Database Management Systems

Module 19: Entity-Relationship Model/2

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Module Recap

- Design Process for Database Systems
- ER Model for real world representation with entities, entity sets, attributes, and relationships

Module Objectives

- To illustrate ER Diagram notation for ER Models
- To explore translation of ER Models to Relational Schemas

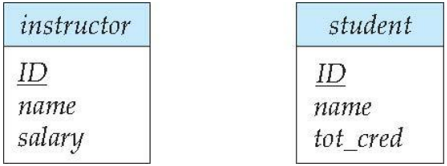
Module Outline

- ER Diagram
- ER Model to Relational Schema

ER Diagram

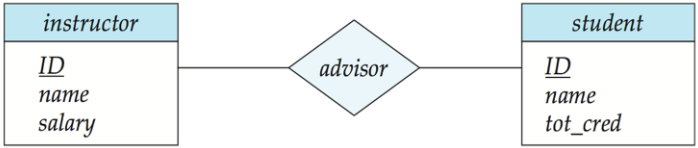
Entity Sets

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

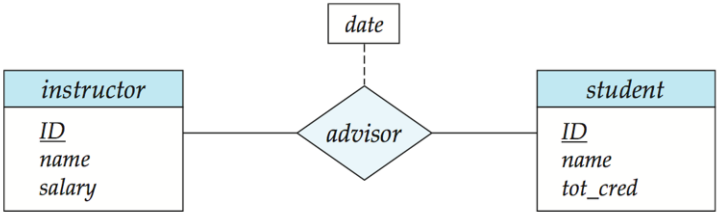


Relationship Sets

- Diamonds represent relationship sets.

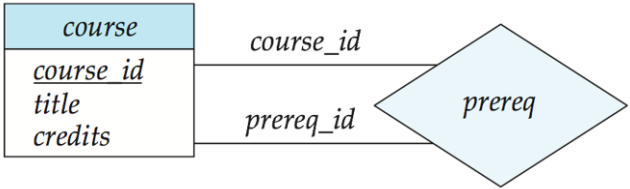


Relationship Sets with Attributes



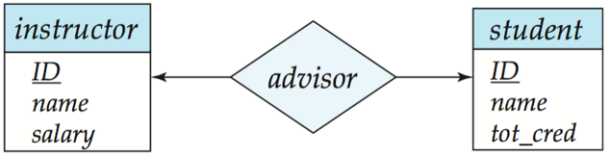
Roles

- 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**.



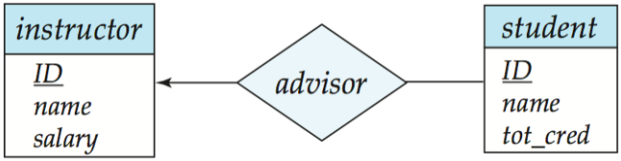
Cardinality Constraints

- 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*
  - An instructor is associated with at most one student via the relationship *advisor*



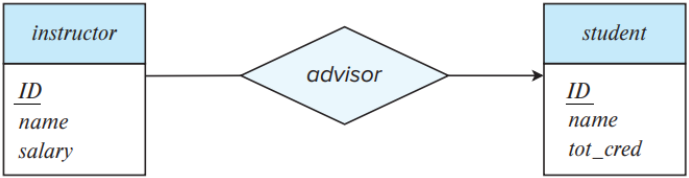
One-to-Many Relationship

- 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*



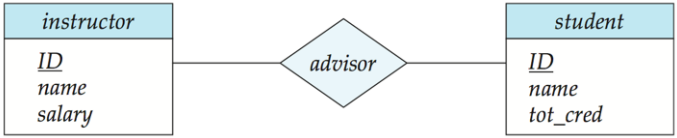
Many-to-One Relationships

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



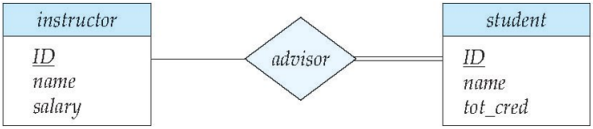
Many-to-Many Relationship

- 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

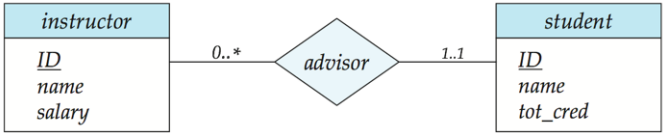
- Total participation (indicated by double line): every entity in the entity set participates in at least one relationship in the relationship set



  - 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

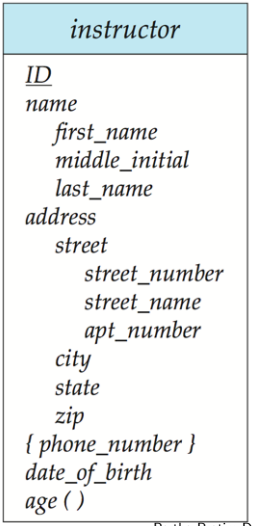
Notation for Expressing More Complex Constraints

- 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.



