CGS 2545: Database Concepts
Spring 2014

Chapter 2 – Modeling Data In The Organization

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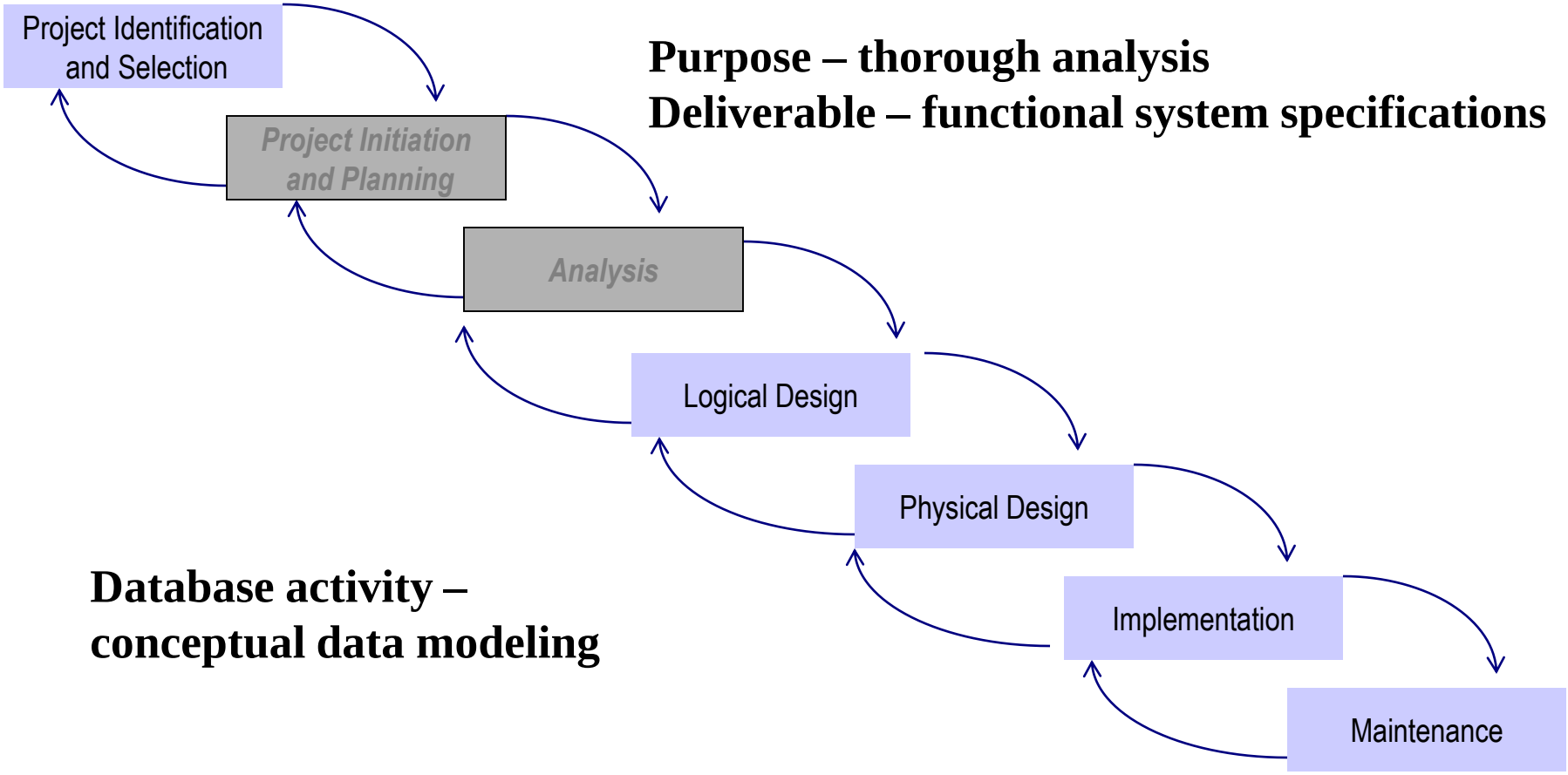
SDLC Revisited – Data Modeling is an Analysis Activity



Purpose – thorough analysis
Deliverable – functional system specifications

Database activity – conceptual data modeling

Business Rules

- Statements that define or constrain some aspect of the business.
  - Assert business structure.
  - Control/influence business behavior.
- Examples:
  - *A student may register for a course only if they have satisfied the prerequisites for the course.*
  - *A customer qualifies for a 10% discount if their purchase totals more than $250.00.*
- Expressed in terms familiar to end users.
- Automated through DBMS software.

Business Rules

- Most organizations have many business rules.
- Capturing and documenting business rules is an important and complex task.
- Business rules have been used in information systems for some time now, however, in the database world they have been more commonly referred to as integrity constraints.
  - In general, an integrity constraint has a more limited scope than does a business rule. An integrity constraint is typically more focused on maintaining valid data values and relationships.
  - A business rule has a much broader scope that includes any rule which has an impact on the databases of an organization.
- Business rules are commonly referred to as the "standards and procedures" of an organization.

Business Rules

- Business rules are a core concept in an enterprise because they express the policies of the organization and guide both individual as well as aggregate behavior.
- Business rules are commonly stated in a natural language for end users and in a data model for system developers.
- Business rules are highly maintainable. They can be stored in a central repository and each rule need be expressed only once, then shared throughout the organization.
- Enforcement of business rules is automated through the integrity mechanism of the DBMS.

Characteristics Of Good Business Rules

Characteristic	*Explanation*
Declarative	A business rule is a statement of policy, not how policy is enforced or conducted; the rule does not describe a process or implementation, but rather describes what a process validates
Precise	With the related organization, the rule must have only one interpretation among all interested people, and its meaning must be clear
Atomic	A business rule marks one statement, not several; no part of the rule can stand on its own as a rule (that is, the rule is indivisible, yet sufficient)
Consistent	A business rule must be internally consistent (that is, not contain conflicting statements) and must be consistent with (and not contradict) other rules
Expressible	A business rule must be able to be stated in natural language, but it will be stated in a structured natural language so that there is no misinterpretation
Distinct	Business rules are not redundant, but a business rule may refer to other rules (especially refer to definitions)
Business-oriented	A business rule is stated in terms business people can understand, and since it is a statement of business policy, only business people can modify or invalidate a rule; thus, a business rule is owned by the business

Obtaining Business Rules

- Business rules appear (possibly implicitly) in the descriptions of business functions, events, policies, units, etc.
- They can be found in:
  - interview notes from individual and group information systems requirements collection sessions.
  - organizational documents such as personnel manuals, policies, contracts, marketing brochures, technical instructions, etc..
  - And many other sources.
- Rules are identified by asking questions about the whom what, where, why, and how of the organization.
- The data analyst needs to be persistent in clarifying initial statements which are sometimes vague or imprecise.
- Thus, business rules are formulated from an iterative inquiry process.
- Be sure to ask questions such as: “is this always true”, “are there any special cases which might arise”, “is historical data required or only current data”.

A Good Data Name is:

- Related to business, not technical characteristics of the hardware or software. Example: use “customer” not “file 10”.
- Meaningful and self-documenting. Avoid using words like “has”, “is”, etc.
- Unique
- Readable
- Composed of words from an approved list
- Repeatable

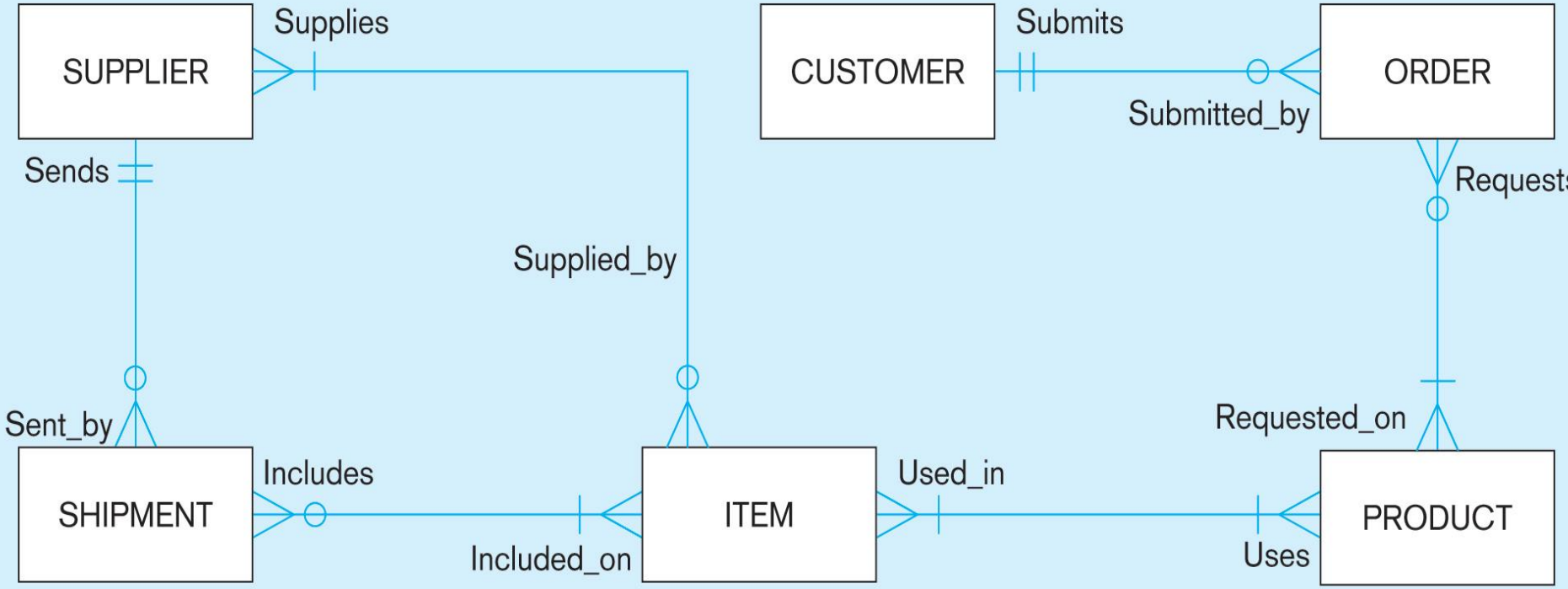
Data Definitions

- Explanation of a term or fact
  - Term – word or phrase with specific meaning
  - Fact – association between two or more terms

- Guidelines for good data definition
  - Gathered in conjunction with systems requirements
  - Accompanied by diagrams
  - Iteratively created and refined
  - Achieved by consensus

E-R Model Constructs

- Entity instance - person, place, object, event, concept (often corresponds to a row in a table).
- Entity Type – collection of entities (often corresponds to a table).
- Attribute - property or characteristic of an entity type (often corresponds to a field in a table).
- Relationship instance – link between entities (corresponds to primary key-foreign key equivalencies in related tables).
- Relationship type – category of relationship…link between entity types.



