

Chapter 7: Entity-Relationship Model

E-R diagrams

Database System Concepts, 7th Ed.

©Silberschatz, Korth and Sudarshan

See www.db-book.com for conditions on re-use



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

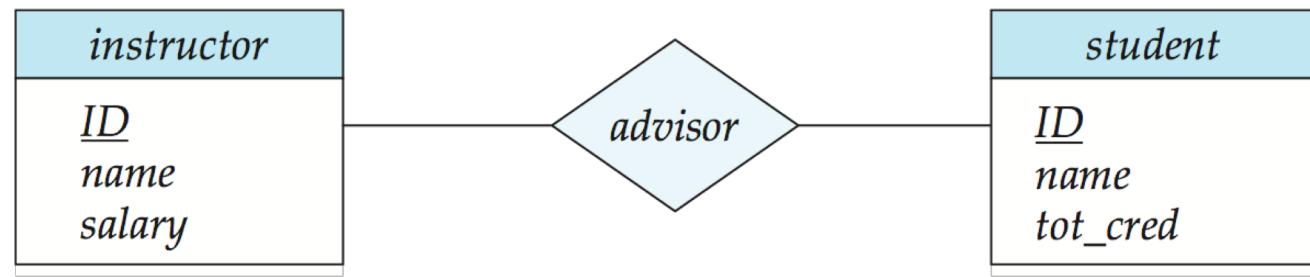
<i>instructor</i>
<u>ID</u>
<i>name</i>
<i>salary</i>

<i>student</i>
<u>ID</u>
<i>name</i>
<i>tot_cred</i>



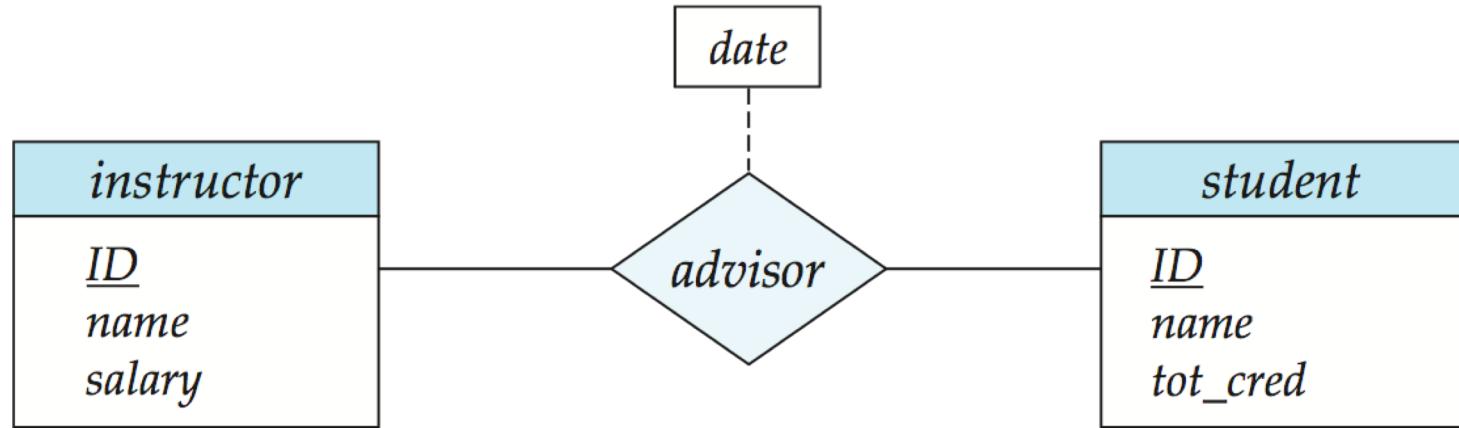
Relationship Sets

- Diamonds represent relationship sets.





