Entity-Relationship Model

("E-R" Diagrams/Models)

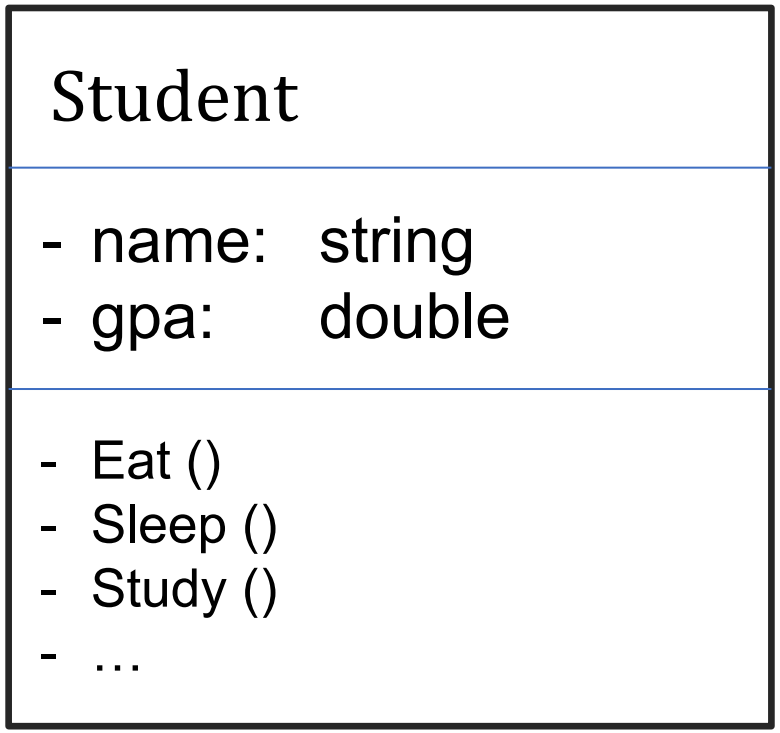
UNIVERSITY OF VIRGINIA
DATA SCIENCE
INSTITUTE

Creating your own database?

- How do you know what tables to use?
- *What was your thought process?*

Class Diagram

(something you might see in an early CS course)



- Class name
- Class attributes / fields
- Class operations / methods

Most of you are familiar with the Object-Oriented model
(classes, how messages are passed, etc)
Doing ER is relatively easy – it's OO for DBs!

Modeling

- So what is ER? **“Entity-Relationship”** Model

- A *database* can be modeled as:
  - a collection of entities, and
  - relationship among entities.

