

Database Management Systems

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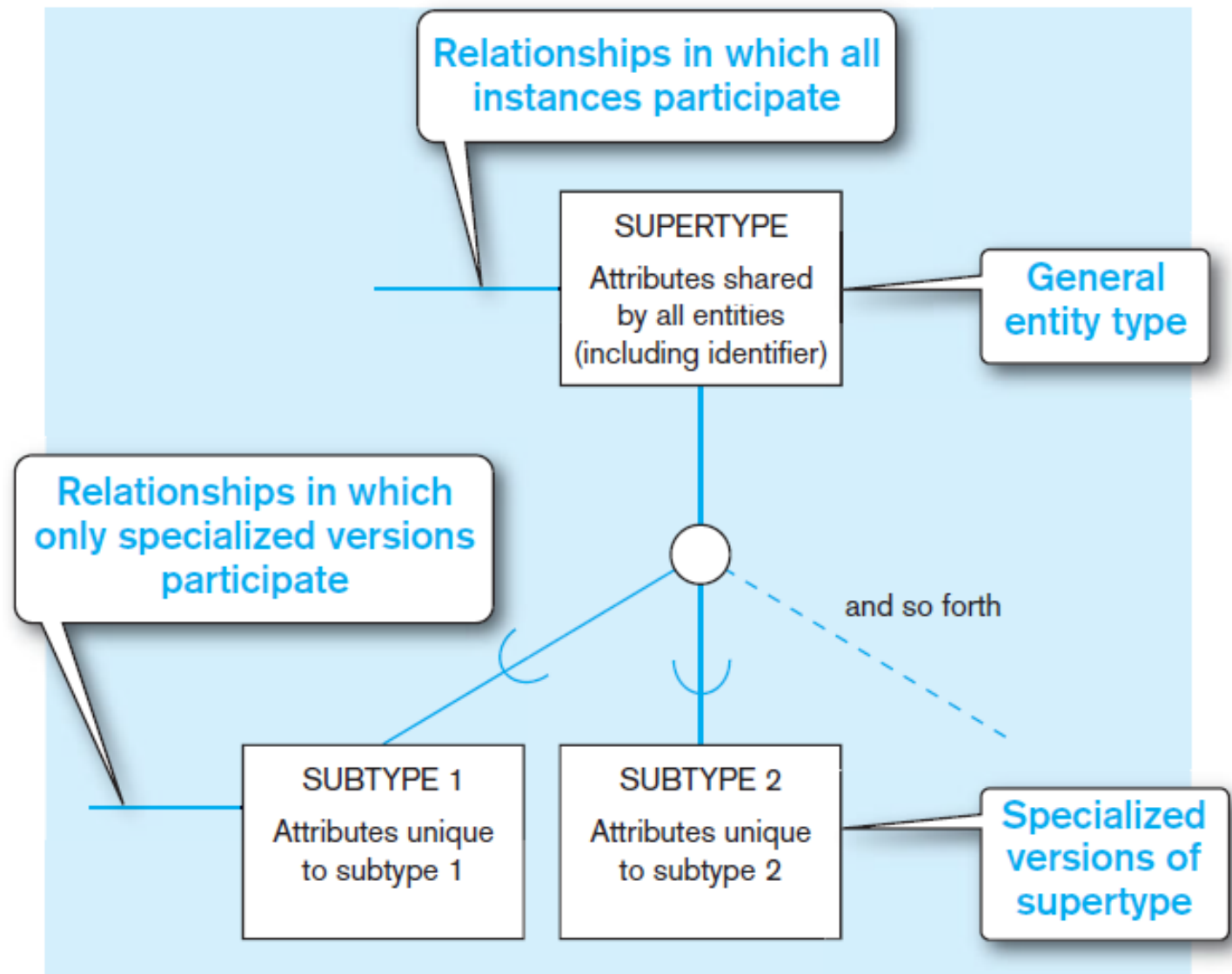
Overview

- Enhanced E-R Modeling
 - Supertype/Subtype Relationships
 - Generalization
 - Specialization
 - Completeness Constraints
 - Disjointness Constraints
 - Supertype/Subtype Discriminator
 - Supertype/Subtype Hierarchy
- Entity Clusters
- More on Business Rules

Supertypes and Subtype

- Subtype: A subgrouping of the entities in an entity type which has attributes that are distinct from those in other subgroupings
- Supertype: A generic entity type that has a relationship with one or more subtypes
- Inheritance:
 - Subtype entities inherit values of all attributes of the supertype
 - An instance of a subtype is also an instance of the supertype

Figure 3-1:
Basic notation for
supertype/subtype
relationships (Entity
supertypes and
subtypes are
organized in a
specialization
hierarchy).



Motivation for Entity Subtypes and Supertypes: Nulls Created by Unique Attributes

Consider an example of aviation business where employees can be pilots, mechanics, accountants, etc. Some attributes are only for pilots which generate nulls for non-pilots (e.g. EMP_LICENSE, EMP_RATINGS, EMP_MED_TYPE) are only for pilots.

Table name: EMPLOYEE_V1

Database name: Ch04_AirCo

	EMP_NUM	EMP_LNAME	EMP_LICENSE	EMP_RATINGS	EMP_MED_TYPE	EMP_HIRE_DATE
▶	100	Kolmycz				15-Mar-88
	101	Lewis	ATP	SEL/MEL/Instr/CFII	1	25-Apr-89
	102	Vandam				20-Dec-93
	103	Jones				28-Aug-03
	104	Lange	ATP	SEL/MEL/Instr	1	20-Oct-97
	105	Williams	COM	SEL/MEL/Instr/CFI	2	08-Nov-97
	106	Duzak	COM	SEL/MEL/Instr	2	05-Jan-04
	107	Diante				02-Jul-97
	108	Miesenbach				18-Nov-95
	109	Travis	COM	SEL/MEL/SES/Instr/CFII	1	14-Apr-01
	110	Genkazi				01-Dec-03

Motivation for Entity Subtypes and Supertypes:

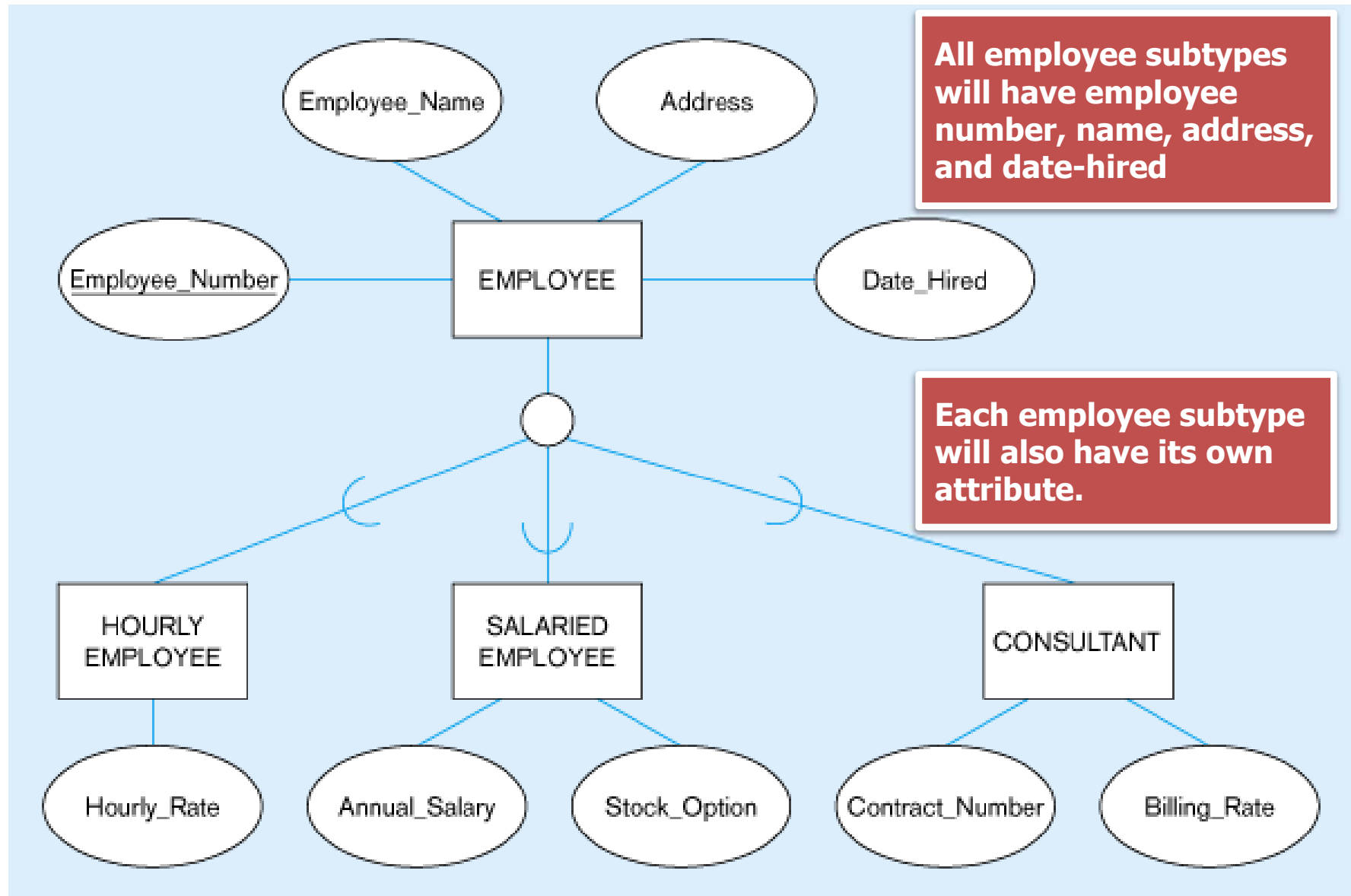
Null Created by Unique Attributes

- So the grouping of employees to create various types of employees provide two important details:
 - It **avoids unnecessary nulls** in the employee attributes when some employees have characteristics that are not shared by other employees.
 - It enables a particular employee type to **participate in relationship** that are unique to that employee type.

Specialized Hierarchy

- A specialization hierarchy (i.e. entity subtypes/supertypes) provides a mean to:
 - Support attribute **inheritance** (which enables an entity subtype to inherit the attributes and relationships of the supertype).
 - Define a special supertype attribute known as the **subtype discriminator**.
 - Define **disjoint/overlapping constraints** and **complete/partial constraints**.

