

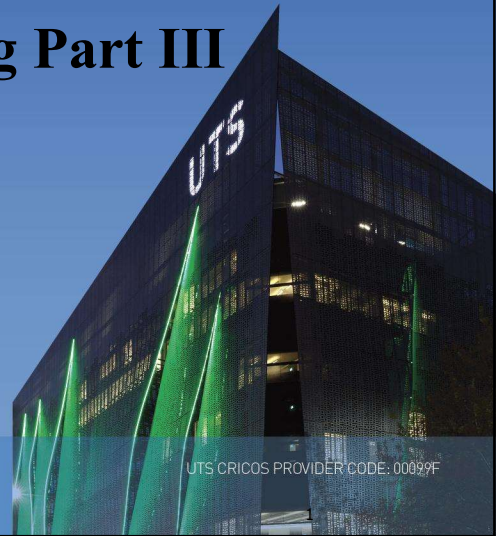
## lecture 3: Data Modeling Part III

Modern Database Management  
11<sup>th</sup> Edition, International Edition

Chapter 3: The Enhanced E-R Model

Jeffrey A. Hoffer, V. Ramesh, Heikki Topi

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### Participations and Discussions

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If you have any question and you don't want to share it now,  
send it to us via **UTSOnline/Discussion Board**.

**However, it is better to speak out 😊**

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## Email structure to the subject coordinator:

The subject coordinator is more than happy to answer the emails from students that have the following requirements:

- The email is related to a **personal** issue, OR
- The information is not provided in the **subject outline** or the **assignment specification**, or is not posted in the **announcements**, OR
- There is no related forum on **discussion board**.

Your email needs to have the following information in its **title**:

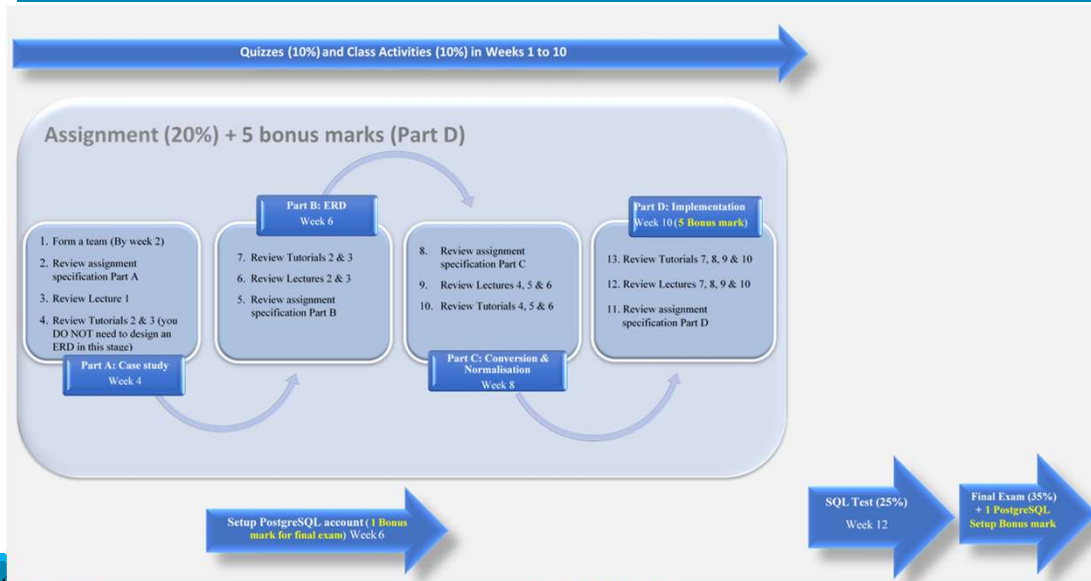
- **Subject Number (31271)**
- **Subject of the email (e.g. Request for Extension)**
- **First Name & Last Name**
- **Student ID**
- **Your tutorial name (e.g. Tut1-05)**

Considering the number of students in this subject (400), I need to say that we may not be able to answer emails that do not meet these requirements.

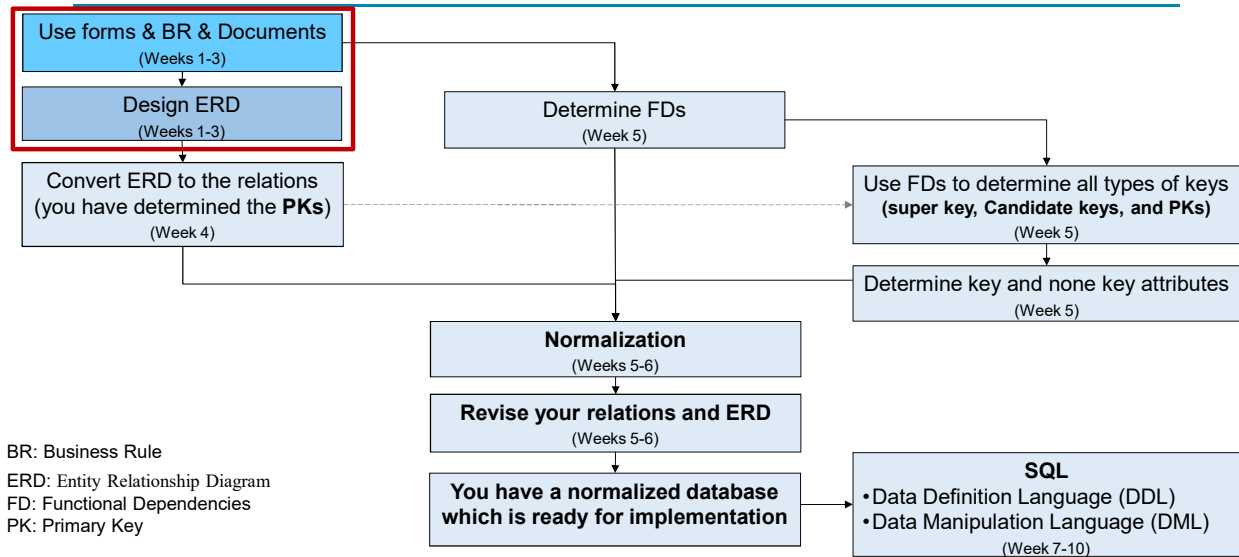
The response to the emails that do not meet the aforementioned requirements will be “see the email structure in Page 9 of Lecture 1 and Page 3 of Lecture 3”.

Many thanks and kind regards,  
Fahimeh

## Assessment Chart and Knowledge Guideline



## Subject Flowchart



## DF Learning Plan

**Description:** we will have collaborative lecture at the beginning of the class. You need to do some tasks during the lecture as part of your class activities. Then you will do a quiz of what you have learned, then the tutorial will start. you will work in groups during the class.

Please be aware that the lecture slides with Blue title are designed for your self study.

