Entity Relationship Diagram (ERD): Basics

CIS 3730
Designing and Managing Data

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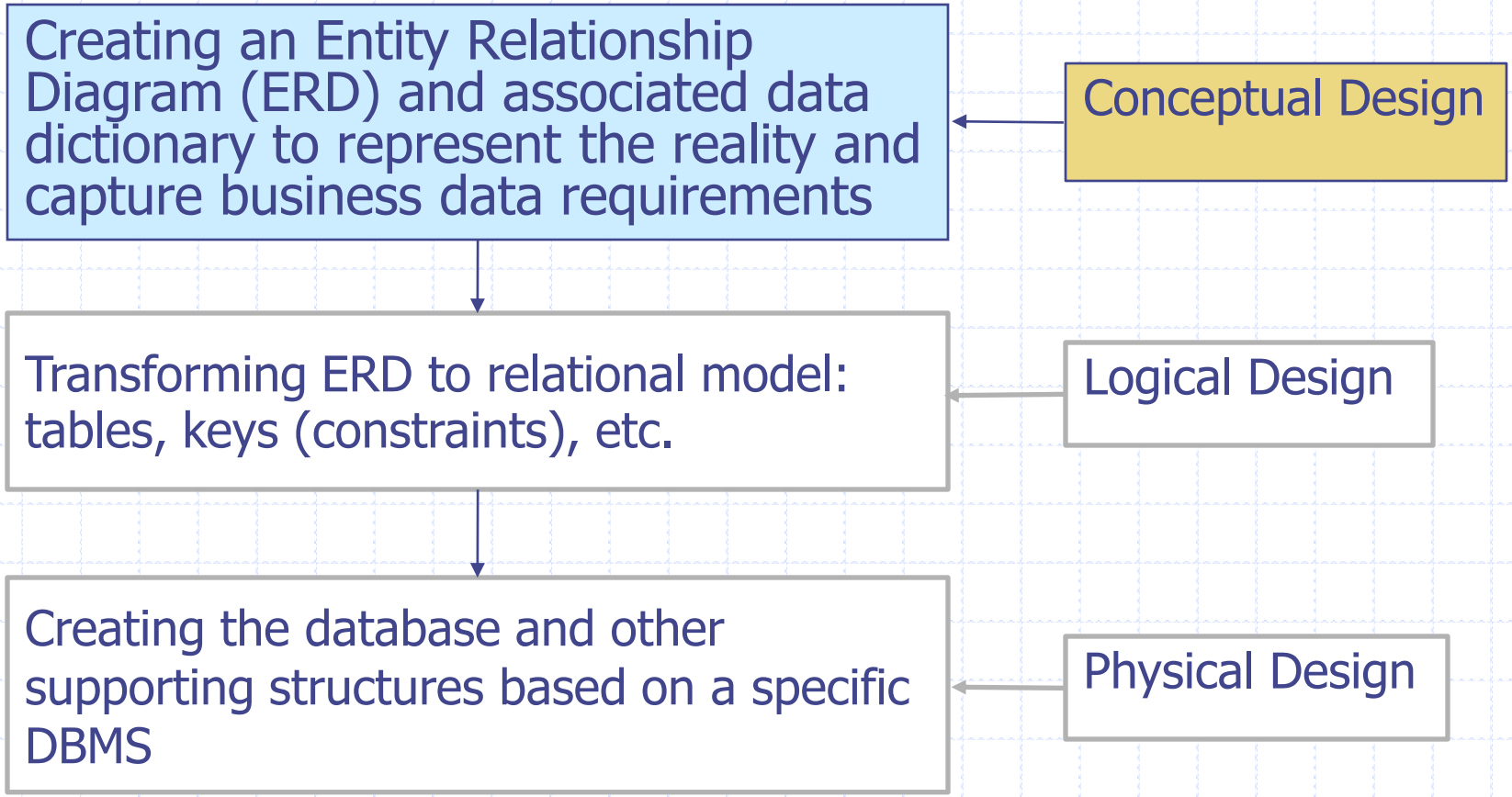
Overview: 3 Level Database Design