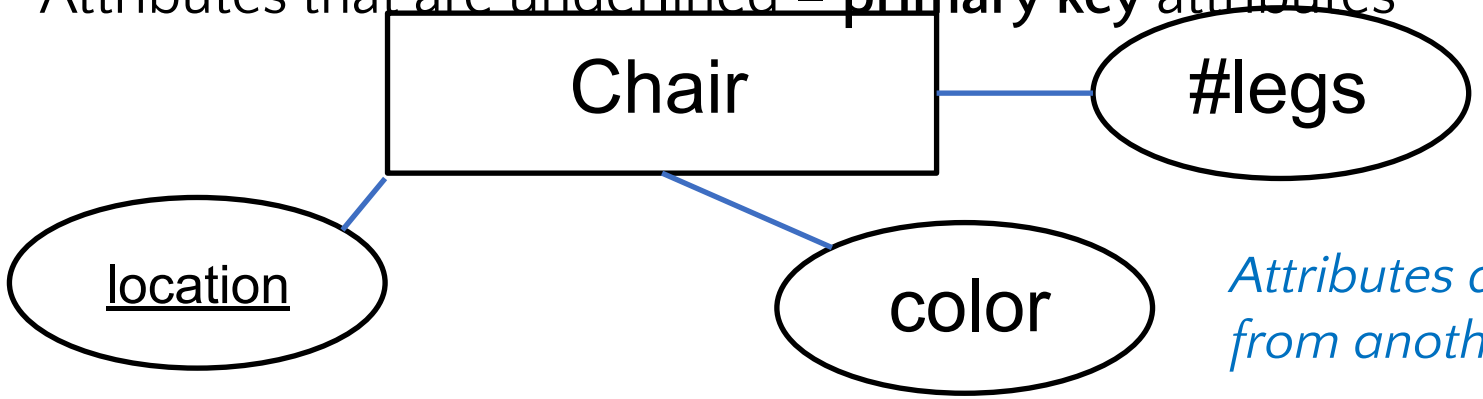
Modeling

Entity – Database version of a "Class"
Entity attributes – Database version of Class fields

- An **entity** is an object that exists and is distinguishable from other objects.
  - Example: specific person, company, event, plant
- Entities have **attributes** (and ***domains*** for the attributes)
  - Example: people have *names* and *addresses*
- An **entity set** is a set of entities of the same type that share the same properties.
  - Example: set of all persons, companies, trees, holidays

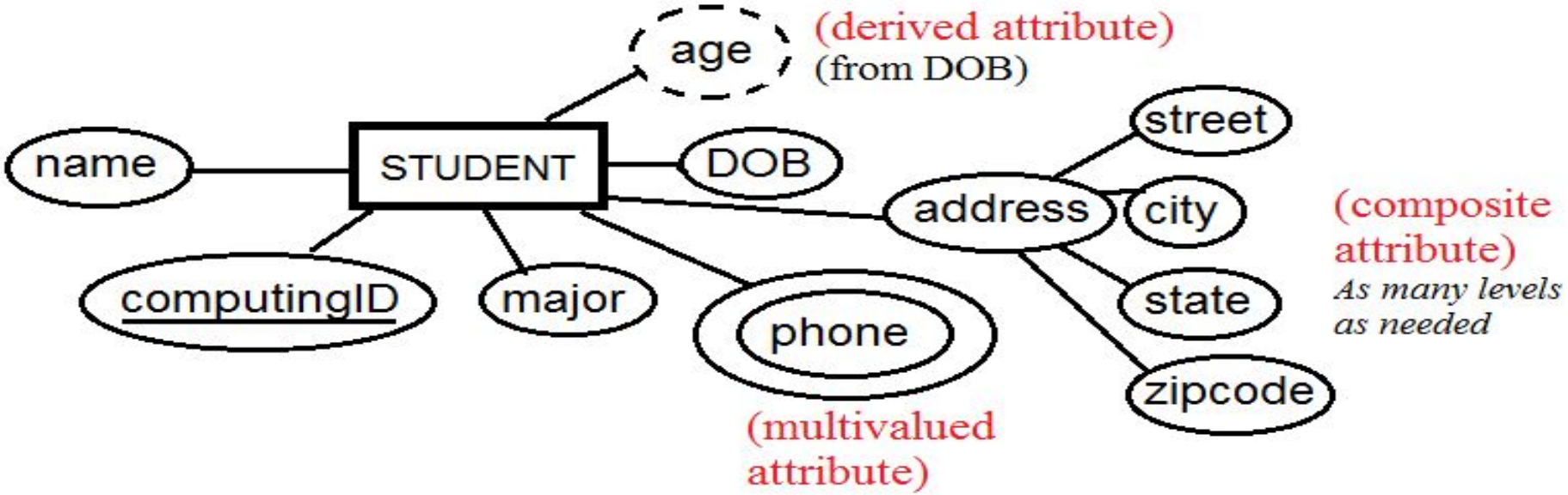
E-R Diagrams - Basics

- For instance, an entity set in this room: Chairs
- Entities – represented by *rectangles*
- Attributes – represented by *ovals*
  - Attributes that are underlined – **primary key** attributes



Attributes are what defines one entity from another entity in an entity set.

