

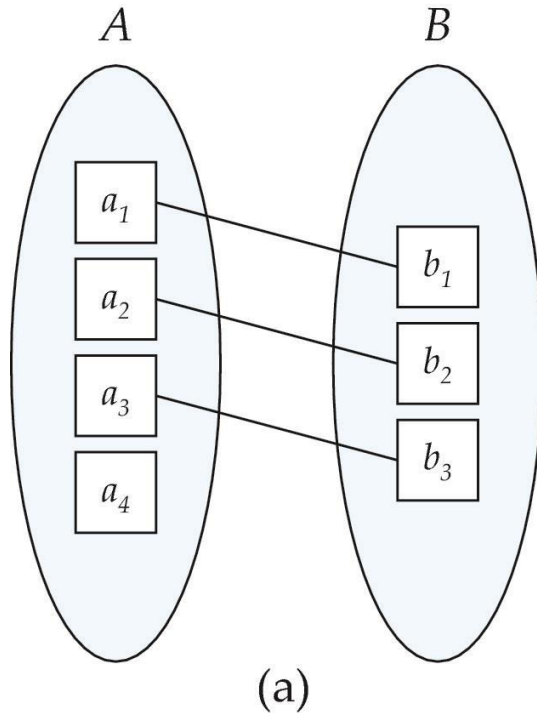
Degree of a Relationship Set

- binary relationship
 - involve two entity sets (or degree two).
 - most relationship sets in a database system are binary.
- Relationships between more than two entity sets are rare.
Most relationships are binary. (More on this later.)
 - ▶ Example: *students* work on research *projects* under the guidance of an *instructor*.
 - ▶ relationship *proj_guide* is a ternary relationship between *instructor*, *student*, and *project*

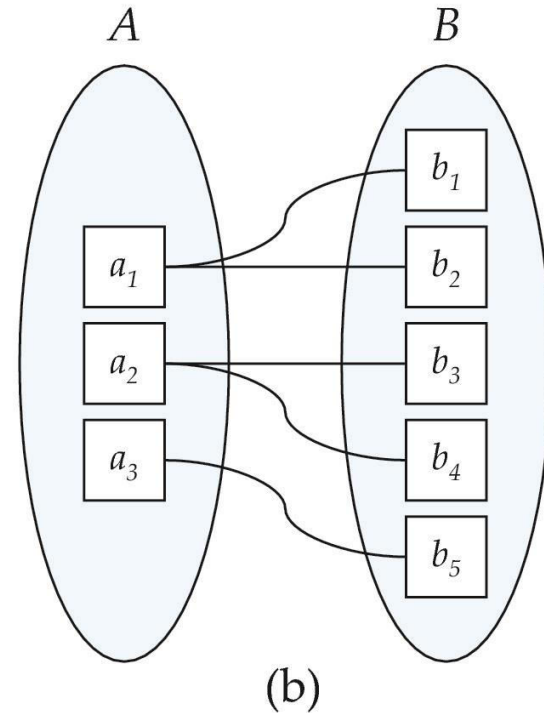
Mapping Cardinality Constraints

- Express the number of entities to which another entity can be associated 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
 - One to many
 - Many to one
 - Many to many