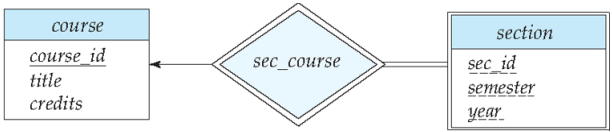
Instructor can advise 0 or more students.
A student must have 1 advisor; cannot have multiple advisors

Notation to Express Entity with Complex Attributes

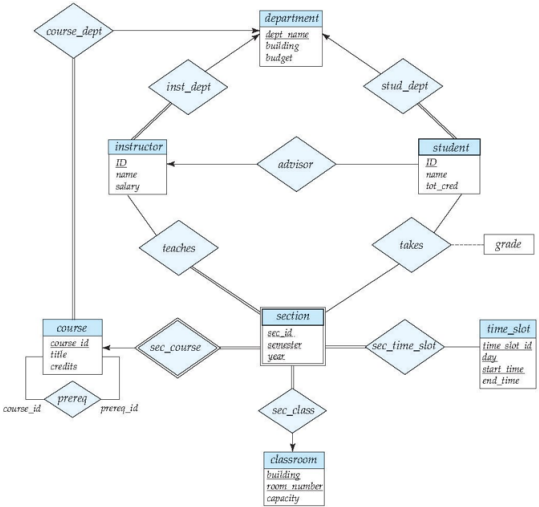


Expressing Weak Entity Sets

- In ER 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)*



ER Diagram for a University Enterprise



ER Model to Relational Schema

Reduction to Relation Schema

- Entity sets and relationship sets can be expressed uniformly as *relation schemas* that represent the contents of the database
- A database which conforms to an ER diagram can be represented by a collection of schemas
- For each entity set and relationship set there is a unique schema that is assigned the name of the corresponding entity set or relationship set
- Each schema has a number of columns (generally corresponding to attributes), which have unique names

Representing Entity Sets

- A strong entity set reduces to a schema with the same attributes

  student(ID, name, tot_cred)

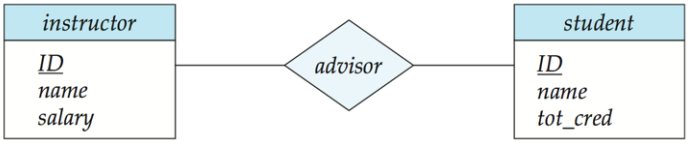
- A weak entity set becomes a table that includes a column for the primary key of the identifying strong entity set

  section (course_id, sec_id, sem, year)

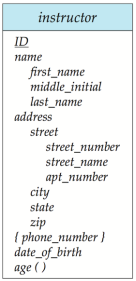
Representing Relationship Sets

- A many-to-many relationship set is represented as a schema with attributes for the primary keys of the two participating entity sets, and any descriptive attributes of the relationship set.
- Example: schema for relationship set *advisor*

advisor = (*s_id*, *i_id*)



Representation of Entity Sets with Composite Attributes



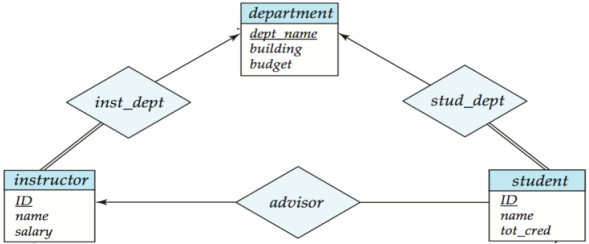
- Composite attributes are flattened out by creating a separate attribute for each component attribute
  - Example: given entity set **instructor** with composite attribute **name** with component attributes **first_name** and **last_name** the schema corresponding to the entity set has two attributes **name_first_name** and **name_last_name**
    - ▷ Prefix omitted if there is no ambiguity (**name_first_name** could be **first_name**)
- Ignoring multivalued attributes, extended instructor schema is
  - **instructor(ID, first_name, middle_initial, last_name, street_number, street_name, apt_number, city, state, zip_code, date_of_birth)**

Representation of Entity Sets with Multivalued Attributes

- A multivalued attribute M of an entity E is represented by a separate schema EM
- Schema EM has attributes corresponding to the primary key of E and an attribute corresponding to multivalued attribute M
- Example: Multivalued attribute phone_number of *instructor* is represented by a schema: *inst_phone*= (*ID*, *phone_number*)
- Each value of the multivalued attribute maps to a separate tuple of the relation on schema EM
  - For example, an *instructor* entity with primary key 22222 and phone numbers 456-7890 and 123-4567 maps to two tuples: (22222, 456-7890) and (22222, 123-4567)

Redundancy of Schema

- Many-to-one and one-to-many relationship sets that are total on the many-side can be represented by adding an extra attribute to the "many" side, containing the primary key of the "one" side
- Example: Instead of creating a schema for relationship set *inst_dept*, add an attribute *dept_name* to the schema arising from entity set *instructor*



Redundancy of Schema (2)

- For one-to-one relationship sets, either side can be chosen to act as the "many" side
  - That is, an extra attribute can be added to either of the tables corresponding to the two entity sets
- If participation is *partial* on the "many" side, replacing a schema by an extra attribute in the schema corresponding to the "many" side could result in null values

Redundancy of Schema (3)

- The schema corresponding to a relationship set linking a weak entity set to its identifying strong entity set is redundant.
- Example: The *section* schema already contains the attributes that would appear in the *sec_course* schema

Module Summary

- Illustrated ER Diagram notation for ER Models
- Discussed translation of ER Models to Relational Schema

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