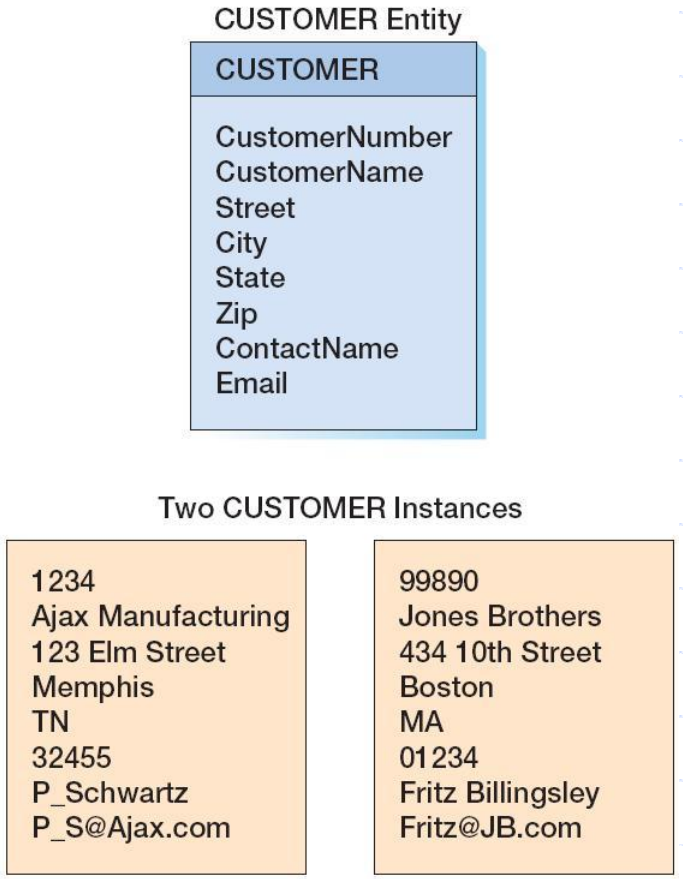


Entity-Relationship Diagram

- Proposed by Dr. Peter Chen in 1970s
  - http://en.wikipedia.org/wiki/Peter_Chen
- ERD is a conceptual model
- Major elements
  - Entity (with attributes and identifier)
  - Relationship

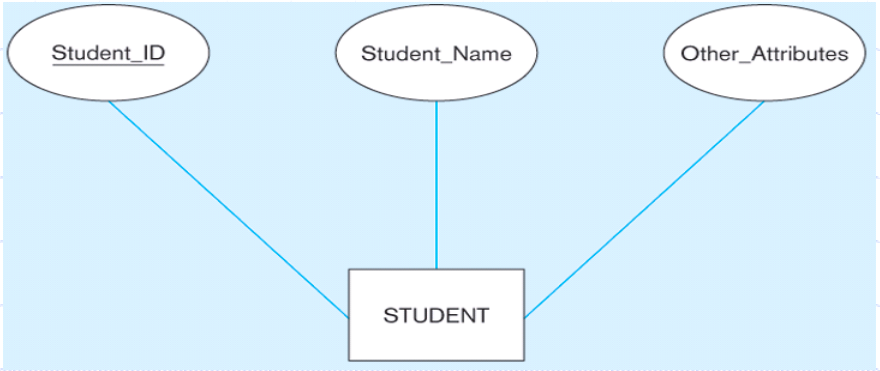
Entity and Attribute

- Entity
  - Entity class (entity set) is a structural description of things that share common attributes
  - Entity instance is the occurrence of a particular entity
- Attribute
  - Describes an entity class
  - All entity instances of a given entity class have the same attributes, but vary in the values of those attributes
- Identifier
  - Identifies an entity instance
  - The value of the identifier attribute is unique for each entity instance

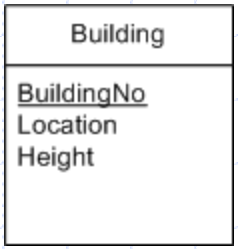


Entity Notations in ERD

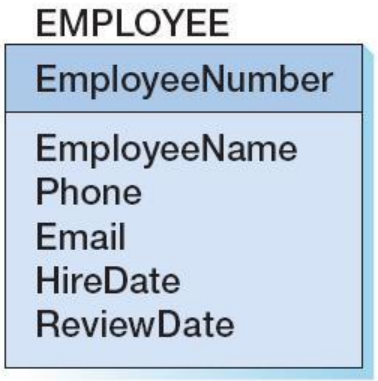
Chen's original style



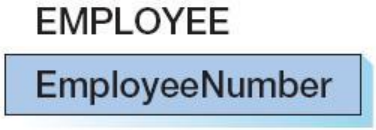
The style used in my Visio examples



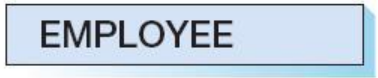
Style used in the textbook



(a) Entity with All Attributes



(b) Entity with Identifier Attribute Only



(c) Entity with No Attributes

Other Attribute Types

- Composite attribute
  - An attribute that can be further divided into more attributes
    - Example: Name, Address, etc.
- Multi-Value Attribute
  - An attribute that allow multiple values
    - Example: skills, phone numbers, etc.
- Derived attribute
  - Attributes that can be calculated (derived) from other attributes
    - Example: age, total, interest, due date, etc.
- Unlike the relational model, these attribute are allowed in conceptual models

Relationship

- Relationship describes how entities are related
- Relationship features
  - Cardinality
    - Entity instance's participation count
  - Degree of relationship
    - How many entities are involved in a relationship?

