Chapter 9: Relational DB Design byER/EER to Relational Mapping

- Relational Database Design Using ER-to-Relational Mapping
- Mapping EER Model Constructs to Relations

Relational Database Design by ER- and EER-to-Relational Mapping

- **Design a relational database schema**
  - Based on a conceptual schema design
- Seven-step algorithm to convert the basic ER model constructs into relations
- Additional steps for EER model

Relational Database Design Using ER-to-Relational Mapping

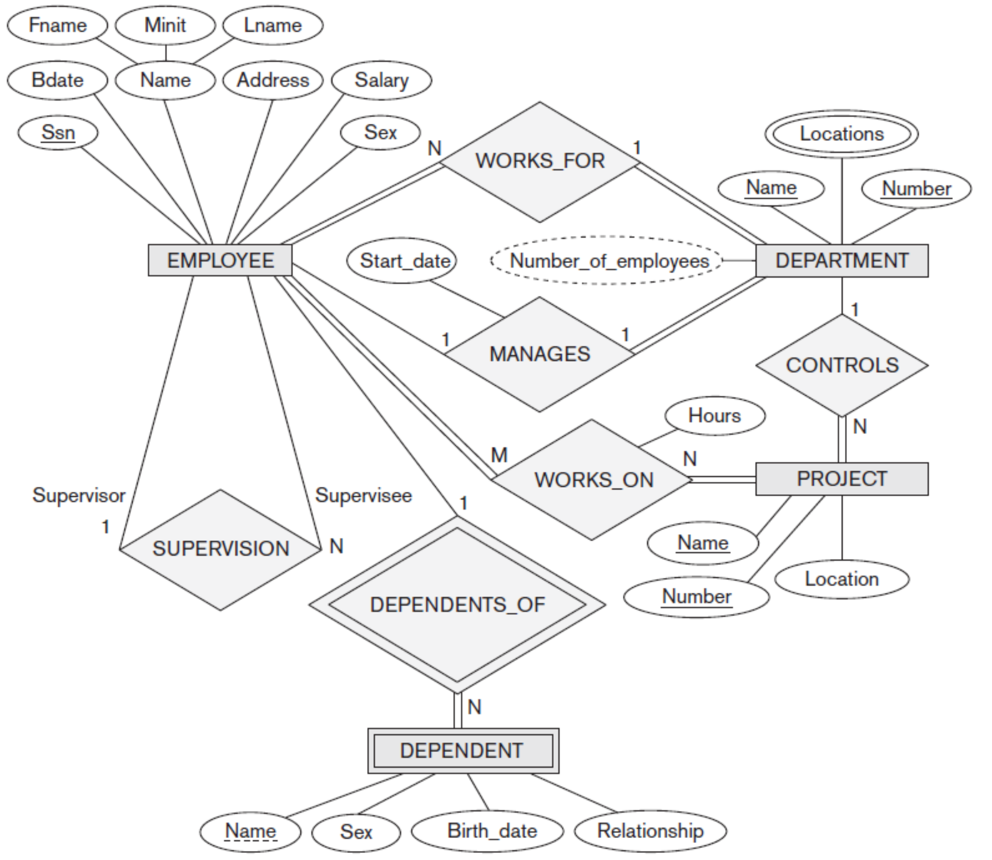
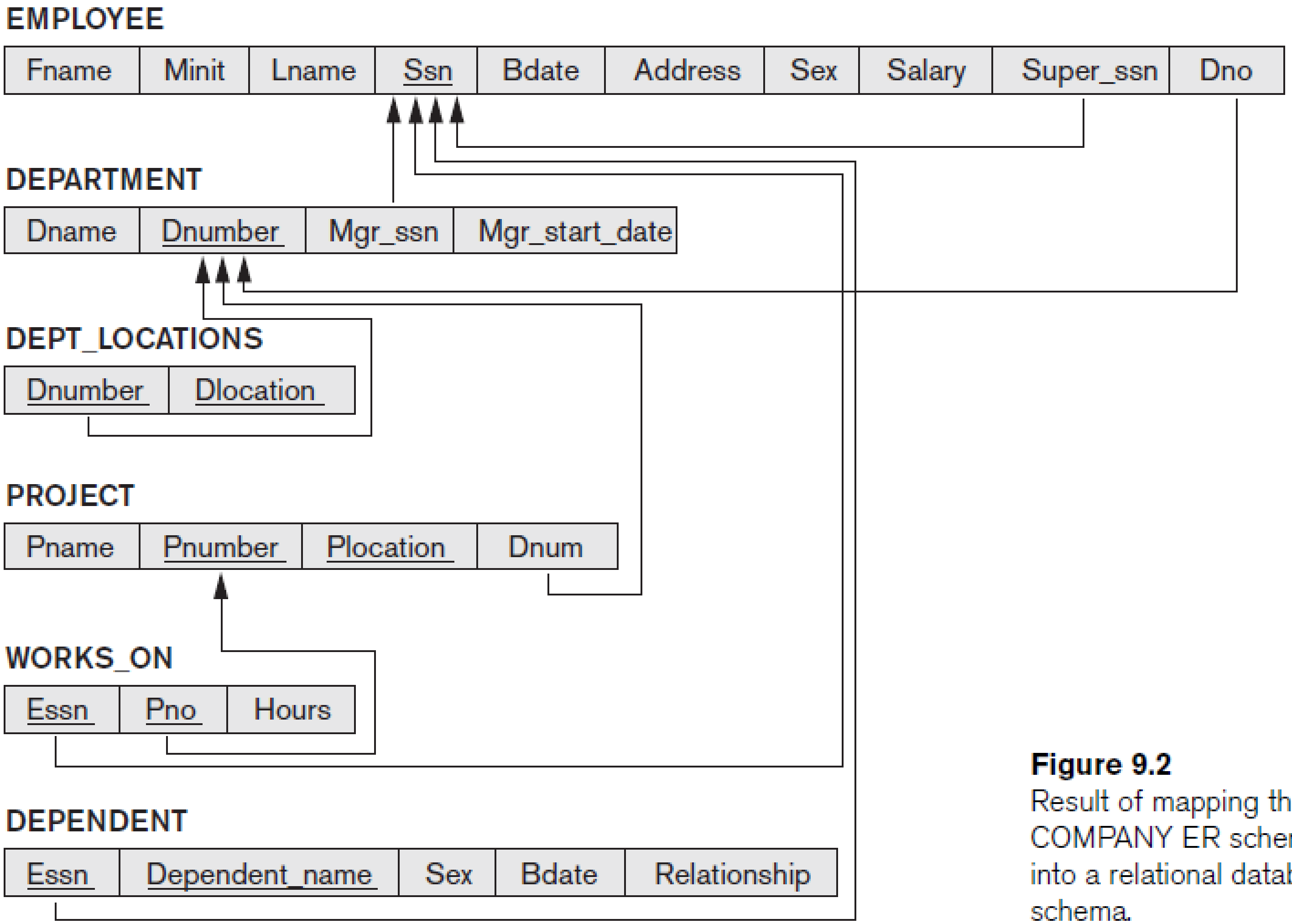


