CS 220
ER/EER to Relational Mapping

START RECORDING

Attendance Quiz: Tuple Relational Calculus

- Use the tuple relational calculus to form these queries:
  1. Retrieve the names of all employees
  2. Retrieve the name of the employee with SSN = 123456789
  3. Retrieve the names and SSNs of the employees making more than $71,000
  4. Retrieve the names of all employees who are not managers
  5. Retrieve the name of each manager and the name of the department they manage
  6. Retrieve the names of each department with an office in Houston

Employee

Full_Name	SSN	Salary
John Smith	123456789	70000
Jane Smith	234567891	71000
Franklin Wong	345678912	72000

Department

Name	ID	Mgr_SSN
Research	1	345678912
Administration	2	234567891

D_Locations

D_ID	Location
1	Houston
1	Boston
2	Boston

Chapter 9 Outline

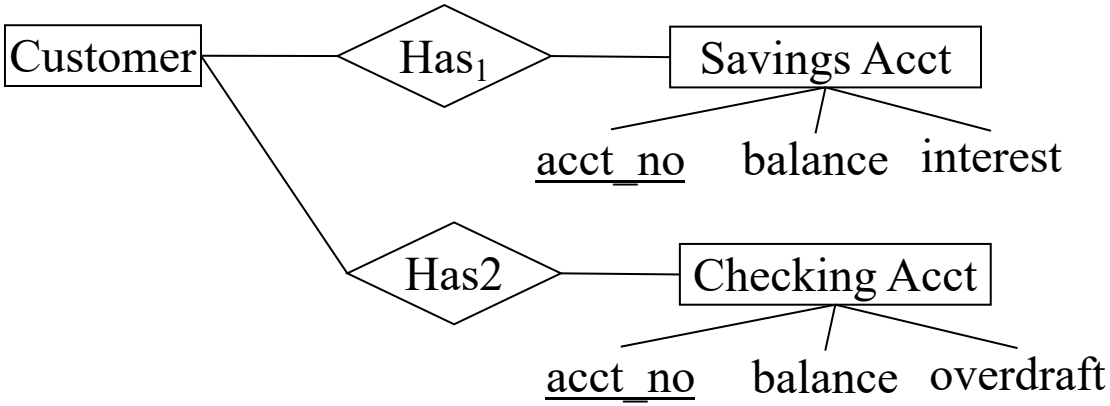
- Relational Database Design Using ER-to-Relational Mapping
- Mapping EER Model Constructs to Relations

Today you will learn…

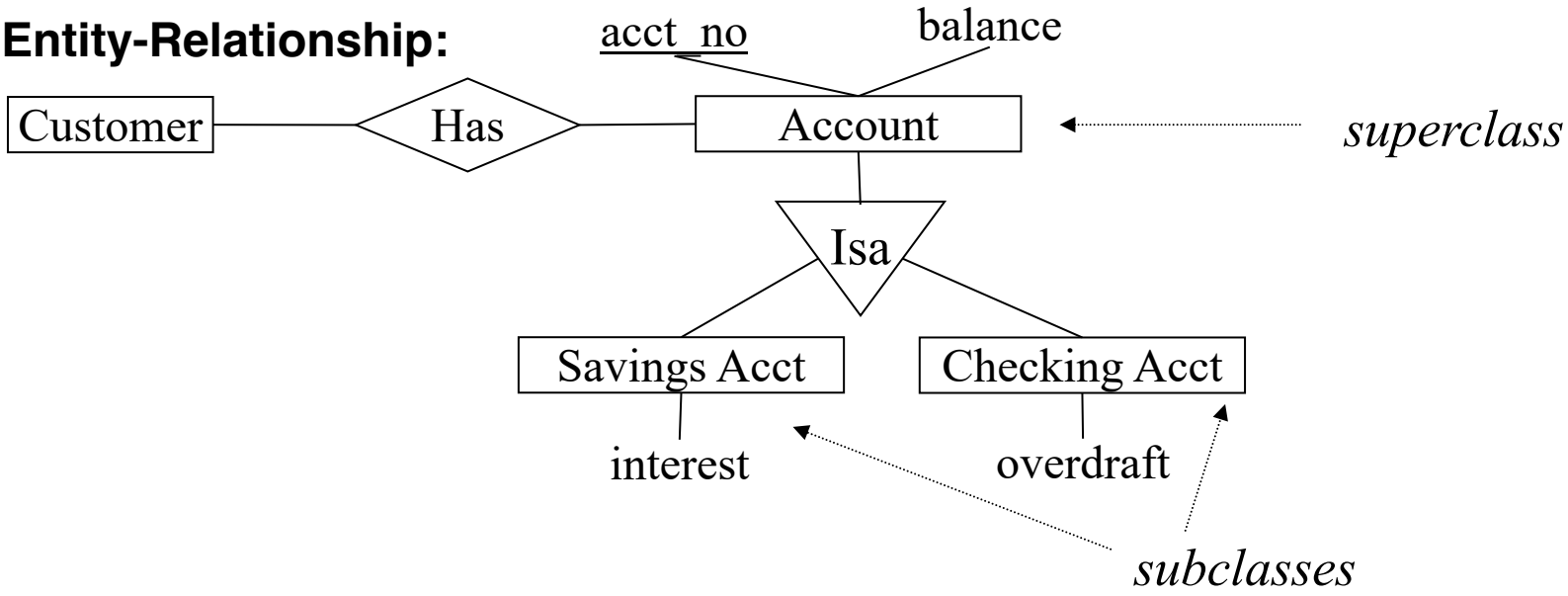
- How to convert an ER model into the relational model
  - Seven-step algorithm for basic ER models
  - Additional steps for EER model

ER vs EER

Entity-Relationship:

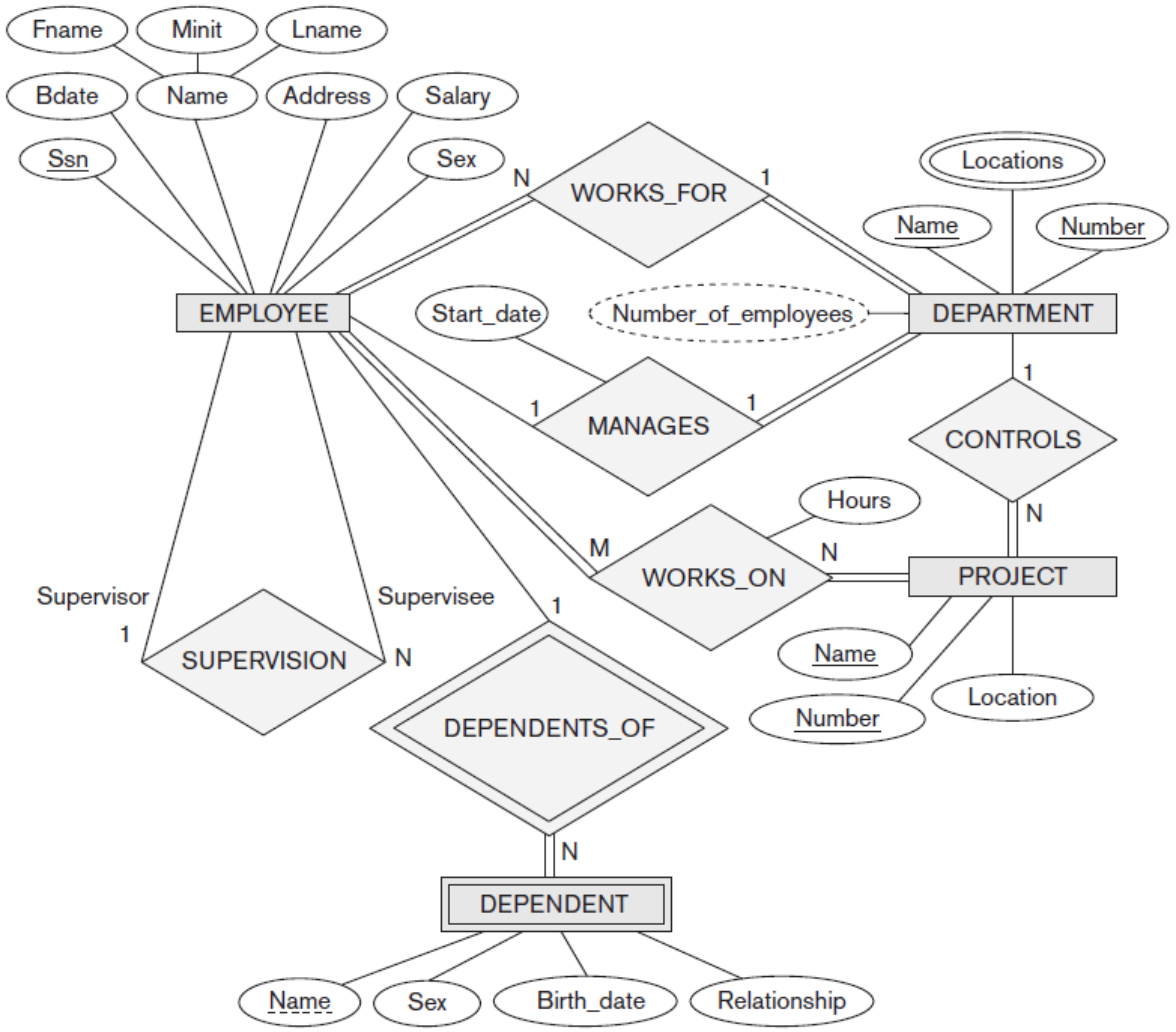


Enhanced Entity-Relationship:



COMPANY database example

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



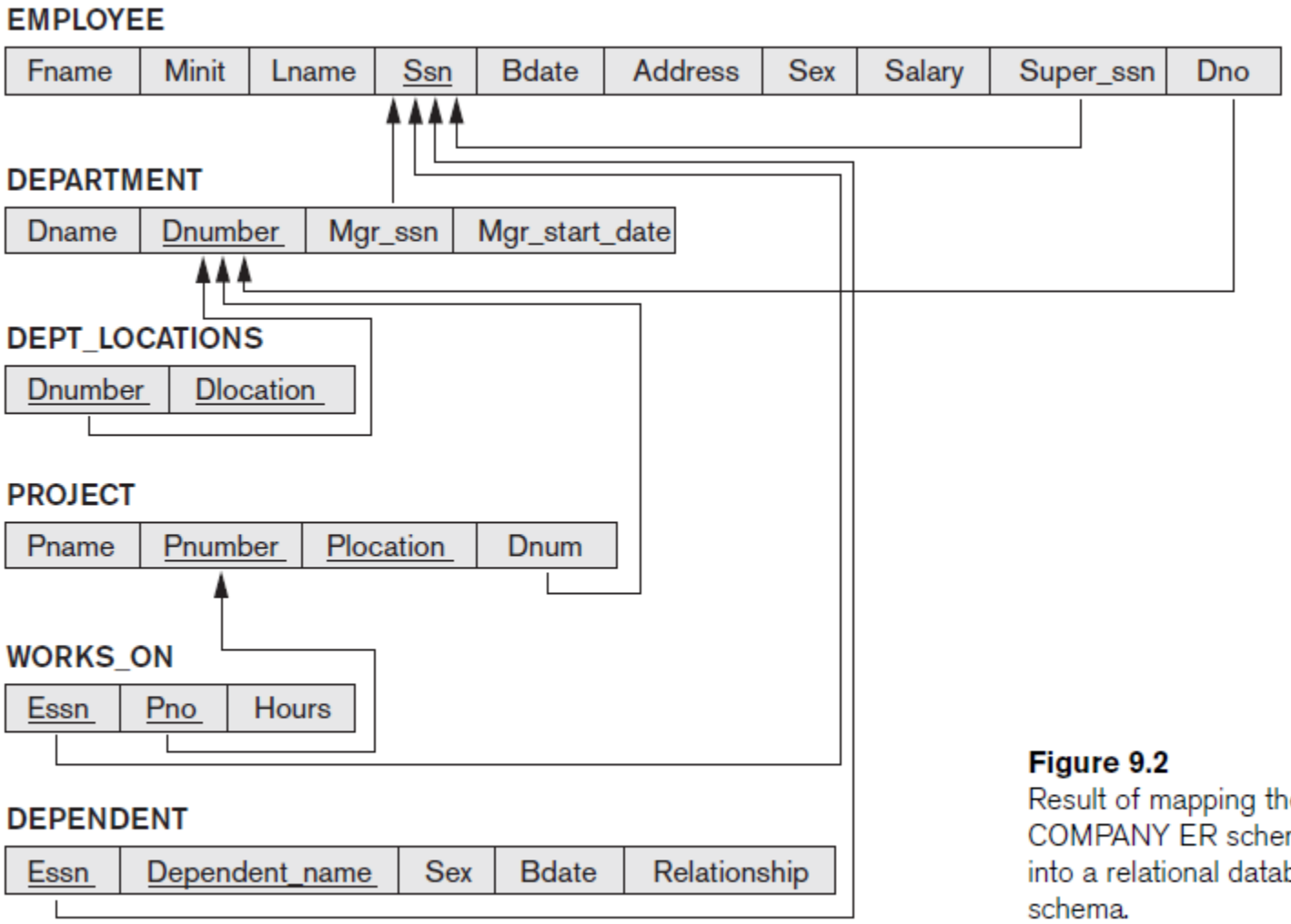
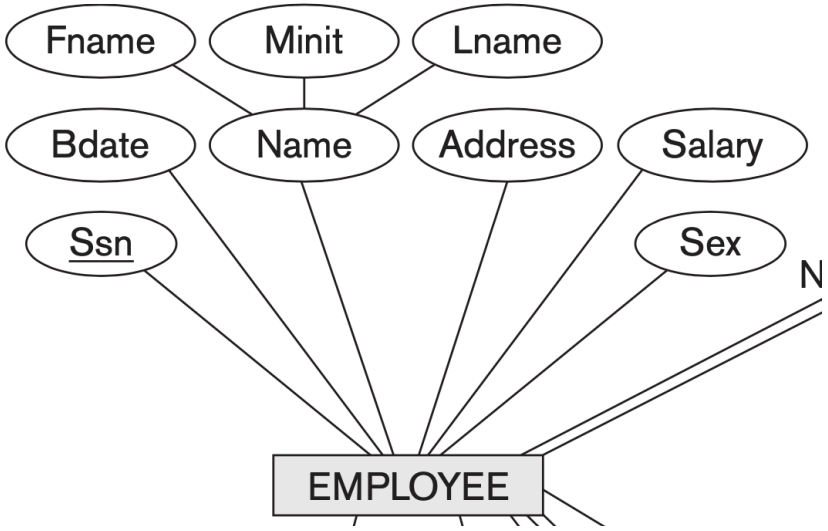


