Topic 2 Polls

POLL 4

For OU business purposes, each OU professor is allowed to own at most one laptop, and the same laptop cannot be owned by more than one professor. The relationship set "own" between the entity set Professor and the entity set Laptop is called:

a) A one-to-one relationship

b) A one-to-many relationship

c) A many-to-one relationship

d) A many-to-many relationship

POLL 5

For a given entity set X in a database, depending on the requirements of X, the primary key of X may have more attributes than a super key of X:

a) True

b) False

POLL 6

Using the ER diagram given in class that shows the Instructor and Student entity sets and the many-to-many relationship set Advisor between Instructor and Student, if the database now must also keep track of the email addresses of each instructor, we will need to modify the ER diagram by:

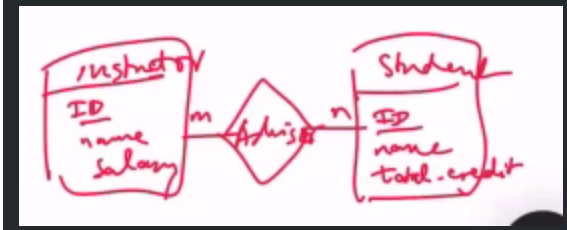
a) Adding a composite attribute (email_address) to Instructor

b) Adding a multi-value attribute (email_address) to Instructor

c) Adding a multi-value attribute (email_address) to Advisor

d) None of the above

The ER Diagram represented in Poll 6:

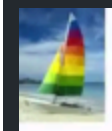


POLL 7

With specialization/generalization, it is possible to have a lower-level entity set that does not have any additional attribute:

a) True

b) False



POLL 8

An aggregation is used when we need an abstract entity set to combine a number of unrelated real entity sets:

a) True

b) False

Lecture 1

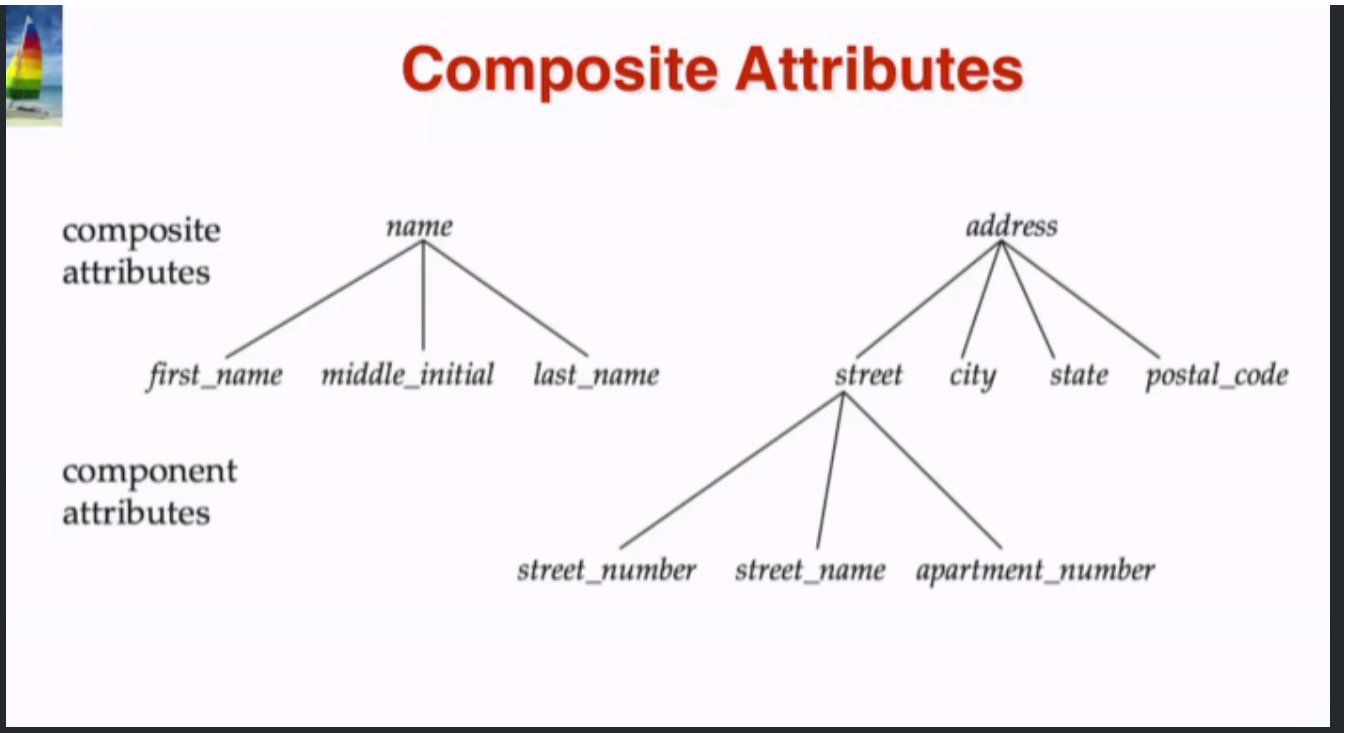
Topic 2: Entity-Relationship Model

- **Conceptual design**: After analyzing the requirements for our database—what we want to store and how those elements are related—we develop the ER Diagram.
  - The ER Diagram is not implemented directly in any system.
  - The ER Model has certain **limitations** that may prevent us from accurately representing all aspects of the database.
- **Logical schema**: Once we have the ER Diagram, we convert it into a logical schema by creating tables using SQL, tailored to the specific database management system (DBMS) we are using.
- **Functional analysis**: This involves examining the requirements for our queries, such as whether they are retrieving or joining data.
  - This analysis informs our decisions regarding the **physical design**, including considerations like whether to create indexes.

