Ch 2

Database Management Systems

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Overview

- Conceptual Data Modeling/Schema in Organization
  - E-R Model Constructs
    - Modeling ENTITIES
    - Modeling ATTRIBUTES
    - Modeling RELATIONSHIPS
    - Modeling CARDINALITIES
  - Examples
  - Case Study: Pine Valley Furniture Company

Basic E-R Notation

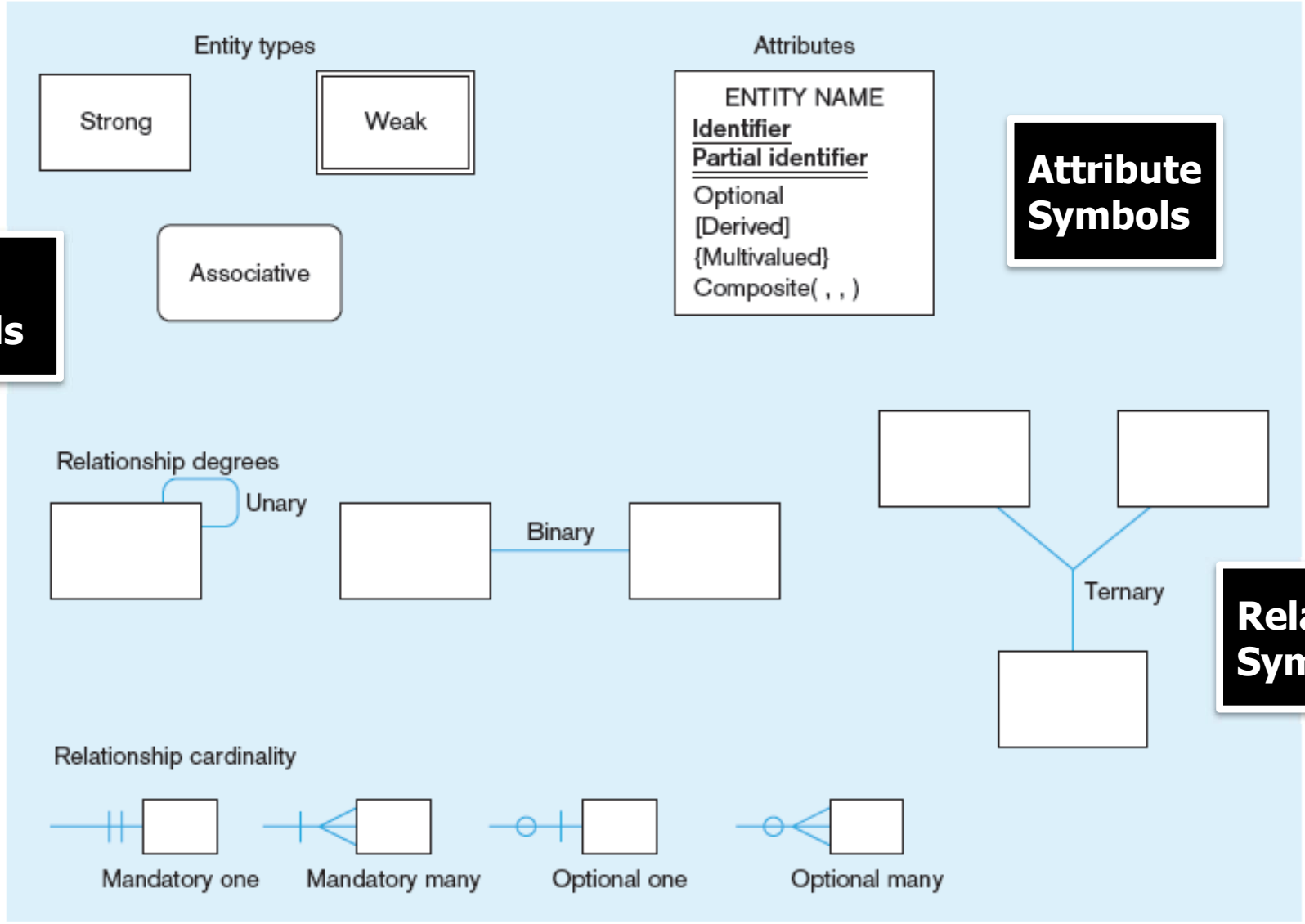


Figure 2-2: Basic E-R Notation

Entity

- Entity – A person, place, object, event, or concept in the user environment about which the organization wishes to maintain data.

Person:	EMPLOYEE, STUDENT, PATIENT
Place:	STORE, WAREHOUSE, STATE
Object:	MACHINE, BUILDING, AUTOMOBILE
Event:	SALE, REGISTRATION, RENEWAL
Concept:	ACCOUNT, COURSE, WORK CENTER

- Entity Type – A collection of entities that share common properties or characteristics

- Entity Instance – A single occurrence of entity type

Entity Type Vs. Entity Instance

Entity type: EMPLOYEE

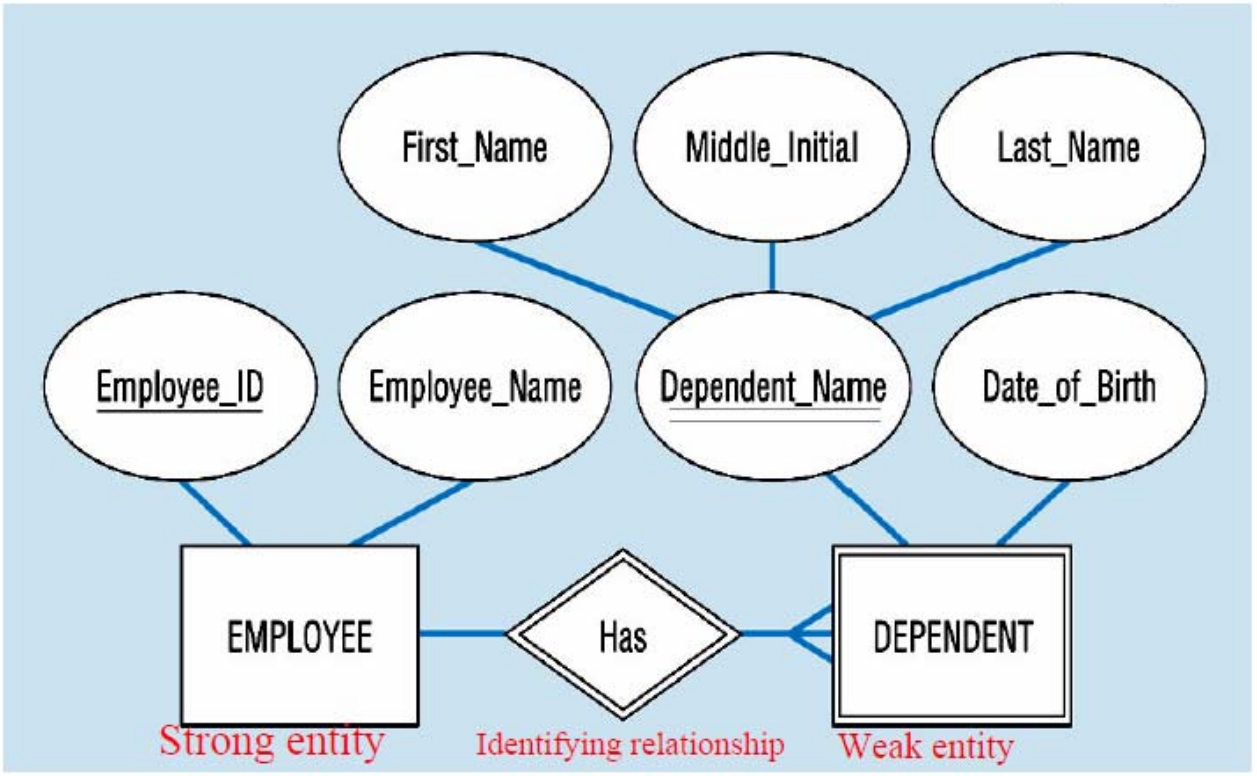
Attributes	Attribute Data Type	Example Instance	Example Instance
Employee Number	CHAR (10)	642-17-8360	534-10-1971
Name	CHAR (25)	Michelle Brady	David Johnson
Address	CHAR (30)	100 Pacific Avenue	450 Redwood Drive
City	CHAR (20)	San Francisco	Redwood City
State	CHAR (2)	CA	CA
Zip Code	CHAR (9)	98173	97142
Date Hired	DATE	03-21-1992	08-16-1994
Birth Date	DATE	06-19-1968	09-04-1975

Figure 2-3: Entity Type EMPLOYEE with two instances

Strong vs. Weak Entities & Identifying Relationships

- Strong Entity
  - Exists independently of other types of entities
  - Has its own unique identifier
  - Represented with single–line rectangle
- Weak Entity
  - Dependent on a strong entity… can't exist on its own
  - Does not have a unique identifier
  - Represented with double–line rectangle
- Identifying Relationship
  - Link strong entities to weak entities
  - Represented with double line diamond

Strong & Weak Entities



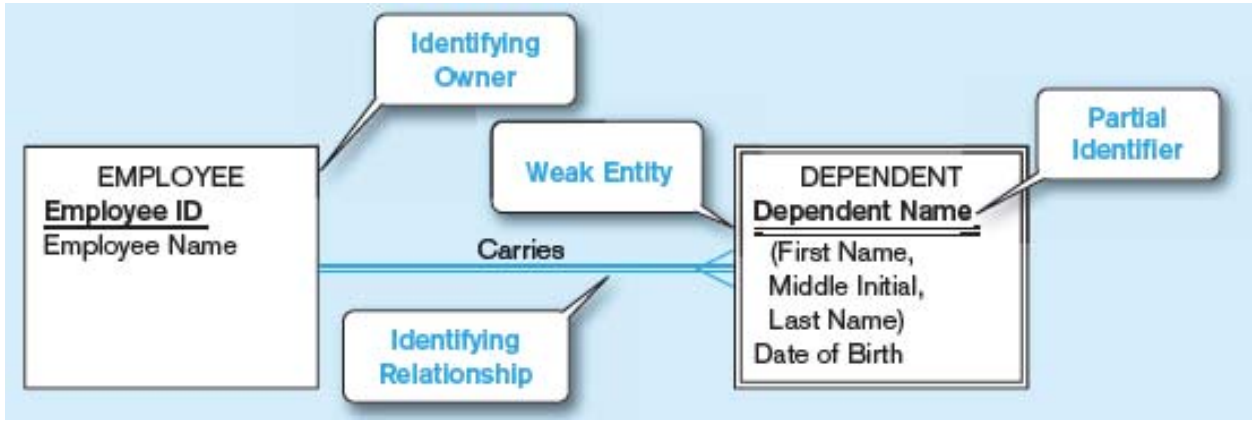


Figure 2-5: Example of Weak Entity

Attributes

- Attribute – A property or characteristic of an entity or relationship type that is of interest to the organization

STUDENT	Student ID, Student Name, Home Address, Phone Number, Major
AUTOMOBILE	Vehicle ID, Color, Weight, Horsepower
EMPLOYEE	Employee ID, Employee Name, Payroll Address, Skill

- Required Attribute – An attribute that must have a value for every entity (or relationship) instance with which it is associated

- Optional Attribute – An attribute that may not have a value for every entity (or relationship) instance with which it is associated

When we represent entities in a database, we actually store only the attributes.

Required & Optional Attributes

Entity type: STUDENT

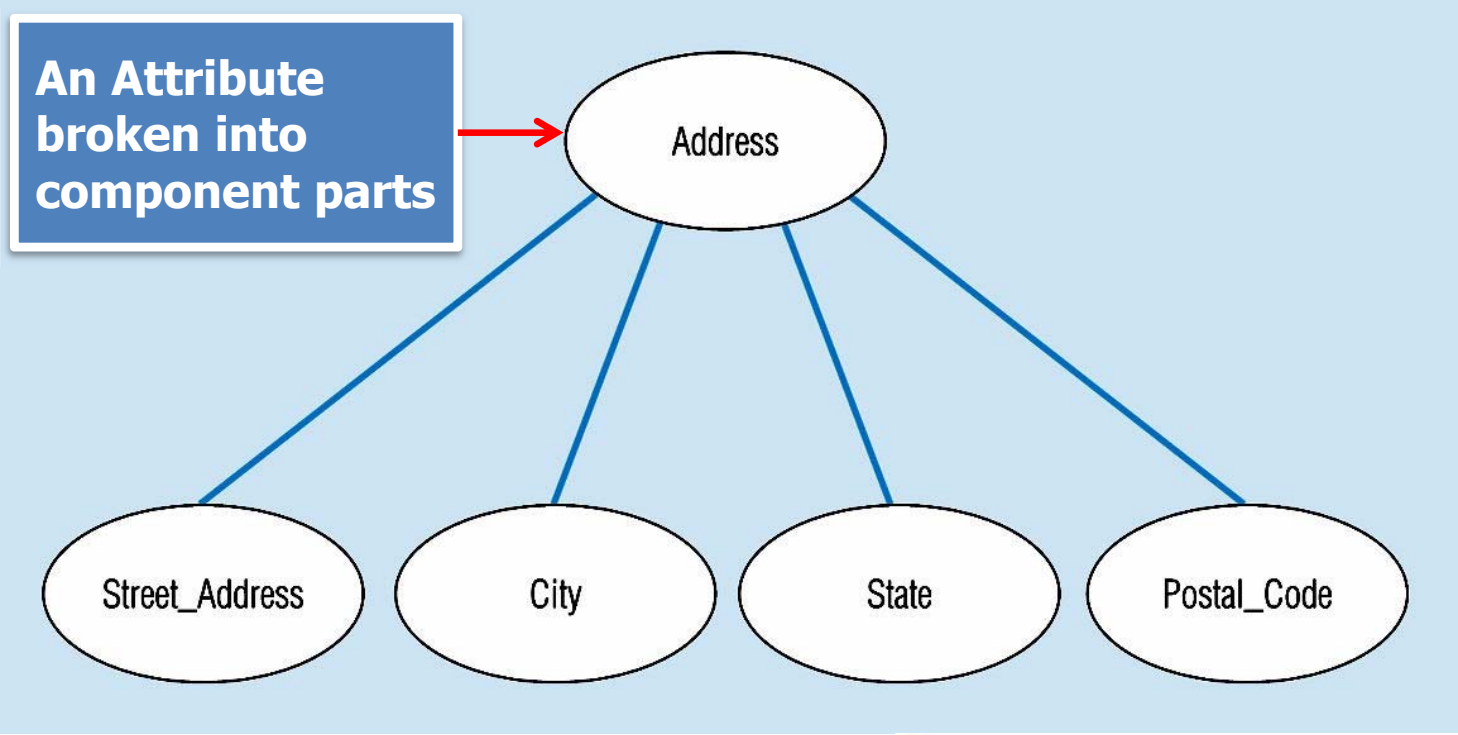
Attributes	Attribute Data Type	Required or Optional	Example Instance	Example Instance
Student ID	CHAR (10)	Required	876-24-8217	822-24-4456
Student Name	CHAR (40)	Required	Michael Grant	Melissa Kraft
Home Address	CHAR (30)	Required	314 Baker St.	1422 Heft Ave
Home City	CHAR (20)	Required	Centerville	Miami
Home State	CHAR (2)	Required	OH	FL
Home Zip Code	CHAR (9)	Required	45459	33321
Major	CHAR (3)	Optional	MIS	