Figure 9.2
Result of mapping the COMPANY ER schema into a relational database schema.

ER-to-Relational Mapping Algorithm

- Step 1: Mapping of Regular Entity Types
  - For each regular entity type, create a relation that includes all the simple attributes of the entity
  - Include the simple components of all compound attributes
  - Called **entity relations**
    - Each tuple represents an entity instance

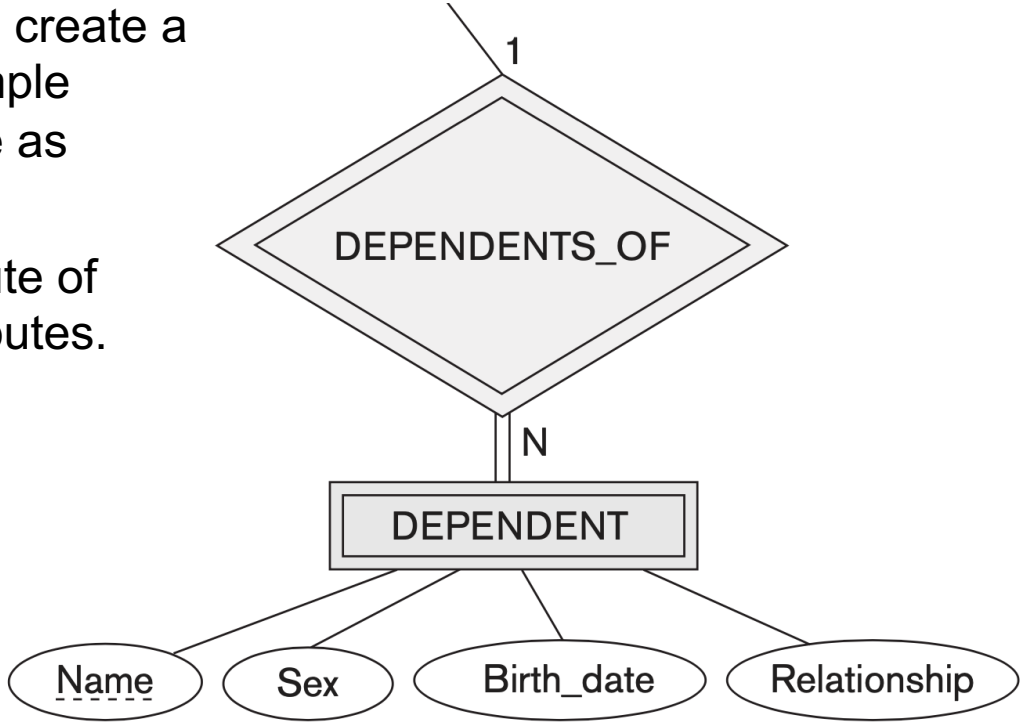


EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary

ER-to-Relational Mapping Algorithm

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

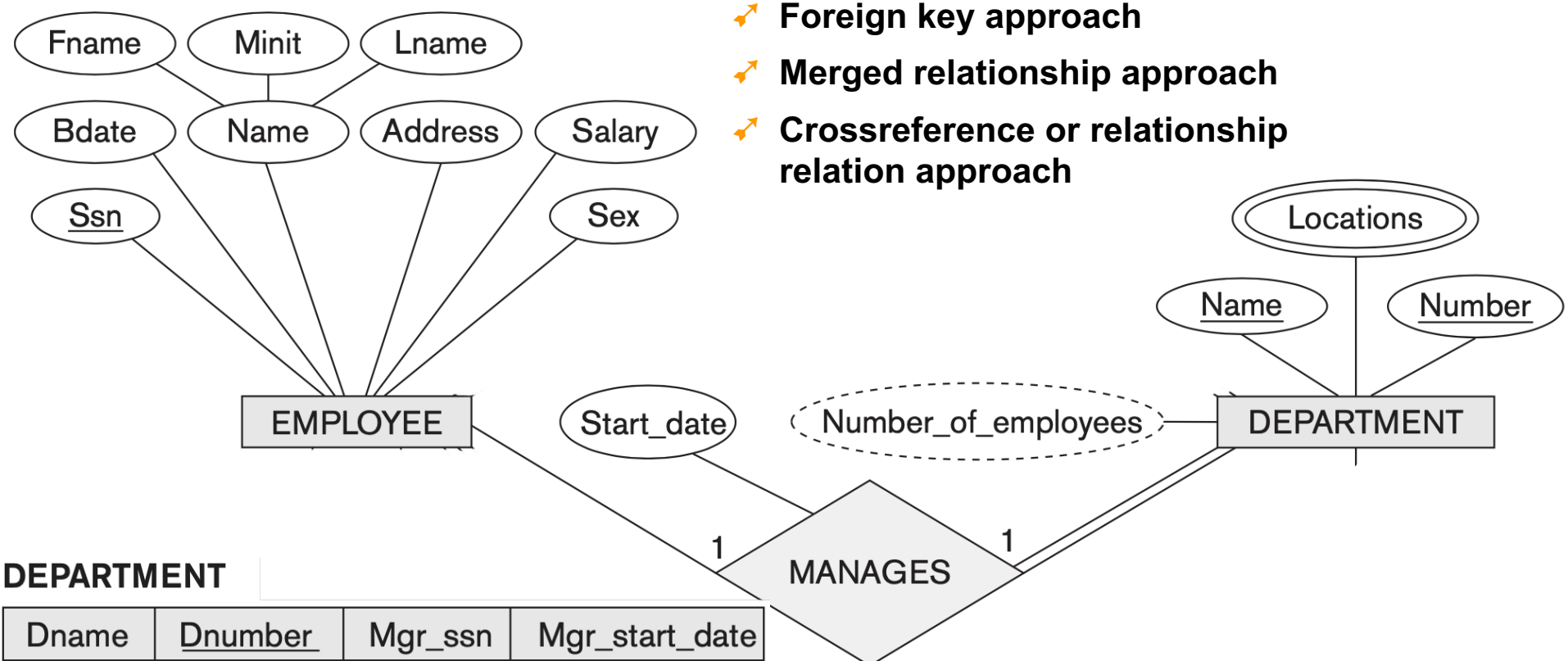


DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship

ER-to-Relational Mapping Algorithm

- 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**

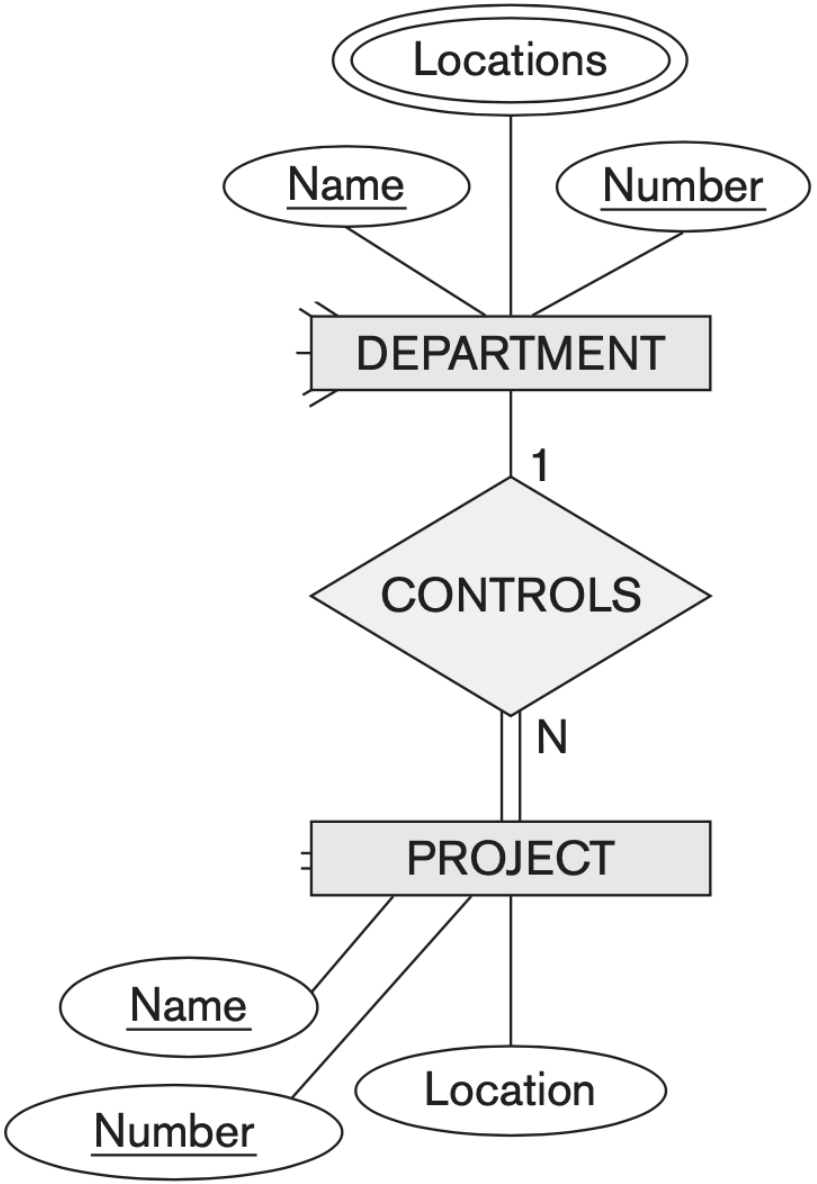


DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date

ER-to-Relational Mapping Algorithm

- Step 4: Mapping of Binary 1:*N* Relationship Types
  - For each regular binary 1:*N* relationship type
    - The entity type at the *N*-side of the relationship should include the primary key of the other entity as a foreign key
    - Include simple attributes of 1:*N* relationship type as attributes
  - Alternative:
    - Use a **relationship relation** (cross-reference)

