Database systems ITCS2322

Chapter 5: Advanced Data Modeling

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Learning Objectives

- In this chapter, you will learn:
  - About the extended entity relationship (EER) model

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Extended Entity Relationship Model (EERM)

- Result of adding more semantic constructs to the original entity relationship (ER) model

- **EER diagram (EERD)**: Uses the EER model

Entity Supertypes and Subtypes

- The grouping of employees into various *types* provides two important benefits:

- It avoids unnecessary nulls in attributes when some employees have characteristics that are not shared by other employees.

- It enables a particular employee type to participate in relationships that are unique to that employee type.

Entity Supertypes and Subtypes

FIGURE 5.1 NULLS CREATED BY UNIQUE ATTRIBUTES

Database name: Ch05_AirCo

EMP_NUM	EMP_LNAME	EMP_FNAME	EMP_INITIAL	EMP_LICENSE	EMP_RATINGS	EMP_MED_TYPE	EMP_HIRE_DATE
100	Kolmycz	Xavier	T				15-Mar-88
101	Lewis	Marcos		ATP	SEL/MEL/Instr/CFII	1	25-Apr-89
102	Vandam	Jean					20-Dec-93
103	Jones	Victoria	R				28-Aug-03
104	Lange	Edith		ATP	SEL/MEL/Instr	1	20-Oct-97
105	Williams	Gabriel	U	COM	SEL/MEL/Instr/CFI	2	08-Nov-97
106	Duzak	Mario		COM	SEL/MEL/Instr	2	05-Jan-04
107	Diante	Venite	L				02-Jul-97
108	Wiesenbach	Joni					18-Nov-95
109	Travis	Brett	T	COM	SEL/MEL/SES/Instr/CFI	1	14-Apr-01
110	Genkazi	Stan					01-Dec-03

Entity Supertypes and Subtypes

- **Entity supertype**: Generic entity type related to one or more entity subtypes
  - ◦ Contains common characteristics
- **Entity subtype**: Contains unique characteristics of each entity subtype
- Criteria to determine the usage
  - ◦ There must be different, identifiable kinds of the entity in the user's environment
  - ◦ The different kinds of instances should each have one or more attributes that are unique to that kind of instance
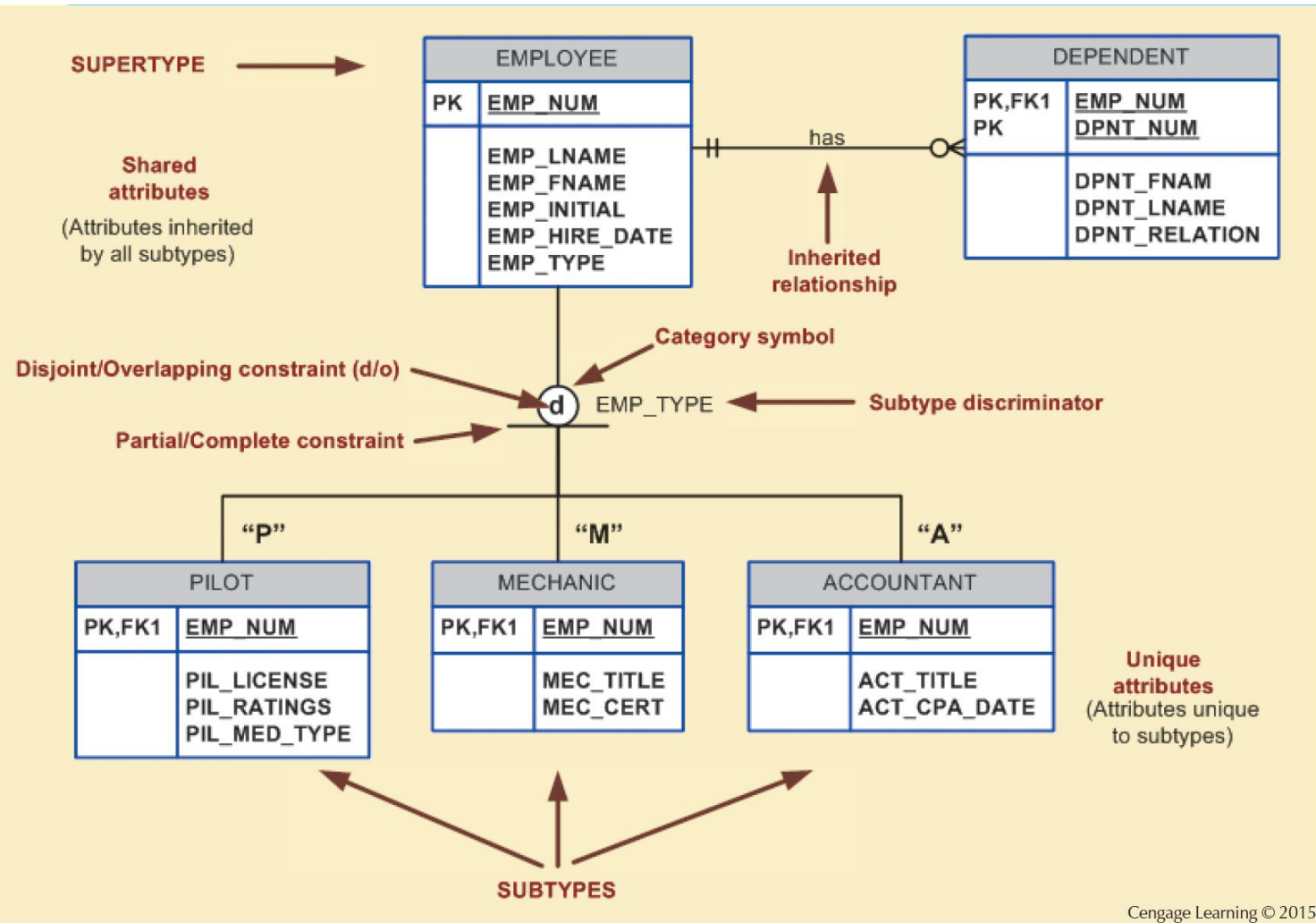
Specialization Hierarchy