Figure 2-6: Entity Type STUDENT with required and optional attributes

Classification of Attributes

- Classification of attributes
  - Simple (e.g. age, sex, marital status) versus Composite (e.g. address, phone number) Attribute
  - Single-Valued (e.g. NIC number, serial number of a manufactured part SE-08-02-189935) versus Multi- valued (e.g. a house having several phones, a person having several degrees) Attribute
  - Stored versus Derived (whose values are calculated from other attributes e.g. age is current date minus DOB. In Access: INT((Date() EMP_DOB)/365)) Attributes
  - Identifier Attributes

Composite Attribute



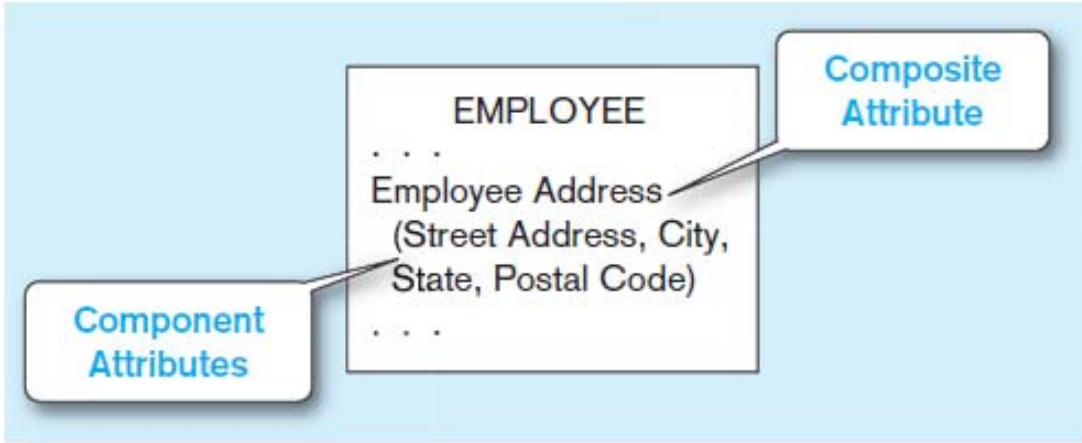


Figure 2-7: Example of Composite Attribute

Entity with Multi-Valued & Derived Attributes

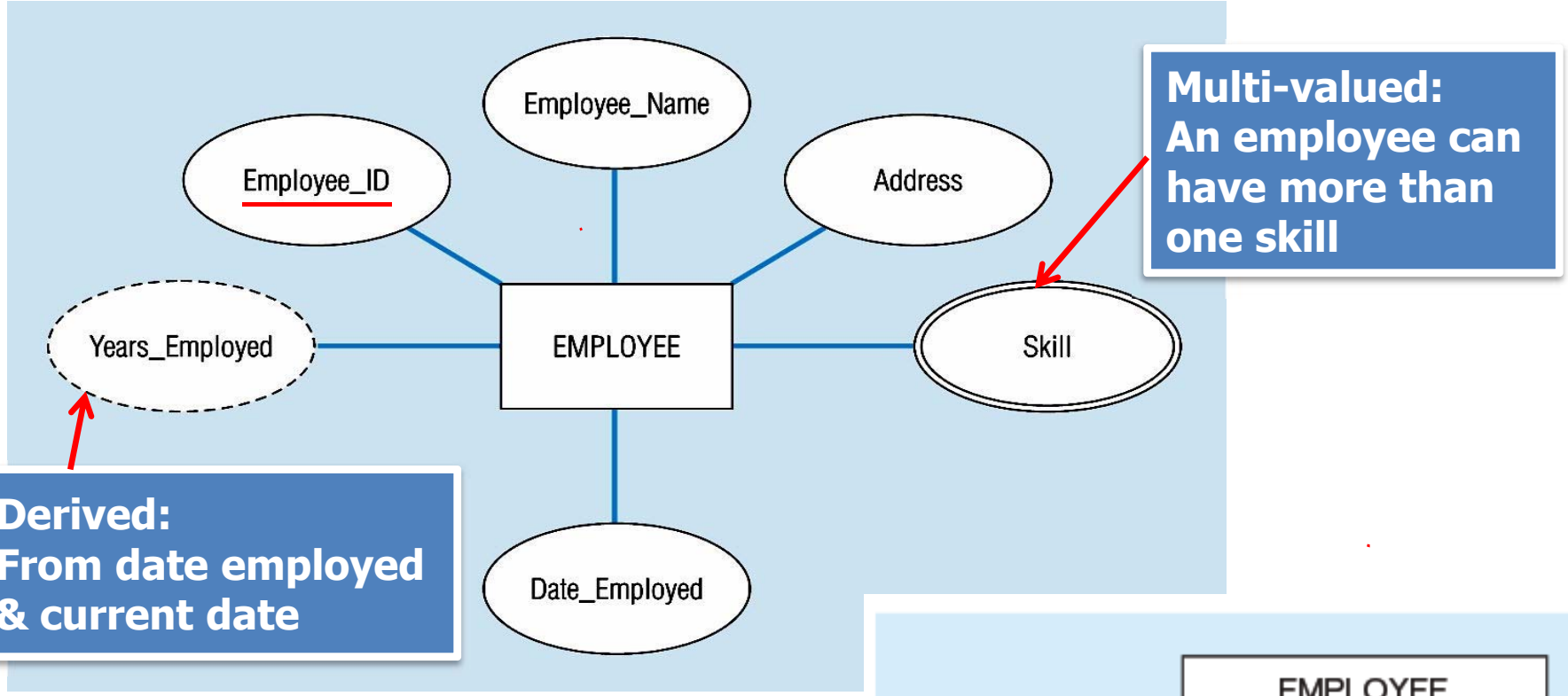
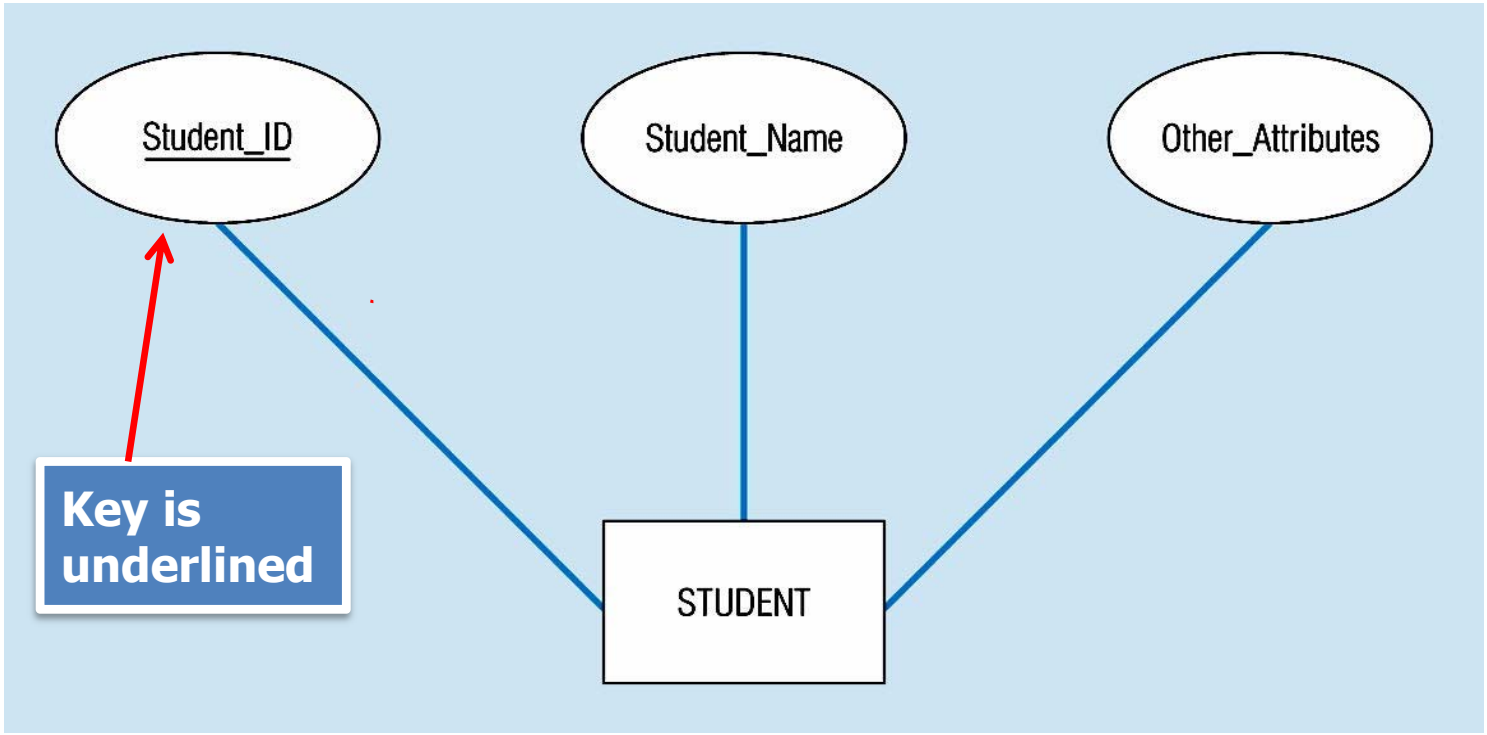


Figure 2-8: Example of Multivalued & Derived Attribute

Identifiers (Keys)

- Identifier (Key) – An attribute (or combination of attributes) that uniquely identifies individual instances of an entity type
- Simple Key versus Composite Key
- Candidate Key – an attribute that could be a key… satisfies the requirements for being key

Key Attribute



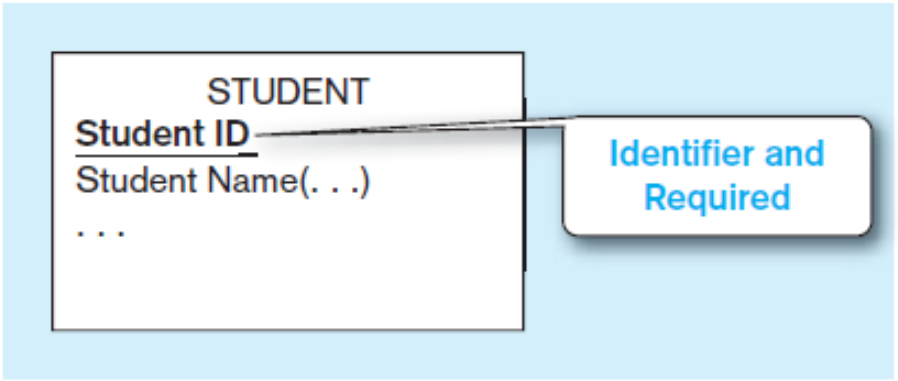
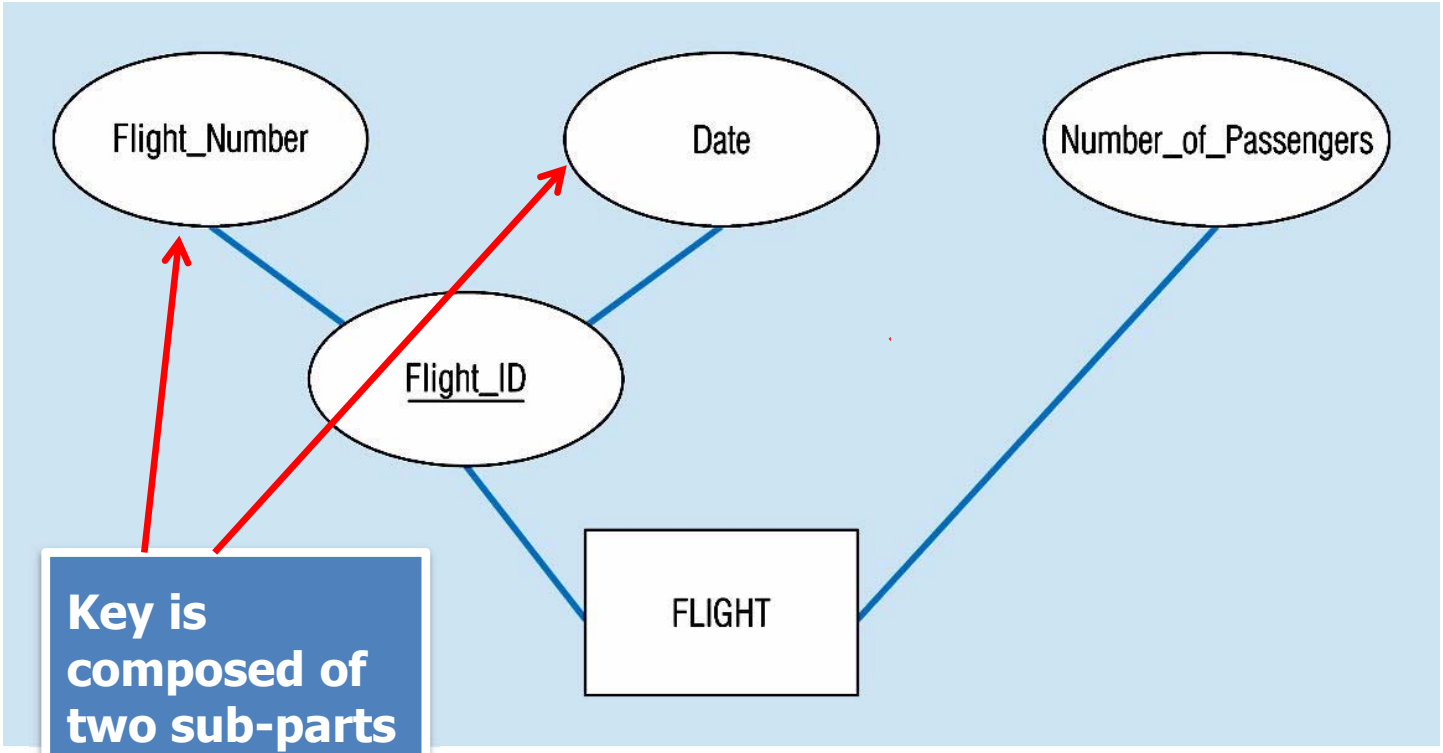