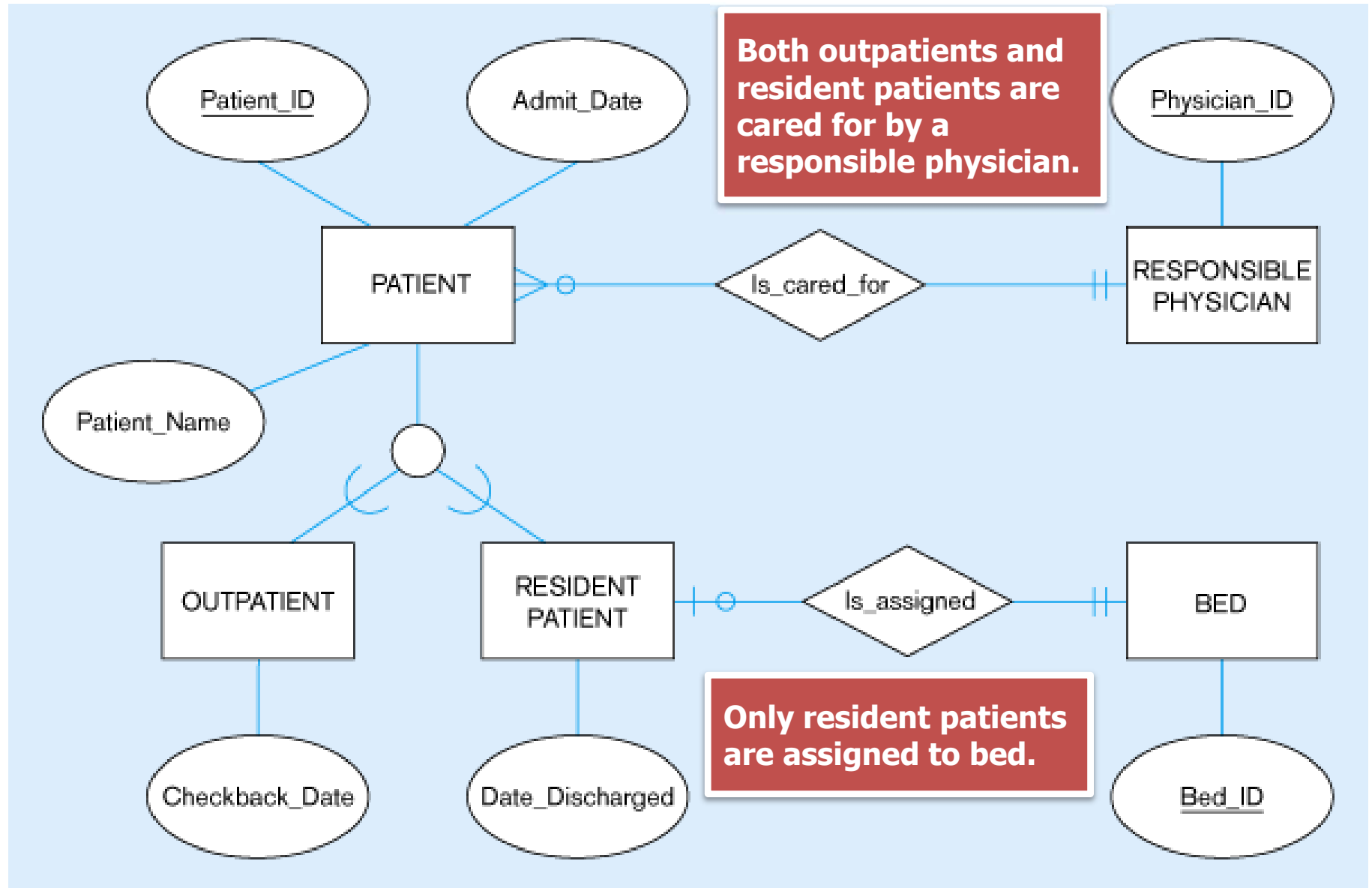
Employee Supertype with Three Subtypes



Relationships and Subtypes

- Relationships at the supertype level indicate that all subtypes will participate in the relationship
- The instances of a subtype may participate in a relationship unique to that subtype. In this situation, the relationship is shown at the subtype level

Supertype/Subtype Relationships in a Hospital

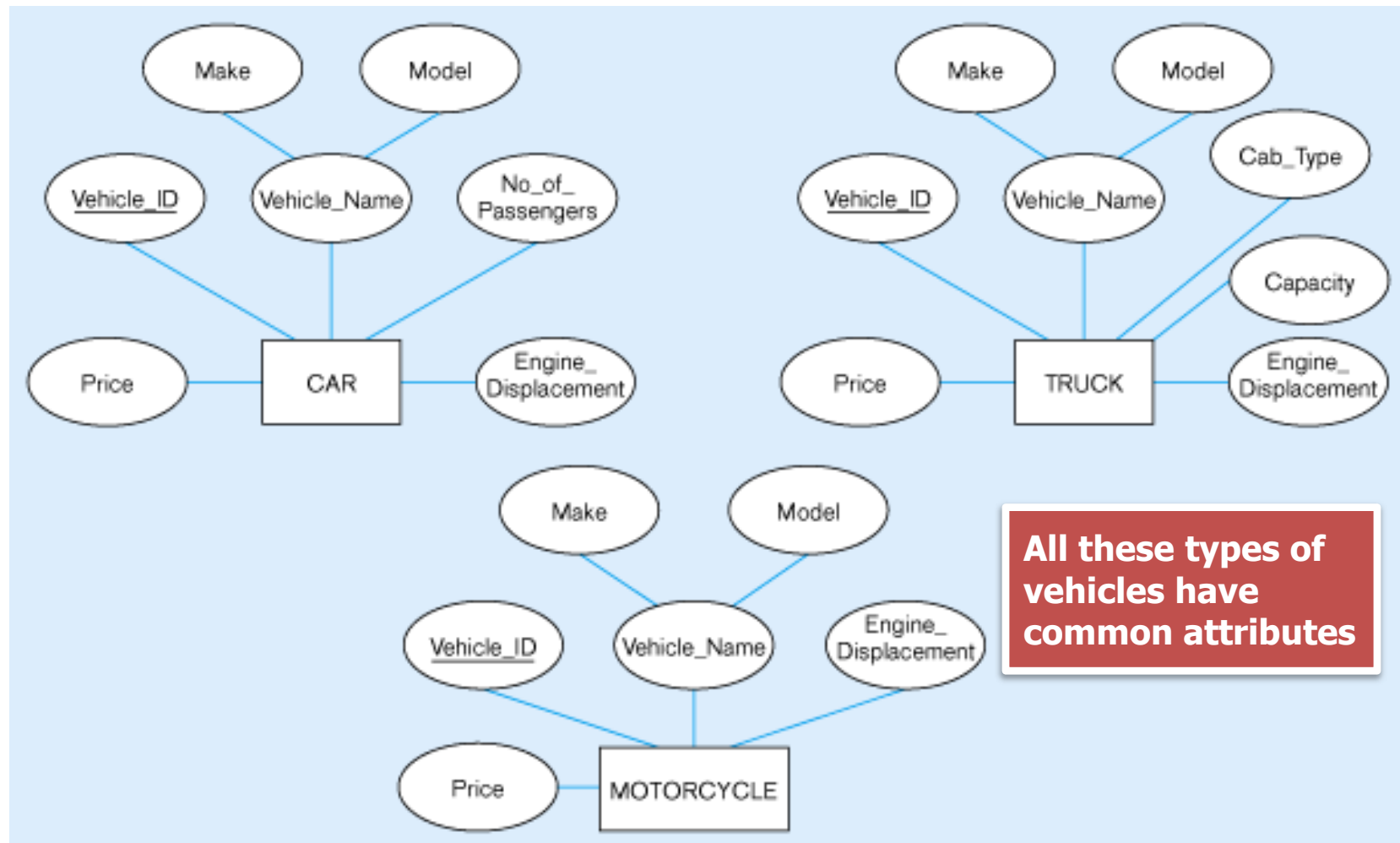


Generalization

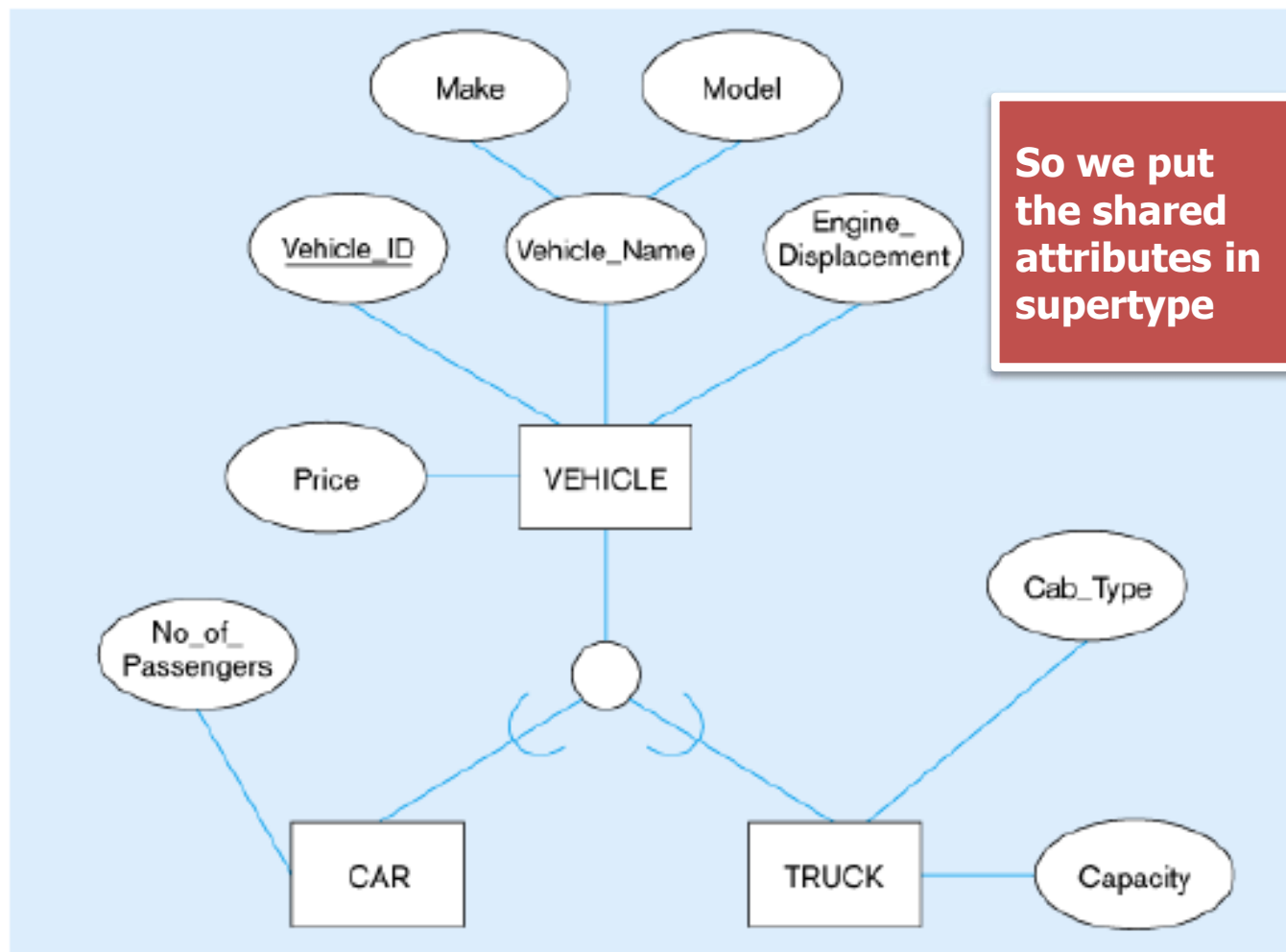
- Generalization: The process of defining a more general entity type from a set of more specialized entity types. **BOTTOM-UP**