Sure! Here's an improved version of your notes:

ER Modeling

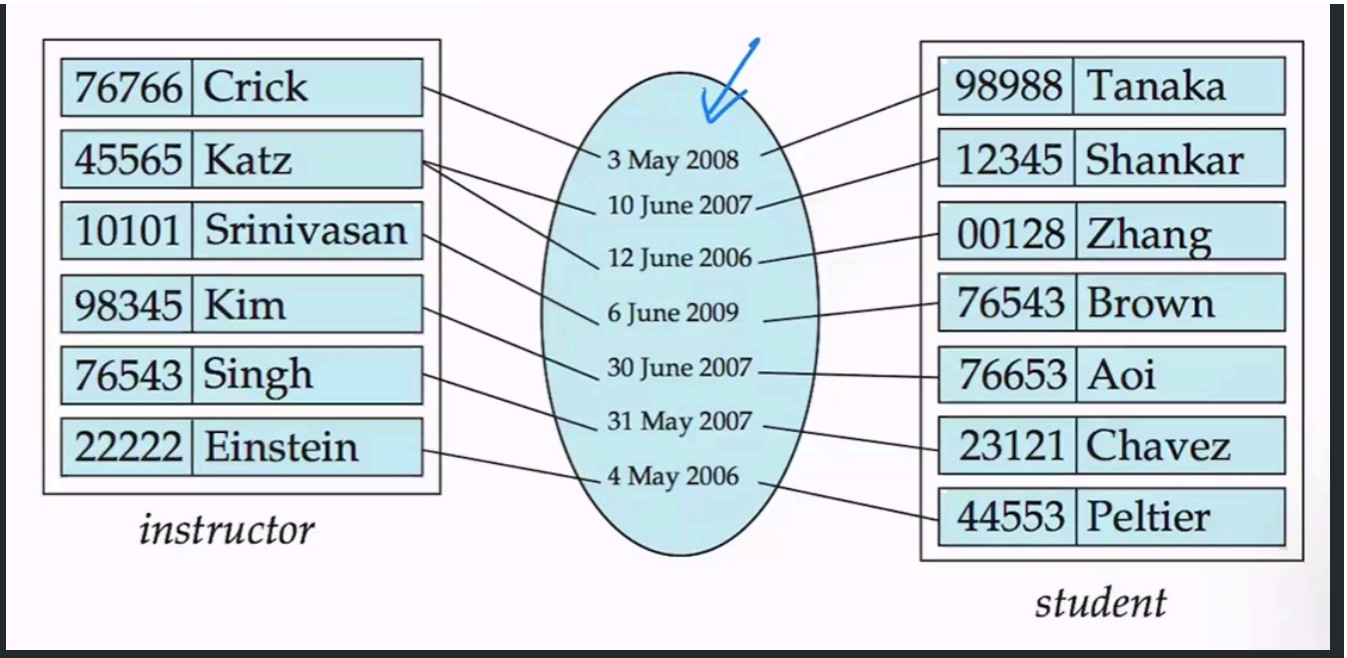
- **Entity**: A distinct object that can be identified separately from other objects.
  - **Example**: Person, department, company, test.
- **Attributes**: Properties or characteristics that describe an entity.
  - **Example**: A person has a name and age; a department has a name; a company has a name and annual profit; a test has a name and date.
  - **Domain**: the set of values the attribute is permitted to take on. this is decided based on application requirements.
  - **Ex**: In SQL, we define these with constraints. We may not want a GPA to be negative for a student entity, for instance.
  - **Simple Attribute**: is not divisible, has only one part.
  - **Composite Attribute**: composed of more than one part.



  - **Single-valued attribute**: has only one value
  - **Multi-valued attribute**: has multiple values
    - **Ex**: a student may have multiple values for phone numbers, called `phone_numbers`
    - **Derived attribute**: can be computed from other attributes
    - **Ex**: we may store `date_of_birth` which allows us to calculate `age`, the derived attribute
- **Entity Set**: A collection of all entities of the same type that share the same attributes.
  - **Example**: The set of all persons, the set of all departments, etc.

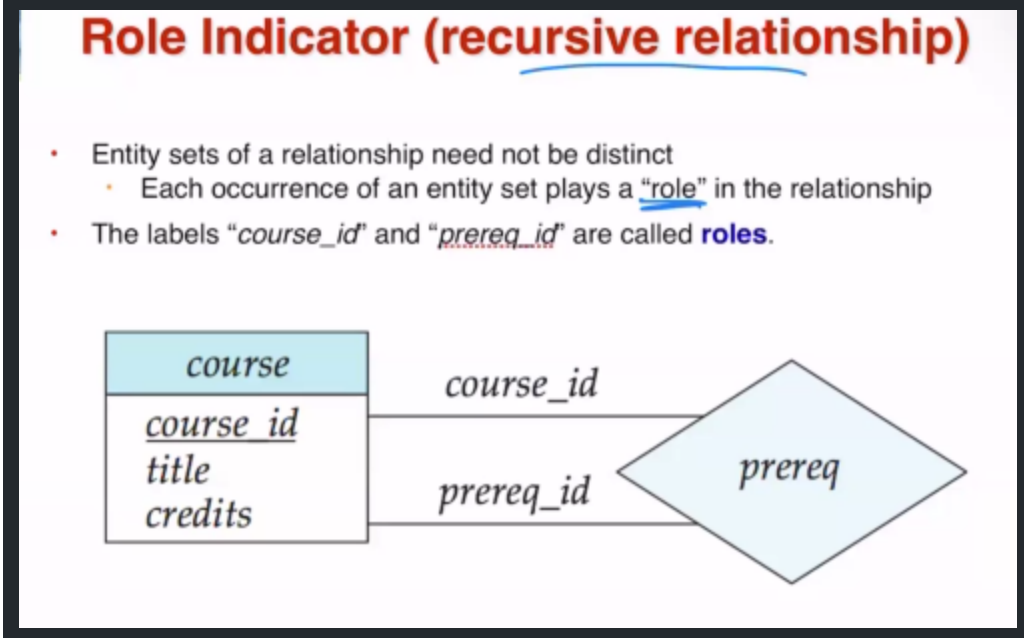
Relationships

- **Relationship**: An association between two or more entities.
- **Relationship Set**: A collection of similar relationships that share common attributes.
- **Attributes of Relationships**: Relationships can possess their own attributes, which describe the relationship rather than the individual entities involved.
  - In SQL, relationships may be represented in separate tables, which include additional columns for these relationship attributes.