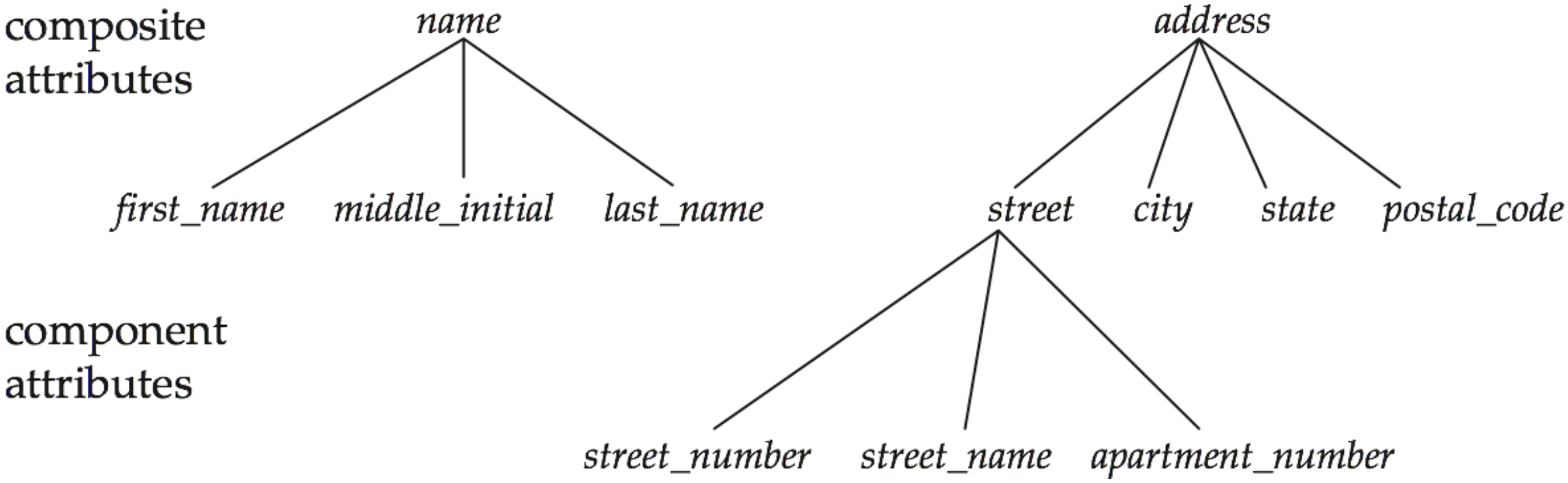
E-R Diagrams - Basics



The multivalued attribute (vs. single-valued) allows you to have multiple values at the same time.

If picked, say, 3 numbers (p1, p2, and p3), what would you do with people who had one, or five?

E-R Diagrams – Composite Attributes



Relationships

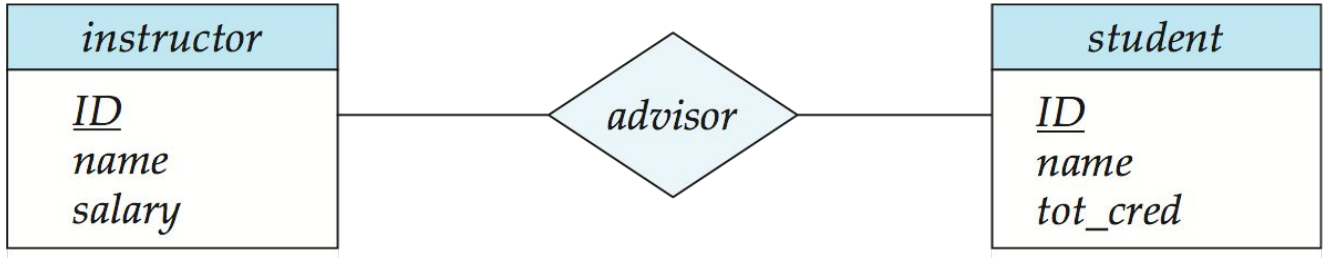
- We now have two entities – Chair and Student
- Each has a primary key
- A **relationship** is an association among several entities (the ways these two relate to one another)
  - Example: 22217 (Jones) advisor 44499 (Einstein)
    student entity **relationship set** **instructor entity**
- A relationship set is a mathematical relation among ≥ 2 entities, each taken from entity sets