Figure 2-9a: Simple Identifier Attribute

Composite Key Attribute



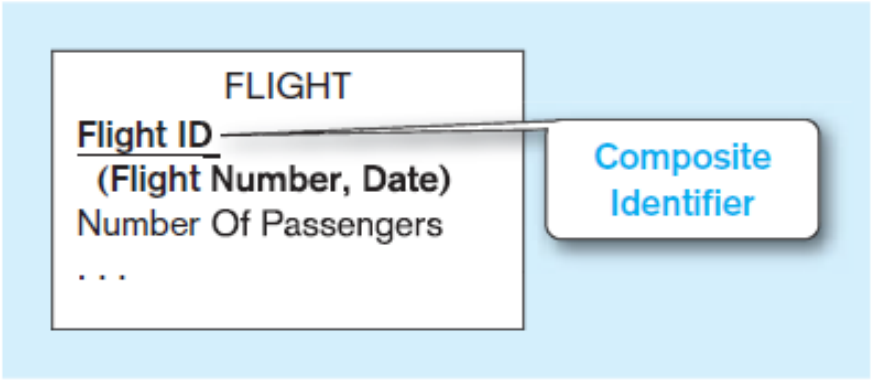
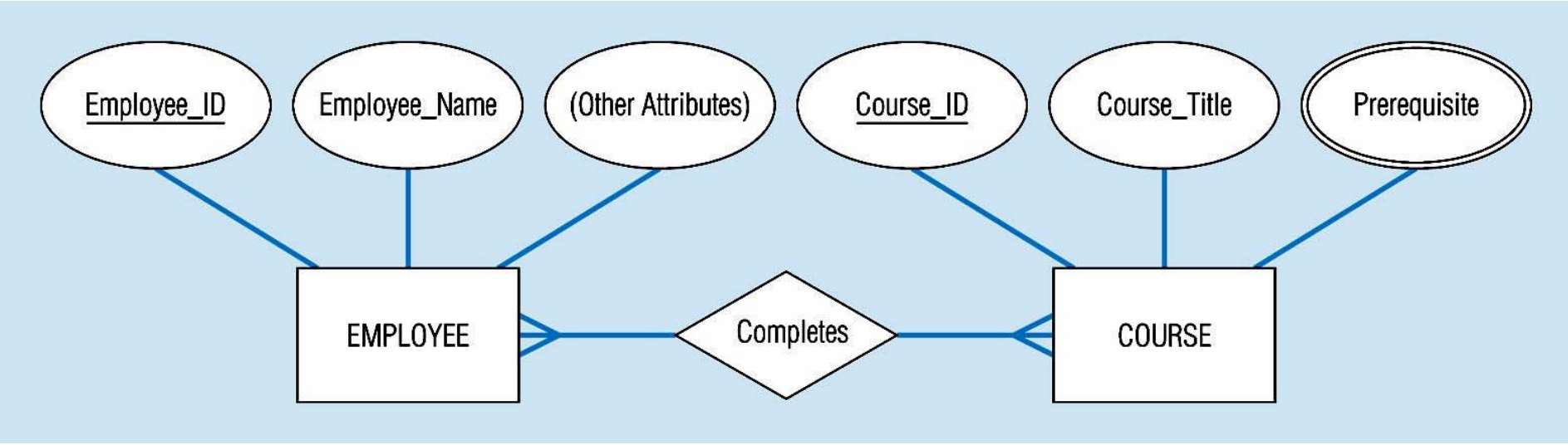


Figure 2-9b: Composite Identifier Attribute

Characteristics of Identifiers

- Will not change in value
- Will not be null
- No intelligent identifier (for instance containing locations or people that might change)
- Substitute new, simple keys for long, composite keys

Relationship Type



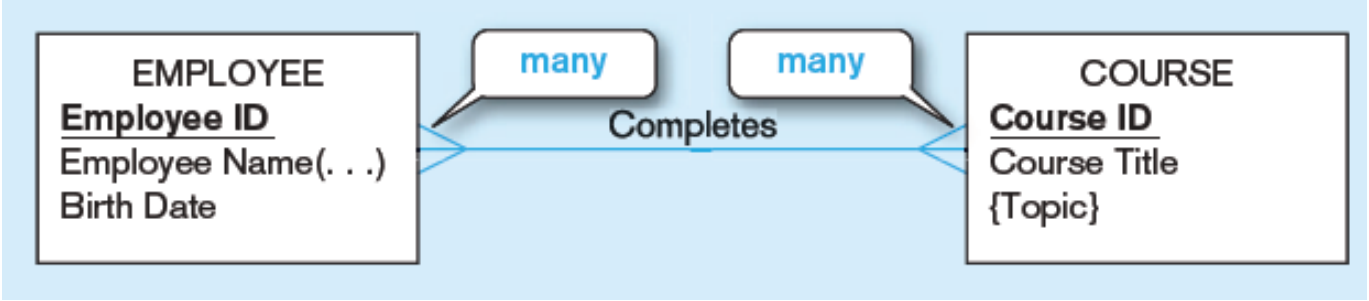


Figure 2-10a: Relationship Type

Relationship Instances

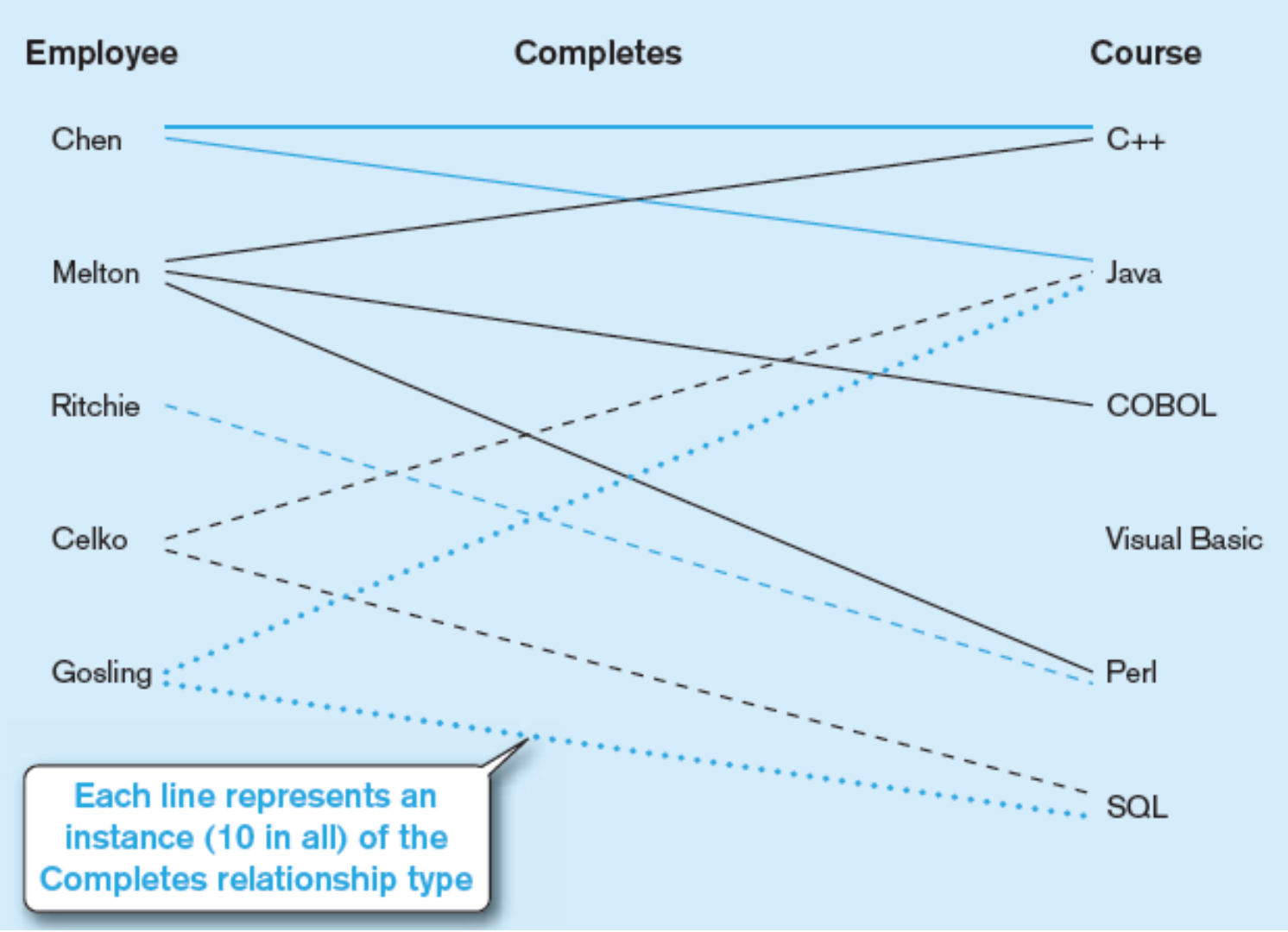


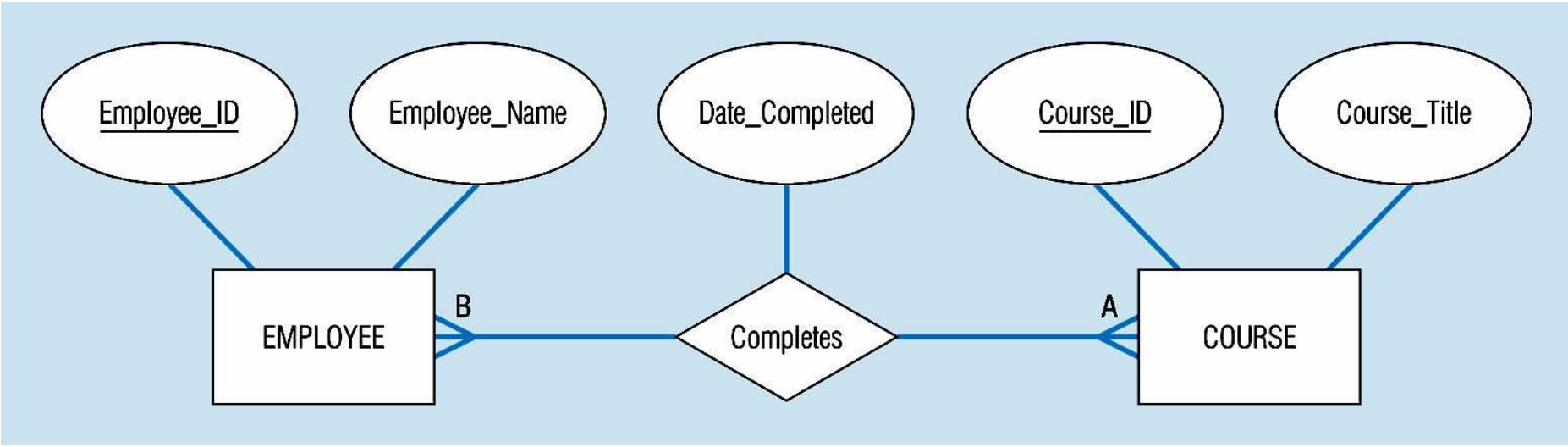
Figure 2-10b: Relationship Instances

Table 2-2

TABLE 2-2 Instances Showing Date Completed

Employee Name	Course Title	Date Completed
Chen	C++	06/2009
Chen	Java	09/2009
Melton	C++	06/2009
Melton	COBOL	02/2010
Melton	SQL	03/2009
Ritchie	Perl	11/2009
Celko	Java	03/2009
Celko	SQL	03/2010
Gosling	Java	09/2009
Gosling	Perl	06/2009

Binary Relationship with an Attribute



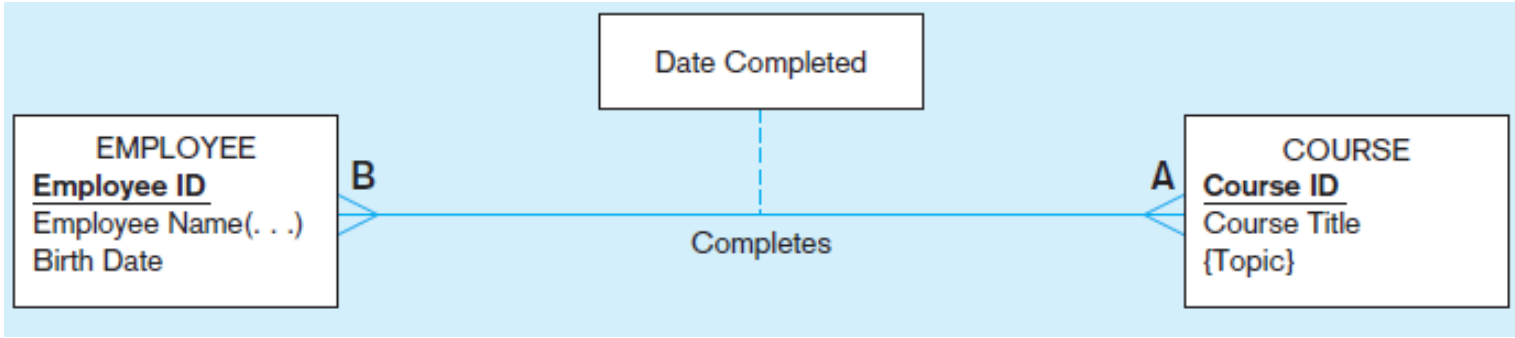


Figure 2-11a: Attribute on a Relationship

Here date_completed attribute pertains specifically to the employee's completion of a course… it is an attribute of the *relationship*

Associative Entities

- It's an entity – it has attributes
- And it's a relationship – it links entities together
- When should a relationship with attributes instead be an associative entity?
  - All relationships for the associative entity should be many
  - The associative entity could have meaning independent of the other entities
  - The associative entity preferably has a unique identifier, and should also have other attributes
  - The associative may be participating in other relationships other than the entities of the associated relationship
  - Ternary relationships should be converted to associative entities

An Associative Entity (Certificate)