- Depicts arrangement of higher-level entity supertypes and lower-level entity subtypes

- Relationships are described in terms of "is-a" relationships

- Subtype exists within the context of a supertype

- Every subtype has one supertype to which it is directly related

- Supertype can have many subtypes

Specialization Hierarchy

- Provides the means to:
  - Support attribute inheritance
  - Define a special supertype attribute known as the subtype discriminator
  - Define disjoint/overlapping constraints and complete/partial constraints

Figure 5.2 - Specialization Hierarchy

SUPERTYPE →

EMPLOYEE

PK	EMP_NUM
	EMP_LNAME
	EMP_FNAME
	EMP_INITIAL
	EMP_HIRE_DATE
	EMP_TYPE

Shared attributes
(Attributes inherited by all subtypes)

has

DEPENDENT

PK,FK1 PK	EMP_NUM DPNT_NUM
	DPNT_FNAM
	DPNT_LNAME
	DPNT_RELATION

Inherited relationship

Category symbol

Disjoint/Overlapping constraint (d/o) →

d — EMP_TYPE ← **Subtype discriminator**

Partial/Complete constraint →

"P" "M" "A"

PILOT

PK,FK1	EMP_NUM
	PIL_LICENSE
	PIL_RATINGS
	PIL_MED_TYPE

MECHANIC

PK,FK1	EMP_NUM
	MEC_TITLE
	MEC_CERT

ACCOUNTANT

PK,FK1	EMP_NUM
	ACT_TITLE
	ACT_CPA_DATE

Unique attributes
(Attributes unique to subtypes)

SUBTYPES

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Inheritance

- Enables an entity subtype to inherit attributes and relationships of the supertype

- All entity subtypes inherit their primary key attribute from their supertype

- At the implementation level, supertype and its subtype(s) maintain a 1:1 relationship

- Entity subtypes inherit all relationships in which supertype entity participates

- Lower-level subtypes inherit all attributes and relationships from its upper-level supertypes