Example of Generalization

Three entity types: CAR, TRUCK, and MOTORCYCLE



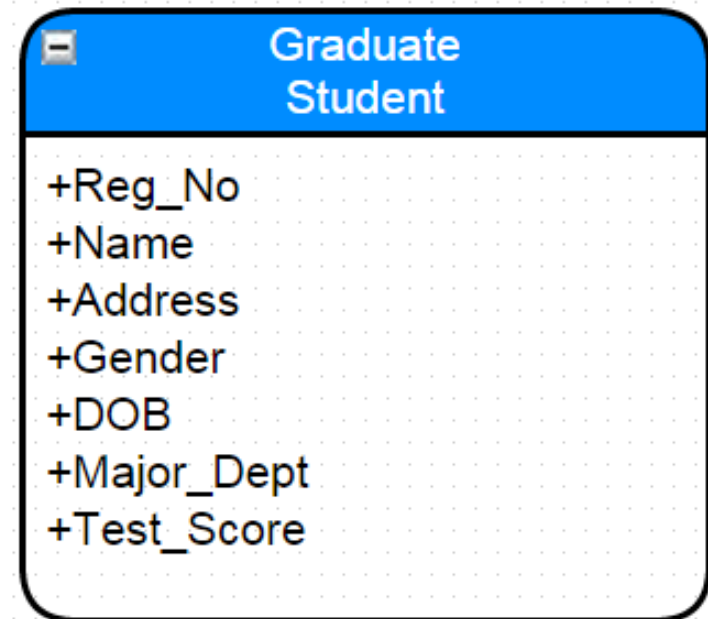
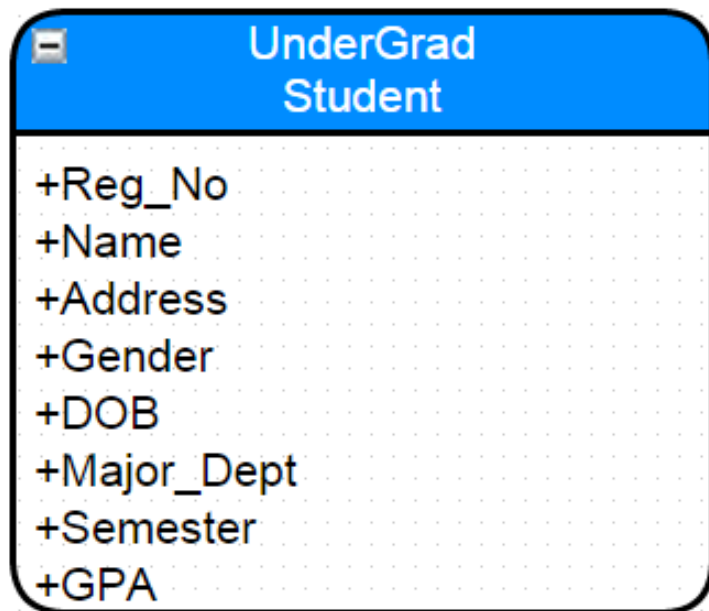
Generalization of VEHICLE Supertype



Note: no subtype for motorcycle, since it has no unique attributes

Task 1

- Given the following entities, perform **Generalization**. What will be the Generalized entity and its attributes? What will be attributes of specialized entities? Make proper EER diagram.

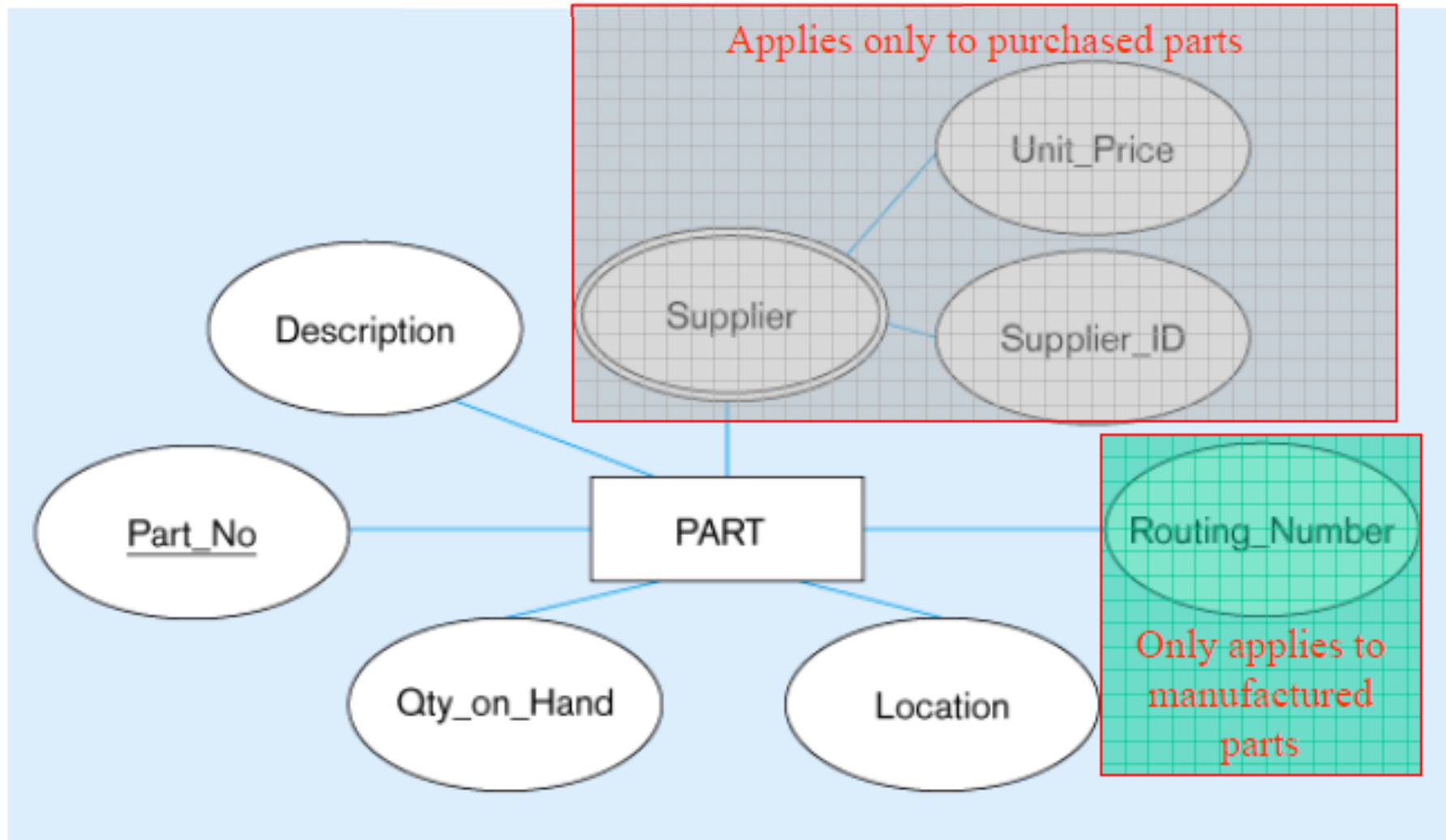


Specialization

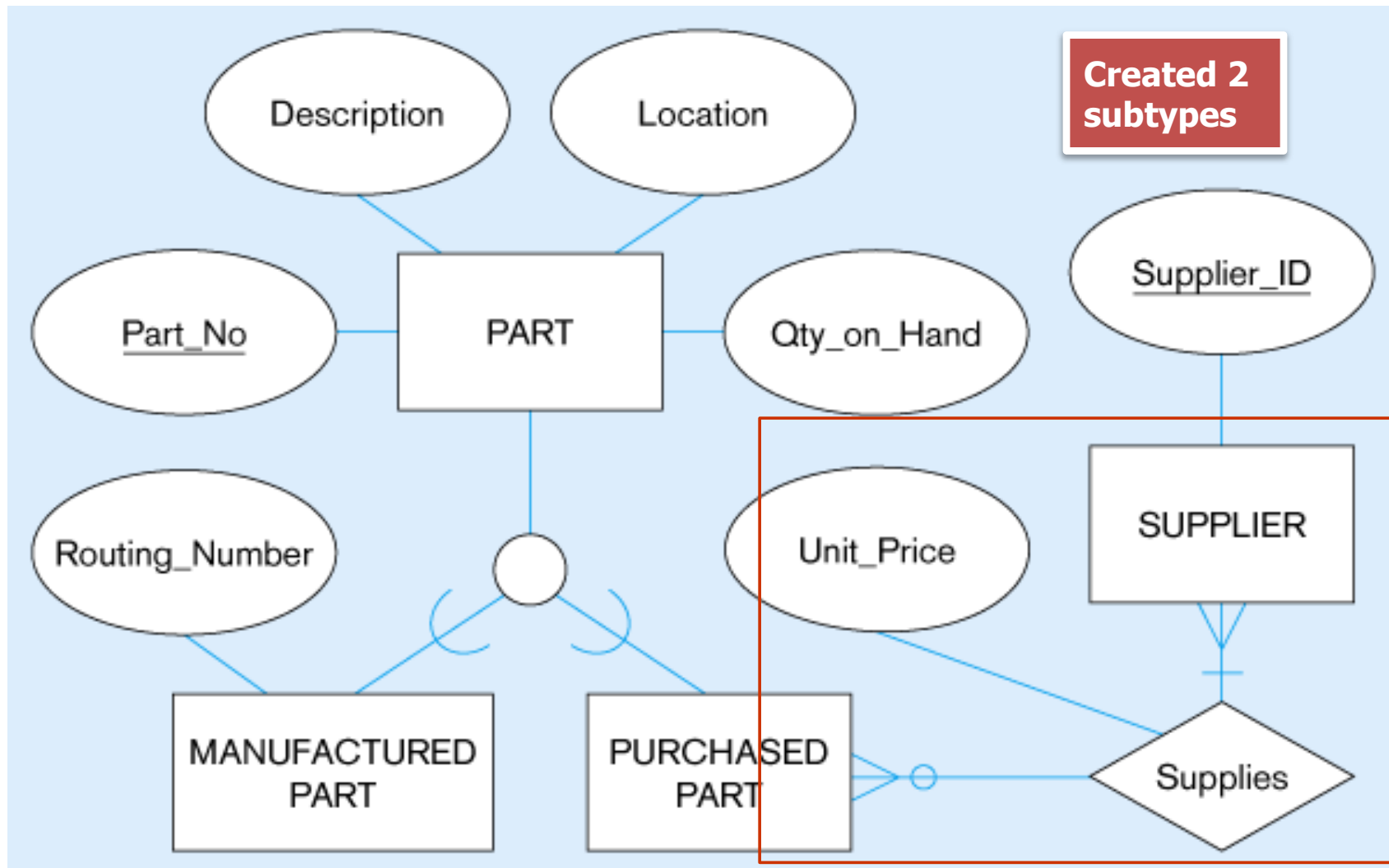
- Specialization: The process of defining one or more subtypes of the supertype, and forming supertype/subtype relationships. **TOP-DOWN**

Example of Specialization

(a) Entity type PART



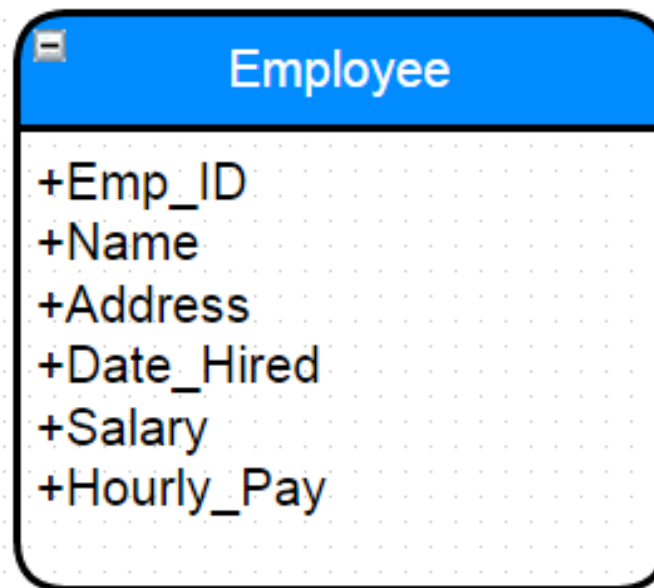
Specialization to MANUFACTURED PART and PURCHASED PART



Note: multivalued attribute was replaced by a relationship to another entity

Task 2

- Given the following entity, perform **Specialization**. What will be the Specialized entities and their attributes? What will be attributes of generalized entities? Make proper EER diagram.