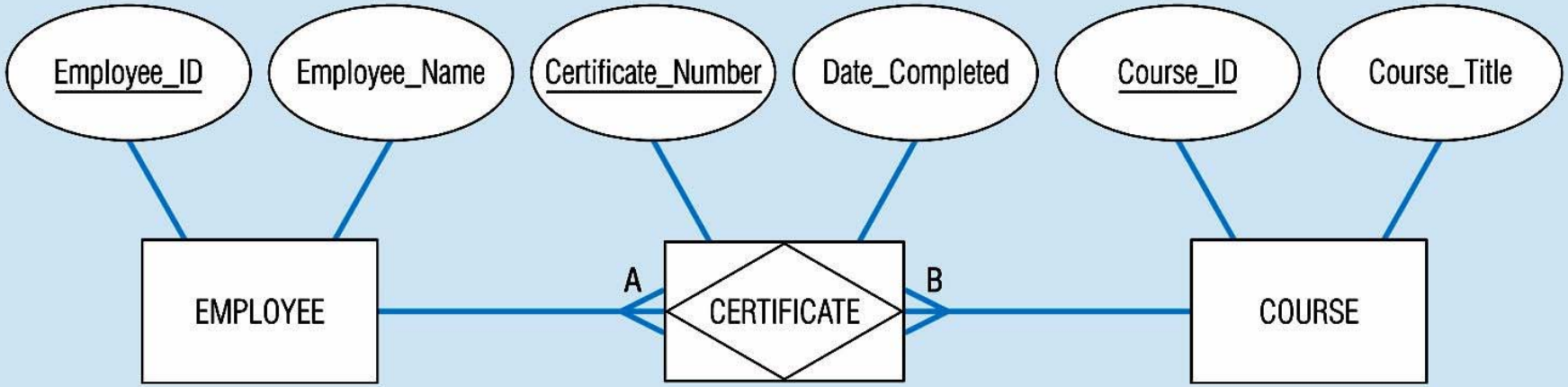
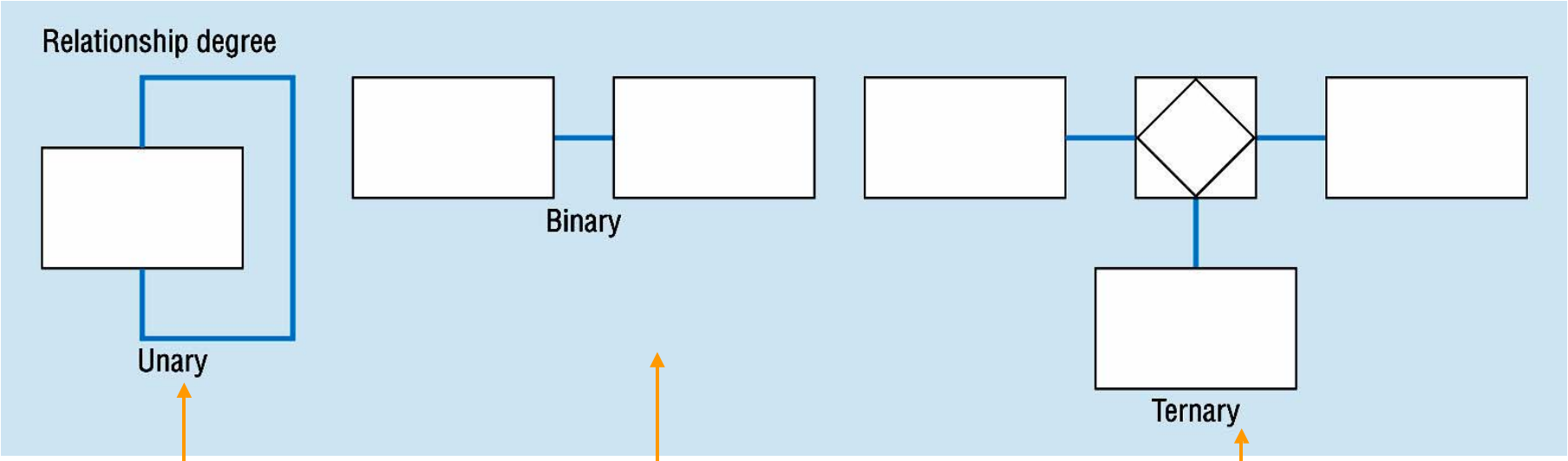


Figure 2-11b: Associative Entity

Associative entity involves a rectangle with a diamond inside. Note that the many-to-many cardinality symbols face toward the associative entity and not toward the other entities.

Degree of Relationships



One entity related to another of the same entity type.

Entity of two different types related to each other.

Entity of three different types related to each other.

Unary Relationships

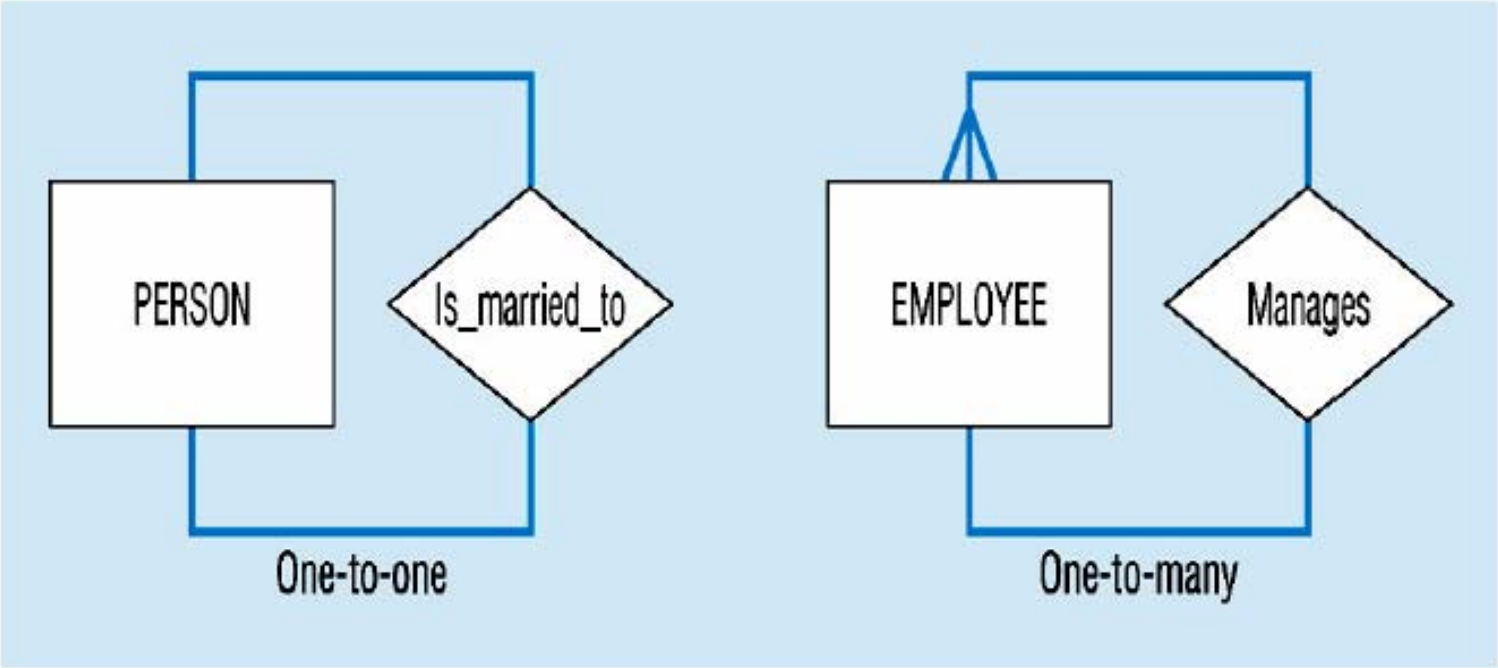
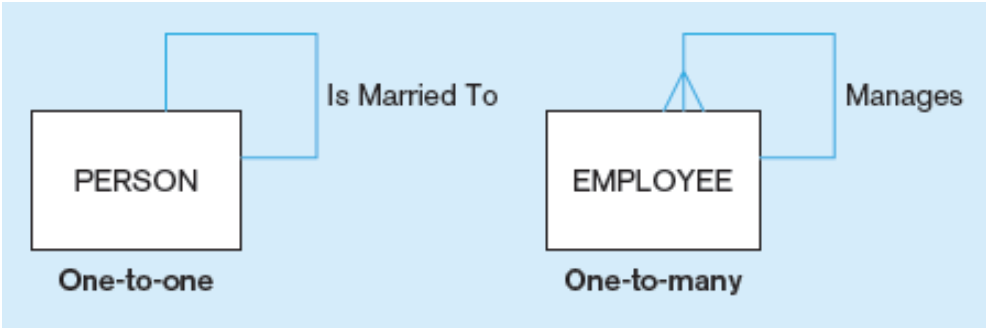


Figure 2-12a: Unary Relationships



Unary Relationship with an Attribute

Unary relationship with an attribute (many-to-many relationship)

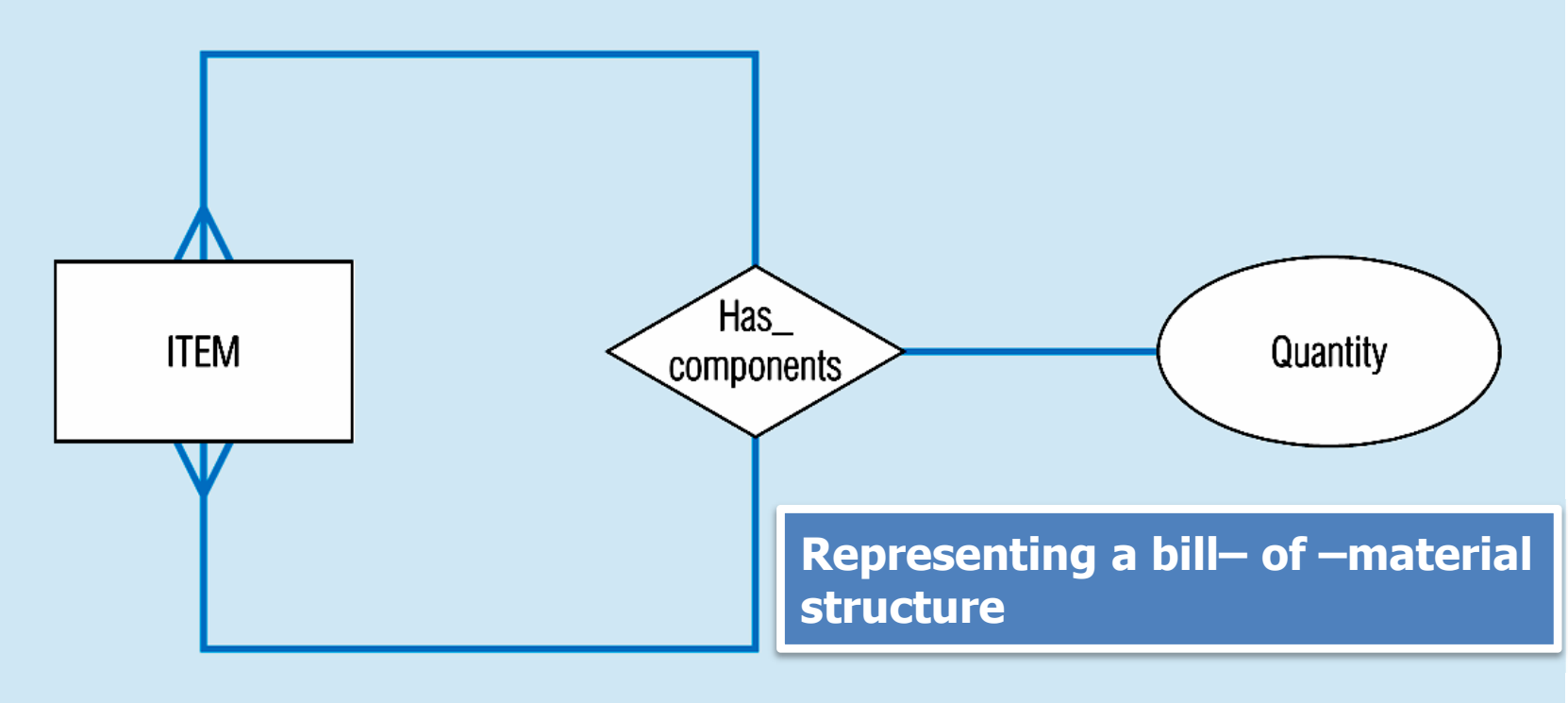


Figure 2-13a: Unary M:M Relationship

Example

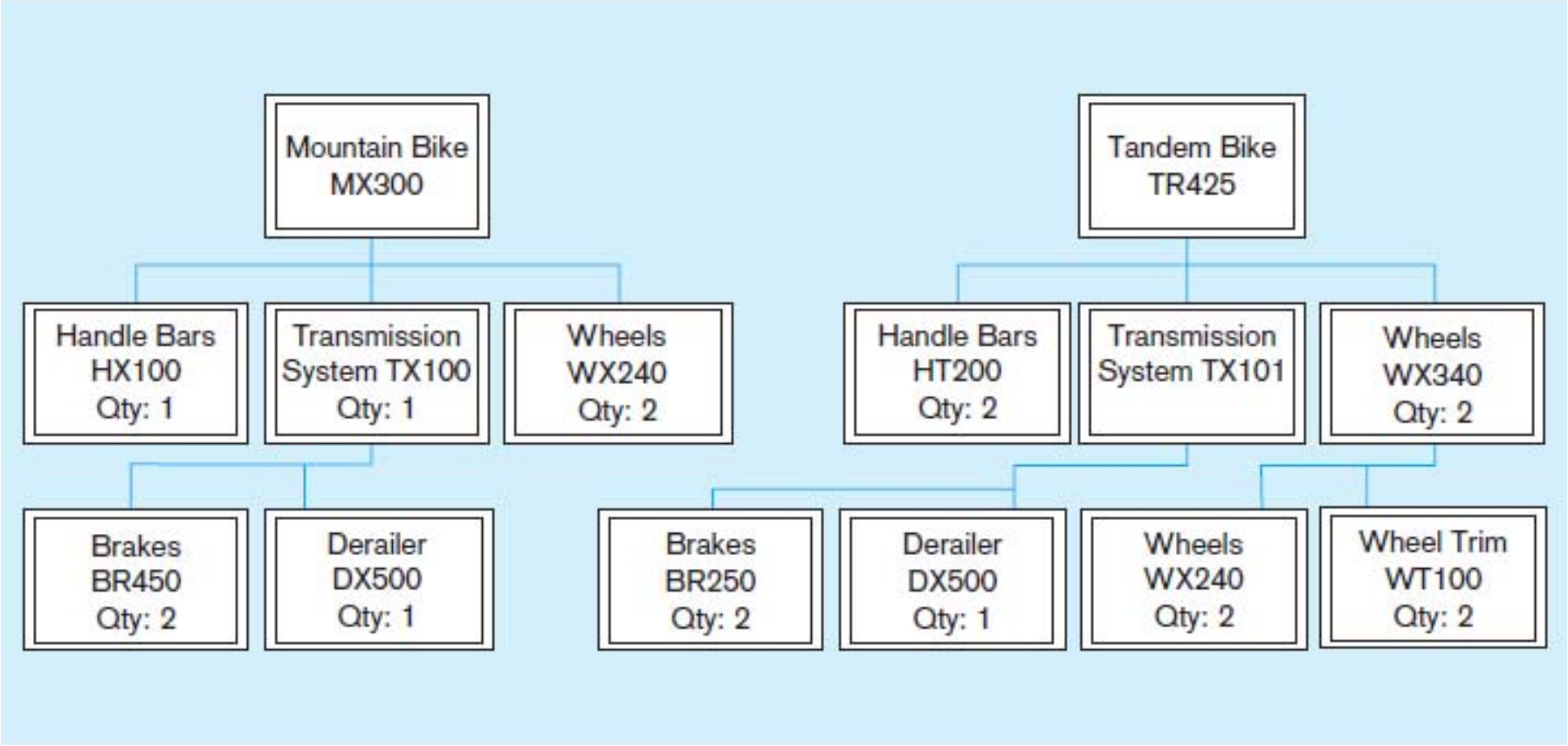


Figure 2-13b: Two ITEM bill-of-materials structure instances

An Associative Entity (Bill of Material Structure)