  $\{(e_1, e_2, \ldots e_n) \mid e_1 \in E_1, e_2 \in E_2, \ldots, e_n \in E_n\}$

  where $(e_1, e_2, \ldots, e_n)$ is a relationship
  - Example: $(44553,22222) \in advisor$

Relationships

- Relationship – represented by *diamonds*
- Example: Advisor relationship between instructor and student



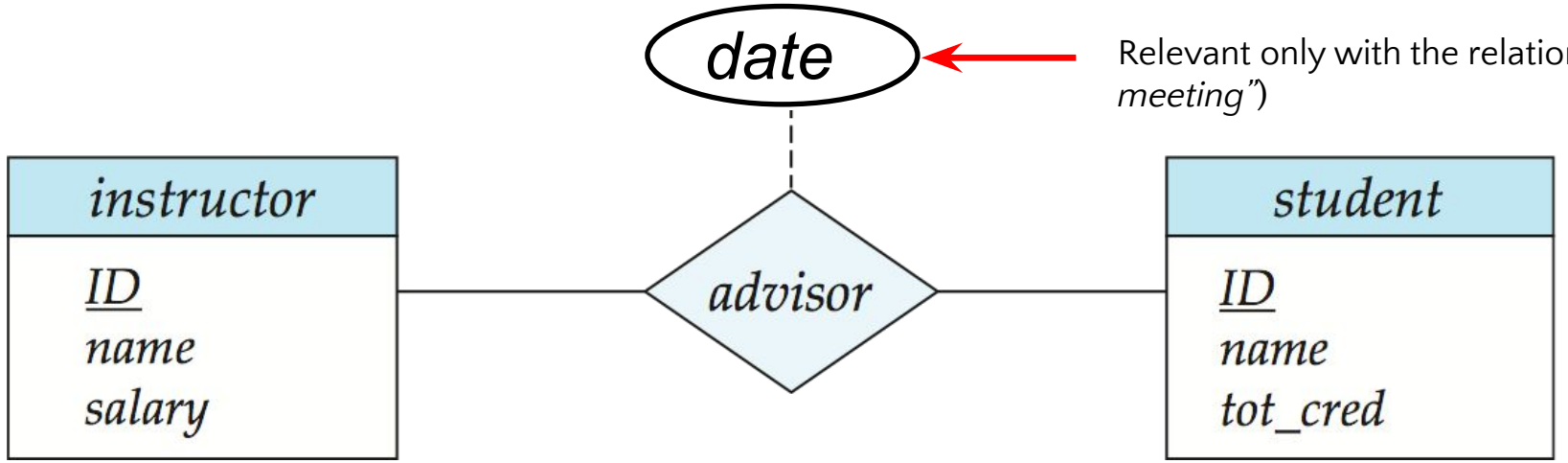
- What's the relationship between student and chair?

Exercise: Come up with as many relationships as you can between pairs of the following entity sets: (e.g. a Student “bought” Fruit)