Figure 9.1
The ER conceptual schema diagram for the COMPANY database.



EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date

DEPT_LOCATIONS

Dnumber	Dlocation

PROJECT

Pname	Pnumber	Plocation	Dnum

WORKS_ON

Essn	Pno	Hours

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship

Figure 9.2
Result of mapping the COMPANY ER schema into a relational database schema.

ER-to-Relational Mapping Algorithm

- COMPANY database example
  - Assume that the mapping will create tables with simple single-valued attributes
- Step 1: Mapping of Regular Entity Types
  - For each regular entity type, create a relation *R* that includes all the simple attributes of *E*
  - Called **entity relations**
    - Each tuple represents an entity instance

ER-to-Relational Mapping Algorithm (cont'd.)

- Step 2: Mapping of Weak Entity Types
  - For each weak entity type, create a relation *R* and include all simple attributes of the entity type as attributes of *R*
  - Include primary key attribute of owner as foreign key attributes of *R*

ER-to-Relational Mapping Algorithm (cont’d.)

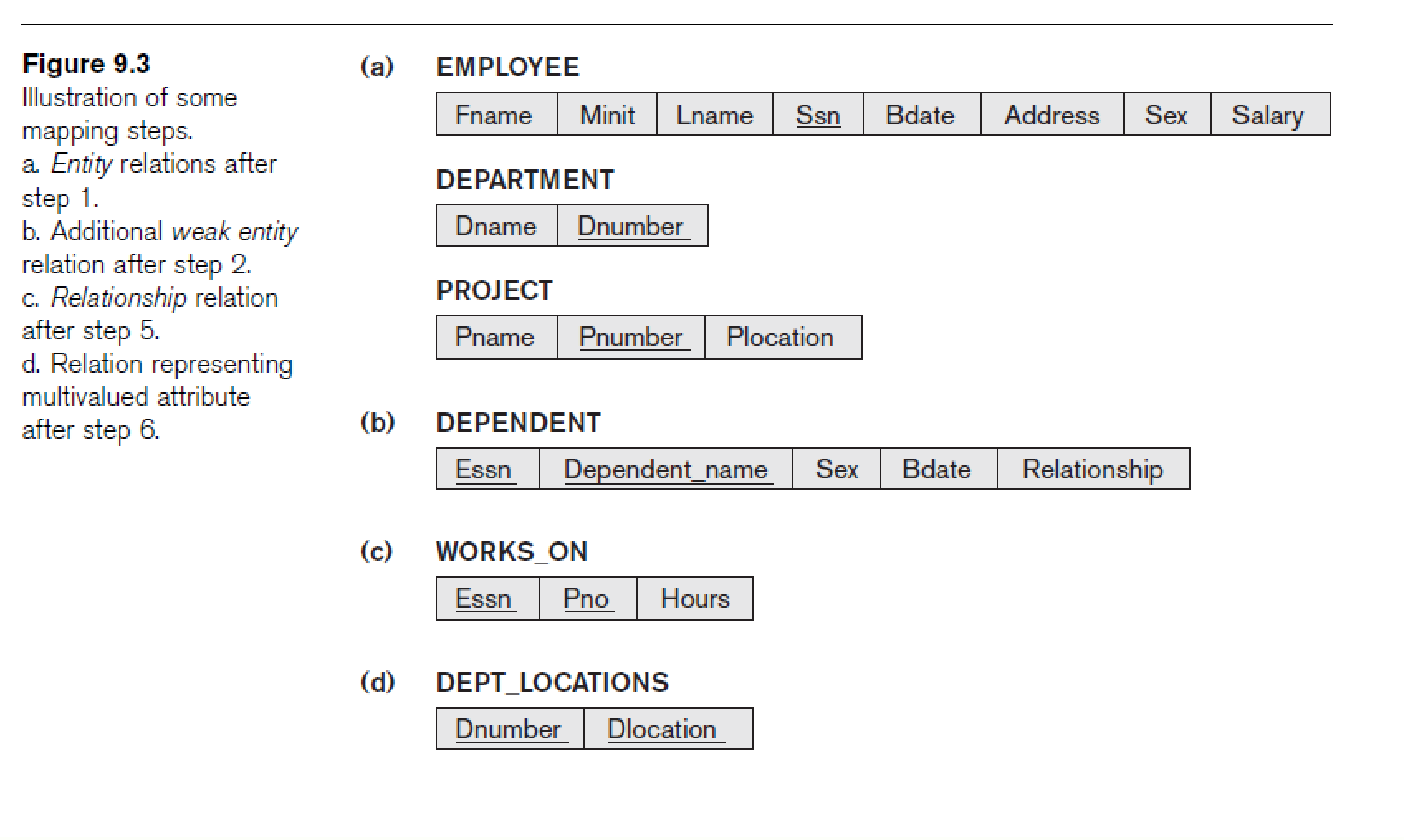


Figure 9.3
Illustration of some mapping steps.
a. *Entity* relations after step 1.
b. Additional *weak entity* relation after step 2.
c. *Relationship* relation after step 5.
d. Relation representing multivalued attribute after step 6.

(a) **EMPLOYEE**

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary

DEPARTMENT

Dname	Dnumber

PROJECT

Pname	Pnumber	Plocation

(b) **DEPENDENT**

Essn	Dependent_name	Sex	Bdate	Relationship

(c) **WORKS_ON**

Essn	Pno	Hours

(d) **DEPT_LOCATIONS**

Dnumber	Dlocation

ER-to-Relational Mapping Algorithm (cont'd.)

- Step 3: Mapping of Binary 1:1 Relationship Types
  - For each binary 1:1 relationship type
    - Identify relations that correspond to entity types participating in *R*
  - Possible approaches:
    - **Foreign key approach**
    - **Merged relationship approach**
    - **Crossreference or relationship relation approach**

ER-to-Relational Mapping Algorithm (cont’d.)

- Step 4: Mapping of Binary 1:*N* Relationship Types
    - For each regular binary 1:*N* relationship type
        - Identify relation that represents participating entity type at *N*-side of relationship type
        - Include primary key of other entity type as foreign key in *S*
        - Include simple attributes of 1:*N* relationship type as attributes of *S*

ER-to-Relational Mapping Algorithm (cont'd.)

- Alternative approach
  - Use the **relationship relation** (cross-reference) option as in the third option for binary 1:1 relationships

ER-to-Relational Mapping Algorithm (cont'd.)

- Step 5: Mapping of Binary *M*:*N* Relationship Types
  - For each binary *M*:*N* relationship type
    - Create a new relation *S*
    - Include primary key of participating entity types as foreign key attributes in *S*
    - Include any simple attributes of *M*:*N* relationship type

ER-to-Relational Mapping Algorithm (cont'd.)

- Step 6: Mapping of Multivalued Attributes
  - For each multivalued attribute
    - Create a new relation
    - Primary key of *R* is the combination of *A* and *K*
    - If the multivalued attribute is composite, include its simple components

ER-to-Relational Mapping Algorithm (cont'd.)

- Step 7: Mapping of *N*-ary Relationship Types
  - For each *n*-ary relationship type *R*
    - Create a new relation *S* to represent *R*
    - Include primary keys of participating entity types as foreign keys
    - Include any simple attributes as attributes