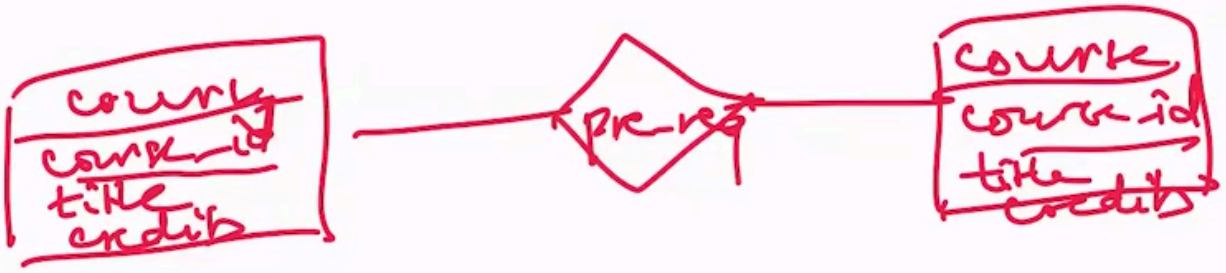


In this example, each instructor is associated with at least one student, and a date is linked to that relationship.

- **Degree of Relationship Set**: The number of entities involved in a relationship set.
  - **Binary Relationship**: Involves two entity sets and has a degree of `2`.
  - **Non-Binary Relationship**: Involves more than two entity sets and has a degree of `n > 2`.
- **Recursive-relationships**: A relationship between entities that are not distinct from eachother.



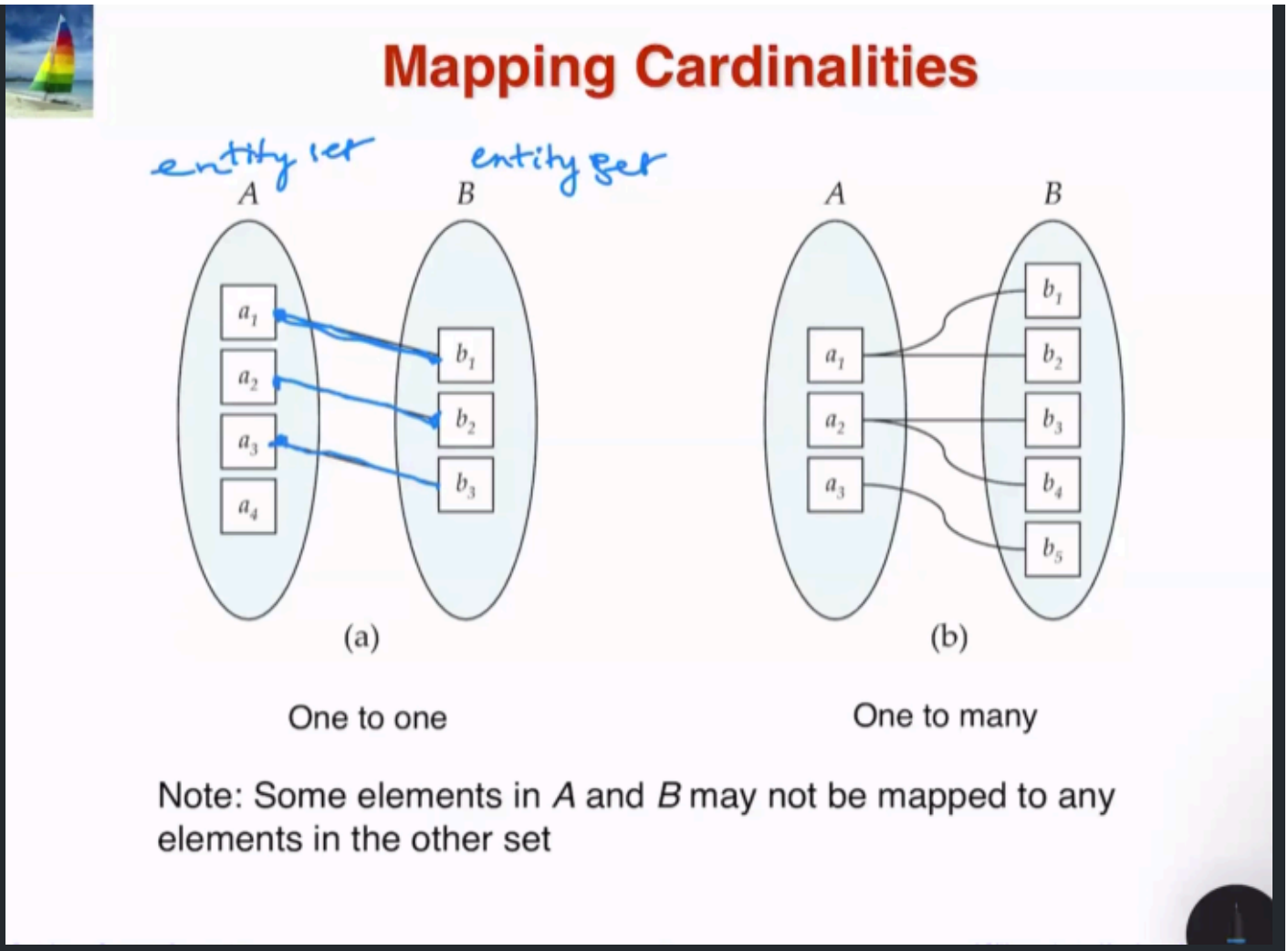
This is essentially what is happening:



Cardinality Constraints

Types

- One-to-One
- One-to-Many
- Many-to-One
- Many-to-Many



Caveats

These definitions differ from their mathematical counterparts. For example, in a one-to-one cardinality, an element of set A may not have a corresponding element in set B, even though a one-to-one relationship exists. This applies to all cardinality types.