Legend

ENTITY TYPE

Relationship

Cardinalities

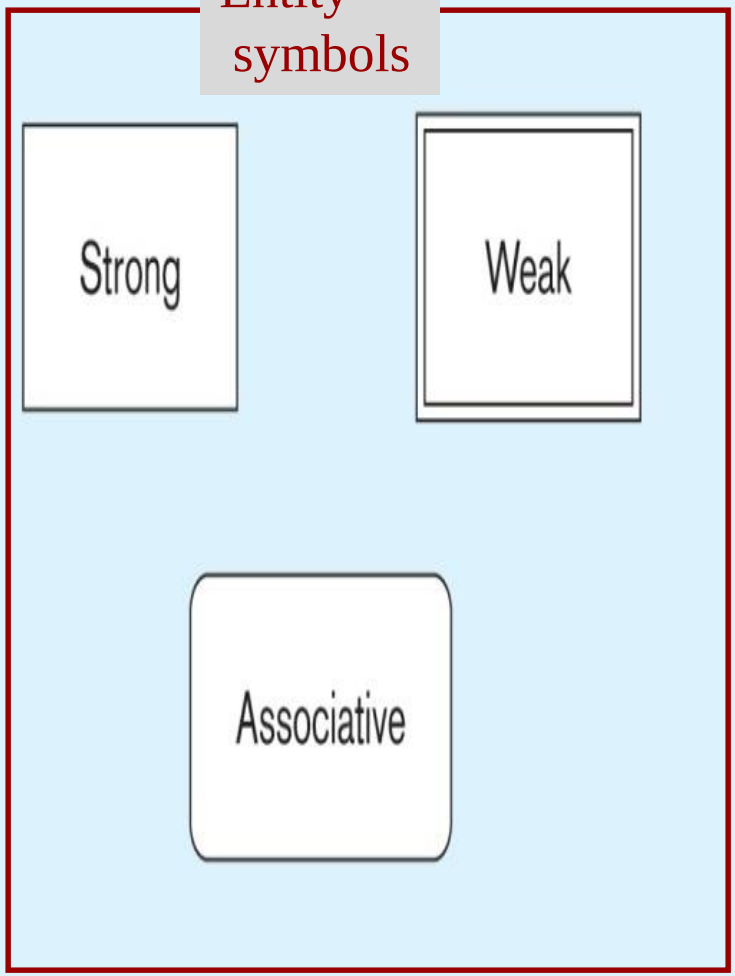
Mandatory One

Optional One

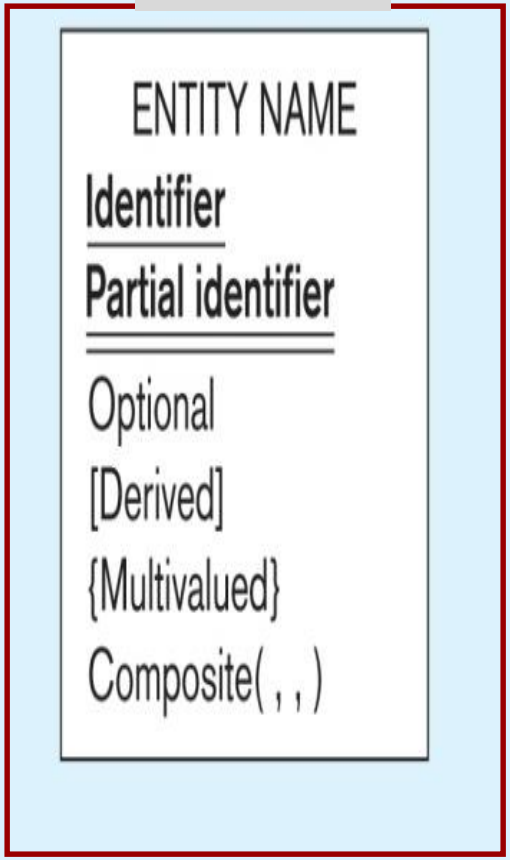
Mandatory Many

Optional Many

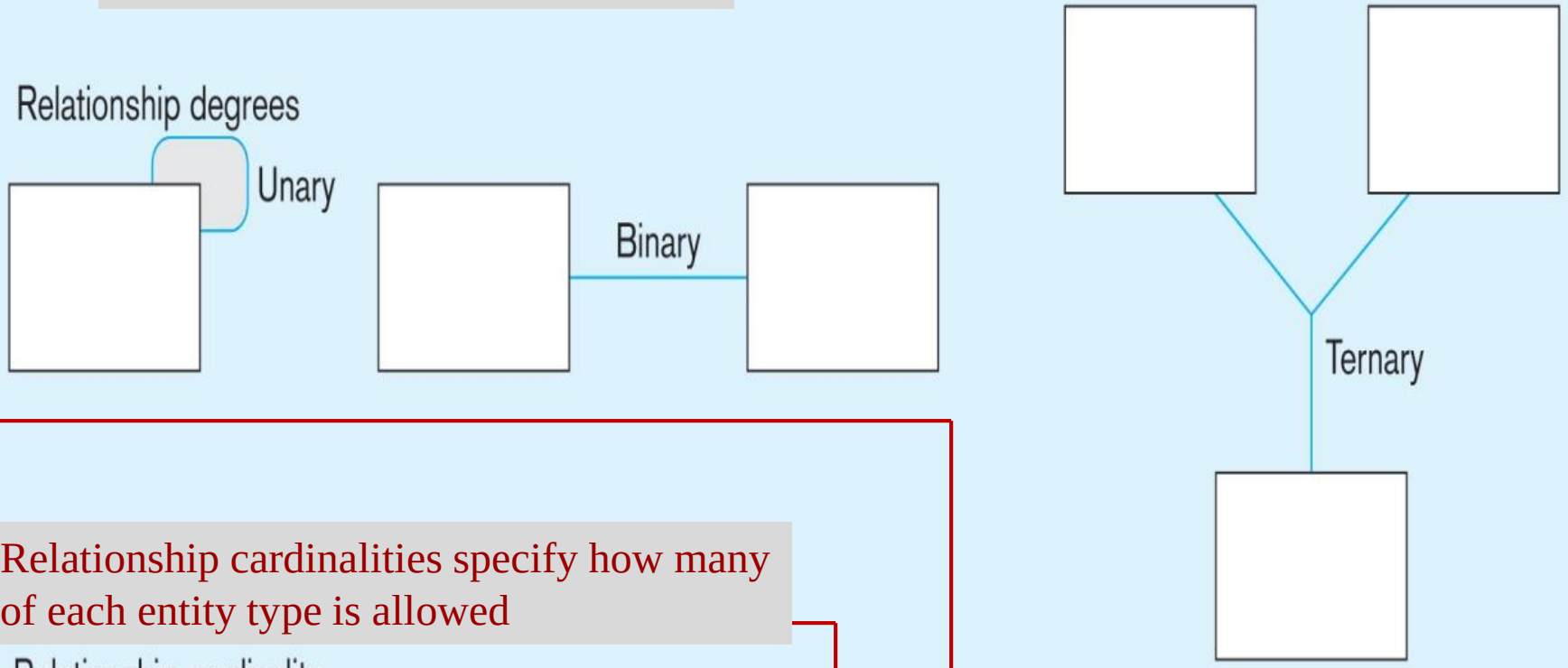
Entity symbols



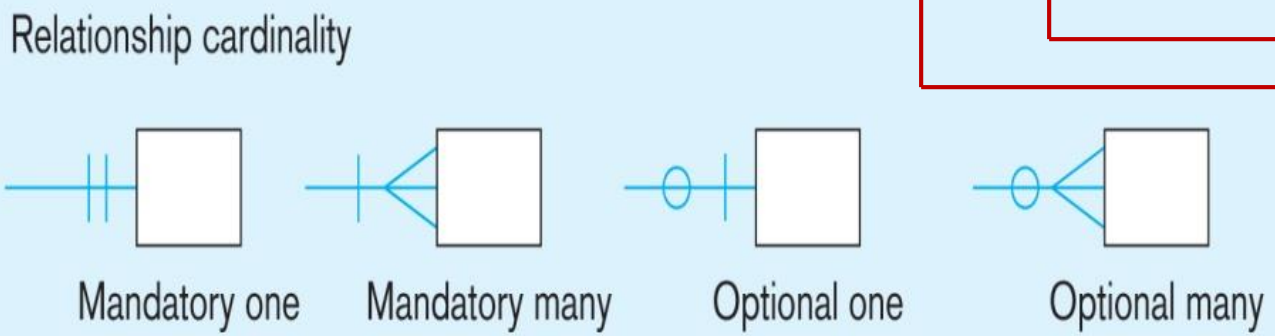
Attribute notation



Relationship degrees specify number of entity types involved



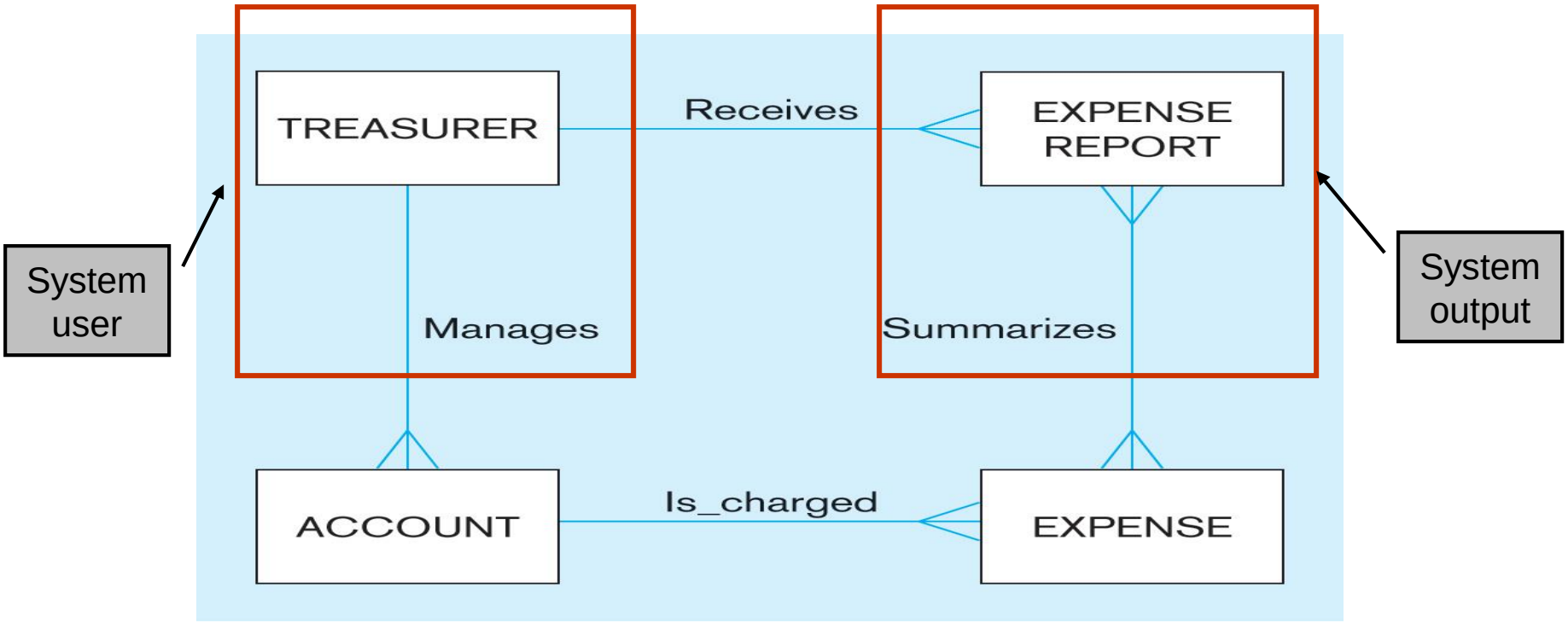
Relationship cardinalities specify how many of each entity type is allowed



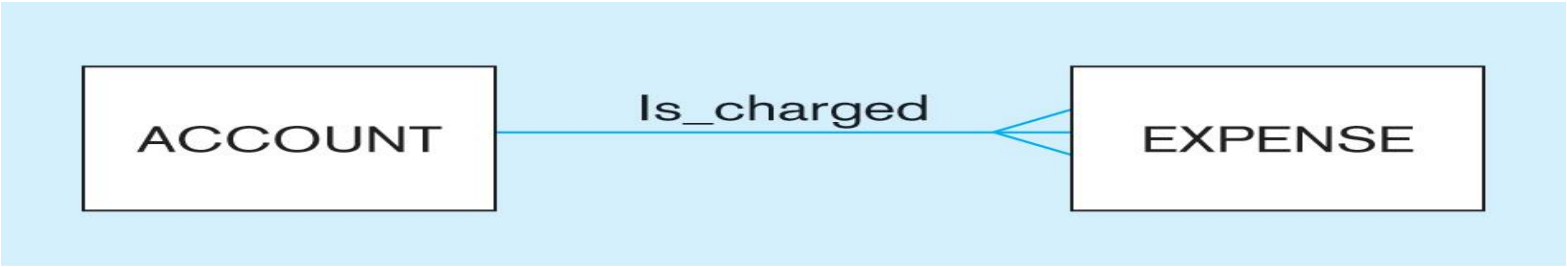
What Should an Entity Be?

- SHOULD BE:
  - An object that will have many instances in the database
  - An object that will be composed of multiple attributes
  - An object that we are trying to model
- SHOULD NOT BE:
  - A user of the database system
  - An output of the database system (e.g. a report)

Inappropriate Entities



Only necessary entities



Attributes

- Attribute - property or characteristic of an entity type
- Classifications of attributes:
  - Required versus Optional Attributes
  - Simple versus Composite Attribute
  - Single-Valued versus Multivalued Attribute
  - Stored versus Derived Attributes
  - Identifier Attributes