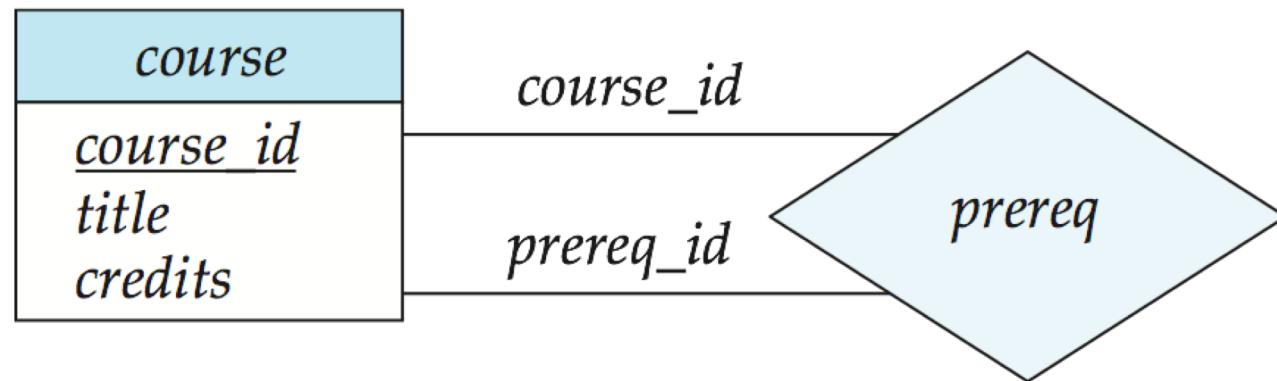
Relationship Sets with Attributes





Roles

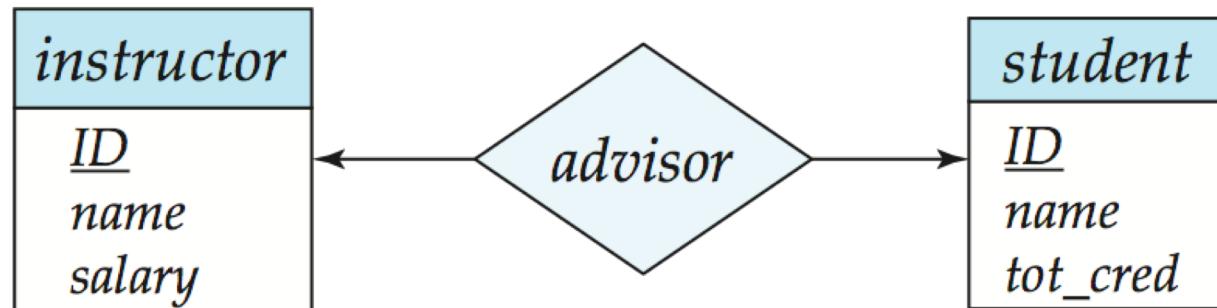
- Entity sets of a relationship need not be distinct
 - Each occurrence of an entity set plays a “role” in the relationship
- The labels “*course_id*” and “*prereq_id*” are called **roles**.





Cardinality Constraints

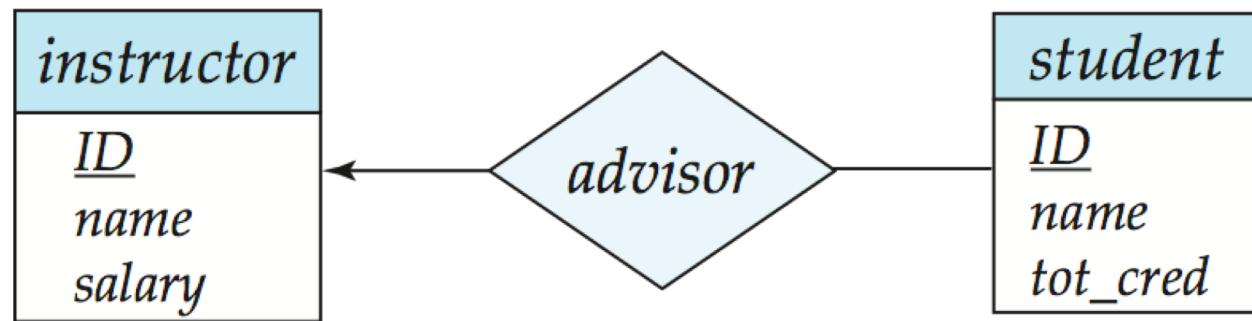
- We express cardinality constraints by drawing either a directed line (\rightarrow), signifying “one,” or an undirected line ($-$), signifying “many,” between the relationship set and the entity set.
- One-to-one relationship between an *instructor* and a *student* :
 - A student is associated with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





