Enhanced Entity-Relationship Model

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The EER Model

Entity Supertypes and Subtypes

- In real world, many businesses employ people with **wide range** of **skills** & **special qualifications**.
- e.g. in **aviation** business; employs **pilots**, **mechanics**, **accountants**, **database managers**, etc.
- Each pilot **share certain characteristics** with other employees such as last name (EMP_LNAME) & hire date (EMP_HIRE_DATE).
- **Many** pilot **characteristics are not shared** by other types of employees such as EMP_LICENSE, EMP_RATINGS & EMP_MED_TYPE (this **generate null values** for employees who are not pilots).
- These unshared characteristics create problems when you try to store all employees' attributes in the same table.

Nulls Created by Unique Attributes

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	Wiesenbach				18-Nov-95
109	Travis	COM	SEL/MEL/SES/Instr/CFII	1	14-Apr-01
110	Genkazi				01-Dec-03

Entity Supertypes and Subtypes

- We can solve this problem by:
  - Creating separate entities to store **specific/unique attributes** (PILOT) and **common attributes** (EMPLOYEE).
  - PILOT is a **subtype** of EMPLOYEE and EMPLOYEE is the **supertype** of PILOT.

The EMPLOYEE-PILOT supertype-subtype relationship

Table Name: EMPLOYEE

EMP_NUM	EMP_LNAME	EMP_FNAME	EMP_INITIAL	EMP_HIRE_DATE	EMP_TYPE
100	Kolmycz	Xavier	T	15-Mar-88	
101	Lewis	Marcos		25-Apr-89	P
102	Vandam	Jean		20-Dec-93	A
103	Jones	Victoria	R	28-Aug-03	
104	Lange	Edith		20-Oct-97	P
105	Williams	Gabriel	U	08-Nov-97	P
106	Duzak	Mario		05-Jan-04	P
107	Diante	Venite	L	02-Jul-97	M
108	Wiesenbach	Joni		18-Nov-95	M
109	Travis	Brett	T	14-Apr-01	P
110	Genkazi	Stan		01-Dec-03	A

SUPERTYPE

Table Name: PILOT

EMP_NUM	PIL_LICENSE	PIL_RATINGS	PIL_MED_TYPE
101	ATP	SEL/MEL/Instr/CFII	1
104	ATP	SEL/MEL/Instr	1
105	COM	SEL/MEL/Instr/CFI	2
106	COM	SEL/MEL/Instr	2
109	COM	SEL/MEL/Instr/CFII	1