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 a key.

Characteristics of Identifiers

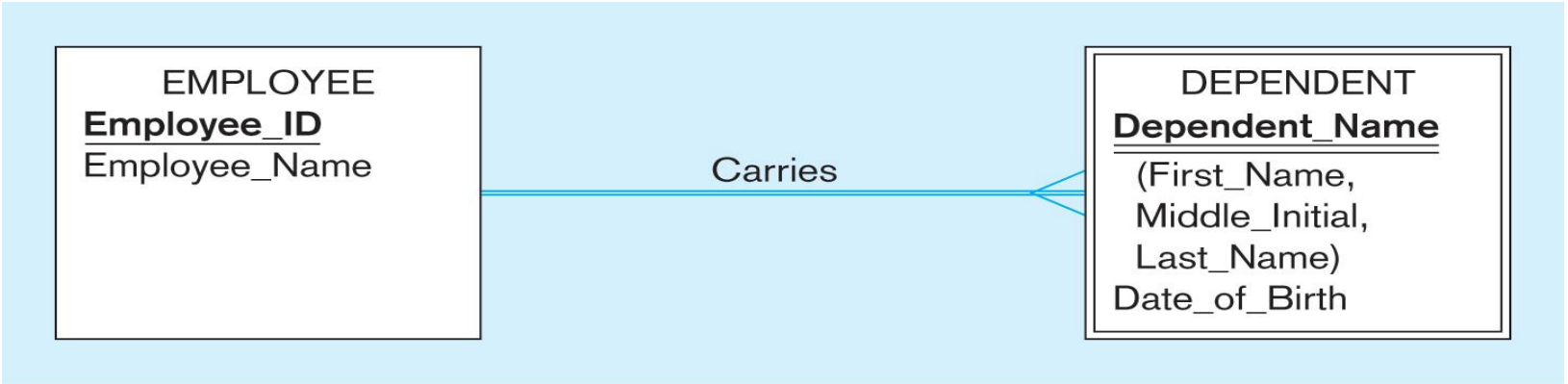
- Will not change in value.
- Will not be null.
- No intelligent identifiers (e.g. containing locations or people that might change).
- Substitute new, simple keys for long, composite keys.

Strong vs. Weak Entities, and Identifying Relationships

- Strong entities
  - exist independently of other types of entities
  - has its own unique identifier
- Weak entity
  - dependent on a strong entity…cannot exist on its own
  - does not have a unique identifier
- Identifying relationship
  - links strong entities to weak entities

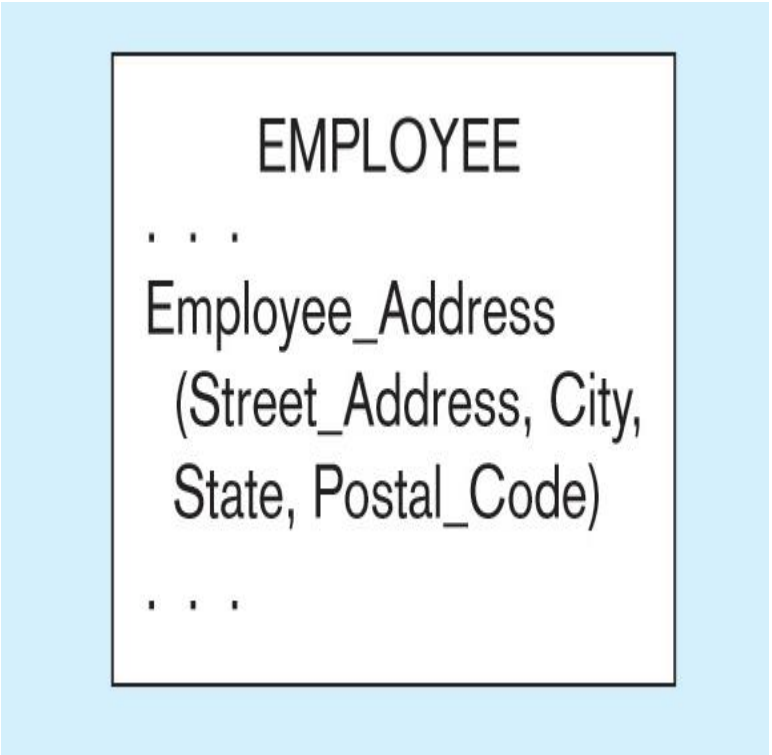
Weak vs. Strong Entities

- A weak entity is an entity type whose existence depends on some other entity type.
- The entity type on which the weak entity is dependent is called the identifying owner (or simply owner).
- A weak entity does not have its own identifier.



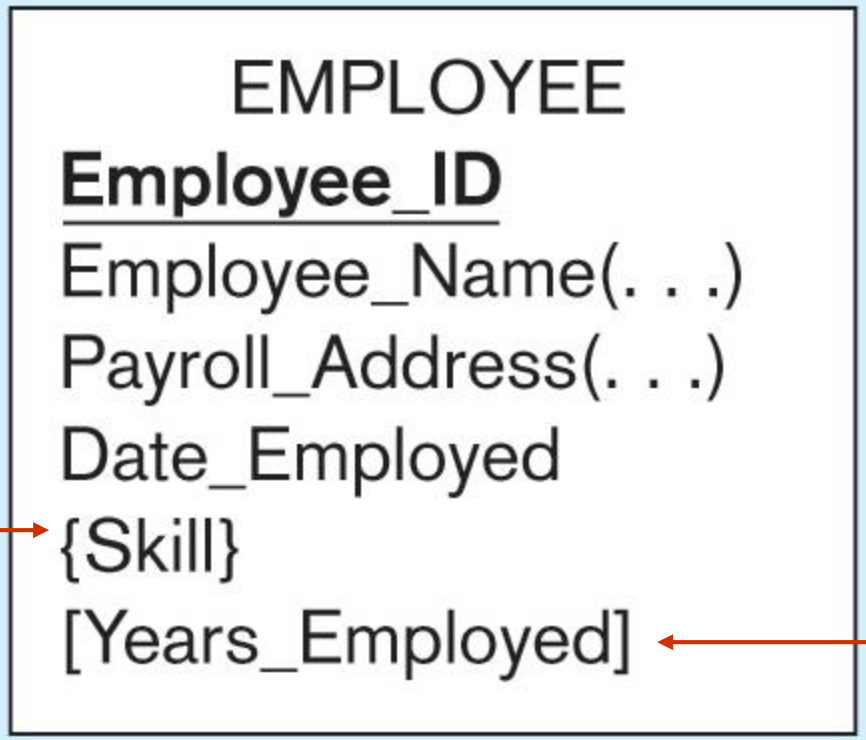
A Composite Attribute

An attribute broken into component parts



A Multi-valued Attribute And A Derived Attribute

A multi-valued attribute. Represented in curly braces.