Keys of an Entity Set

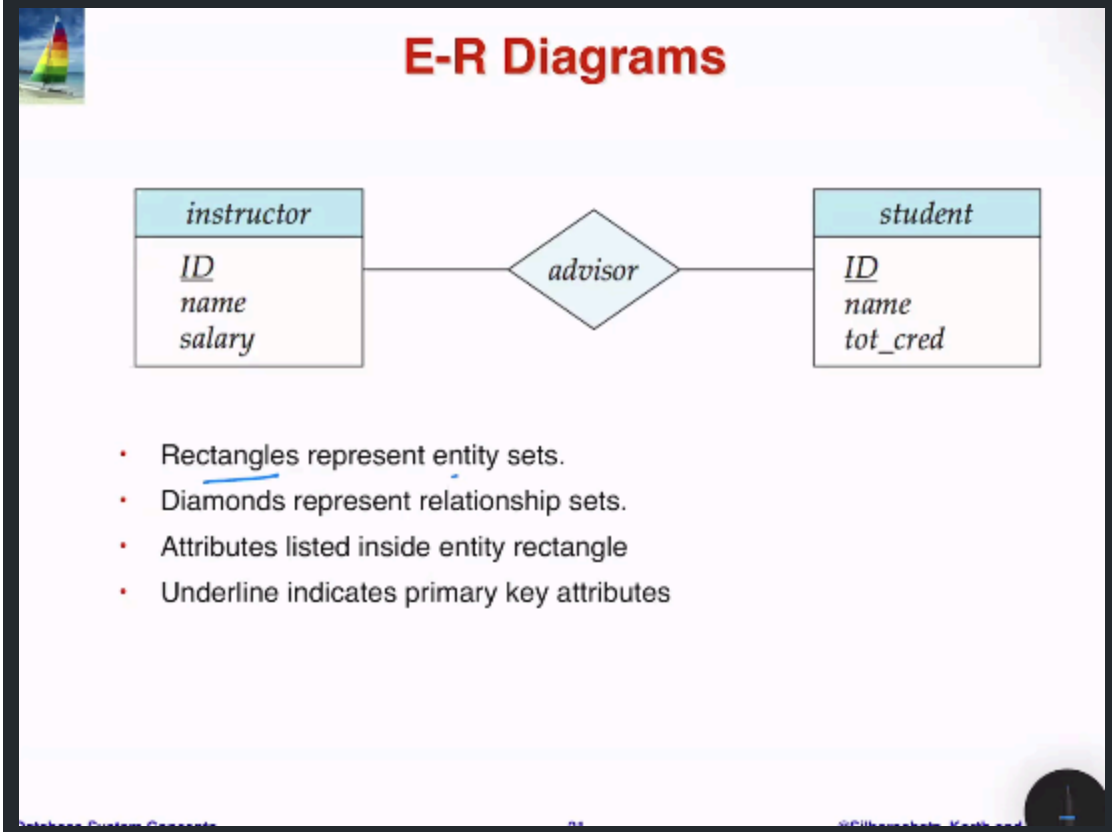
- **Super Key**
  - Composed of one or more attributes.
  - These attributes collectively *uniquely identify* an entity within the entity set.
- **Candidate Key**
  - A *minimal* super key, meaning it contains the fewest number of attributes necessary to uniquely identify the entity.
  - **Example**: If `ID` is a super key, then adding attributes (e.g., `(ID, name)`, `(ID, salary)`) still results in super keys. However, these are not minimal because they contain more attributes than `ID`, which has only one. Therefore, `ID` is the *minimal super key* (or candidate key).

- **Primary Key**
  - The candidate key that is *selected* for identification purposes.
  - While multiple candidate keys may exist, only one can be designated as the primary key.

Lecture 2

Symbols used in ER Notation

Many of these symbols are described in this lecture, so I've included the key from the textbook here.



