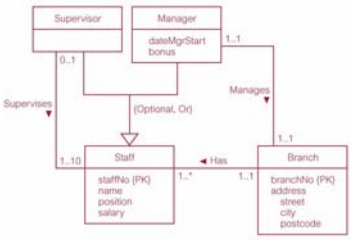
IT2201 / IT2601 / IT2564 / IT2621 / IT2521 / IT2323

Database Management Systems



Unit 4
Entity-Relationship Modeling

1

Unit Objectives

- At the end of this unit, you should be able to:
  - Explain the basic concepts associated with the ER model.
  - Construct ER Diagram using Unified Modeling Language (UML).
  - Use ER Modeling in database design.

ER Modeling ELO

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ER Modeling

- What is ER Model?
  - A detailed, **logical representation of the data** for an organization or for a business area.
  - The ER model is expressed in terms of **entities** in the business environment, the **relationships** (or associations) among those entities, and the **attributes**(or properties) of both the entities and their relationships.
- Why ER modeling?
  - Get a **precise understanding of the nature of the data** and how it is used by the enterprise.
  - **A model for communication** that is non-technical and free of ambiguities.

3

ER Modeling Notations

- Though the basic concepts of the ER model are commonly agreed, there is no standard representation of ER diagrams.
- The complexity of ER modeling is not in the representation, but lies in the
  - Understanding of the **business**.
  - Recognition of the **entities** that play a role in that business.
  - Relevant **attributes** that describe the entities.
  - **Relationships** that connect the entities.

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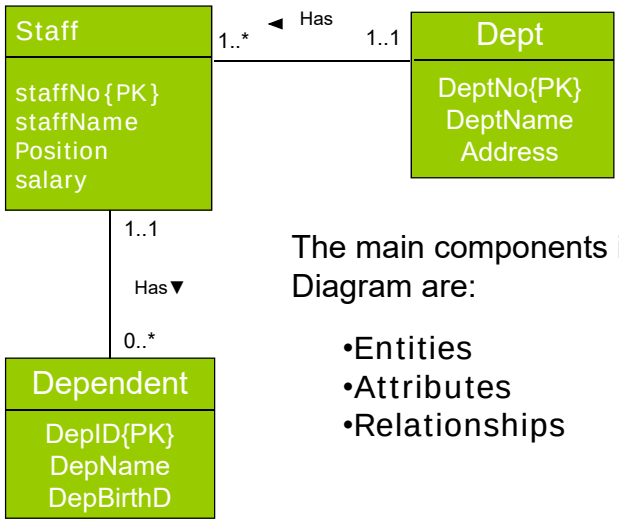
ER Diagram using UML Notation



The main components in the ER Diagram are:

- Entities
- Attributes
- Relationships

5

Entity Type

- Entity type
  - Group of objects with same properties, identified by enterprise as having an independent existence.
- Entity occurrence
  - Uniquely identifiable object of an entity type.

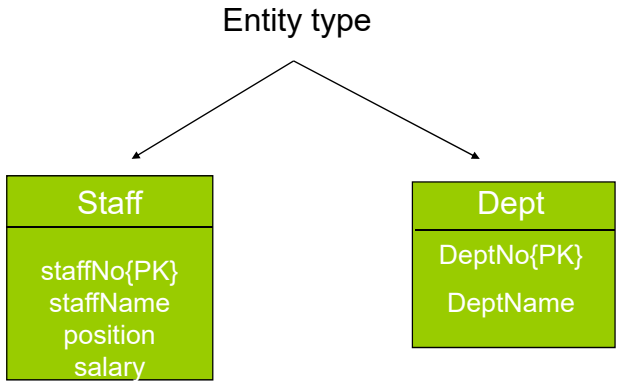
6

Examples of Entity Types

Physical existence	
Staff	Part
Property	Supplier
Customer	Product
Conceptual existence	
Viewing	Sale
Inspection	Work experience

7

ER Diagram of Staff and Department Entity Types



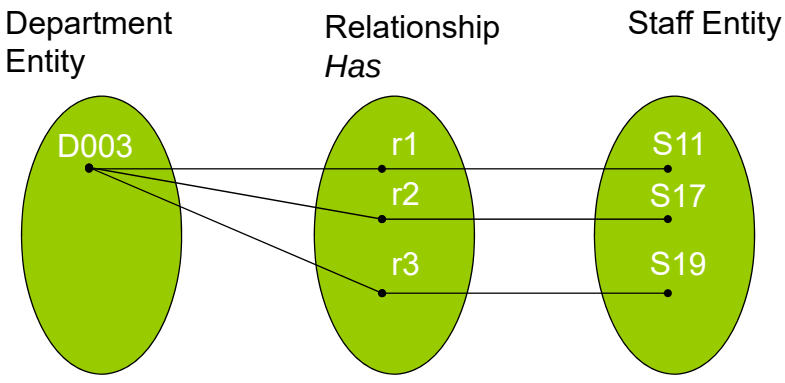
8

Relationship Types

- Relationship type
  - Set of meaningful associations among entity types.
- Relationship occurrence
  - Uniquely identifiable association, which includes one occurrence from each participating entity type.

9

Semantic Net of *Has* Relationship Type



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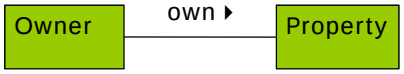
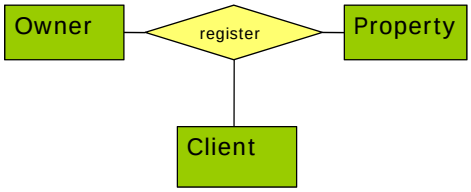
Relationship Types

- Degree of a Relationship
  - Number of participating entities in relationship.
- Relationship of degree:
  - two is binary; (This is the most common one)
  - three is ternary;
  - four is quaternary.





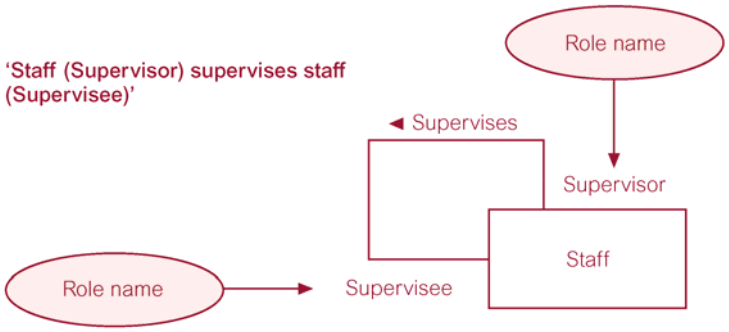
11

Relationship Types

- Recursive Relationship
  - Relationship type where *same* entity type participates more than once in *different roles*.
- Relationships may be given role names to indicate purpose that each participating entity type plays in a relationship.

12

Recursive Relationship called *Supervises* with Role Names



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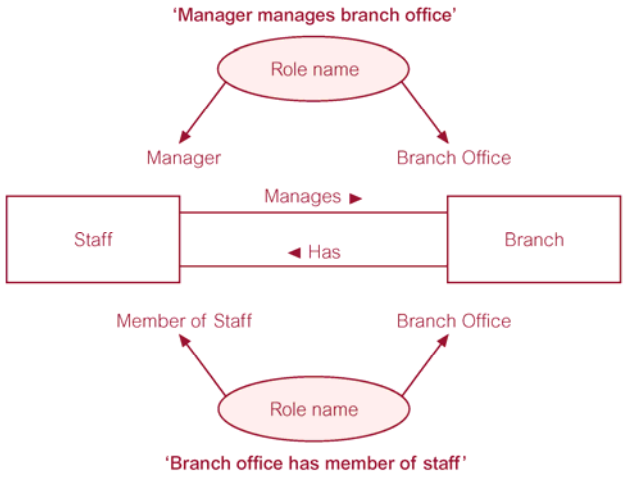
Entities associated through two distinct Relationships with Role Names



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Attributes

- Attribute
  - Property of an entity or a relationship type.
- Attribute Domain
  - Set of allowable values for one or more attributes.
- Simple Attribute
  - Attribute composed of a single component with an independent existence.
- Composite Attribute
  - Attribute composed of multiple components, each with an independent existence.

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Attributes

- Single-valued Attribute
  - Attribute that holds a single value for each occurrence of an entity type.
- Multi-valued Attribute
  - Attribute that holds multiple values for each occurrence of an entity type.
- Derived Attribute
  - Attribute that represents a value that is derivable from value of a related attribute, or set of attributes, not necessarily in the same entity type.

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Exercise 1 – Indicate type of attribute

Attribute	Simple	Composite	Single-valued	Multi-valued	Derived
Name					
Address Blk No. Street name House no. Postal code					
Gender					
Phone (1..3)					
DOB					
Age (current yr – year of birth)					

Keys

- Candidate Key
  - Minimal set of attributes that uniquely identifies each occurrence of an entity type.
- Primary Key
  - Candidate key selected to uniquely identify each occurrence of an entity type.
- Composite Key
  - A candidate key that consists of two or more attributes.

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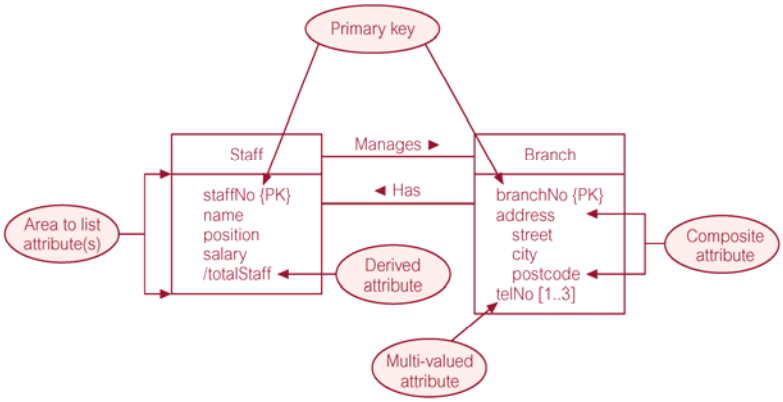
ER Diagram of Staff and Branch Entities and their Attributes



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Entity Type

- Strong Entity Type
  - Entity type that is *not* existence-dependent on some other entity type.
- Weak Entity Type
  - Entity type that is existence-dependent on some other entity type.

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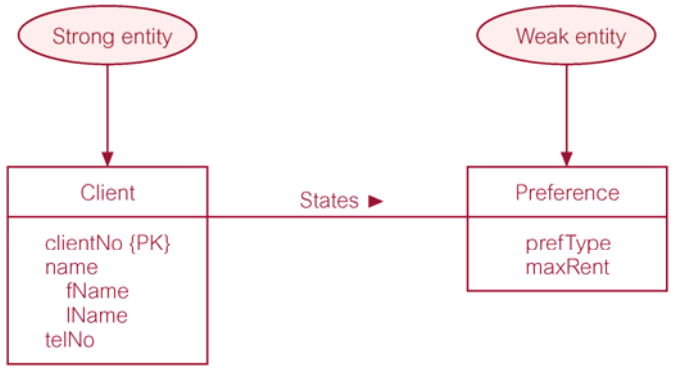
Strong Entity Type called Client and Weak Entity Type called Preference



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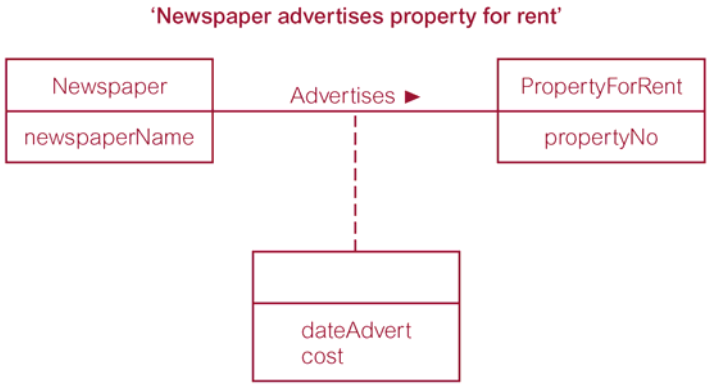
Relationship called *Advertises* with Attributes



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Structural Constraints

- Main type of constraint on relationships is called multiplicity.
- The multiplicity on the binary relationship can be:
  - one-to-one (1:1)
  - one-to-many (1:*)
  - many-to-many (*:*)

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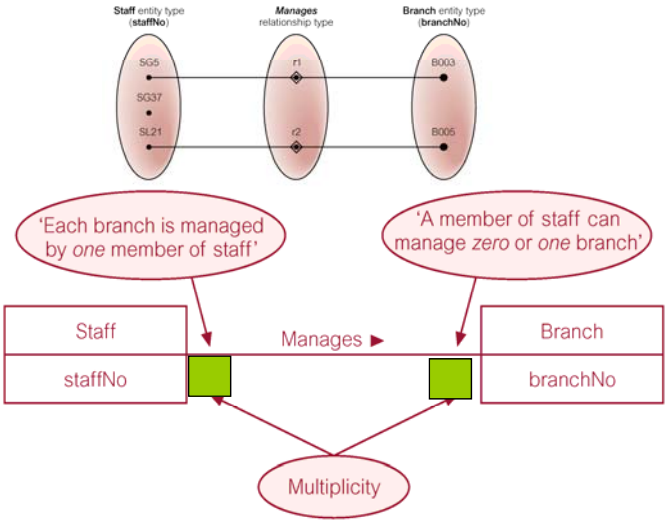
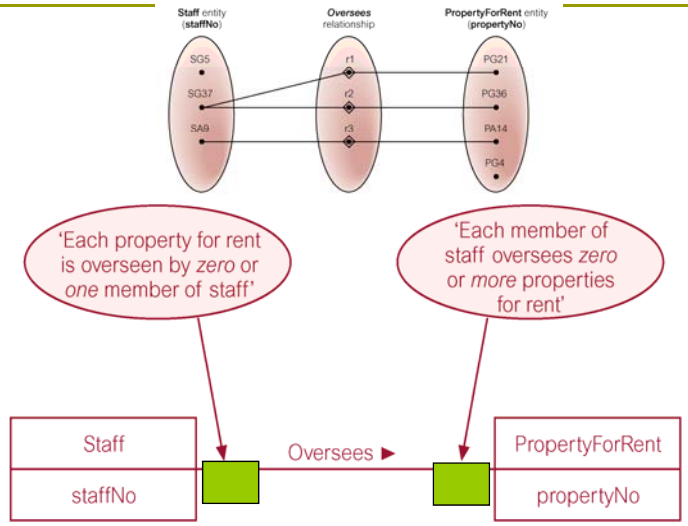
Multiplicity of Staff *Manages* Branch (1:1) Relationship Type



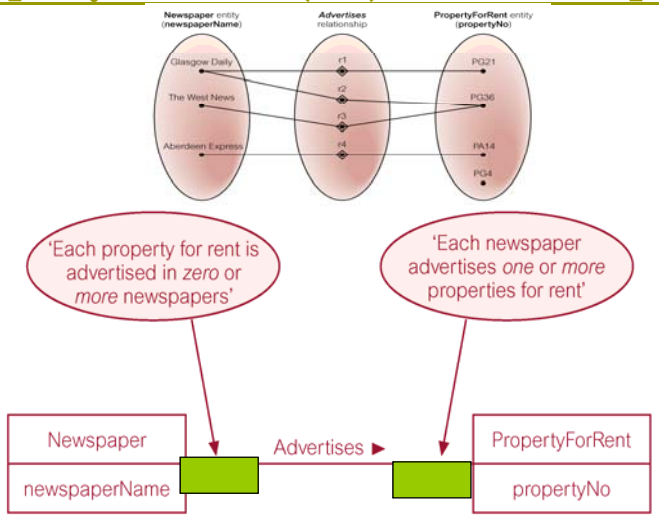
24

Multiplicity of Staff *Oversees* PropertyForRent (1:*) Relationship



25

Multiplicity of Newspaper *Advertises* PropertyForRent (*:*) Relationship



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Summary of Multiplicity Constraints

Table 11.1 A summary of ways to represent multiplicity constraints.

Alternative ways to represent multiplicity constraints	Meaning
0..1	Zero or one entity occurrence
1..1	Exactly one entity occurrence
0..*	Zero or many entity occurrences
1..*	One or many entity occurrences
5..10	Minimum of 5 up to a maximum of 10 entity occurrences
0, 3, 6–8	Zero or three or six, seven, or eight entity occurrences

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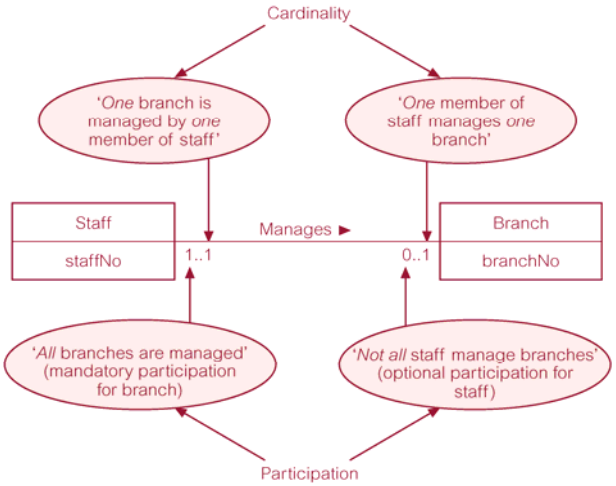
Multiplicity as Cardinality and Participation Constraints



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Exercise 2 – Construct an ER Diagram

- Each customer can place one or more orders. Customer is identified by customer number and order is identified by order number.
- One order can have one or more order lines. Each order line is referring to a product purchased. Each product is identified by a product number.

29

Enhanced Entity Relationship Modeling

- Superclass
  - An entity type that includes one or more distinct subgroupings of its occurrences.
- Subclass
  - A distinct subgrouping of occurrences of an entity type.

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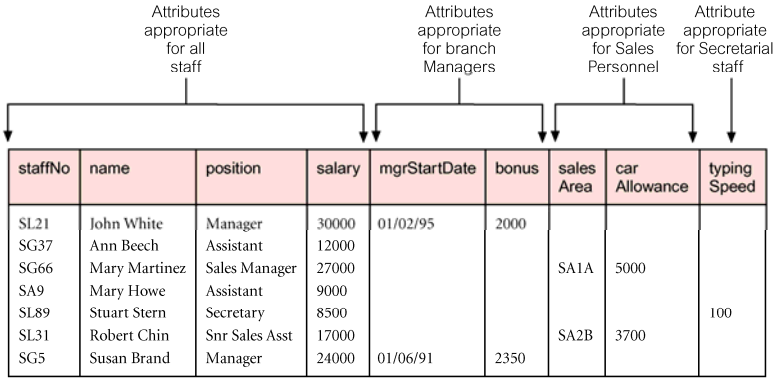
AllStaff Relation Holding Details of all Staff



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			

31

Superclass/subclass Relationships

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

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Attribute Inheritance

- Attribute Inheritance
  - An entity in a subclass represents same 'real world' object as in superclass, and may possess subclass-specific attributes, as well as those associated with the superclass.

33

Specialization / Generalization Process

- Specialization
  - Process of maximizing differences between members of an entity by identifying their distinguishing characteristics.
- Generalization
  - Process of minimizing differences between entities by identifying their common characteristics.

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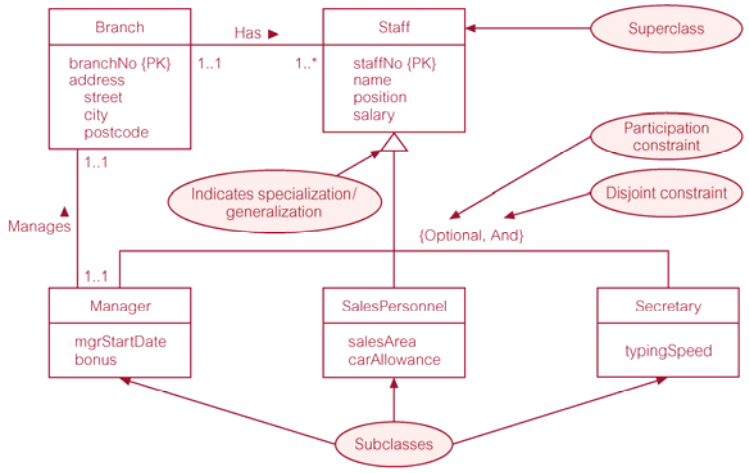
Specialization/Generalization of Staff Entity into Subclasses Representing Job Roles



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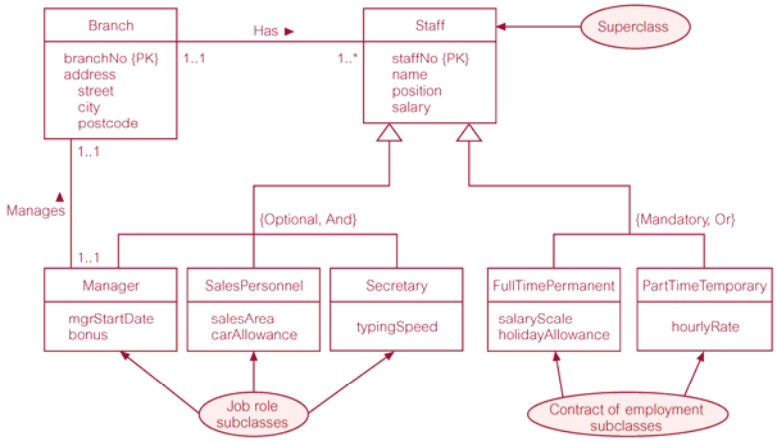
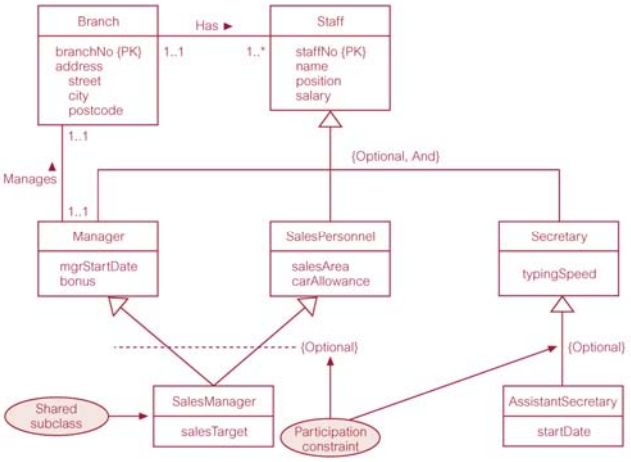
Specialization/Generalization of Staff Entity into Job Roles and Contracts of Employment



36

EER Diagram with Shared Subclass and Subclass with its own Subclass



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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.

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Constraints on Specialization / Generalization

- 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.

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Exercise 3

- There are two types of customers. One type pays by GIRO and another type pays by cheque. Use Generalization to create an EER diagram to show subclasses of the customer.
- GIRO customer (cust_no, cust_name, cust_addr, acct_no, bank, GIRO limit)
- Cheque customer (cust_no, cust_name, cust_addr, credit_period)

40

Exercise 3 Answer

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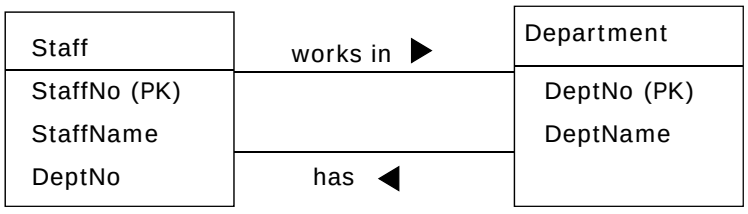
Exercise 4 : What is wrong with this ER diagram?



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Summary

- An ER diagram consists of entity types, attributes and relationships.
- Entity types can be classified as strong or weak.
- Attributes can be a simple or composite attribute, a single-valued or multi-valued attribute, or a derived attribute.
- A relationship type can involve one(unary/recursive), two(binary), three (ternary) or four (quarternary) entity types.
- The constraints on the relationships can be 1:1, 1:* and *:* .
- Use specialization/generalization if it can represent the user view better.

43

Reference Materials

1. Database Systems, Connolly, Ch 12 & 13
2. Database Solutions, Connolly, Ch 5

44