A derived attribute. Represented in square braces.

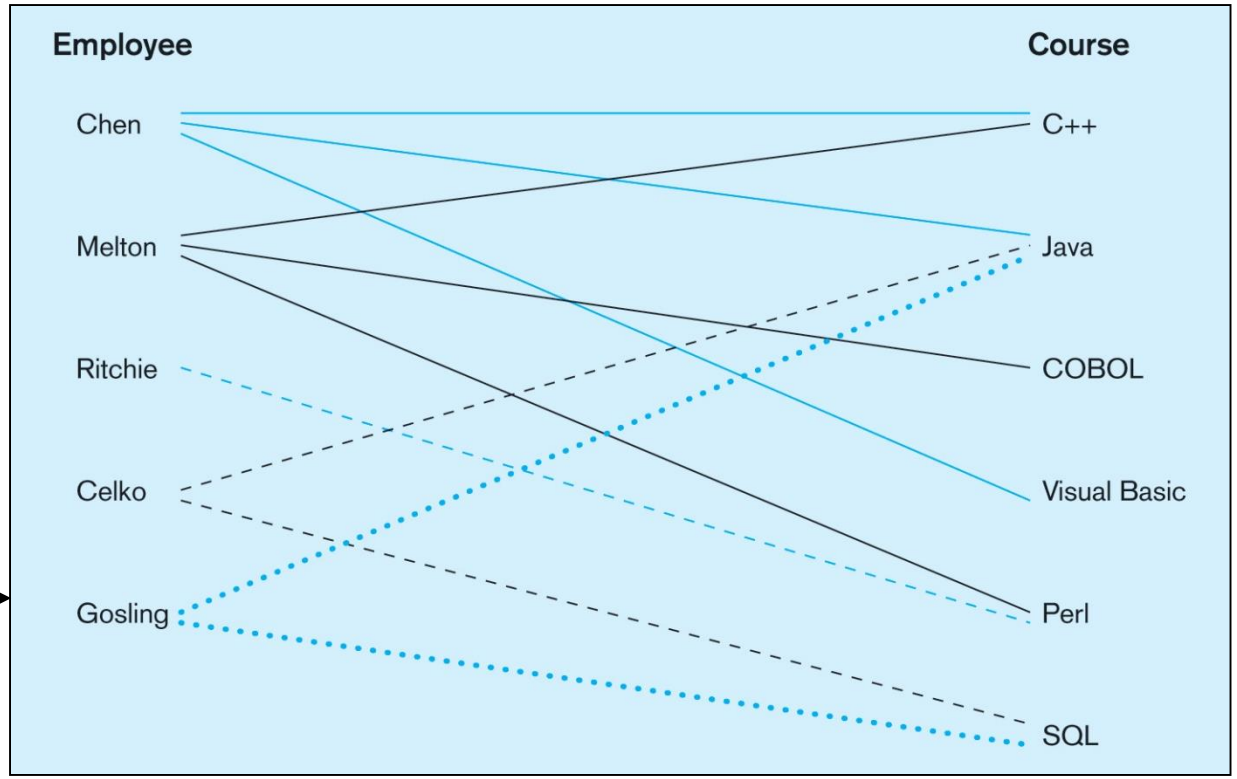
A Simple Identifier Attribute And A Composite Identifier Attribute

More on Relationships

- Relationship Types vs. Relationship Instances
  - The relationship type is as a line between entity types…the instance is between specific entity instances
- Relationships can have attributes
  - These describe features pertaining to the association between the entities in the relationship
- Two entities can have more than one type of relationship between them (multiple relationships)
- Associative Entity – combination of relationship and entity

More on Relationships

Relationship type



Relationship instance

Degree of Relationships

- Degree of a relationship is the number of entity types that participate in it:
  - Unary Relationship
  - Binary Relationship
  - Ternary Relationship

Cardinality of Relationships

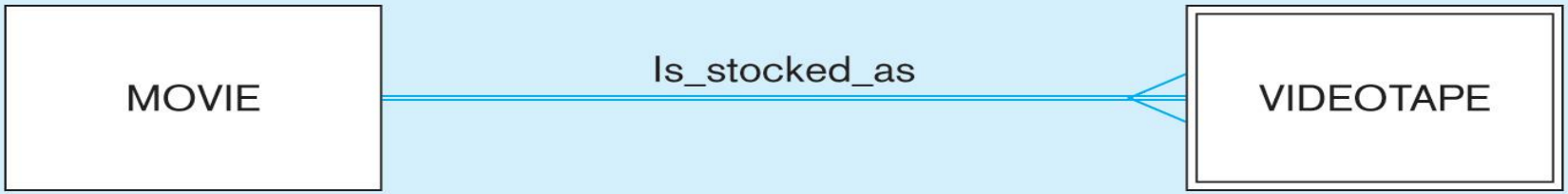
- One-to-One
  - Each entity in the relationship will have exactly one related entity.
- One-to-Many
  - An entity on one side of the relationship can have many related entities, but an entity on the other side will have a maximum of one related entity.
- Many-to-Many
  - Entities on both sides of the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

Cardinality Constraints

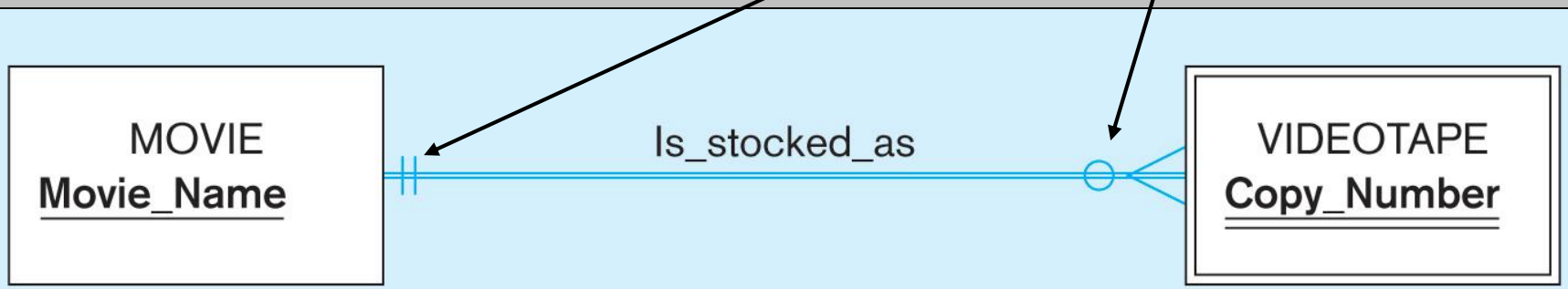
- Cardinality Constraints - the number of instances of one entity that can or must be associated with each instance of another entity.
- Minimum Cardinality
  - If zero, then optional.
  - If one or more, then mandatory.
- Maximum Cardinality
  - The maximum number possible.

Cardinality Constraints

Basic relationship: 1:M from Movie to Videotape (min =1, max = ?)

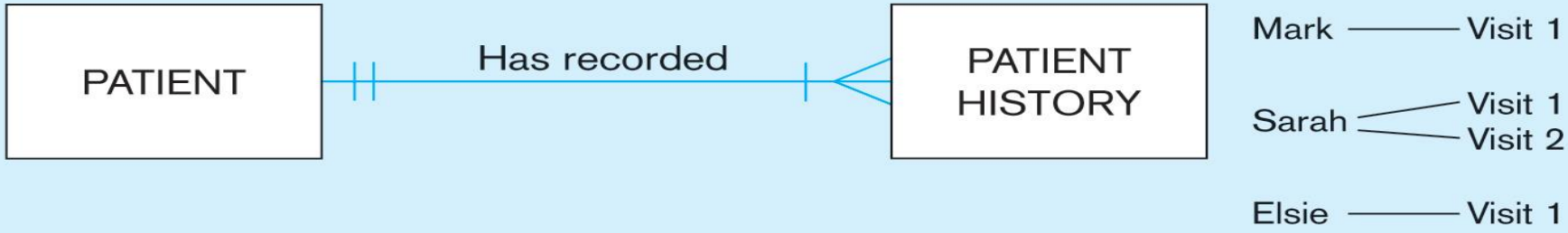


Relationship with cardinality constraints: mandatory on Movie side, Optional on Videotape side

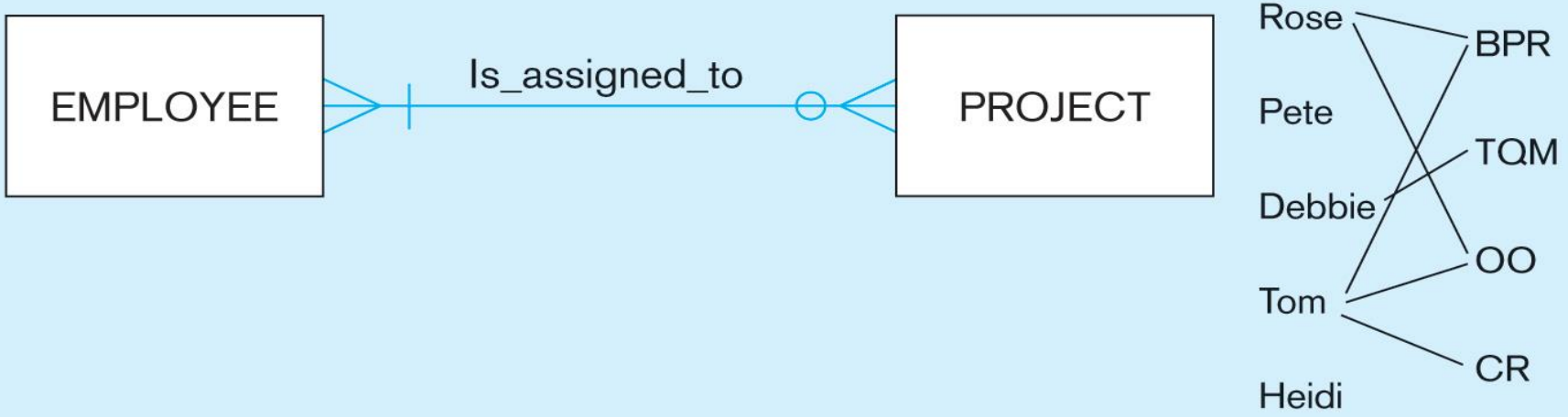


Cardinality Constraints

Mandatory cardinalities – Every patient must have at least 1 history. Every history belongs to 1 patient.

