An Introduction to the Database Management Systems

By
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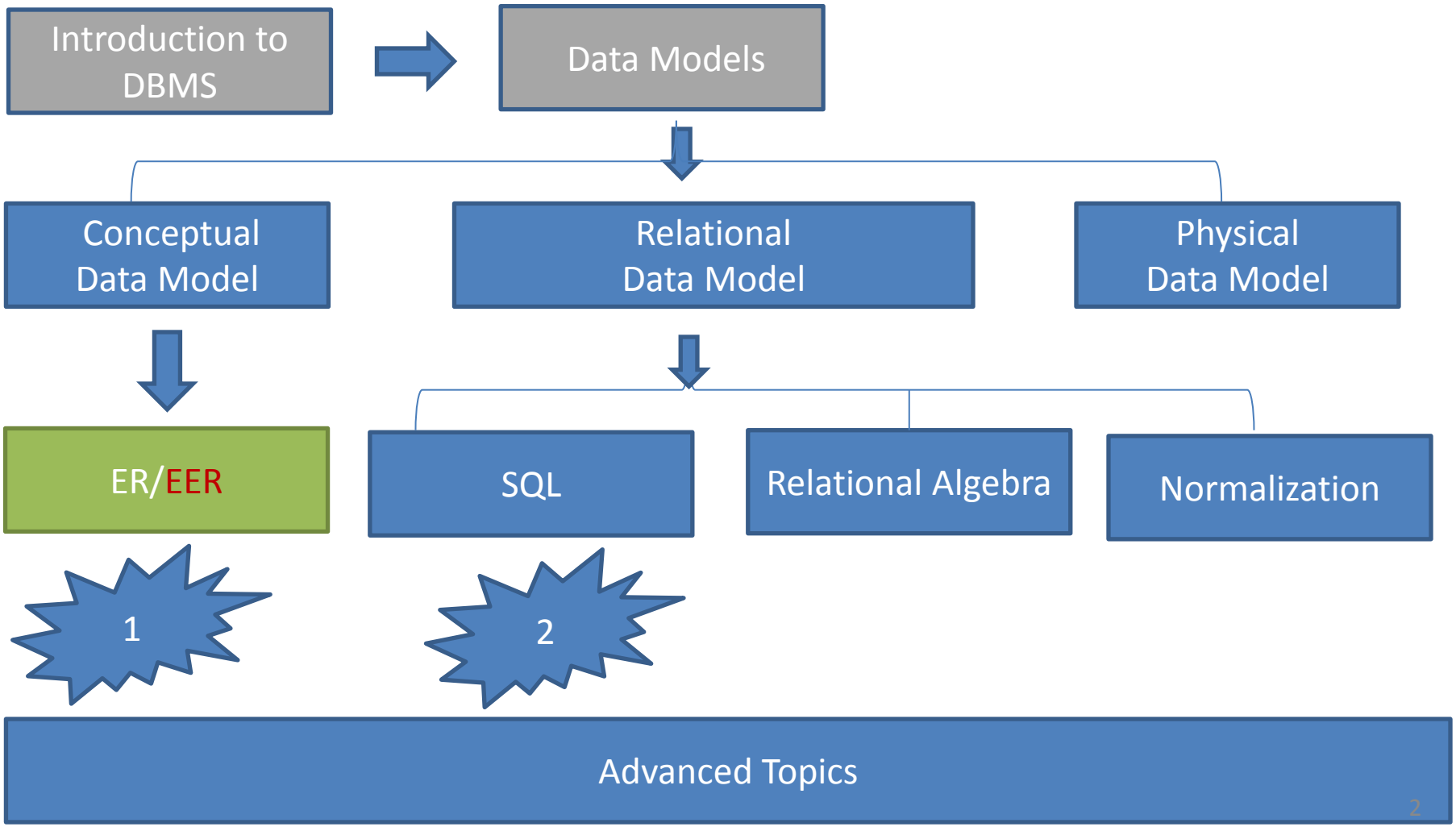
Slides originally by Book(s) Resources

Road Map

(Might change!)

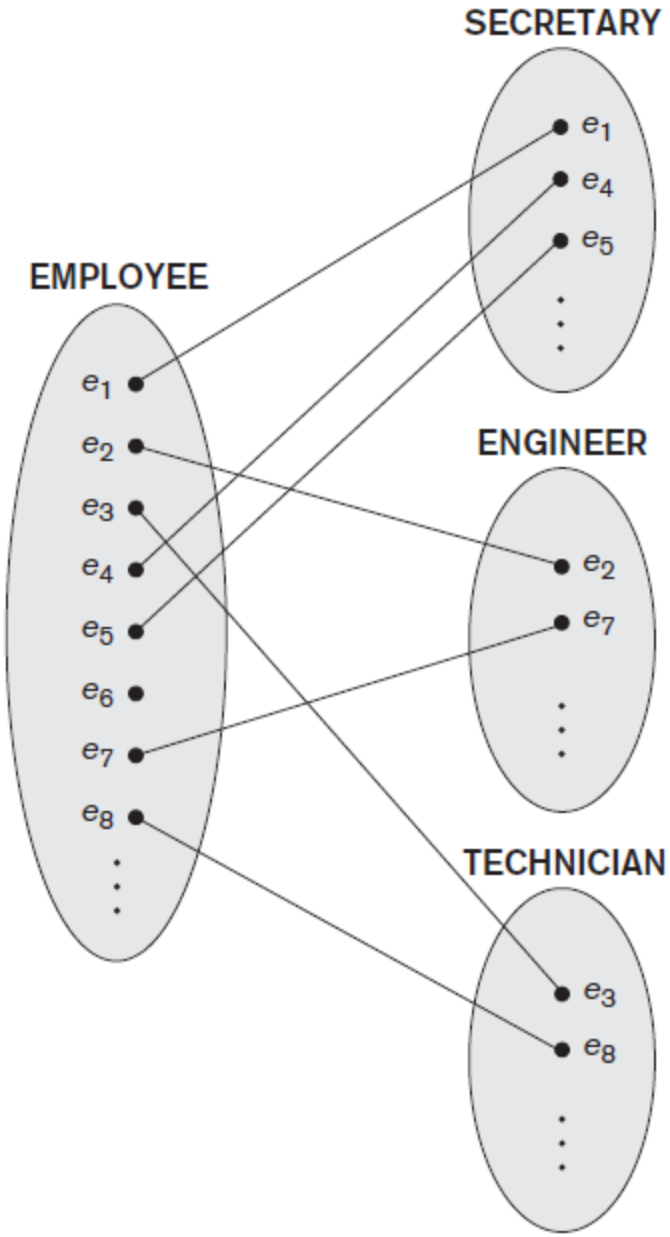


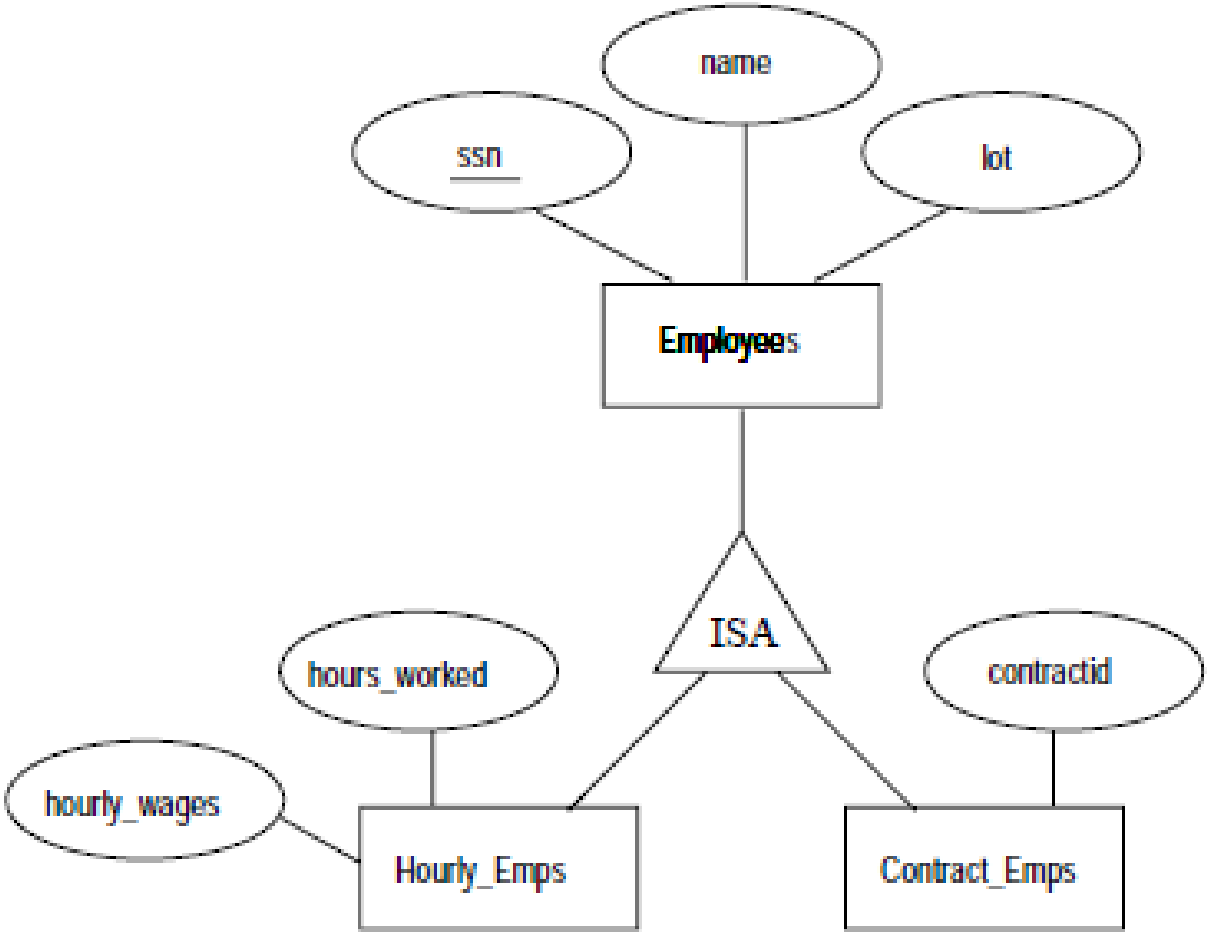
The Enhanced Entity-Relationship (EER) Model

- Subclasses, Superclasses 
- Specialization and Generalization
- Constraints In Specialization/Generalization
- Modeling of UNION Types Using Categories
- Aggregation

Entity types in ER diagrams

- Until now, each entity was assigned to one entity type
- In many cases an entity type has numerous subgroupings or subtypes of its entities that are meaningful and need to be represented explicitly
- Members of the EMPLOYEE entity type may be distinguished further into SECRETARY, ENGINEER, MANAGER, etc


SECRETARY
e_1
e_4
e_5
EMPLOYEE
e_1
e_2
e_3
e_4
e_5
e_6
e_7
e_8
ENGINEER
e_2
e_7
TECHNICIAN
e_3
e_8


name
ssn
lot
Employees
ISA
hours_worked
contractid
hourly_wages
Hourly_Emps
Contract_Emps

Subclasses and Superclasses

- Each of these subgroupings is called a **subclass** or **subtype** of the EMPLOYEE entity type, and the EMPLOYEE entity type is called the **superclass** or **supertype**
- Each subclass member is the same as the entity in the superclass, but in a distinct *specific role*

Subclasses and Superclasses

- An entity type *A* is a **subclass** of *B* if all entities of type *A* are always also of type *B* (but not vice versa)
- Entity type *B* is a **superclass** of *A*
- A subclass *inherits* all attributes and relation types of its superclass
- Entities belong to *more than one* entity type!

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Specialization

- *Specialization* is identifying a set of subclasses of an entity type
  - Additional attributes in the subclasses are called *specific* (or *local*) attributes
  - Additional relations on the subclasses are called specific (or local) relations
  - There can be more than one specialization of an entity type simultaneously!
- Example:
  - specialize student to graduate and freshman;
  - specialize student to field of study

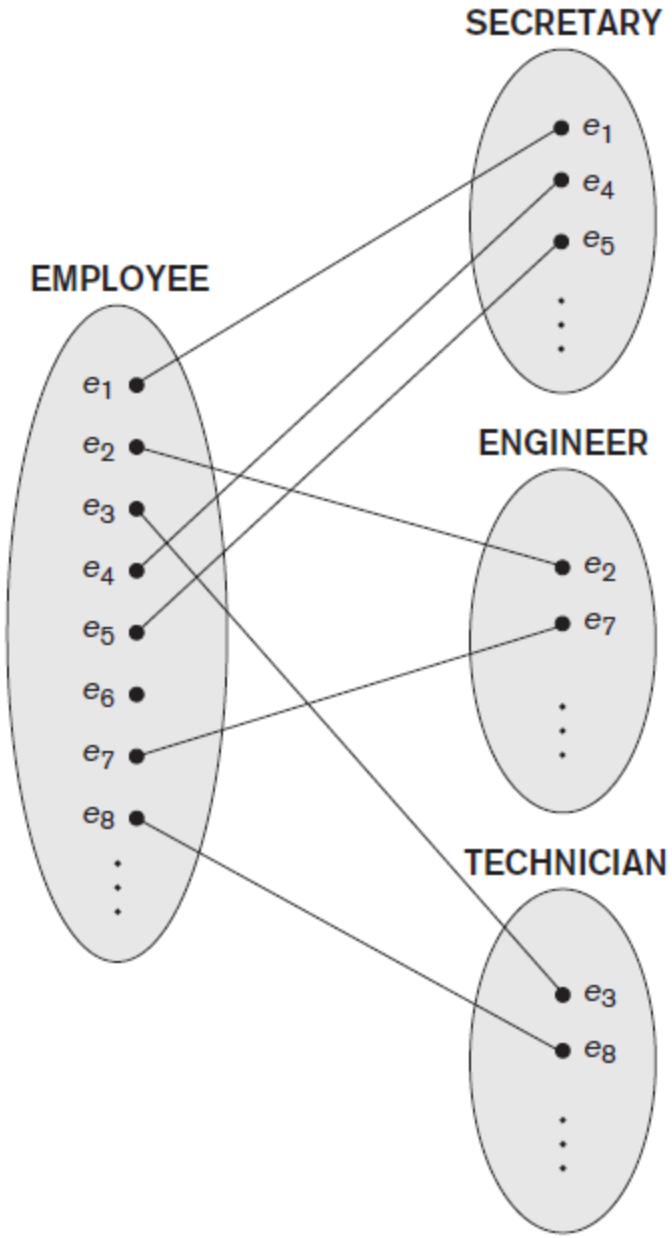
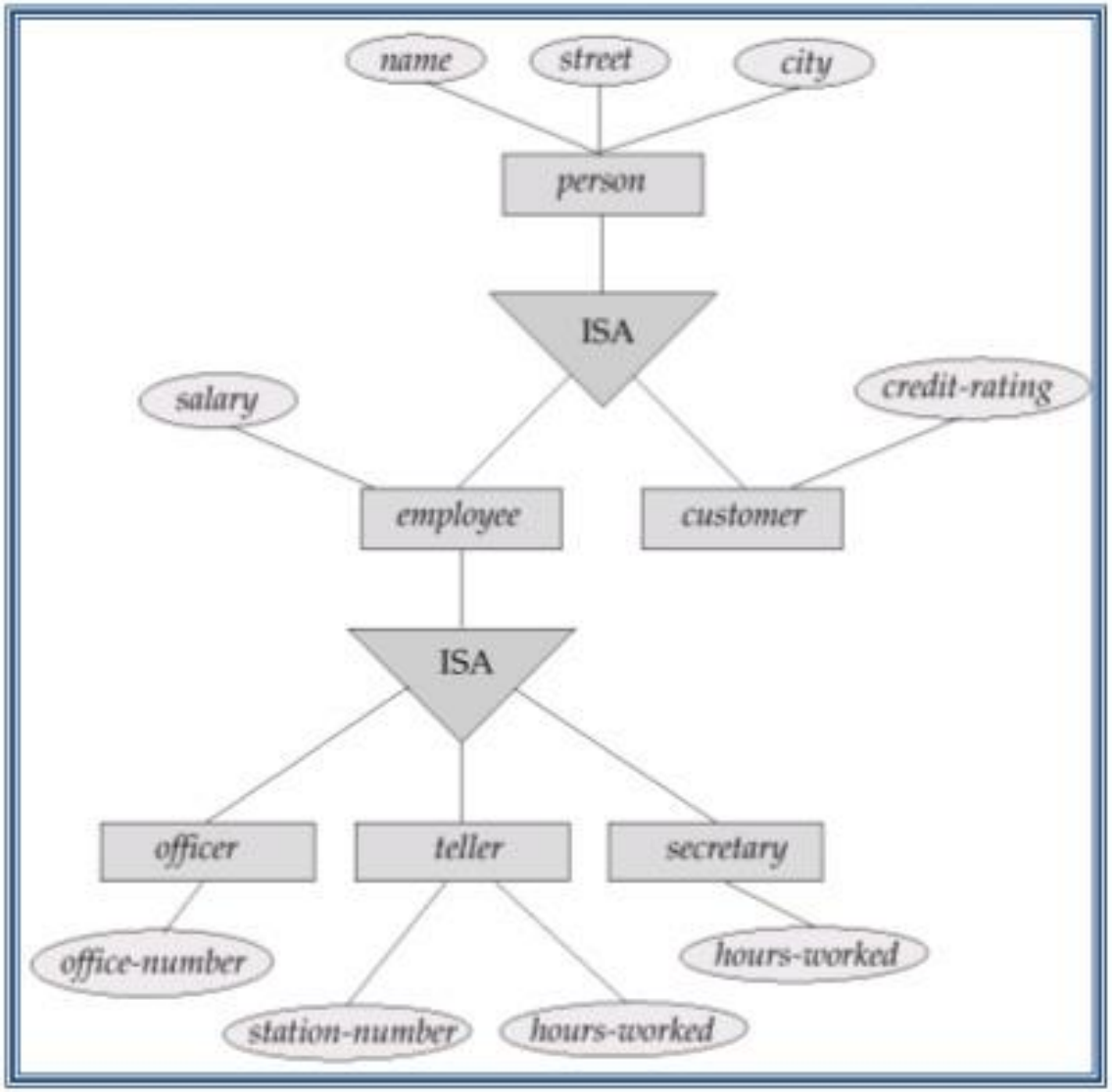
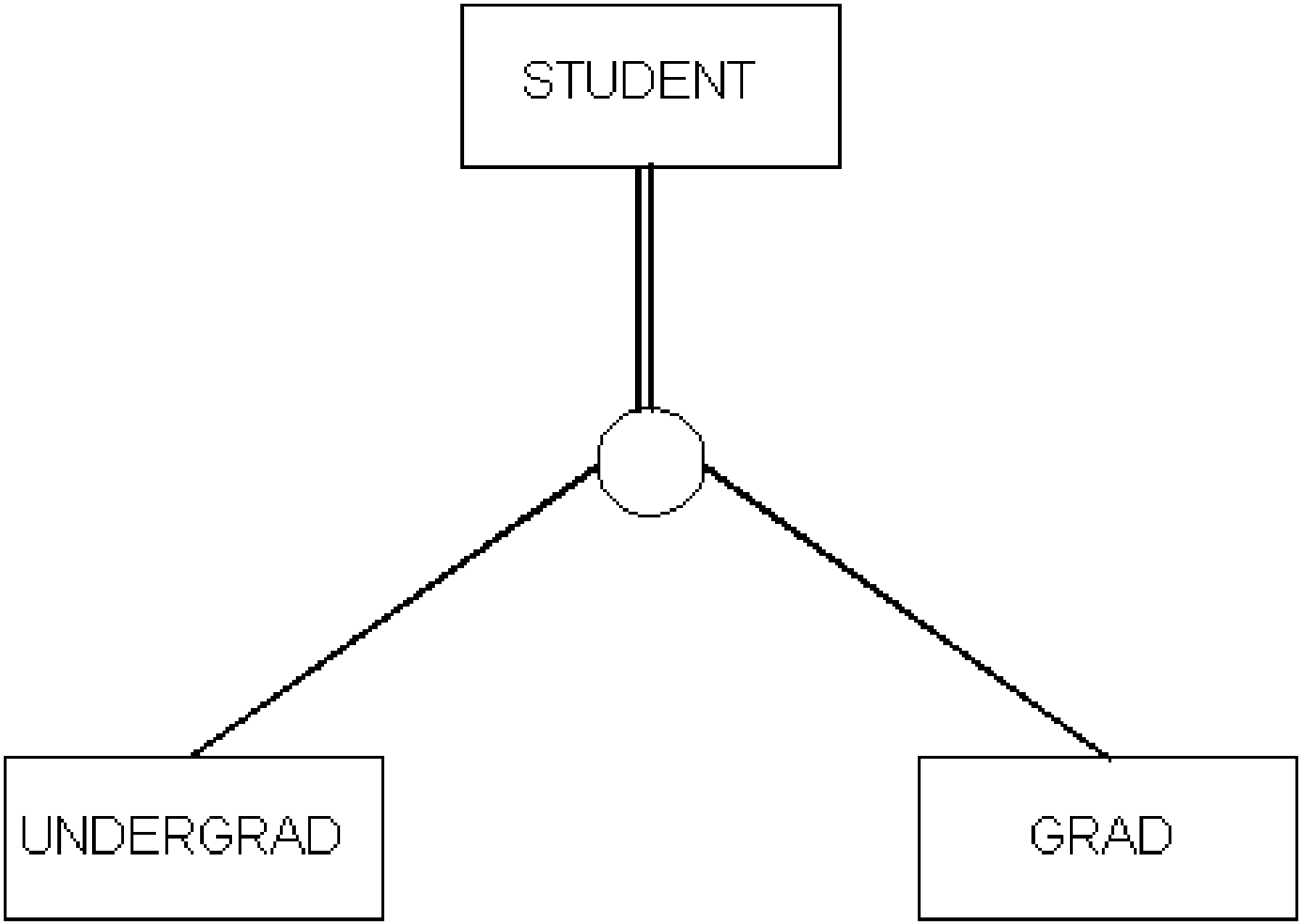


Figure 8.2
Instances of a specialization.

Specialization Example

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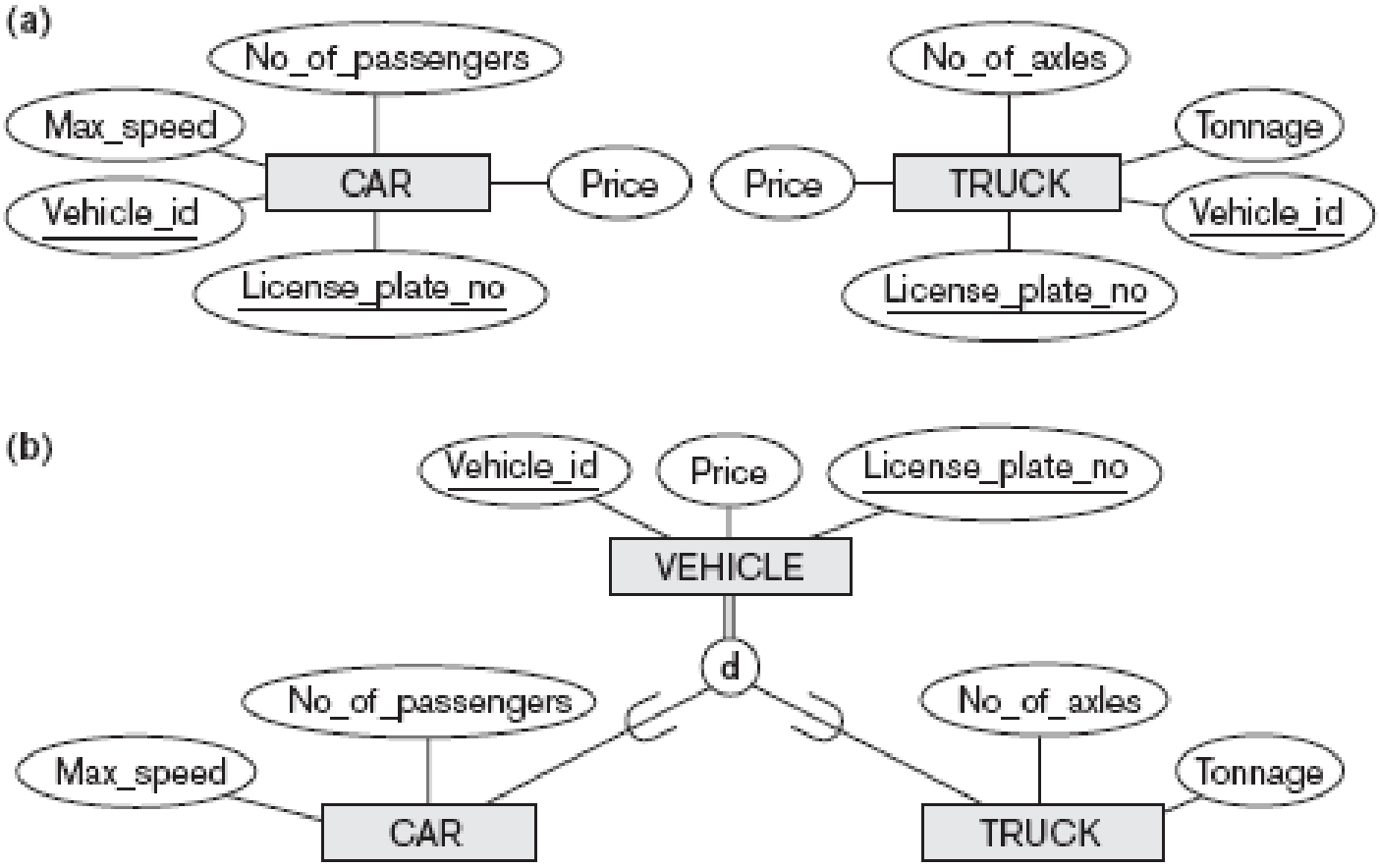
UNDERGRAD
GRAD

Generalization

- Generalization is the construction of an entity type that embodies the common properties (attributes and relations) of a number of given entity types
  - The new entity type is the generalized superclass of the entity types
  - An entity type can participate in multiple generalizations
- Example:
  - generalize bicycle and car to vehicle

Example


(a)
No_of_passengers
Max_speed
CAR
Price
Vehicle_id
License_plate_no
No_of_axles
Tonnage
Price
TRUCK
Vehicle_id
License_plate_no
(b)
Vehicle_id
Price
License_plate_no
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d
No_of_passengers
Max_speed
CAR
No_of_axles
Tonnage
TRUCK

15

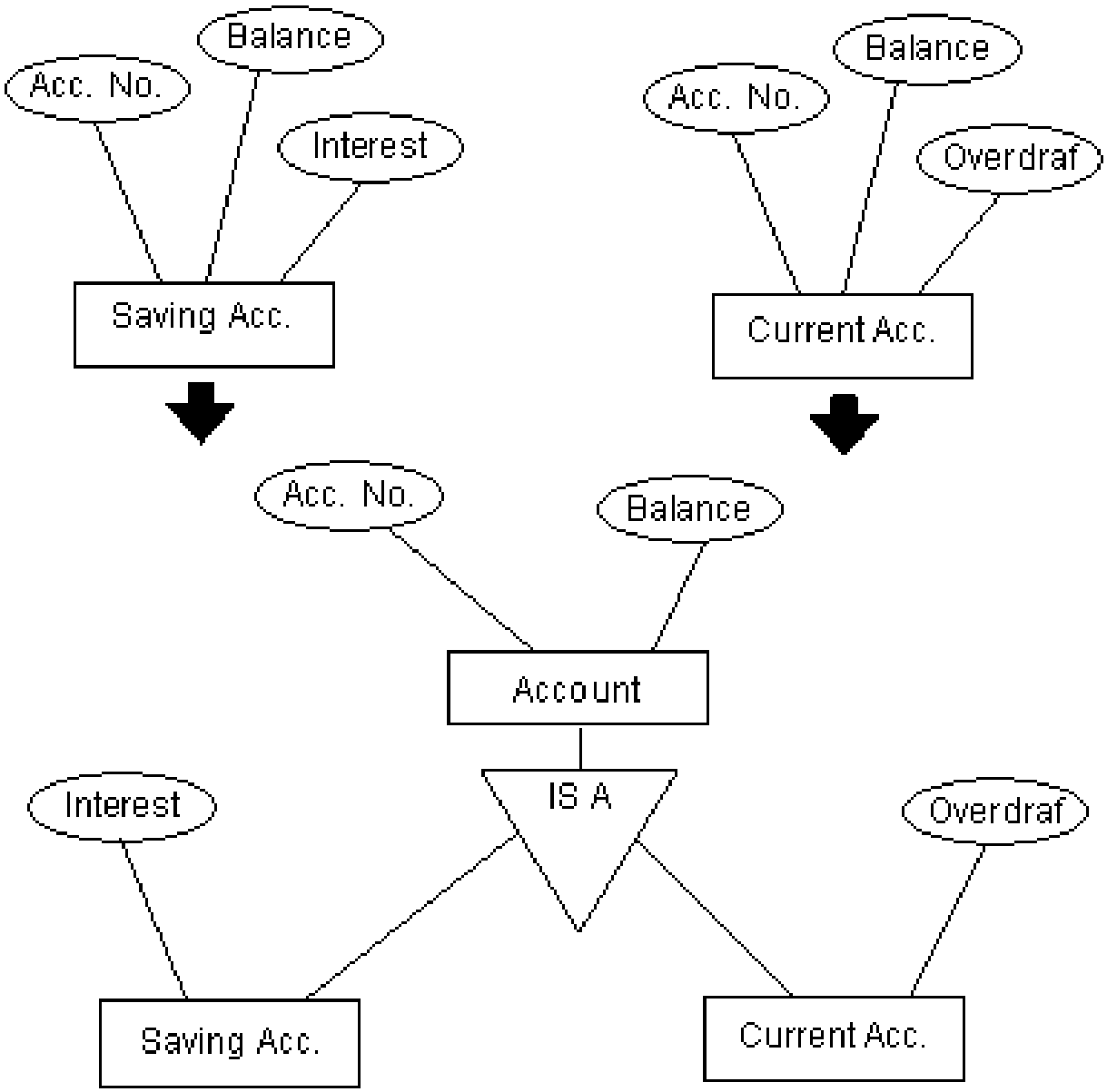
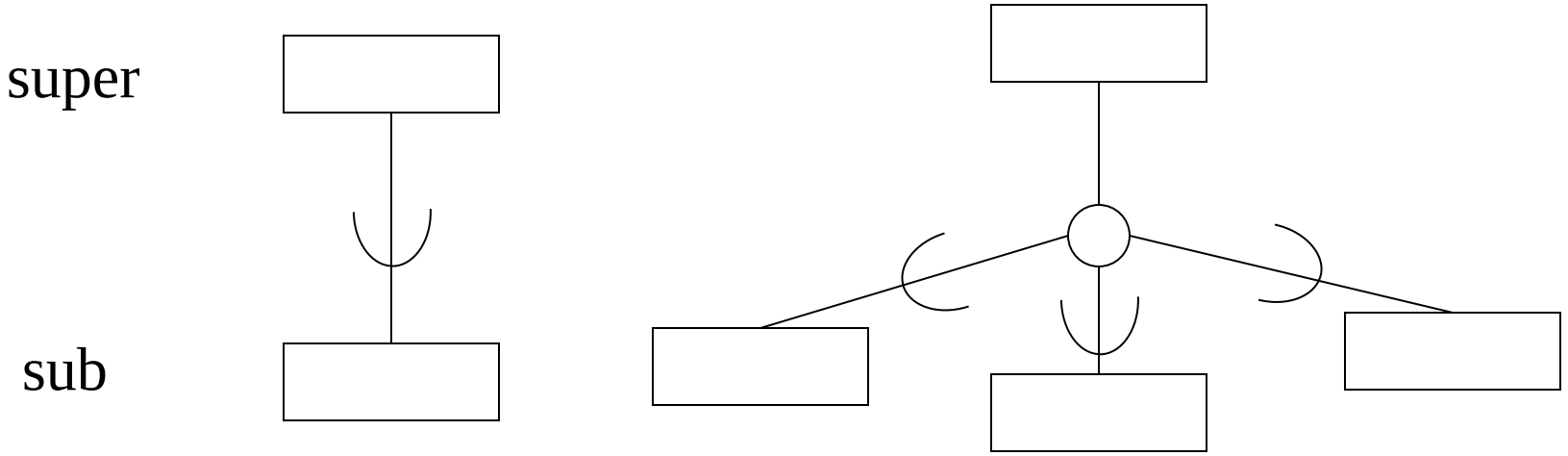


Figure 3.7 : Generalization procedure

EER construct

- EER (extended ER model / schema) contains one construct for specialization and generalization together:



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Restrictions
Total Vs Option

- **Total:**
  - *every* entity in the superclass must be a member of at least one subclass in the specialization
  - **total**: double line from superclass;
  - **partial**: optional participation in specialization

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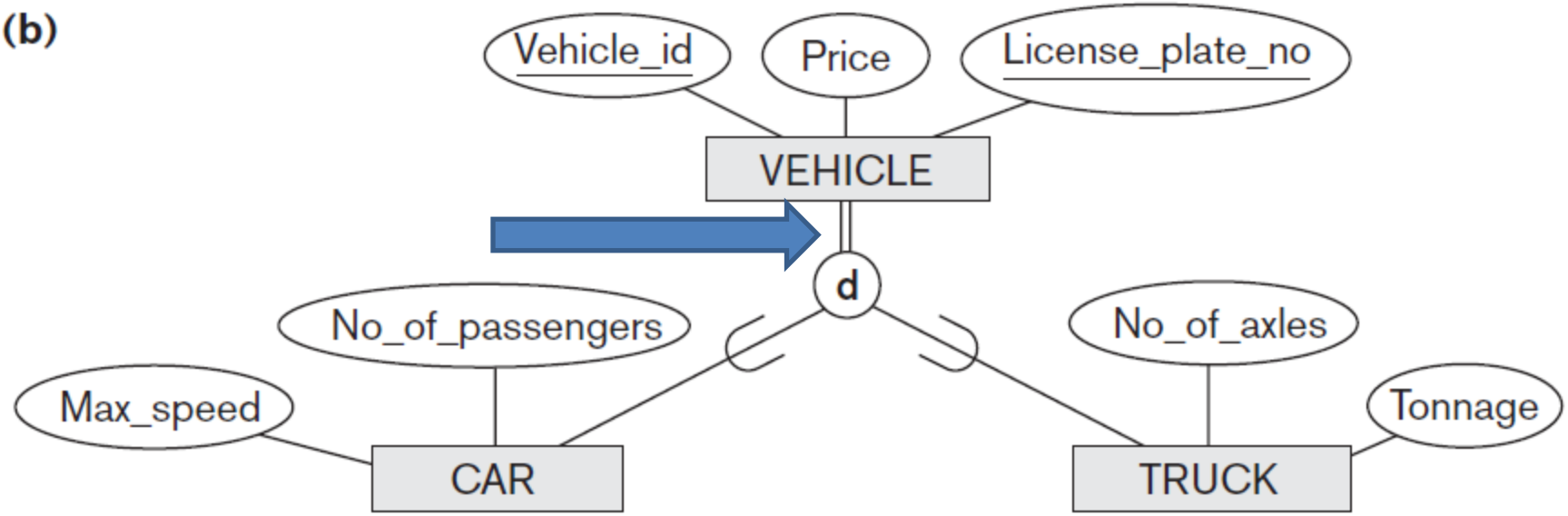
(b)


Vehicle_id
Price
License_plate_no
VEHICLE
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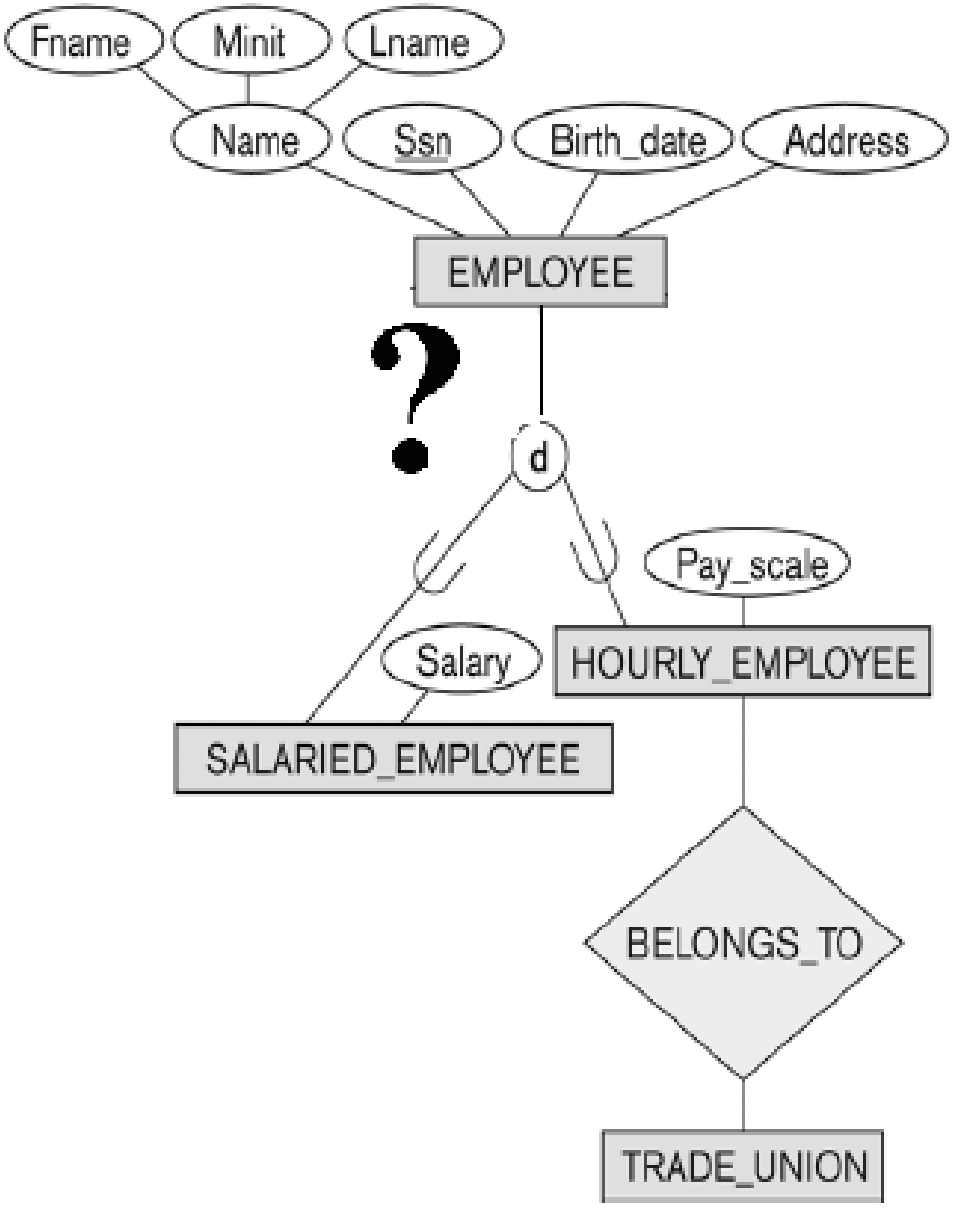
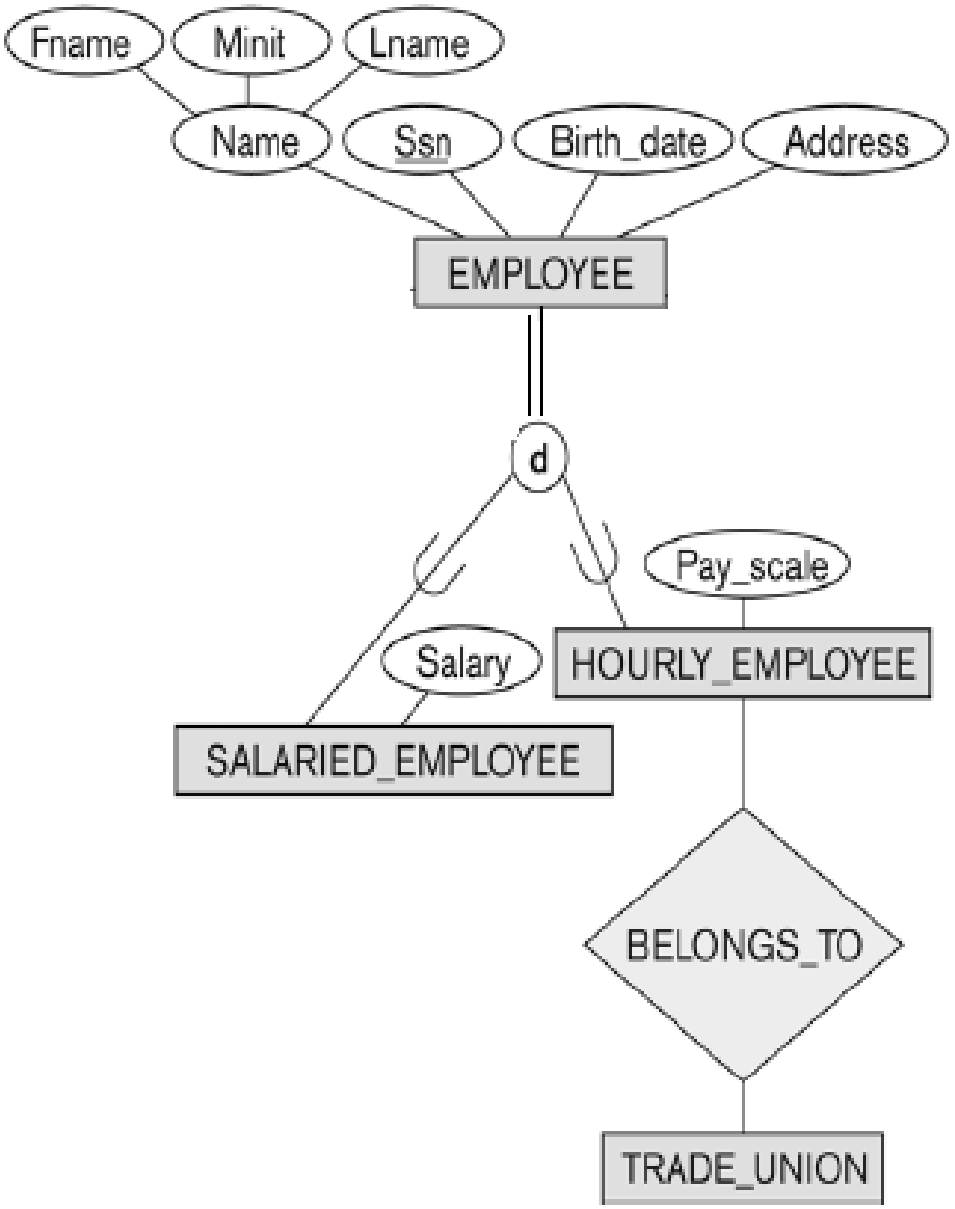
No_of_passengers
Max_speed
CAR
No_of_axles
Tonnage
TRUCK


Fname
Minit
Lname
Name
Ssn
Birth_date
Address
EMPLOYEE
?
d
Pay_scale
Salary
HOURLY_EMPLOYEE
SALARIED_EMPLOYEE
BELONGS_TO
TRADE_UNION


Fname
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Ssn
Birth_date
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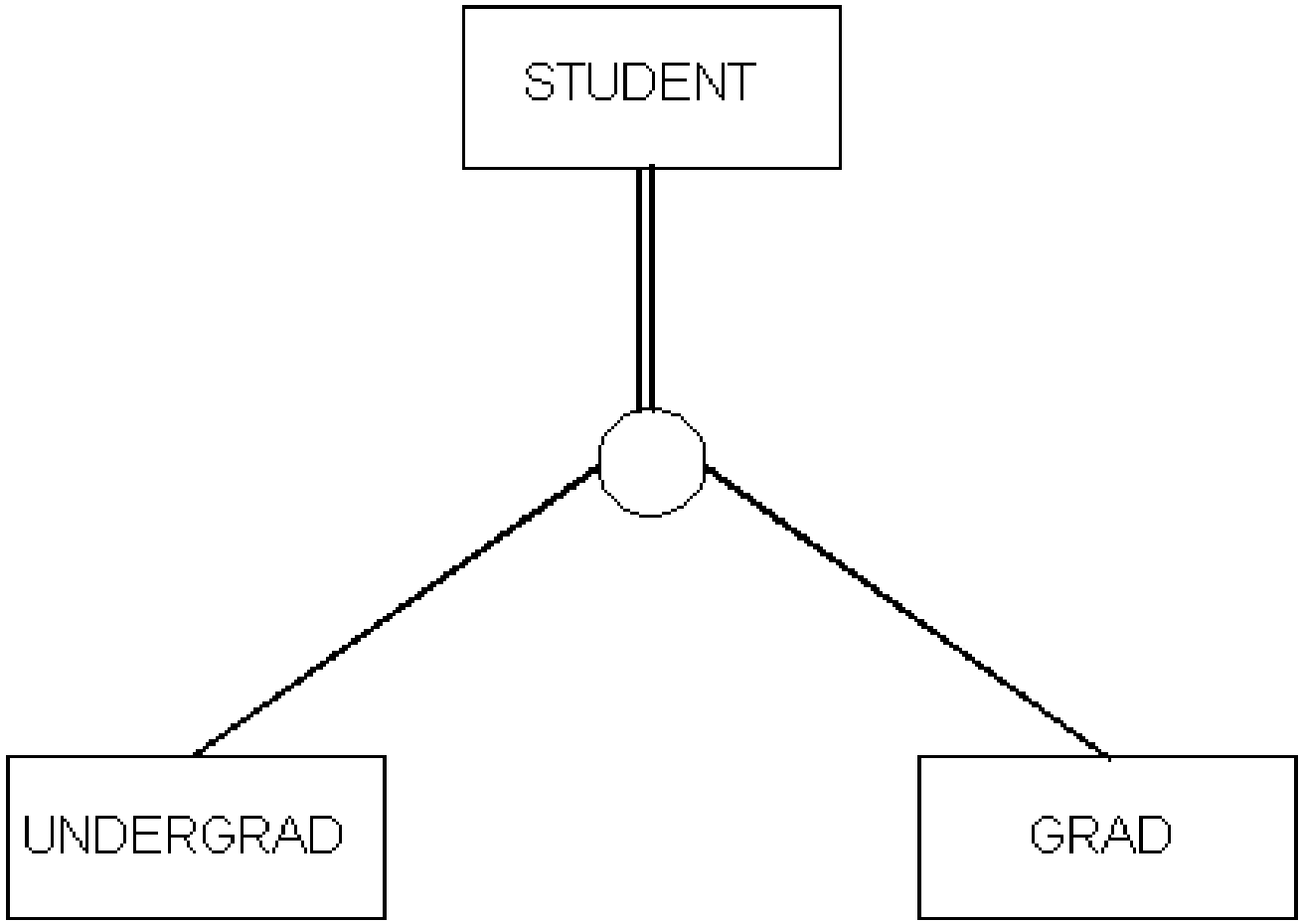
Pay_scale
Salary
HOURLY_EMPLOYEE
SALARIED_EMPLOYEE
BELONGS_TO
TRADE_UNION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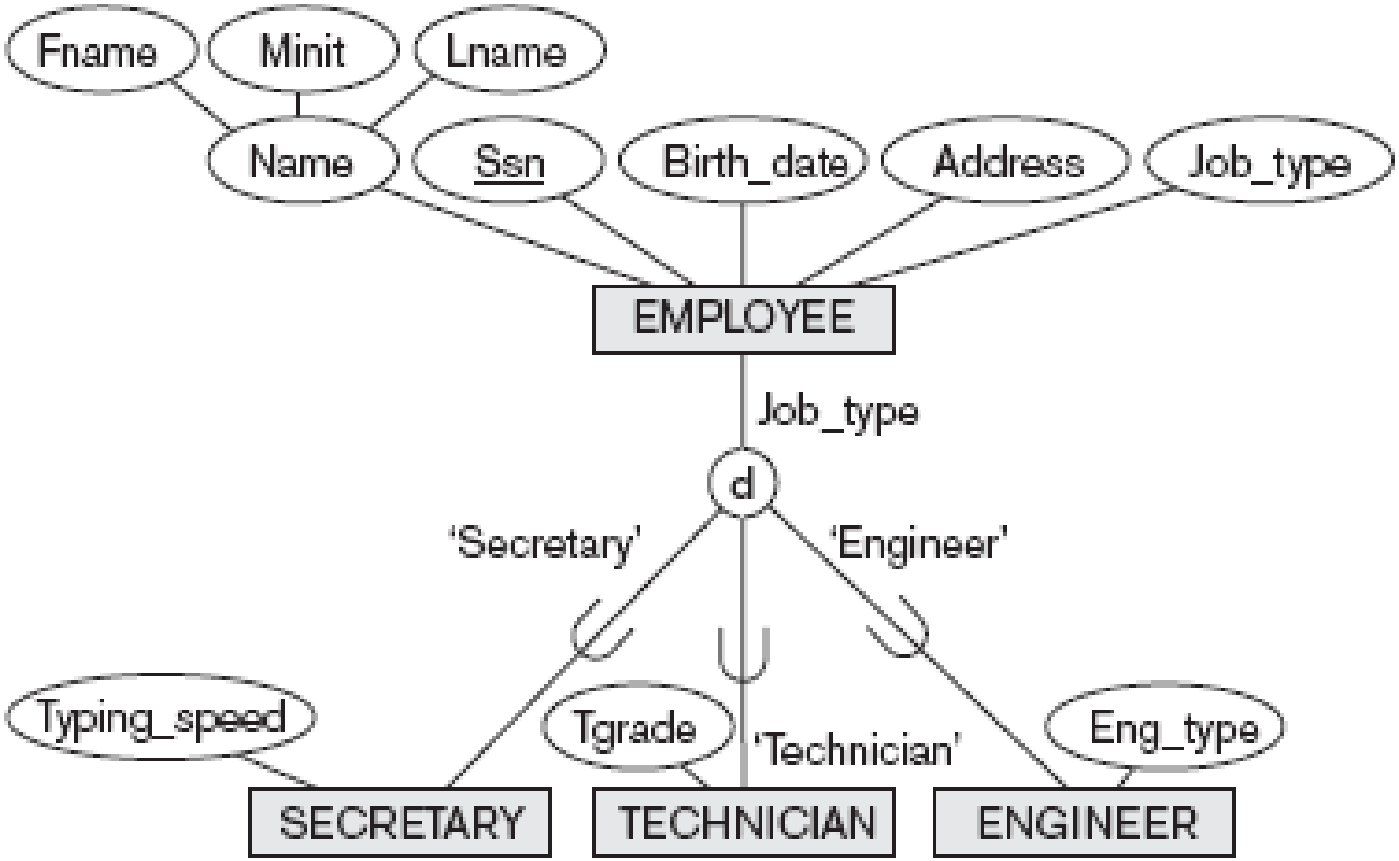
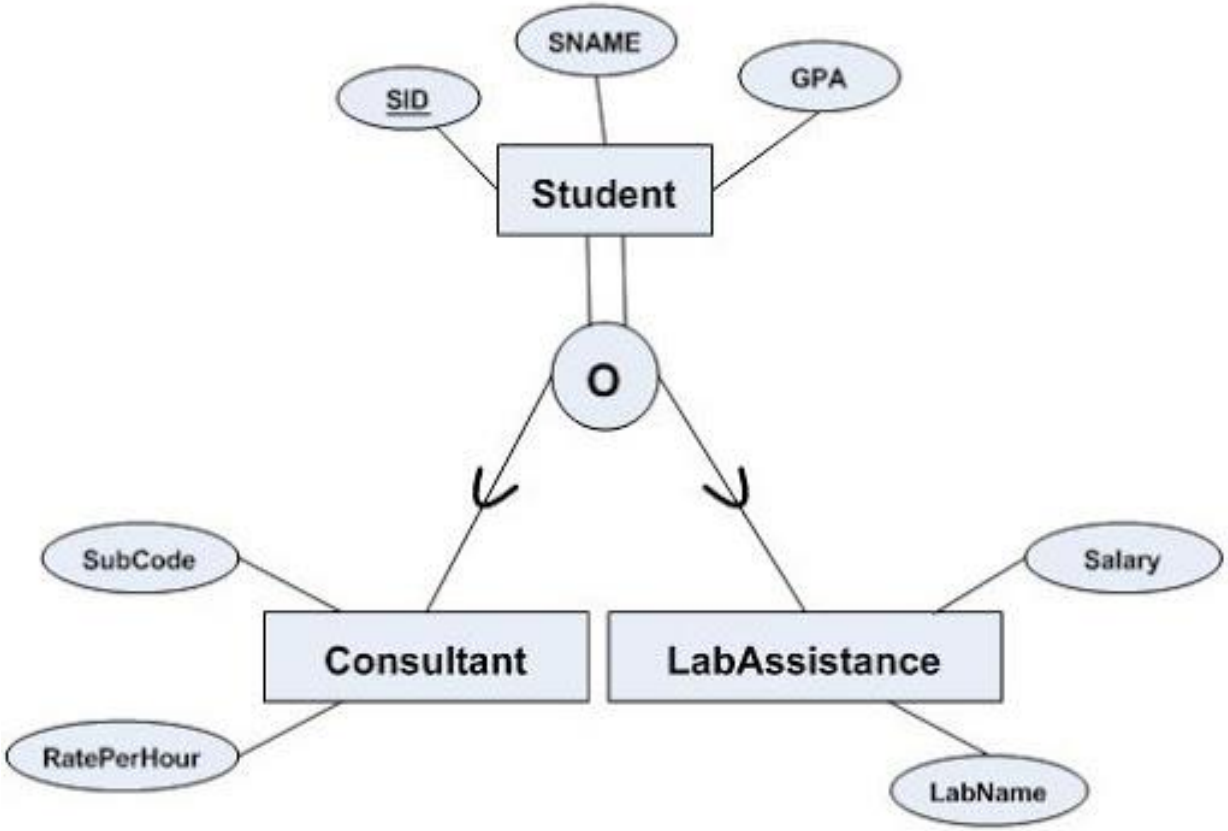
Restrictions
Disjoint Vs overlapping

- Disjoint:
  - entity can be a member of at most one of the subclasses of the specialization.
  - Letter **d**
- Overlapping:
  - Entity may be a member of more than one subclass of the specialization.
  - Letter **o**

Example 1: partial/disjoint



Example 2: total/overlapping

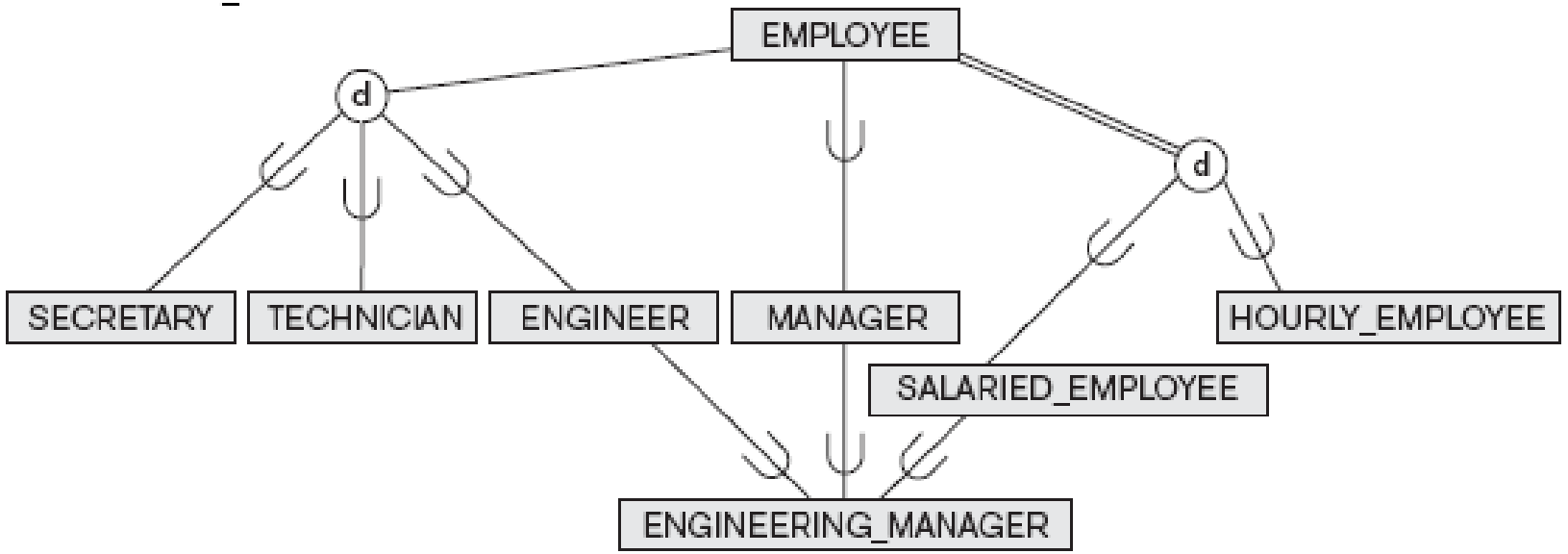


Hierarchy and Lattice

- Entity types can have complex sub/superclass relations
  - more specializations in a row
  - more superclasses
  - shared subclasses
- The sub/superclass-relation is *transitive*
  - So if *A* is-a *B* and *B* is-a *C*, then *A* is-a *C*
- Cycles are not allowed! (DAG)

Example 1: specialization lattice

A specialization lattice with shared subclass ENGINEERING_MANAGER.



Example 2: specialization lattice

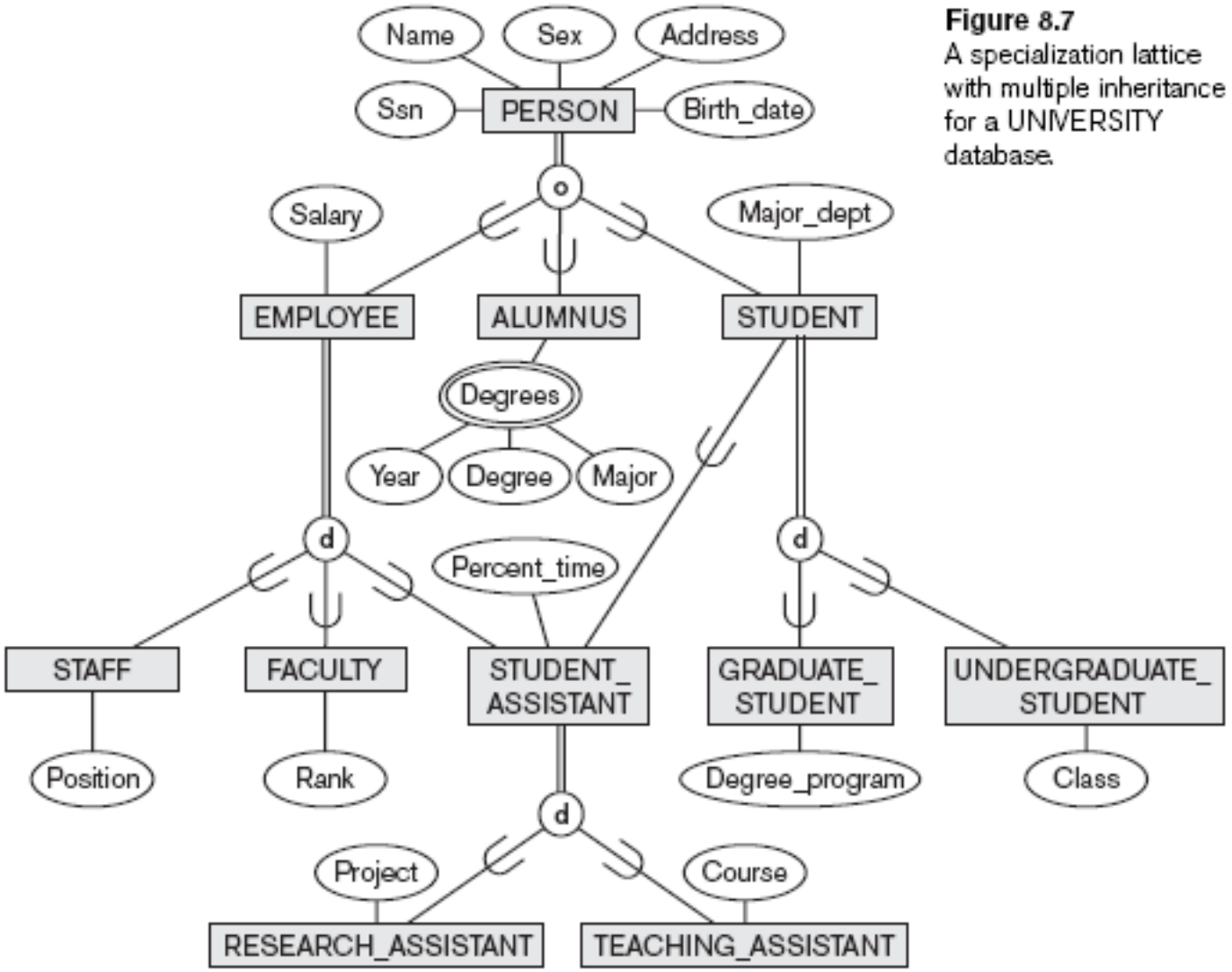
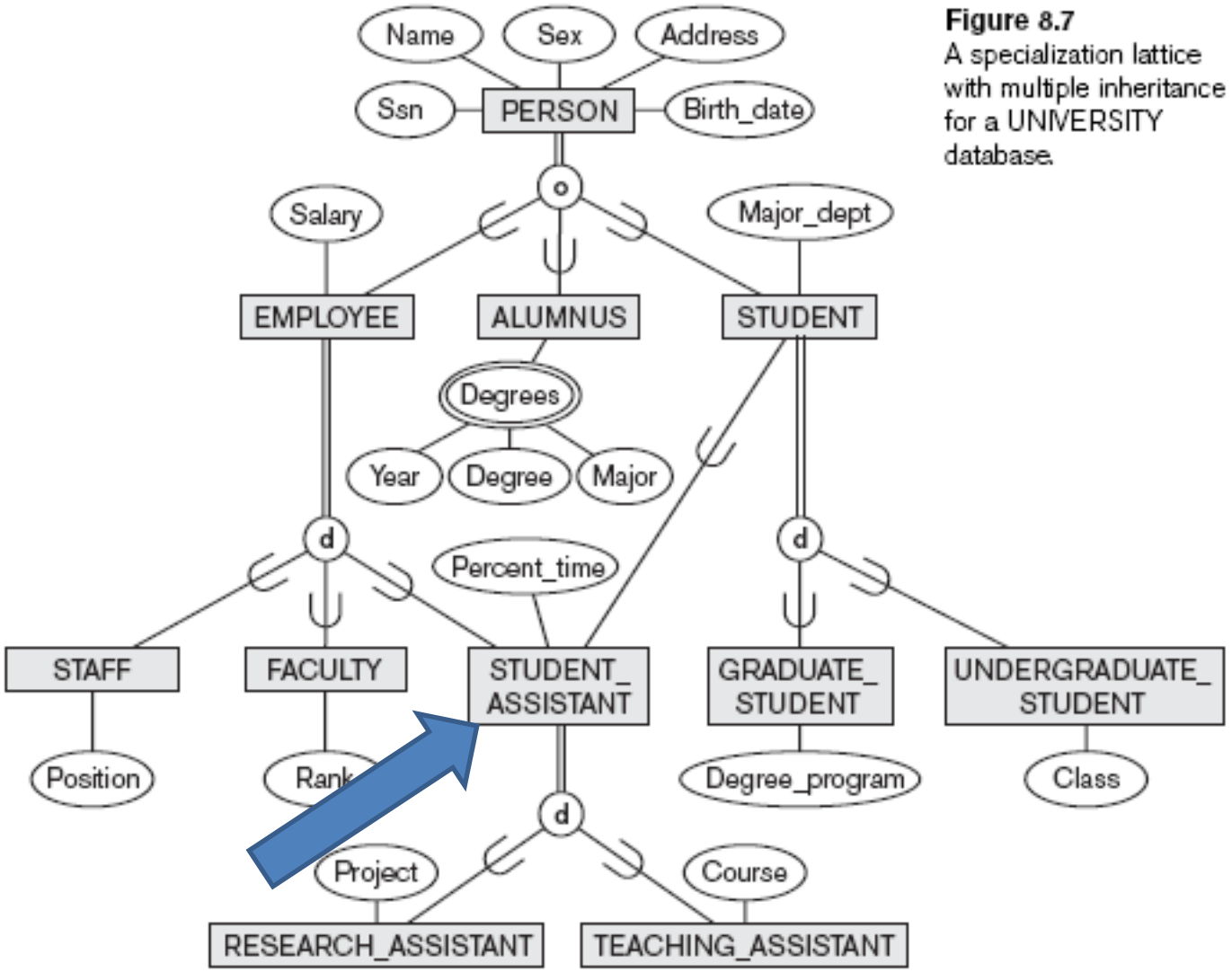


Figure 8.7
A specialization lattice with multiple inheritance for a UNIVERSITY database.

Multiple Inheritance

- **Multiple inheritance**
  - Subclass with more than one superclass
  - If attribute (or relationship) originating in the same superclass inherited more than once via different paths in lattice
    - Included only once in shared subclass
- **Single inheritance**
  - Some models and languages limited to single inheritance



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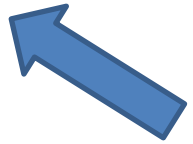
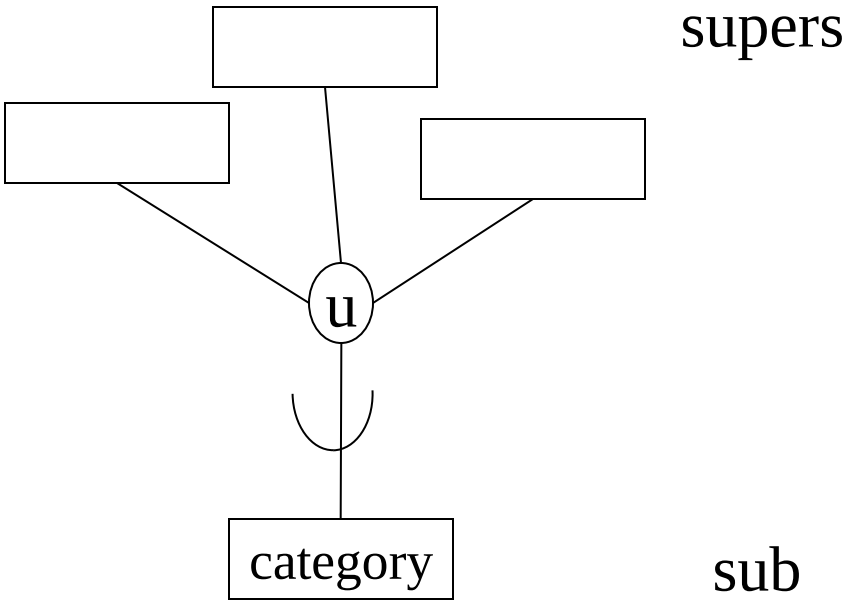


Categories

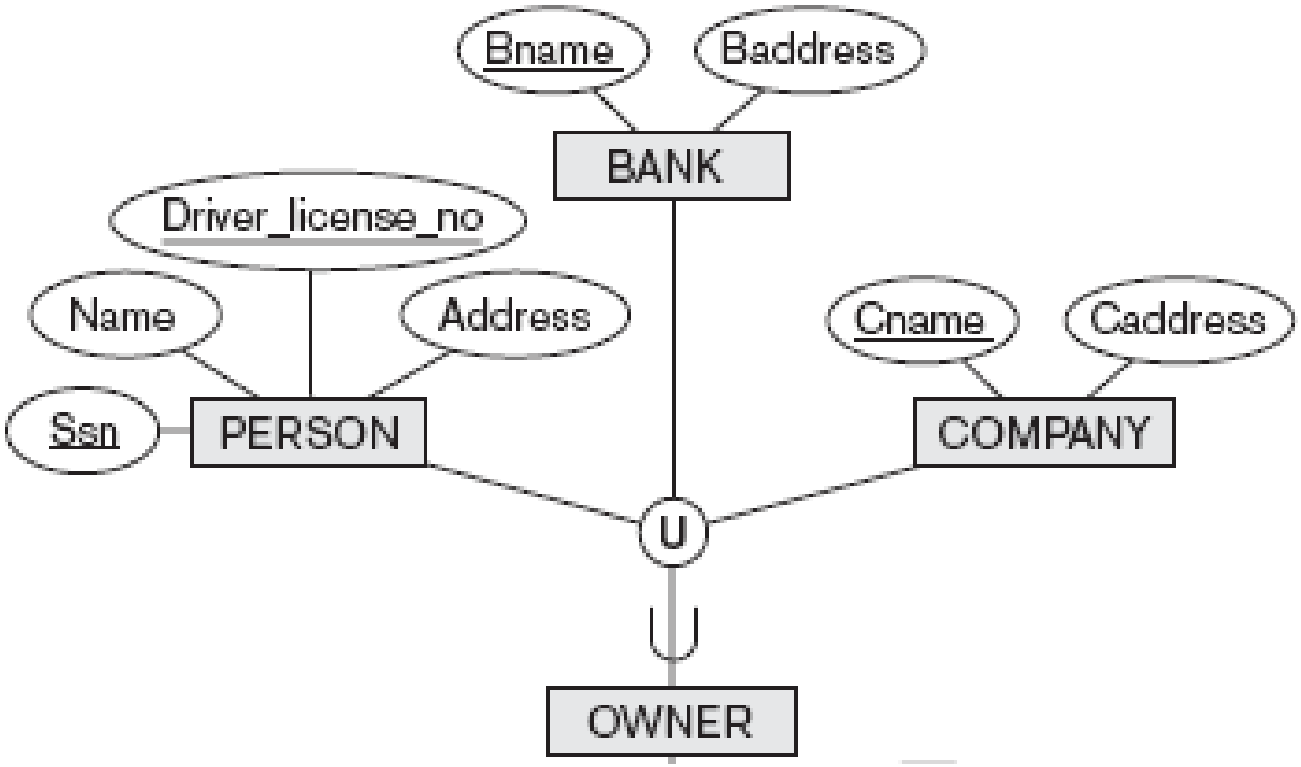
- Sometimes we want to create a subclass out of the *union* of some (different) entity types
  - Example: OWNER from PERSON and COMPANY
- This is called a *category* or *union-class*
- One subclass has more than one superclass, but these are not UNION-compatible!
- *union-compatible:* that is, the two relations must have the same set of attributes
- An entity from the category belongs to exactly one of the superclasses, not more

EER construct

- Letter **u** in the circle
- Category can participate totally or optionally
  - total: double line to category



Example: category



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A Sample UNIVERSITY EER Schema

- The UNIVERSITY Database Example
  - UNIVERSITY database
    - Students and their majors
    - Transcripts, and registration
    - University's course offerings

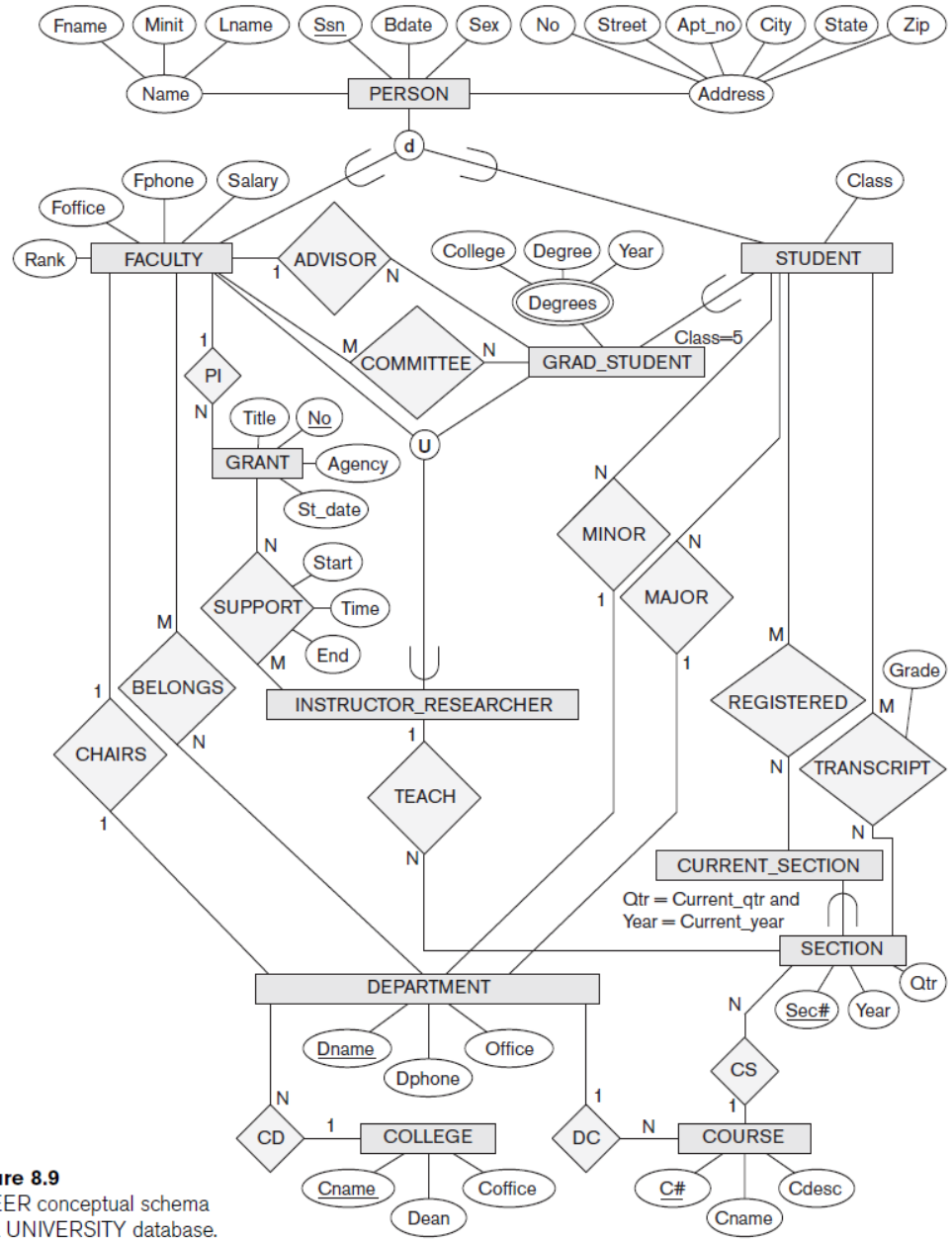

Figure 8.9
An EER conceptual schema for a UNIVERSITY database.

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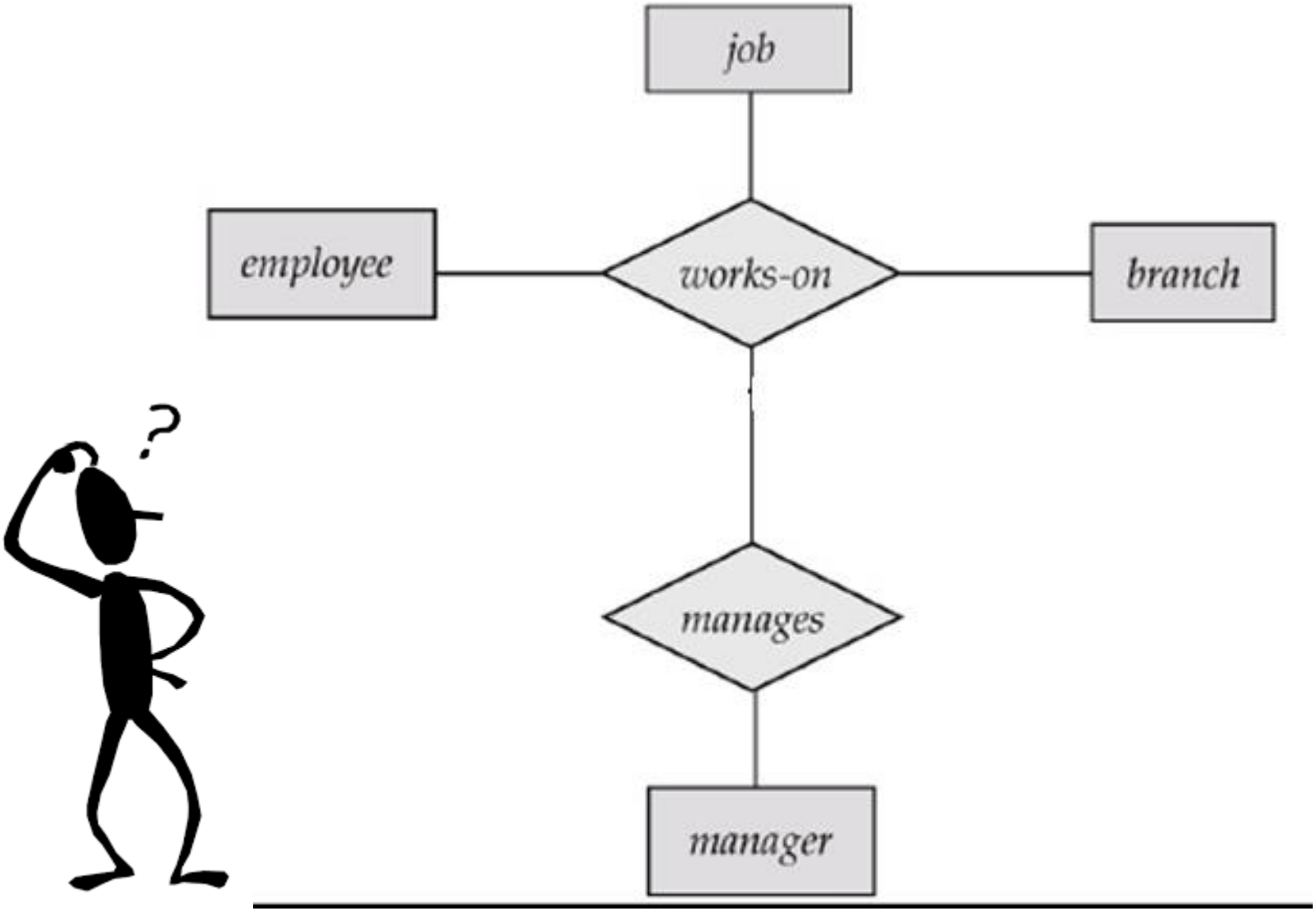
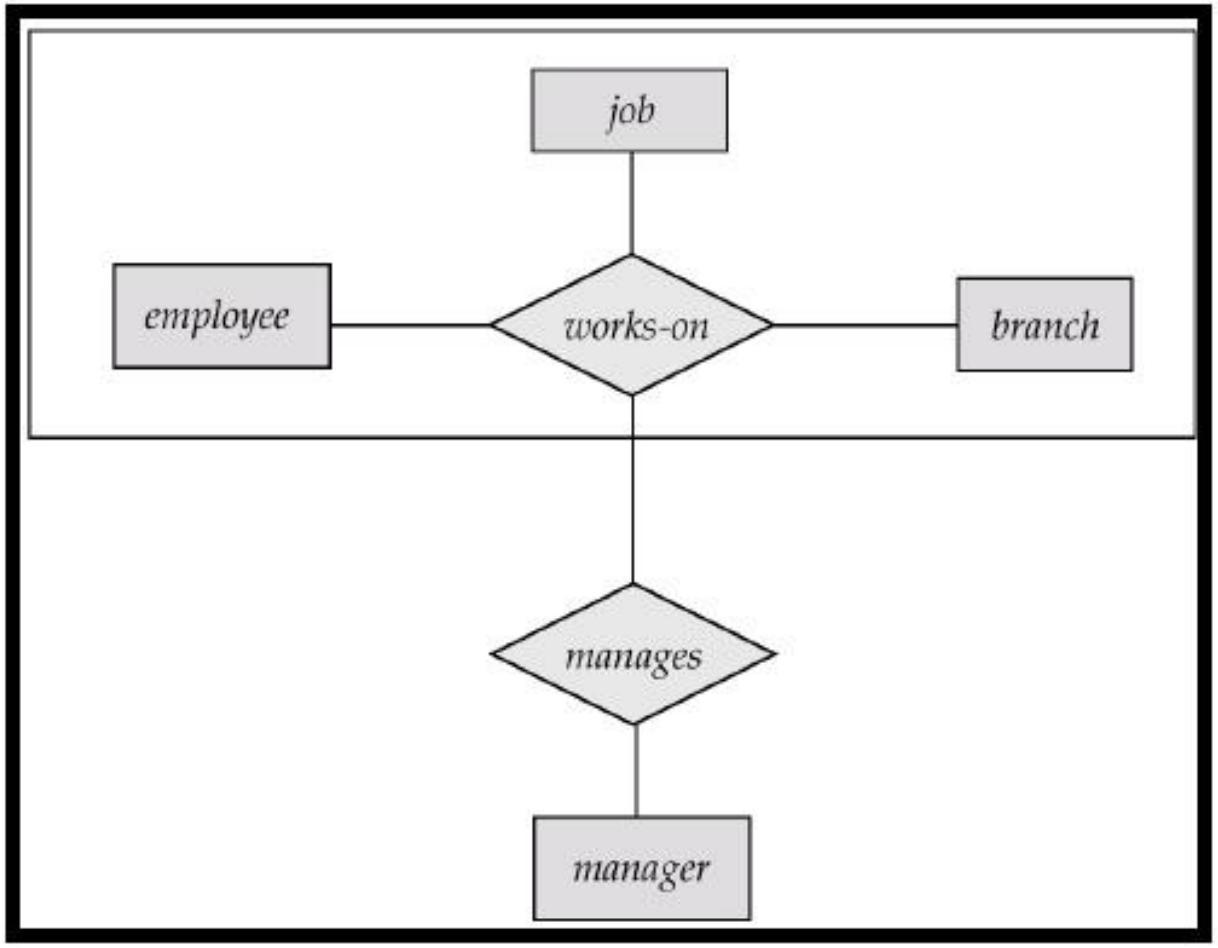
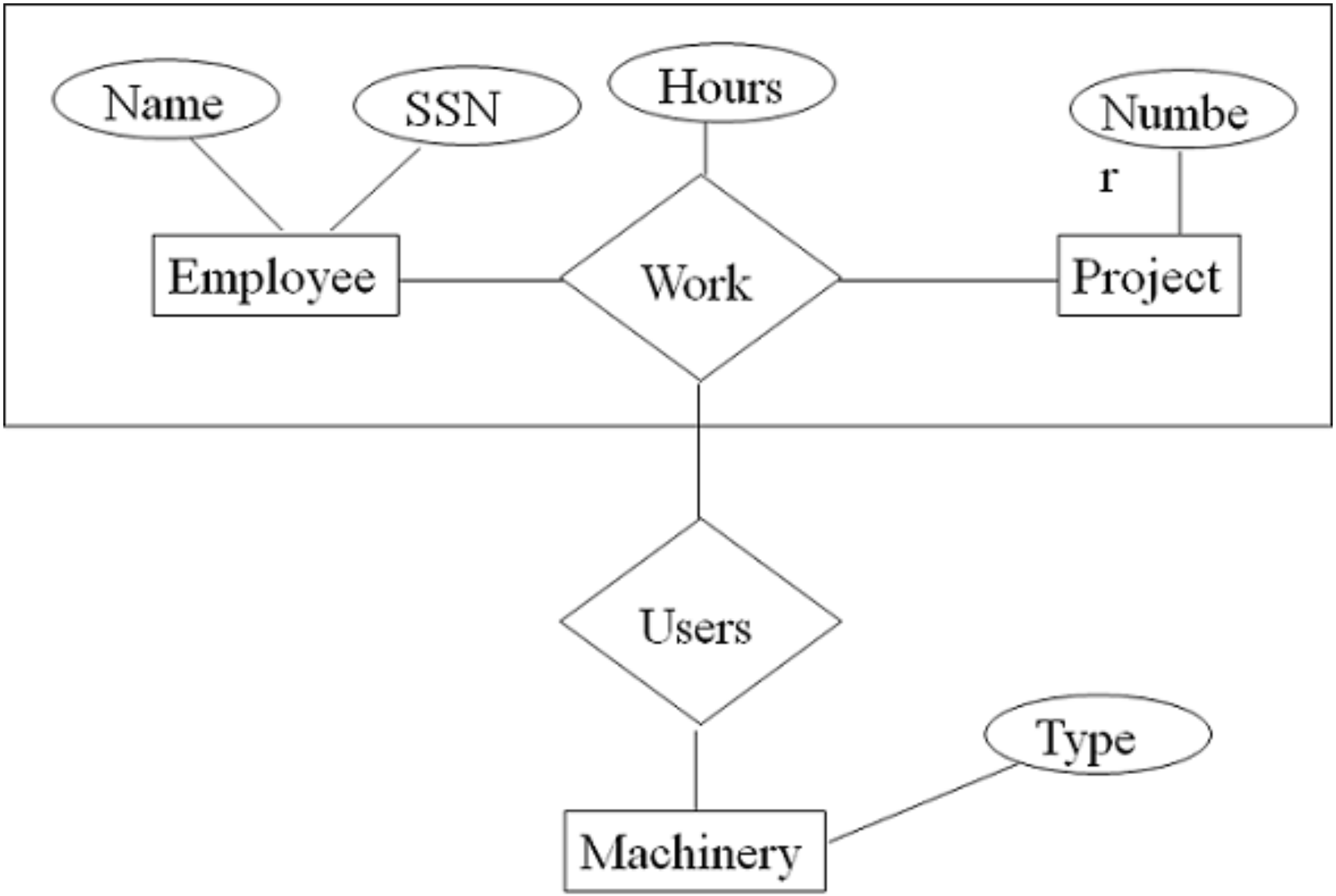
Aggregation and Association

- **Aggregation**
  - Abstraction concept for building composite objects from their component objects
- **Association**
  - Associate objects from several independent classes
- Main structural distinction
  - When an association instance is deleted
    - Participating objects may continue to exist


job
employee
works-on
branch
manages
manager

E-R Diagram With Aggregation




Name
SSN
Hours
Numbe
r
Employee
Work
Project
Users
Type
Machinery

Summary

- Enhanced ER or EER model
  - Extensions to ER model that improve its representational capabilities
  - Subclass and its superclass
  - Category or union type
  - Aggregation and Association

Quiz

- Consider the BANK ER schema in following figure

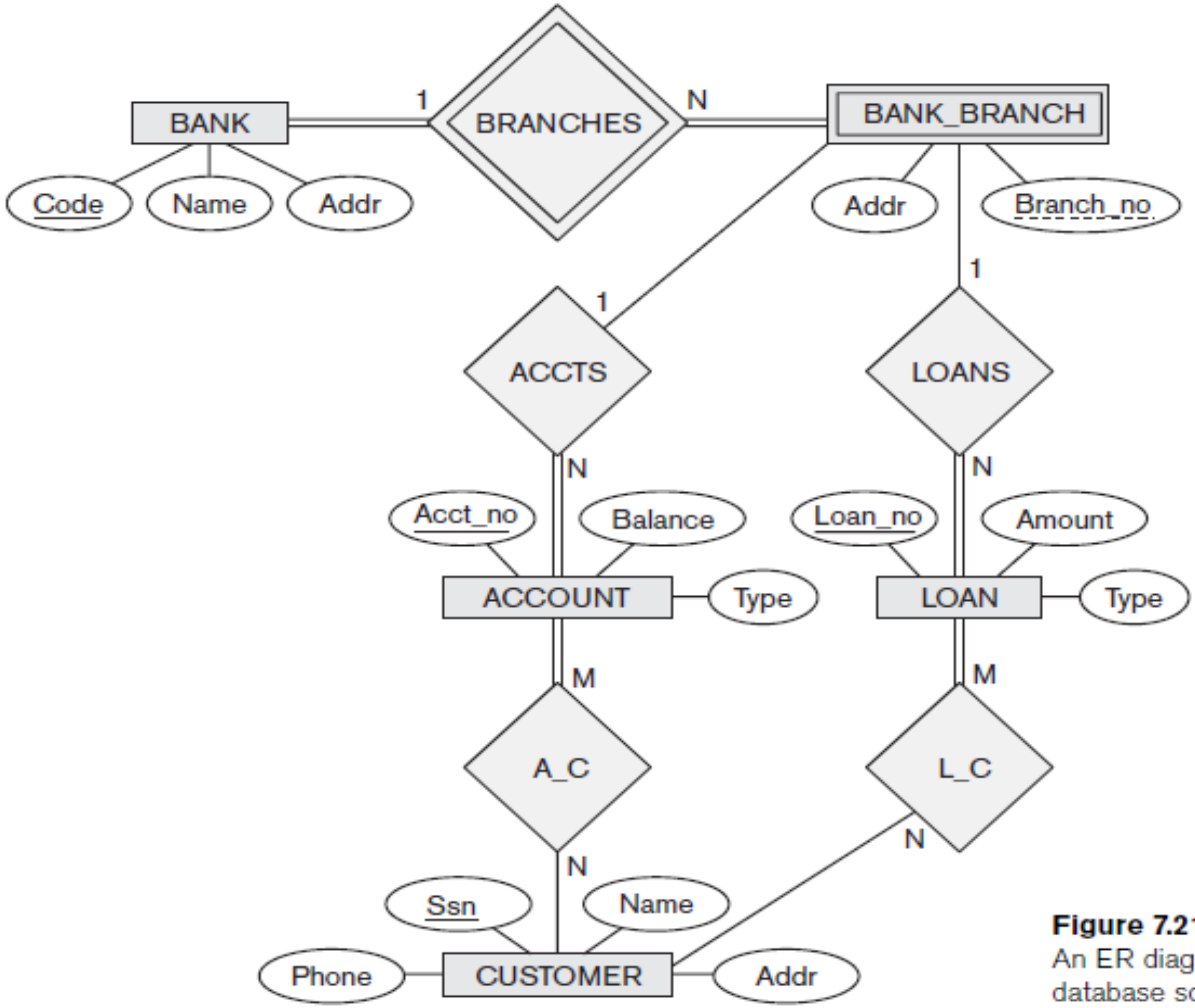


Figure 7.21
An ER diagram for a BANK database schema.

- Suppose that it is necessary to keep track of different types of ACCOUNTS (SAVINGS_ACCTS, CHECKING_ACCTS, ...) and LOANS (CAR_LOANS, HOME_LOANS, ...). Suppose that it is also desirable to keep track of each ACCOUNT's TRANSACTIONS (deposits, withdrawals, checks, ...) and each LOAN's PAYMENTS; both of these include the amount, date, and time.
- Modify the BANK schema, using ER and EER concepts of specialization and generalization. State any assumptions you make about the additional requirements.