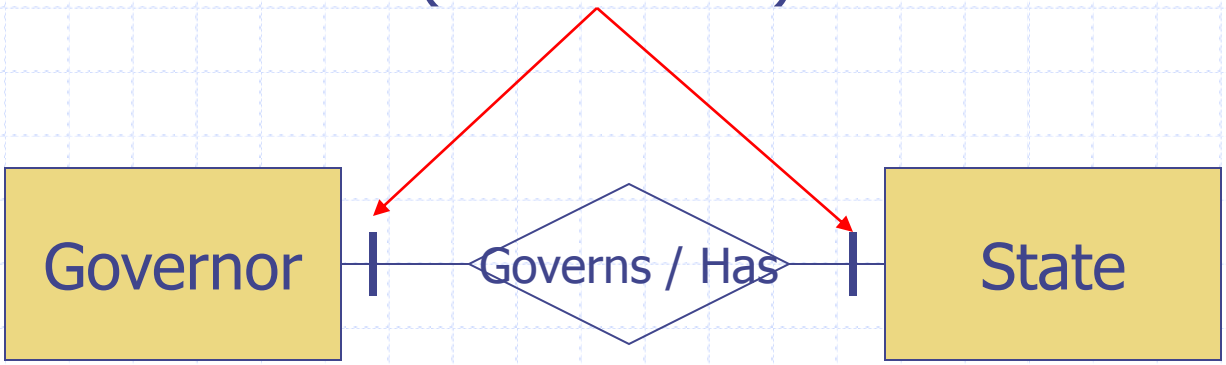
Cardinality

- Cardinality
  - Describes how many entity instance can be in the relationship
- Maximum cardinality (type of relationship)
  - Describes the maximum number of entity instances that participate in a relationship
    - One-to-one
    - One-to-many
    - Many-to-many
- Minimum cardinality
  - Describes the minimum number of entity instances that *must* participate in a relationship

One-to-One Relationship

- One-to-One (1:1)
  - A single entity instance in one entity class is related to a single entity instance in another entity class

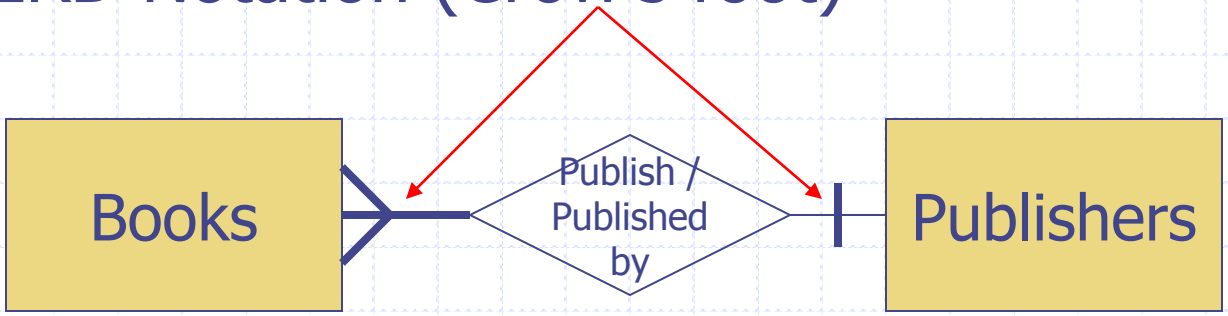
- ERD Notation (Crow's foot)



  - A governor governs (only) one state; a state has (only) one governor.

One-to-Many Relationship

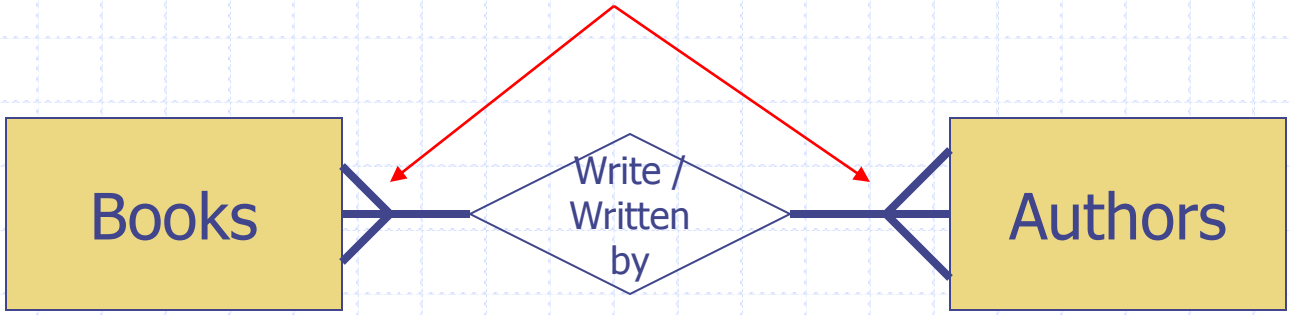
- One-to-Many (1:N)
  - A single entity instance in one entity class (parent) is related to multiple entity instances in another entity class (child)
- ERD Notation (Crow's foot)



