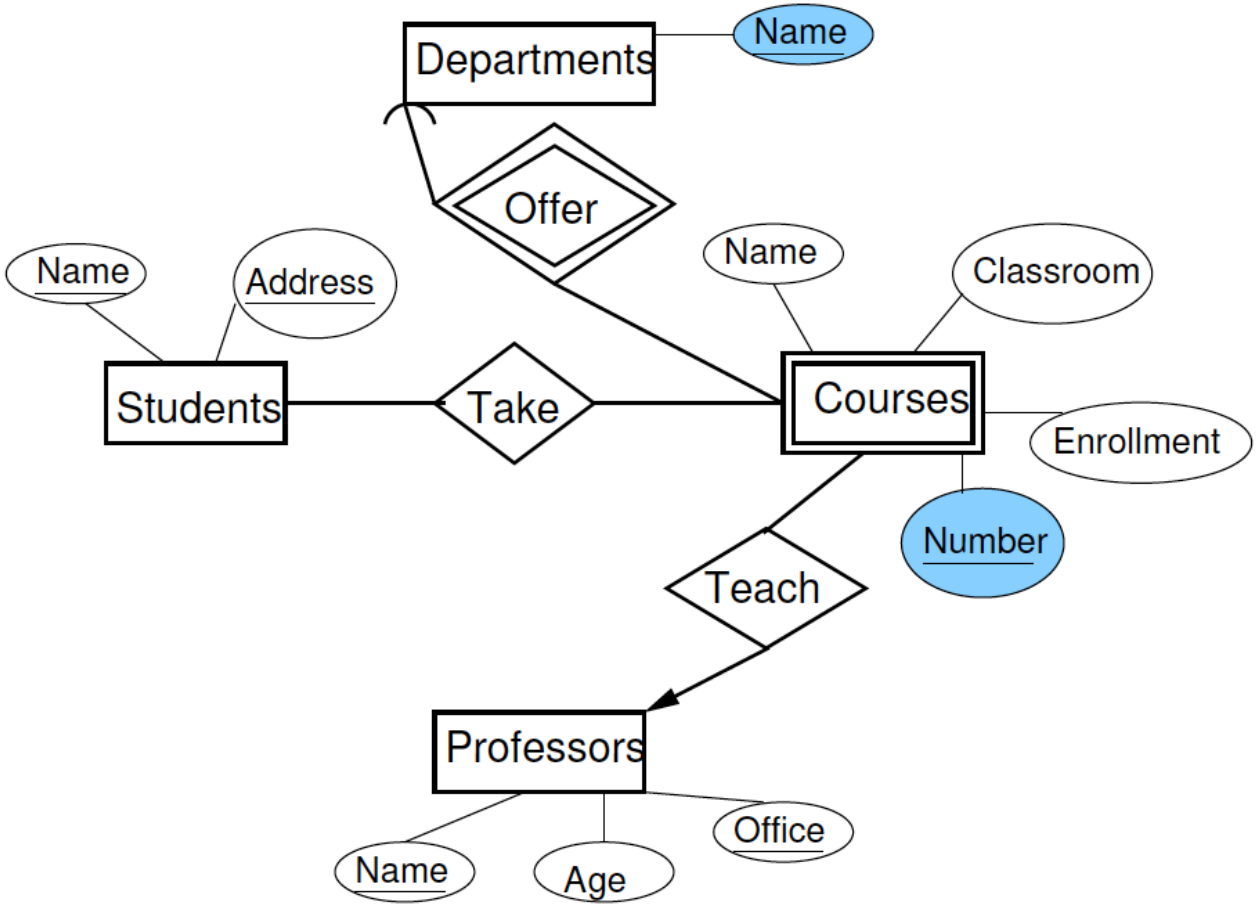

Finding the Key for a Weak Entity Set

- E is a weak entity set if its key consists of
  - Zero or more of its own attributes
  - Key attributes from supporting relationships for E
- A relationship R from a weak entity set E to F is supporting if
  - R is a binary, many-one relationship from E to F
  - R has referential integrity from E to F

Finding the Key for a Weak Entity Set contd…

- How does F help E?
  - F supplies its key attributes to define E's key
  - If F is itself a weak entity set, some of its key attributes come from entity sets to which F is connected by supporting relationships
- Representation in the E/R diagram
  - Weak entity set: rectangle with a double border
  - Supporting relationship: diamond with a double border