SUBTYPE

The EMPLOYEE-PILOT supertype-subtype relationship

Table Name: MECHANIC

EMP_NUM	MEC_TITLE	MEC_CERT
107	XYZ	XYZ
108	XYZ	XYZ

SUBTYPE

Table Name: ACCOUNTANT

EMP_NUM	ACT_TITLE	ACT_CPA_DATE
102	XYZ	XYZ
110	XYZ	XYZ

SUBTYPE

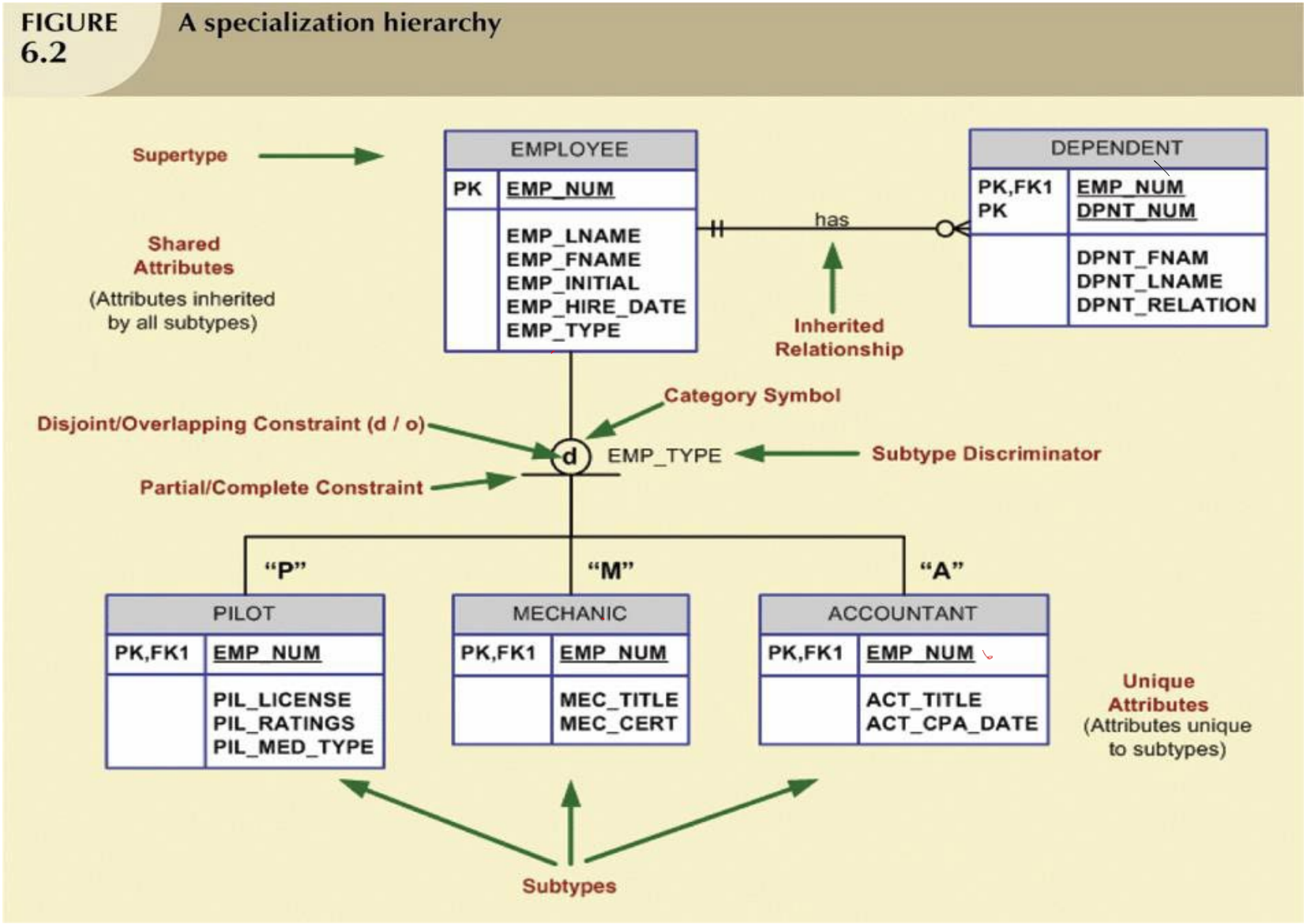
Entity Supertypes and Subtypes

- **Entity supertype**
  - Generic entity type that is related to **one** or **more entity subtypes**
  - Contains **common characteristics** (**shared attributes**)
- **Entity subtypes**
  - Contains **unique characteristics** of each entity subtype (**unique attributes**)

Specialization Hierarchy

- Shows arrangement of higher-level entity **supertypes** (parent entities) and lower-level entity **subtypes** (child entities)
- Relationships sometimes described in terms of "**IS-A**" relationships (**1:1** relationship)
- Subtype can exist only within context of supertype and every subtype can have only one supertype to which it is directly related
- Can have many levels of supertype/subtype relationships

Specialization Hierarchy



Specialization Hierarchy

- Support attribute **inheritance**
- Define special supertype attribute known as **subtype discriminator**
- Define **disjoint/overlapping** constraints and **complete/partial** constraints

Inheritance

- Subtype will inherit **primary key**, **attributes** and **relationships** of the supertype.
- **PILOT**, **MECHANIC** & **ACCOUNTANT** inherit **attributes** EMP_NUM, EMP_LNAME, EMP_FNAME, EMP_INITIAL, EMP_HIRE_DATE from **EMPLOYEE**
- All entity subtypes inherit **primary key** **EMP_NUM** from **EMPLOYEE**
- All entity subtypes inherit **relationship** with **DEPENDENT** entity

Subtype Discriminator

- **Subtype discriminator:** Attribute in supertype entity that determines to which subtype the supertype occurrence is related.
- **EMP_TYPE** is the subtype discriminator in this case.
- Refer to figure 6.2, the supertype related to a

  PILOT subtype if **EMP-TYPE = "P"**,

  MECHANIC if **EMP-TYPE = "M"** and

  ACCOUNTANT if EMP-TYPE = "A"

Disjoint and Overlapping Constraints

- **Disjoint subtypes**
  - Also known as **non-overlapping** subtypes
  - Subtypes that contain unique subset of supertype entity set
  - Each entity instance of the supertype can appear in only one of the subtypes.
  - e.g. a PILOT cannot be a mechanic at the same time

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- **Overlapping subtypes**
  - Subtypes that contain nonunique subsets of supertype entity set
  - Each entity instance of the supertype can appear in more than one subtypes.
  - e.g. an EMPLOYEE can be a STUDENT at the same time