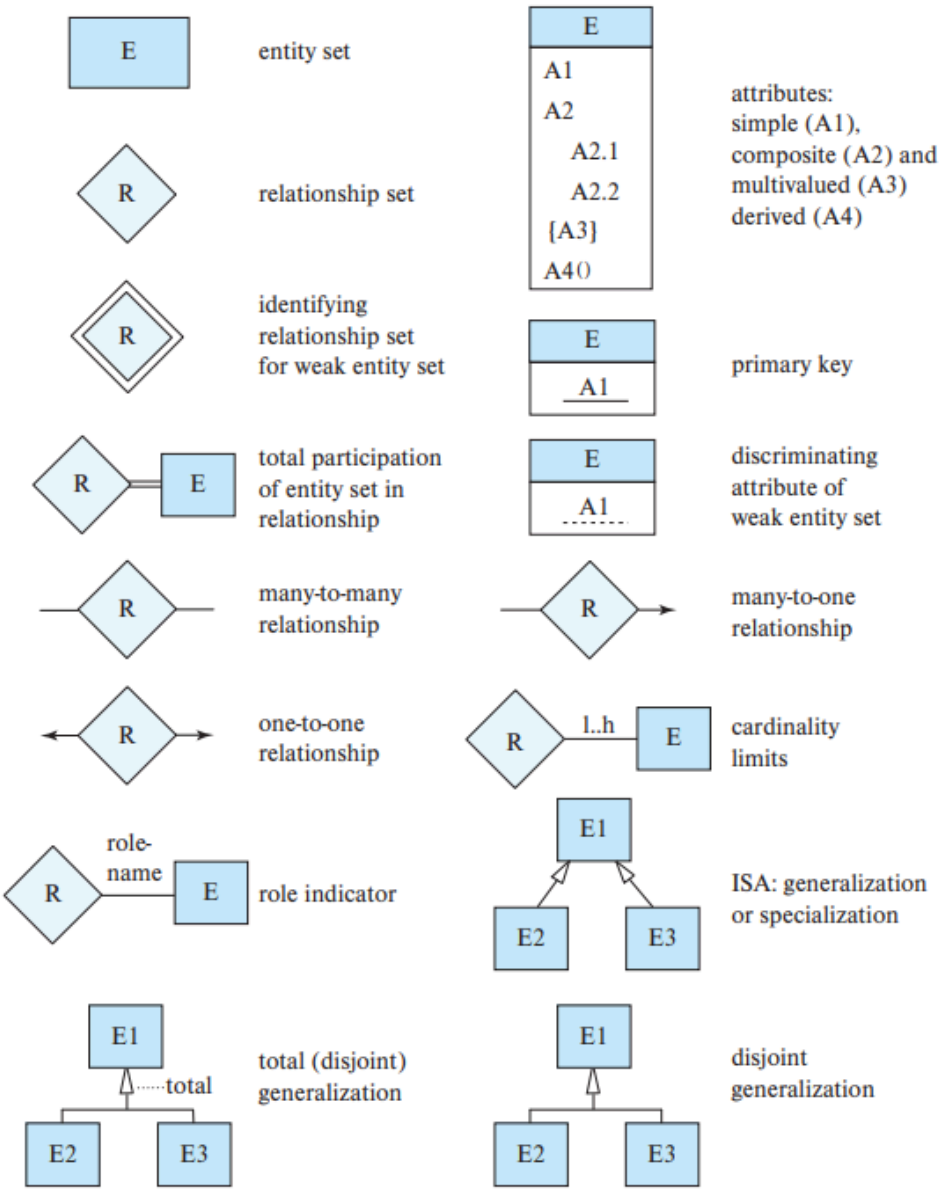
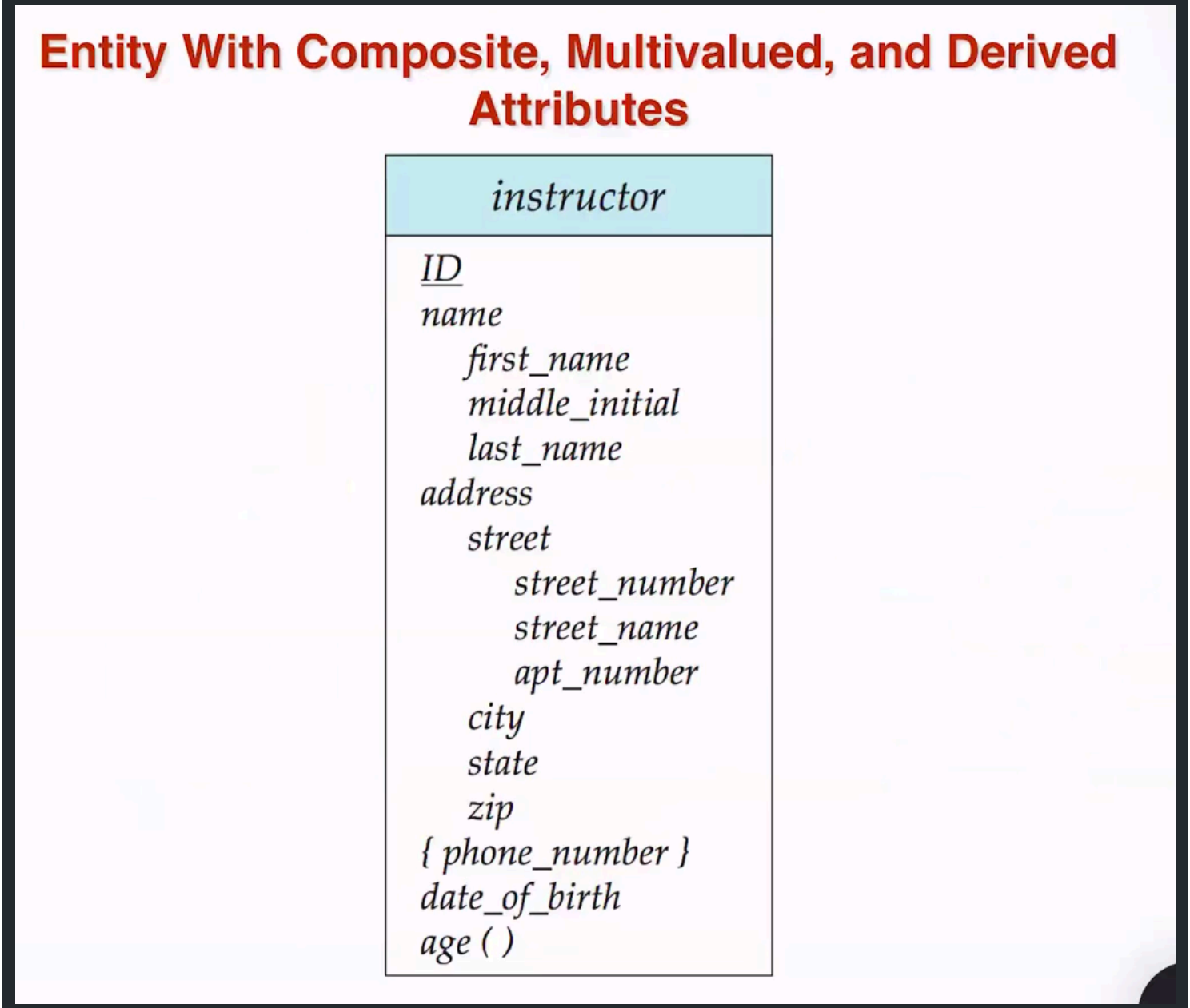


Figure 6.26 Symbols used in the E-R notation.

Attribute Types



- The `name` attribute is a composite attribute, as indicated by the indented attributes beneath it, which include `first_name`, `middle_name`, and `last_name`.
- The `{phone_number}` attribute is multivalued, as denoted by `{}`, allowing for the storage of multiple phone numbers per instructor.
- The `age()` attribute is derived, indicated by `()`, likely calculated from the `date_of_birth`.

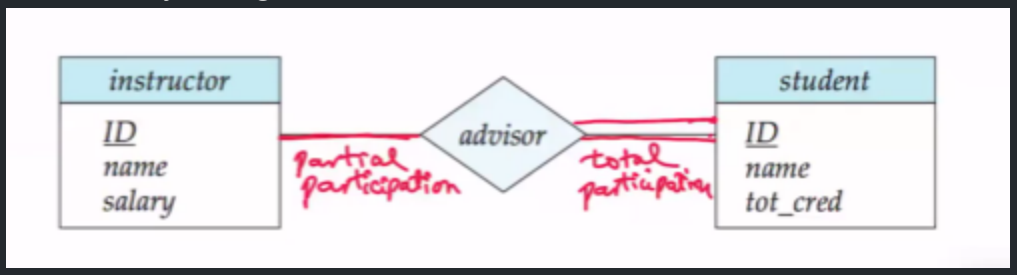
Simple Attributes

- `first_name`
- `middle_name`
- `last_name`
- `city`

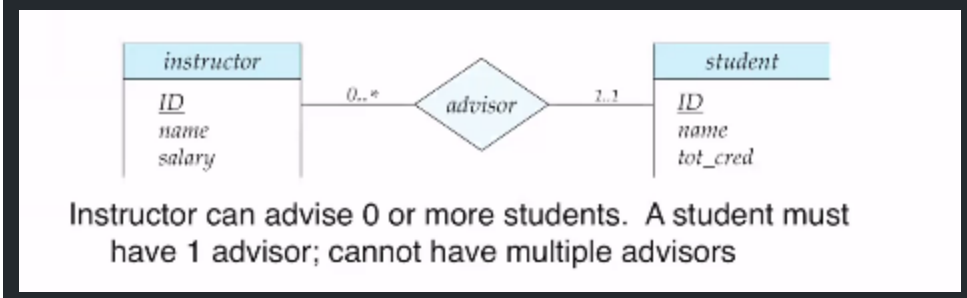
- `zip`
- `state`
- `date_of_birth`

Participation of an Entity in a Relationship Set

- **Total Participation** (Every, all)
  - Indicated by a double line.
  - A line without an arrowhead signifies a many-to-many relationship. A double line indicates total participation.
  - In the image below, an instructor can advise 0 or more students. However, the double line indicates that *every* student must be advised by at least one advisor.
- **Partial Participation** (Some, 0 or more)
  - Indicated by a single line.