### Workshop Timetable:

Activity	Duration	Comments
Lecture	1 hour and 30 minutes	You will have 3 tasks to complete that need to take 21 minutes in total
Rest	10 minutes	Have fun and start to form your group if you wish to do group assignment (We will provide you a <b>Google Form</b> to register your team and team names soon)
Review		Please review the review questions at home and ask your questions if you have any vi discussion board
Tutorial	1 hour and 10 minutes	Have even more fun :D (Rea the case study in 10 minutes, then you have two tasks, and need to take be completed in 35 minutes plus 15 minutes for tutors to provide you the solution)
Quiz (Open Book)	5 minutes	On today's content. Will be run before or after the tutorial. Do your best ;)
Leave the class	5 minutes	Don't forget to review what you have learn in this class, and check the information that is provided on UTSONline/Learning Material/Week 3

**Note:** Week 2 has a longer lecture and a shorter tutorial, and Week 3 has a shorter lecture and a longer tutorial

## Subject Overview

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### ➤ Design Entity Relationship Diagram (ERD)

- Week 1: Data Modelling I (Conceptual Level)
- Week 2: Data Modelling II (Conceptual Level)
- **Week 3: Data Modelling III (Conceptual Level)**
- Week 4: Convert ERD to Relations (Logical Level)
- Week 5: Functional Dependencies
- Week 5: Normalization I
- Week 6: Normalization II

### ➤ Data manipulation

- Week 7: Simple Query
- Week 8: Multiple Table Queries
- Week 9: Subquery
- Week 10: Correlated Subquery

## Objectives

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### 1. Supertype/Subtype Relationships

### 2. Relationships and Subtypes

### 3. Generalization and Specialization

### 4. Constraints in Supertype/Subtype Relationships

4.1. Completeness Constraints (Total or Partial Specialization)

4.2. Disjointness Constraints (Disjoint or Overlapping sub-types)

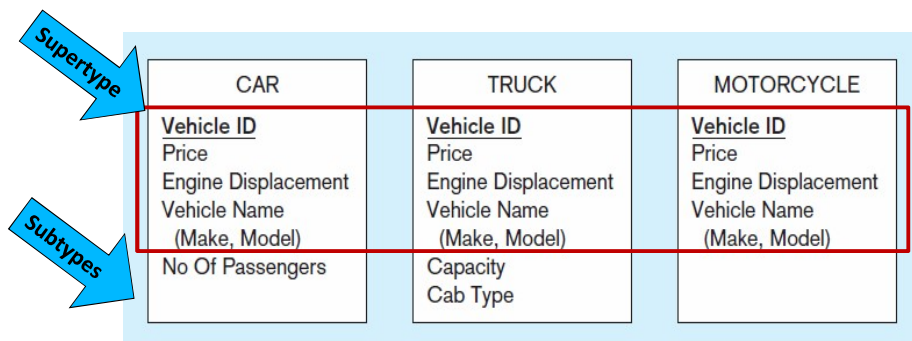
4.3. Subtype Discriminator

# 1. Supertypes and Subtypes

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## 1. Supertypes and Subtypes

Three **entity types**: CAR, TRUCK, and MOTORCYCLE



All these types of vehicles have the **same entity type**. They have **common** attributes ... they need to have specific attribute(s) to be a subtype

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# 1. Supertypes and Subtypes

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	

Enhanced ER model by extending the original ER model with new modeling constructs using:

➤ **Subtype:** A **subgrouping** of the **entities** in an entity type that has attributes **distinct** from those in other subgroupings

➤ **Supertype:** A generic entity type that has a relationship with one or more subtypes ... has the **common** attributes between the subtypes

## ➤ Attribute Inheritance:

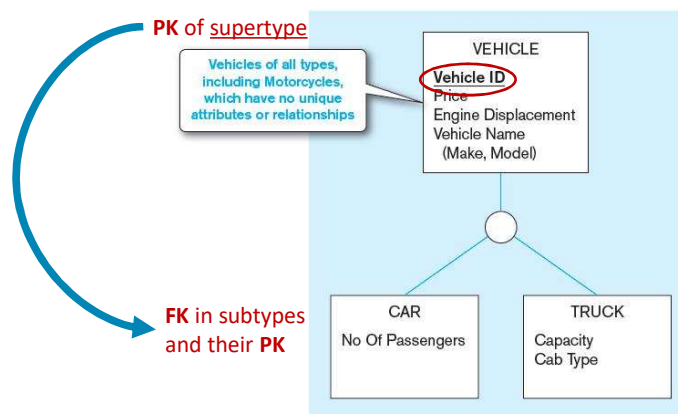
- Subtype entities **inherit** values of all attributes of the supertype
- An **instance** of a subtype **is also an instance** of the supertype

• **Note:** **Supertype** and its **Subtypes** have the **same Entity Type**.

## PK and FK of Supertype and its Subtypes

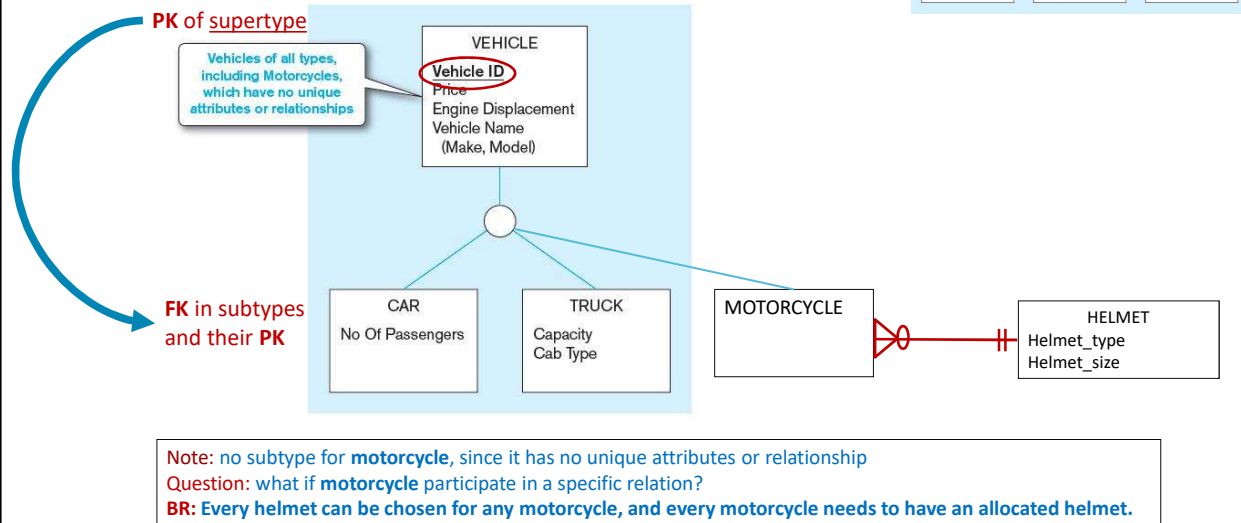
CAR	TRUCK	MOTORCYCLE
Vehicle ID	Vehicle ID	Vehicle ID
Price	Price	Price
Engine Displacement	Engine Displacement	Engine Displacement
Vehicle Name	Vehicle Name	Vehicle Name
(Make, Model)	(Make, Model)	(Make, Model)
No Of Passengers	Capacity	
	Cab Type	

- **PK of supertype** is **FK** in each **subtype**
- This **FK** is **PK** of the subtypes



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

## Discussion: Supertype and its Subtypes



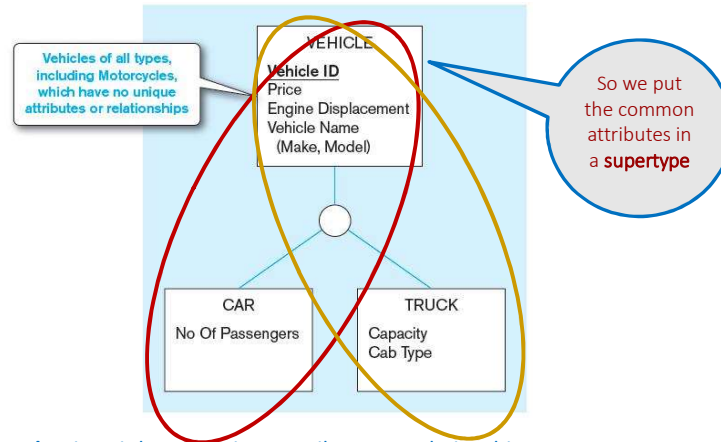
## Discussion (10 Minutes)

- Introduce another example for Supertypes and Subtypes.
- What the following definitions mean:
  - Subtype entities **inherit** values of all attributes of the supertype
  - An **instance** of a subtype **is also an instance** of the supertype
  - **Supertype** and its **Subtypes** have the **same Entity Type**.

