Chapter 3
The Enhanced E-R Model

Objectives

- Define terms
- Understand use of supertype/subtype relationships
- Understand use of specialization and generalization techniques
- Specify completeness and disjointness constraints
- Develop supertype/subtype hierarchies for realistic business situations

What is the EE-R Model?

- The Enhanced E-R model (EE-R) is an extended E-R model with new modeling constructs.
- Why the EE-R model?
  - The business environment has changed dramatically.
 - Business relationships and data are more complex.

Supertypes and Subtypes

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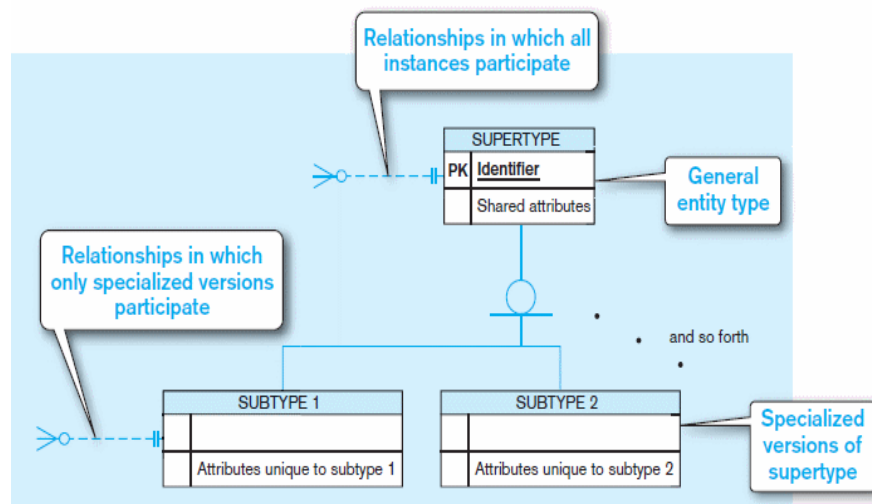 - An instance of a subtype is also an instance of the supertype

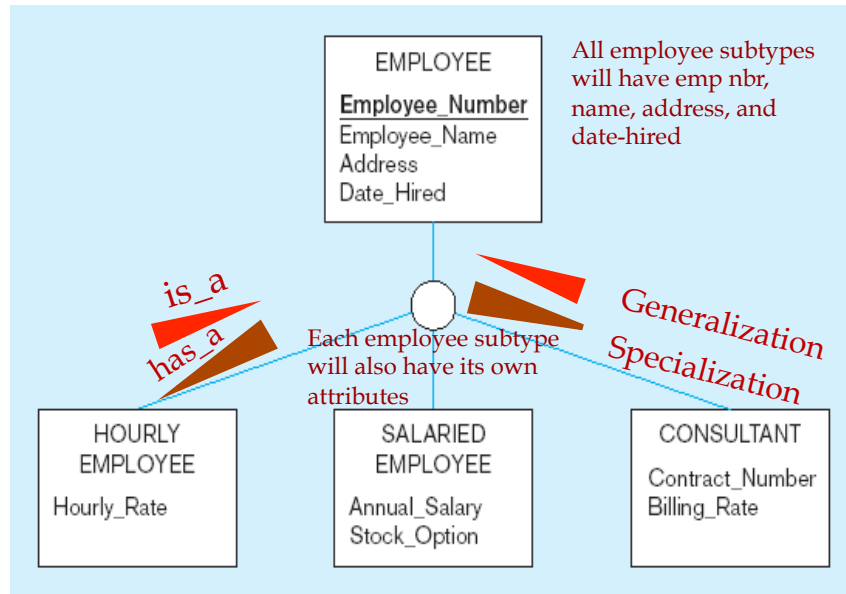Figure 3-1 Basic notation for supertype/subtype notation
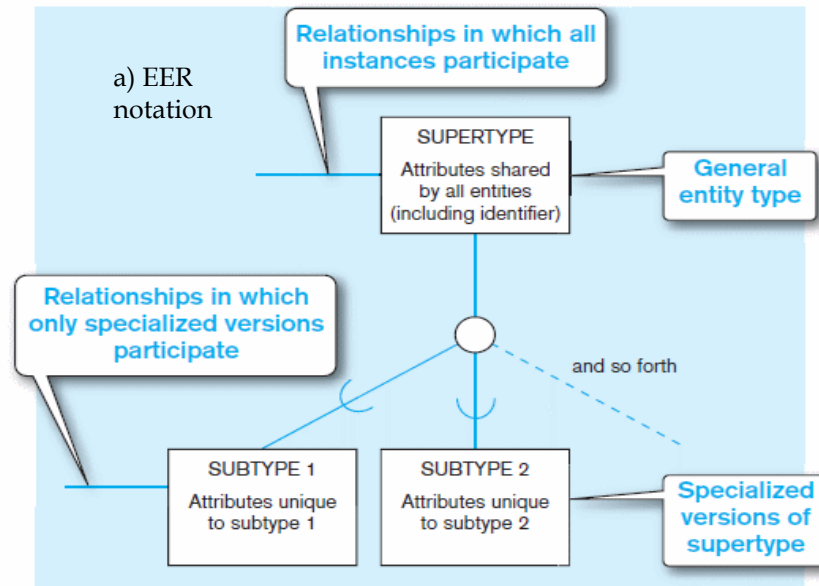
Figure 3-1 Basic notation for supertype/subtype notation (cont.)