One-to-Many Relationship

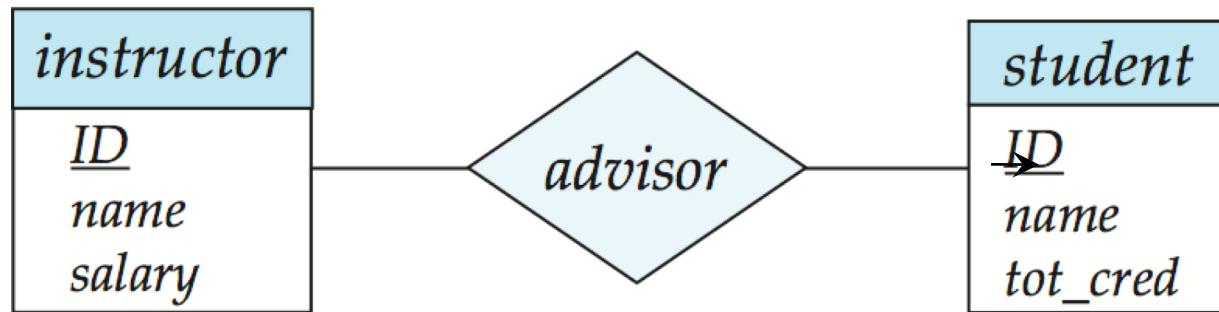
- one-to-many relationship between an *instructor* and a *student*
 - an instructor is associated with several (including 0) students via *advisor*
 - a student is associated with at most one instructor via advisor,





Many-to-One Relationships

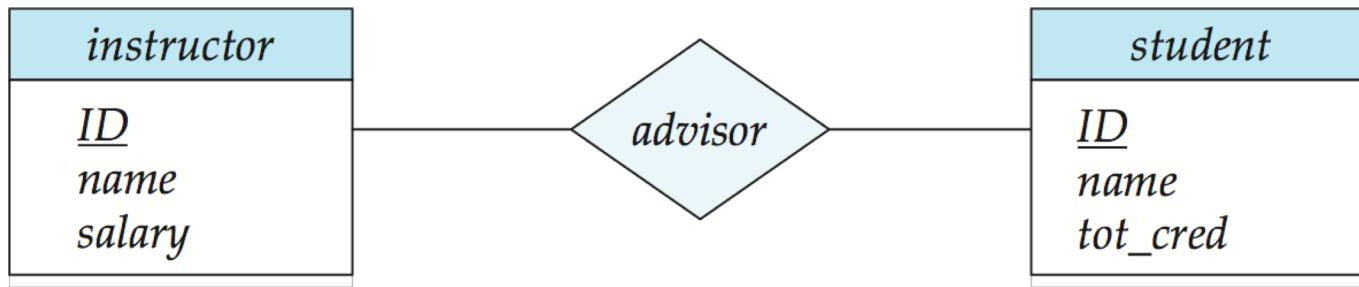
- In a many-to-one relationship between an *instructor* and a *student*,
 - an *instructor* is associated with at most one *student* via *advisor*,
 - and a *student* is associated with several (including 0) *instructors* via *advisor*





Many-to-Many Relationship

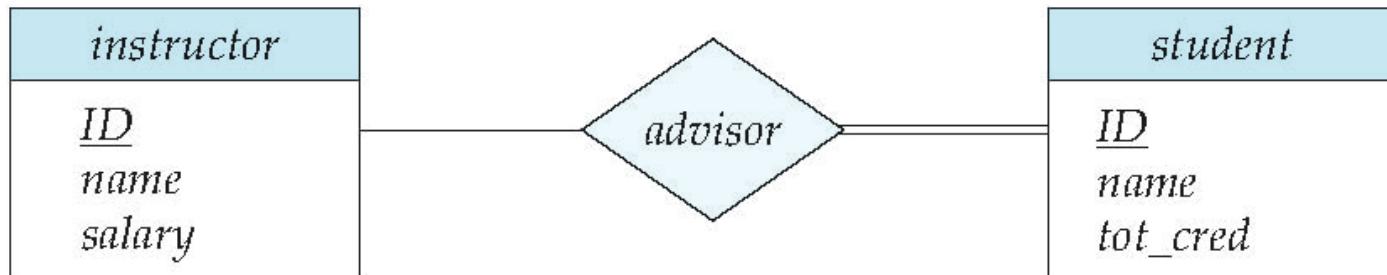
- An instructor is associated with several (possibly 0) students via *advisor*
- A student is associated with several (possibly 0) instructors via *advisor*