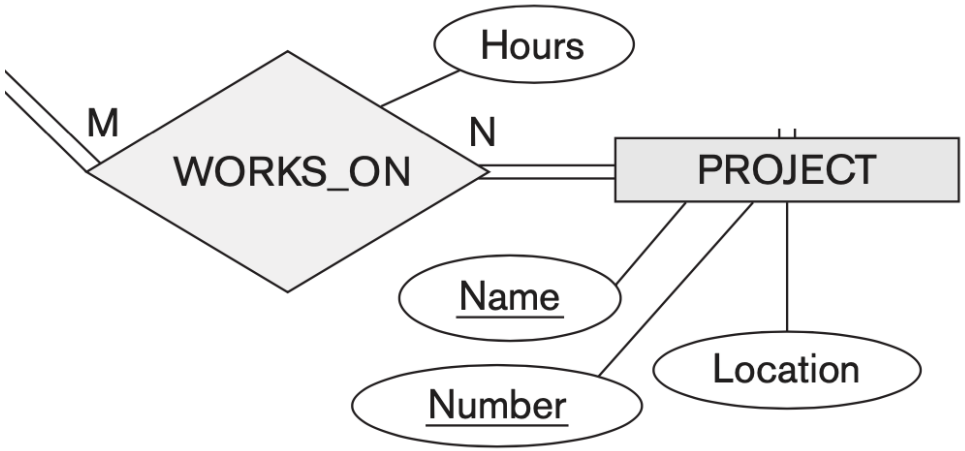


PROJECT

Pname	Pnumber	Plocation	Dnum

ER-to-Relational Mapping Algorithm

- Step 5: Mapping of Binary *M*:*N* Relationship Types
  - For each binary *M*:*N* relationship type
    - Create a "relationship relation" (AKA a cross-reference)
    - Include primary key of participating entity types as foreign key attributes.
    - Include any simple attributes of *M*:*N* relationship type

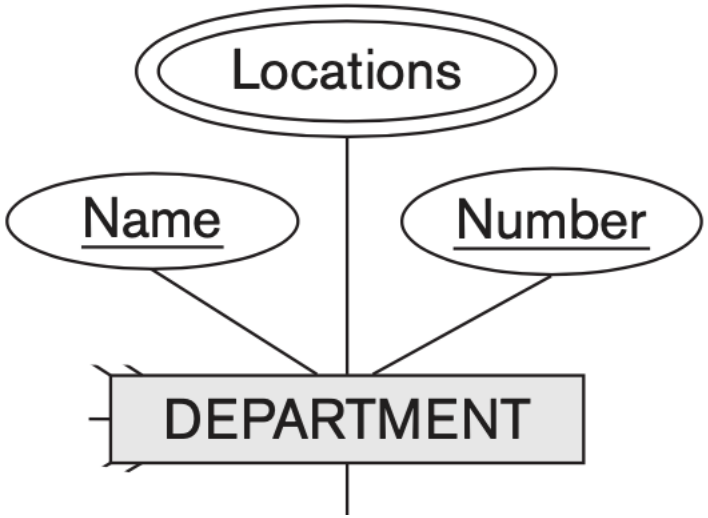


WORKS_ON

Essn	Pno	Hours

ER-to-Relational Mapping Algorithm

- Step 6: Mapping of Multivalued Attributes
  - For each multivalued attribute
    - Create a new relation.
    - Primary key of the new relation is the combination of the primary key of the owning entity and the new attribute.
    - If the multivalued attribute is composite, include its simple components