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

Fig. 3-2: Employee supertype with three subtypes

EMPLOYEE

Employee_Number
Employee_Name
Address
Date_Hired

All employee subtypes will have emp nbr, name, address, and date-hired

is_a

has_a

Each employee subtype will also have its own attributes

Generalization
Specialization

HOURLY EMPLOYEE

Hourly_Rate

SALARIED EMPLOYEE

Annual_Salary
Stock_Option

CONSULTANT

Contract_Number
Billing_Rate

7

Supertypes and Subtypes

- Give another supertype / subtype example.

8

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

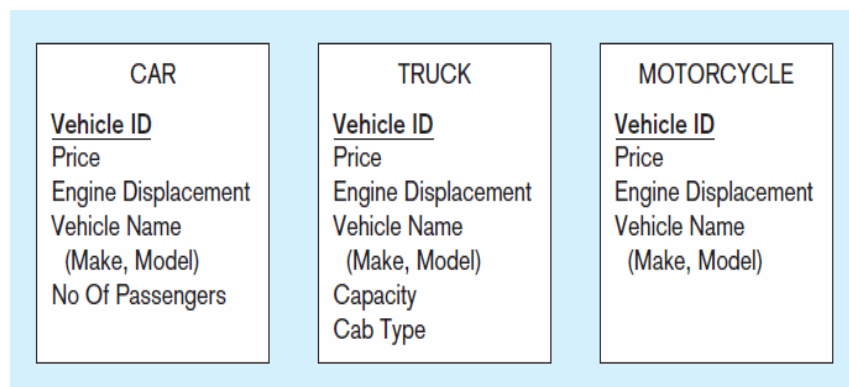Figure 3-3 -- Supertype/subtype relationships in a hospital
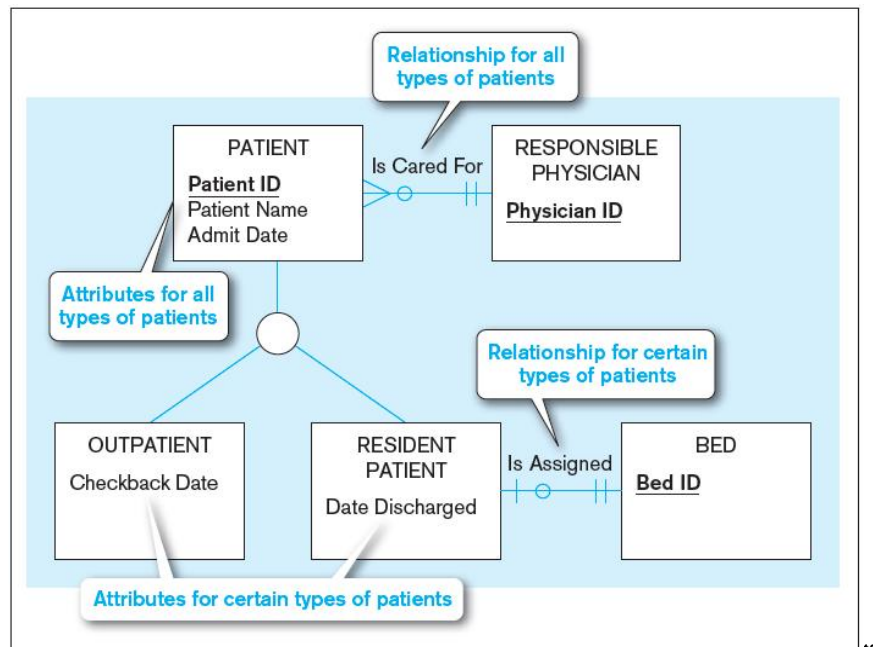
Generalization and Specialization