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



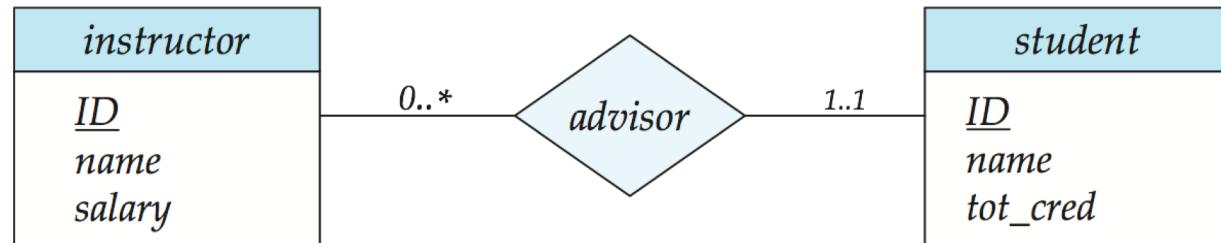
participation of *student* in *advisor* relation is total

- ▶ 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



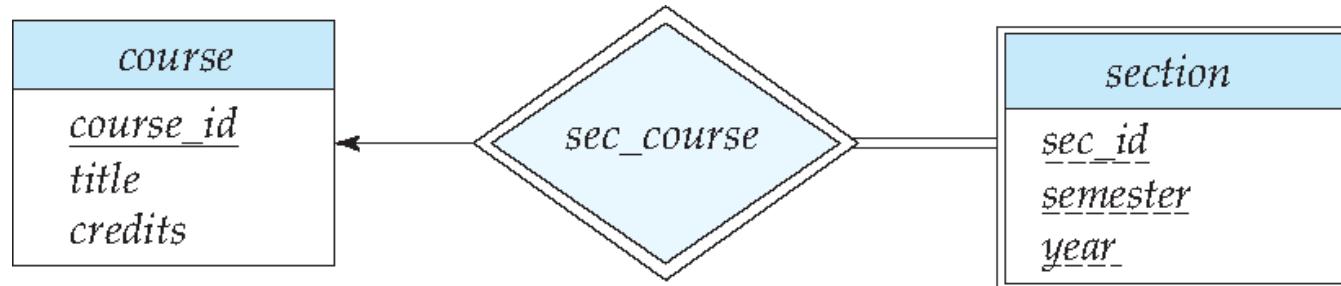
Notation to Express Entity with Complex Attributes

<i>instructor</i>
<i>ID</i>
<i>name</i>
<i>first_name</i>
<i>middle_initial</i>
<i>last_name</i>
<i>address</i>
<i>street</i>
<i>street_number</i>
<i>street_name</i>
<i>apt_number</i>
<i>city</i>
<i>state</i>
<i>zip</i>
{ <i>phone_number</i> }
<i>date_of_birth</i>
<i>age</i> ()