The EMPLOYEE-PILOT super type-subtype relationship

FIGURE 5.3 THE EMPLOYEE-PILOT SUPERTYPE-SUBTYPE RELATIONSHIP

Specialization hierarchy with overlapping subtypes

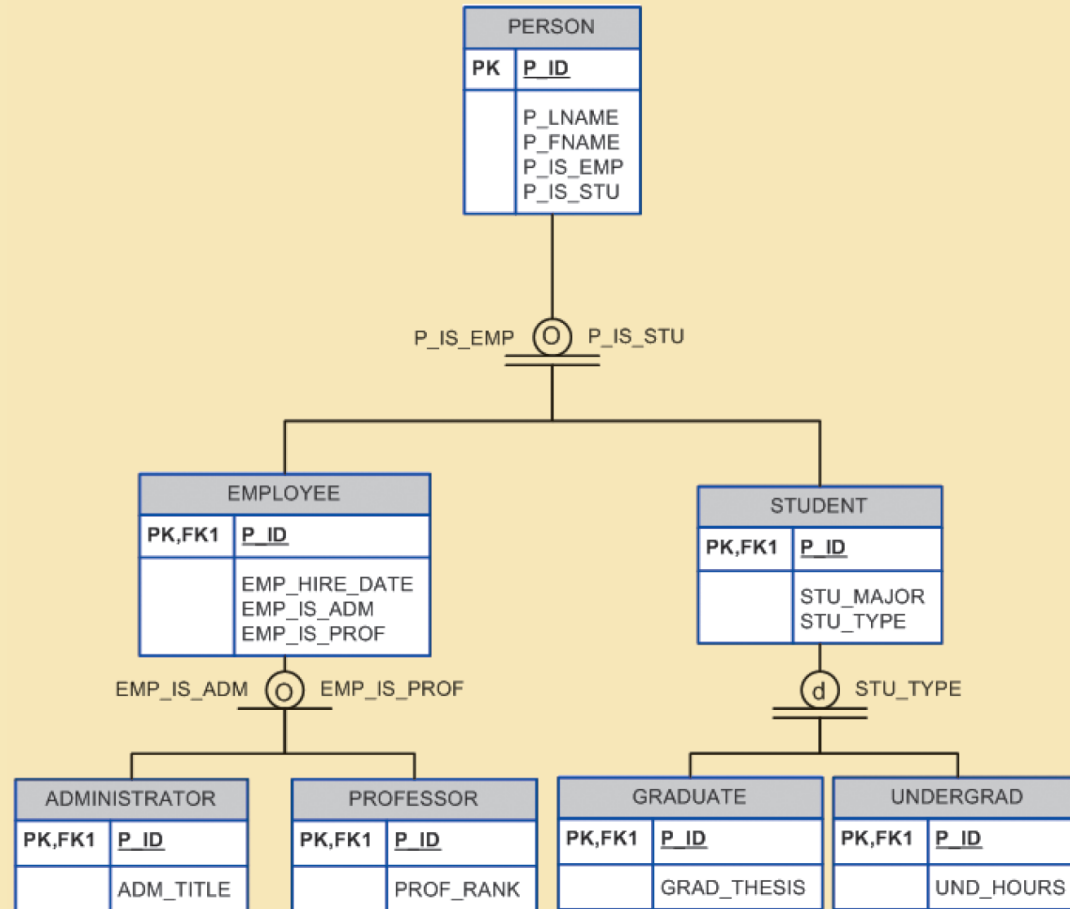FIGURE 5.4 SPECIALIZATION HIERARCHY WITH OVERLAPPING SUBTYPES
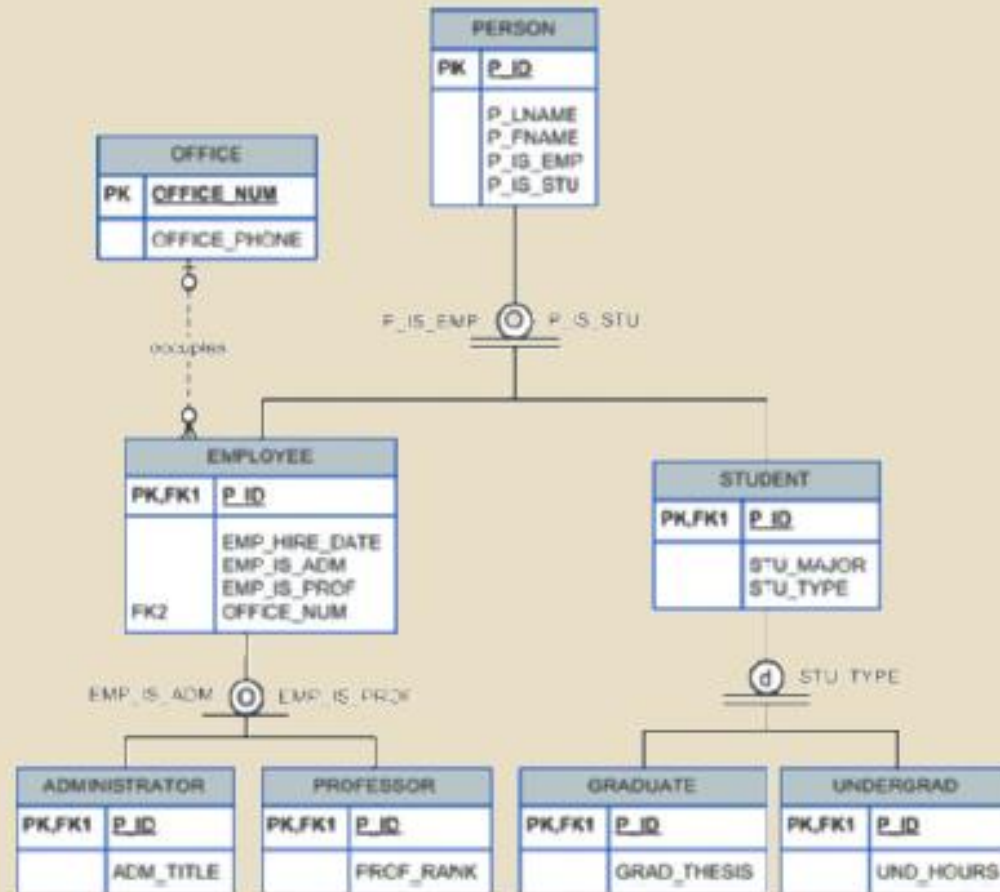
Subtype Discriminator