Discussion and Summary of Mapping for ER Model Constructs

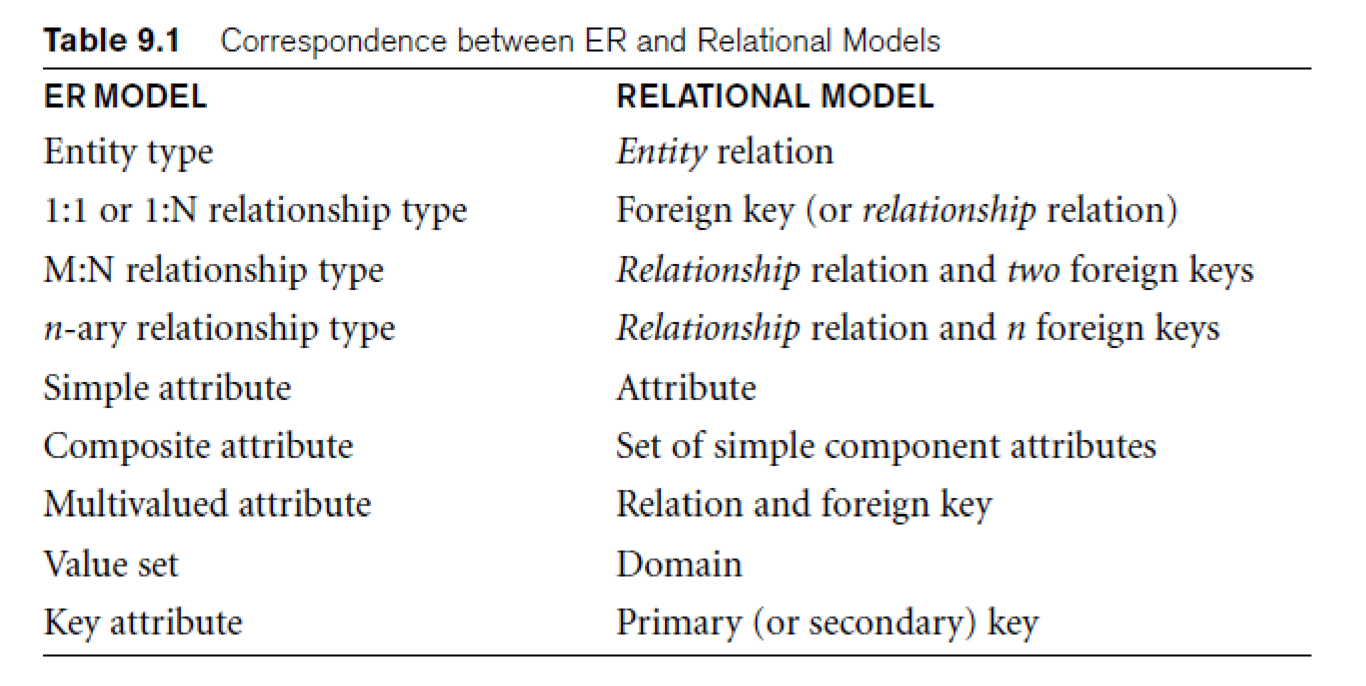


Table 9.1 Correspondence between ER and Relational Models

ER MODEL	RELATIONAL MODEL
Entity type	*Entity* relation
1:1 or 1:N relationship type	Foreign key (or *relationship* relation)
M:N relationship type	*Relationship* relation and *two* foreign keys
n-ary relationship type	*Relationship* relation and *n* foreign keys
Simple attribute	Attribute
Composite attribute	Set of simple component attributes
Multivalued attribute	Relation and foreign key
Value set	Domain
Key attribute	Primary (or secondary) key

Discussion and Summary of Mapping for ER Model Constructs (cont'd.)

- In a relational schema relationship, types are not represented explicitly
  - Represented by having two attributes *A* and *B*: one a primary key and the other a foreign key

Mapping EER Model Constructs to Relations

- Extending ER-to-relational mapping algorithm

Mapping of Specialization or Generalization

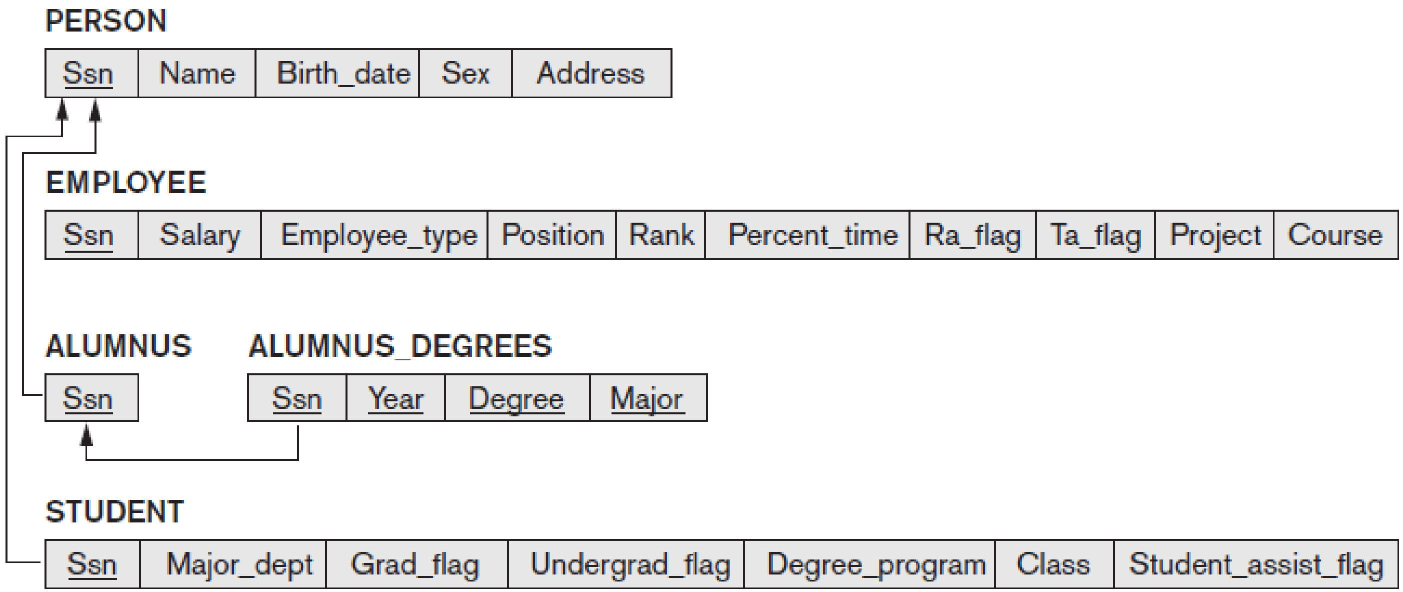
- Step 8: Options for Mapping Specialization or Generalization (see pages 294-295)
  - **Option 8A: Multiple relations—superclass and subclasses**
    - For any specialization (total or partial, disjoint or overlapping)
  - **Option 8B: Multiple relations—subclass relations only**
    - Subclasses are total
    - Specialization has disjointedness constraint

Mapping of Specialization or Generalization (cont'd.)