- Person
- Student
- Manager
- Employee
- Cat
- Dog
- Textbook
- Course
- Car

Relationship Sets with Attributes

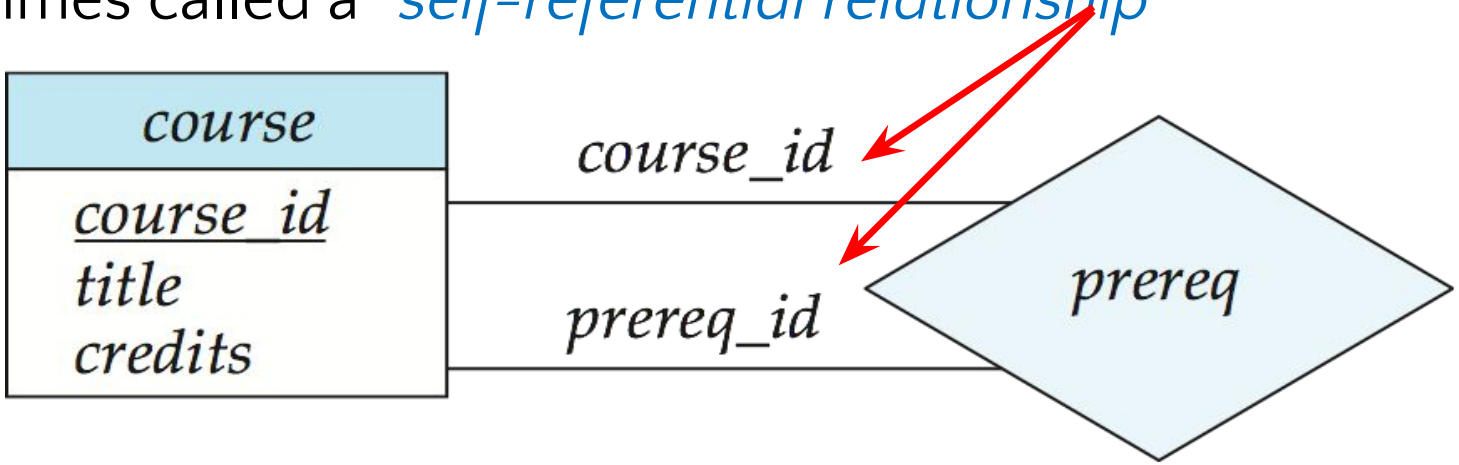
- An attribute can be attached to the relationship set



- Remember: dotted line when connecting an attribute to the relationship set

Self-referential Relationship (Roles)

- Entity sets of a relationship need not be distinct
  - Each occurrence of an entity set can play a "role" in the relationship
- The labels (e.g. "course_id" and "prereq_id") are called **roles**
- Sometimes called a "*self-referential relationship*"



Relationships

- Right now, there is no notion of **participation** or **cardinality**
- Doesn't tell us if everyone has to be sitting OR every chair has to have someone sat-in

- … so let's talk about what *participation* and *cardinality* is next

Participation

- **Total Participation** – double line

- *Every chair must have a student in it*
- *However, there can still be students up and walking around*

- ***ALL entities** in an entity set (on the side of the double line) **participate** in this relationship (no exceptions!) – in this case, all chars are engaged in a sit-in relationship (with a student)*

Participation

- **Total Participation** – double line

- *Every student has a chair and every student is sitting in that chair*
- *But, there are still empty chairs in the room*

Cardinality

- **Arrows** are a way of showing **cardinality**
- Types of cardinality:
  - One-to-one
  - One-to-many
  - Many-to-one
  - Many-to-many

- A “line” side is the “**many**”; an “arrow” side is the “**one**”

Cardinality – Many-to-many

- “Many students sitting in many chairs”

Cardinality – One-to-one

- “Only one person will sit in one chair”

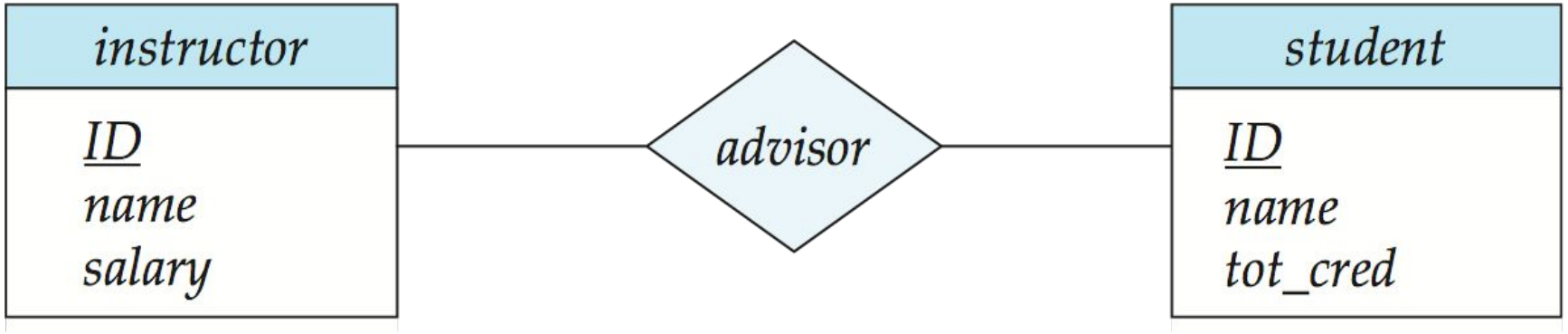
Cardinality – Many-to-one

- “Many students can sit in one chair”