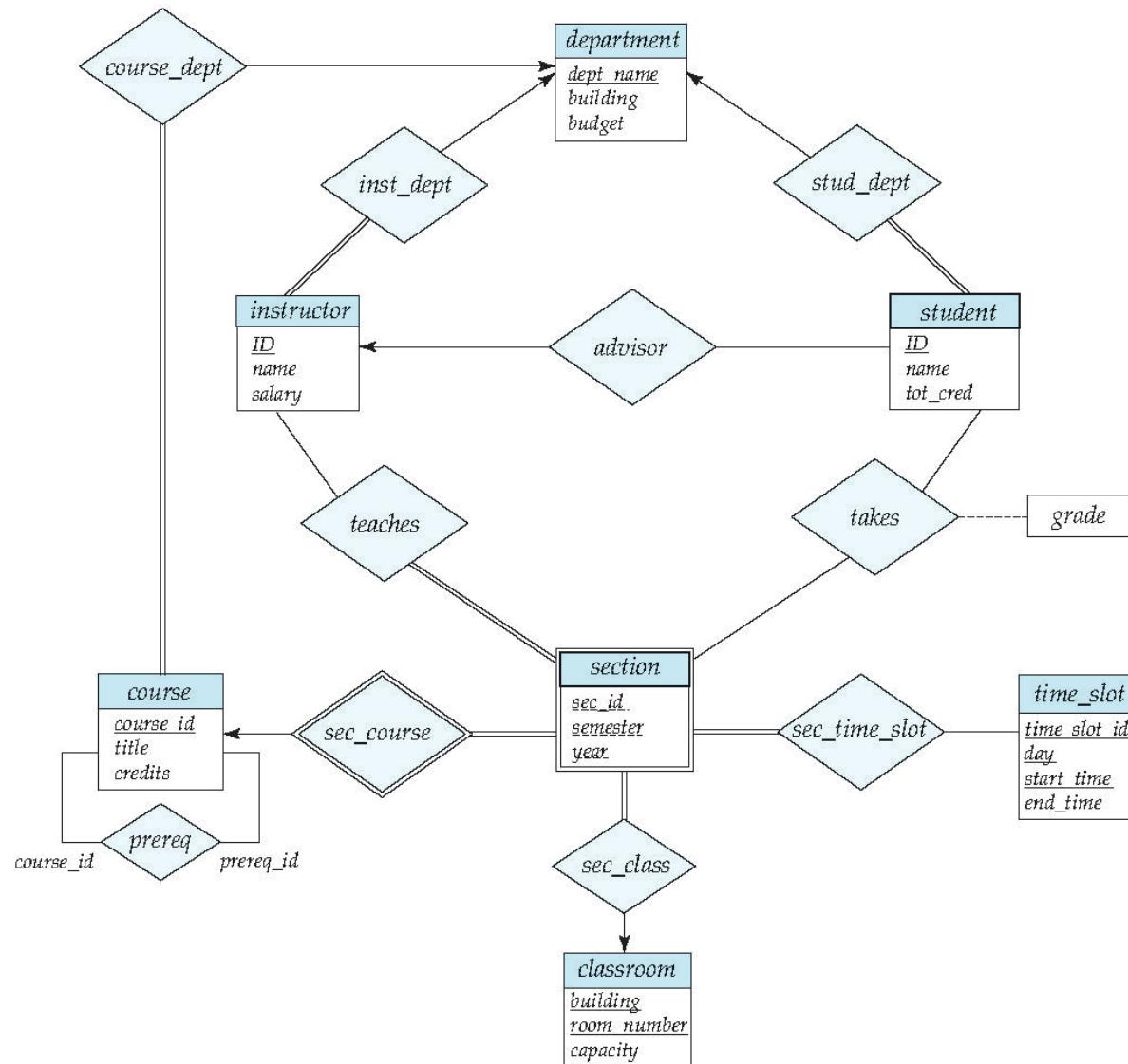
Expressing Weak Entity Sets

- 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*)





E-R Diagram for a University Enterprise



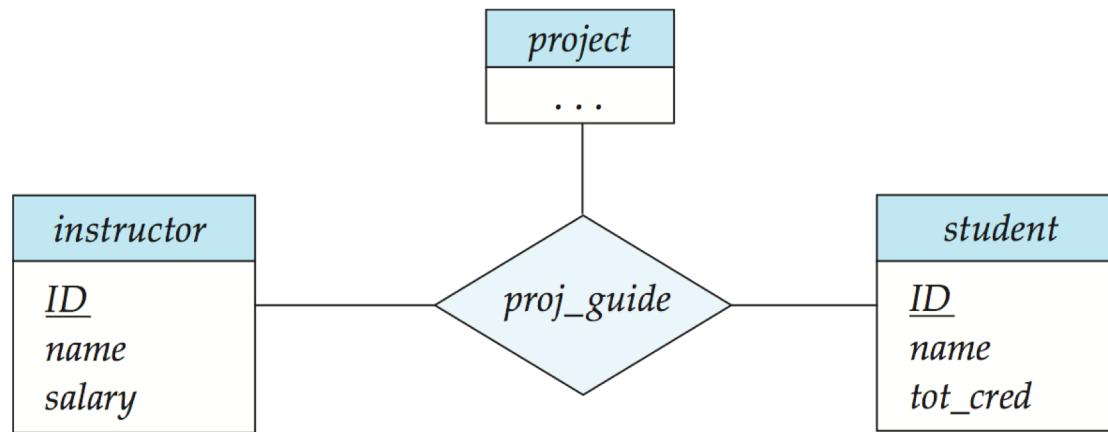


Advanced Topics



Non-binary Relationship Sets

- Most relationship sets are binary
- There are occasions when it is more convenient to represent relationships as non-binary.
- E-R Diagram with a Ternary Relationship





Cardinality Constraints on Ternary Relationship

- We allow at most one arrow out of a ternary (or greater degree) relationship to indicate a cardinality constraint
- For example, an arrow from *proj_guide* to *instructor* indicates each student has at most one guide for a project
- If there is more than one arrow, there are two ways of defining the meaning.
 - For example, a ternary relationship *R* between *A*, *B* and *C* with arrows to *B* and *C* could mean
 1. Each *A* entity is associated with a unique entity from *B* and *C* or
 2. Each pair of entities from (*A*, *B*) is associated with a unique *C* entity, and each pair (*A*, *C*) is associated with a unique *B*
 - Each alternative has been used in different formalisms
 - To avoid confusion we outlaw more than one arrow



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