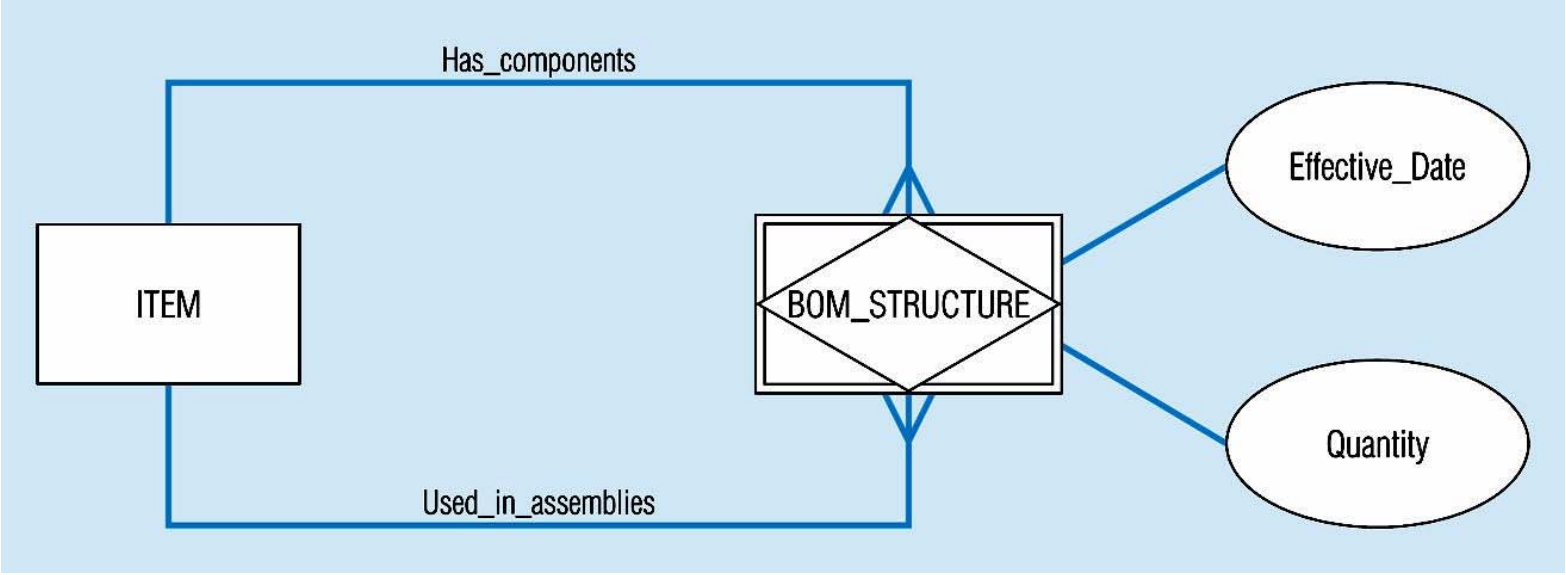
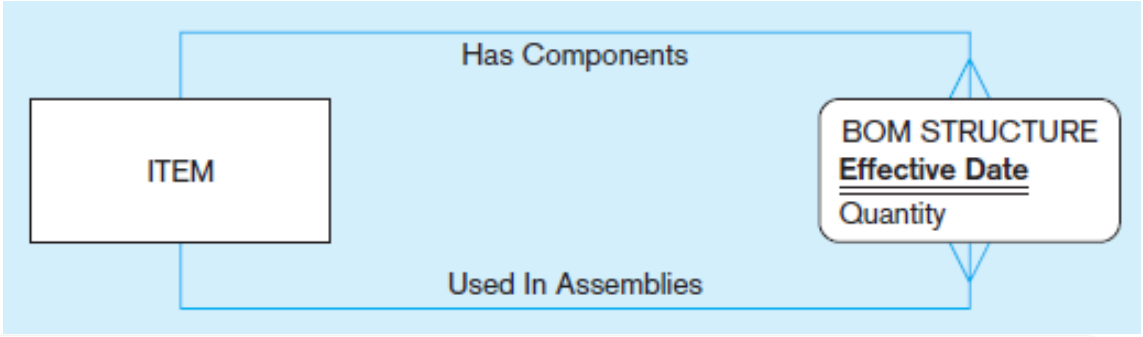
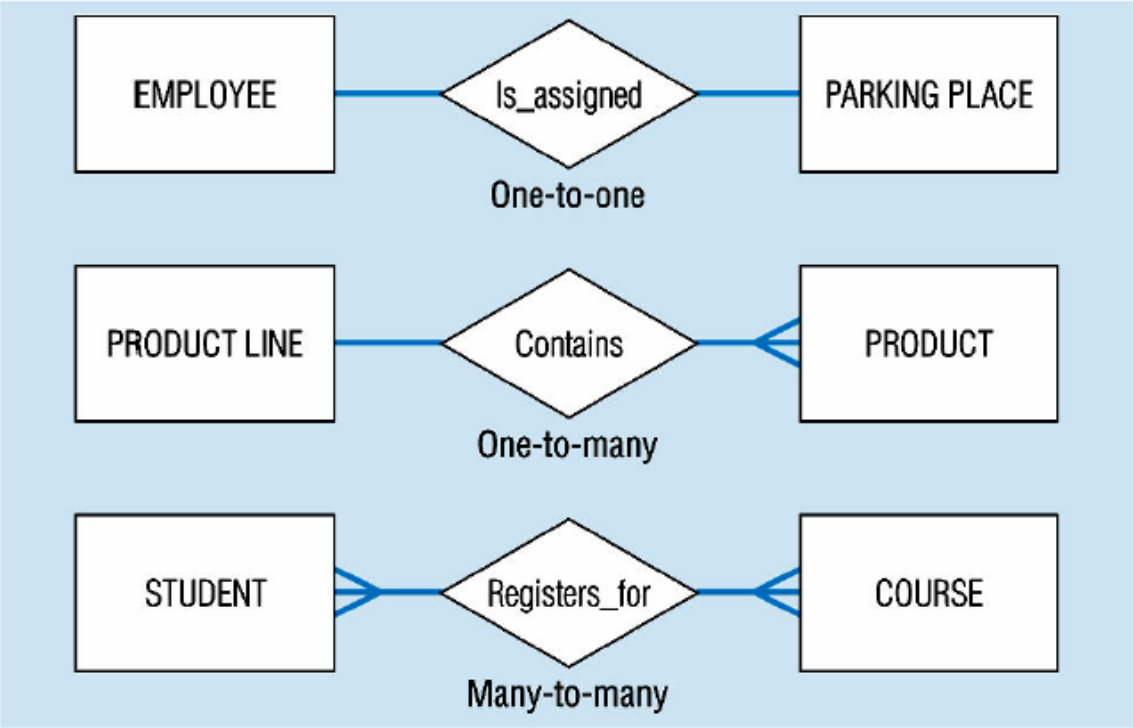


Figure 2-13c: An Associative Entity



This could just be a relationship with attributes… it's a judgment call

Binary Relationships



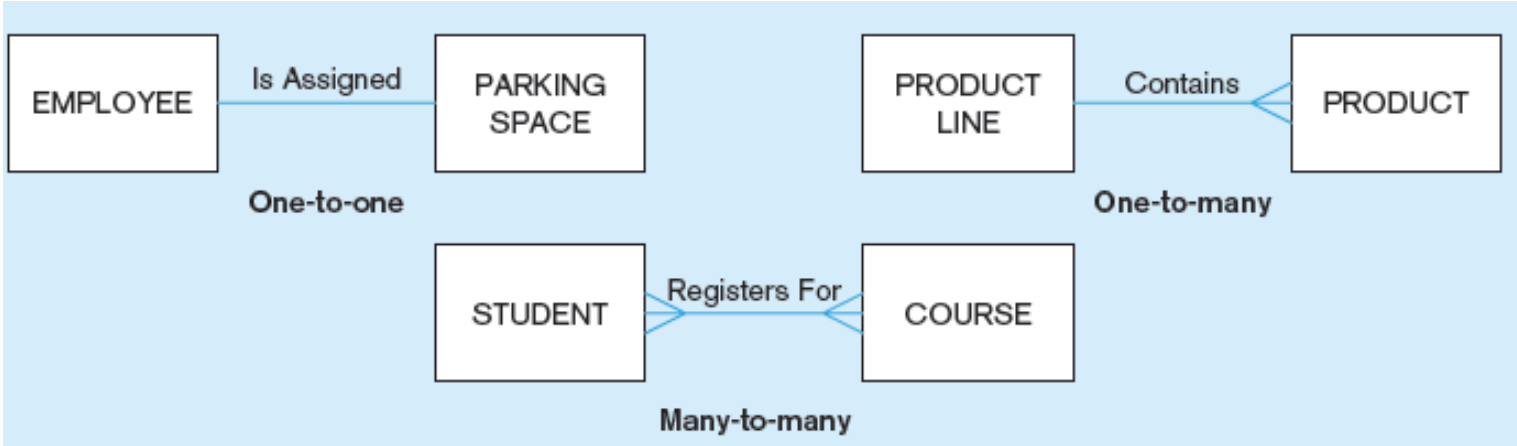


Figure 2-12b: Binary Relationships

Ternary Relationships

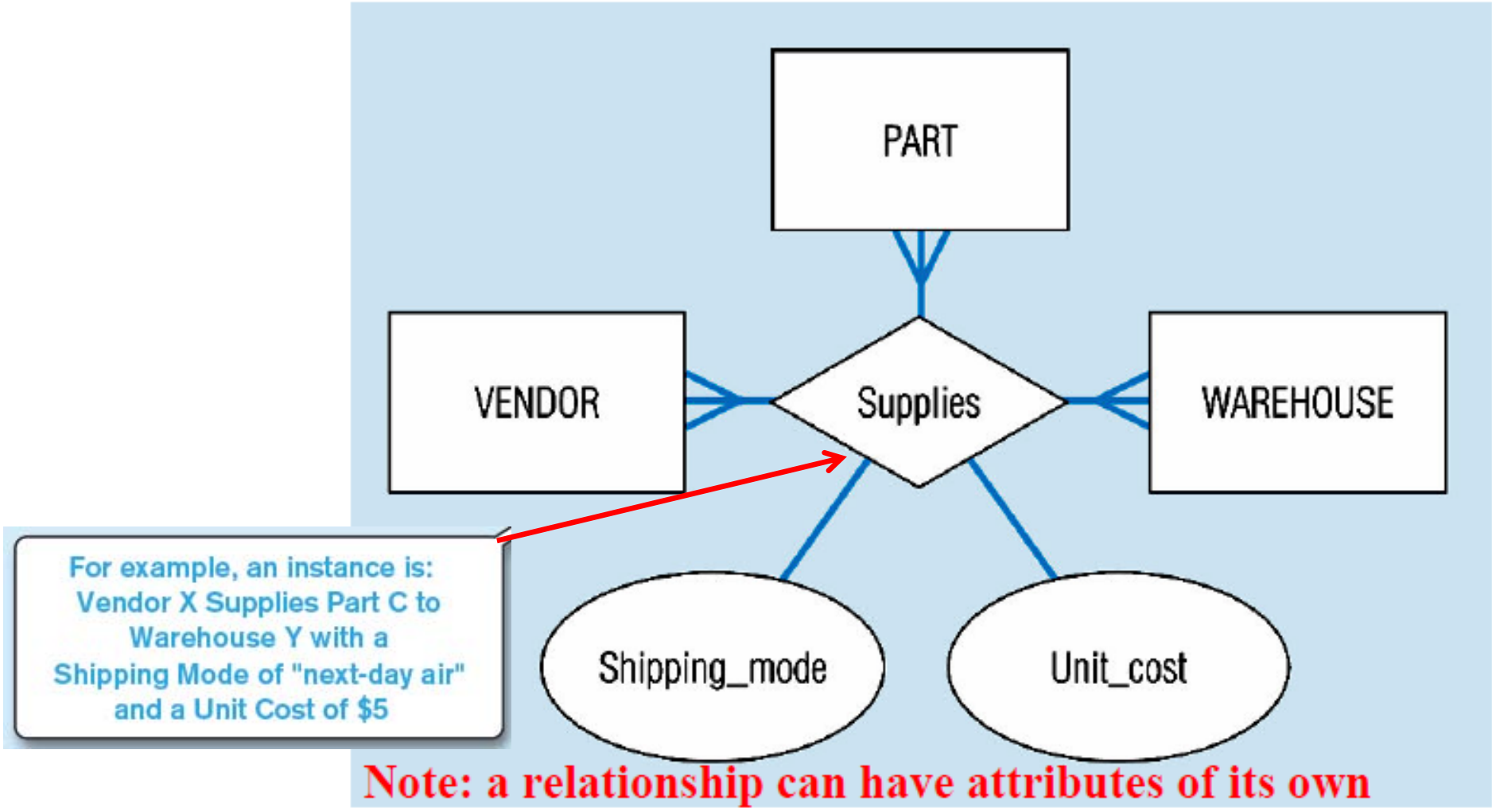


Figure 2-12c: Ternary Relationship

Cardinality of Relationships

- Cardinality Constraints - the number of instances of one entity that can or must be associated with each instance of another entity.

