



Module 20

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Das

Objectives &
Outline

ER Features

Non-binary
Relationship

Specialization

Specialization as
Schema

Generalization

Aggregation

Design Issues

Entities vs Attributes

Entities vs
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Binary vs Non-Binary

Design Decisions

ER Notation

Module Summary

Database Management Systems

Module 20: Entity-Relationship Model/3

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- ER Diagram for ER Models
- Translation of ER Models to Relational Schema



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Module Summary

- To understand extended features of ER Model
- To discuss various design issues



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- Extended ER Features
- Design Issues



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Non-binary Relationship Sets

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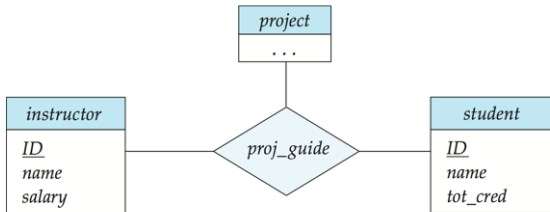
Binary vs Non-Binary

Design Decisions

ER Notation

Module Summary

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





Cardinality Constraints on Ternary Relationship

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- 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
 - a) Each A entity is associated with a unique entity from B and C or
 - b) 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: ISA

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- **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: ISA (2)

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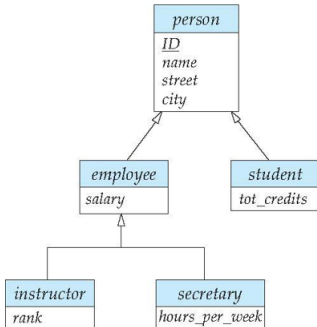
Binary vs Non-Binary

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ER Notation

Module Summary

- **Overlapping:** *employee* and *student*
- **Disjoint:** *instructor* and *secretary*
- Total and Partial





Representing Specialization via Schema

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Module Summary

- Method 1:

- Form a schema for the higher-level entity
- Form a schema for each lower-level entity set, include primary key of higher-level entity set and local attributes

schema	attributes
person	ID, name, street, city
student	ID, tot_cred
employee	ID, salary

- Drawback: Getting information about, an *employee* requires accessing two relations, the one corresponding to the low-level schema and the one corresponding to the high-level schema



Representing Specialization as Schema (2)

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Module Summary

- Method 2:

- Form a schema for each entity set with all local and inherited attributes

schema	attributes
person	ID, name, street, city
student	ID, name, street, city, tot_cred
employee	ID, name, street, city, salary

- Drawback: *name*, *street* and *city* may be stored redundantly for people who are both students and employees



Generalization

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Module Summary

- **Bottom-up design process:** Combine a number of entity sets that share the same features into a higher-level entity set
- Specialization and generalization are simple inversions of each other; they are represented in an ER diagram in the same way
- The terms specialization and generalization are used interchangeably



Design Constraints on a Specialization / Generalization

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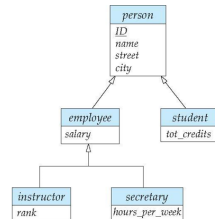
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Module Summary

- **Completeness constraint:** Specifies whether or not an entity in the higher-level entity set must belong to at least one of the lower-level entity sets within a generalization
 - **total:** an entity must belong to one of the lower-level entity sets
 - **partial:** an entity need not belong to one of the lower-level entity sets
- Partial generalization is the default. We can specify total generalization in an ER diagram by adding the keyword **total** in the diagram and drawing a dashed line from the keyword to the corresponding hollow arrow-head to which it applies (for a total generalization), or to the set of hollow arrow-heads to which it applies (for an overlapping generalization).
- The *student* generalization is total. All student entities must be either graduate or undergraduate. Because the higher-level entity set arrived at through generalization is generally composed of only those entities in the lower-level entity sets, the completeness constraint for a generalized higher-level entity set is usually total.