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Disjoint and Overlapping Constraints

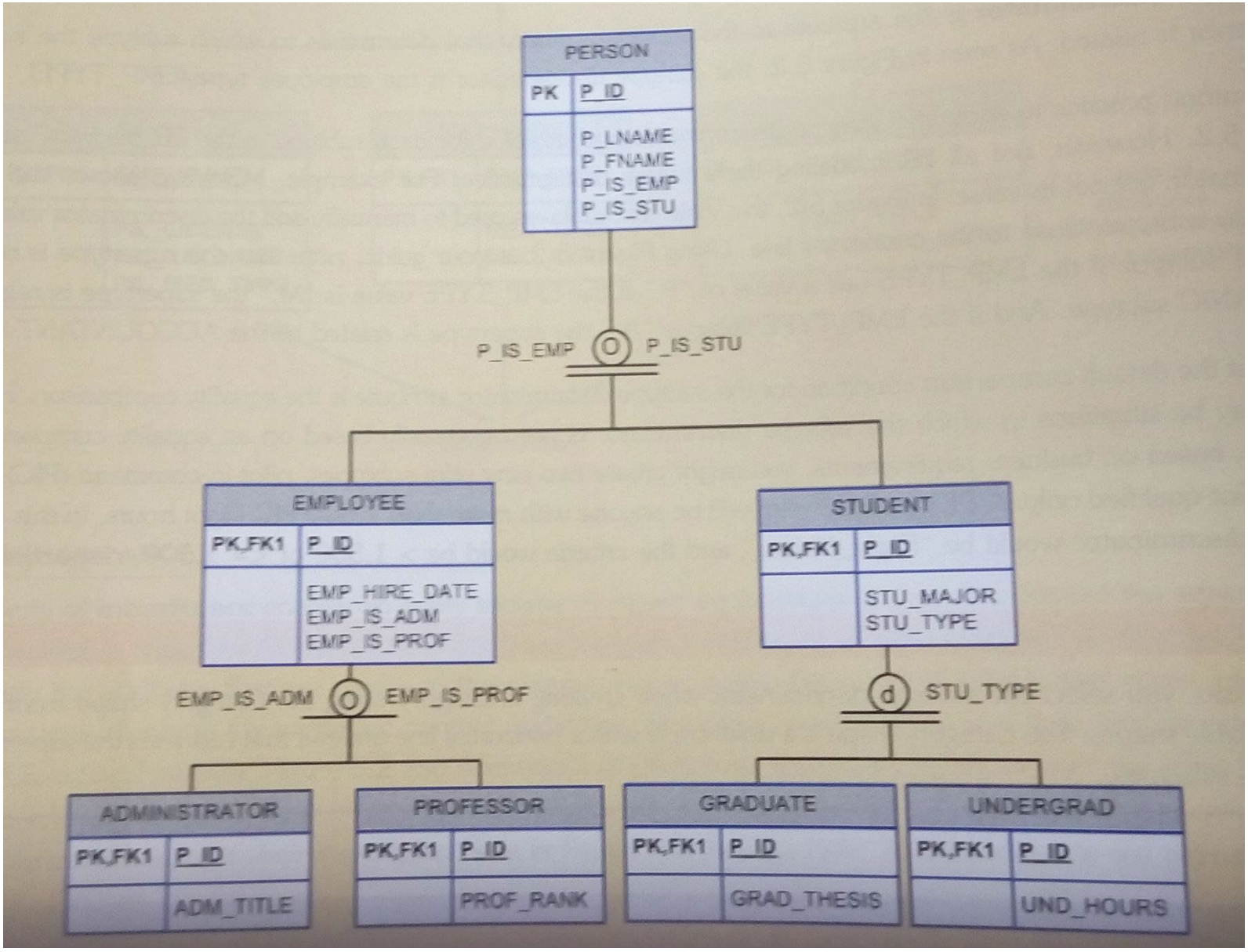


TABLE 6.1 Discriminator Attributes with Overlapping Subtypes

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.

PERSON

P_ID	P_LNAME	P_FNAME	P_IS_EMP	P_IS_STU
P01	ALI	AISYAH		
P02	RAHMAN	AMIRAH		
P03	HISYAM	ASYRAF		
P04	ANWAR	YASEEN		

EMPLOYEE

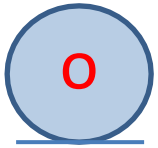
P_ID	EMP_HIRE_DATE	EMP_ID_ADM	EMP_IS_PROF

STUDENT

P_ID	STD_MAJOR	STD_TYPE

EMPLOYEE

P_ID	EMP_HIRE_DATE	EMP_ID_ADM	EMP_IS_PROF

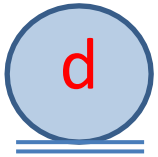


ADMINISTRATOR

P_ID	ADM_TITLE

PROFESSOR

P_ID	PROF_RANK



STUDENT

P_ID	STD_MAJOR	STD_TYPE

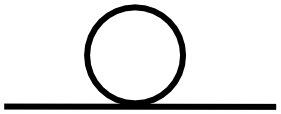
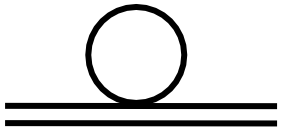
GRADUATE

P_ID	GRAD_THESIS

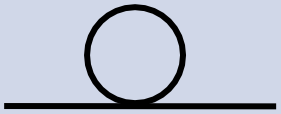
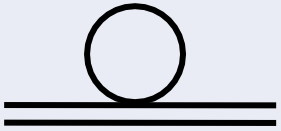
UNDERGRAD

P_ID	UND_HOURS

Completeness Constraint

- Specifies whether each entity supertype occurrence must also be a member of at least one subtype.
- **Partial completeness**:
  - not every supertype occurrence is a member of a subtype
  - notation: 
- **Total completeness**:
  - every supertype occurrence must be a member of at least one subtype
  - notation: 

Completeness Constraint

Type	Disjoint Constraint	Overlapping Constraint
Partial 	Supertype has optional subtypes Subtype discriminator can be null Subtype sets are unique	Supertype has optional subtypes Subtype discriminator can be null Subtype sets are not unique
Total 	Every supertype occurrence is a member of a (at least one) subtype Subtype discriminator cannot be null Subtype sets are unique	Every supertype occurrence is a member of a (at least one) subtype Subtype discriminator cannot be null Subtype sets are not unique

Specialization and Generalization

- **Specialization:**
  - Top-down process of identifying lower-level, more specific entity subtypes from a higher-level entity supertype
  - Grouping unique characteristics and relationships of the subtypes
- **Generalization:**
  - Bottom-up process of identifying a higher-level more generic entity supertype from lower-level entity subtypes
  - Grouping common characteristics and relationships of the subtypes

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The Enhanced Entity-Relationship Model

- Since 1980s there has been an increase in emergence of new database applications with more demanding requirements.
- Basic concepts of ER modeling are not sufficient to represent requirements of newer, more complex applications.
- Response is development of additional ‘semantic’ modeling concepts.
- Semantic concepts are incorporated into the original ER model and called the Enhanced Entity-Relationship (EER) model.
- Examples of additional concept of EER model is called specialization / generalization.

Specialization / Generalization

Superclass

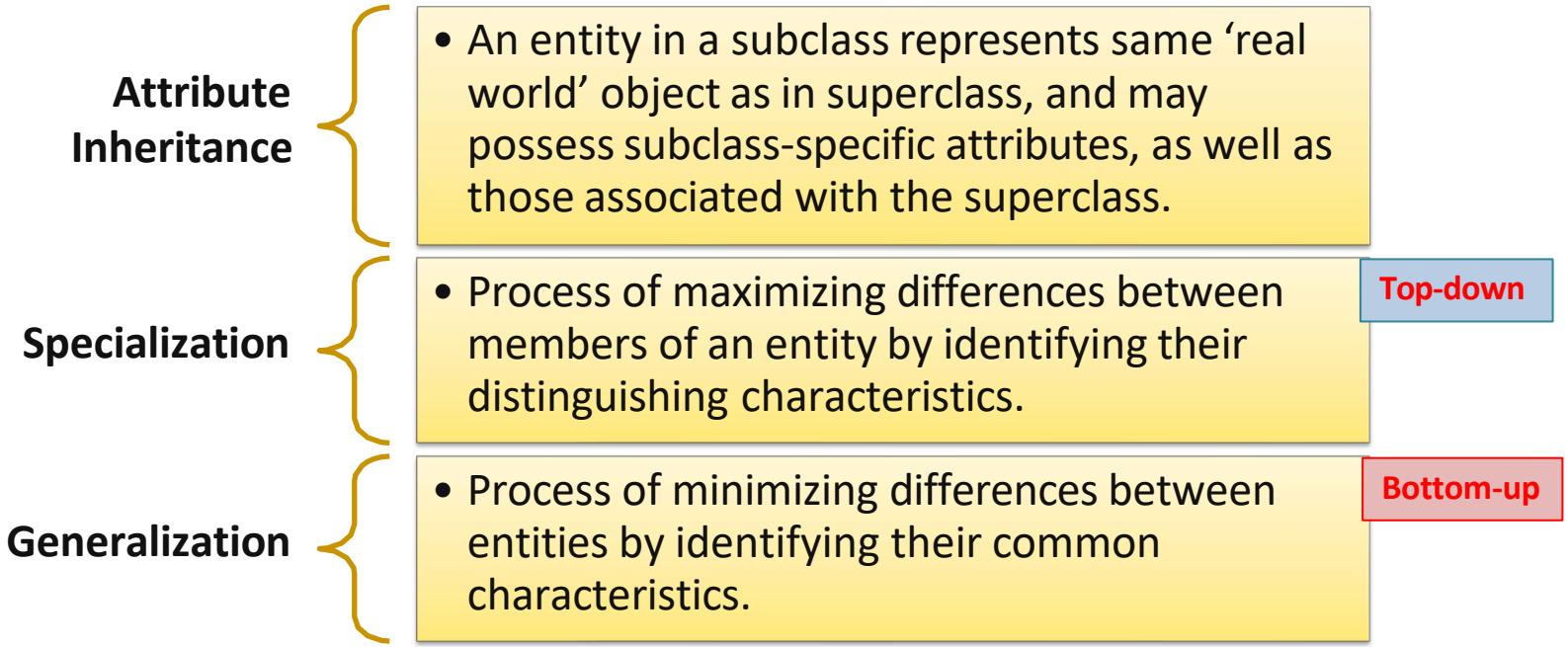
- An entity type that includes one or more distinct subgroupings of its occurrences.

Subclass

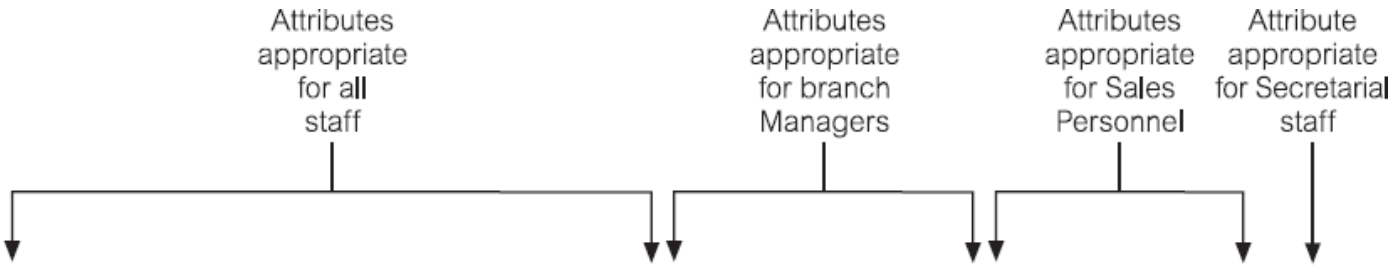
- A distinct subgrouping of occurrences of an entity type.

- Superclass/subclass relationship is one-to-one (1:1).
- Superclass may contain overlapping or distinct subclasses.
- NOT ALL members of a superclass need to be a member of a subclass.

Specialization / Generalization

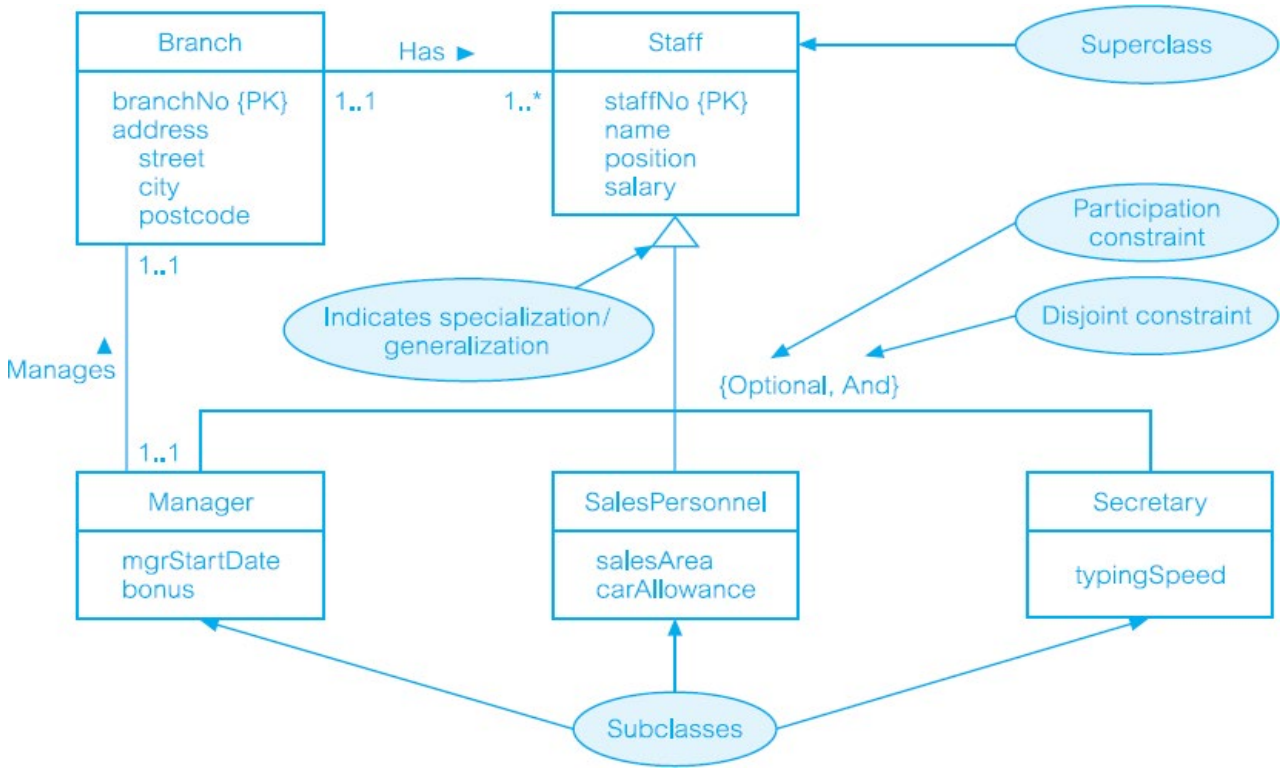


All Staff relation holding details of all staff



staffNo	name	position	salary	mgrStartDate	bonus	sales Area	car Allowance	typing Speed
SL21	John White	Manager	30000	01/02/95	2000			
SG37	Ann Beech	Assistant	12000					
SG66	Mary Martinez	Sales Manager	27000			SA1A	5000	
SA9	Mary Howe	Assistant	9000					
SL89	Stuart Stern	Secretary	8500					100
SL31	Robert Chin	Snr Sales Asst	17000			SA2B	3700	
SG5	Susan Brand	Manager	24000	01/06/91	2350			

Specialization/generalization of Staff entity into subclasses representing job roles



STAFF

staffNo	Name	Position	Salary
SL21		MANAGER	
SG37		ASSISSTANT	
SG66		SALES MANAGER	
SA9		ASSISSTANT	
SL89		SECRETARY	
SL31		SNR SALES ASSISTANT	
SG5		MANAGER	

MANAGER

staffNo	mgrStartDate	bonus
SL21		
SG5		

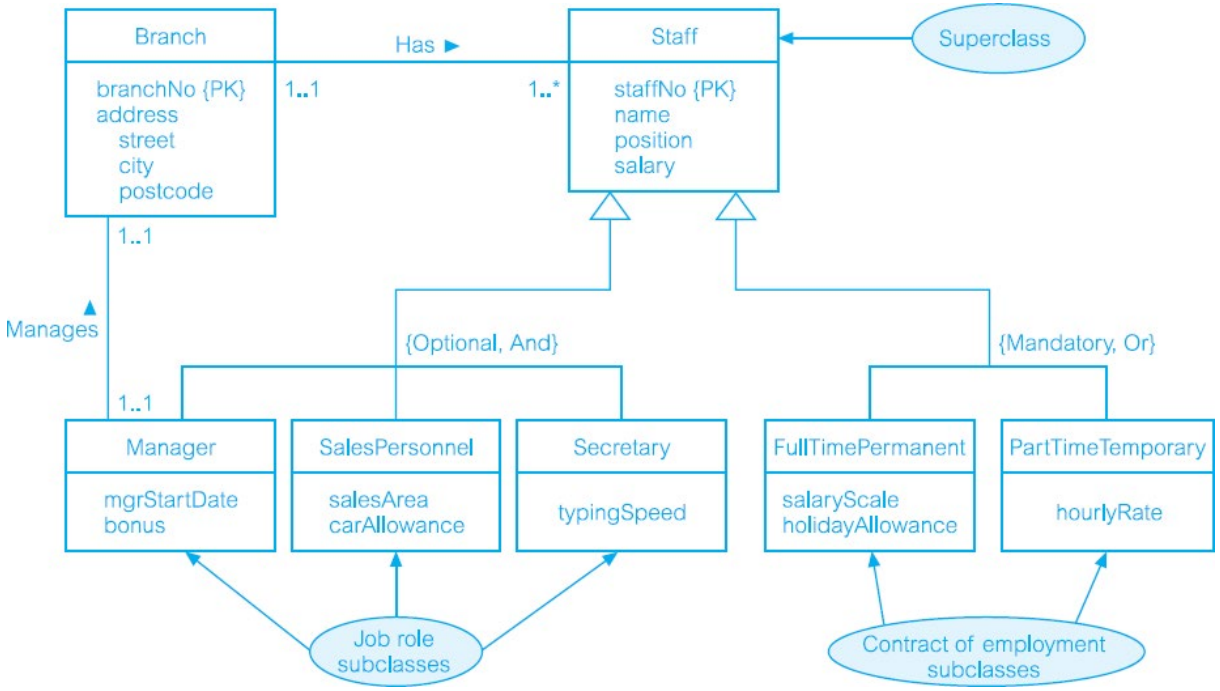
SALESPERSONNEL

staffNo	salesArea	carAllowance
SG66		
SL31		

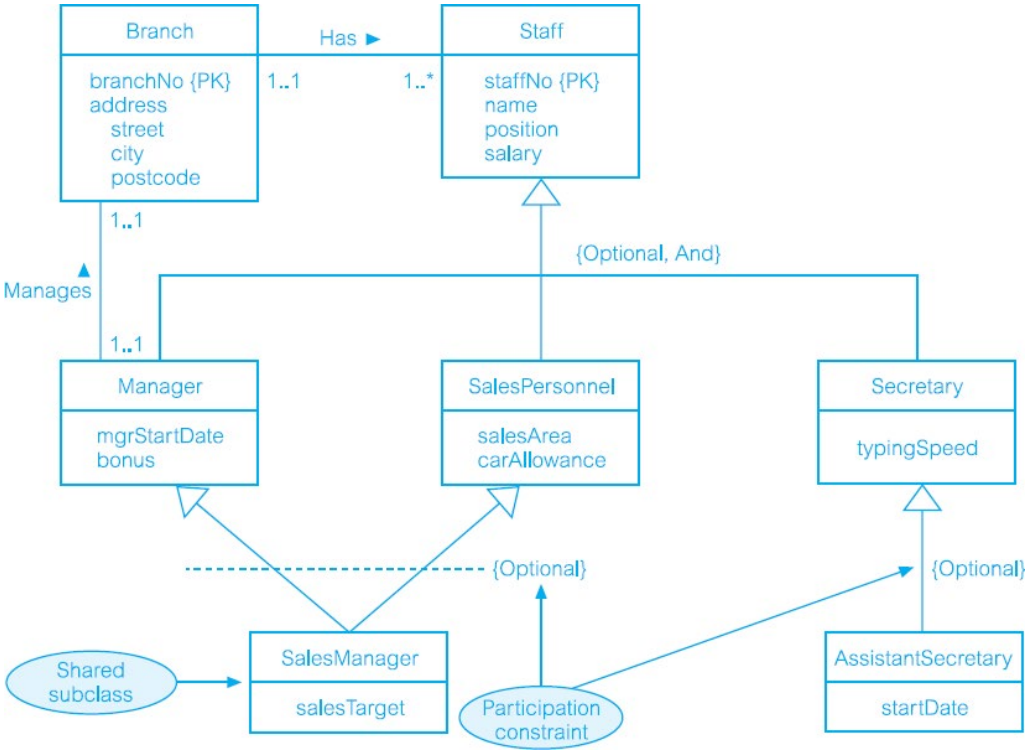
SECRETARY

staffNo	typingSpeed
SL89	

Specialization/generalization of Staff entity into job roles and contracts of employment



EER diagram with shared subclass and subclass with its own subclass



Constraints on Specialization / Generalization

Participation constraint

- Determines whether every member in superclass must participate as a member of a subclass.
- May be ***mandatory*** or ***optional***.

Disjoint constraint

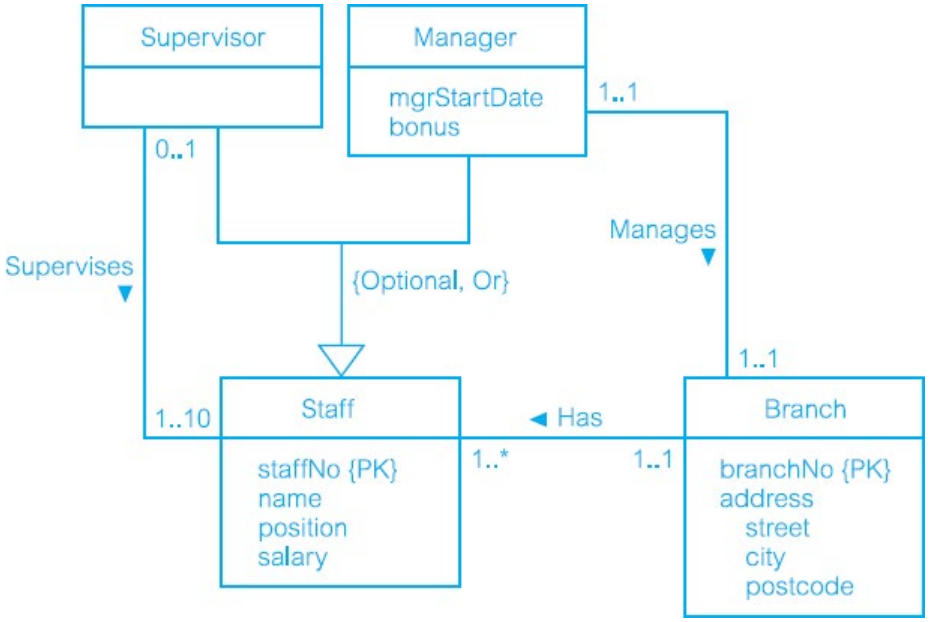
- Describes relationship between members of the subclasses and indicates whether member of a superclass can be a member of one, or more than one, subclass.
- May be ***disjoint*** or ***nondisjoint***.

Constraints on Specialization / Generalization

There are four categories of constraints of specialization and generalization:

- ✓ Mandatory + Disjoint (or)
- ✓ Optional+ Disjoint
- ✓ Mandatory + Nondisjoint (and) overlap
- ✓ Optional+ Nondisjoint

DreamHome worked example - Staff Superclass with Supervisor and Manager subclasses



STAFF

staffNo	Name	Position	Salary
SL21		MANAGER	
SG37		ASSISSTANT	
SG66		SALES MANAGER	
SA9		ASSISSTANT	
SL89		SECRETARY	
SL31		SNR SALES ASSISTANT	
SG5		MANAGER	
SG12		SUPERVISOR	

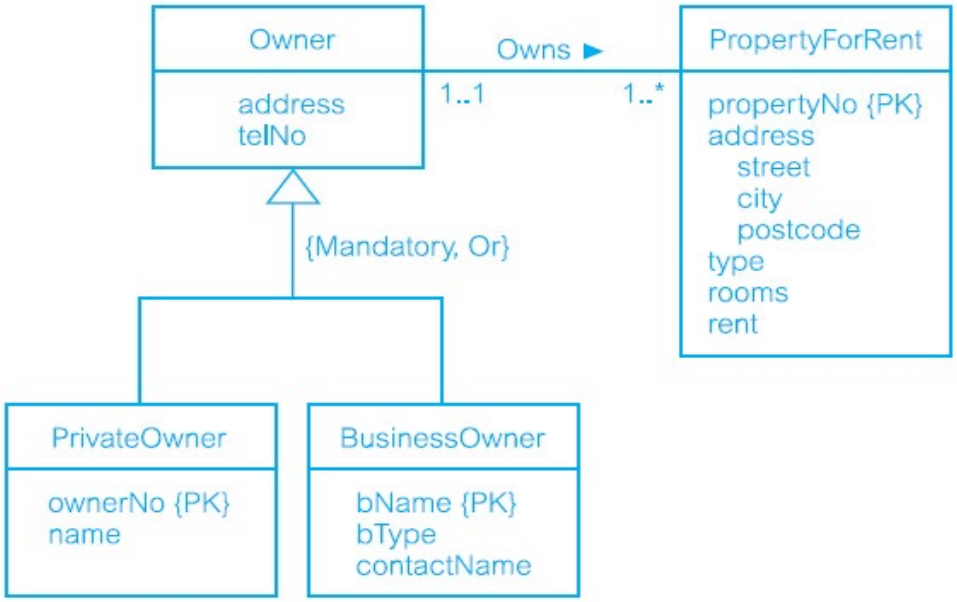
MANAGER

staffNo	mgrStartDate	bonus
SL21		
SG5		

SUPERVISOR

staffNo	
SG12	

DreamHome worked example - Owner Superclass with PrivateOwner and BusinessOwner subclasses



OWNER

ownerNo	Name
1	
2	
3	
4	

PRIVATE OWNER

ownerNo		
1		
4		

BUSINESS OWNER

ownerNo	
2	
3	

DreamHome worked example - Person superclass with Staff, PrivateOwner, and Client subclasses