  - A book is published by (only) one publisher; a publisher can publish many (multiple) books

Many-to-Many Relationship

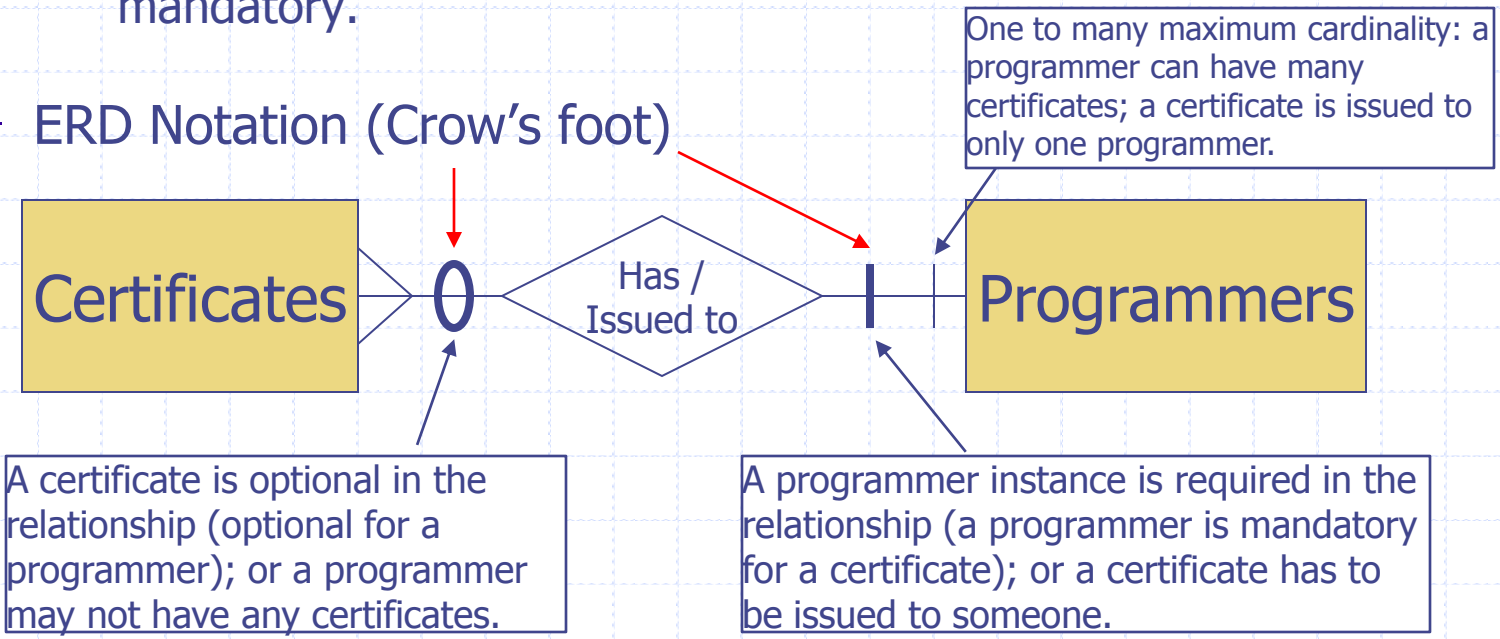
- Many-to-Many (N:M)
  - Each entity instance in one entity class is related to multiple entity instances in another entity class; and vice versa.
- ERD Notation (Crow's foot)



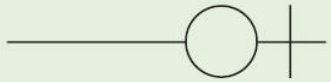
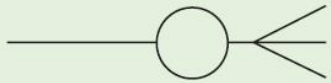
  - A book can be written by many (multiple) authors; an author can write many (multiple) books

Minimum Cardinality

- Minimum cardinality describes the minimum number of instances that must participate in a relationship for any one instance
- Minimums are generally stated as either zero or one:
  - 0 (optional): participation in the relationship by the entity is optional.
  - 1 (mandatory): participation in the relationship by the entity is mandatory.
- ERD Notation (Crow's foot)