## Attribute Inheritance (Figure 3-4)

- Subtype entities **inherit** values of all attributes of the supertype
- An **instance** of a subtype is also an **instance** of the supertype

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	

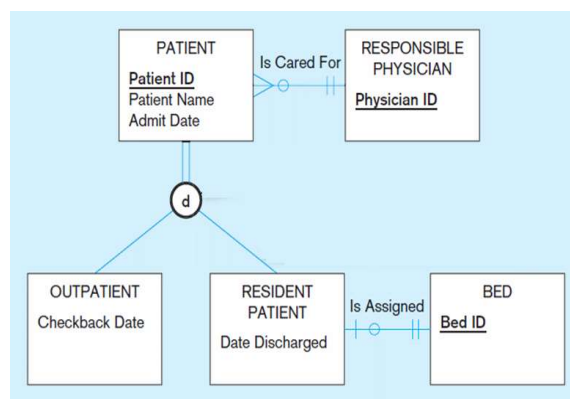


Note: no subtype for **motorcycle**, since it has no unique attributes or relationship

## Class Activity 3.1 (2 Minutes)

- In the figure below, which of the following apply to both OUTPATIENTs and RESIDENT\_PATIENTs?

- Checkback\_D
- Date\_Discharged
- Bed\_ID
- Patient\_ID

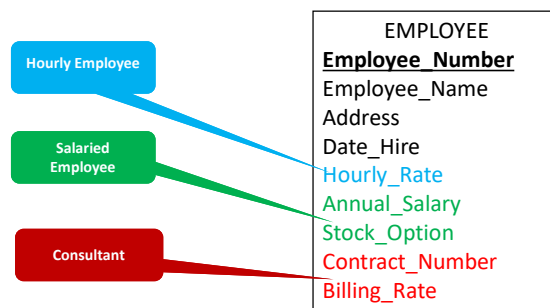




## Why we need to construct supertype and subtypes?



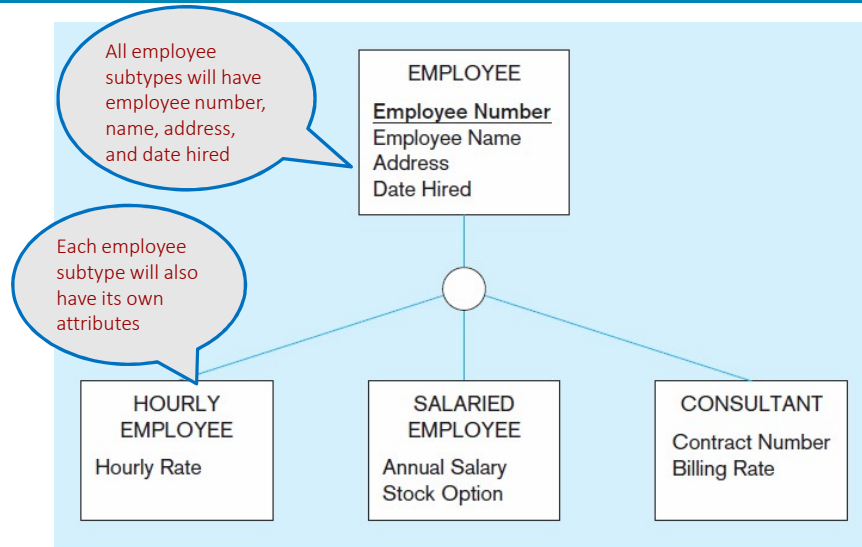
## Why we need to construct supertype and subtypes?



What is the main issue of this design (i.e. store all data in one general entity)?

Employee_Number	Employee_Name	Address	Date_Hire	Hourly_Rate	Annual_Salary	Stock_Option	Contract_Number	Billing_Rate
1123	Sara	UTS	1/1/2014	80	null	null	null	null
1456	Jake	32/50 ...	5/8/2013	null	70000	0.2	null	null
7892	Fahimeh	12/97 ...	2/3/2013	null	null	null	9856	50

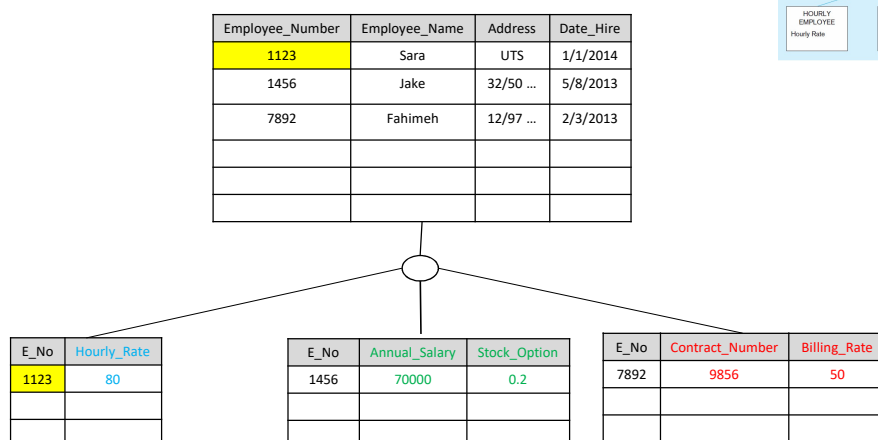
## Employee supertype with three subtypes (Figure 3-2)



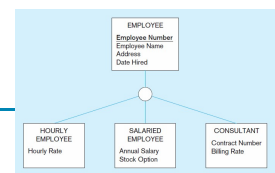
EMPLOYEE	
<u>Employee Number</u>	
Employee Name	
Address	
Date Hire	
Hourly Rate	
Annual Salary	
Stock Option	
Contract Number	
Billing Rate	

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## Why we need to construct supertype and subtypes? (cont.)