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

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

Figure 3-4 Example of Generalization

a) Three entity types: CAR, TRUCK, and MOTORCYCLE

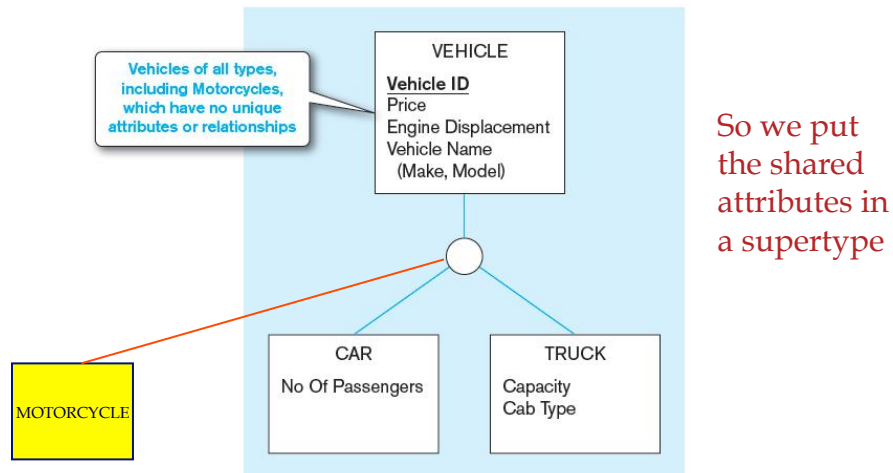| CAR	TRUCK	MOTORCYCLE
Vehicle ID	Vehicle ID	Vehicle ID
Price	Price	Price
Engine Displacement	Engine Displacement	Engine Displacement
Vehicle Name	Vehicle Name	Vehicle Name
(Make, Model)	(Make, Model)	(Make, Model)
No Of Passengers	Capacity	
	Cab Type	

All these types of vehicles have common attributes

Figure 3-4 Example of Generalization (cont.)
b) Generalization to VEHICLE supertype

Vehicles of all types, including Motorcycles, which have no unique attributes or relationships

VEHICLE
Vehicle ID
Price
Engine Displacement
Vehicle Name
(Make, Model)