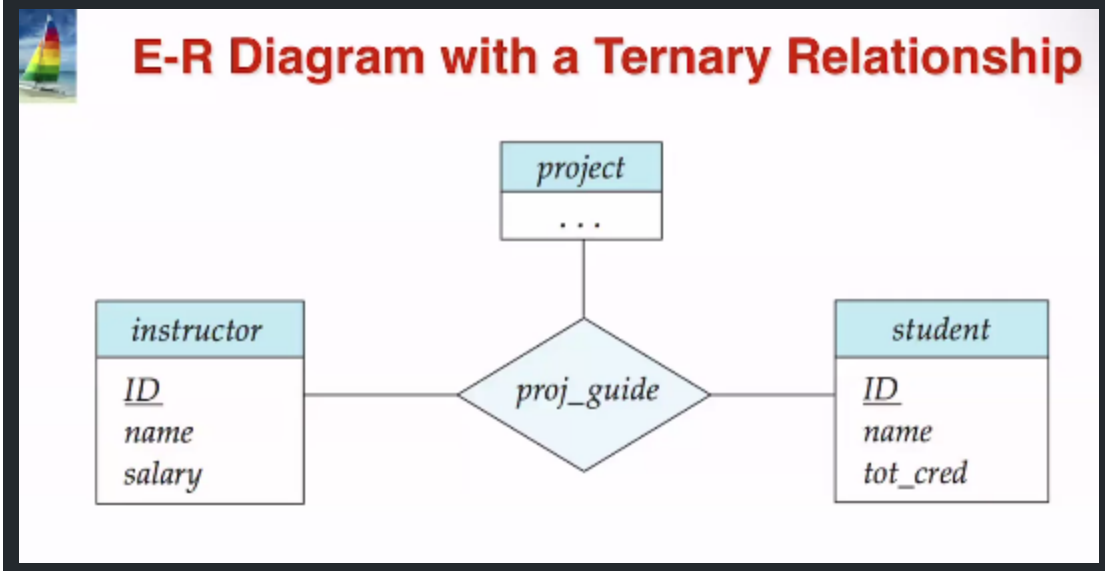


Notation for Complicated Constraints



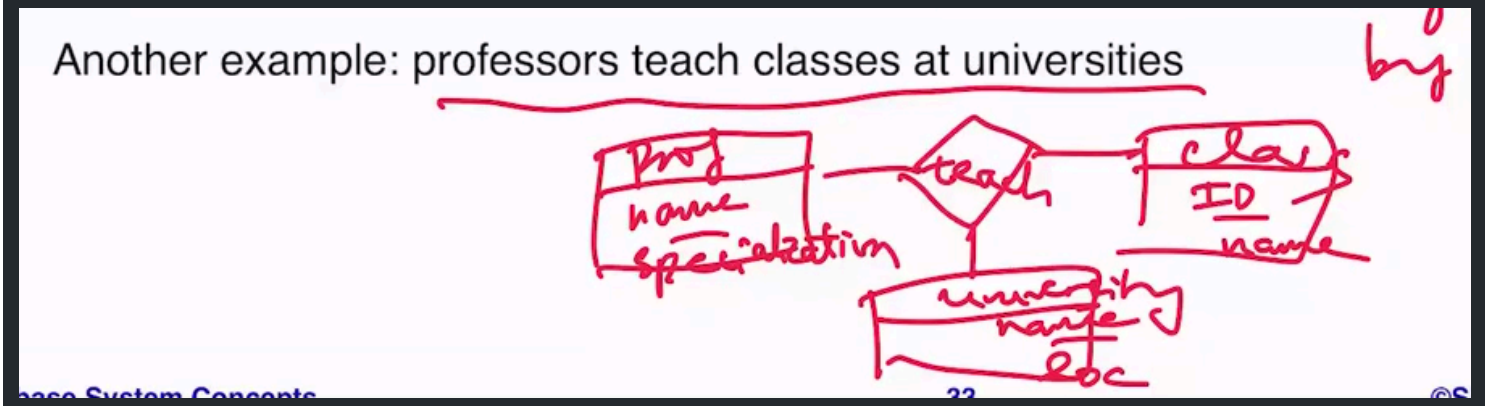
- `min..max` notation
- `*` denotes no limit.
- A minimum value of 1 signifies total participation.
- A maximum value of 1 indicates that the entity participates in at most one relationship.
- A maximum value of `*` denotes no upper limit.

Ternary Relationships



Example

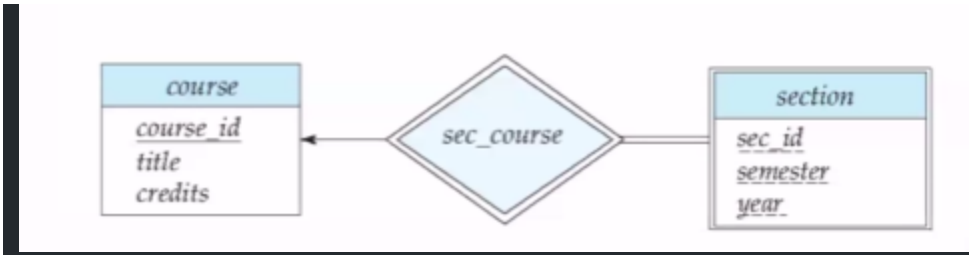
- This relationship connects students, projects, and instructors, thereby linking all three entities.
- Thus, whenever the `proj_guide` relationship exists, these three entities must also coexist.