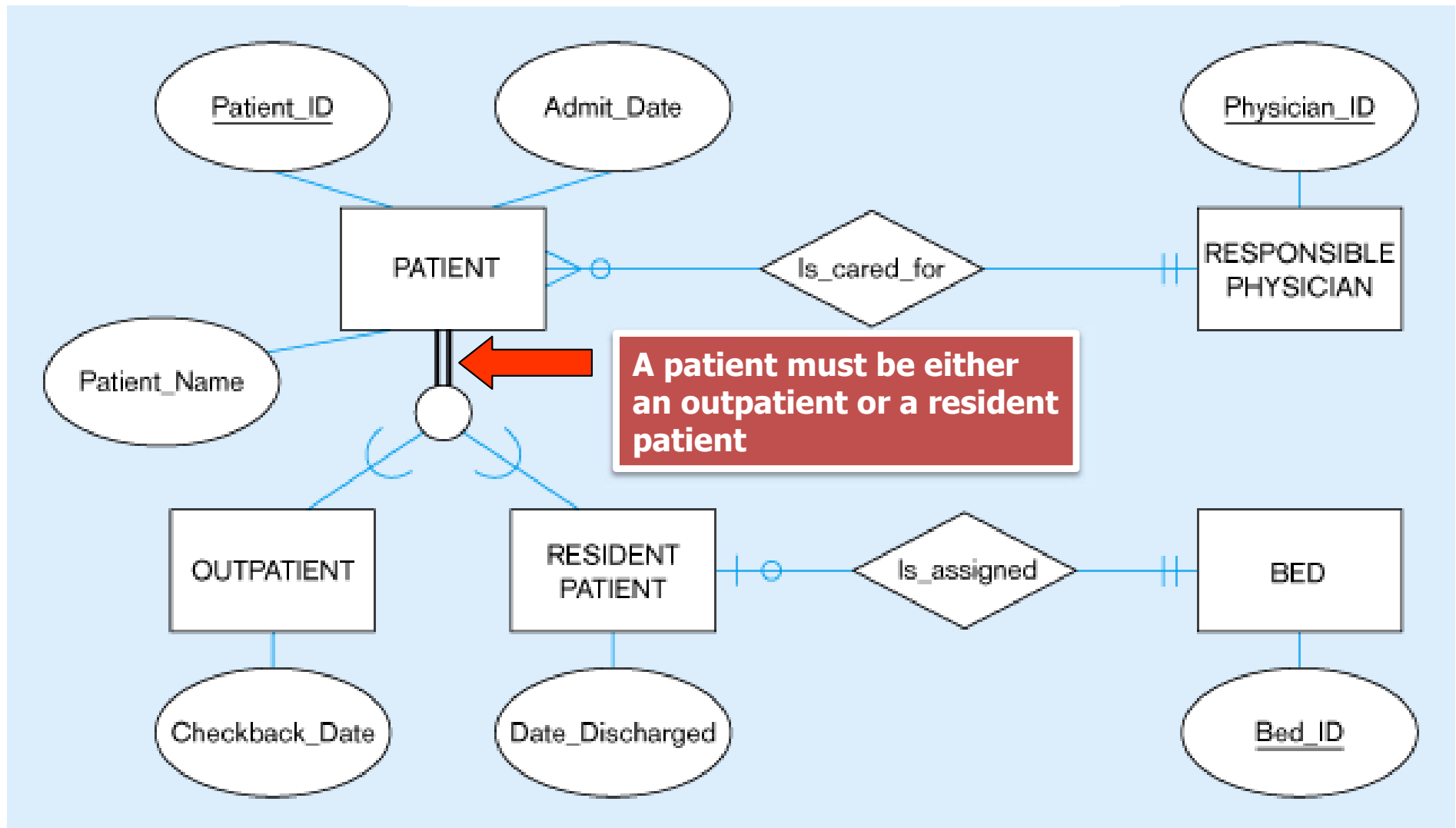


Constraints in Supertype/Completeness Constraint

- Completeness Constraint: Whether an instance of supertype **must** also be a member of at least one subtype
 - Total Specialization Rule: Yes (notation: double line)
 - Partial Specialization Rule: No (notation: single line)

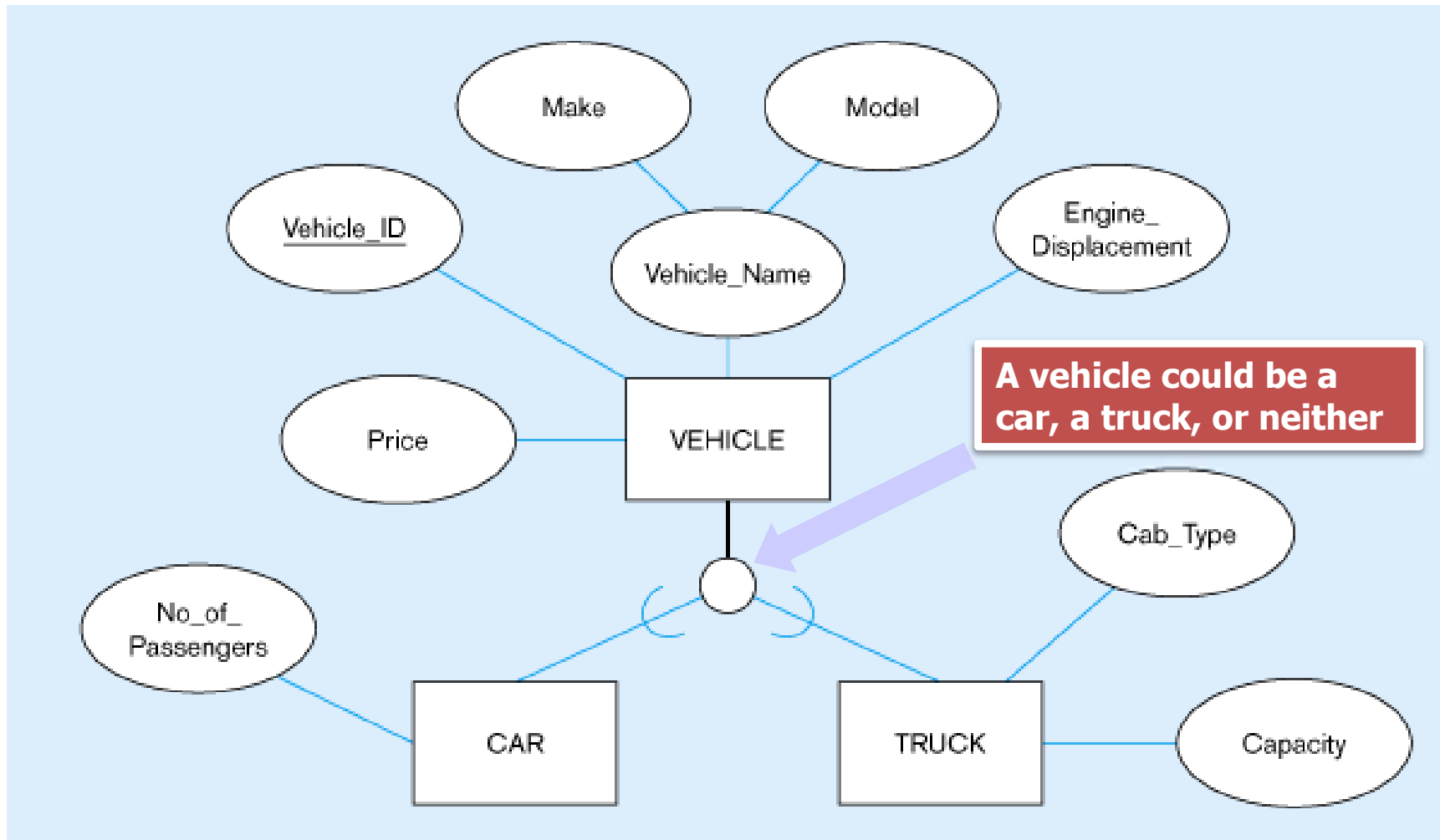
Examples of Completeness Constraints

(a) Total Specialization Rule



Examples of Completeness Constraints

(b) Partial Specialization Rule



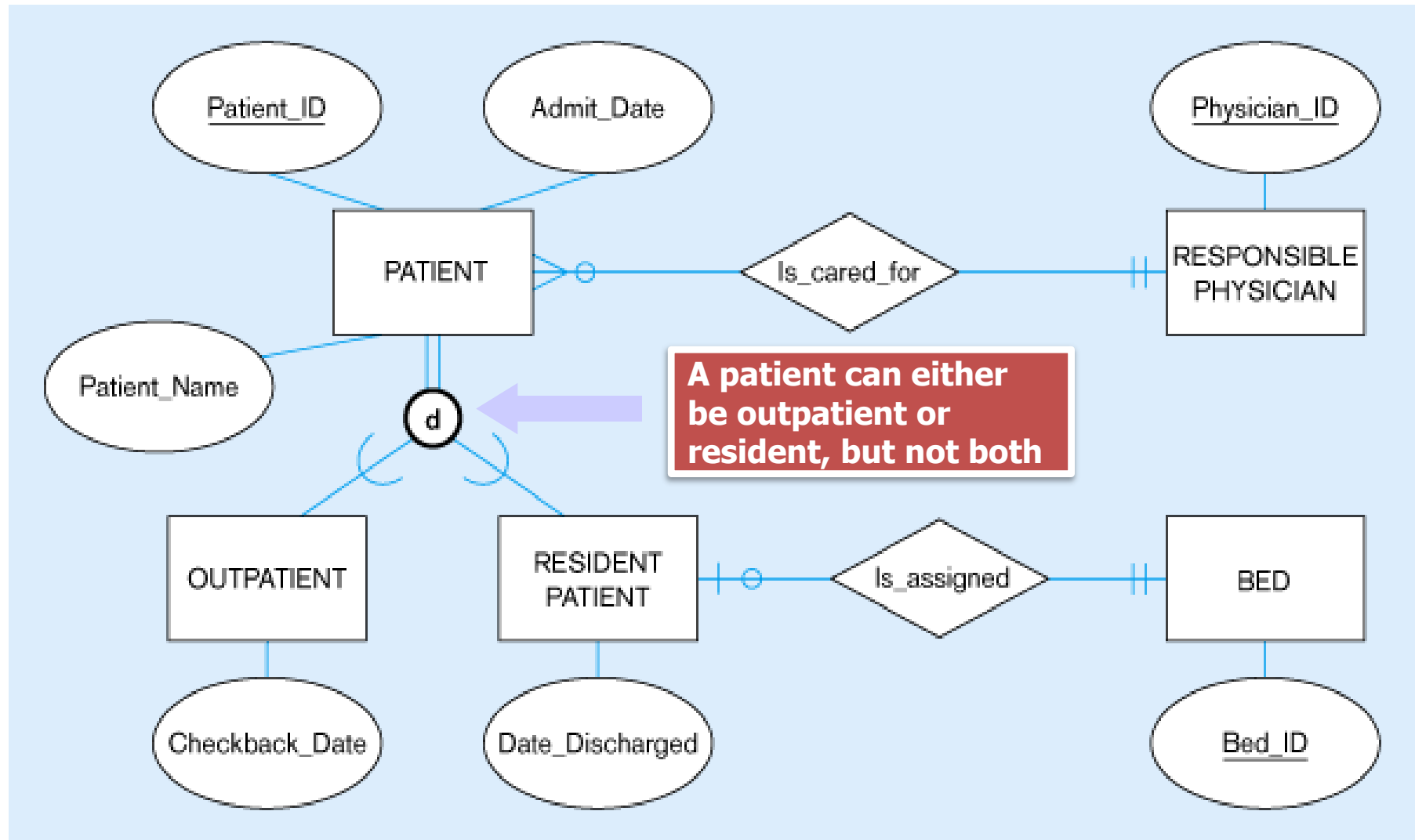
Constraints in Supertype/Disjointness

Constraint

- Disjointness Constraint: Whether an instance of supertype **may** simultaneously be a member of two (or more) subtypes.
 - Disjoint Rule: An instance of the supertype can be only ONE of the subtypes (notation: d alphabet)
 - Overlap Rule: An instance of the supertype could be more than one of the subtypes (notation: o alphabet)