So we put the shared attributes in a supertype
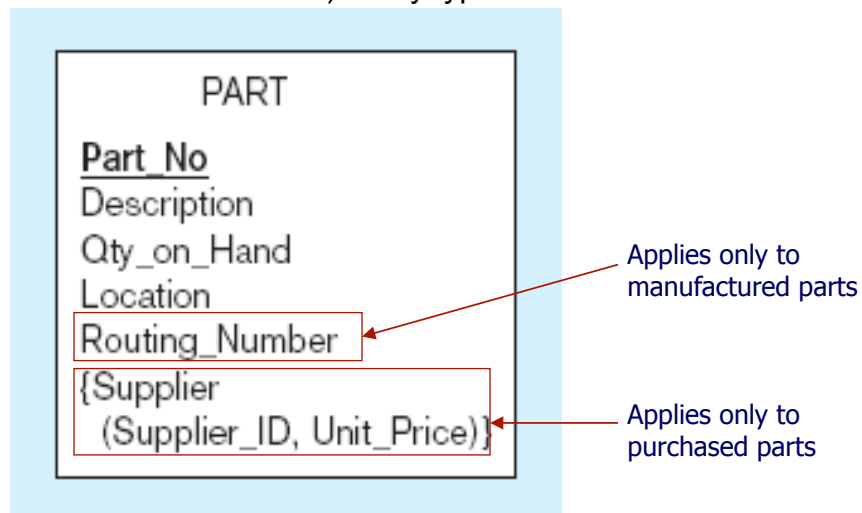
MOTORCYCLE

CAR
No Of Passengers

TRUCK
Capacity
Cab Type

Note: no subtype for motorcycle, since it has no unique attributes, and it has no unique relationships.
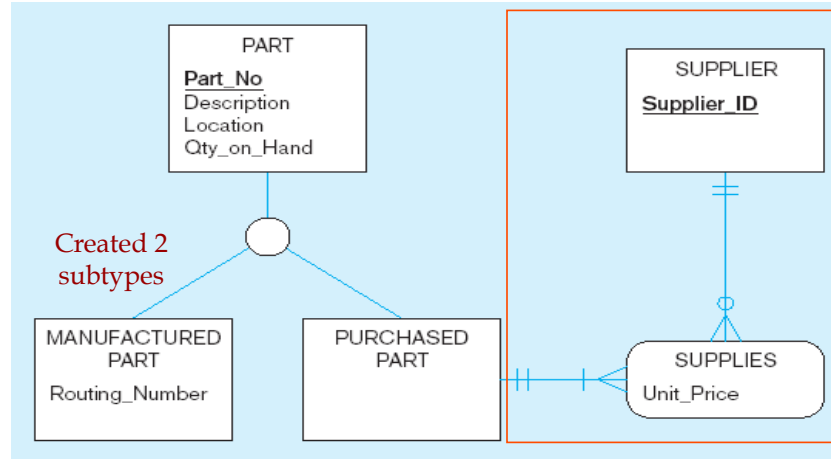
Figure 3-5 Example of Specialization
a) Entity type PART

PART

Part_No
Description
Qty_on_Hand
Location
Routing_Number
{Supplier
   (Supplier_ID, Unit_Price)}

Applies only to manufactured parts

Applies only to purchased parts

Figure 3-5 Example of Specialization (cont.)

b) Specialization to MANUFACTURED PART and PURCHASED PART

Created 2 subtypes

Note: multivalued attribute was replaced by an associative entity relationship to another entity
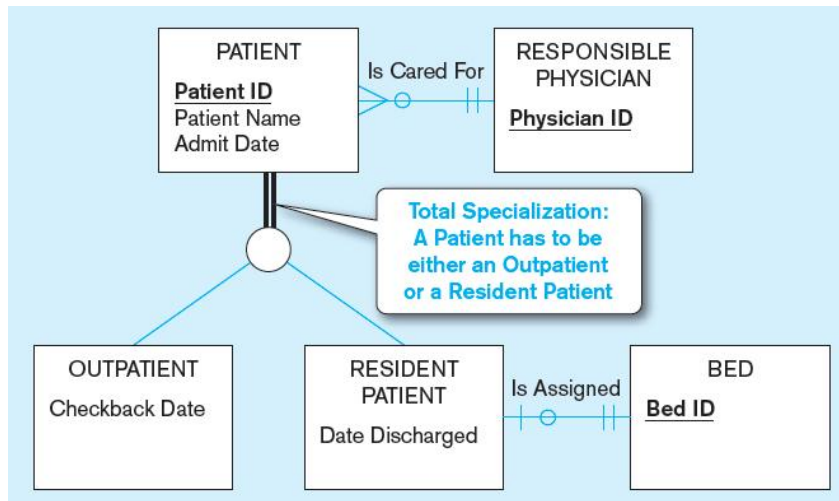
15