Crow's Foot Notation Summary

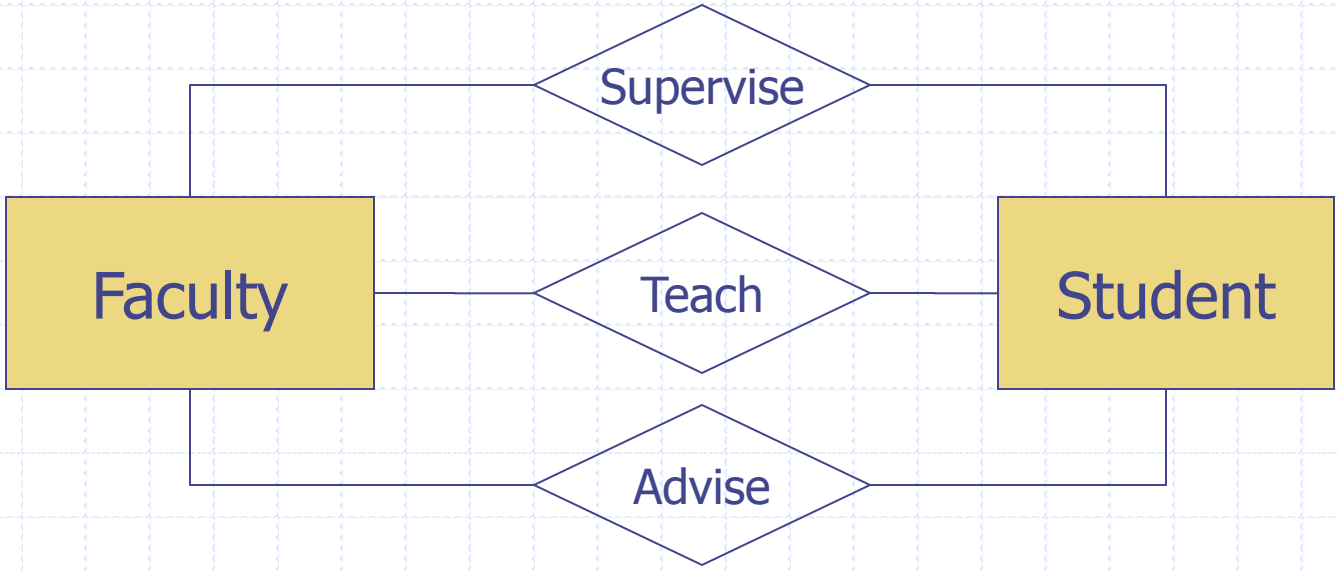
Symbol	Meaning	How many instances
	One—Mandatory	Exactly one
	Many—Mandatory	From one to many
	One—Optional	From zero to one
	Many—Optional	From zero to many

Relationship Modeling Considerations

1. Multiple relationships
2. Transitive relationship
3. Attributes of relationships
4. Promoting relationship to entity

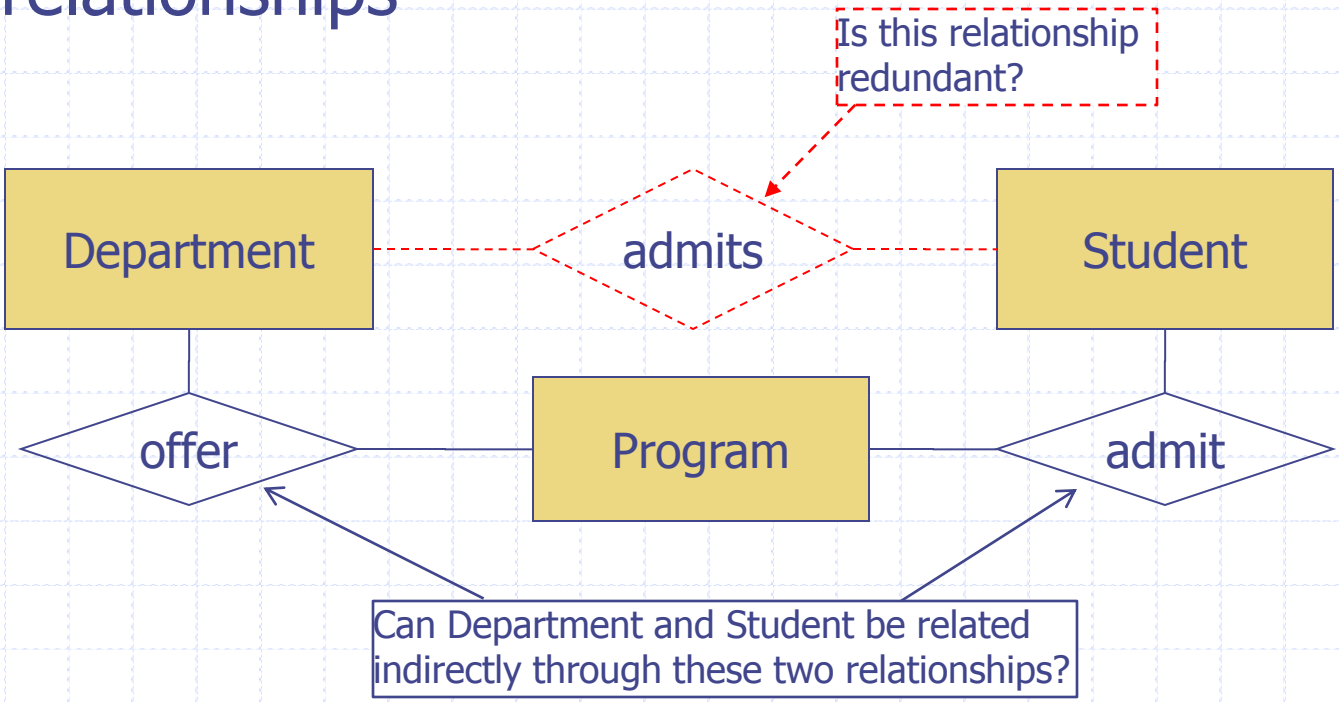
1. Multiple Relationships

- Multiple relationships can exists between entities, as long as they are independent or different