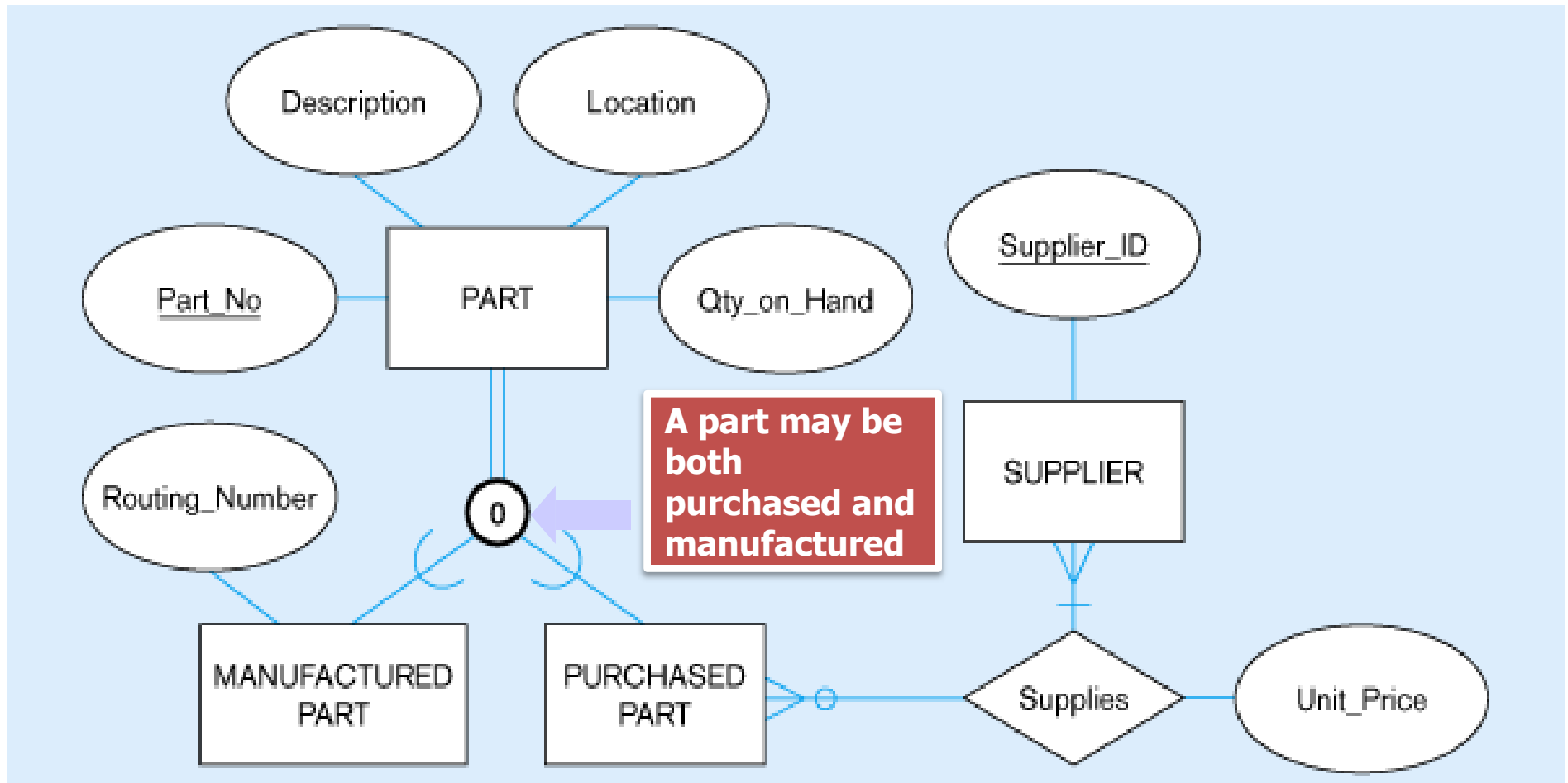
Examples of Disjointness Constraints

(a) Disjoint Rule



Examples of Disjointness Constraints

(b) Overlap Rule



Task 3

- At a weekend retreat, the entity type PERSON has three subtypes: CAMPER, BIKER, and RUNNER. Draw a separate EER diagram segment for each of the following situations:
 - a. At a given time, a person must be exactly one of these subtypes.
 - b. A person may or may not be one of these subtypes. However, a person who is one of these subtypes cannot at the same time be one of the other subtypes.
 - c. A person may or may not be one of these subtypes. On the other hand, a person may be any two (or even three) of these subtypes at the same time.
 - d. At a given time, a person must be at least one of these subtypes.

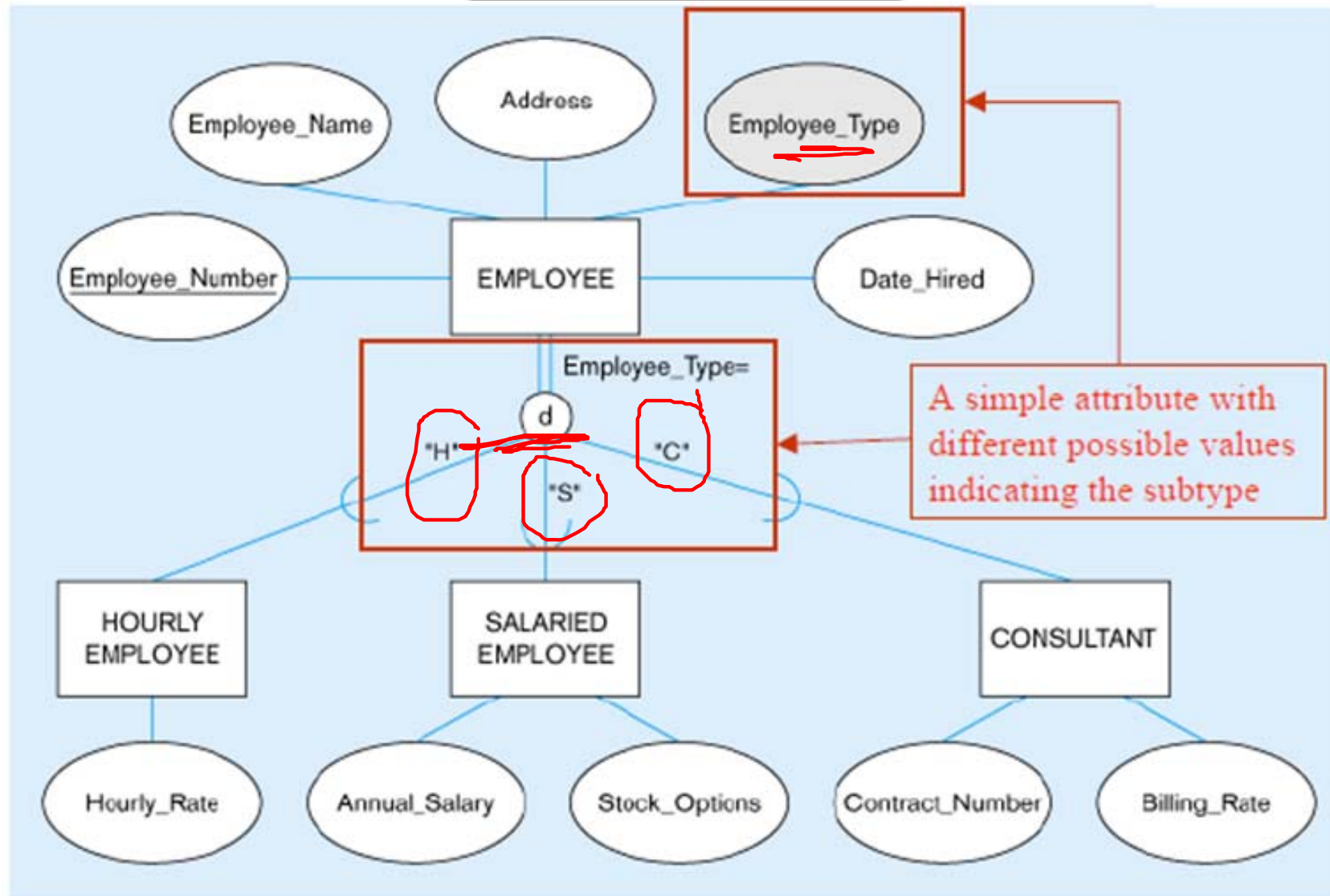
Constraints in Supertype/Subtype

Discriminators

- Subtype Discriminator: An attribute of the supertype whose values determine the target subtype(s)
 - Disjoint: a simple attribute with alternative values to indicate the possible subtypes
 - Overlapping: a composite attribute whose subparts pertain to different subtypes. Each subpart contains a Boolean value to indicate whether or not the instance belongs to the associated subtype

Introducing a Subtype Discriminator

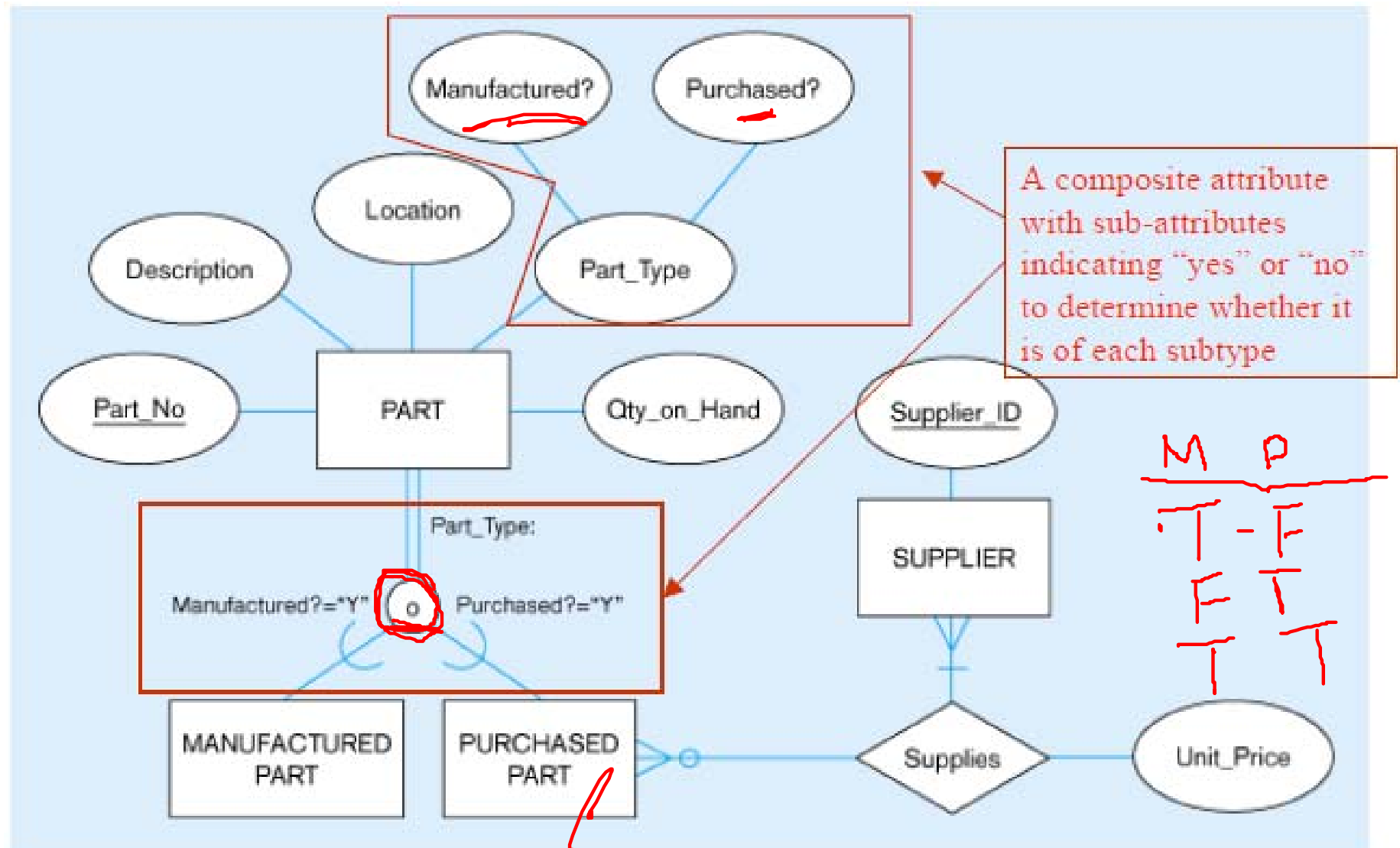
(a) Disjoint Rule



Introducing a Subtype Discriminator (cont...)