Cardinality – One-to-many

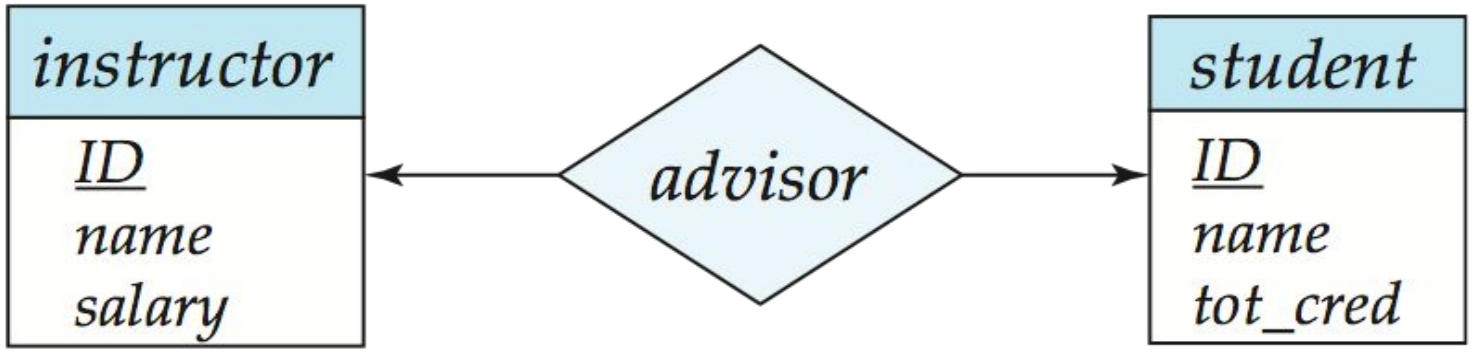
- “One student can sit in many chairs”

Cardinality – Many-to-many



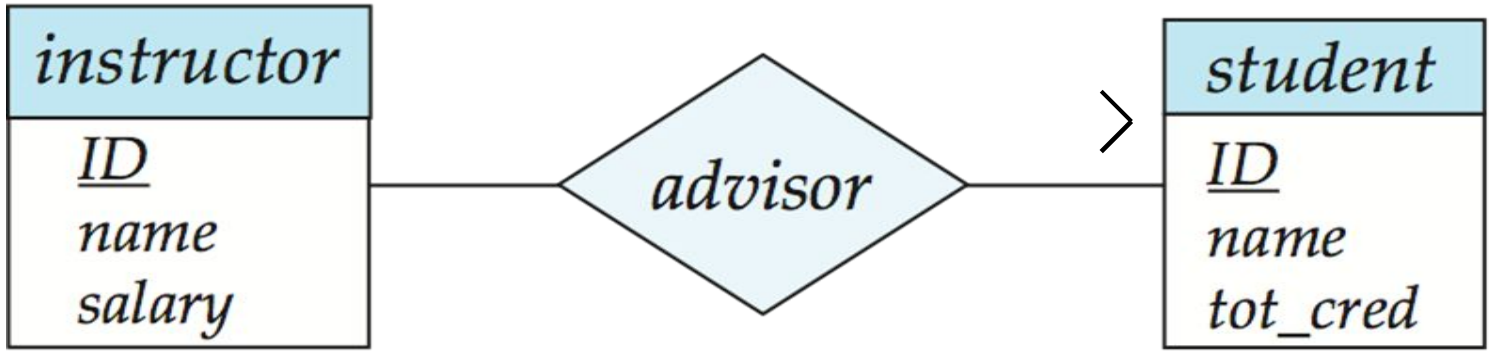
- An instructor is associated with several (possibly 0) students via *advisor*
- A student is associated with several (possibly 0) instructors via *advisor*