- PK of supertype is FK in each subtype
- This FK is PK of the subtypes

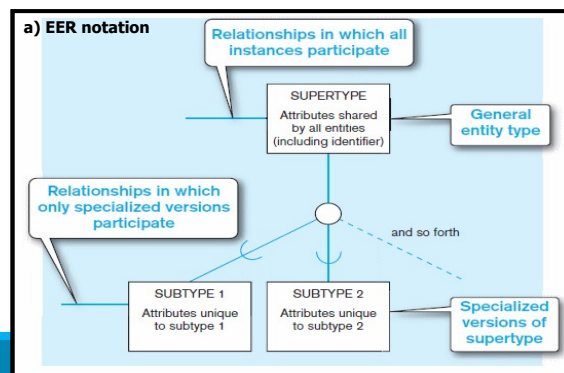


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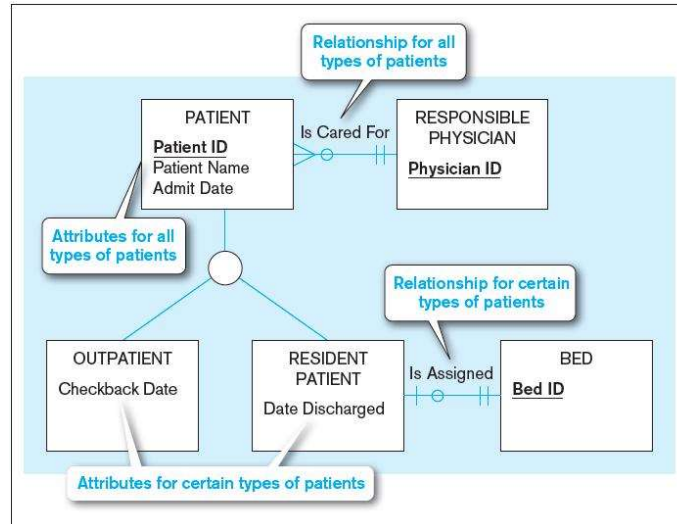
# 1. Relationships and Subtypes

## 2. 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**



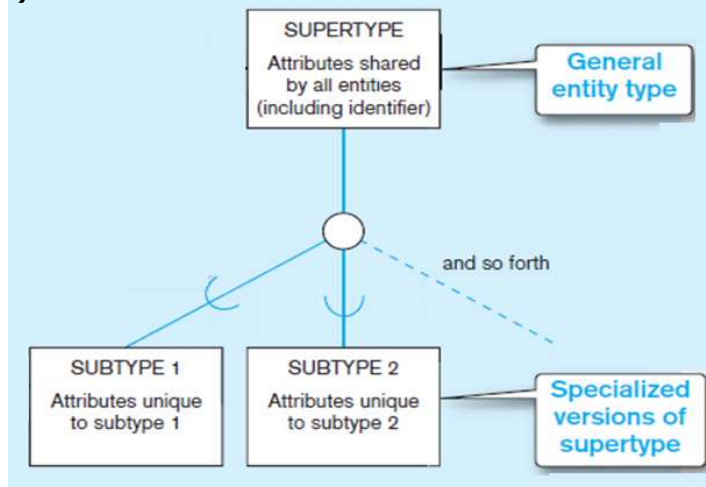
## Supertype/subtype relationships in a hospital (Figure 3-3 using Entity Relationship Notation)



## Notations

## Basic notation for supertype/subtype notation (Figure 3-1: EER notation)

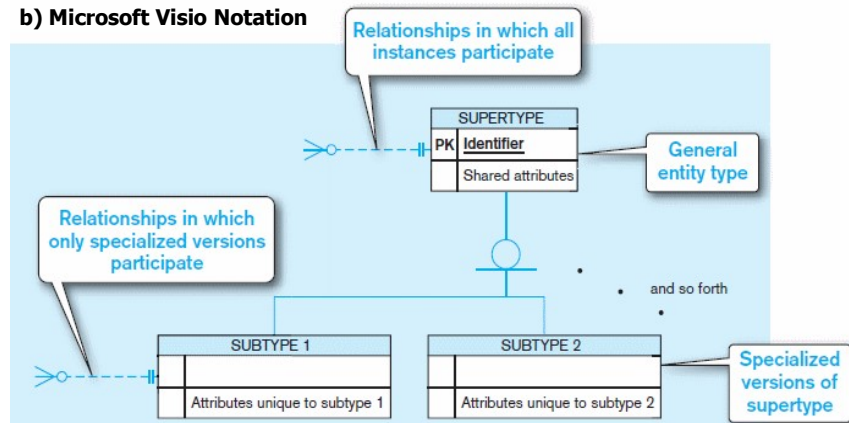
### a) EER notation



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## Supertype/subtype relationships in a hospital (Figure 3-1: Microsoft Visio Notation)

### b) Microsoft Visio Notation



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

**Note: Do not use the Visio notation in your assignments.**

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## 3. Generalization and Specialization

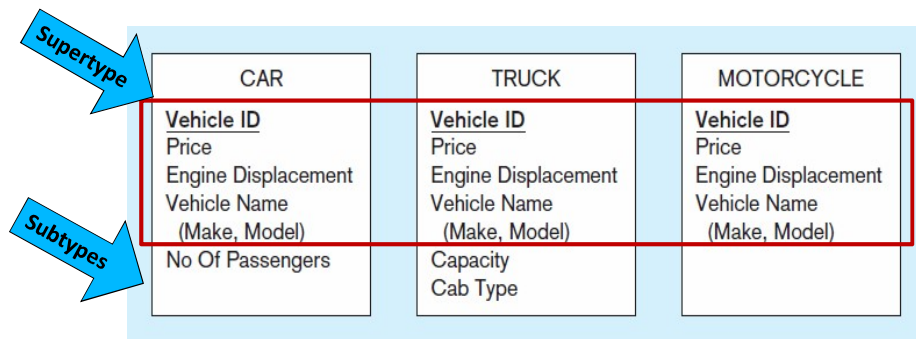
## 3. Generalization and Specialization

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- **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

### Example of generalization (Figure 3-4)

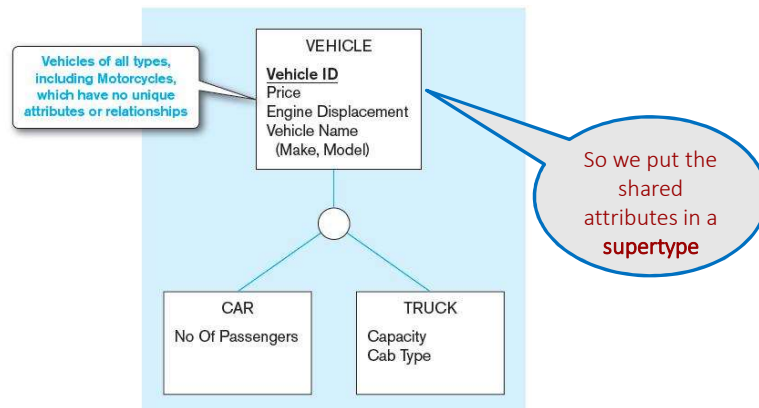
- **Generalization:** The process of defining a **more general entity type** from a set of more specialized entity types. **BOTTOM-UP**



Three **entity types**: **CAR**, **TRUCK**, and **MOTORCYCLE**. All these types of vehicles have the **same entity type**. They have **common attributes** ... they need to have specific attribute(s) to be a subtype

### Example of generalization (Figure 3-4) (cont.)

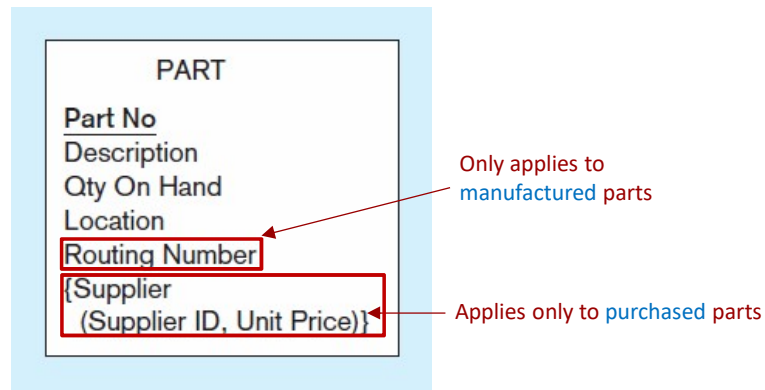
#### b) Generalization to VEHICLE supertype