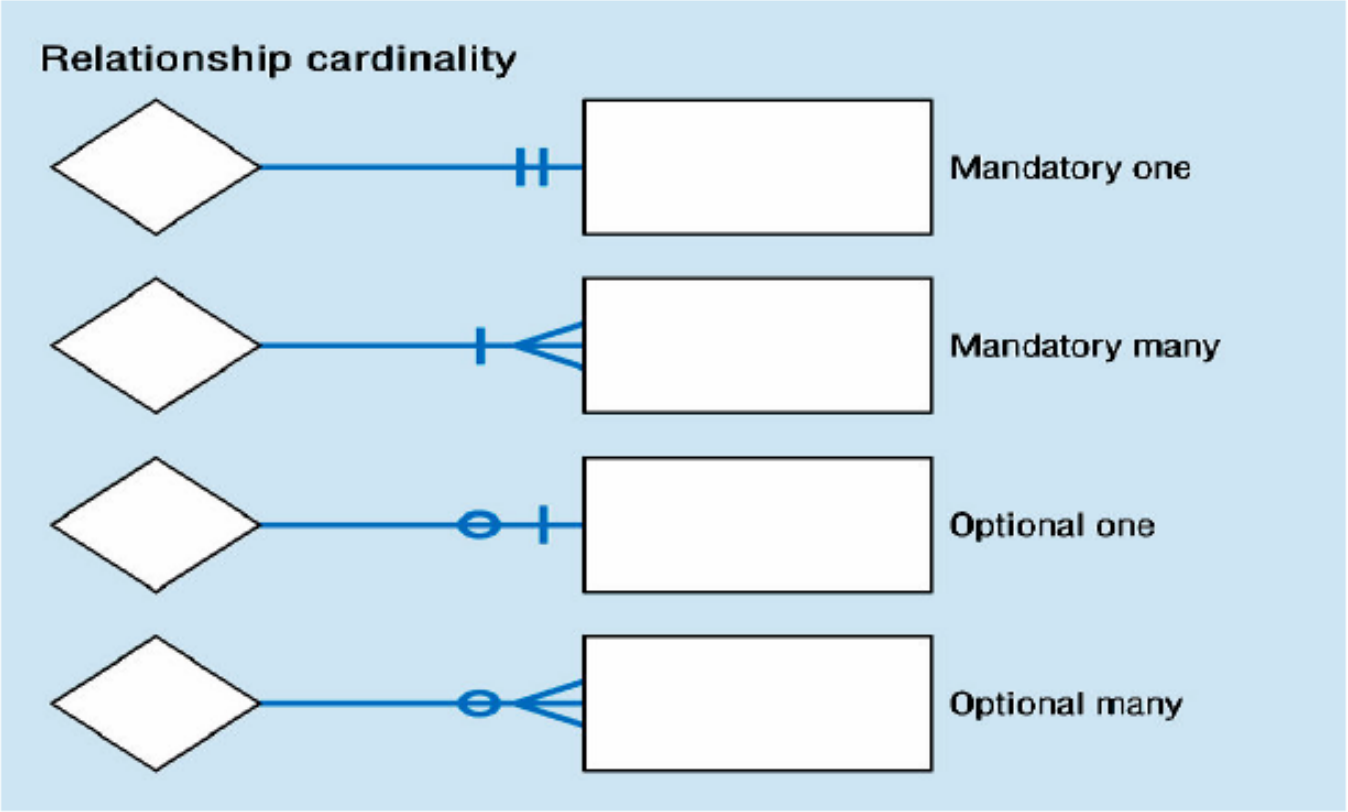
- Minimum Cardinality
  - If zero, then optional
  - If one or more, then mandatory

- Maximum Cardinality
  - The maximum number

Cardinality of Relationships

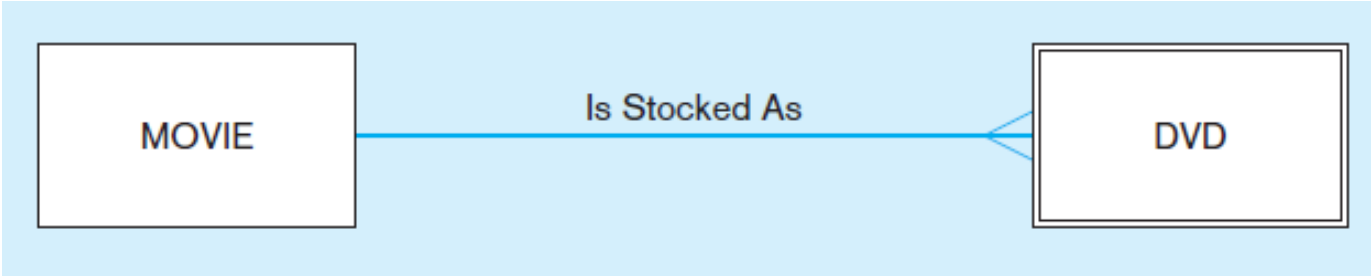
- One-to-One
  - Each entity in the relationship will have exactly one related entity
- One-to-Many
  - An entity on one side of the relationship can have many related entities, but an entity on other side will have a maximum of one related entity
- Many-to-Many
  - Entities on both sides of the relationship can have many related entities on the other side

Cardinality



Minimum & Maximum Cardinalities Example

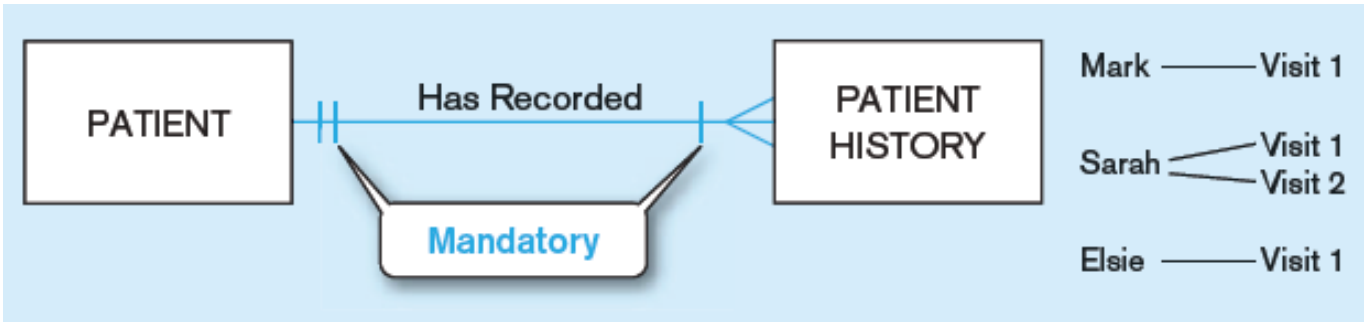
Basic relationship with only maximum cardinalities:

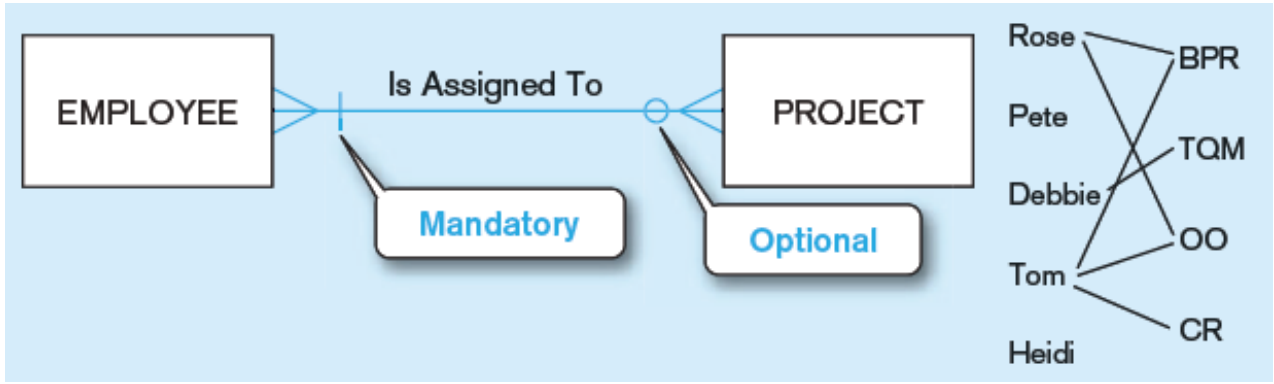


Relationship with cardinality constraints:

Figure 2-16: Cardinality Constraints

Example of Cardinality Constraints





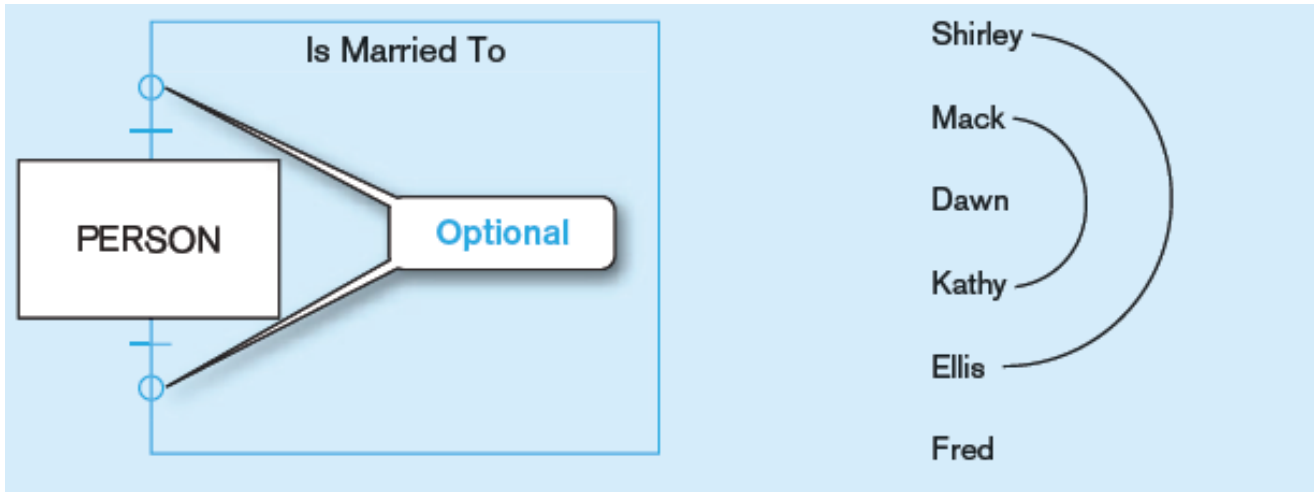


Figure 2-17: Examples of Cardinality Constraints

E-R Diagram

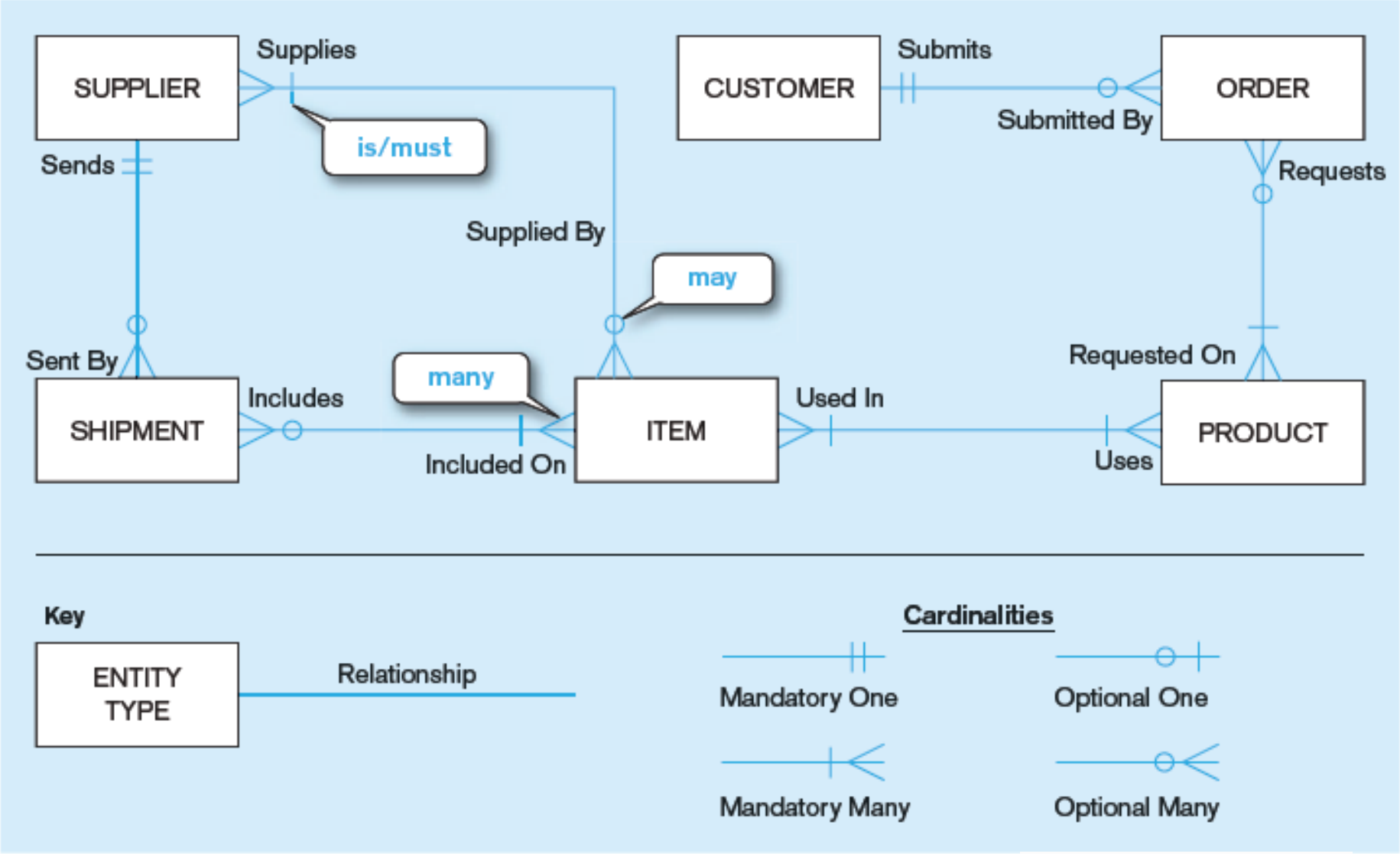
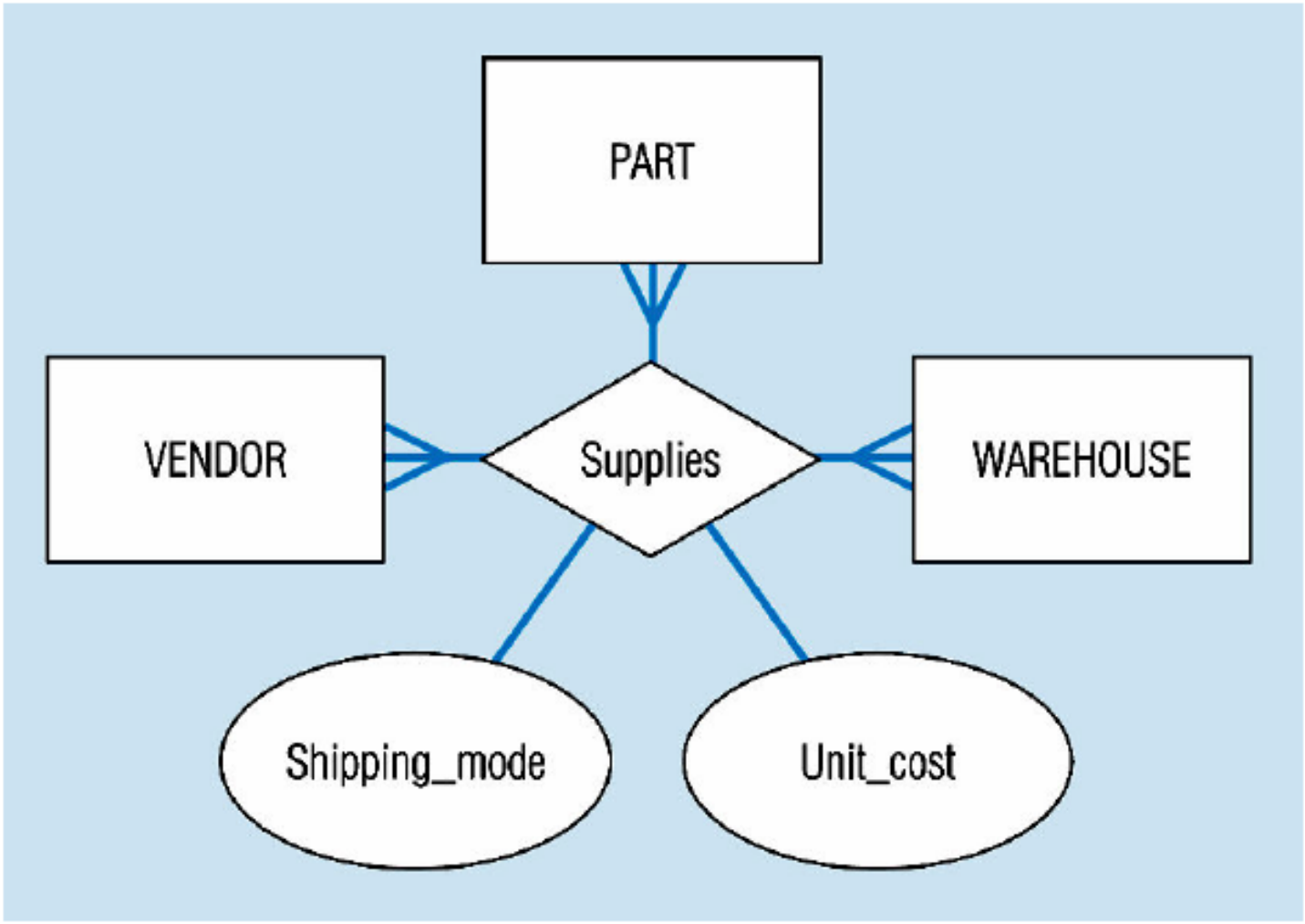