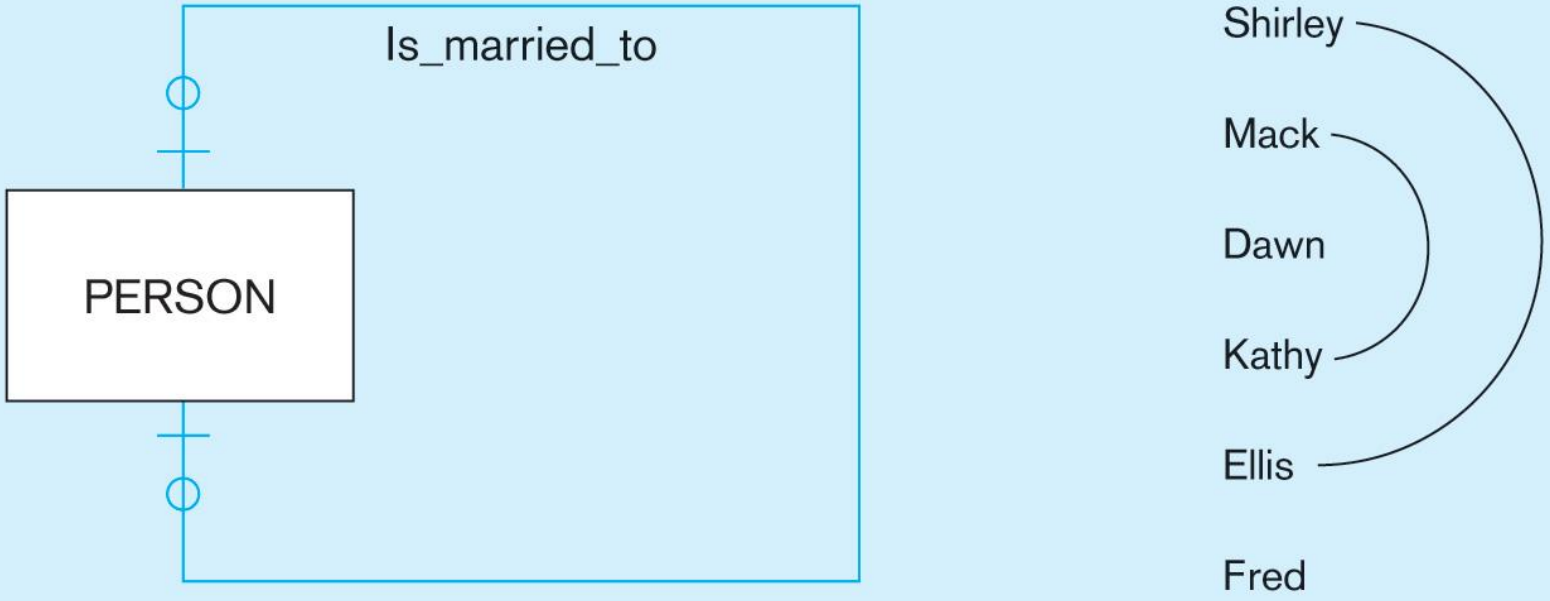


Optional cardinalities – An employee may not be assigned to a project. Every project has at least 1 employee assigned.



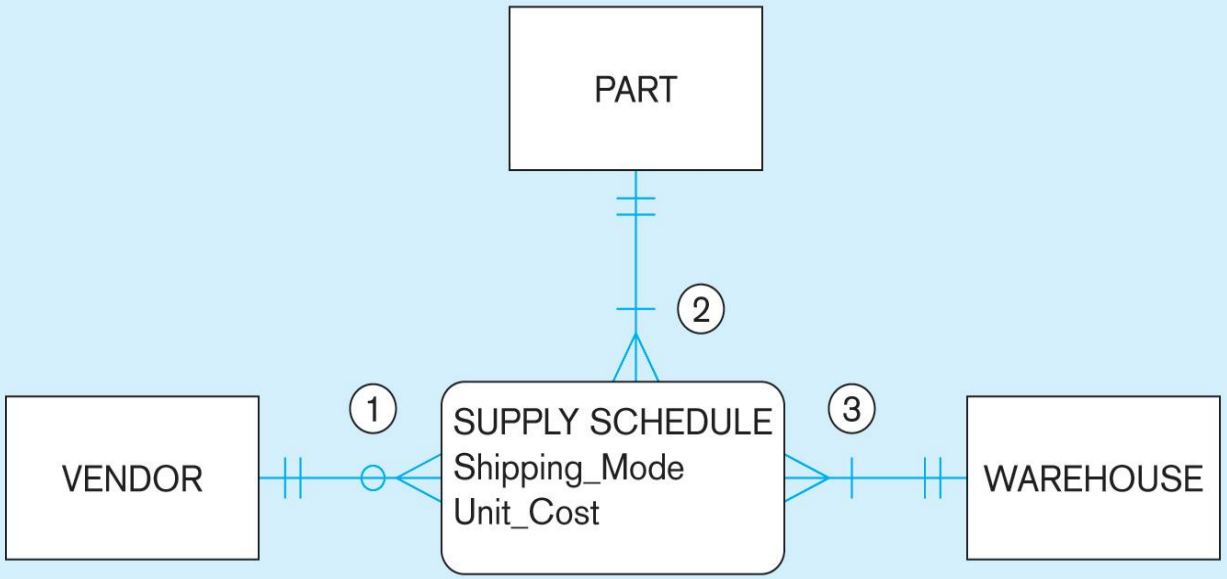
Cardinality Constraints

Optional cardinalities in a unary relationship – Not every person is married, but relationships are 1:1



Cardinality Constraints

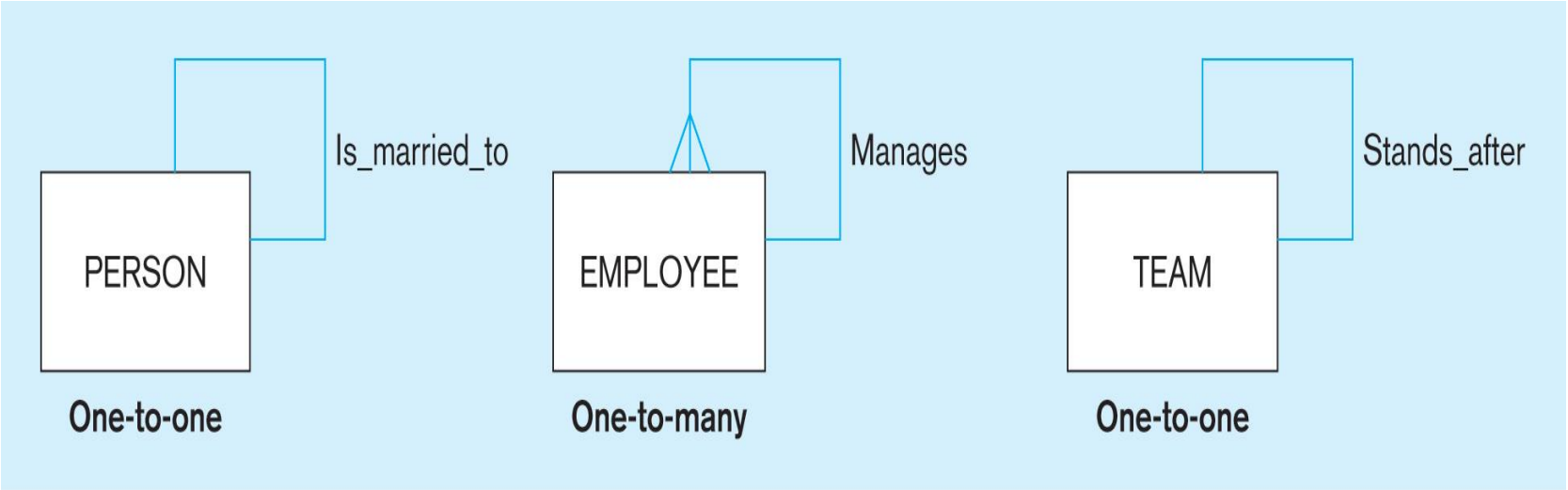
Cardinality constraints in a ternary relationship



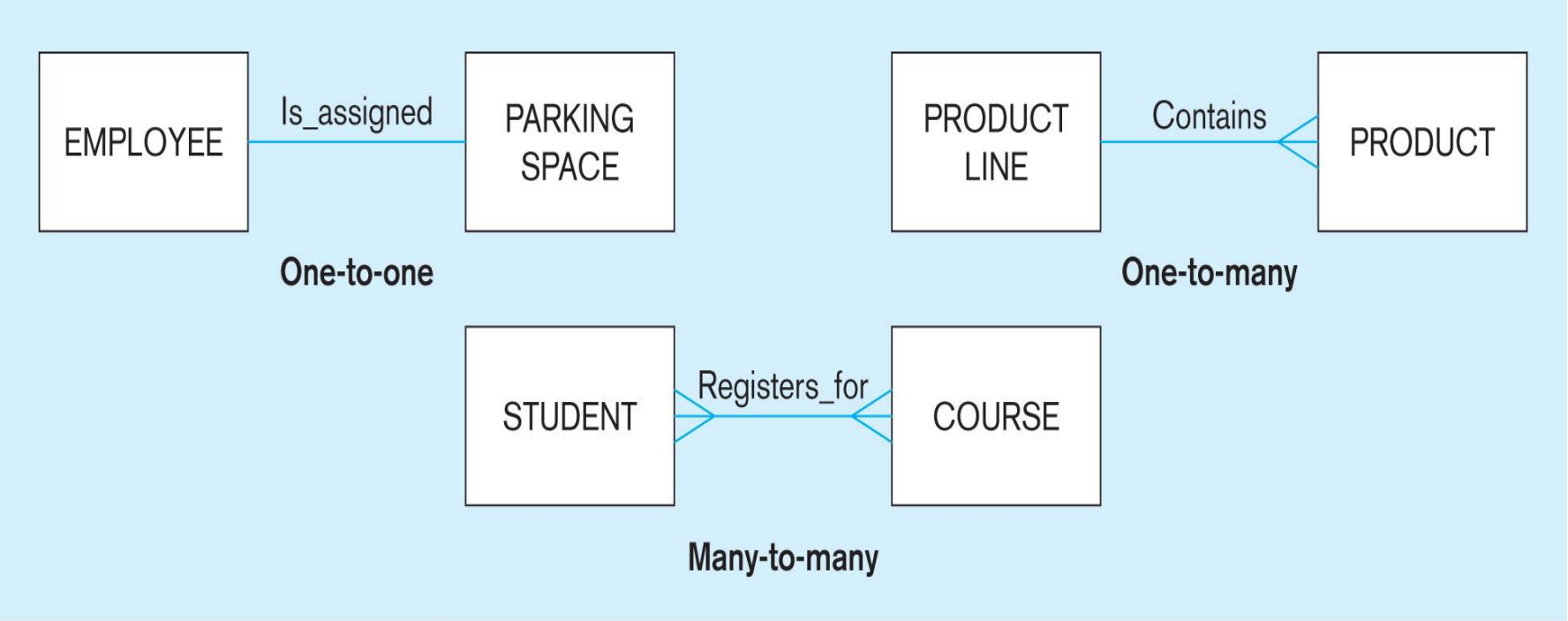
Business Rules

1. Each vendor can supply many parts to any number of warehouses, but need not supply any parts.
2. Each part can be supplied by any number of vendors to more than one warehouse, but each part must be supplied by at least one vendor to a warehouse.
3. Each warehouse can be supplied with any number of parts from more than one vendor, but each warehouse must be supplied with at least one part.