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

### Example of specialization (Figure 3-5)

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



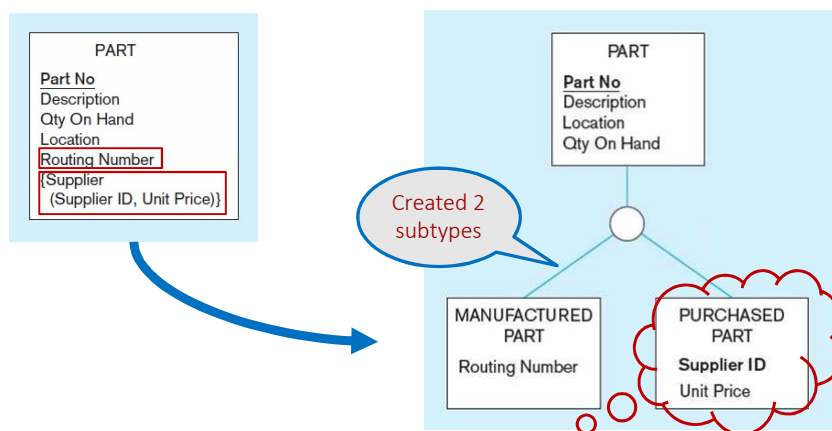
a) Entity type PART (BR: Each part can be supplied to many suppliers.)

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### Example of specialization (Figure 3-5) (cont.)

- b) Specialization to **MANUFACTURED PART** and **PURCHASED PART**

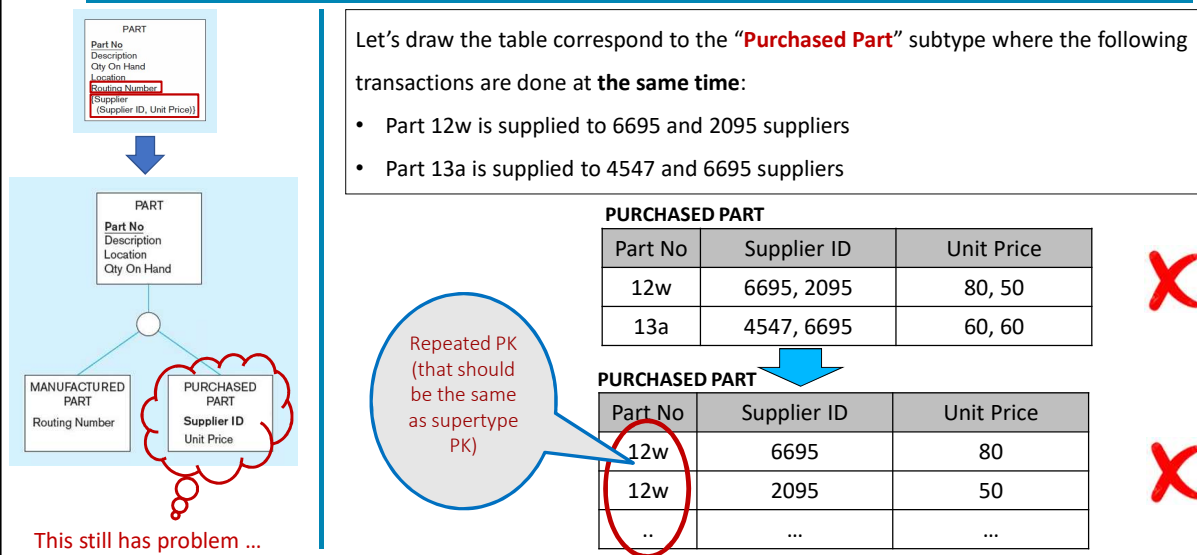


Note: based on the "BR: Each part can be supplied by many suppliers" there are multivalued composite attributes in this ERD ...

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Note: based on the “BR: Each part can be supplied by many suppliers” there are multivalued composite attributes in this ERD ...



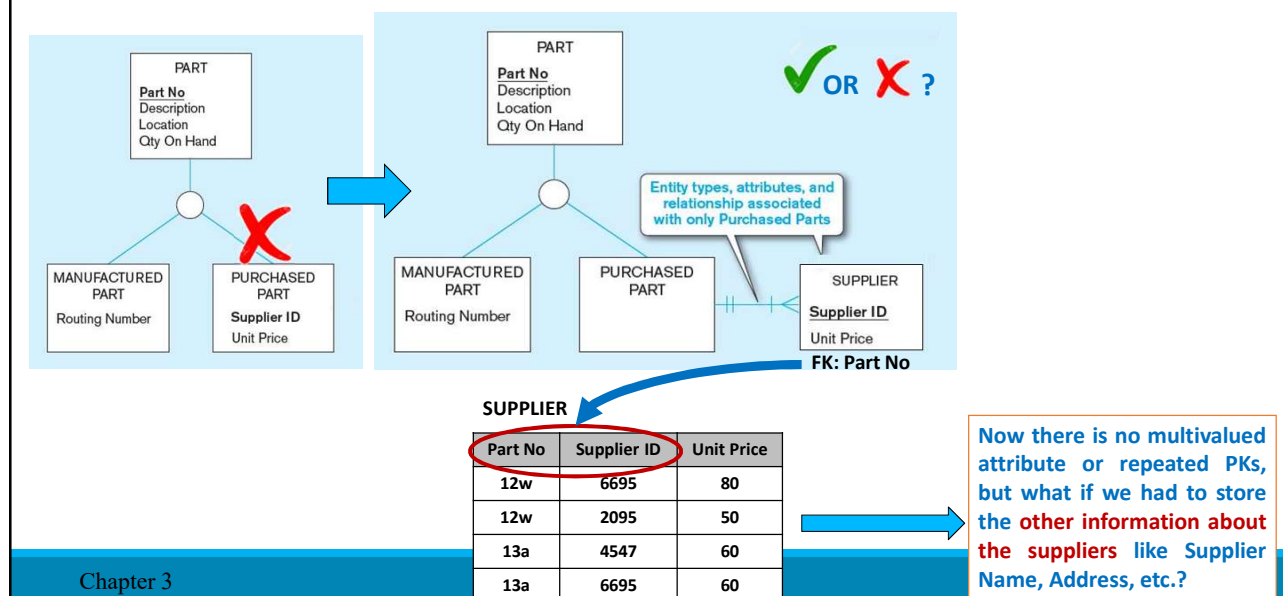
Chapter 3

Date 4/12/2019

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Note: based on the “BR: Each part can be supplied by many suppliers” there are multivalued composite attributes in this ERD ...

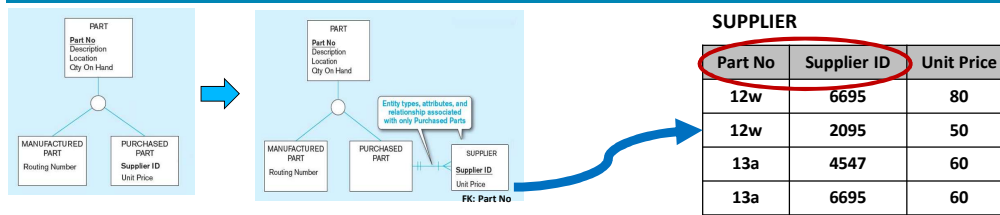


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In addition to the aforementioned issues related to **multivalued** attributes ... ..