Aggregation

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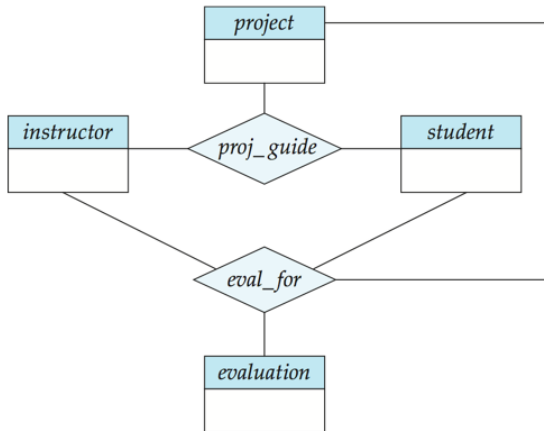
Binary vs Non-Binary

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Module Summary

- Consider the ternary relationship *proj_guide*, which we saw earlier
- Suppose we want to record evaluations of a student by a guide on a project





Aggregation (2)

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- Relationship sets *eval_for* and *proj_guide* represent overlapping information
 - Every *eval_for* relationship corresponds to a *proj_guide* relationship
 - However, some *proj_guide* relationships may not correspond to any *eval_for* relationships
 - ▷ So we cannot discard the *proj_guide* relationship
- Eliminate this redundancy via *aggregation*
 - Treat relationship as an abstract entity
 - Allows relationships between relationships
 - Abstraction of relationship into new entity



Aggregation (3)

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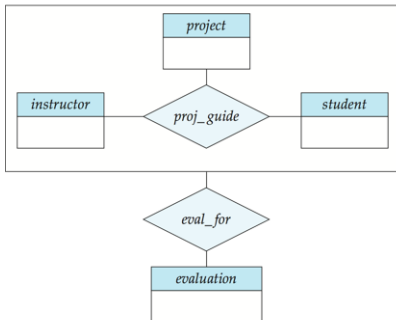
Binary vs Non-Binary

Design Decisions

ER Notation

Module Summary

- Eliminate this redundancy via *aggregation* without introducing redundancy, the following diagram represents:
 - A student is guided by a particular instructor on a particular project
 - A student, instructor, project combination may have an associated evaluation





Representing Aggregation via Schema

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- To represent aggregation, create a schema containing
 - Primary key of the aggregated relationship,
 - The primary key of the associated entity set
 - Any descriptive attributes
- In our example:
 - The schema *textiteval_for* is:
eval_for (s_ID, project_id, i_ID, evaluation_id)
 - The schema *proj_guide* is redundant



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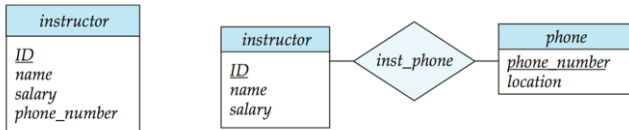
Binary vs Non-Binary

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ER Notation

Module Summary

- Use of entity sets vs. attributes



- Use of phone as an entity allows extra information about phone numbers (plus multiple phone numbers)



Entities vs Relationship Sets

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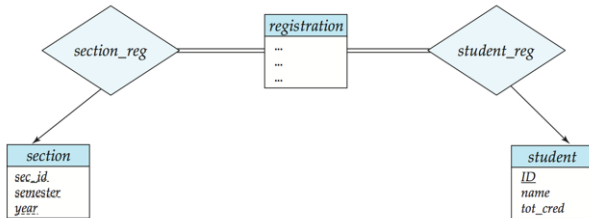
Design Decisions

ER Notation

Module Summary

- **Use of entity sets vs. relationship sets**

Possible guideline is to designate a relationship set to describe an action that occurs between entities



- **Placement of relationship attributes**

For example, attribute date as attribute of advisor or as attribute of student



Binary vs Non-Binary Relationships

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Module Summary

- Although it is possible to replace any non-binary (n -ary, for $n > 2$) relationship set by a number of distinct binary relationship sets, a n -ary relationship set shows more clearly that several entities participate in a single relationship
- Some relationships that appear to be non-binary may be better represented using binary relationships
 - For example, a ternary relationship *parents*, relating a child to his/her father and mother, is best replaced by two binary relationships, *father* and *mother*
 - ▷ Using two binary relationships allows partial information (e.g., only mother being known)
 - But there are some relationships that are naturally non-binary
 - ▷ Example: *proj_guide*



Binary vs Non-Binary Relationships (2): Conversion

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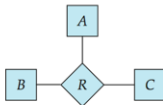
Binary vs Non-Binary

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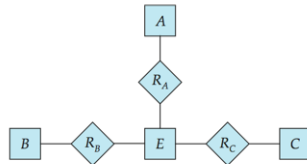
ER Notation