Constraints in Supertype/ Subtype Relationships

- **Completeness Constraints**: Whether an instance of a supertype must also be a member of at least one subtype.
  - Total Specialization Rule: Yes (double line)
  - Partial Specialization Rule: No (single line)
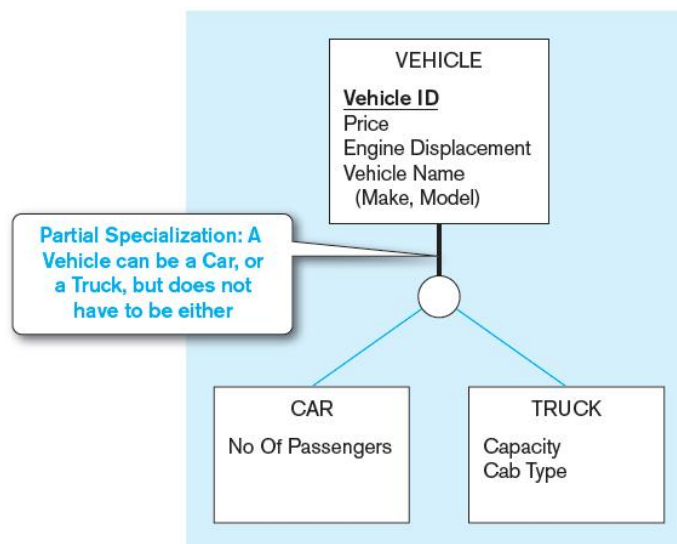
16

Figure 3-6 Examples of Completeness constraints
a) Total Specialization rule

PATIENT
Patient ID
Patient Name
Admit Date

Is Cared For

RESPONSIBLE PHYSICIAN
Physician ID

Total Specialization: A Patient has to be either an Outpatient or a Resident Patient

OUTPATIENT
Checkback Date

RESIDENT PATIENT
Date Discharged

Is Assigned

BED
Bed ID

Figure 3-6 Examples of completeness constraints (cont.)
b) Partial Specialization rule

VEHICLE
Vehicle ID
Price
Engine Displacement
Vehicle Name
  (Make, Model)

Partial Specialization: A Vehicle can be a Car, or a Truck, but does not have to be either