Mapping Cardinalities



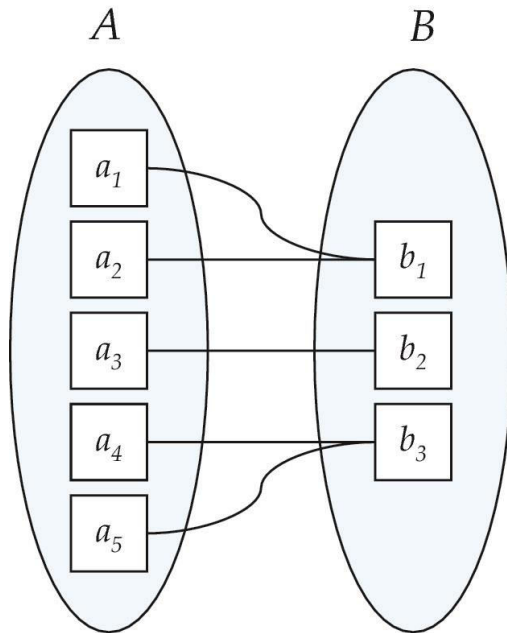
One to one



One to many

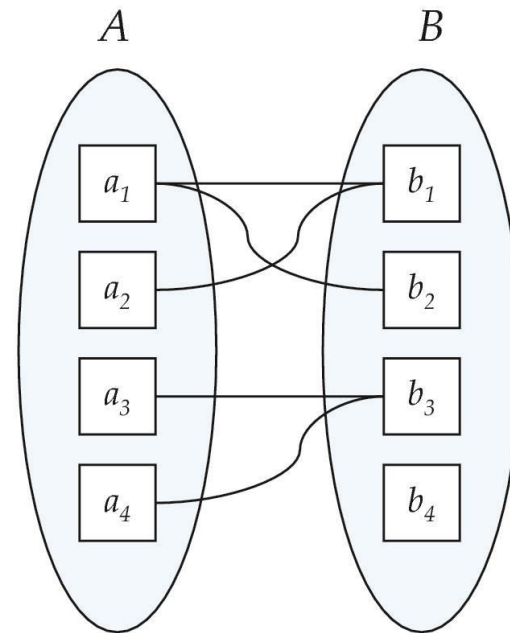
Note: Some elements in A and B may not be mapped to any elements in the other set

Mapping Cardinalities



(a)

Many to
one



(b)

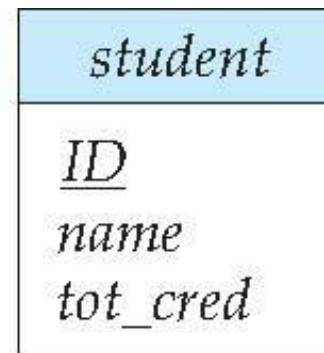
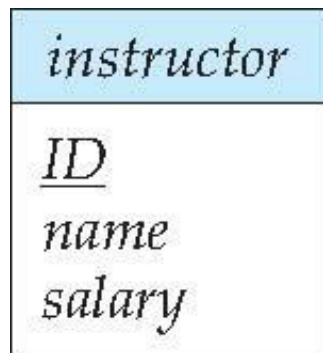
Many to many

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

E-R Diagrams

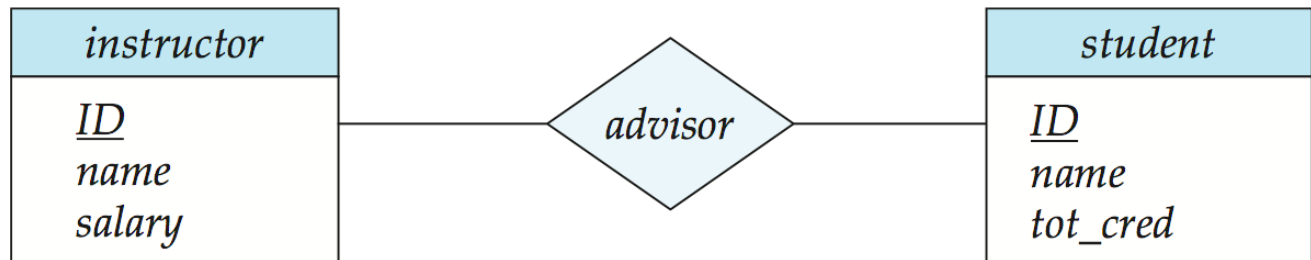
Entity Sets

- Entities can be represented graphically as follows:
 - Rectangles represent entity sets.
 - Attributes listed inside entity rectangle
 - Underline indicates primary key attributes