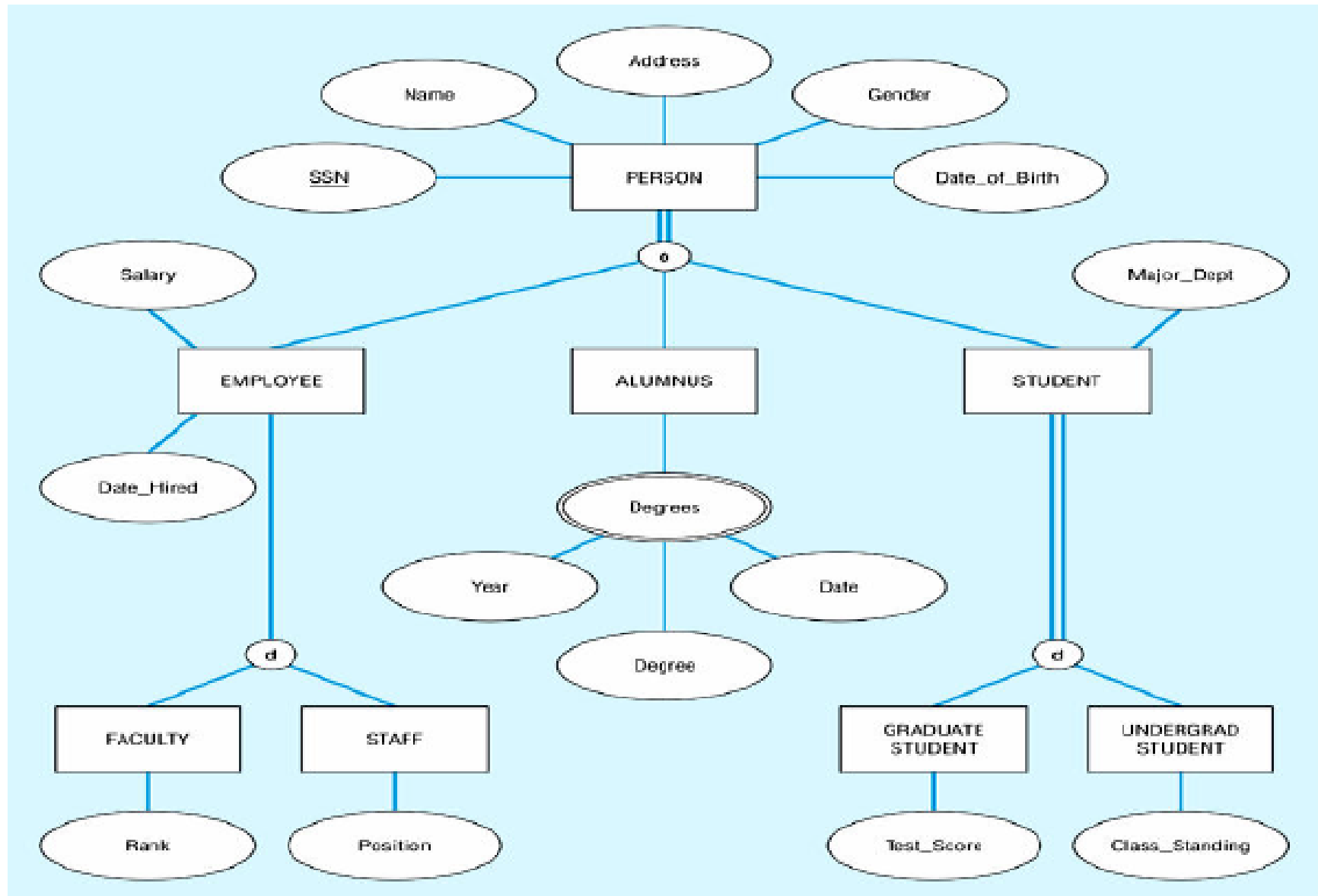
(b) Overlap Rule

$A_1 \quad A_2 \quad A_3$



M	P
T	F
F	T
T	T

Example of Supertype/Subtype Hierarchy



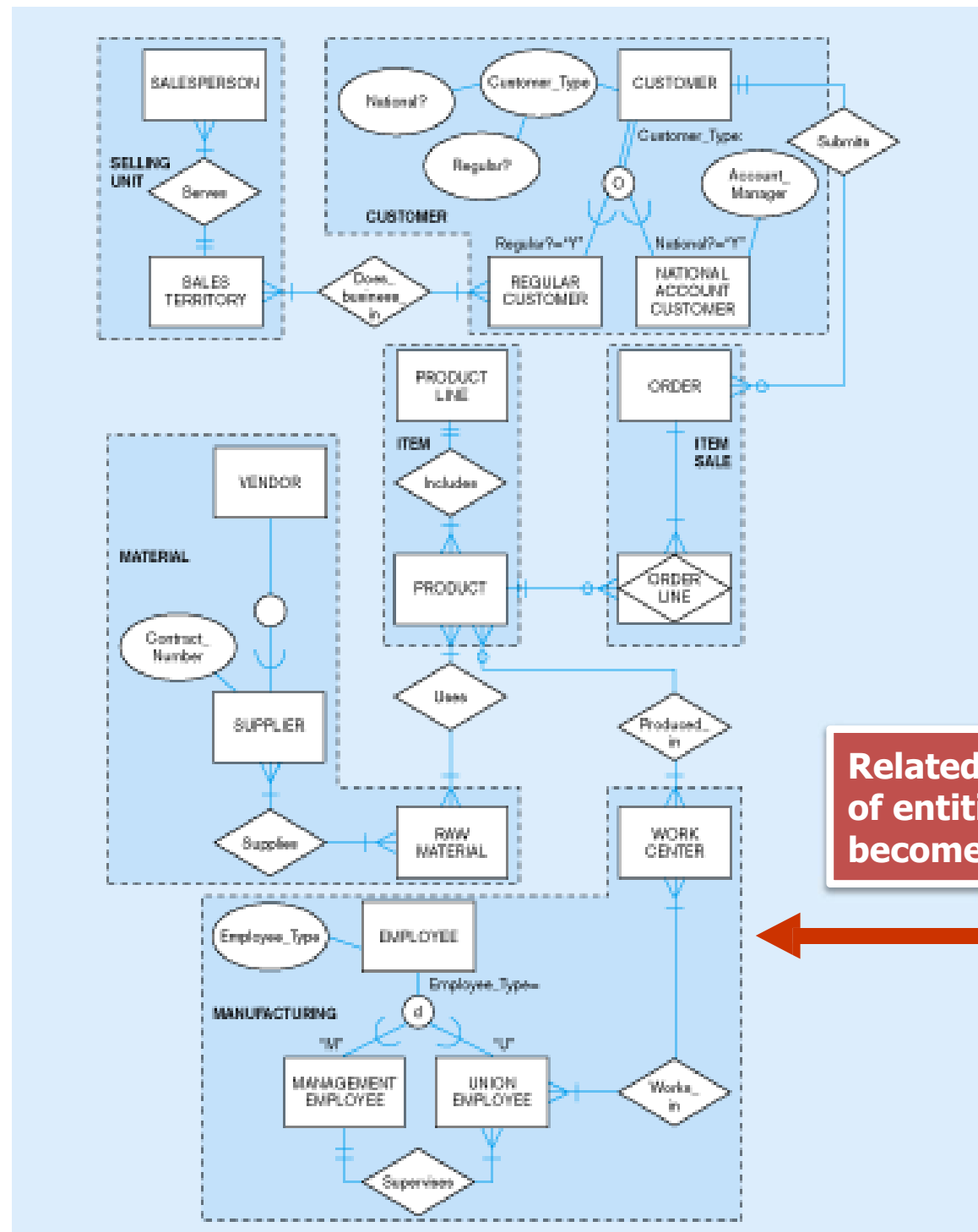
Task 4

- Add a subtype discriminator for each of the supertypes shown in Figure on Slide 31. Show the discriminator values that assign instances to each subtype. Use the following subtype discriminator names and values:
 - a) PERSON: Person Type (Employee? Alumnus? Student?)
 - b) EMPLOYEE: Employee Type (Faculty, Staff)
 - c) STUDENT: Student Type (Grad, Undergrad)