- **Option 8C: Single relation with one type attribute**
  - Type or discriminating attribute indicates subclass of tuple
  - Subclasses are disjoint
    - Potential for generating many NULL values if many specific attributes exist in the subclasses
- **Option 8D: Single relation with multiple type attributes**
  - Subclasses are overlapping
  - Will also work for a disjoint specialization

Mapping of Shared Subclasses (Multiple Inheritance)

- Apply any of the options discussed in step 8 to a shared subclass



PERSON

Ssn	Name	Birth_date	Sex	Address

EMPLOYEE

Ssn	Salary	Employee_type	Position	Rank	Percent_time	Ra_flag	Ta_flag	Project	Course

ALUMNUS

Ssn

ALUMNUS_DEGREES

Ssn	Year	Degree	Major

STUDENT

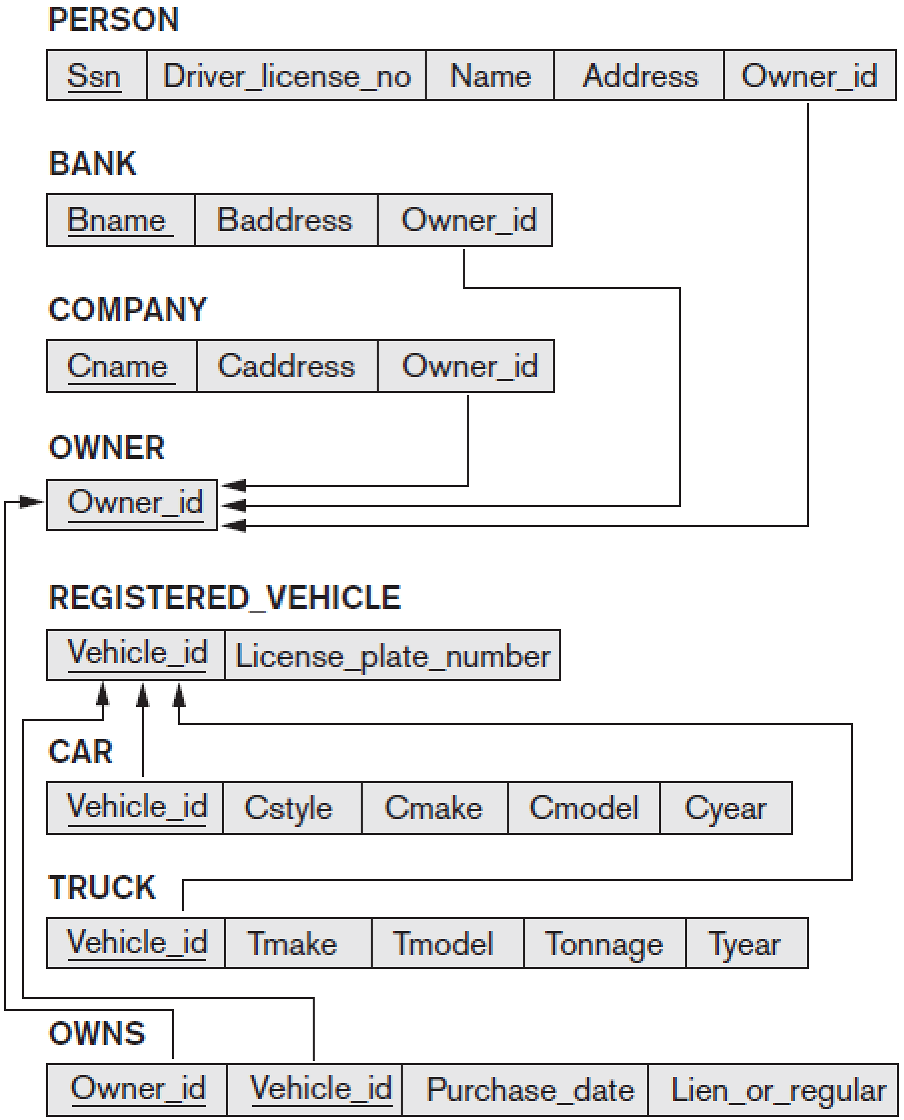
Ssn	Major_dept	Grad_flag	Undergrad_flag	Degree_program	Class	Student_assist_flag

Figure 9.6
Mapping the EER specialization lattice in Figure 8.8 using multiple options.

Mapping of Categories (Union Types)

- Step 9: Mapping of Union Types (Categories)
  - Defining superclasses have different keys
  - Specify a new key attribute
    - **Surrogate key**

Figure 9.7
Mapping the EER categories (union types) in Figure 8.8 to relations.