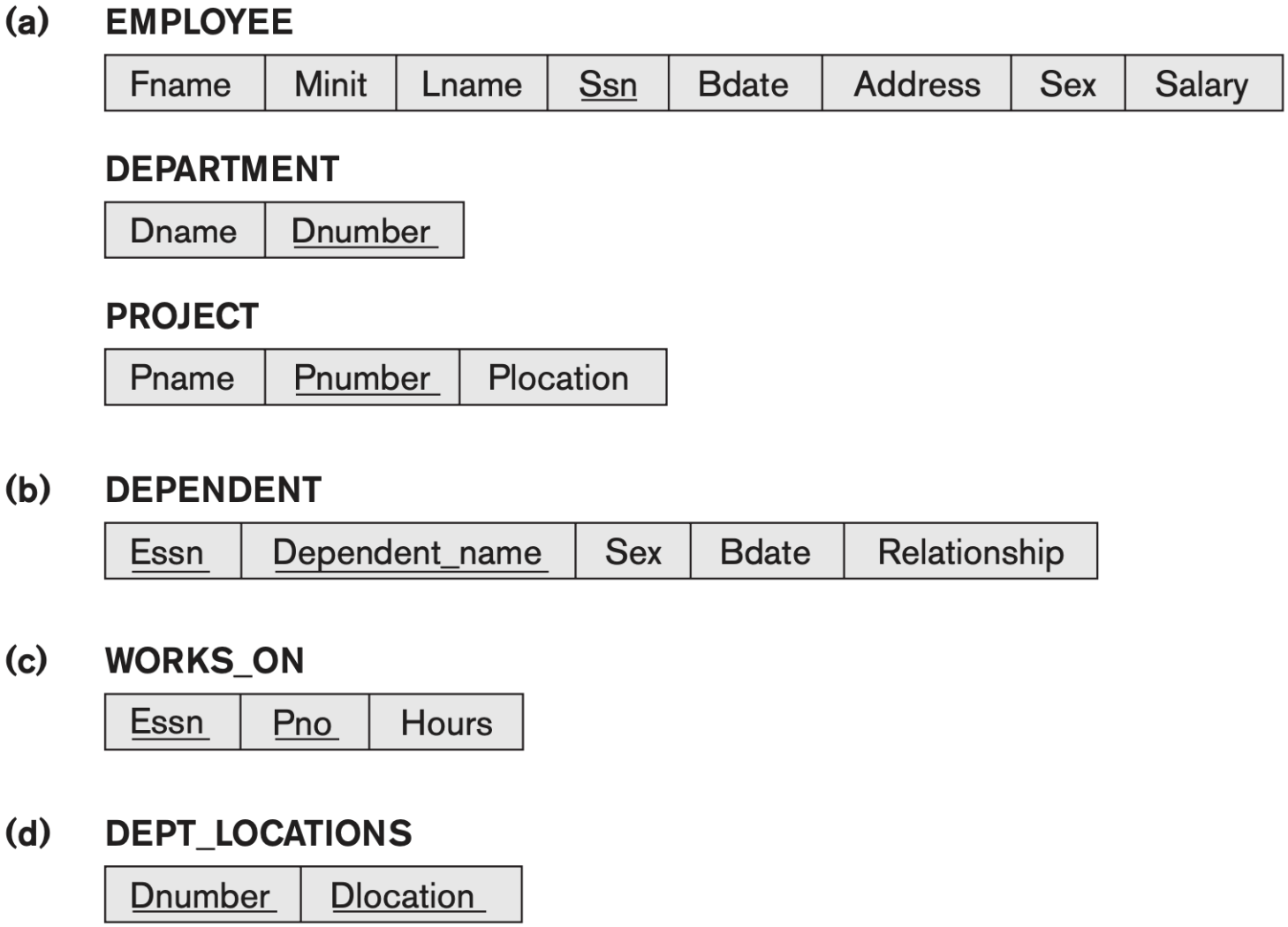


DEPT_LOCATIONS

Dnumber	Dlocation

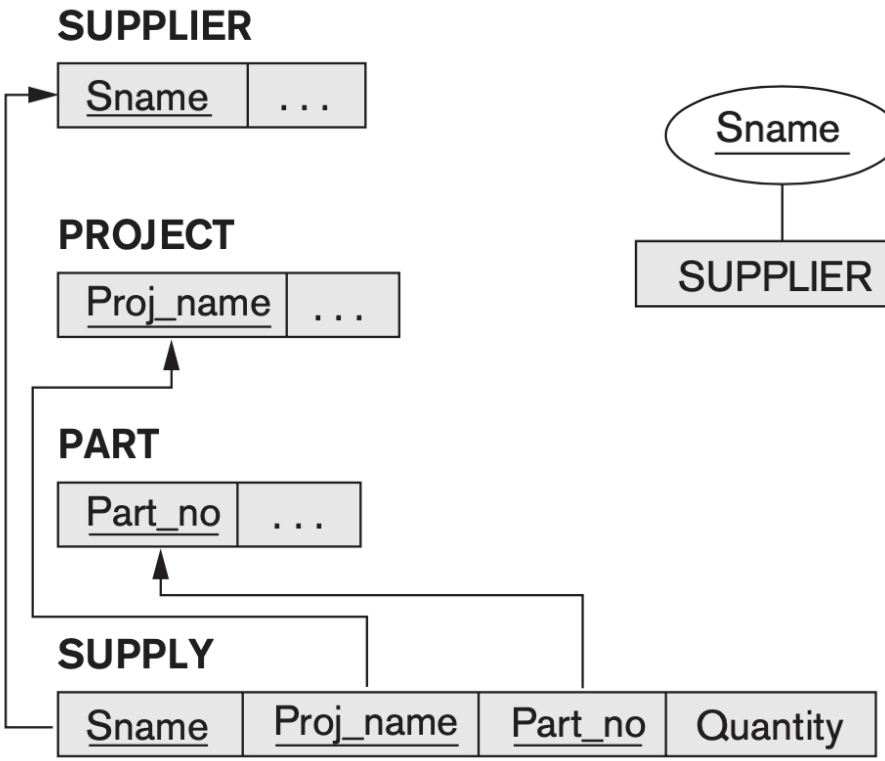
ER-to-Relational Mapping Algorithm

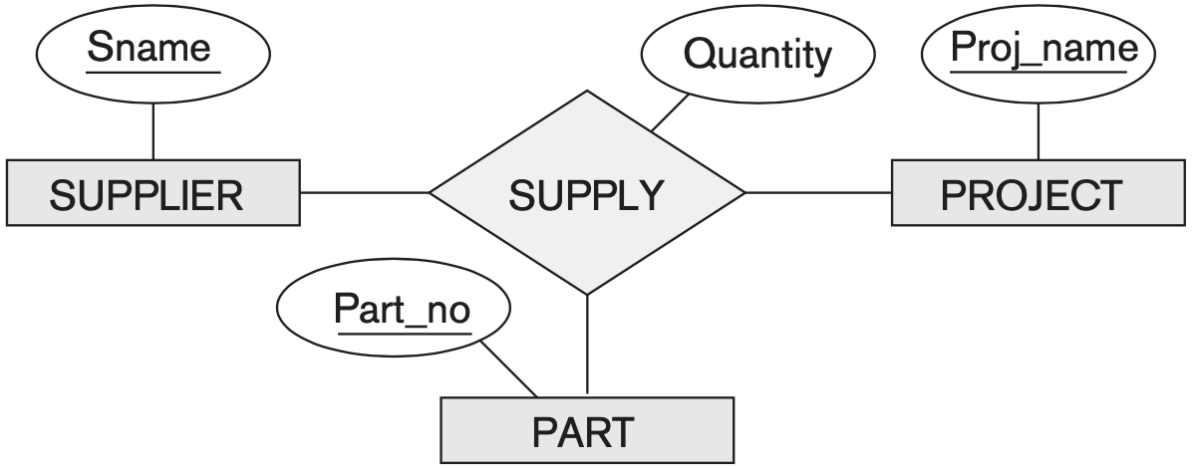
Figure 9.3
Illustration of some mapping steps.
(a) *Entity* relations after step 1.
(b) Additional *weak entity* relation after step 2.
(c) *Relationship* relations after step 5.
(d) Relation representing multivalued attribute after step 6.



ER-to-Relational Mapping Algorithm

- Step 7: Mapping of *N*-ary Relationship Types
  - For each *n*-ary relationship type
    - Create a new relation
    - 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