Figure 2-1: Sample E-R Diagram

Ternary Relationship with Attributes



Ternary Relationship as an Associative Entity

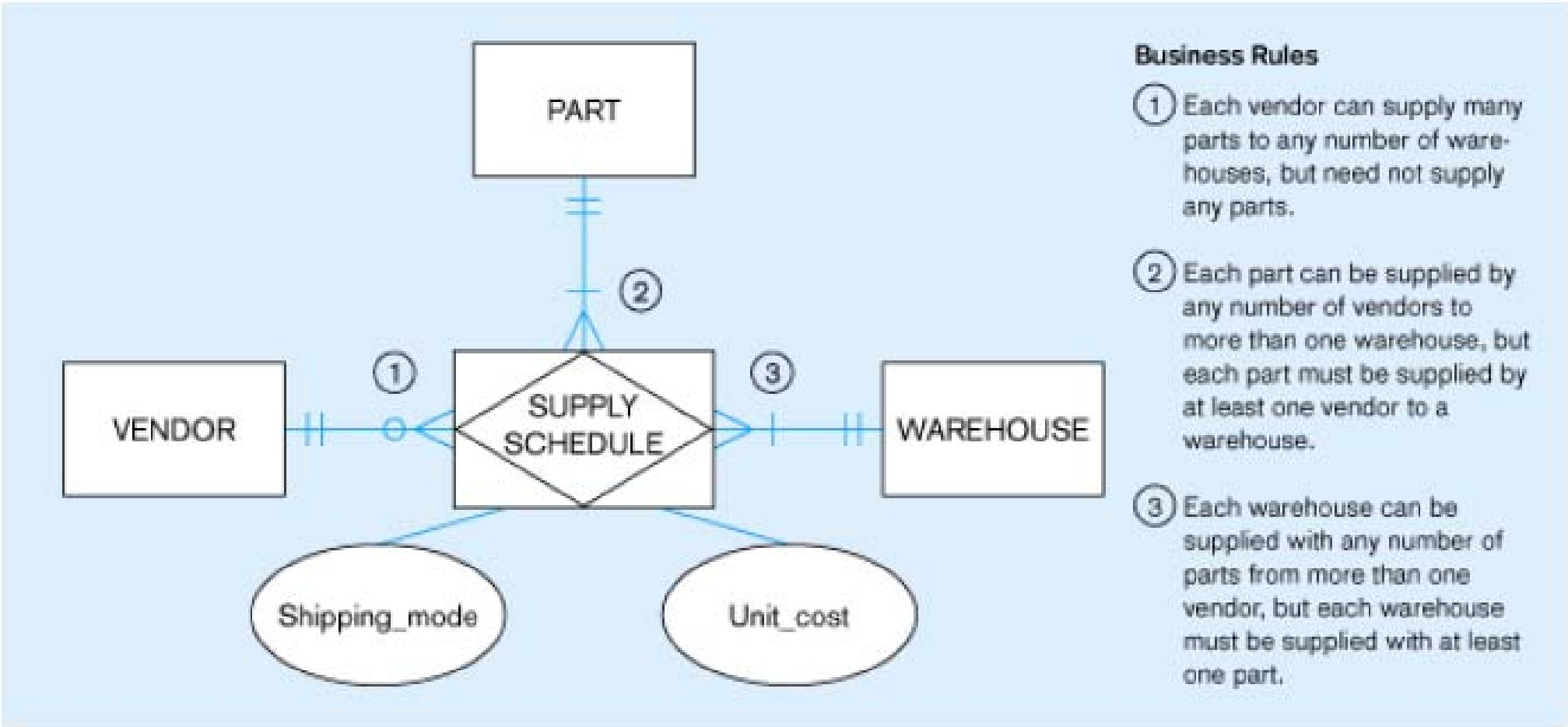
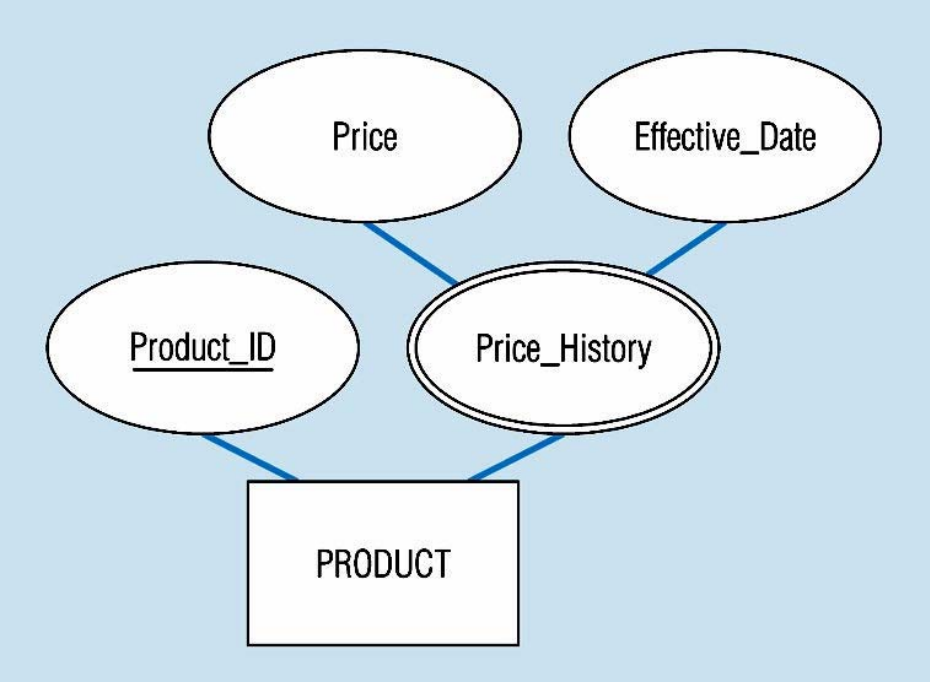


Figure 2-18: Examples of Cardinality Constraints

Attribute – Both Multi-valued & Composite



This is an example of time-stamping

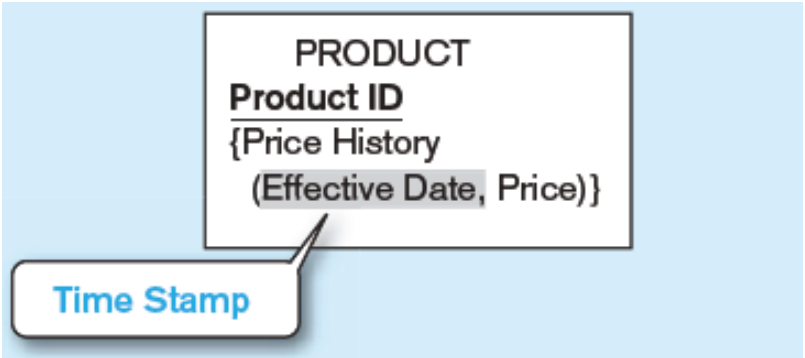


Figure 2-19: Simple Example of Time Stamping

Example of Multiple Relationships

Entities can be related to one another in more than one way…

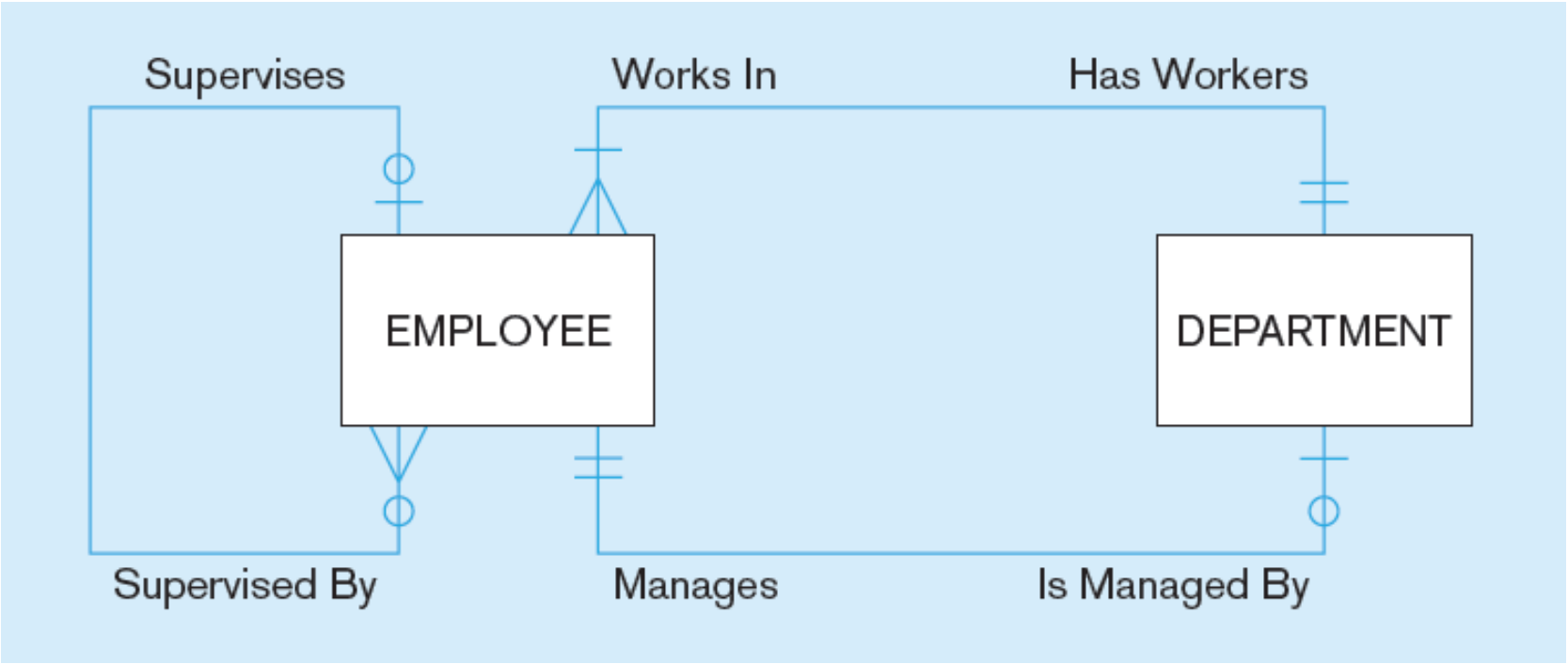
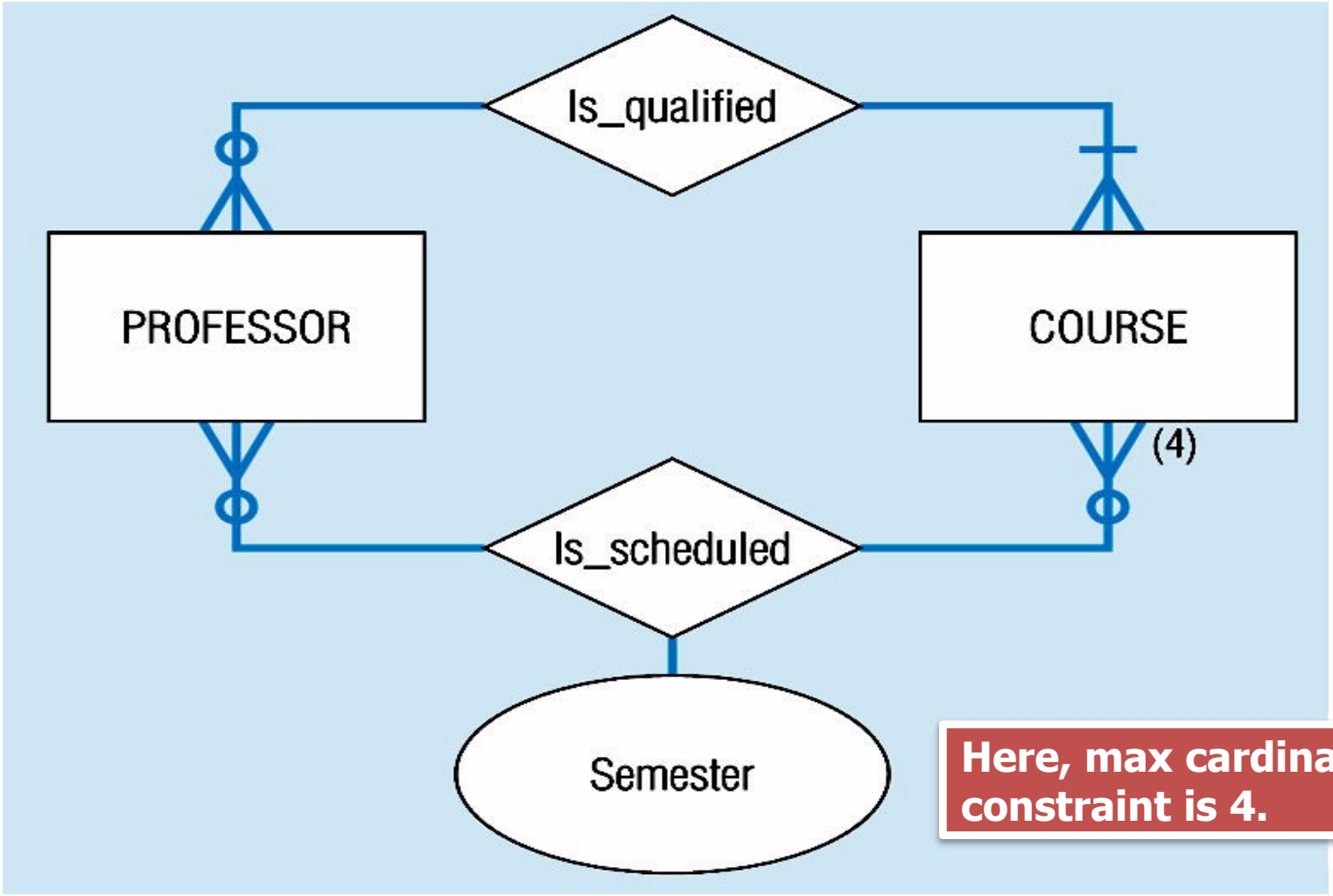


Figure 2-21a: Employees and Departments

Professors & Courses



Professors & Courses (Cont.)