PERSON

Ssn	Driver_license_no	Name	Address	Owner_id

BANK

Bname	Baddress	Owner_id

COMPANY

Cname	Caddress	Owner_id

OWNER

Owner_id

REGISTERED_VEHICLE

Vehicle_id	License_plate_number

CAR

Vehicle_id	Cstyle	Cmake	Cmodel	Cyear

TRUCK

Vehicle_id	Tmake	Tmodel	Tonnage	Tyear

OWNS

Owner_id	Vehicle_id	Purchase_date	Lien_or_regular

Summary

- Map conceptual schema design in the ER model to a relational database schema
  - Algorithm for ER-to-relational mapping
  - Illustrated by examples from the COMPANY database
- Include additional steps in the algorithm for mapping constructs from EER model into relational model

FIGURE 8.7

A specialization lattice with multiple inheritance for a UNIVERSITY database.

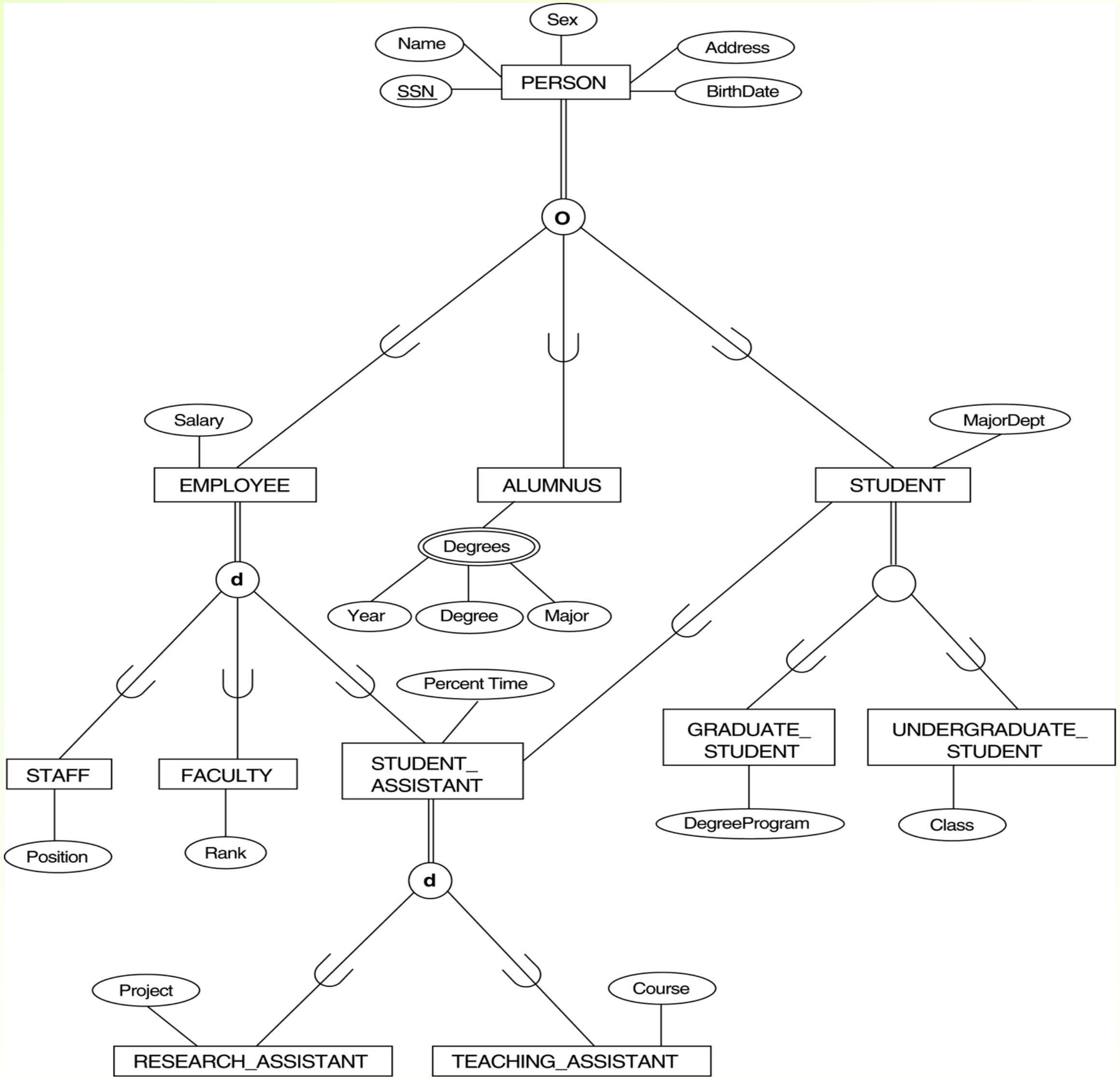
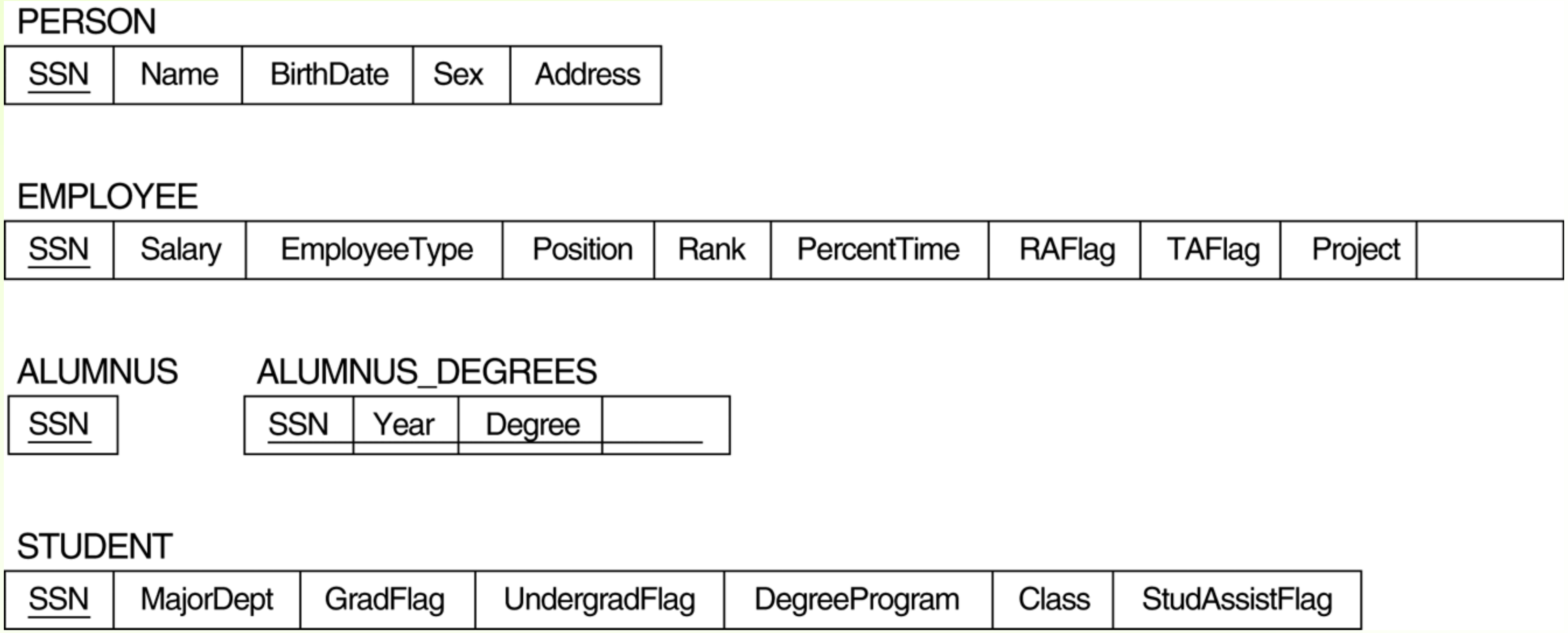