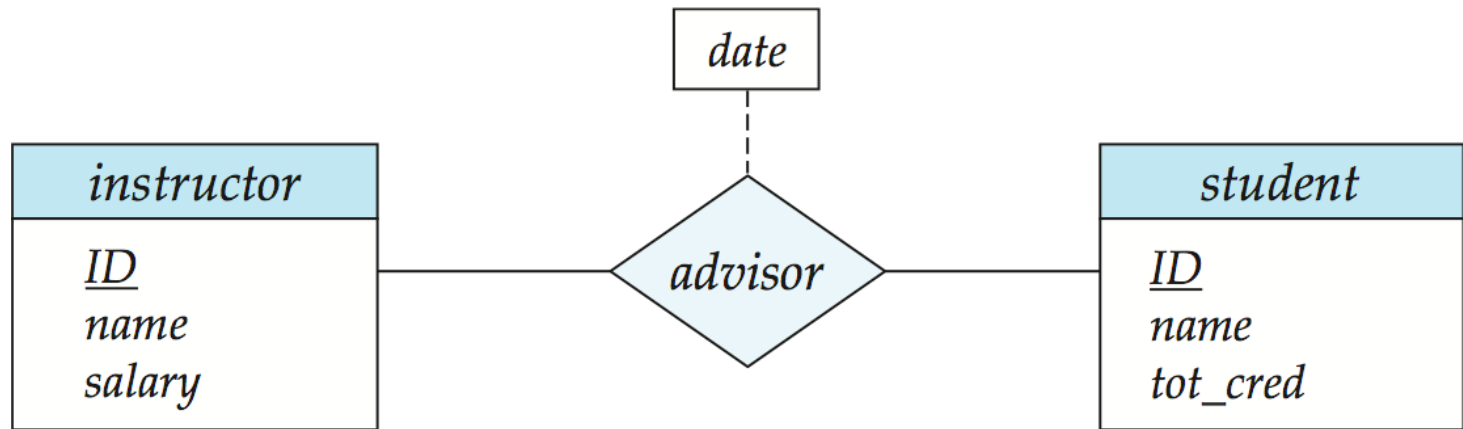


Relationship Sets

- Diamonds represent relationship sets.

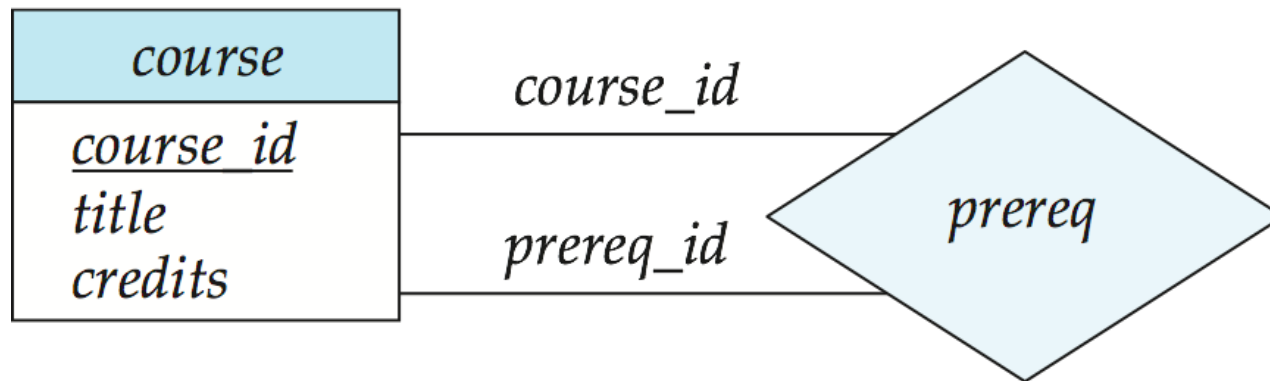


Relationship Sets with Attributes



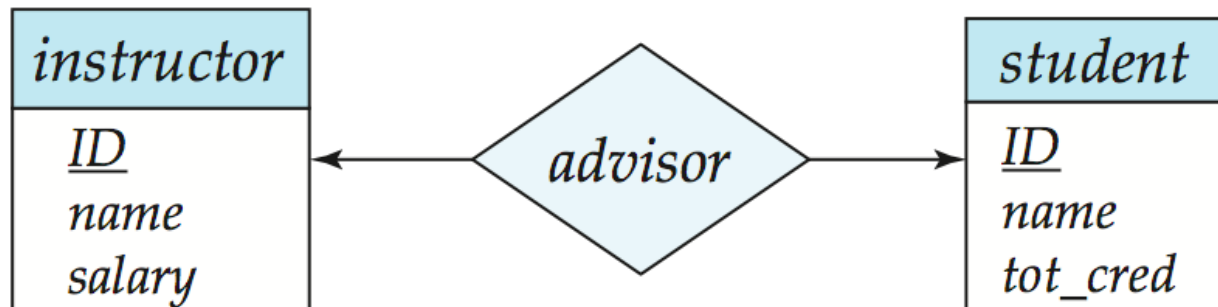
Roles

- Entity sets of a relationship need not be distinct
 - Each occurrence of an entity set plays a “role” in the relationship
- The labels “*course_id*” and “*prereq_id*” are called **roles**.