The designed ERD will have some issues with storing **other information about the suppliers** like **Supplier Name, Address, etc.?**



Now there is no multivalued attribute or repeated PKs, but what if we had to store the **other information about the suppliers** like **Supplier Name, Address, etc.?**

**SUPPLIER**

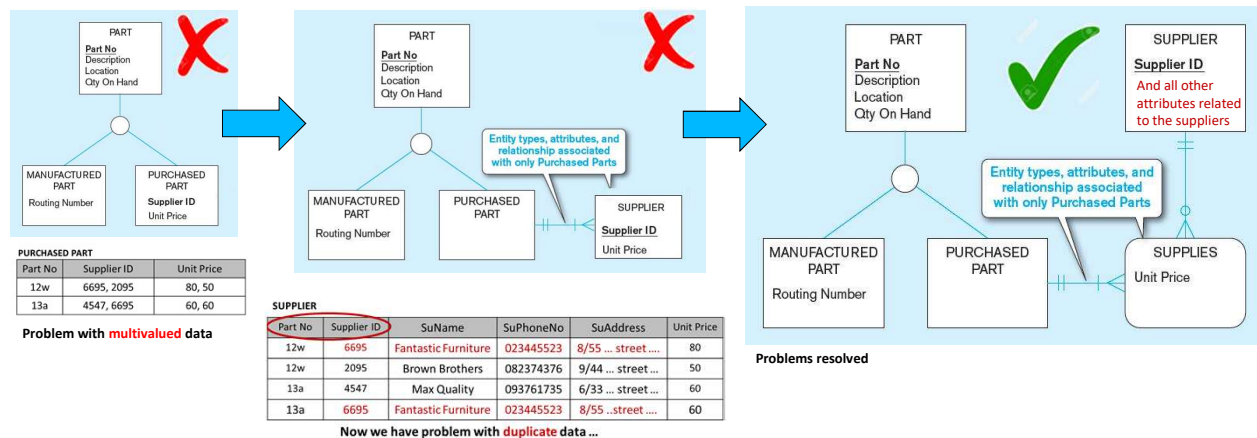
Part No	Supplier ID	SuName	SuPhoneNo	SuAddress	Unit Price
12w	6695	Fantastic Furniture	023445523	8/55 ... street ....	80
12w	2095	Brown Brothers	082374376	9/44 ... street ...	50
13a	4547	Max Quality	093761735	6/33 ... street ...	60
13a	6695	Fantastic Furniture	023445523	8/55 ..street ....	60

Now we have problem with **duplicate** data ...

In addition to the aforementioned issues related to **multivalued** attributes ...

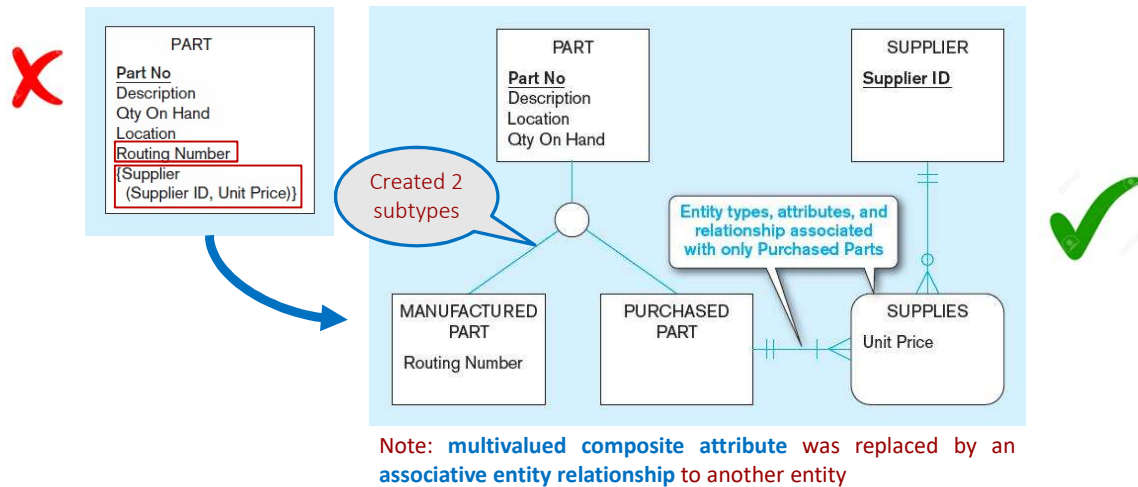
We had problem with **duplicate** data ...

The best solution is to have an **associative** entity between PURCHASED PART and SUPPLIER



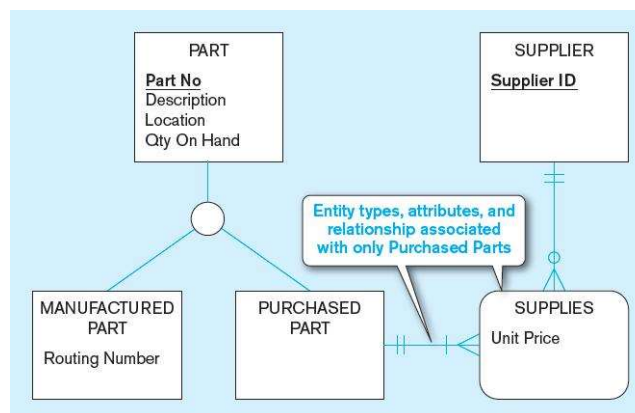
## Example of specialization (Figure 3-5) (cont.)

b) Specialization to **MANUFACTURED PART** and **PURCHASED PART**



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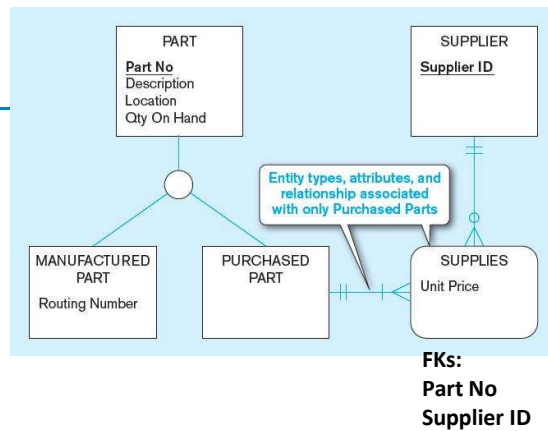
## Class Activity 3.2. Create the SUPPLIES table (6 Minutes)



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

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## Solution:



## Class Activity 3.3 (2 Minutes)

2. The property by which subtype entities possess the values of all attributes of a supertype is called
- A. hierarchy reception
  - B. class management
  - C. attribute inheritance
  - D. generalization

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## 4. Constraints in Supertype/Subtype Relationships

## 4. Constraints in Supertype/Subtype Relationships

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Constraints in Supertype/Subtype Relationships including:

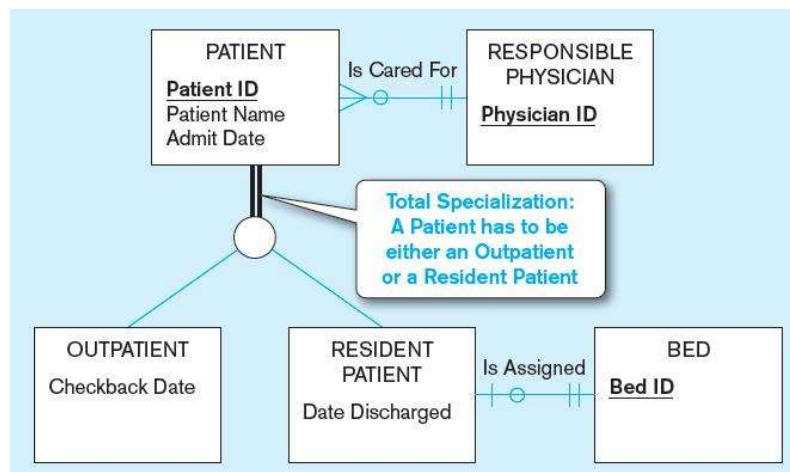
- 4.1. Completeness Constraints (Total or Partial Specialization)
- 4.2. Disjointness Constraints (Disjoint or Overlapping sub-types)
- 4.3. Subtype Discriminator

## 4.1. Constraints in Supertype: Completeness

- **Completeness Constraints:** Whether an instance of a supertype *must* also be a member of at least one subtype
  - **Total Specialization Rule:** Yes (**double line**)
    - ✓ All possible subtypes are included
  - **Partial Specialization Rule:** No (**single line**)
    - ✓ There are more subtypes that have not been included yet.

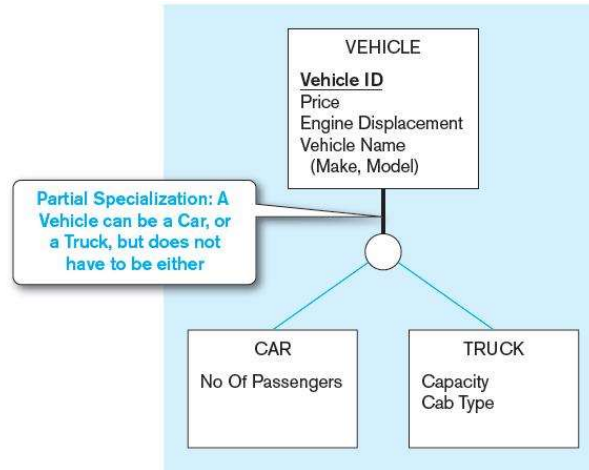
## Examples of completeness constraints (Figure 3-6)

a) Total specialization rule



## Examples of completeness constraints (Figure 3-6) (cont.)

### b) Partial specialization rule

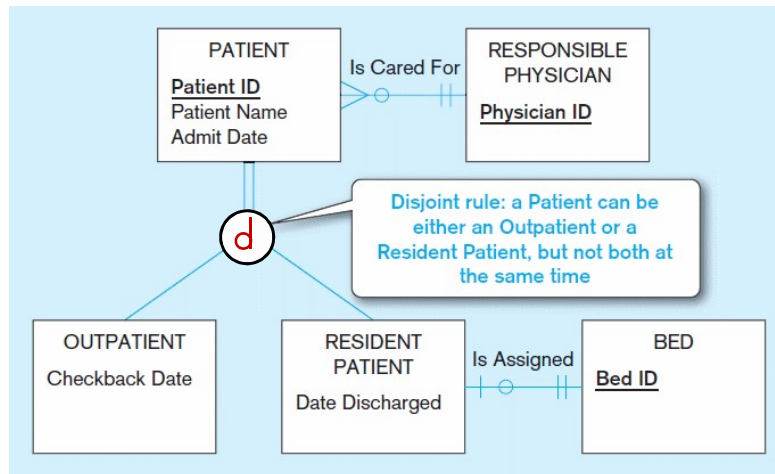


## 4.2. Constraints in Supertype: Disjointness

- **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

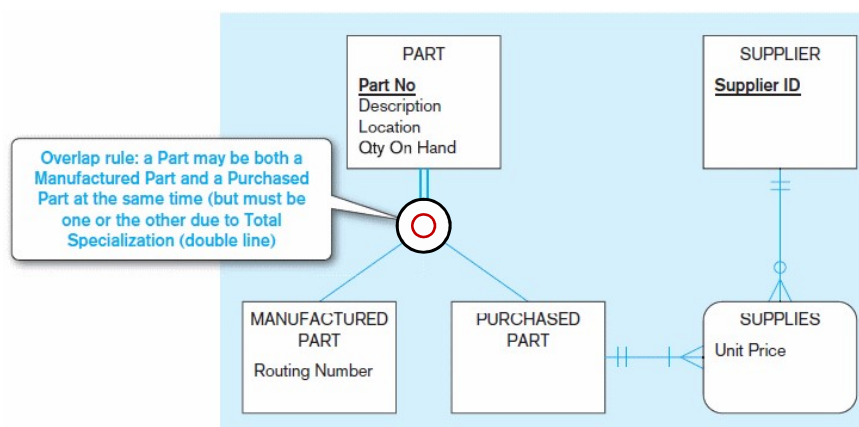
## Examples of disjointness constraints (Figure 3-7)

### a) Disjoint rule



## Examples of disjointness constraints (Figure 3-7) (cont.)

### b) Overlap rule

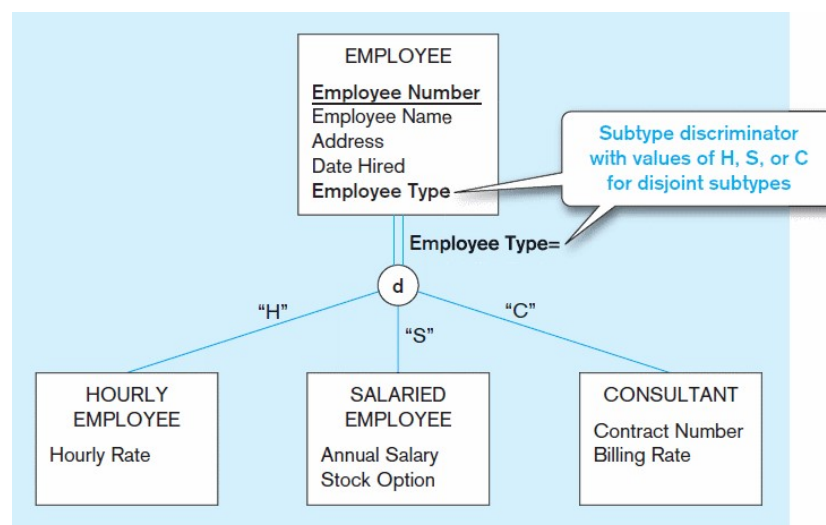




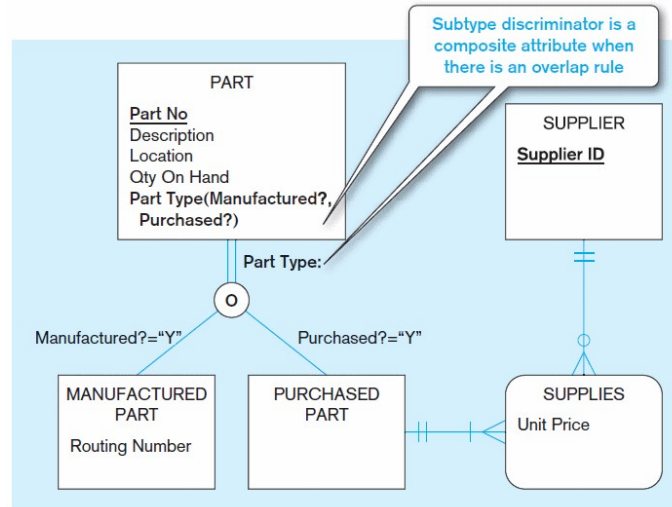
### 4.3. Constraints in Supertype: Subtype Discriminator