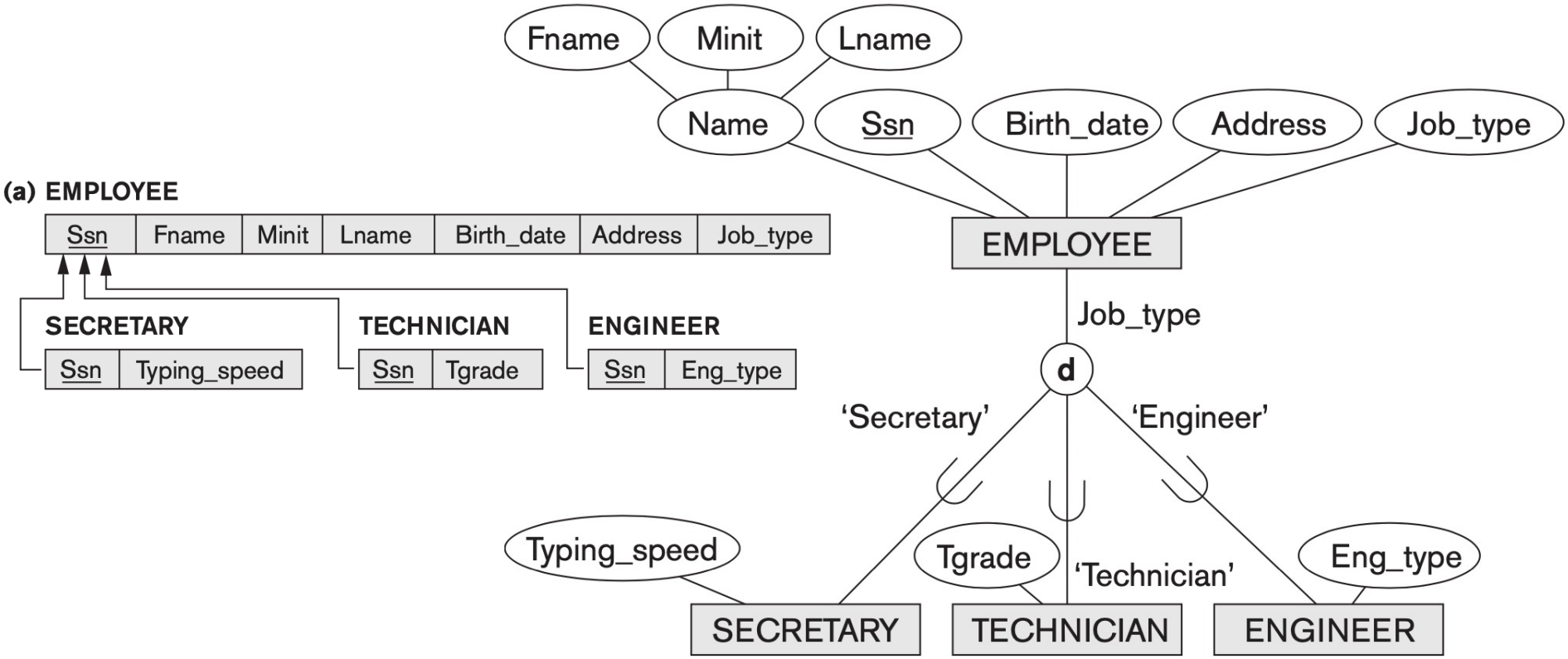
ER MODEL	RELATIONAL MODEL
Entity type	*Entity* relation
1:1 or 1:N relationship type	Foreign key (or *relationship* relation)
M:N relationship type	*Relationship* relation and *two* foreign keys
n-ary relationship type	*Relationship* relation and *n* foreign keys
Simple attribute	Attribute
Composite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

Mapping EER Model Constructs to Relations

- Extending ER-to-relational mapping algorithm

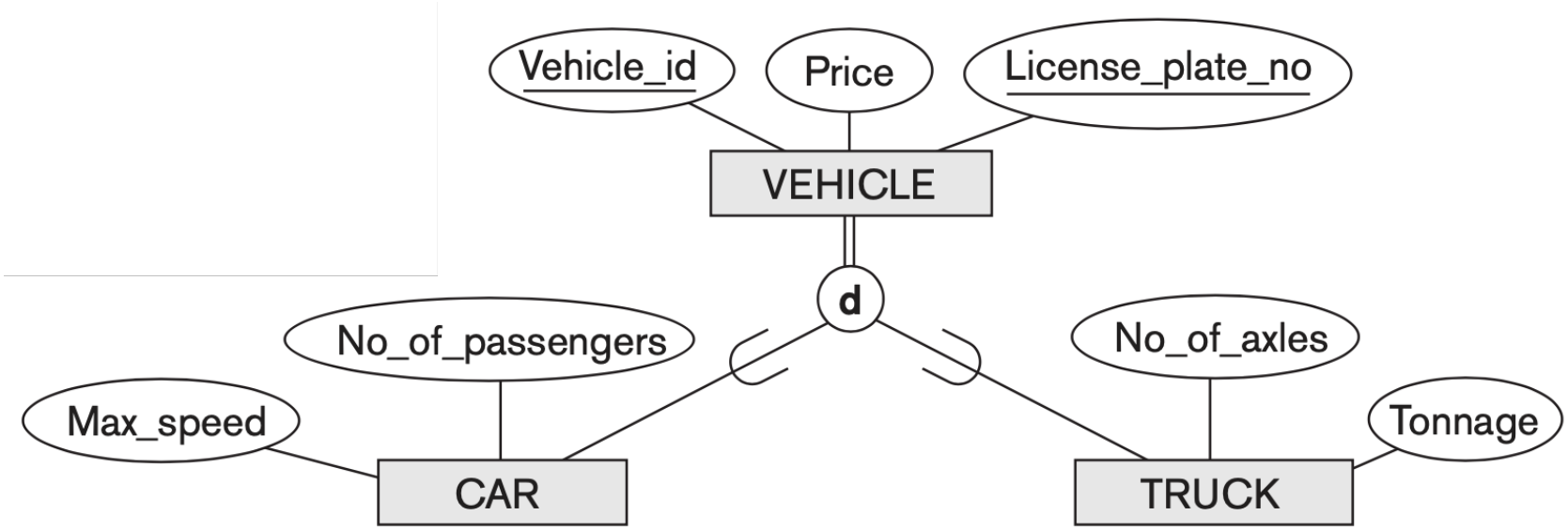
Step 8: Mapping of Specialization or Generalization