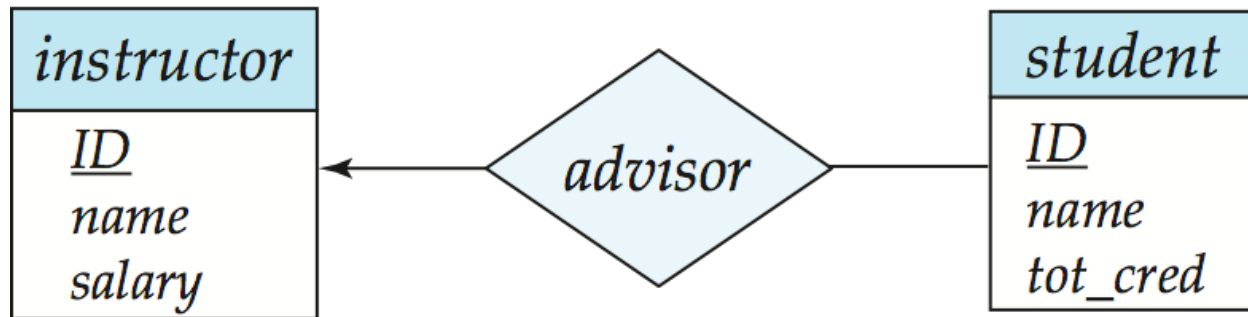
Cardinality Constraints

- We express cardinality constraints by drawing either a directed line (\rightarrow), signifying “one,” or an undirected line ($-$), signifying “many,” between the relationship set and the entity set.
- One-to-one relationship between an *instructor* and a *student* :
 - A student is associated with at most one *instructor* via the relationship *advisor*
 - A *student* is associated with at most one *department* via *stud_dept*



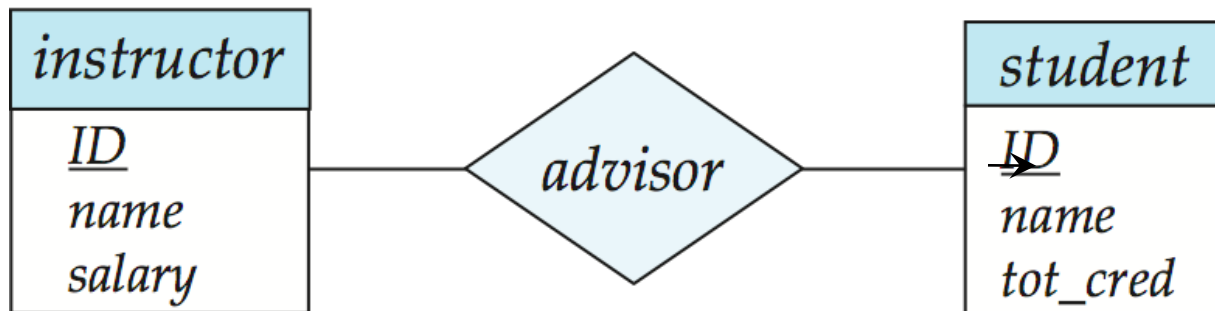
One-to-Many Relationship

- one-to-many relationship between an *instructor* and a *student*
 - an instructor is associated with several (including 0) students via *advisor*
 - a student is associated with at most one instructor via *advisor*,



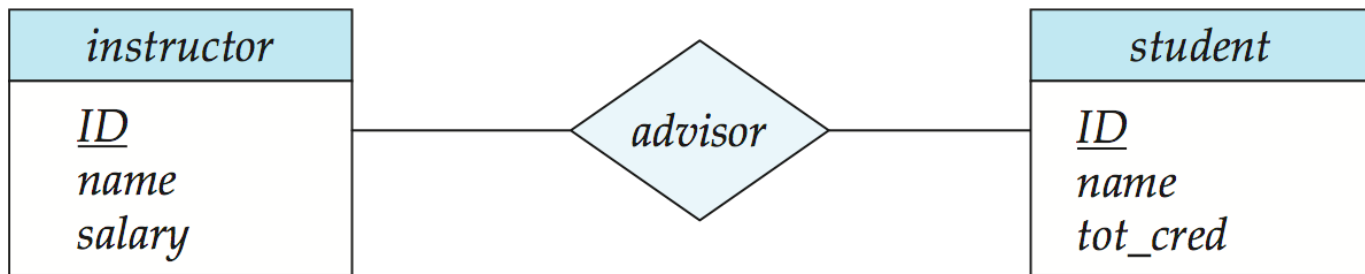
Many-to-One Relationships

- In a many-to-one relationship between an *instructor* and a *student*,
 - an instructor is associated with at most one student via *advisor*,
 - and a student is associated with several (including 0) instructors via *advisor*



