



Module 19

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Das

Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality
Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

Composite Attributes

Multivalued
Attributes

Redundancy

Module Summary

Database Management Systems

Module 19: Entity-Relationship Model/2

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Module 19

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Das

Objectives & Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality

Constraints

Participation

Bounds

ER Model to Relational Schema

Entity Sets

Relationship

Composite Attributes

Multivalued

Attributes

Redundancy

Module Summary

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



Module 19

Partha Pratim
Das

Objectives & Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality

Constraints

Participation

Bounds

ER Model to Relational Schema

Entity Sets

Relationship

Composite Attributes

Multivalued

Attributes

Redundancy

Module Summary

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



Module 19

Partha Pratim
Das

Objectives & Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality

Constraints

Participation

Bounds

ER Model to Relational Schema

Entity Sets

Relationship

Composite Attributes

Multivalued

Attributes

Redundancy

Module Summary

- ER Diagram
- ER Model to Relational Schema



Module 19

Partha Pratim
Das

Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality

Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

Composite Attributes

Multivalued

Attributes

Redundancy

Module Summary

ER Diagram



Entity Sets

Module 19

Partha Pratim
Das

Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality
Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

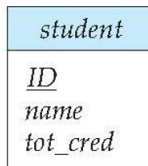
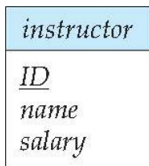
Composite Attributes

Multivalued
Attributes

Redundancy

Module Summary

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





Relationship Sets

Module 19

Partha Pratim
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Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality

Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

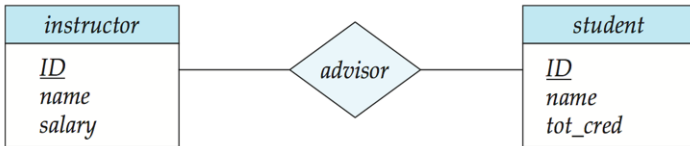
Composite Attributes

Multivalued
Attributes

Redundancy

Module Summary

- **Diamonds** represent relationship sets.





Relationship Sets with Attributes

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Das

Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality

Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

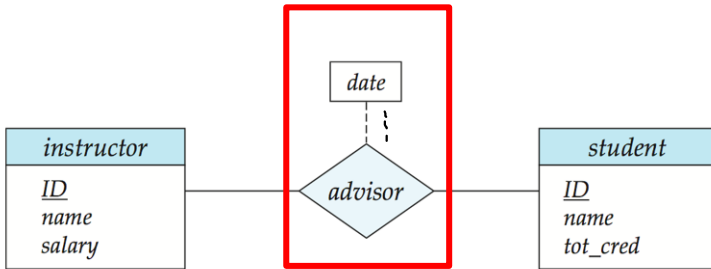
Composite Attributes

Multivalued
Attributes

Redundancy

Module Summary

dashed line means attribute





Module 19

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Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality
Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

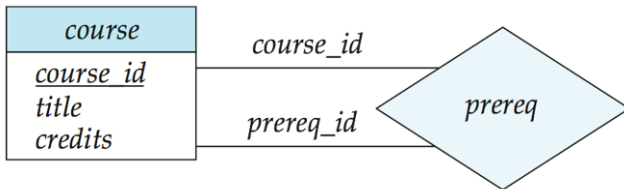
Composite Attributes

Multivalued
Attributes

Redundancy

Module Summary

- 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

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Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality
Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

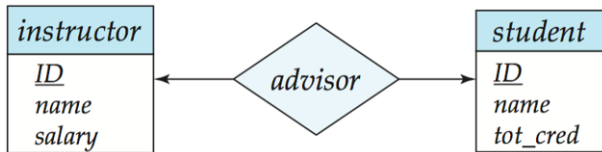
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Multivalued
Attributes

Redundancy

Module Summary

- 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

Module 19

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Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality
Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

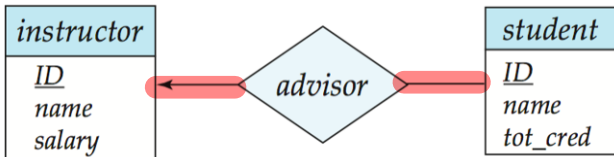
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Multivalued
Attributes

Redundancy

Module Summary

- 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

Module 19

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Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality
Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

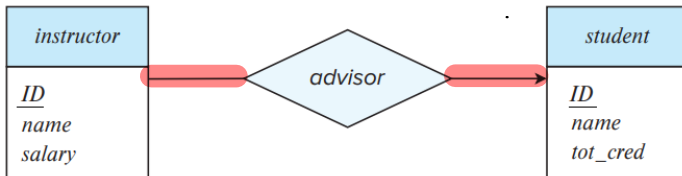
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Multivalued
Attributes

Redundancy

Module Summary

- **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

Module 19

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Das

Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality
Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

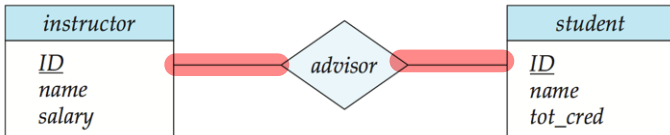
Composite Attributes

Multivalued
Attributes

Redundancy

Module Summary

- 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

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Objectives & Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality

Constraints

Participation

Bounds

ER Model to Relational Schema

Entity Sets

Relationship

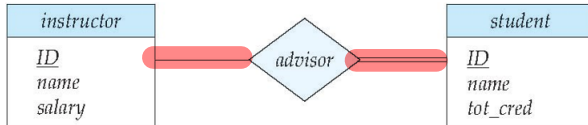
Composite Attributes

Multivalued Attributes

Redundancy

Module Summary

- 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

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Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality
Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

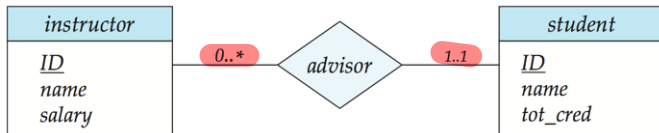
Composite Attributes

Multivalued
Attributes

Redundancy

Module Summary

- 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

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Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality
Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

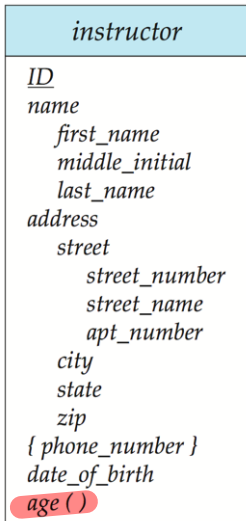
Relationship

Composite Attributes

Multivalued
Attributes

Redundancy

Module Summary





Expressing Weak Entity Sets

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Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality
Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

Composite Attributes

Multivalued
Attributes

Redundancy

Module Summary

- 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

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Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality

Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

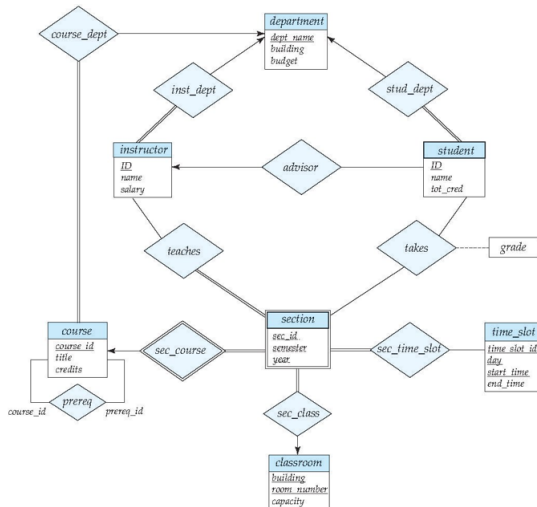
Composite Attributes

Multivalued

Attributes

Redundancy

Module Summary





Module 19

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Das

Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality
Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

Composite Attributes

Multivalued
Attributes

Redundancy

Module Summary

ER Model to Relational Schema



Reduction to Relation Schema

Module 19

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Das

Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality
Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

Composite Attributes

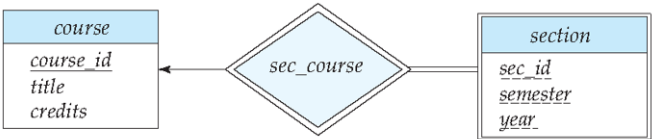
Multivalued
Attributes

Redundancy

Module Summary

- 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

- 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

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Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality
Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

Composite Attributes

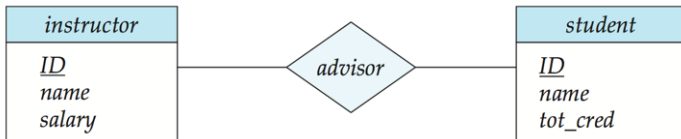
Multivalued
Attributes

Redundancy

Module Summary

- 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

Module 19

Partha Pratim
Das

Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality

Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

Composite Attributes

Multivalued
Attributes

Redundancy

Module Summary

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

- 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

Module 19

Partha Pratim
Das

Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality

Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

Composite Attributes

Multivalued
Attributes

Redundancy

Module Summary

- 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:
 $inst_phone = (\underline{ID}, \underline{phone_number})$
- 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)

Module 19

Partha Pratim Das

Objectives & Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality

Constraints

Participation

Bounds

ER Model to Relational Schema

Entity Sets

Relationship

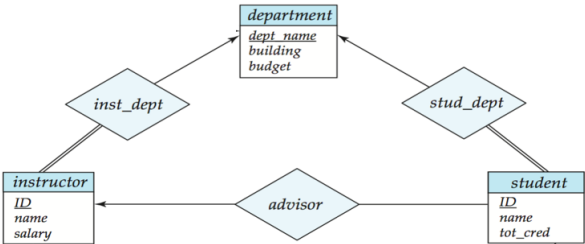
Composite Attributes

Multivalued Attributes

Redundancy

Module Summary

- 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)

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Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality

Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

Composite Attributes

Multivalued
Attributes

Redundancy

Module Summary

- 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)

Module 19

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Das

Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality
Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

Composite Attributes

Multivalued
Attributes

Redundancy

Module Summary

- 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

Module 19

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Das

Objectives &
Outline

ER Diagram

Entity Sets

Relationship Sets

Cardinality
Constraints

Participation

Bounds

ER Model to
Relational
Schema

Entity Sets

Relationship

Composite Attributes

Multivalued
Attributes

Redundancy

Module Summary

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

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