Entity Clusters

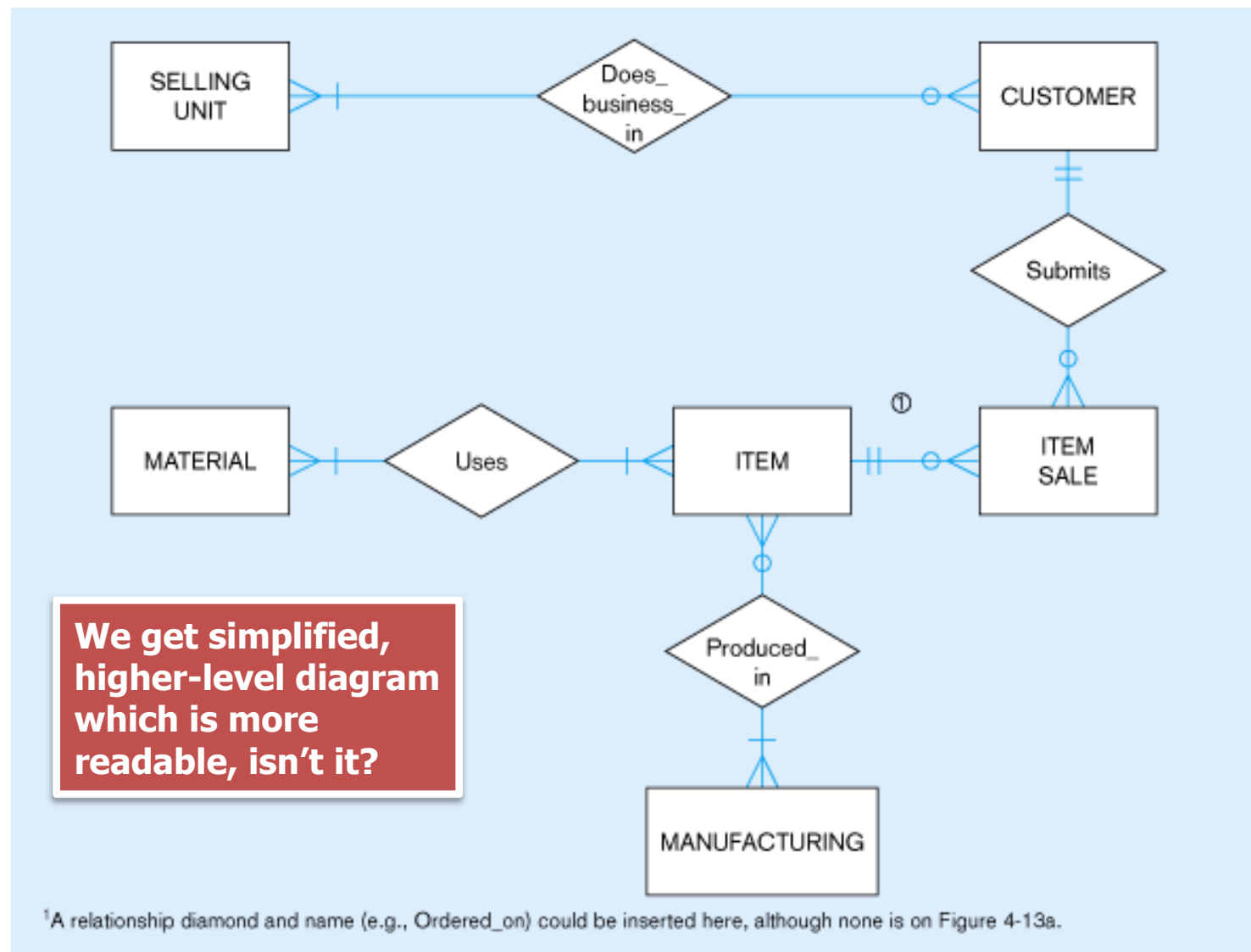
- EER diagrams are difficult to read when there are too many entities and relationships
- Solution: group entities and relationships into entity clusters
- Entity cluster: set of one or more entity types and associated relationships grouped into a single abstract entity type

Figure 3-13 (a):
Possible Entity
Cluster for Pine
Valley Furniture
Company



**Related groups
of entities could
become cluster**

Figure 3-13 (b) – EER Diagram of PV, Entity Clusters

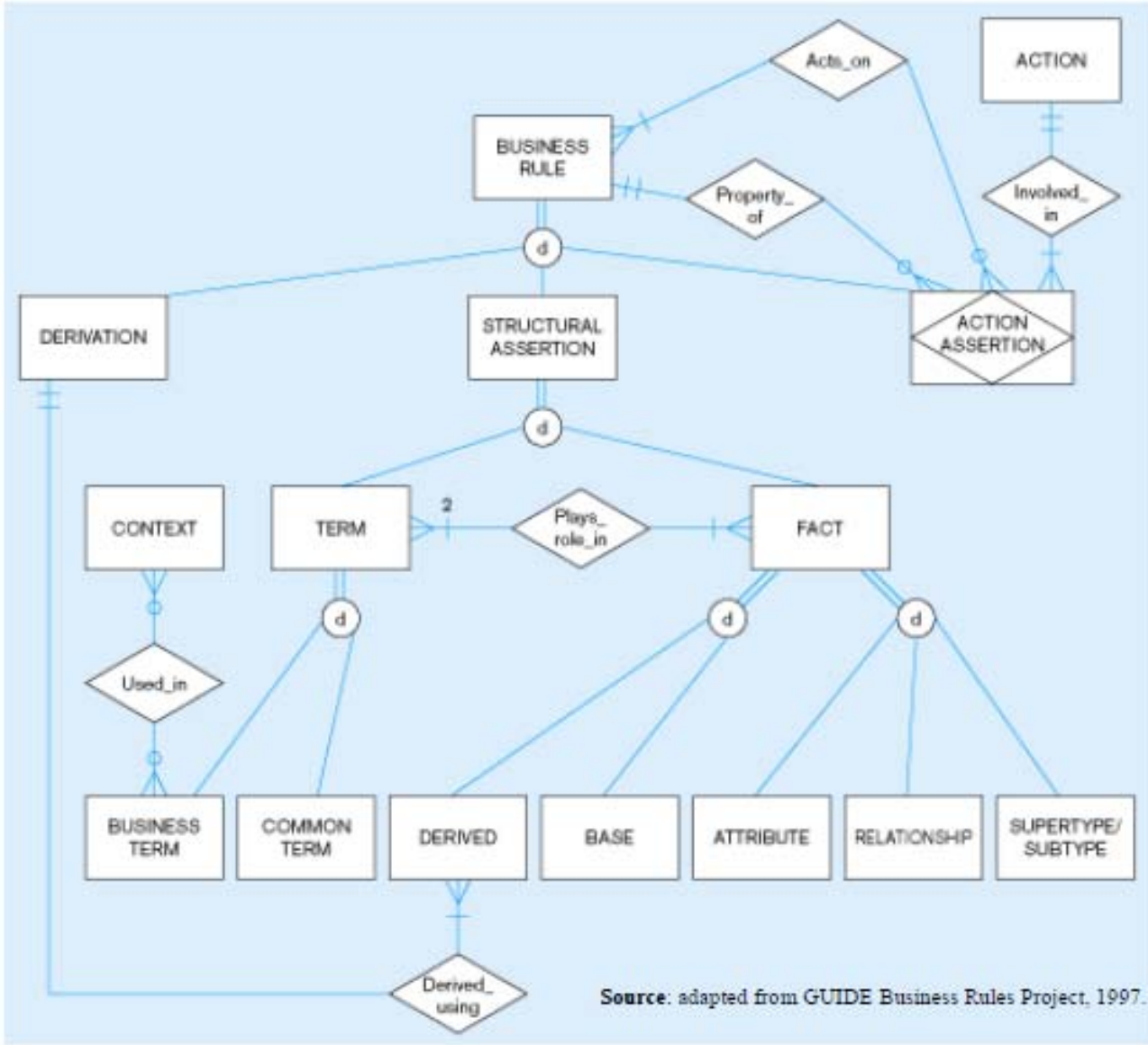


Business Rules Revisited

- A business rule is a:
 - Structure
assertion {
 - **Term**: The application of a single definition to a word or phrase
 - **Fact**: An association between two or more terms
 - **Derivation**: An attribute derived from other attributes
 - Action
assertion {
 - **Constraint**: A condition that determines what values an attribute or relationship can or must have
- In case of designing a database for a university, some examples of business rules are:
 - "A student may register for a section of a course only if he or she has successfully completed the prerequisites".
 - "A faculty member teaches from 0 to a maximum of 3 courses per semester".
 - "Students may not take more than 18 credits (except by special permission)".

Among other things, the ER diagrams we draw must represent such business rules.

EER Depiction of Business Rules Classification



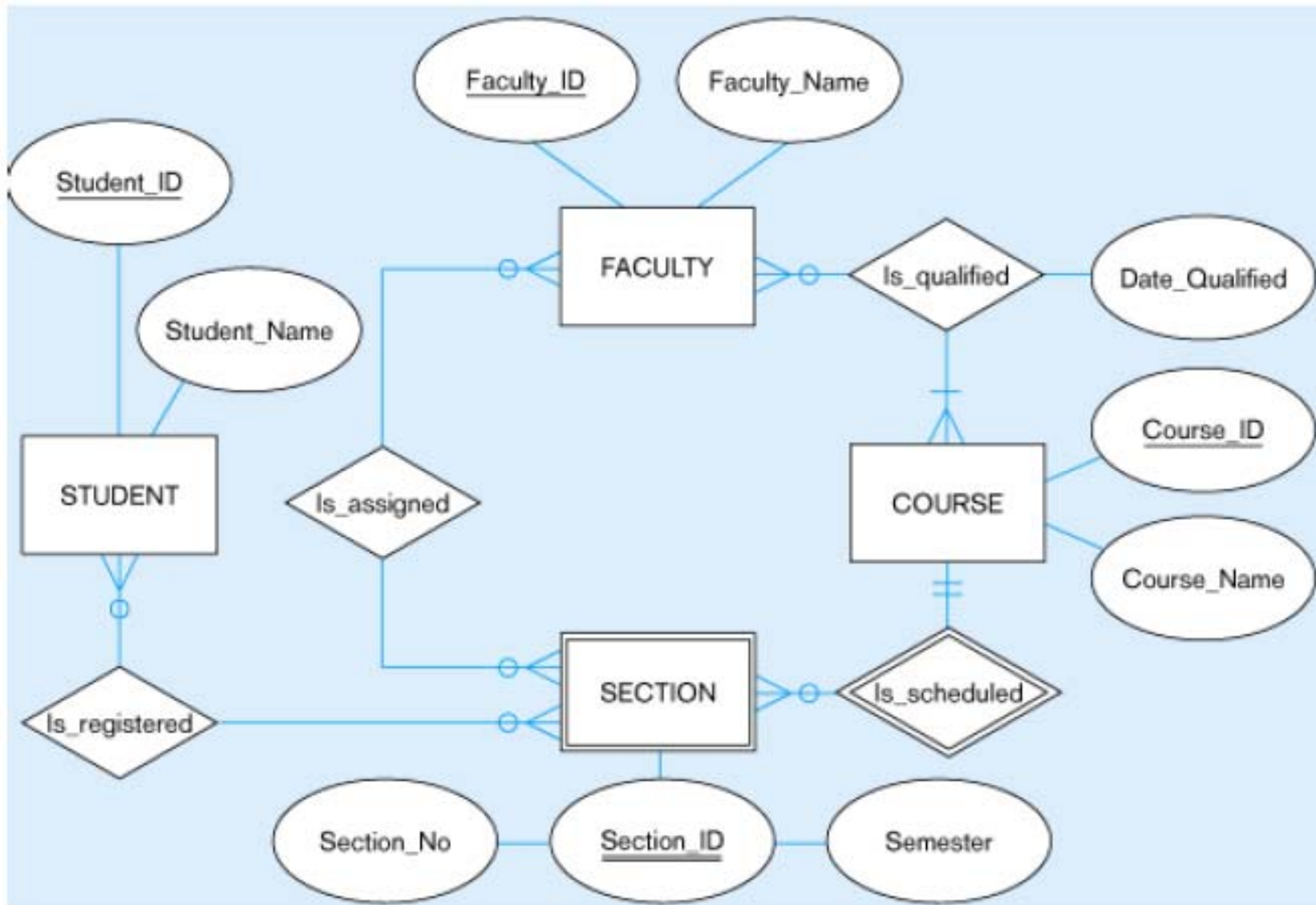
How Action Assertions are Stated?

- **Anchor Object** – and object on which actions are limited
- **Corresponding Objects** – an object influencing the ability to perform an action on another business rule
- **Action** – creation, deletion, update, or read
- Example:

A student must have a GPA of 2.0 or greater for Student GPA to graduate.