Many-to-Many Relationship

- An instructor is associated with several (possibly 0) students via *advisor*
- A student is associated with several (possibly 0) instructors via *advisor*



Total and Partial Participation

- Total participation (indicated by double line): every entity in the entity set participates in at least one relationship in the relationship set



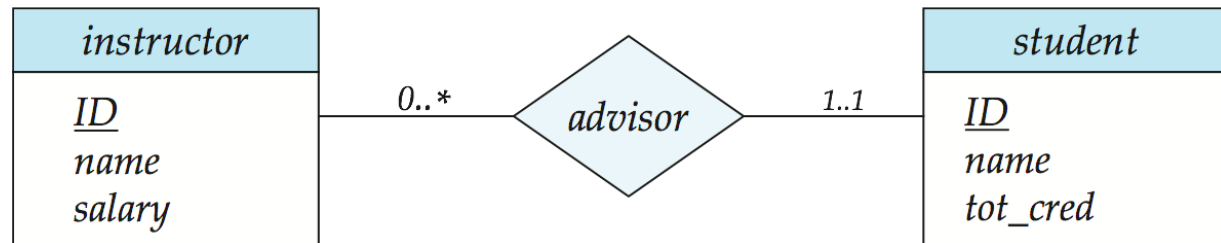
participation of *student* in *advisor* relation is total

- ▶ every *student* must have an associated instructor

- Partial participation: some entities may not participate in any relationship in the relationship set
 - Example: participation of *instructor* in *advisor* is partial

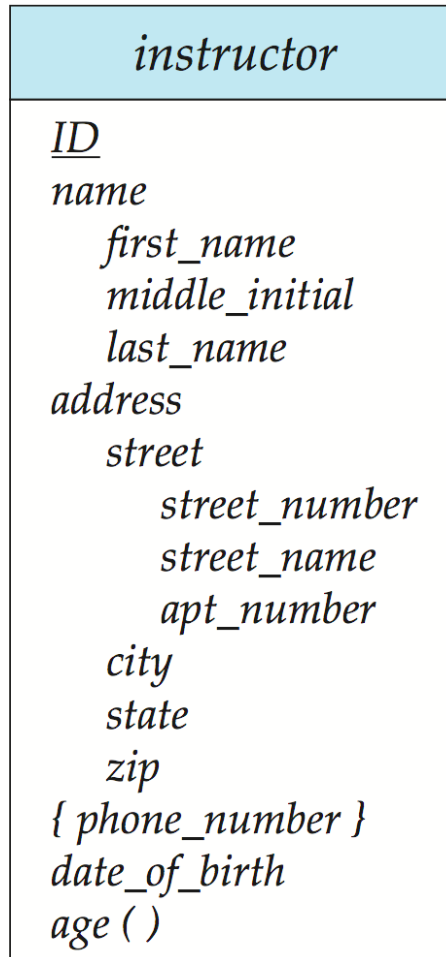
Notation for Expressing More Complex Constraints

- A line may have an associated minimum and maximum cardinality, shown in the form $l..h$, where l is the minimum and h the maximum cardinality
 - A minimum value of 1 indicates total participation.
 - A maximum value of 1 indicates that the entity participates in at most one relationship
 - A maximum value of * indicates no limit.



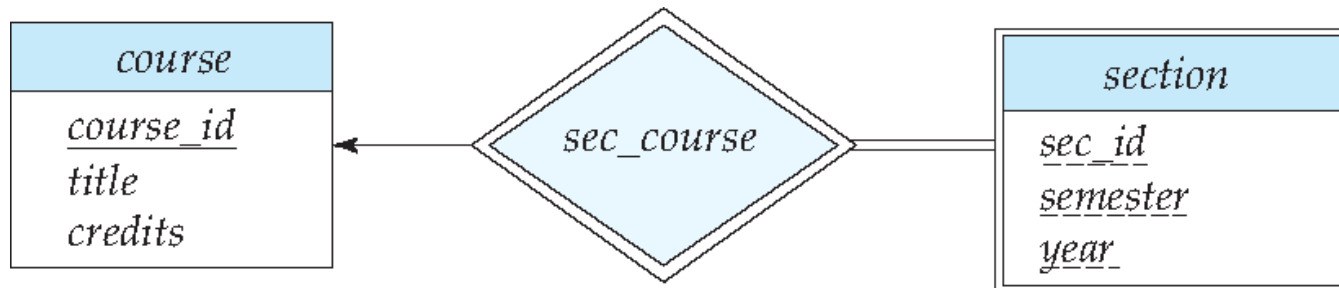
Instructor can advise 0 or more students. A student must have 1 advisor; cannot have multiple advisors