FIGURE 9.6

Mapping the EER specialization lattice in Figure 8.7 using multiple options.



PERSON

SSN	Name	BirthDate	Sex	Address

EMPLOYEE

SSN	Salary	EmployeeType	Position	Rank	PercentTime	RAFlag	TAFlag	Project	

ALUMNUS

SSN

ALUMNUS_DEGREES

SSN	Year	Degree	

STUDENT

SSN	MajorDept	GradFlag	UndergradFlag	DegreeProgram	Class	StudAssistFlag

FIGURE 8.8

Two categories (union types): OWNER and REGISTERED_VEHICLE.

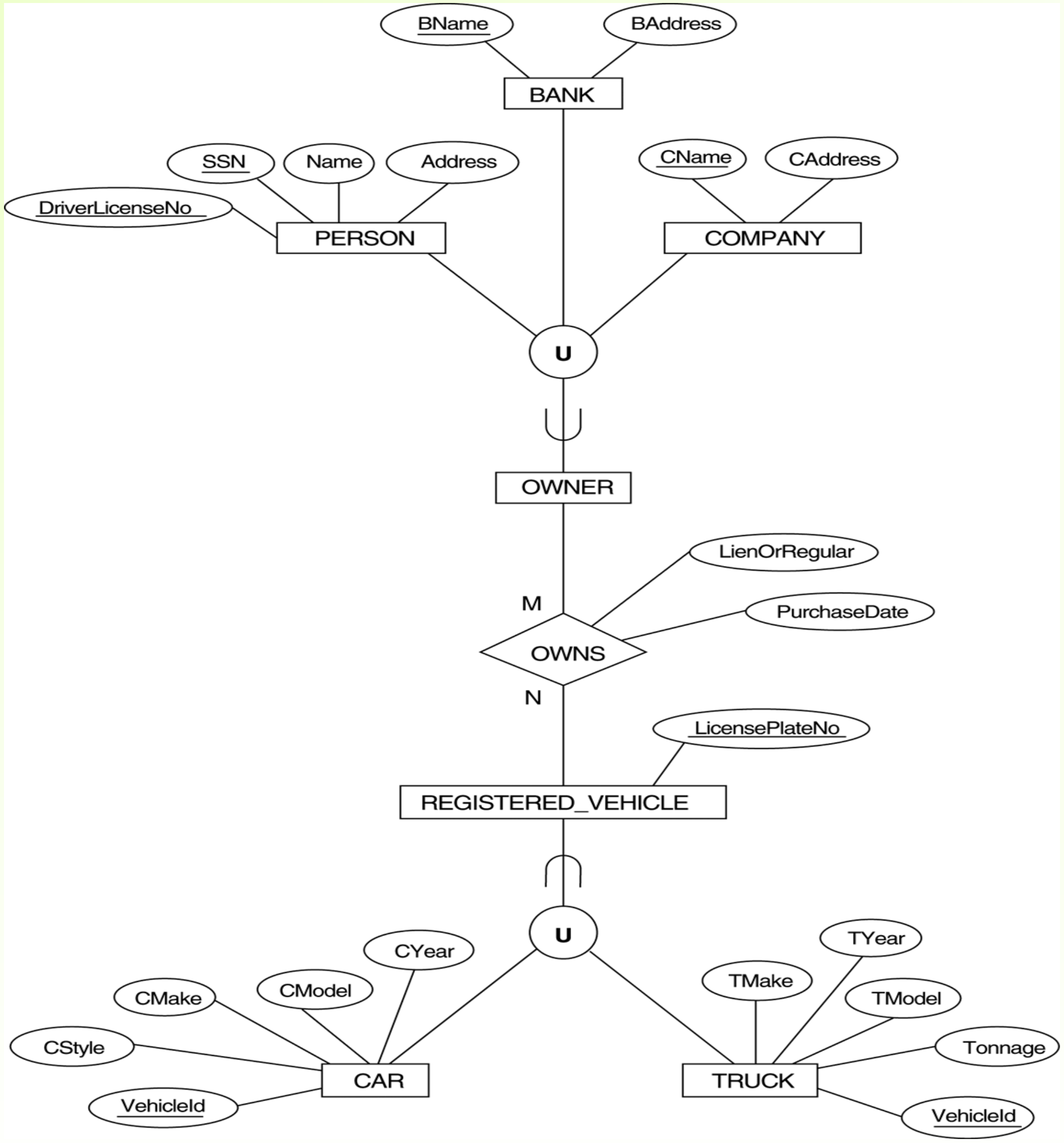