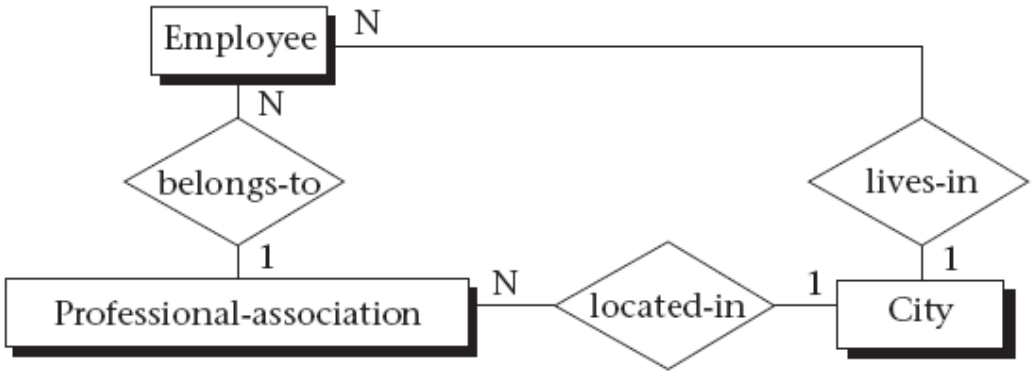


2. Transitive Relationship

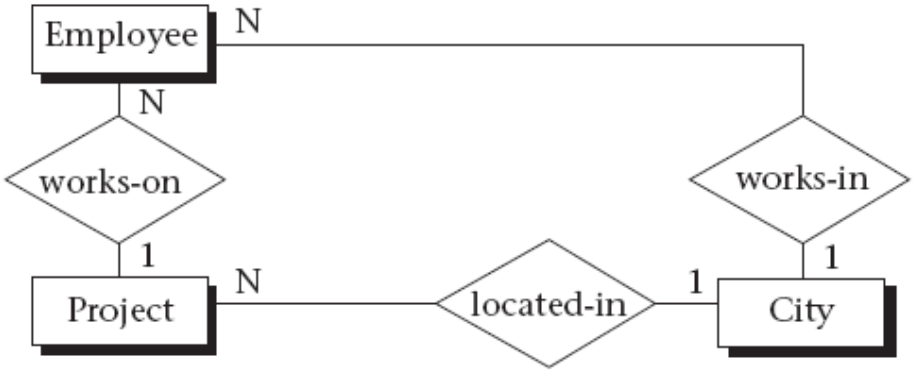
- Entities can be related indirectly by two relationships.
- A relationship is redundant if it can be completely represented by alternate transitive relationships



Redundant Relationship?



(a) Nonredundant relationships

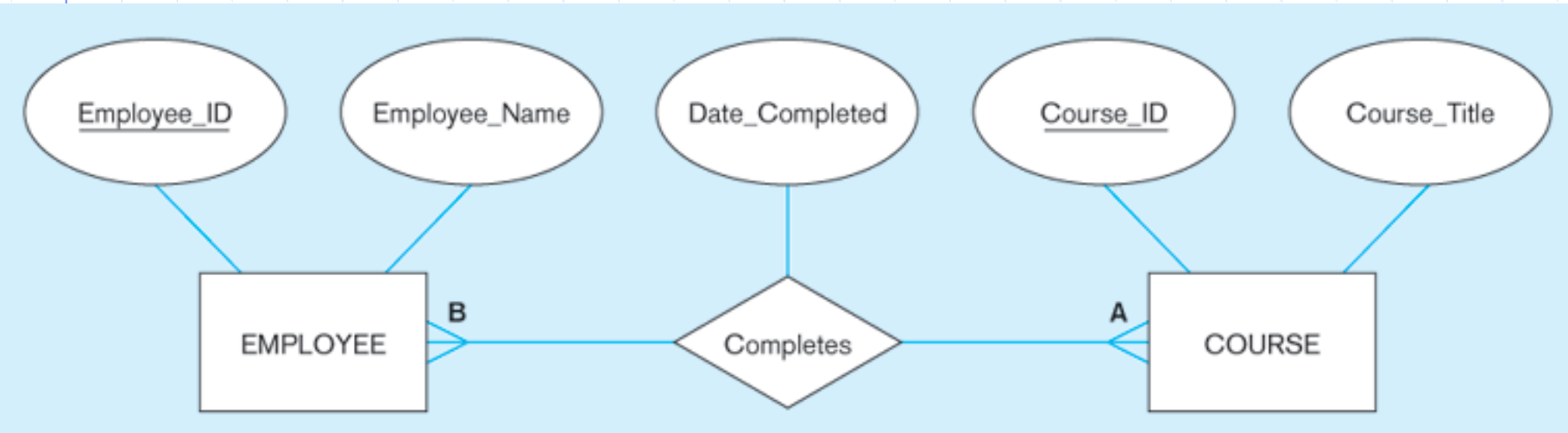


(b) Redundant relationships using transitivity

- From: Database Modeling and Design: Logical Design, 4th Edition by Toby J. Teorey, Sam S. Lightstone, and Tom Nadeau, 2005