Notation to Express Entity with Complex Attributes



Expressing Weak Entity Sets

- In E-R diagrams, a weak entity set is depicted via a double rectangle.
- We underline the discriminator of a weak entity set with a dashed line.
- The relationship set connecting the weak entity set to the identifying strong entity set is depicted by a double diamond.
- Primary key for *section* – (*course_id*, *sec_id*, *semester*, *year*)

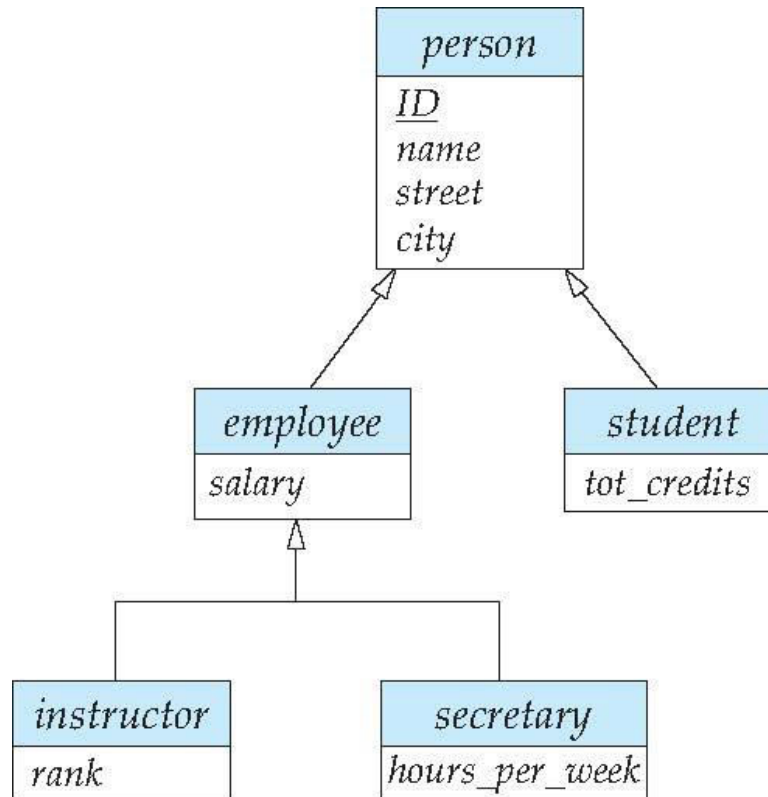


Specialization

- Top-down design process; we designate sub-groupings within an entity set that are distinctive from other entities in the set.
- These sub-groupings become lower-level entity sets that have attributes or participate in relationships that do not apply to the higher-level entity set.
- Depicted by a *triangle* component labeled ISA (e.g., *instructor “is a” person*).
- **Attribute inheritance** – a lower-level entity set inherits all the attributes and relationship participation of the higher-level entity set to which it is linked.

Specialization Example

- **Overlapping** – *employee* and *student*
- **Disjoint** – *instructor* and *secretary*
- Total and partial



Representing Specialization via Schemas

- Method 1:
 - Form a schema for the higher-level entity
 - Form a schema for each lower-level entity set, include primary key of higher-level entity set and local attributes

schema	attributes
person	ID, name, street, city
student	ID, tot_cred
employee	ID, salary

- Drawback: getting information about, an *employee* requires accessing two relations, the one corresponding to the low-level schema and the one corresponding to the high-level schema

Representing Specialization as Schemas (Cont.)