CAR
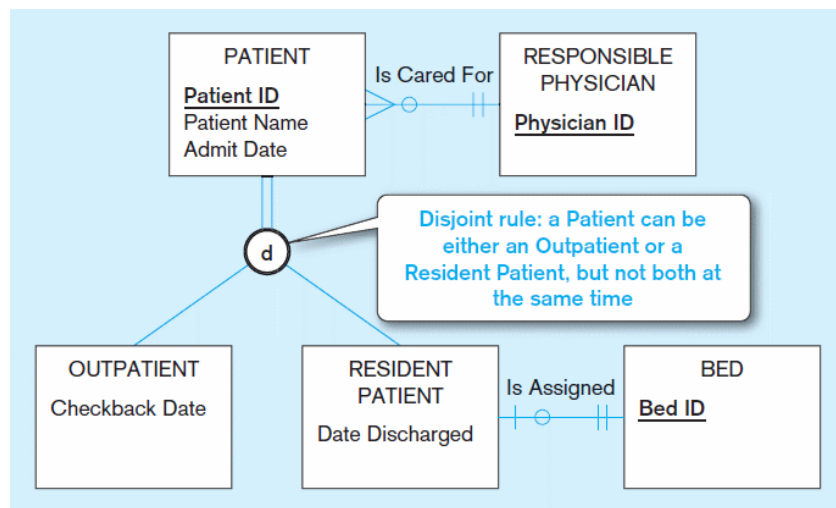No Of Passengers

TRUCK
Capacity
Cab Type

Constraints in Supertype/ Subtype Relationships

- ***Disjointness Constraints***: Whether an instance of a 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
  - Overlap Rule: An instance of the supertype could be more than one of the subtypes

Figure 3-7 Examples of Disjointness constraints

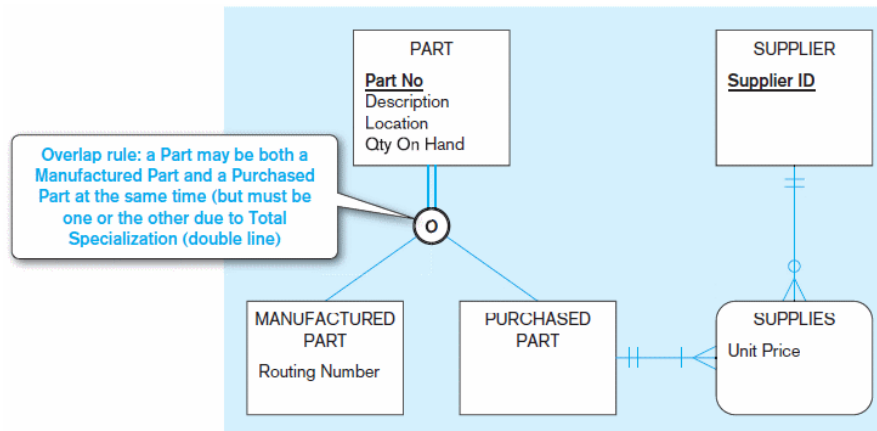a) Disjoint rule

Figure 3-7 Examples of Disjointness constraints (cont.)

b) Overlap rule

Overlap rule: a Part may be both a Manufactured Part and a Purchased Part at the same time (but must be one or the other due to Total Specialization (double line)

Constraints in Supertype/ Subtype Relationships

- ***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
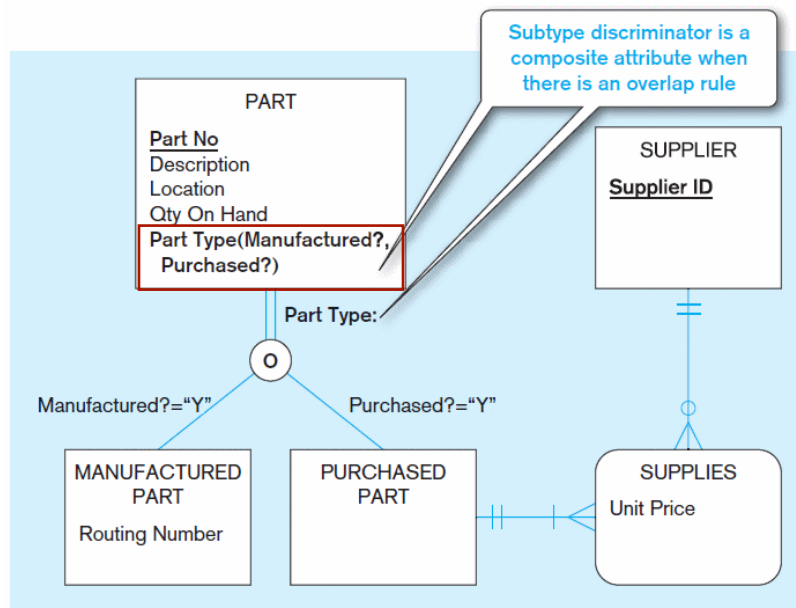
Figure 3-8 Introducing a subtype discriminator (*disjoint* rule)