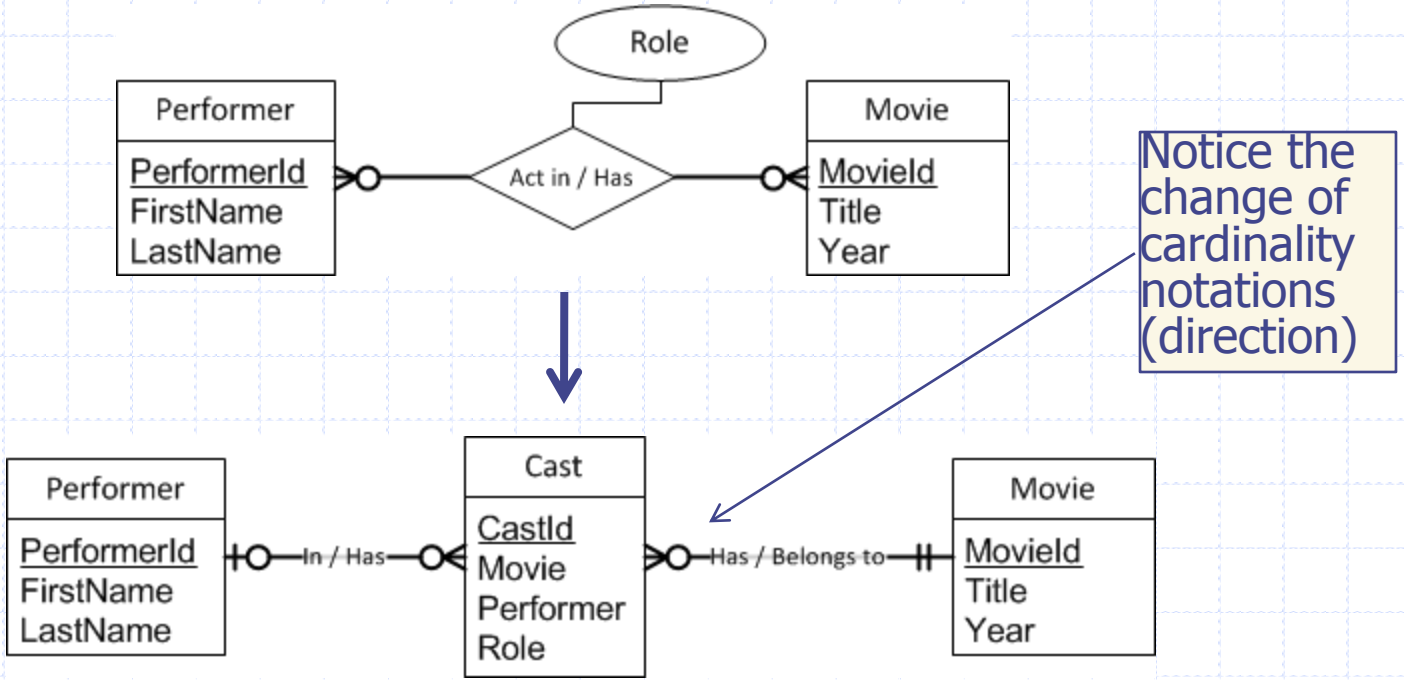
3. Attributes of a Relationship

- A relationship can have attributes



Relationship as an Entity

- Relationships can be modeled as entities, particularly when they have attributes

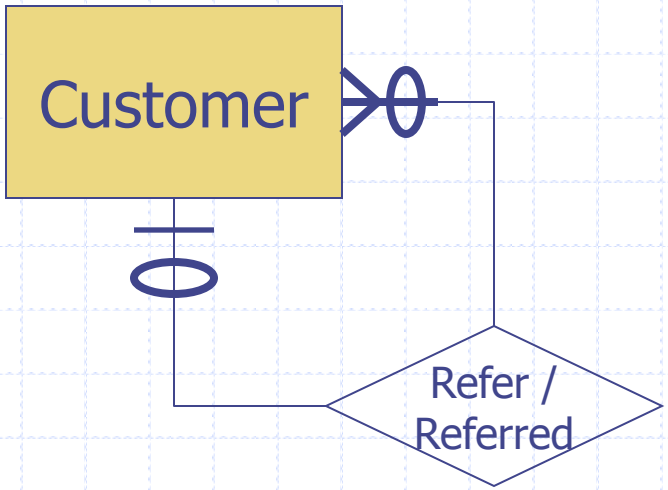


Degree of Relationship

- Degree of relationship: describes the number of entities involved in a relationship
  - Unary (one entity)
  - Binary (two entities)
  - Ternary (three entities)
  - N'ary (more than 3)
- Binary (two entities) relationship is most common