- Method 2:

- Form a schema for each entity set with all local and inherited attributes

schema	attributes
person	ID, name, street, city
student	ID, name, street, city, tot_cred
employee	ID, name, street, city, salary

- Drawback: *name*, *street* and *city* may be stored redundantly for people who are both students and employees

Generalization

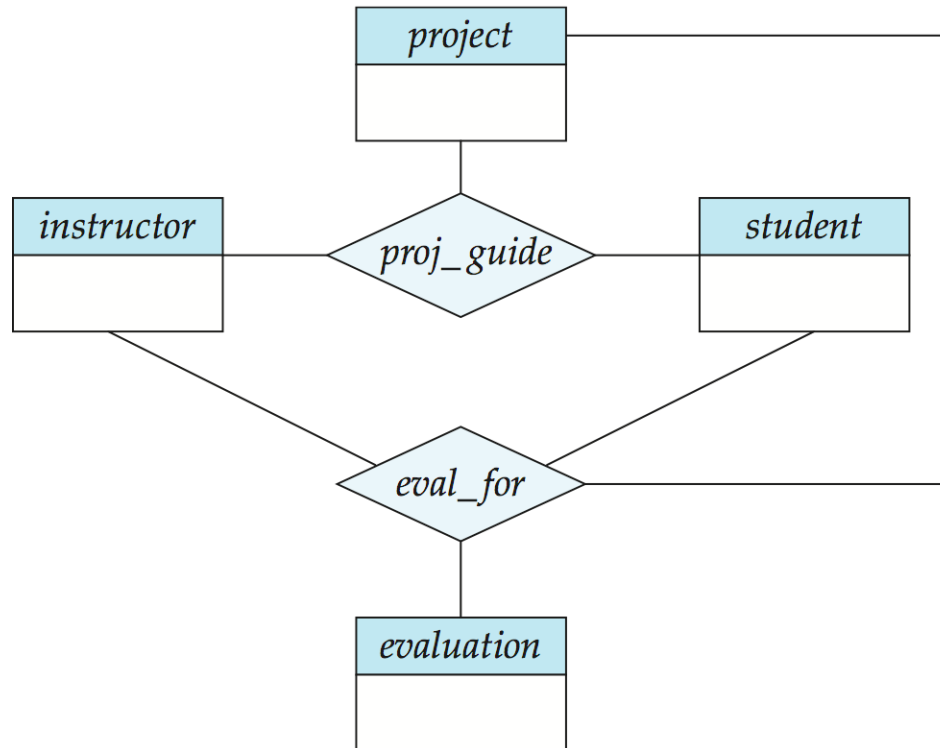
- **A bottom-up design process** – combine a number of entity sets that share the same features into a higher-level entity set.
- Specialization and generalization are simple inversions of each other; they are represented in an E-R diagram in the same way.
- The terms specialization and generalization are used interchangeably.

Design Constraints on a Specialization/Generalization

- **Completeness constraint** -- specifies whether or not an entity in the higher-level entity set must belong to at least one of the lower-level entity sets within a generalization.
 - **total**: an entity must belong to one of the lower-level entity sets
 - **partial**: an entity need not belong to one of the lower-level entity sets
- Partial generalization is the default. We can specify total generalization in an ER diagram by adding the keyword **total** in the diagram and drawing a dashed line from the keyword to the corresponding hollow arrow-head to which it applies (for a total generalization), or to the set of hollow arrow-heads to which it applies (for an overlapping generalization).
- The *student* generalization is total: All student entities must be either graduate or undergraduate. Because the higher-level entity set arrived at through generalization is generally composed of only those entities in the lower-level entity sets, the completeness constraint for a generalized higher-level entity set is usually total

Aggregation

- Consider the ternary relationship *proj_guide*, which we saw earlier
- Suppose we want to record evaluations of a student by a guide on a project



Aggregation (Cont.)

- Relationship sets *eval_for* and *proj_guide* represent overlapping information
 - Every *eval_for* relationship corresponds to a *proj_guide* relationship
 - However, some *proj_guide* relationships may not correspond to any *eval_for* relationships
 - So we can't discard the *proj_guide* relationship
- Eliminate this redundancy via *aggregation*
 - Treat relationship as an abstract entity
 - Allows relationships between relationships
 - Abstraction of relationship into new entity

Aggregation (Cont.)

- Eliminate this redundancy via *aggregation* without introducing redundancy, the following diagram represents:
 - A student is guided by a particular instructor on a particular project
 - A student, instructor, project combination may have an associated evaluation