Cardinality – One-to-one



- An instructor advises at most one student
- A student is advised by at most one instructor

Cardinality – Many-to-one

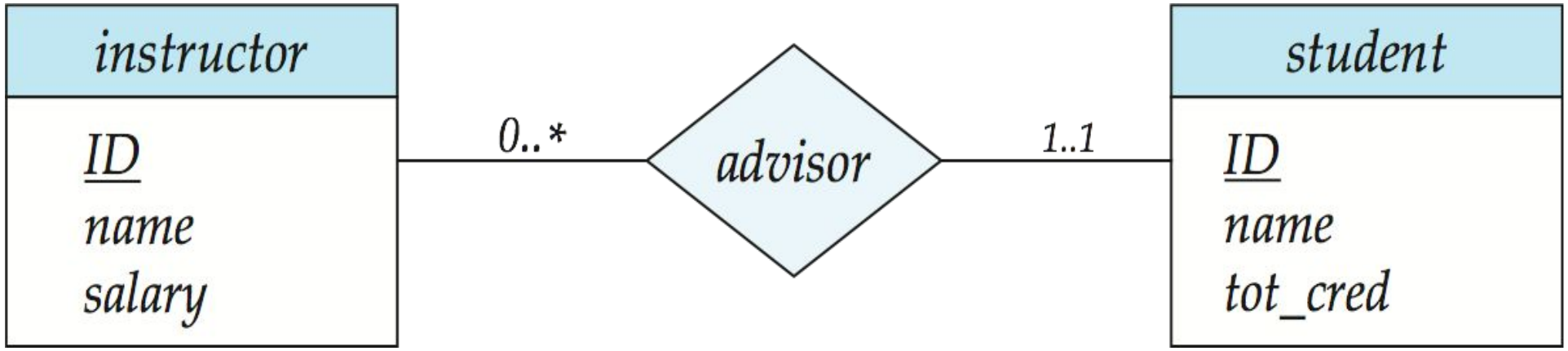


- An instructor can advise at most one student
- A student can be advised by several (including 0) instructors

Cardinality – One-to-many

- An instructor advises several (including 0) students
- A student is advised by at most one instructor