- **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 (*disjoint* rule) (Figure 3-8)

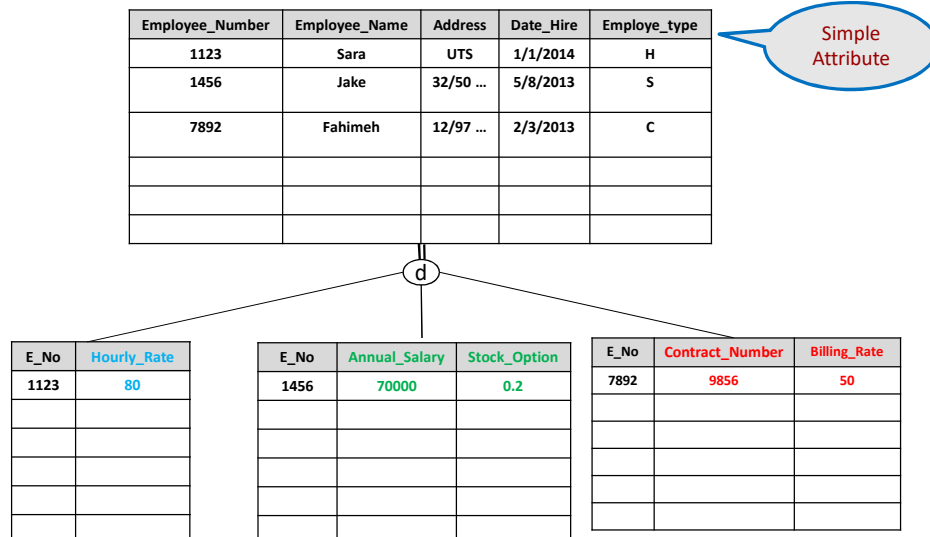


## Subtype discriminator (*overlap* rule) (Figure 3-9)



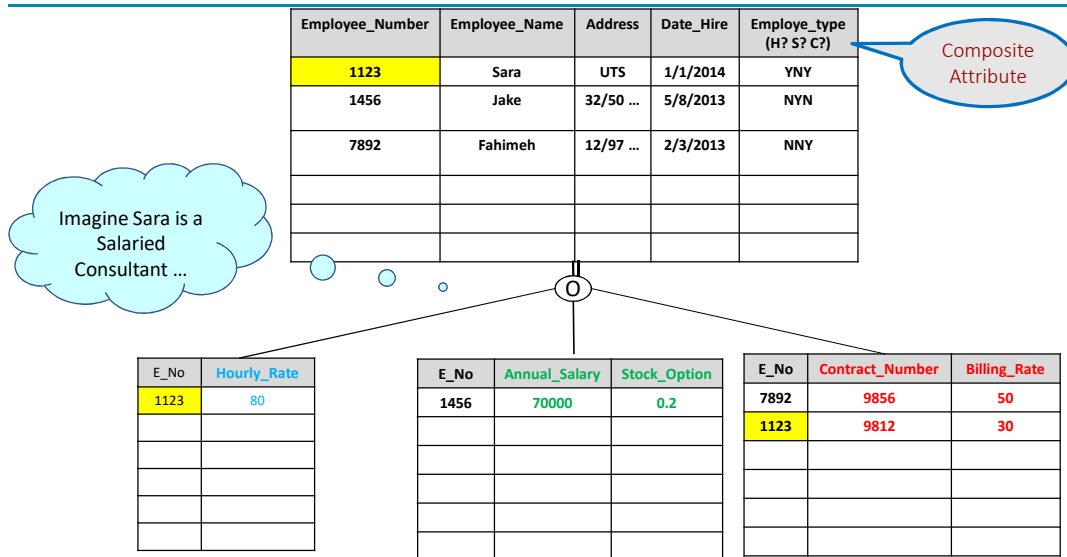
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## Introducing a subtype discriminator (*disjoint* rule)

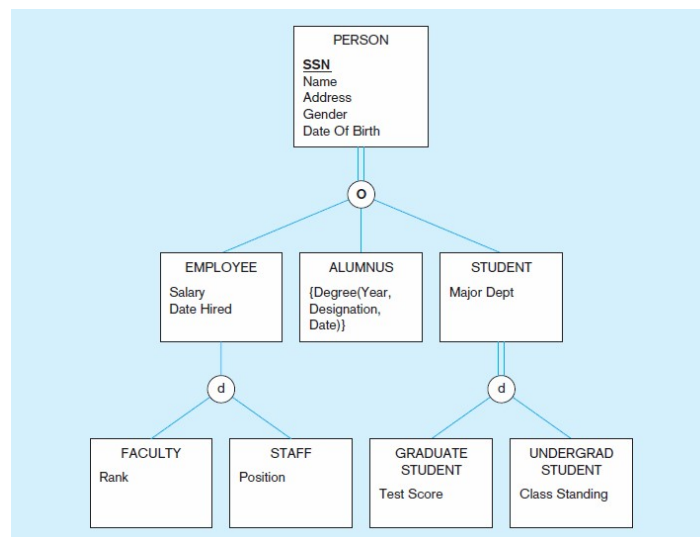


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## Introducing a subtype discriminator (overlap rule)



## Example of supertype/subtype hierarchy (Figure 3-1)



## Summary

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- ✓ 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

## Next Lecture...

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### 1. Components of relational model

### 2. Relations

2.1. Correspondence with E-R Model

2.2. Key Fields

2.3. Constraints

2.3.1. Domain Constraints

2.3.2. Entity Integrity

2.3.3. Action Assertions (Chapter 5)

### 3. Transforming EER Diagrams into Relations

3.1. Mapping Regular Entities to Relations (with simple, composite, and multivalued attributes)

3.2. Mapping Weak Entities

3.3. Mapping Binary Relationships (1:M, M:N, 1:1)

3.4. Mapping Associative Entities

3.5. Mapping Unary Relationships

3.6. Mapping Ternary (and n-ary) Relationships

3.7. Mapping Supertype/Subtype Relationships

## Message from previous students 😊

Angelo Athanasiou (DF Grade HD)

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➤ **Why read the test book:**

The modern database management textbook covers everything more in-depth than the lectures and will greatly help with understanding any areas that are unclear, the textbook is also available from the UTS library so students don't have to pay to access it. Older editions of the textbook can also be obtained for free and contain the same relevant information.

➤ **What to learn:**

Learn how a relational database uses relations, cardinality, etc. because if you don't understand those concepts early on the subject won't be as clear as it progresses.

Learn how SQL statements affect a database and what they do, as it is important to understand **how they work** instead of just understanding what they do, such as knowing why a certain output is given instead of just knowing what to do to get a certain output.

➤ **To aid with the transition from ERD to SQL,**

Microsoft Access can be used to understand how things work as you can view the ERD, as well as use SQL to gain output. What I like about using Microsoft access to help people visualize is because you can use QbE to compare how a query would be undertaken in SQL.

**Links: How to use the Query By Example (QBE) grid | lynda.com tutorial:**

<https://www.youtube.com/watch?v=X9vyzpdUWHs>