Implementation:
C++:
 switch(Employee_Type)
 {
 case 'C':
 ..
 }

SQL:
IF/THEN/ELSE

EMPLOYEE
Employee Number
Employee Name
Address
Date Hired
Employee Type

Subtype discriminator with values of H, S, or C for disjoint subtypes

Employee Type=

d

"H"   "S"   "C"

HOURLY EMPLOYEE
Hourly Rate

SALARIED EMPLOYEE
Annual Salary
Stock Option

CONSULTANT
Contract Number
Billing Rate
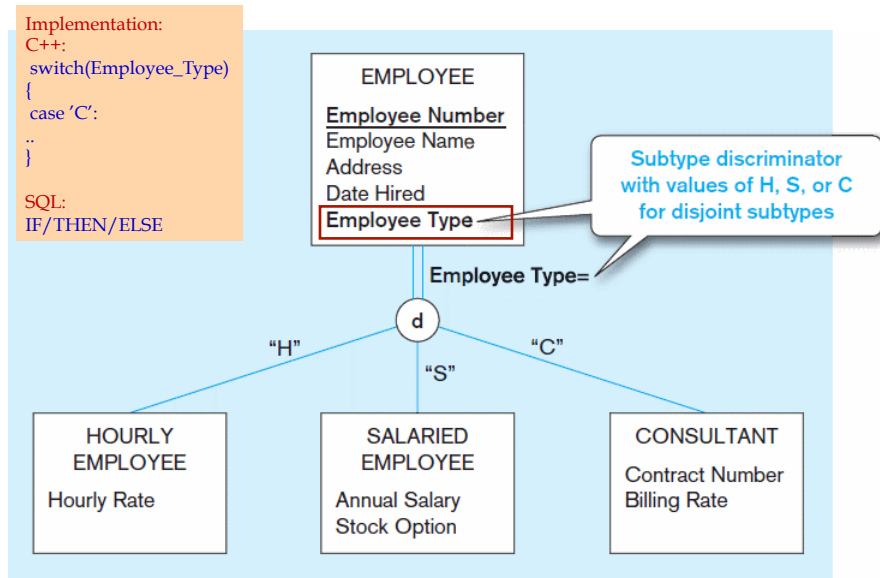
23

Figure 3-9 Subtype discriminator (*overlap* rule)

Subtype discriminator is a composite attribute when there is an overlap rule

PART
Part No
Description
Location
Qty On Hand
Part Type(Manufactured?, Purchased?)

SUPPLIER
Supplier ID

Part Type:

O

Manufactured?="Y"   Purchased?="Y"