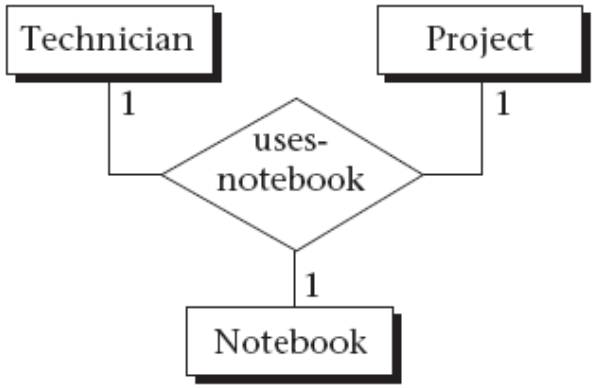
Unary Relationship

- Unary (recursive): only 1 entity
- Example
  - A customer can refer multiple other customers, and it's optional for them to refer other customers (he/she does not have to refer anyone).
  - A customer can be referred by only one other customer, and his/her referee is optional (he/she does not have to be referred by anyone).



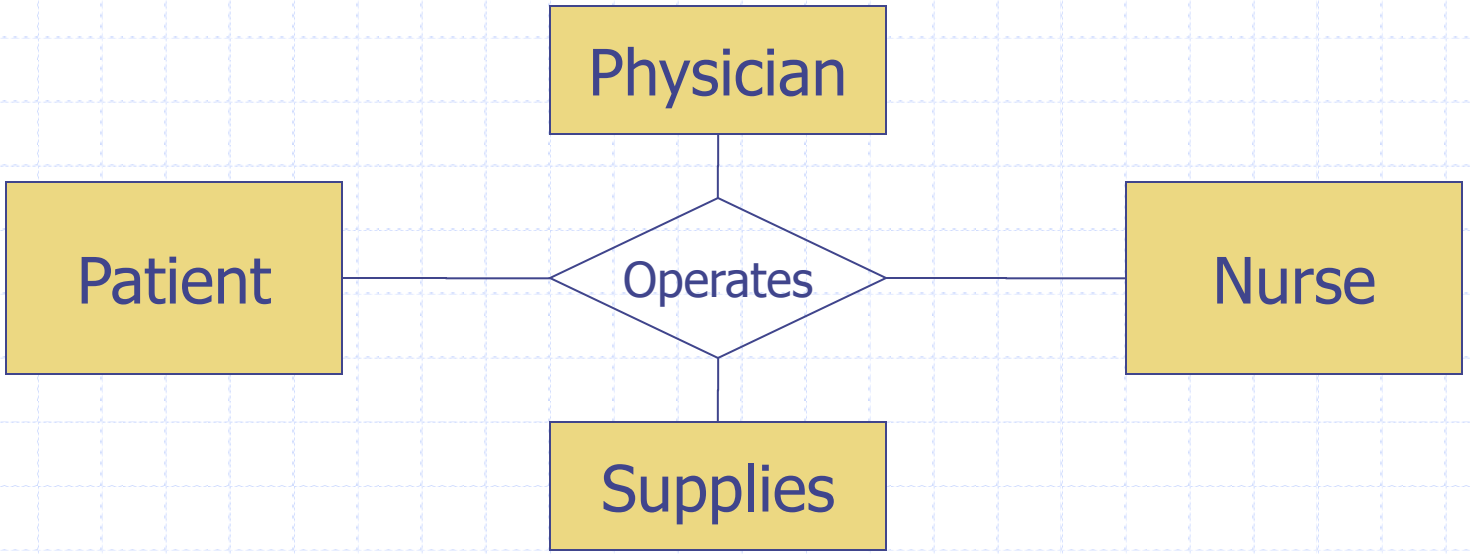
Ternary Relationship

- Ternary: 3 entities are required in this relationship
- Example
  - A technician uses a notebook in a project
  - Notebook and project as a combination always stay together
  - Any of these 3 entities has to participate the relationship



N'ary Relationship Example

- 4 entities
  - A physician operates on a patient, with certain nurses and supplies participating in this operation at the same time



Summary

- Key concepts
  - ERD
  - Entity, attribute and identifier
  - Relationship
    - Cardinality
    - Maximum cardinality: 1:1, 1:N, N:M
    - Minimum cardinality: optional, mandatory
    - Degree: unary, binary, ternary, etc.
  - Crow's foot

- Key skills
  - Interpret simple ERDs involving the key concepts above.
  - Draw simple ERD using the crow's foot notation to model entities, attributes, identifiers, relationships, and cardinalities correctly, in simple scenarios involving binary relationships.