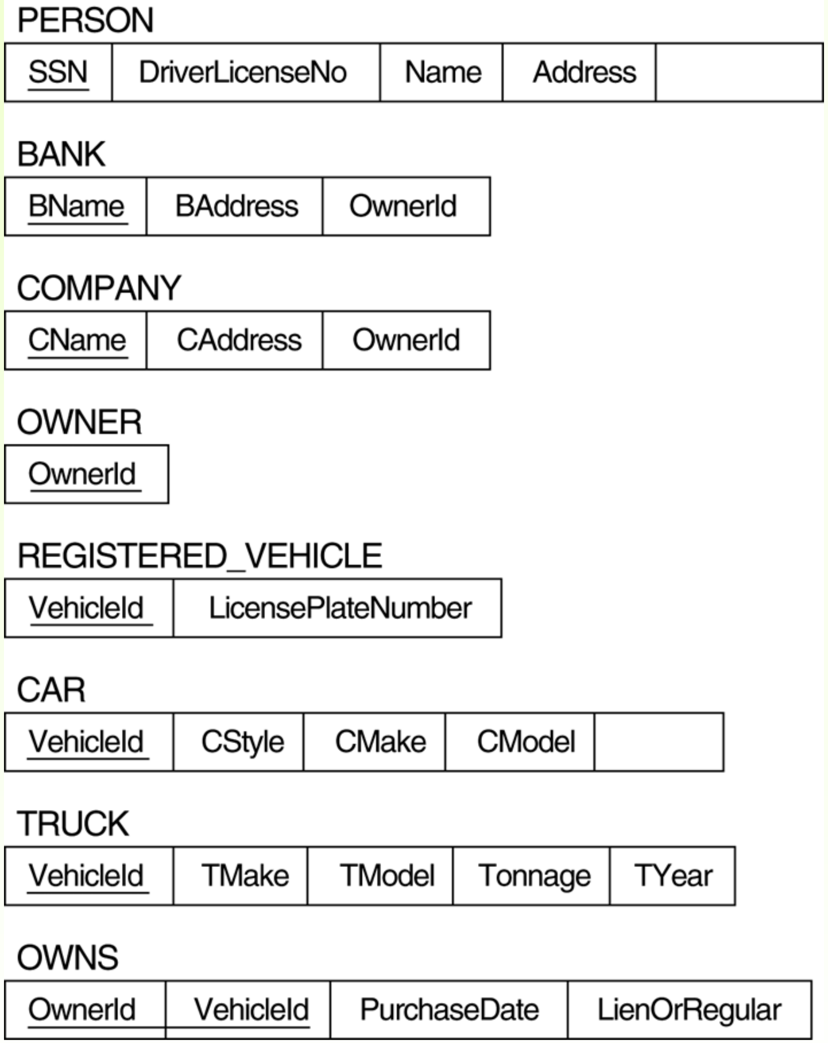


FIGURE 9.7

Mapping the EER categories (union types) in Figure 8.8 to relations.



PERSON

SSN	DriverLicenseNo	Name	Address	

BANK

BName	BAddress	OwnerId

COMPANY

CName	CAddress	OwnerId

OWNER

OwnerId

REGISTERED_VEHICLE

VehicleId	LicensePlateNumber

CAR

VehicleId	CStyle	CMake	CModel	

TRUCK

VehicleId	TMake	TModel	Tonnage	TYear

OWNS

OwnerId	VehicleId	PurchaseDate	LienOrRegular