- "Professors teach classes at universities."
- We have three entities: professors, classes, and universities.
- They share the "teach" relationship with each other—a clear indicator of this is the verb *teach*.
- This necessitates the creation of a ternary relationship among them.

Weak Entity Sets

- **Definition**: Occurs when an entity set lacks a primary key derived from its *own* attributes.
- The existence of this entity set *depends on* the existence of another set, referred to as the **identifying entity set**.



- The strong entity set in this image is the *course* entity set.
  - This is indicated by its primary key, `course_id`.
- The weak entity set is the section, as multiple sections can share the same `sec_id`, `semester`, and `year`.
  - The identifying entity set is the `course` related to each section, indicated by the double diamond around `sec_course`.
  - If we know the `course_id` of the related `course`, we can distinguish between different sections.
  - The dotted line indicates the `descriminator(s)` that help differentiate sections within the same weak entity set. However, to distinguish them uniquely, we require the strong entity set.

Lecture 3

I omitted the section on design issues. Practice the homework to review this topic; notes may not be particularly beneficial.

Extended ER Features

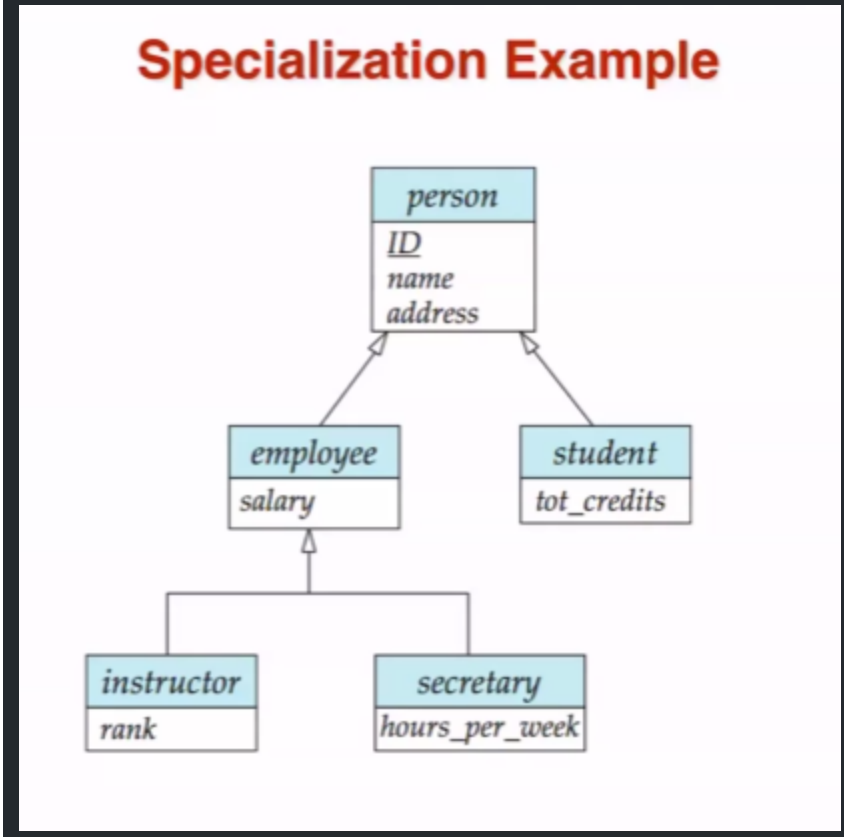
Specialization (Top-down) and Generalization (Bottom-up)

These processes occur when an entity set has designated sub-entity sets ("subgroupings") that inherit attributes and relationship participation from their parent entity sets.

- **Specialization**: A design approach that starts at the top level and creates sub-entity sets that inherit from the parent.
- **Generalization**: A design approach that starts at the bottom level, merging entity sets to create higher-level entity sets that share common attributes.
- Specialization and generalization are often used interchangeably, as both processes yield similar outcomes.
- **Attribute Inheritance**: A lower-level entity set inherits all attributes and relationship participation from the higher-level entity set to which it is connected.

- This is analogous to class inheritance in OOP.
- Represented by a hollow arrow pointing toward the entity.