- Attribute in the supertype entity that determines to which entity subtype the supertype occurrence is related
- Default comparison condition is the equality comparison

Disjoint and Overlapping Constraints

- **Disjoint subtypes**: Contain a unique subset of the supertype entity set
  - Known as **nonoverlapping subtypes**
  - Implementation is based on the value of the subtype discriminator attribute in the supertype

- **Overlapping subtypes**: Contain nonunique subsets of the supertype entity set
  - Implementation requires the use of one discriminator attribute for each subtype

Figure 5.4 - Specialization Hierarchy with Overlapping Subtypes

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Specialization Hierarchy with Overlapping Subtypes
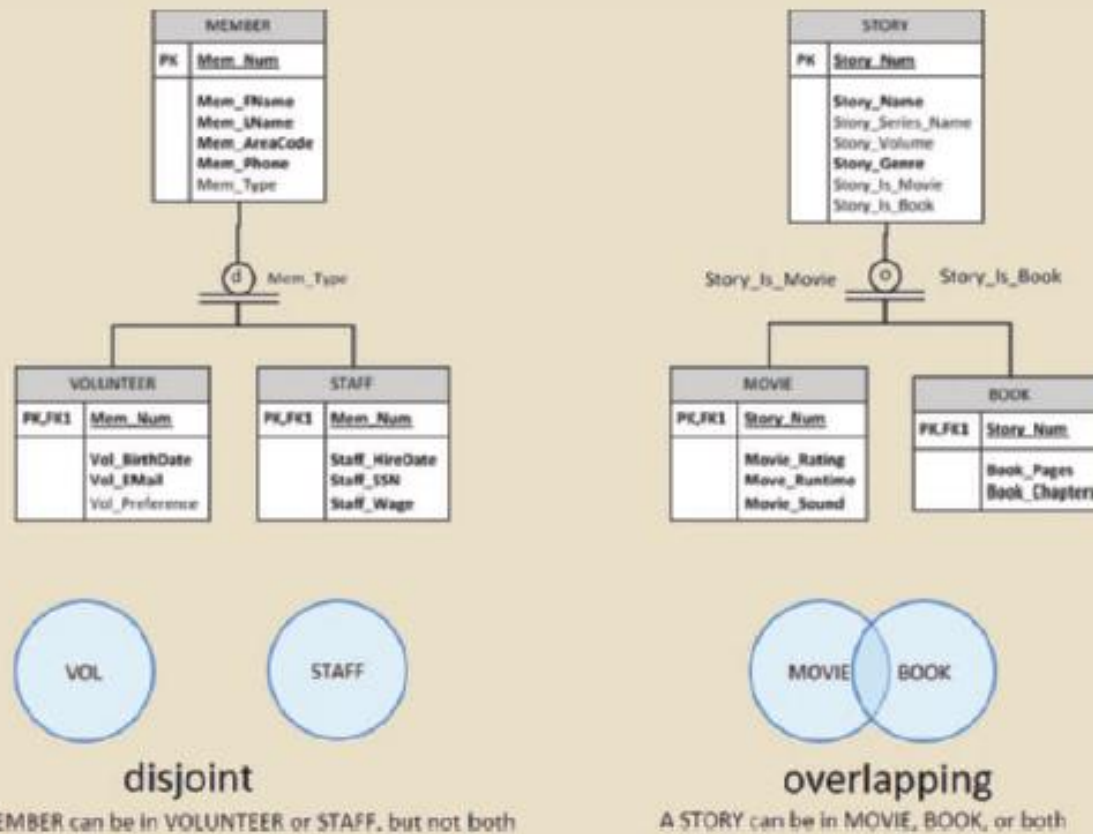

FIGURE 5.5 DISJOINT AND OVERLAPPING SUBTYPES

Table 5.1 - Discriminator Attributes with Overlapping Subtypes

TABLE 5.1		
DISCRIMINATOR ATTRIBUTES WITH OVERLAPPING SUBTYPES		
DISCRIMINATOR ATTRIBUTES		**COMMENT**
PROFESSOR	**ADMINISTRATOR**	
Y	N	The Employee is a member of the Professor subtype.
N	Y	The Employee is a member of the Administrator subtype.
Y	Y	The Employee is both a Professor and an Administrator.

Completeness Constraint

- Specifies whether each supertype occurrence must also be a member of at least one subtype

- Types
  - **Partial completeness**: Not every supertype occurrence is a member of a subtype
  - **Total completeness**: Every supertype occurrence must be a member of any

Table 5.2 - Specialization Hierarchy Constraint Scenarios

TABLE 5.2

SPECIALIZATION HIERARCHY CONSTRAINT SCENARIOS

TYPE	DISJOINT CONSTRAINT	OVERLAPPING CONSTRAINT
Partial	Supertype has optional subtypes. Subtype discriminator can be null. Subtype sets are unique.	Supertype has optional subtypes. Subtype discriminators can be null. Subtype sets are not unique.
Total	Every supertype occurrence is a member of only one subtype. Subtype discriminator cannot be null. Subtype sets are unique.	Every supertype occurrence is a member of at least one subtype. Subtype discriminators cannot be null. Subtype sets are not unique.

Specialization and Generalization

Specialization	Generalization
• Top-down process	• Bottom-up process
• Identifies lower-level, more specific entity subtypes from a higher-level entity supertype	• Identifies a higher-level, more generic entity supertype from lower-level entity subtypes
• Based on grouping unique characteristics and relationships of the subtypes	• Based on grouping common characteristics and relationships of the subtypes