MANUFACTURED PART
Routing Number

PURCHASED PART

SUPPLIES
Unit Price

24

Figure 3-10 Example of supertype/subtype hierarchy

Common attributes for all levels

PERSON
SSN
Name
Address
Gender
Date_of_Birth

EMPLOYEE
Salary
Date_Hired

ALUMNUS
{Degree(Year, Designation, Date)}

STUDENT
Major_Dept

Inherit all attributes from all supertypes

FACULTY
Rank

STAFF
Position

GRADUATE STUDENT
Test_Score

UNDERGRAD STUDENT
Class_Standing
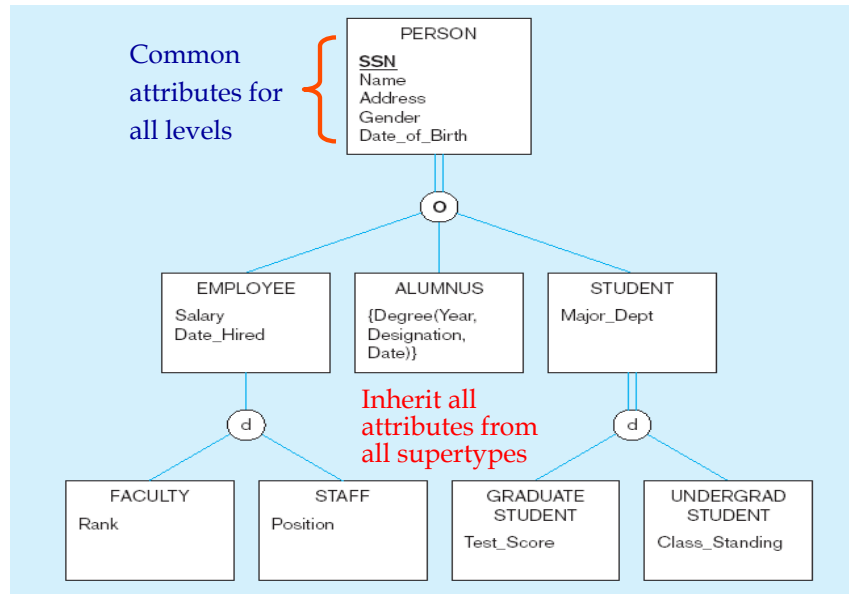
25

Add a subtype discriminator for each supertype:

PERSON
SSN
Name
Address
Gender
Date_of_Birth

EMPLOYEE
Salary
Date_Hired

ALUMNUS
{Degree(Year, Designation, Date)}

STUDENT
Major_Dept

FACULTY
Rank

STAFF
Position

GRADUATE STUDENT
Test_Score

UNDERGRAD STUDENT
Class_Standing
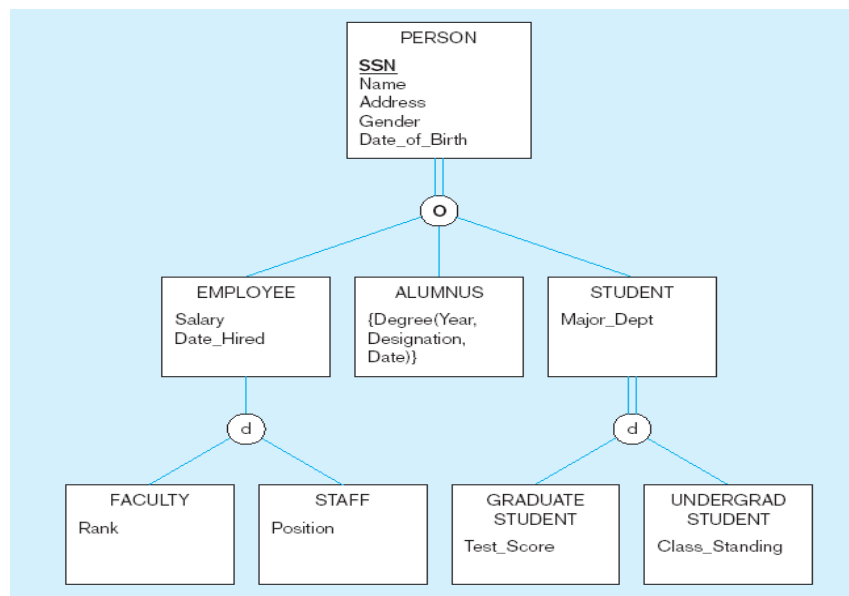
26

Practice Exercise #8, page #144

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.

28

29

Practice Exercise #9, page #144

A bank has three types of accounts: checking, savings, and loan.

Following are the attributes for each type of account:
• CHECKING: Acct No, Date Opened, Balance, Service Charge
• SAVINGS: Acct No, Date Opened, Balance, Interest Rate
• LOAN: Acct No, Date Opened, Balance, Interest Rate, Payment

Assume that each bank account must be a member of exactly one of these subtypes. Using generalization, develop an EER model segment to represent this situation using the traditional EER notation.