Example

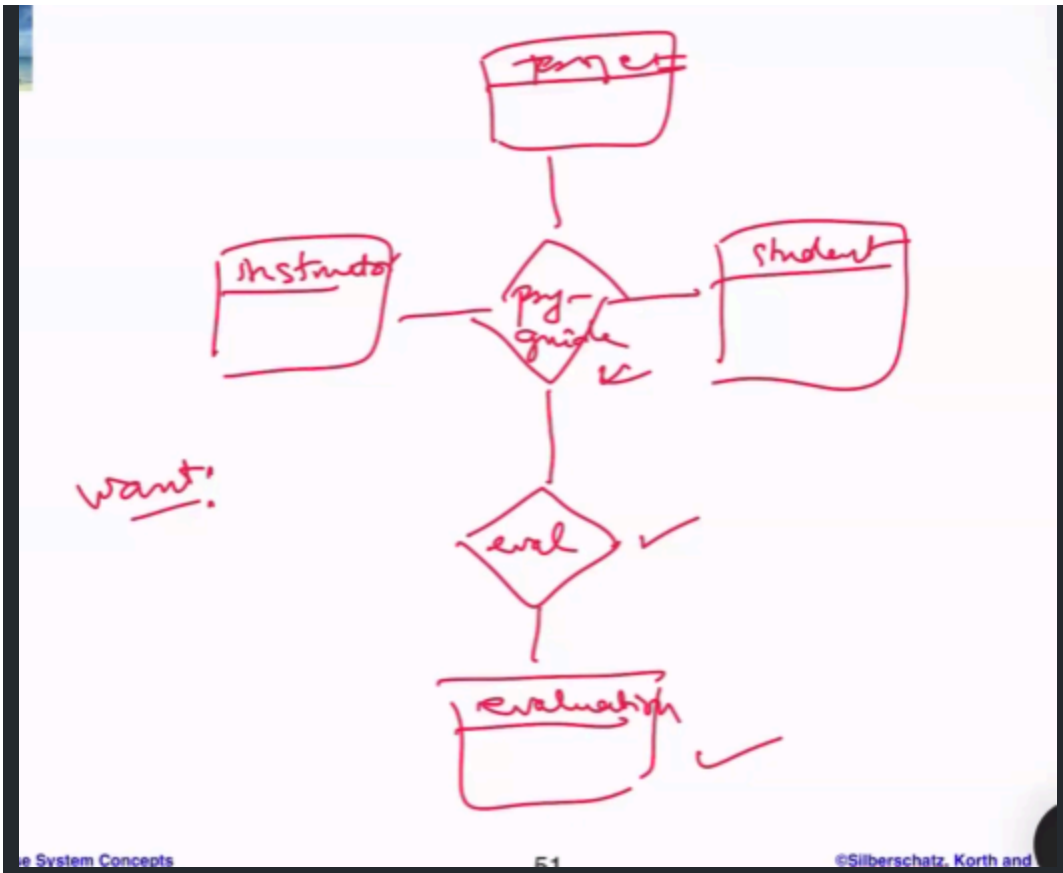


- A person can be both an employee and a student (**overlapping**).
- An instructor can be either an employee *or* a secretary, but not both (**disjoint**).
  - Indicated by the arrow that diverges.
- An employee is a person; an instructor is an employee, so an instructor is also a person.
- An employee is a person; a secretary is an employee, so a secretary is also a person.
- Instructor attributes include: `rank`, `salary`, `name`, `address`, `ID`.
- Secretary attributes include: `hours_per_week`, `salary`, `name`, `address`, `ID`.
- Employee attributes include: `salary`, `name`, `address`, `ID`, and so on.

Aggregation

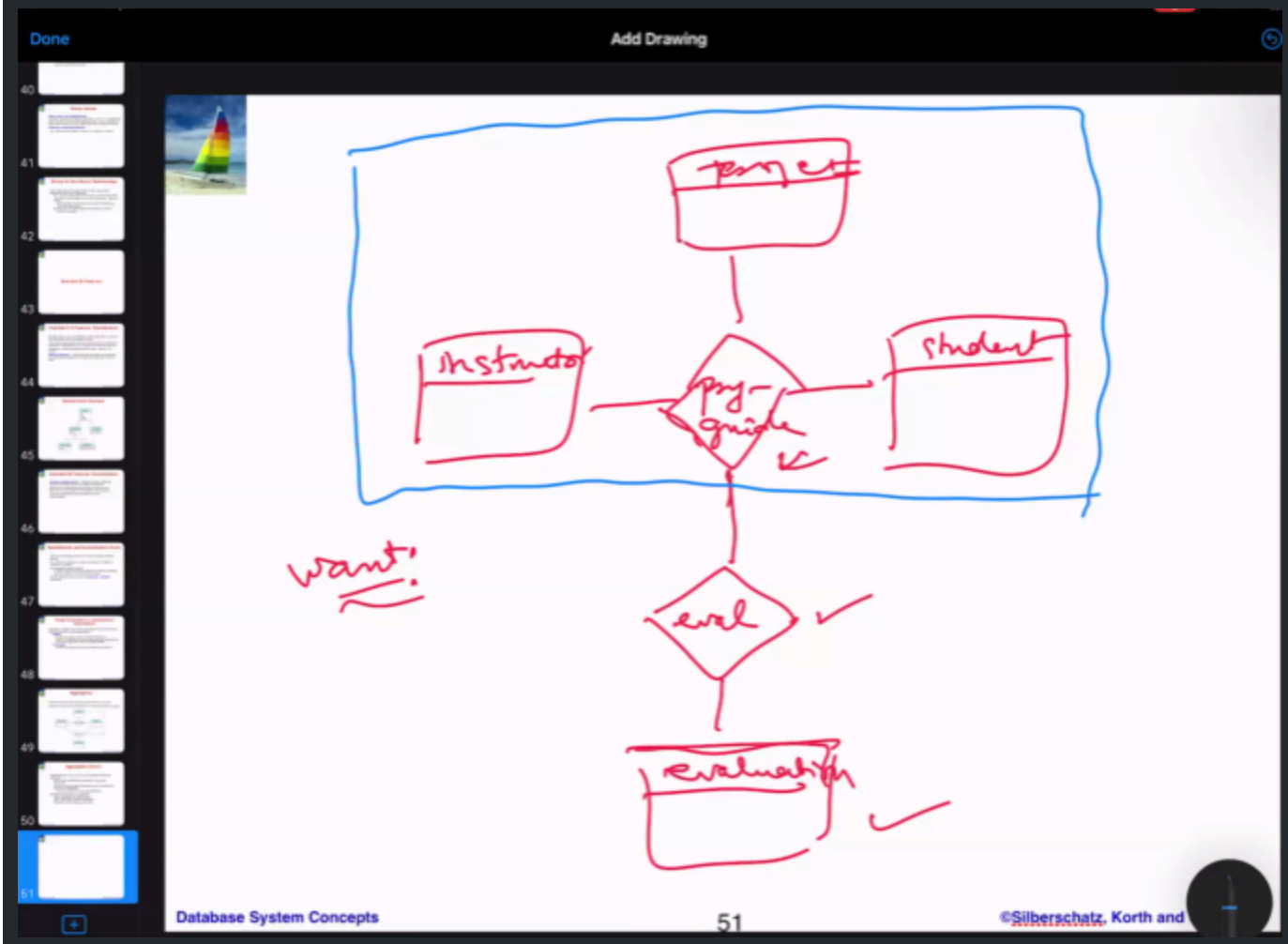
Motivation

What we want: when a student is working on a project guided by an instructor, we wish to record information about that guidance in the evaluation set, meaning the instructor is evaluating the student. Problem: In the ER model, a relationship cannot connect directly to another relationship, which would violate the ER model.



want:

Solution: New Notation



The blue rectangle surrounding the entity sets is not a true entity set; it is merely abstract. We can assert that the combination of these sets is permissible.
This notation expresses a relationship among relationships.

Alternative ER Notation

These were briefly discussed, but we were advised against using them in homework or exams. They are likely not useful for review.

Lecture 4

This entire lecture focused on working through two examples. For brevity, I won't be posting the solutions here. I encourage you to work them out on your own for effective practice. Be sure to tackle the practice problems and revisit the homework questions as well.