Alternative Notation for Cardinality Limits

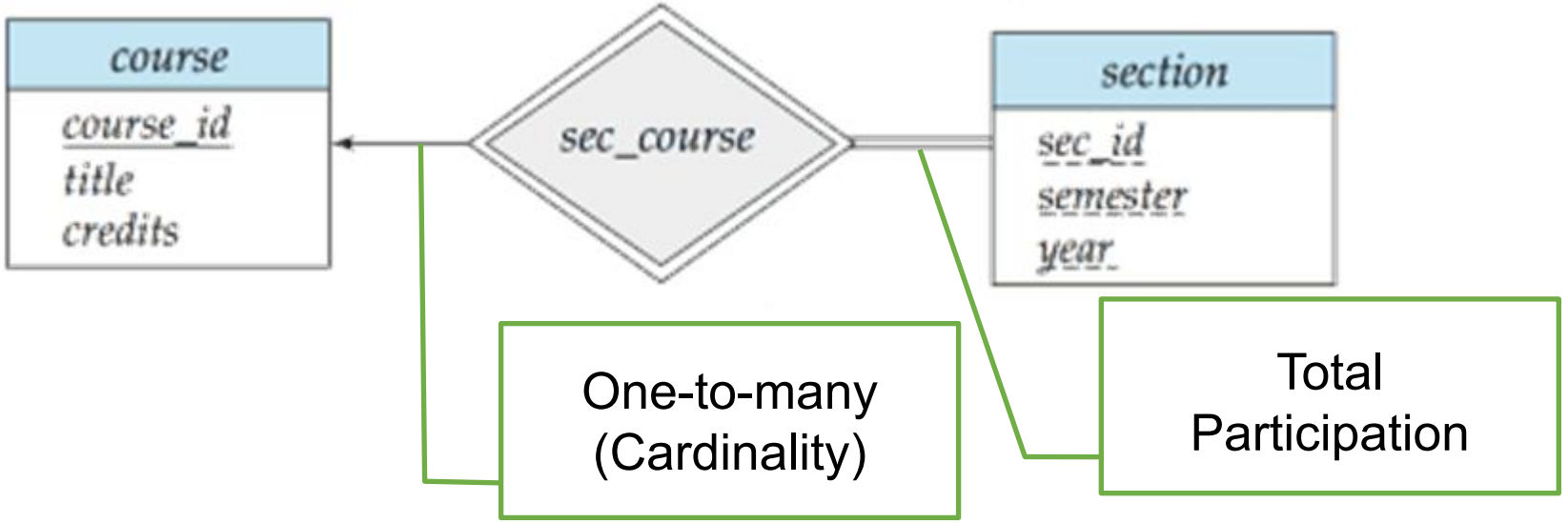


- You can place number ranges on the line
- Allows you to be very specific

- Cardinality limits can also express **participation constraints**
- **However, do NOT use this format for homework/exams/etc!**

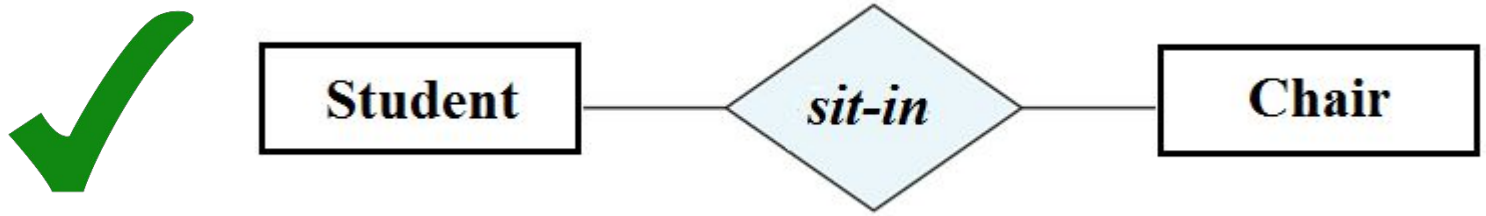
Participation *and* Cardinality

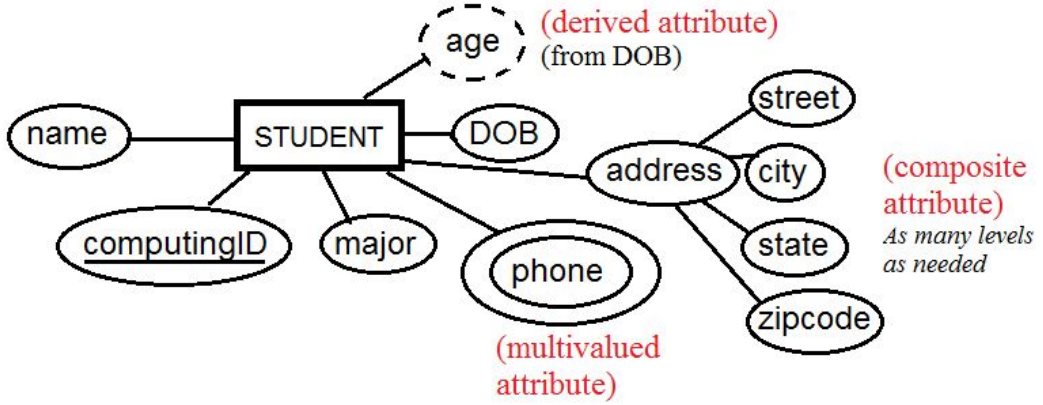
- Mixing participation and cardinality
- In this example, every section must have a course (due to total participation), and every course can have multiple sections



For this course:

- Use:





- Do **not** use: