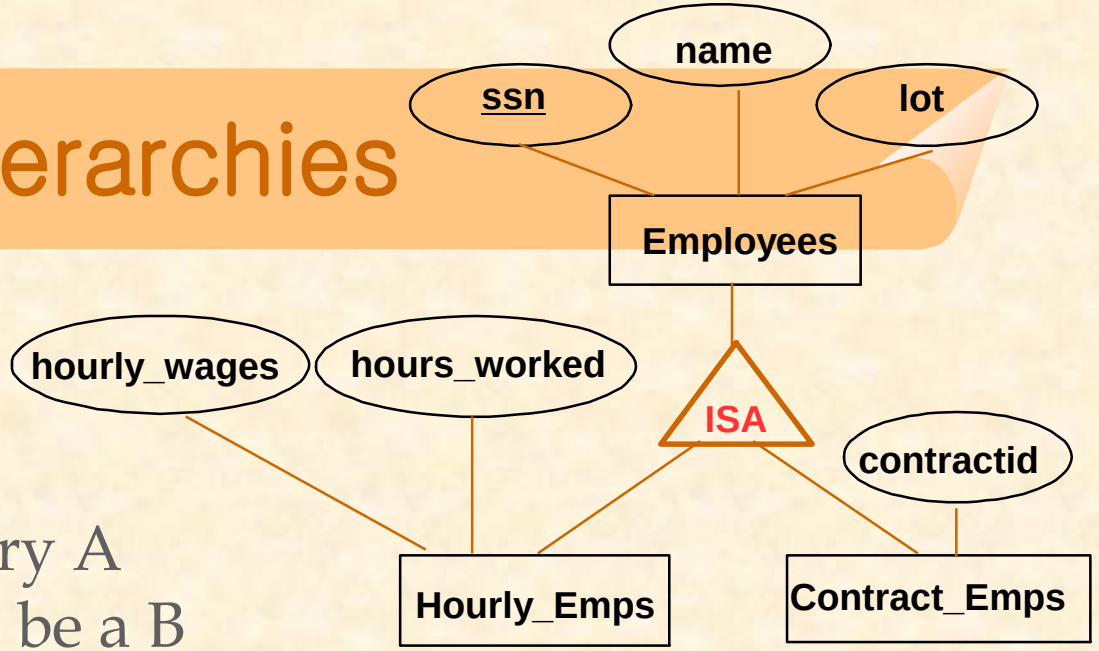
Chap 4. Enhanced Entity-Relationship and Object Model

Enhanced-ER(EER) Model Concepts

- Entity type
  - set of entities with the same properties : class
  - a set of employee entities => employee entity type
- superclass/subclass
  - class C : set of entities
  - subclass S : sub-grouping of entity type $S \subseteq C$
  - if class C_1 is a superclass of class C_2
    let $e_i \in C_1$ and $e_j \in C_2$
    => $e_j \in C_1$ but not $e_i \notin C_2$
- attribute inheritance
  - attribute of C1 = $\{a_{11}, a_{12}, \ldots, a_{1n}\}$
  - attribute of C2 = $\{a_{21}, a_{22}, \ldots, a_{2n}\} \cup \{a_{11},\ldots,a_{1n}\}$

ISA (is-a) Hierarchies



- As in C++, or other PLs, attributes are inherited.
- If we declare A **ISA** B, every A entity is also considered to be a B entity.

- Reasons for using IS-A:
  - To add descriptive attributes specific to a subclass.
  - To identify entitities that participate in a relationship.

Enhanced-ER(EER) Model Concepts

- Specialization $Z = \{S_1, S_2, \ldots, S_n\}$ of superclass G,

  S_i:subclass
  - specialization based on some distinguishing characteristics of superclass G
  - G/S_i = superclass/subclass(is-a) relationship
  - specialization process(G -> Si)
    - a set of subclasses
    - additional specific attributes with each subclass
    - additional specific relationship types between each subclass with other entity types

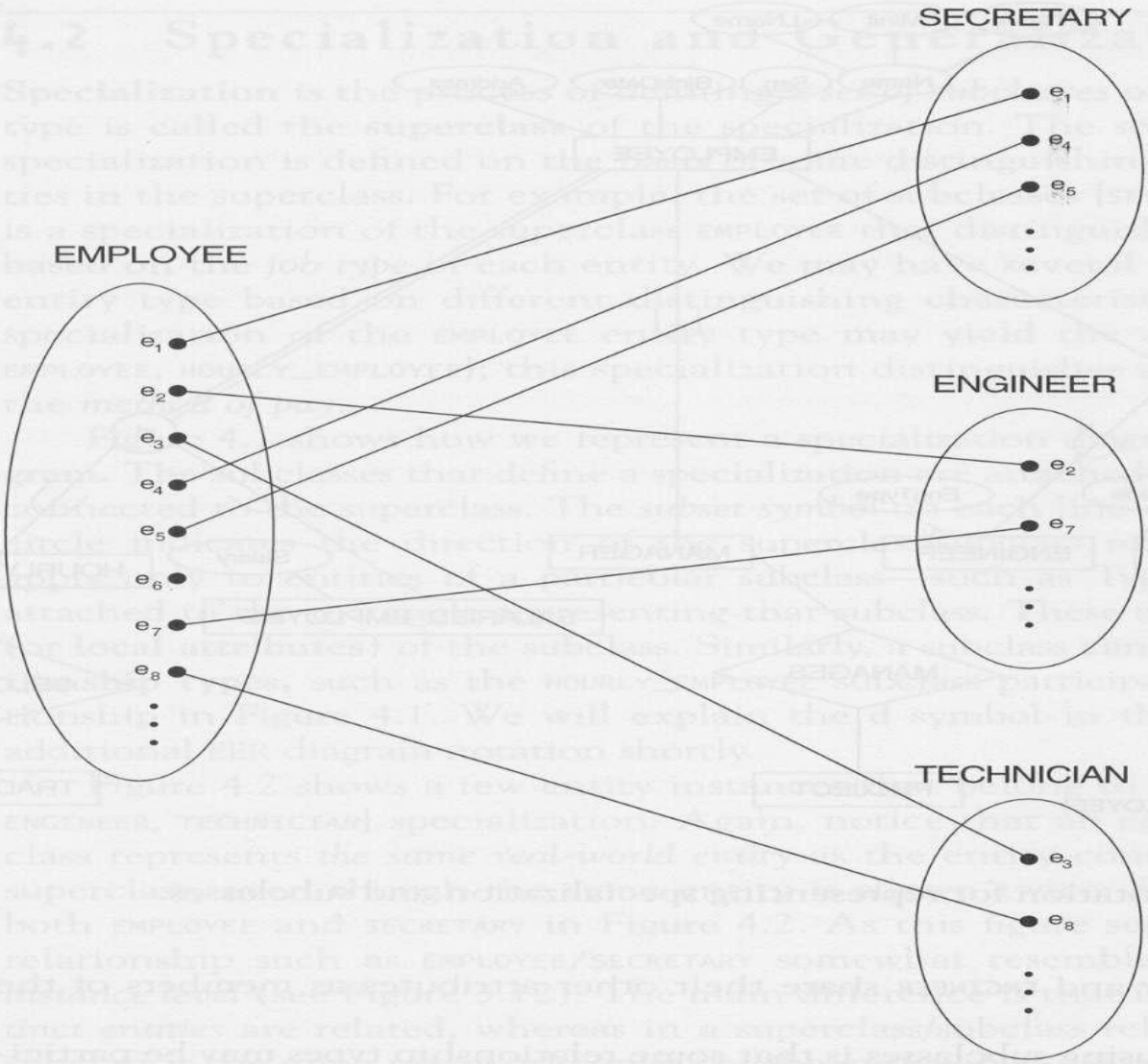


Figure 4.2 Some instances of the specialization of EMPLOYEE into the {SECRETARY, ENGINEER, TECHNICIAN} set of subclasses.

Enhanced-ER(EER) diagram

- Subclasses in data modeling
  - model specific attributes
    - subclass play a specific role => specific attributes
    - [employee => secretary, engineer – secretary&engineer share common attributes but secretary : typingspeed, engineer:engineertype]
  - model specific relationship on subclass [hourly_employees belongs to trade union]
  - Generalization
    - reverse process of specialization

Enhanced-ER(EER) diagram

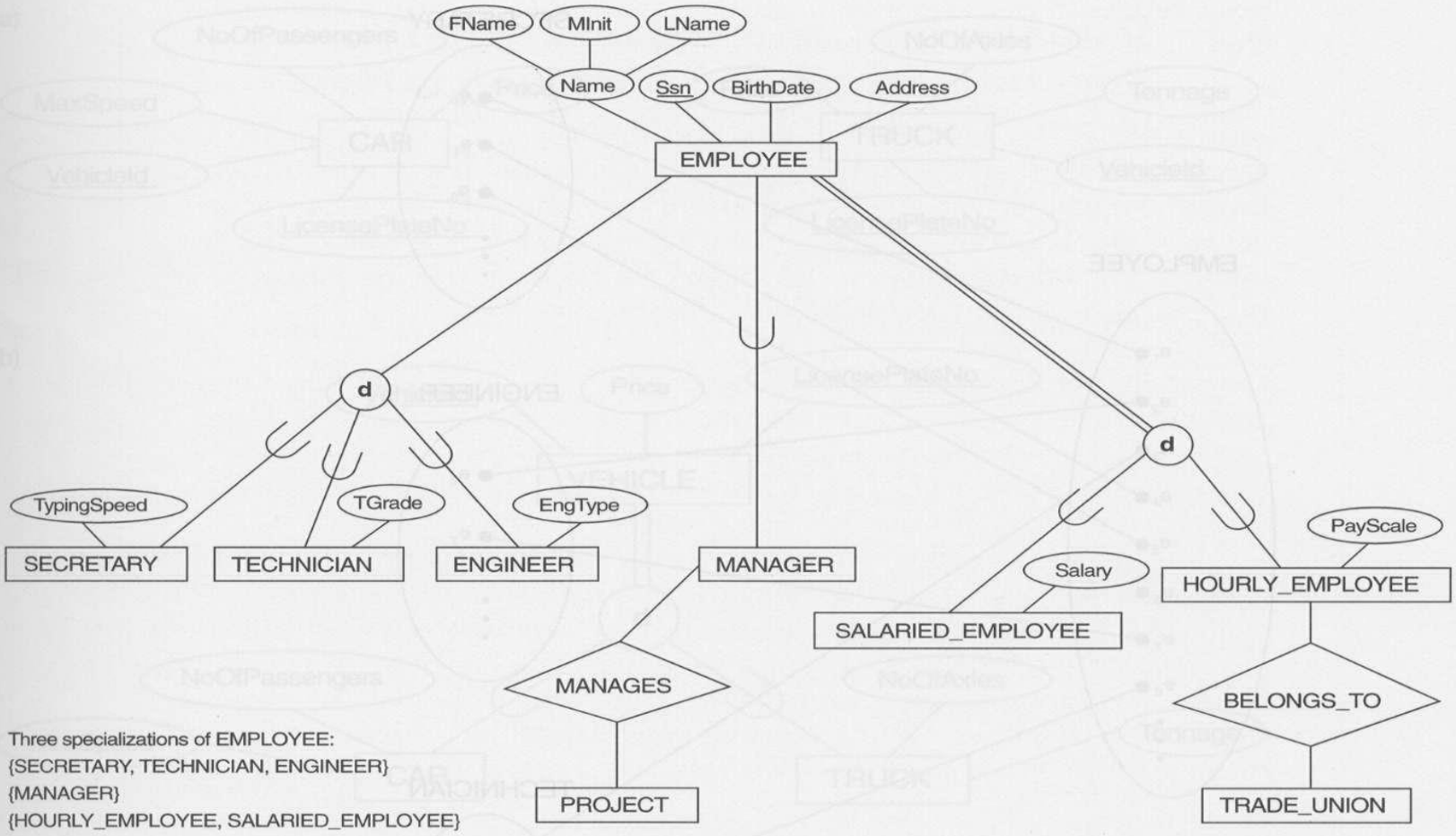


Figure 4.1 EER diagram notation for representing specialization and subclasses.

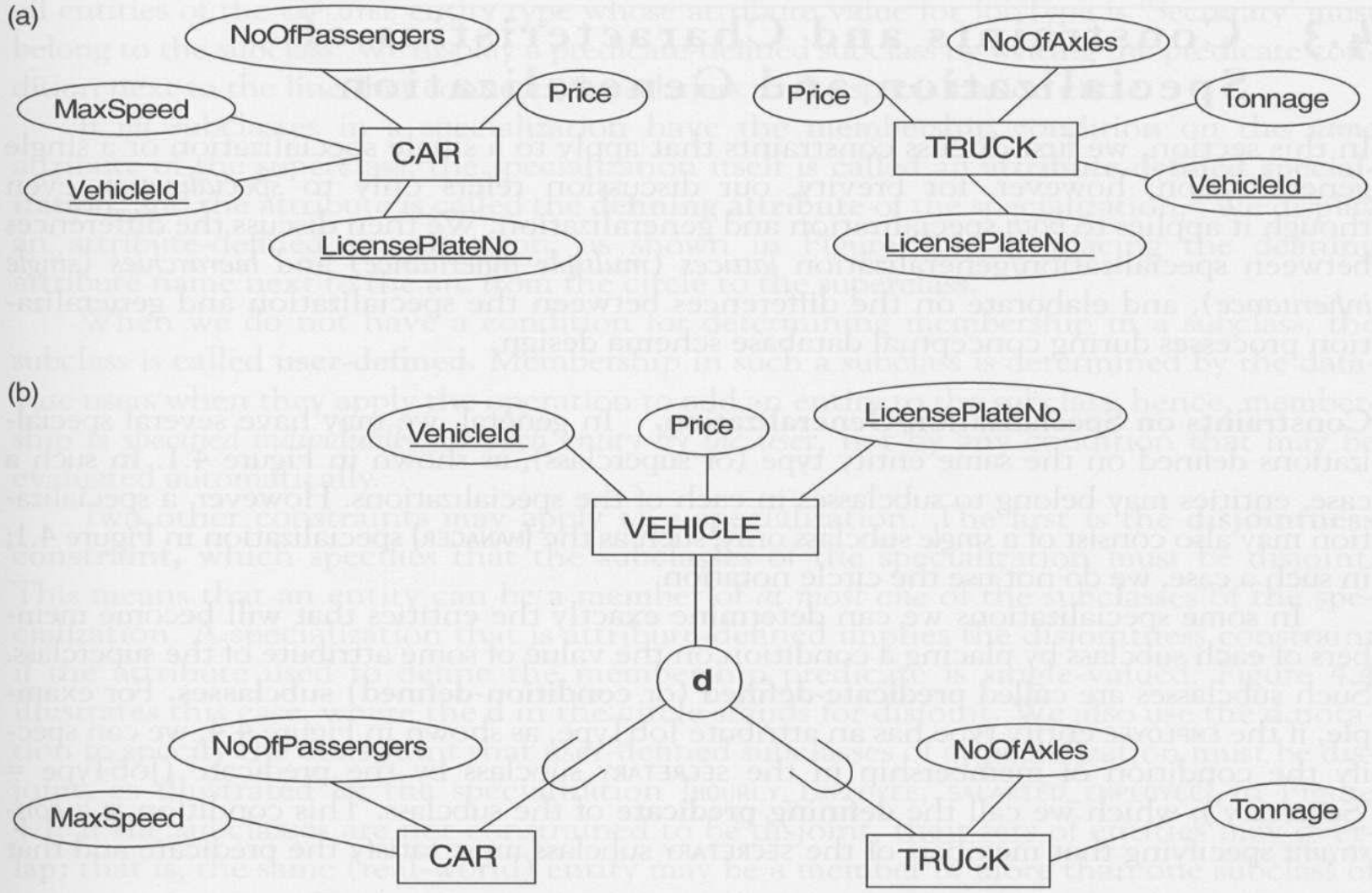


Figure 4.3 Examples of generalization. (a) Two entity types CAR and TRUCK. (b) Generalizing CAR and TRUCK into VEHICLE.

Constraint on specialization/generalization

- Subclass S of superclass C is predicate-defined subclass if
  - subclass membership is defined by some condition on attribute value of superclass : S = C[p]
    - [jobtype=secretary, technician, engineer]
    - defining predicate : P
  - attribute-defined specialization if a predicate is $(A=c_i)$ where A=attribute of G and c_i=constant
  - if all subclasses in specialization have the membership condition on the same attribute
    - defining attribute : specialized attribute
  - diagram : superclass-------circle-------subclass

defining attribute *attr_value*

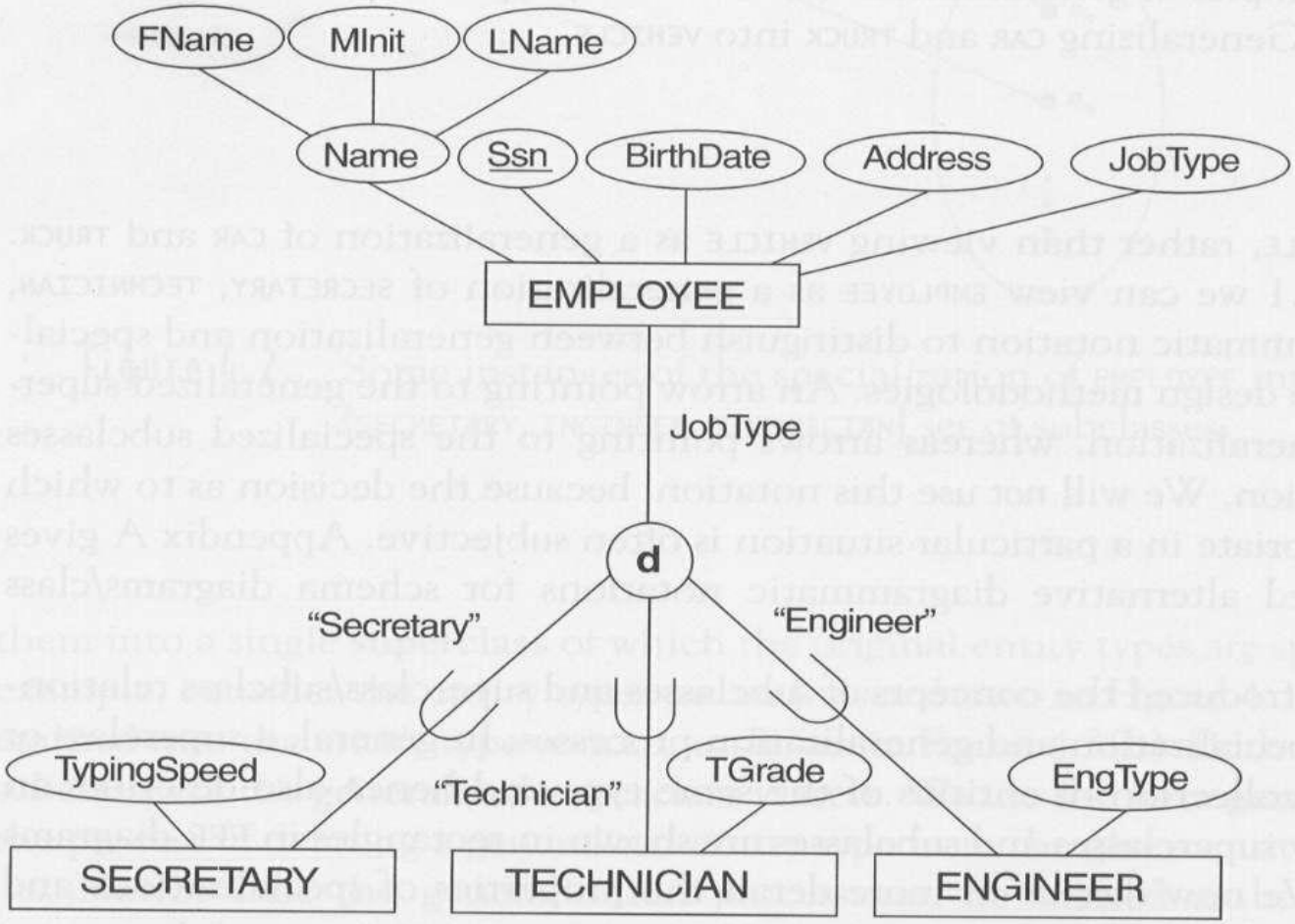


Figure 4.4 An attribute-defined specialization on the JobType attribute of EMPLOYEE.

Constraint on specialization/generalization

- User-defined subclass
  - specialized into one subclass by user when insertion
    - [manager]
  - diagram : no circle

- disjoint subclass : disjoint constraint
  - an entity can be a member of at most one of the subclass => $S_i \cap S_j = \varnothing$ for $i \neq j$
    - if attribute-defined subclass and single-valued attr, => disjoint subclass
  - diagram : place “d” inside the circle [hourly_employee, salaried_employee]

Constraint on specialization/generalization

- overlap subclass
  - the same entity can be a member of more than one subclass
  - diagram:place “o” inside the circle
- total specialization:completeness constraint
  - every entity in superclass must be a member of some subclass => $\cup S_i=G$, i=1..n
    - [hourly_employee, salaried_employee]
  - diagram : superclass ==(double line)==circle
- partial specialization
  - allows an entity not to belong to any subclass
    - [jobtype:secretary, technician, engineer]

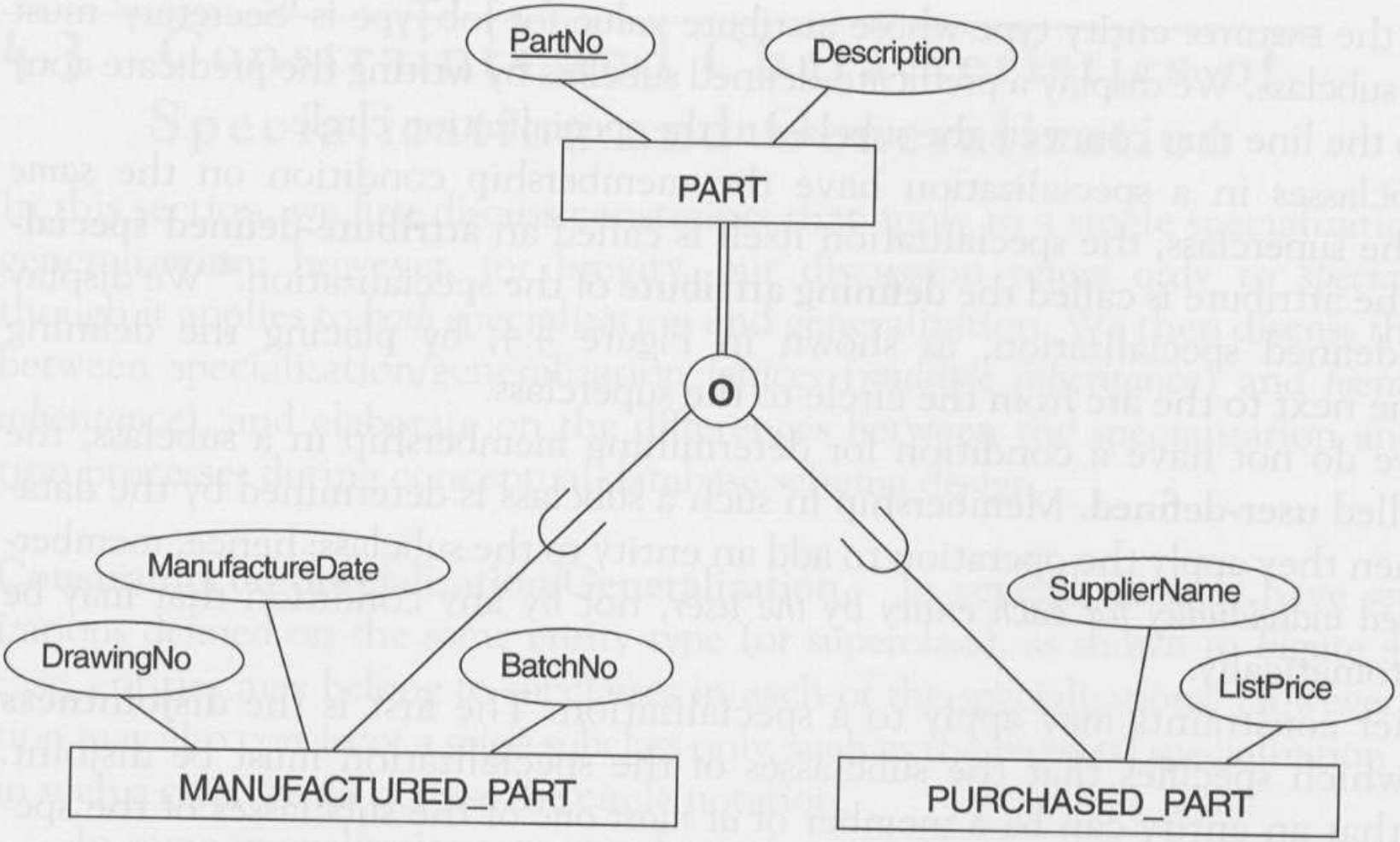


Figure 4.5 Notation for specialization with overlapping (nondisjoint) subclasses.

Constraint on specialization/generalization

- Disjoint and completeness constraint
  - disjoint, total
  - disjoint, partial
  - overlapping, total
  - overlapping, partial

Constraint on specialization/generalization

- Insertion & deletion rules for specialization/ generalization
  - deleting an entity from superclass
    - automatically deleted from all subclasses
  - inserting an entity in a superclass
    - automatically inserted in all the predicate-defined subclasses if defining predicate is satisfied
  - inserting an entity in a superclass of total specialization
    - automatically inserted in at least one of subclasses

Constraint on specialization/generalization

- Specialization hierarchies & lattices
  - hierarchy : single inheritance
  - lattice : multiple inheritance
    - [engineering_manager => engineer, salaried_employee, manager]
    - inherit all the attributes of superclass
- Top-down vs Bottom-up conceptual design
  - successive specialization : top-down design
    - [person in university DB ->{employee, alumni, student} -> ...-> grad_stud, under_stud
  - successive generalization : bottom-up design
  - combination of two

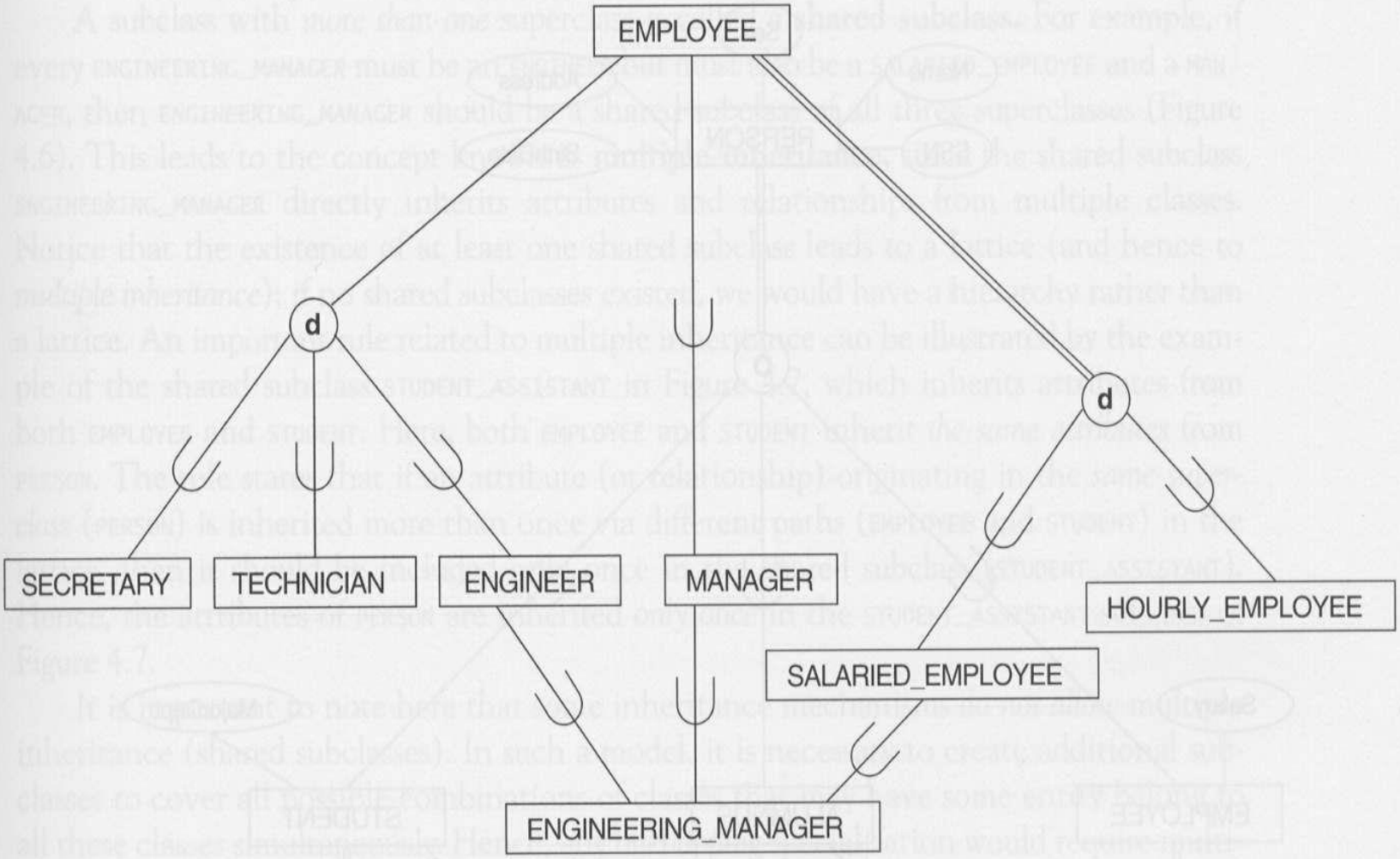


Figure 4.6 A specialization lattice with the shared subclass ENGINEERING_MANAGER.

Modeling Union Types

- If the superclass of a class is Union of two different classes

  => use categories

  - Selective attribute inheritance (one at a time)

  - If all entities of super-classes are participated in a category => total category /* double line

    else

    => partial category

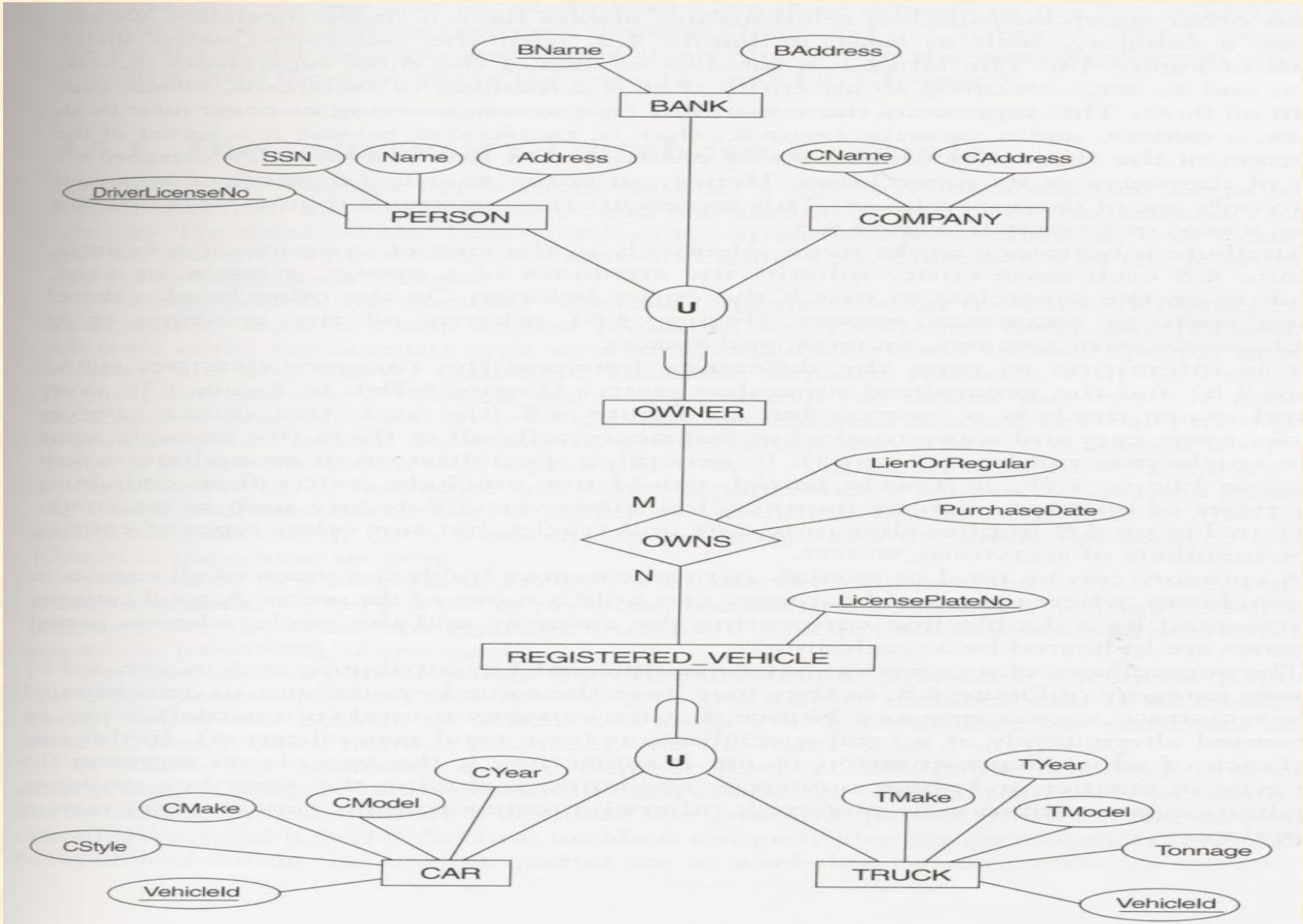


FIGURE 4.8 Two categories (union types): OWNER and REGISTERED_VEHICLE.

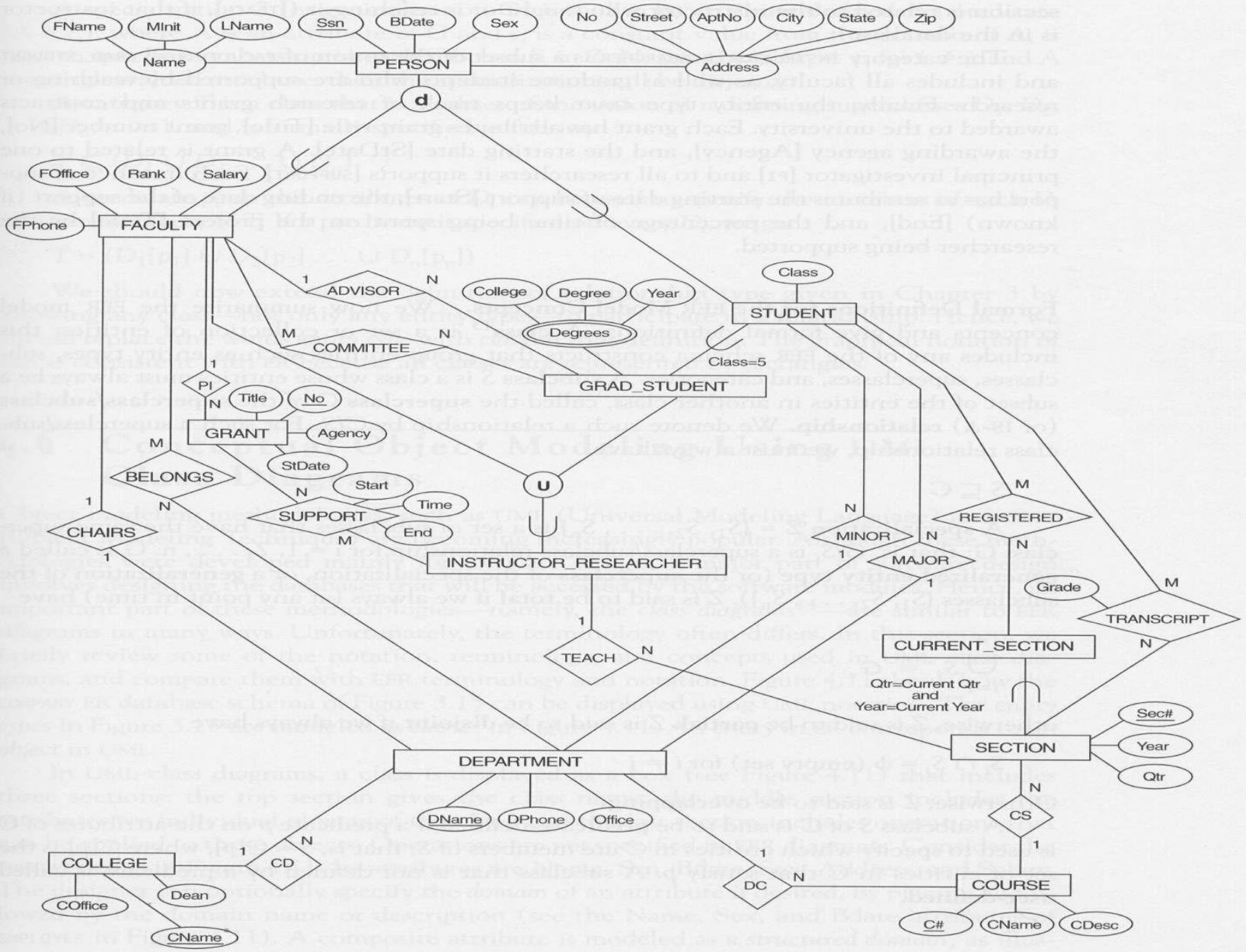


Figure 4.10 An EER conceptual schema for a UNIVERSITY database.

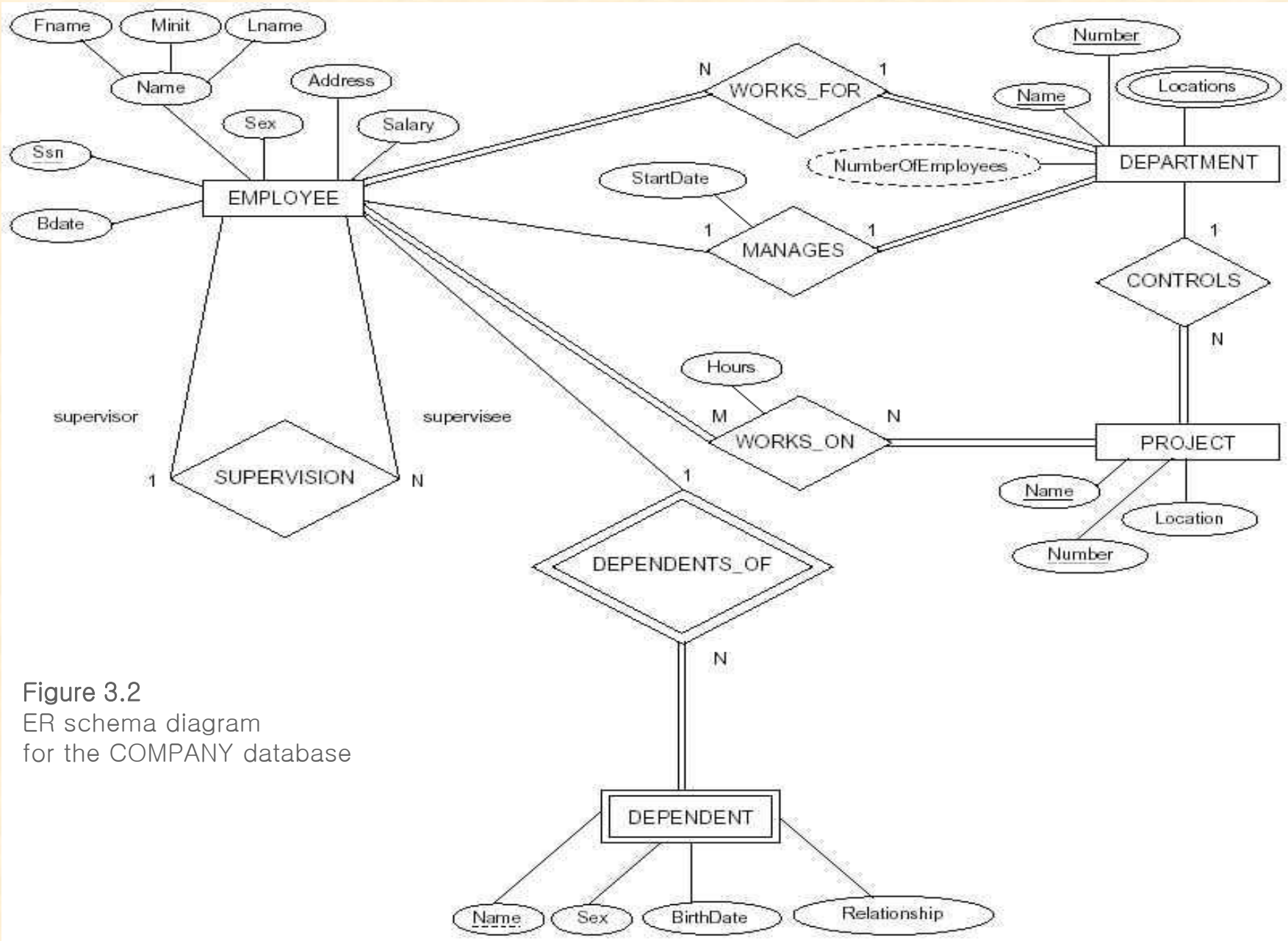
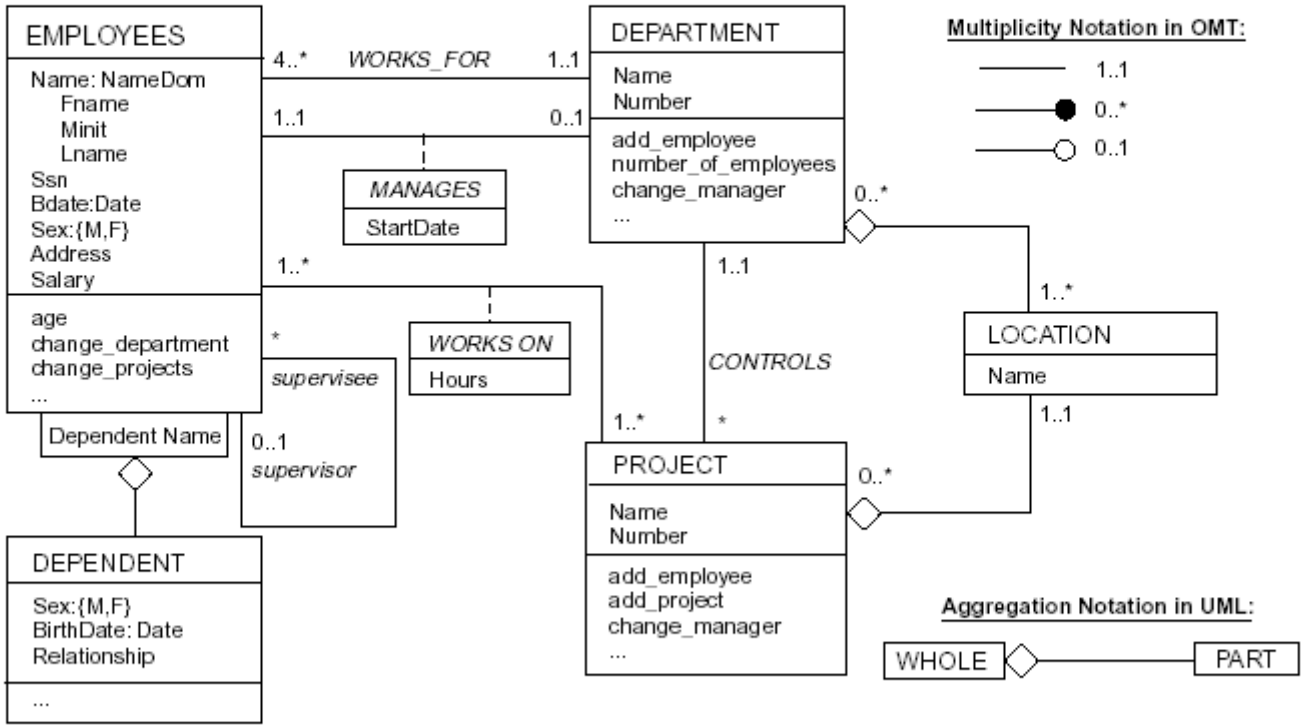


Figure 3.2
ER schema diagram
for the COMPANY database

Figure 4.11 The UML conceptual schema for the COMPANY database in Figure 3.15.



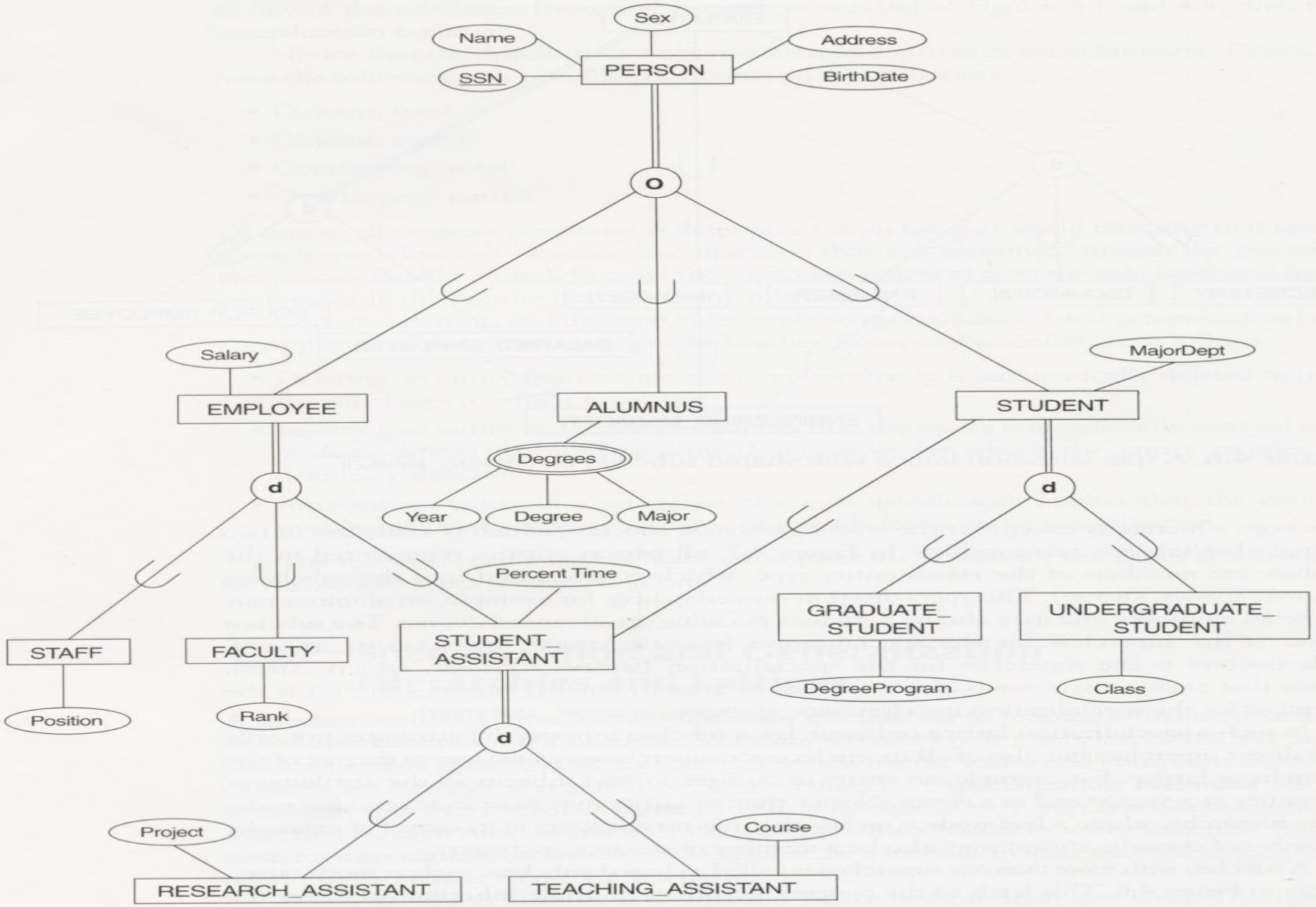


FIGURE 4.7 A specialization lattice with multiple inheritance for a UNIVERSITY database.

Figure 4.12 Specialization/generalization notation in UML shown by a class diagram corresponding to the EER diagram in Figure 4.7.