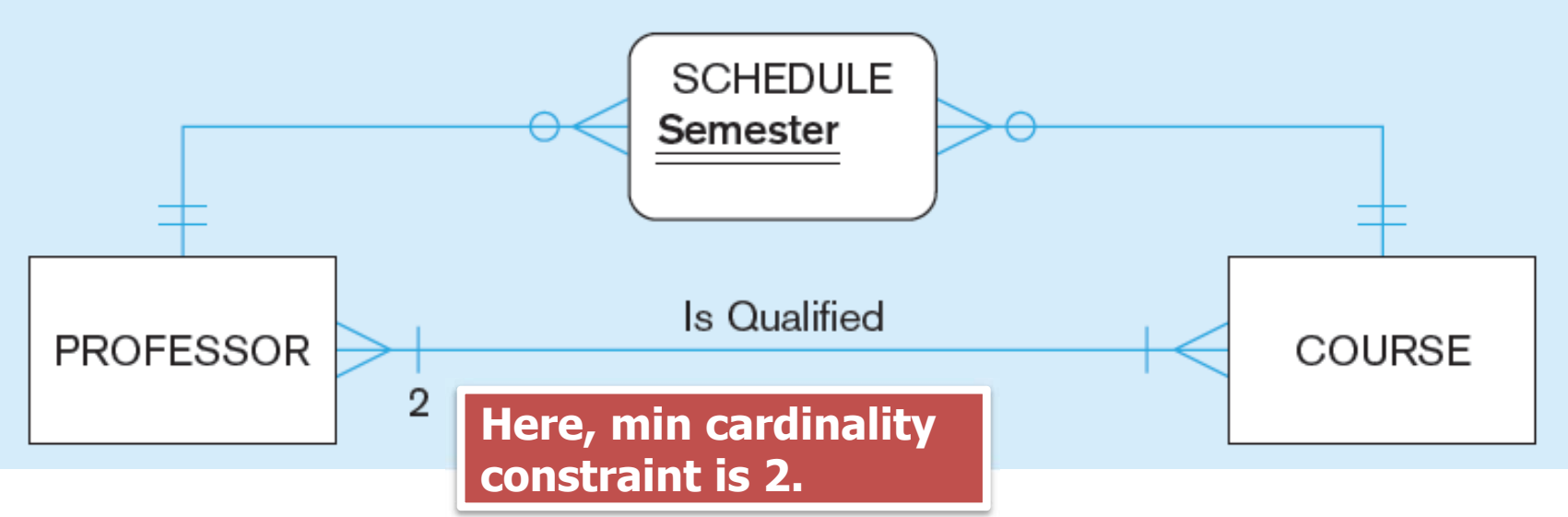
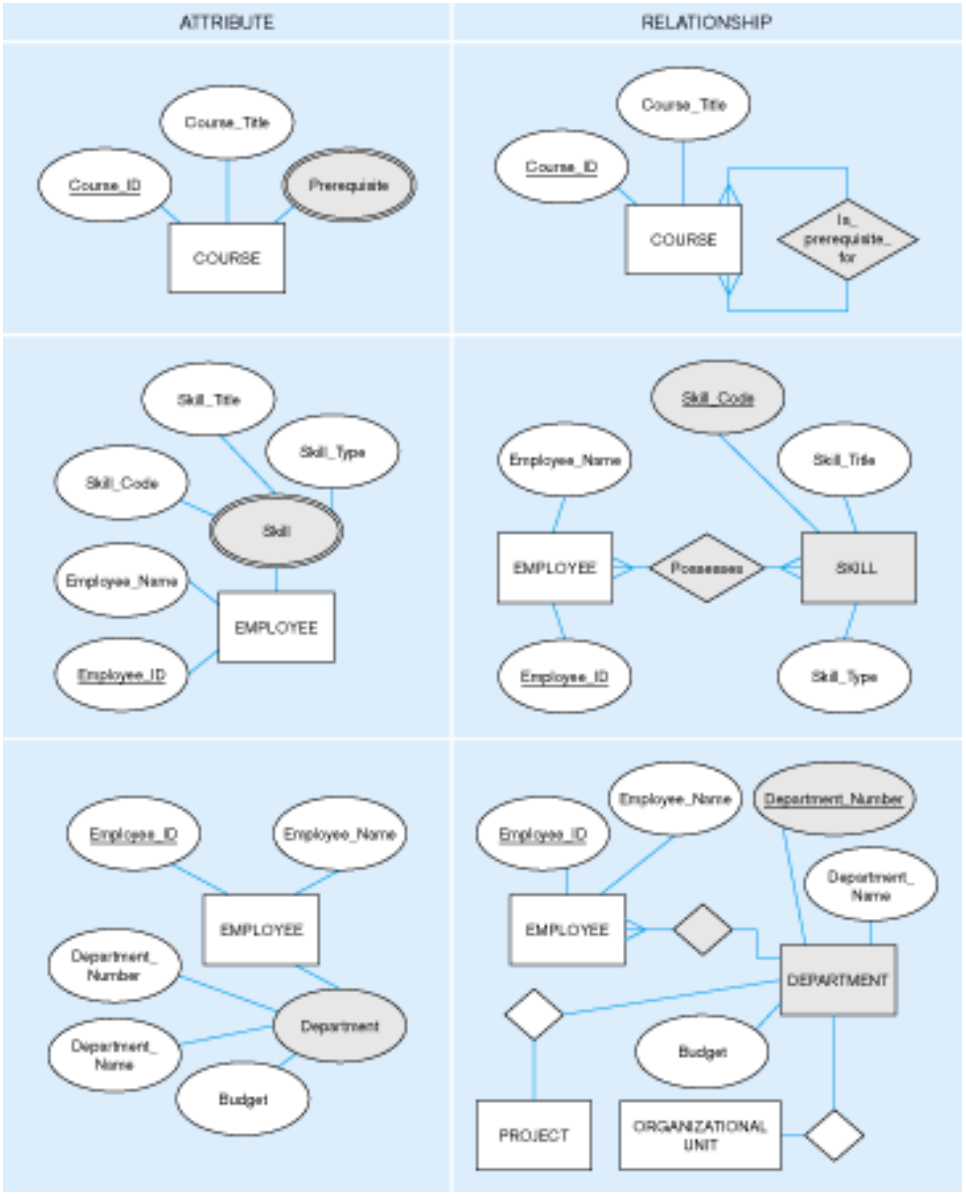


Figure 2-21a: Professors & Courses

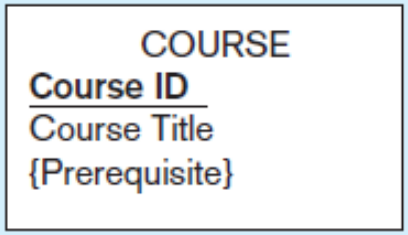
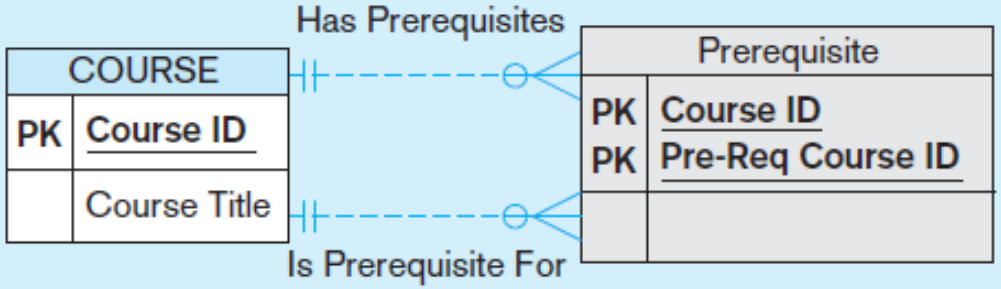
Multi-valued Attribute vs. Relationship



Alternative Approaches

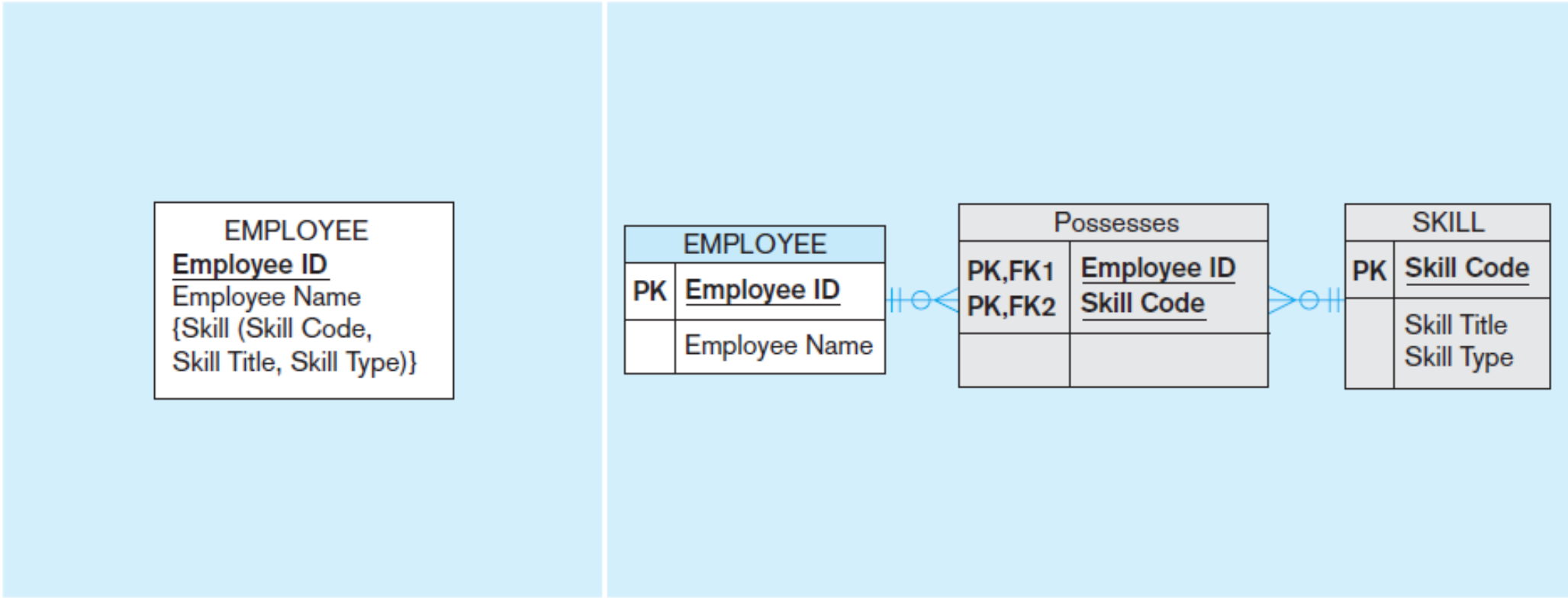
Multi-valued Attribute vs. Relationship (1)

(a) Multivalued attribute versus relationships via bill-of-materials structure

ATTRIBUTE	RELATIONSHIP & ENTITY
	

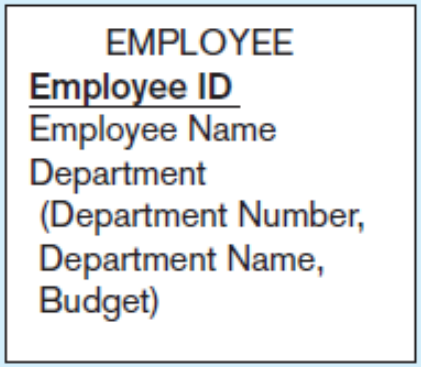
Multi-valued Attribute vs. Relationship (2)

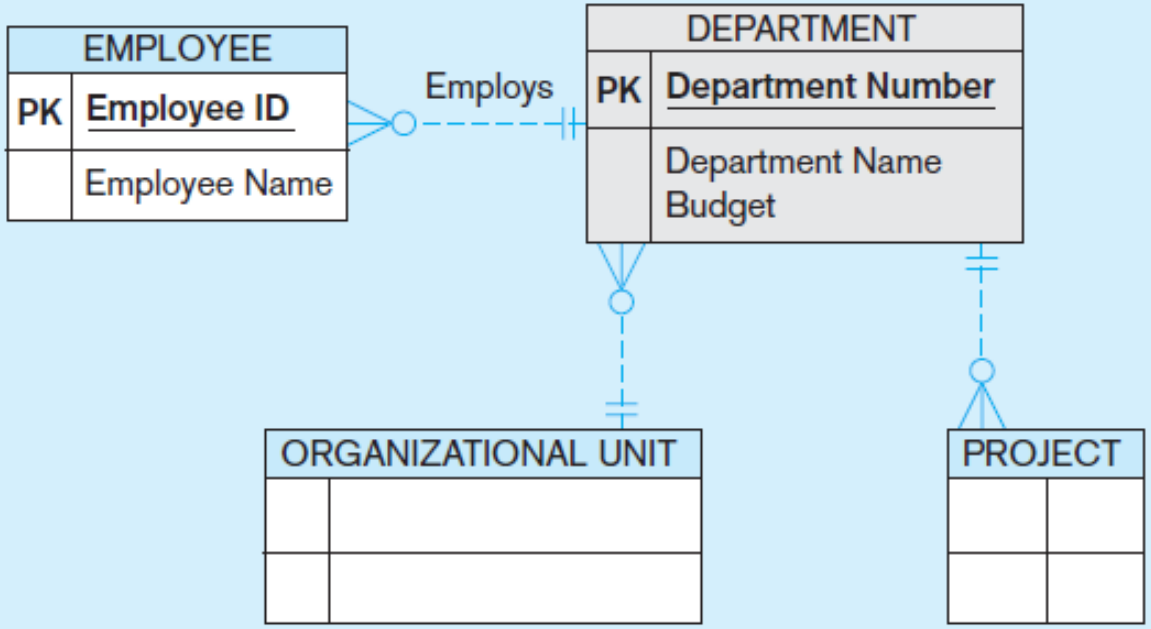
(b) Composite, multivalued attribute versus relationship



Multi-valued Attribute vs. Relationship (3)

(c) Composite attribute of data shared with other entity types





Summary

- Covered Conceptual Data Modeling/Schema in detail
- Covered ERD and its constructs in detail using examples