Module Summary

- In general, any non-binary relationship can be represented using binary relationships by creating an artificial entity set.
 - Replace R between entity sets A , B and C by an entity set E , and three relationship sets:
 1. R_A , relating E and A
 2. R_B , relating E and B
 3. R_C , relating E and C
 - Create an identifying attribute for E and add any attributes of R to E
 - For each relationship (a_i, b_i, c_i) in R , create
 - a) a new entity e_i in the entity set E
 - b) add (e_i, a_i) to R_A
 - c) add (e_i, b_i) to R_B
 - d) add (e_i, c_i) to R_C



(a)



(b)



Binary vs Non-Binary Relationships (3): Conversion

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Module Summary

- Also need to translate constraints
 - Translating all constraints may not be possible
 - There may be instances in the translated schema that cannot correspond to any instance of R .
 - ▷ Exercise: *add constraints to the relationships R_A , R_B and R_C to ensure that a newly created entity corresponds to exactly one entity in each of entity sets — A , B and C*
 - We can avoid creating an identifying attribute by making E , a weak entity set (described shortly) identified by the three relationship sets



ER Design Decisions

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Module Summary

- The use of an attribute or entity set to represent an object
- Whether a real-world concept is best expressed by an entity set or a relationship set
- The use of a ternary relationship versus a pair of binary relationships
- The use of a strong or weak entity set
- The use of specialization/generalization – contributes to modularity in the design
- The use of aggregation – can treat the aggregate entity set as a single unit without concern for the details of its internal structure



Symbols Used in ER Notation

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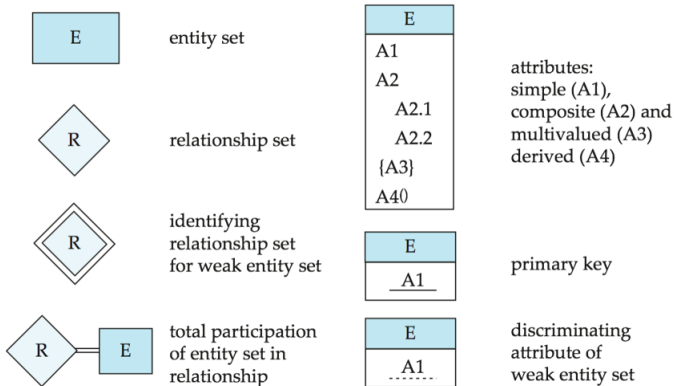
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Symbols Used in ER Notation (2)

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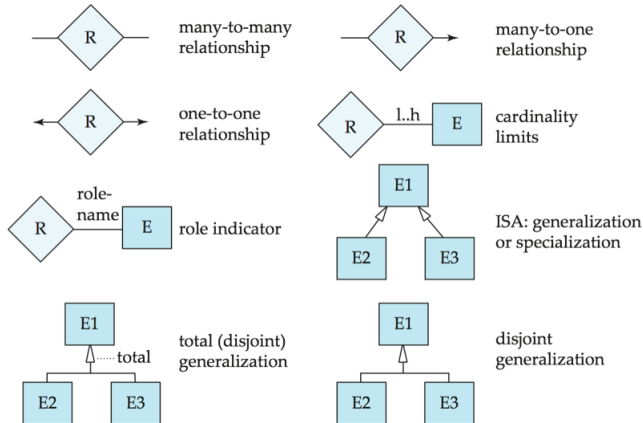
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Symbols Used in ER Notation (3): Alternate

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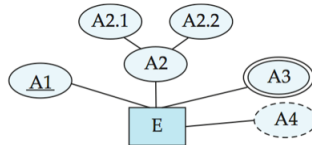
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Module Summary

- Chen, IDE1FX,...

entity set E with
simple attribute A1,
composite attribute A2,
multivalued attribute A3,
derived attribute A4,
and primary key A1



weak entity set



generalization



total
generalization





Symbols Used in ER Notation (4): Alternates

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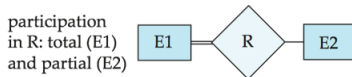
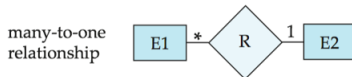
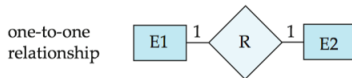
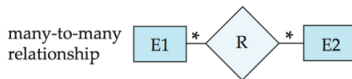
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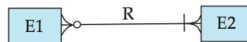
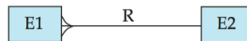
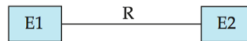
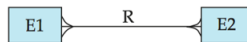
ER Notation

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Chen



IDE1FX (Crows foot notation)





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- Discussed the extended features of ER Model
- Deliberated on various design issues