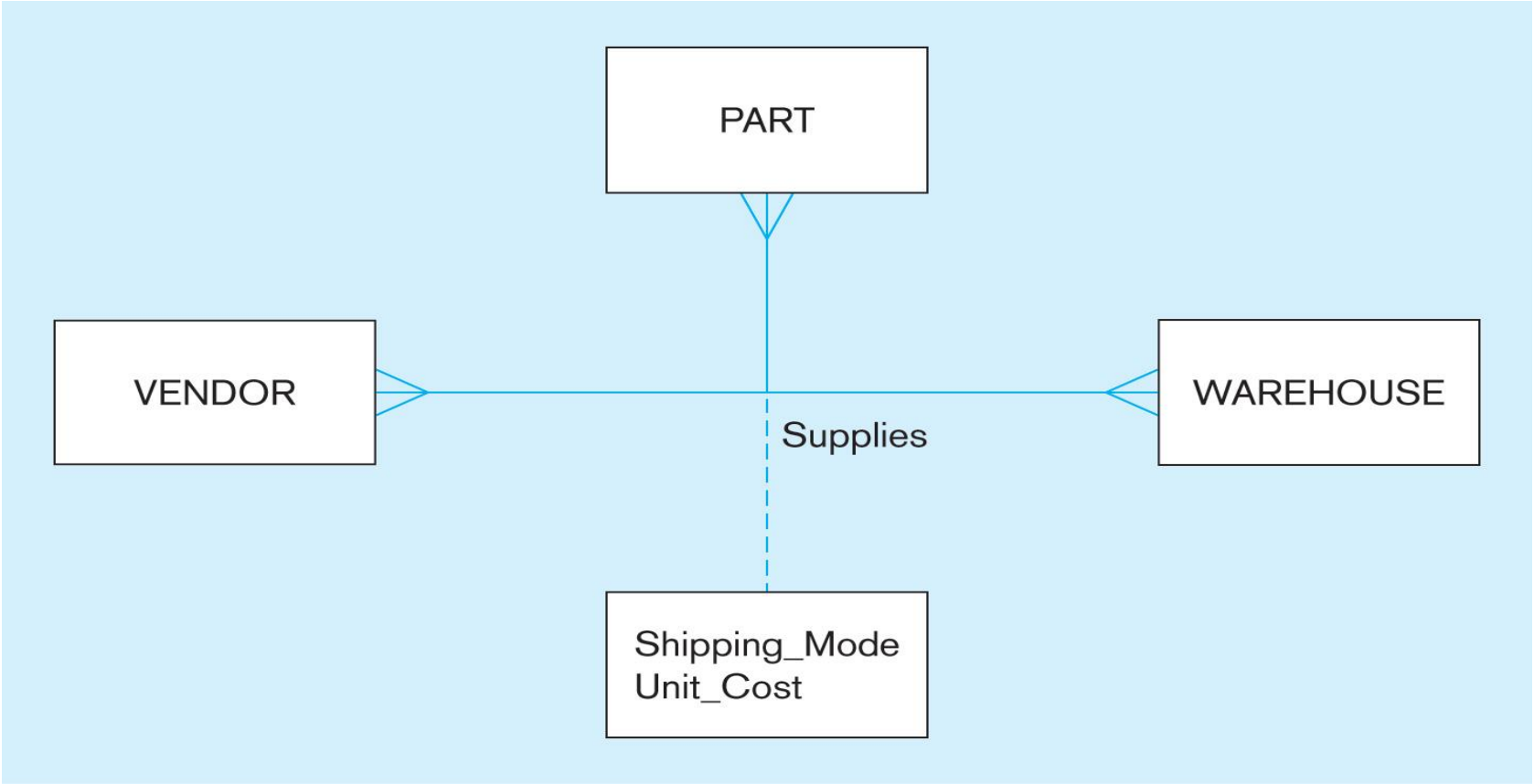
Unary Relationships



Binary Relationships



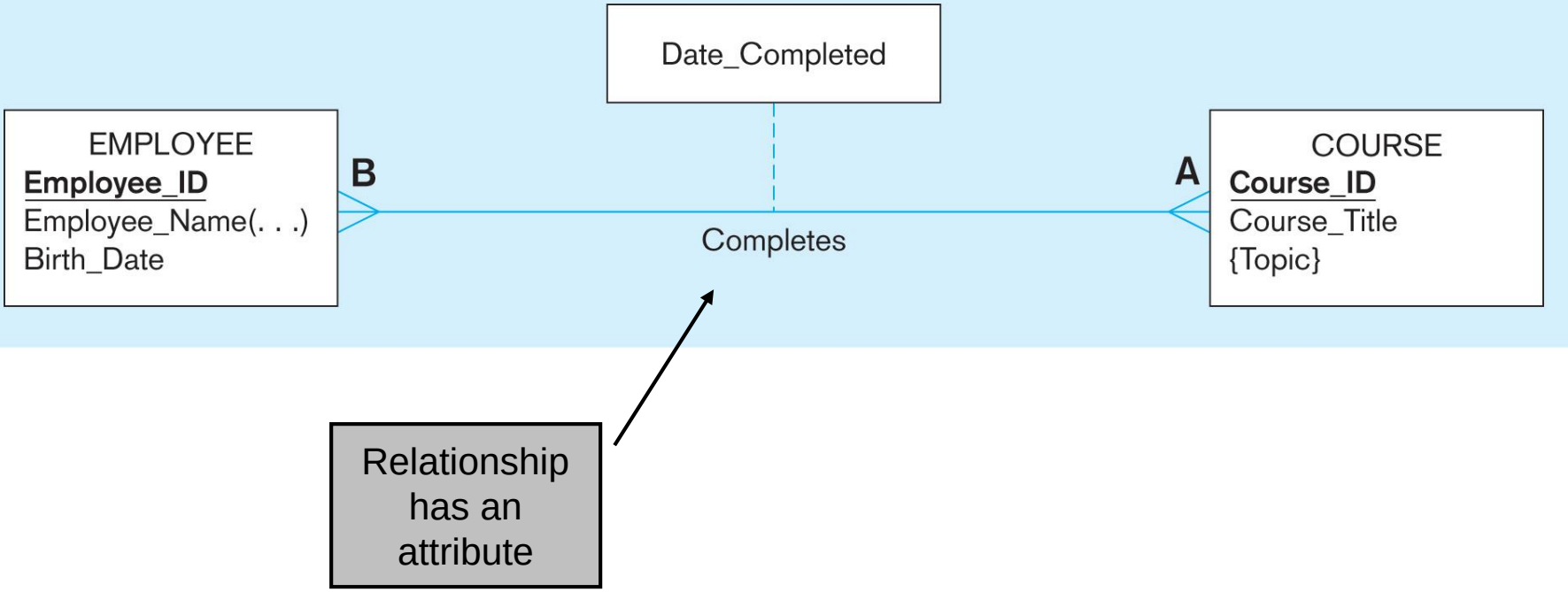
Ternary Relationships



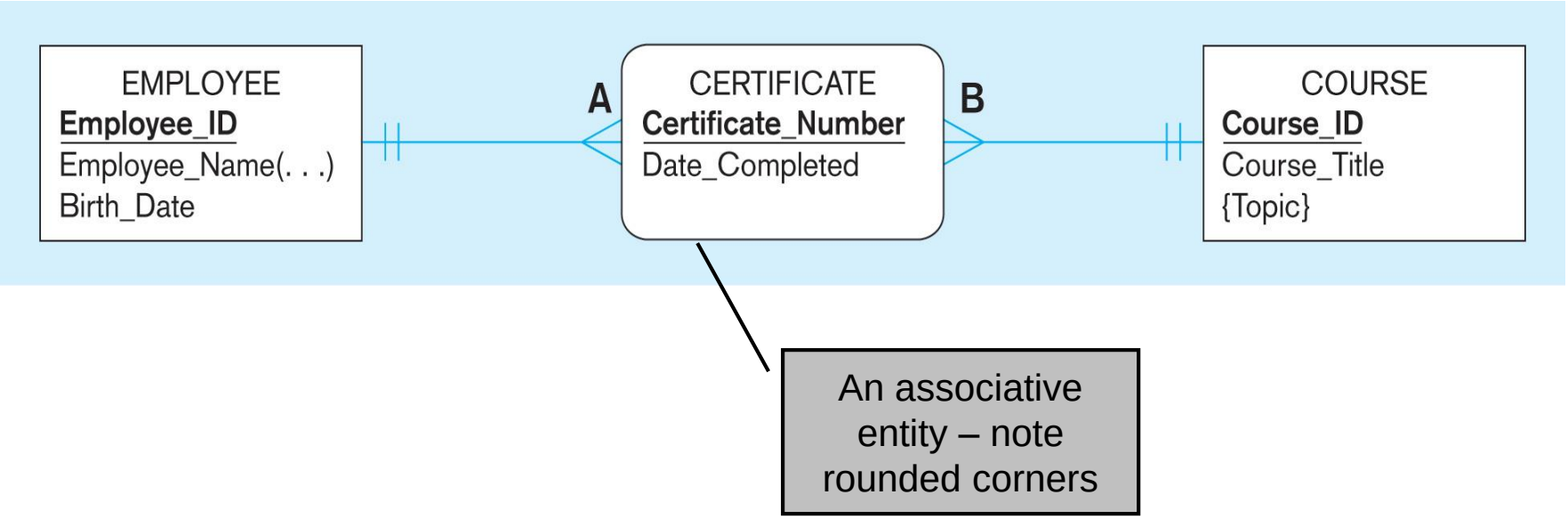
Associative Entities

- 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 to 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 entity may participate in other relationships other than the entities of the associated relationship.
  - Ternary relationships should be converted to associative entities.