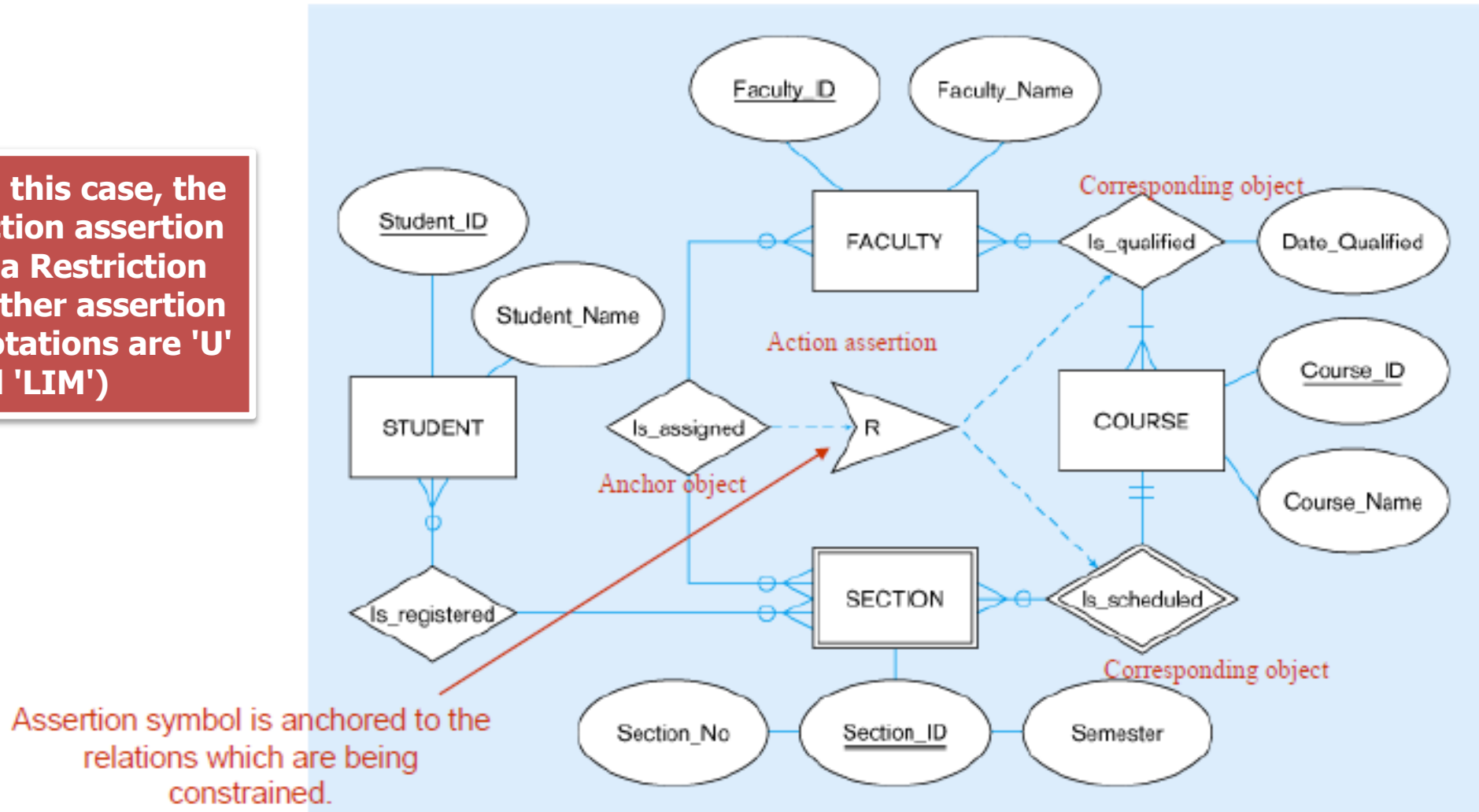
So action assertion will identify corresponding objects that constraint the ability to perform actions on anchor objects

Data Model Segment for Class Scheduling



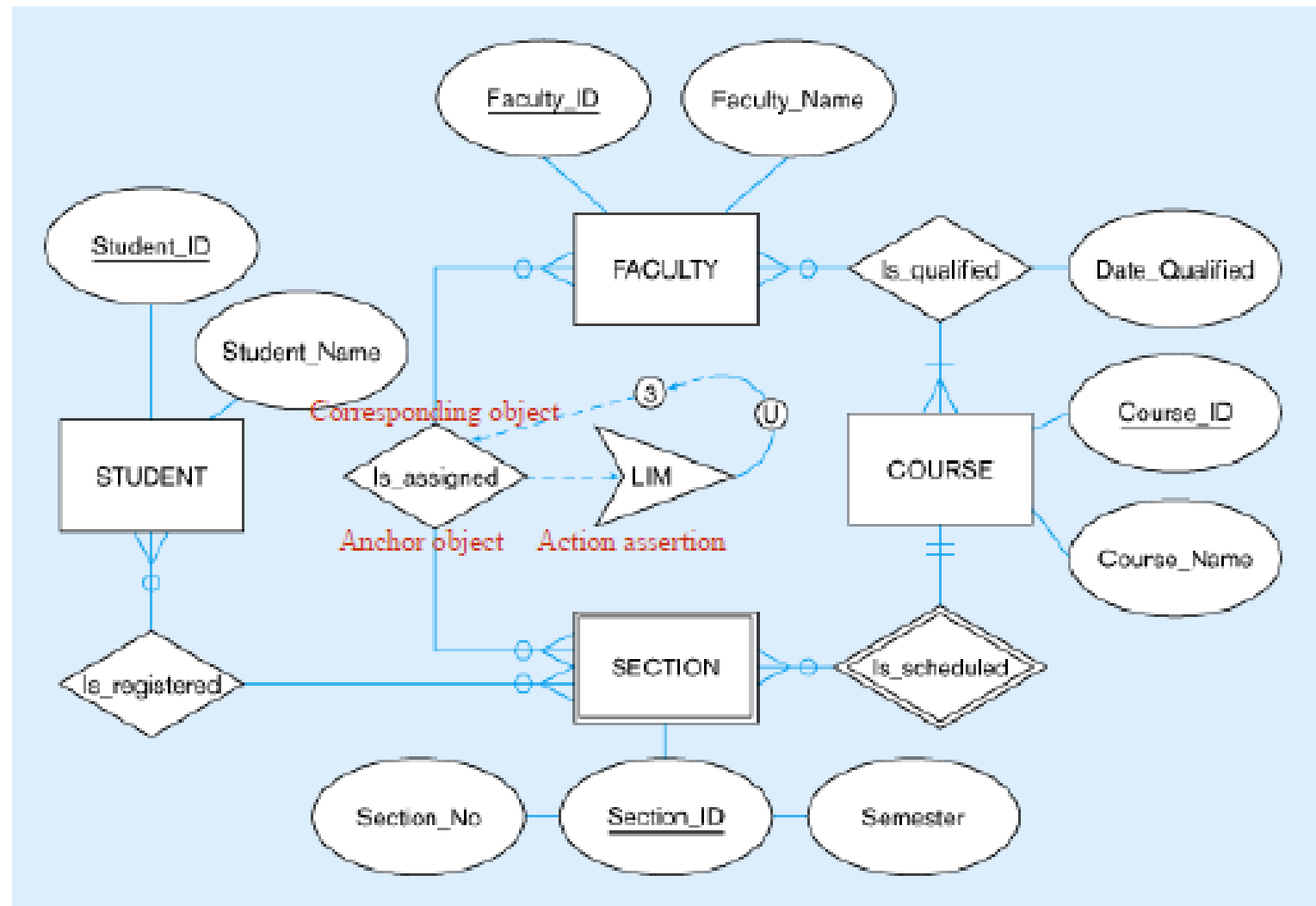
Business Rule 1: For a faculty member to be assigned to teach a section of a course, the faculty member must be qualified to teach the course for which that section is scheduled.

In this case, the action assertion is a Restriction (other assertion notations are 'U' and 'LIM')

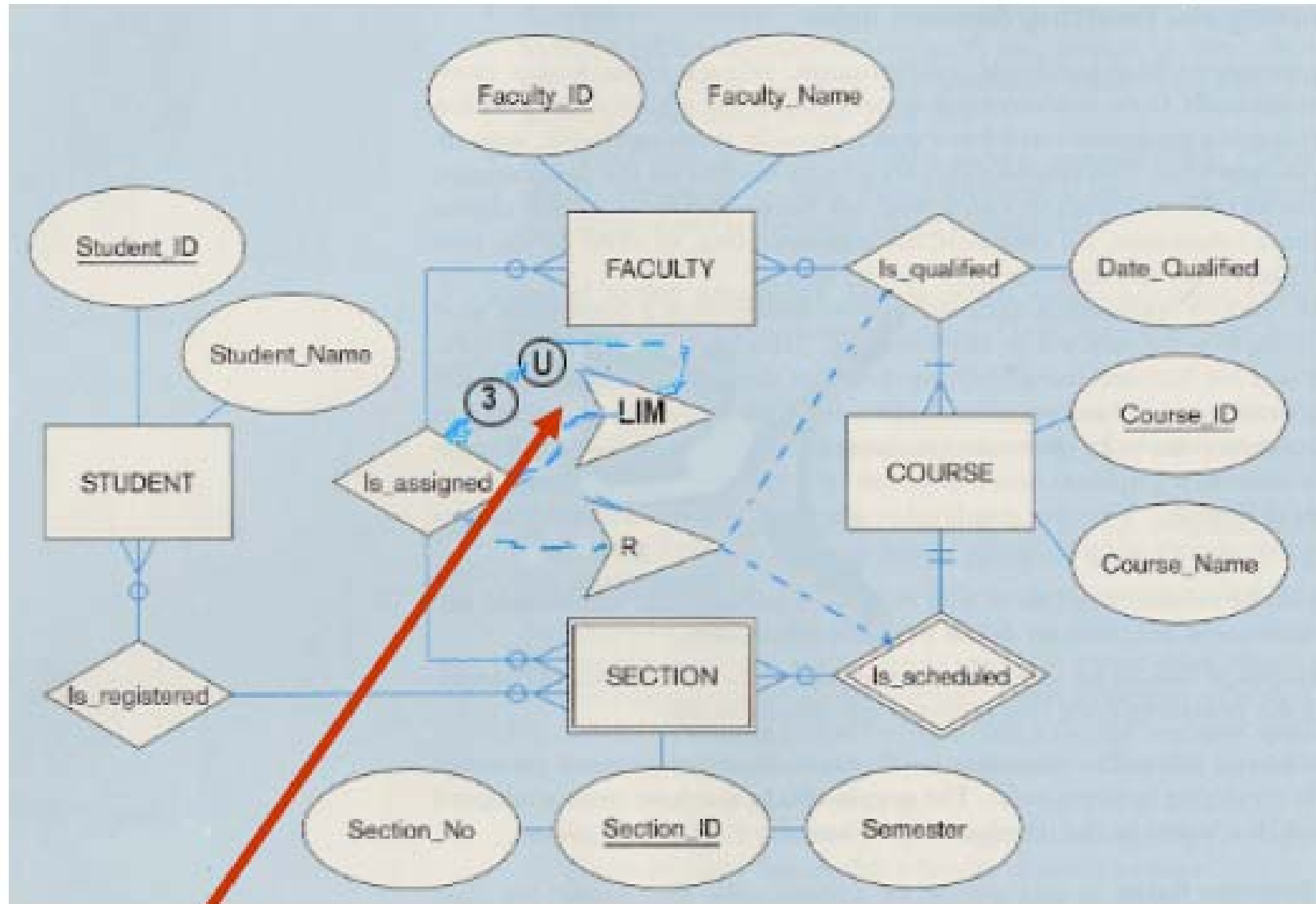


Business Rule 2: For a faculty member to be assigned to teach a section of a course, the faculty member must not be assigned to teach a total of more than three course sections.

In this case, the action assertion is an *Upper LIM*t



Final EER Diagram – Both Business Rules Applied



The anchor object is the relationship 'is-assigned'. It is constraining the assignment of the faculty member to the section they are qualified to teach and the faculty is constrained to teach a maximum of three sections.

References

- [1] "Modeling Business Rules: What Data Models Do ", by David C. Hay

Summary

- Learn how to model enhanced E-R diagram, supertype, subtype, discriminators, constraints etc.
- Discussed entity clusters, EER depiction of business rules, and action assertion.