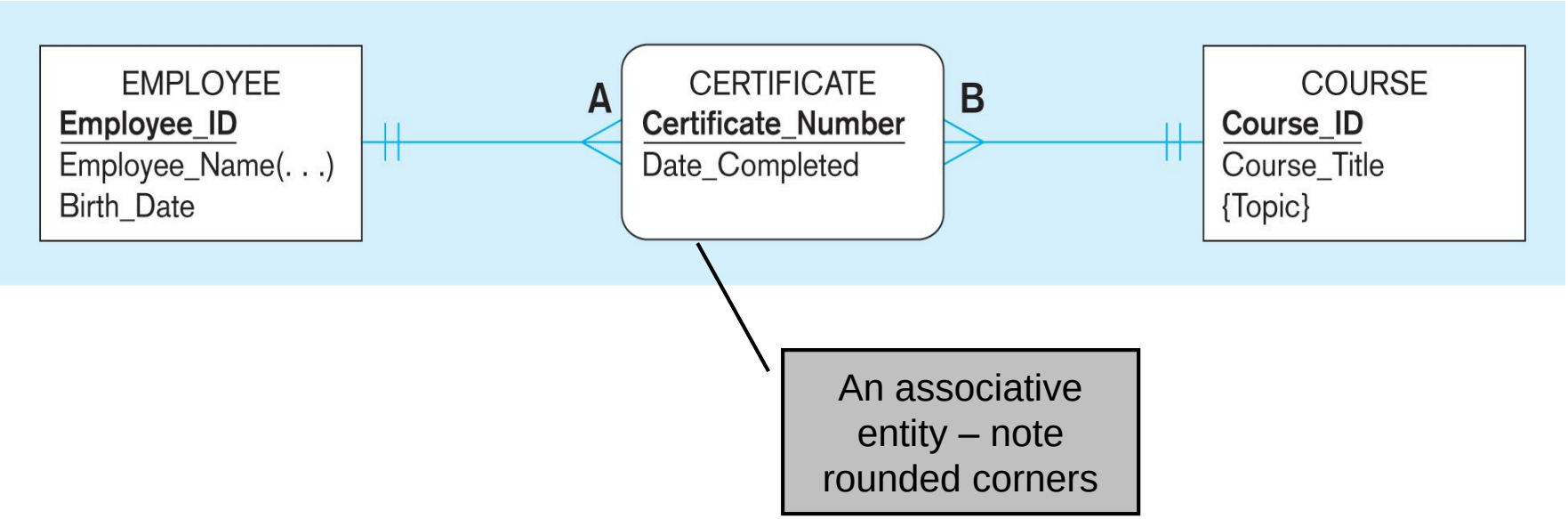
Associative Entities



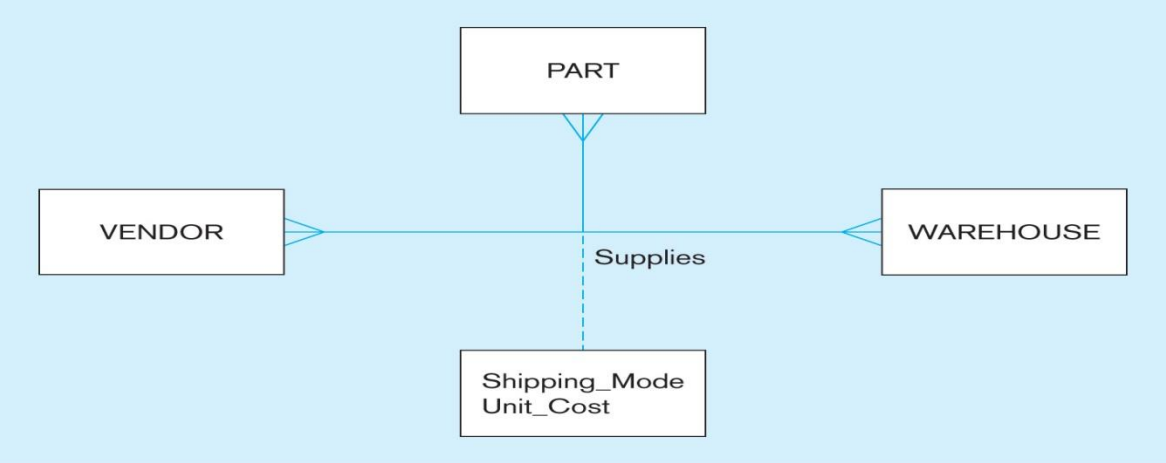
Associative Entities

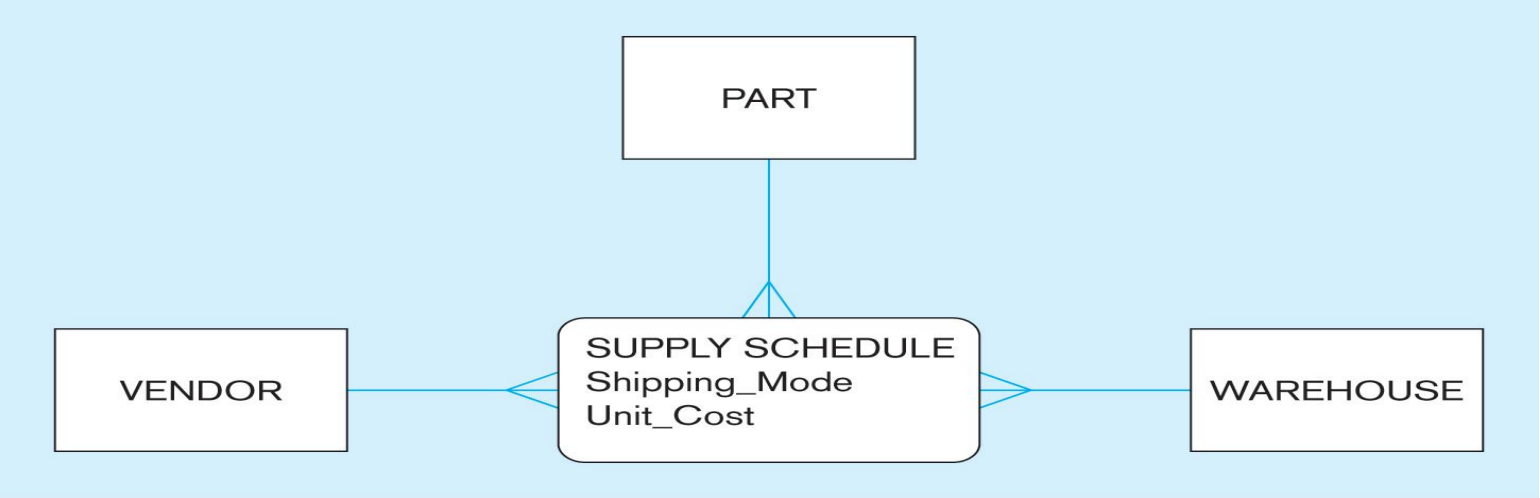


Associative Entities



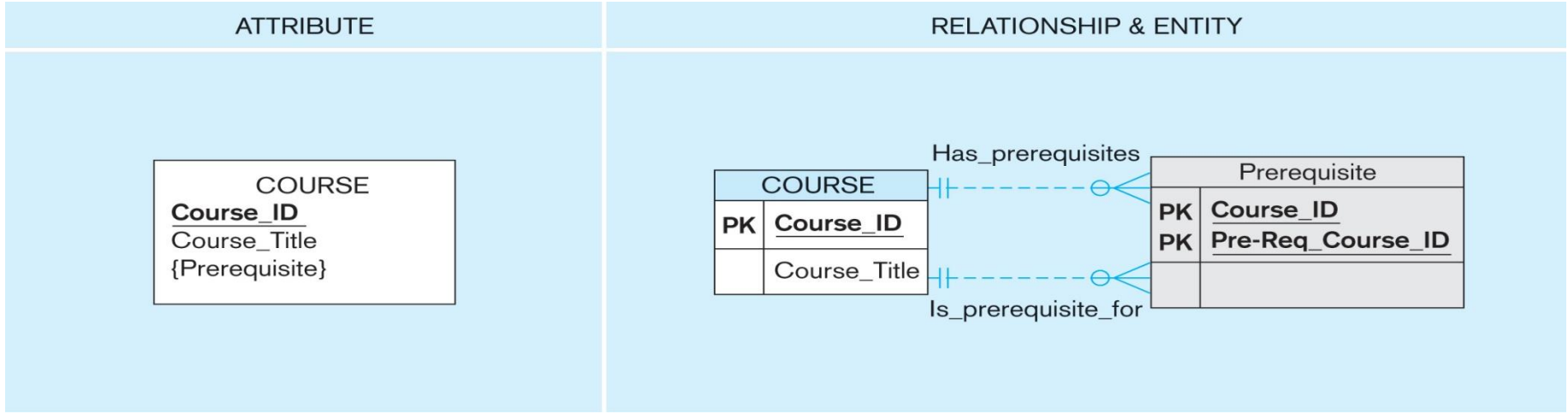
Ternary Relationship to Associative Entity





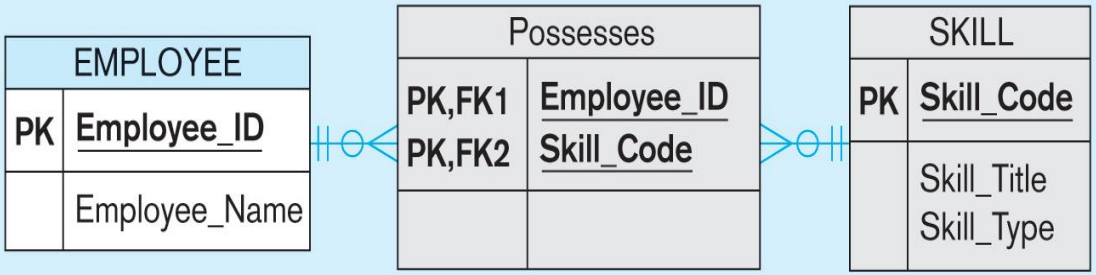
Using Relationships and Entities To Link Related Attributes

Multi-valued attribute as a relationship



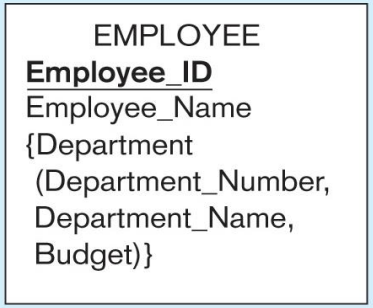
Using Relationships and Entities To Link Related Attributes

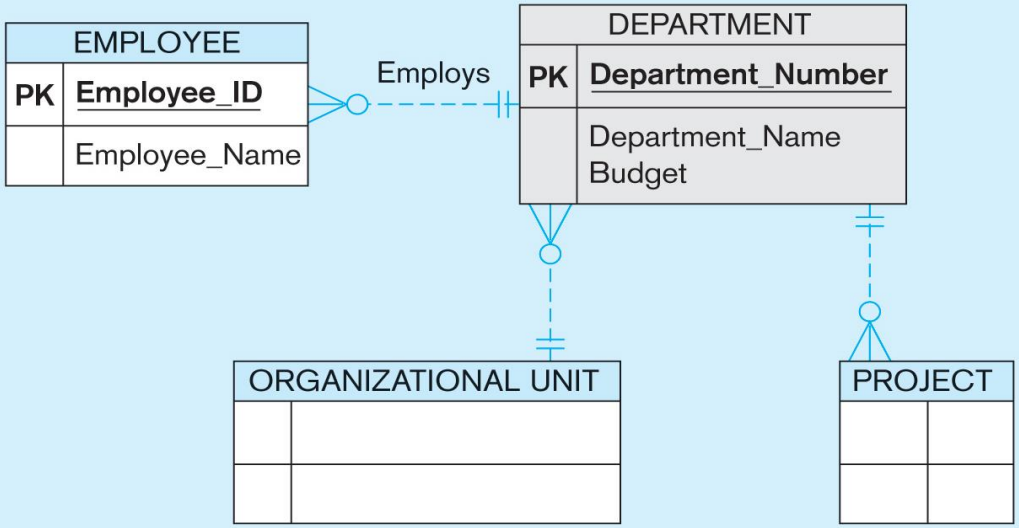
Composite, multi-valued attribute as a relationship



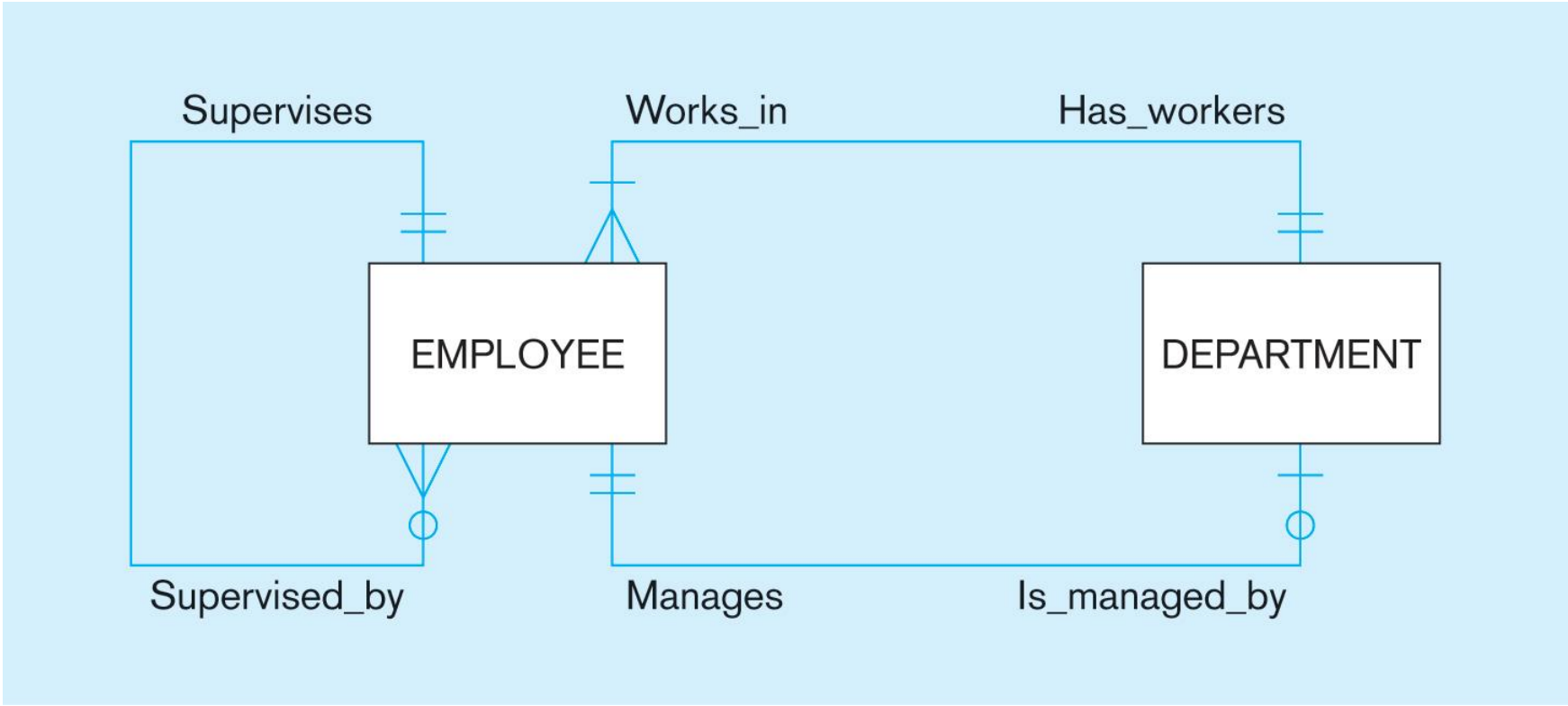
Using Relationships and Entities To Link Related Attributes

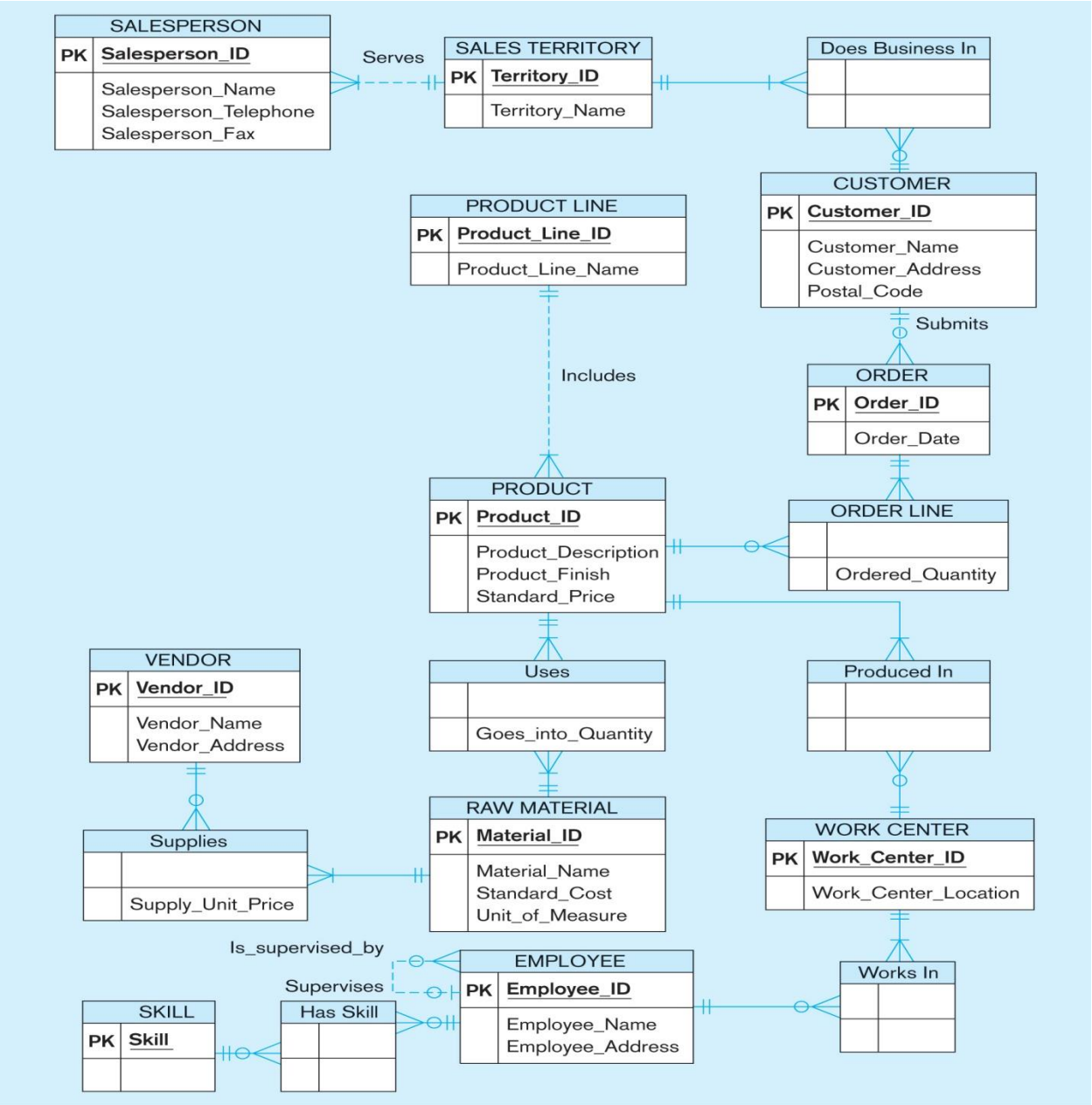
Composite attribute shared with other entities





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





Microsoft Visio Notation for Pine Valley Furniture Example

Different modeling software tools may have different notation for the same constructs