- **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



(b) CAR

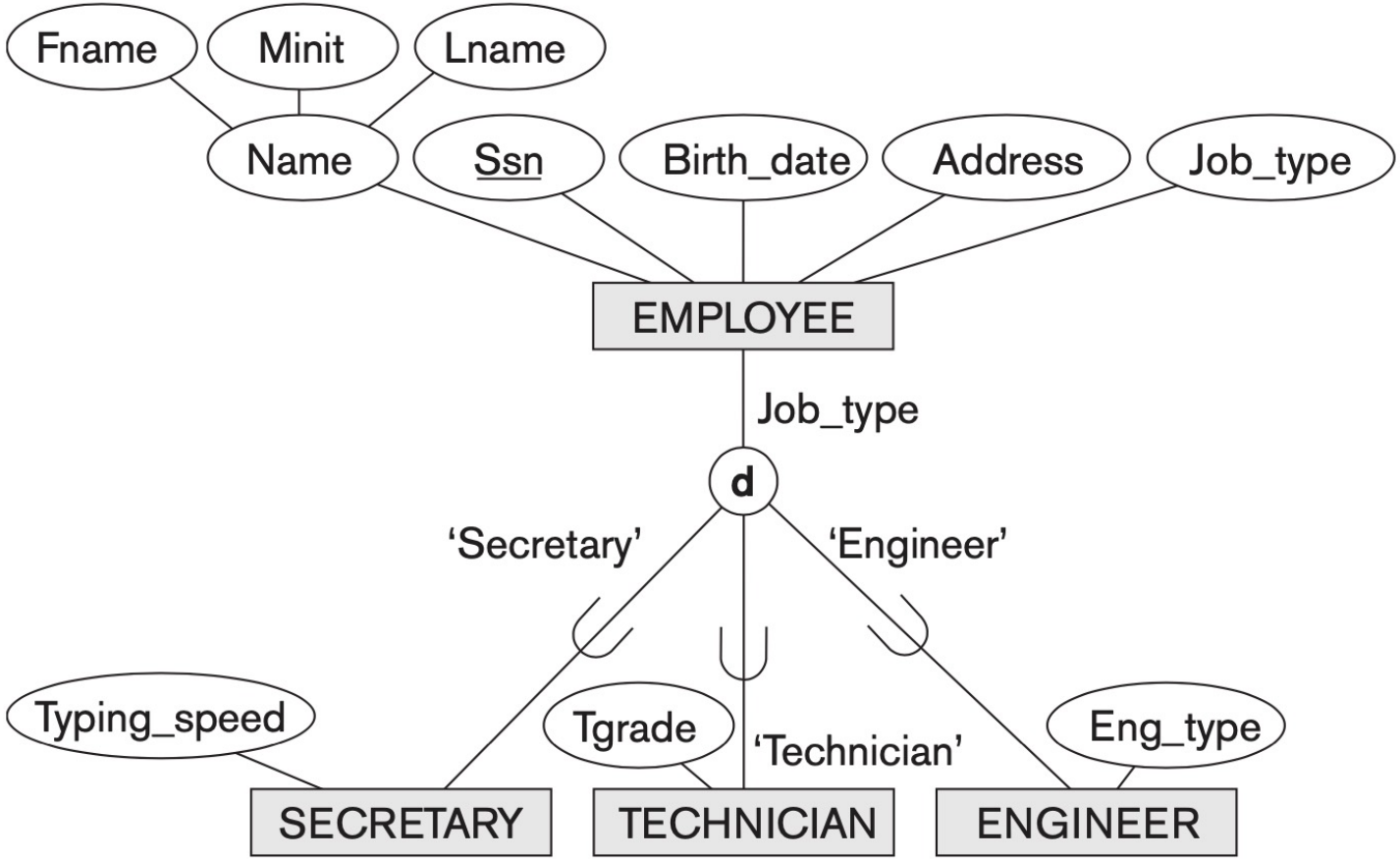
Vehicle_id	License_plate_no	Price	Max_speed	No_of_passengers

TRUCK

Vehicle_id	License_plate_no	Price	No_of_axles	Tonnage

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

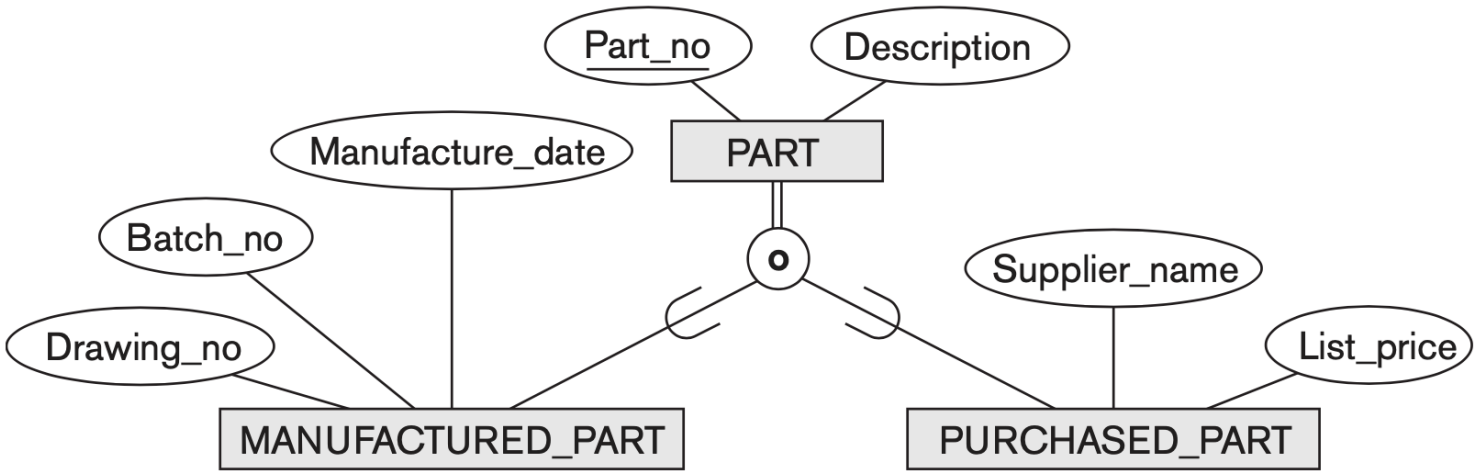


(c) **EMPLOYEE**

Ssn	Fname	Minit	Lname	Birth_date	Address	Job_type	Typing_speed	Tgrade	Eng_type

Option 8D: Single relation with multiple type attributes

- Subclasses are overlapping
- Will also work for a disjoint specialization



(d) PART

Part_no	Description	Mflag	Drawing_no	Manufacture_date	Batch_no	Pflag	Supplier_name	List_price

Mapping of Categories (Union Types)

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

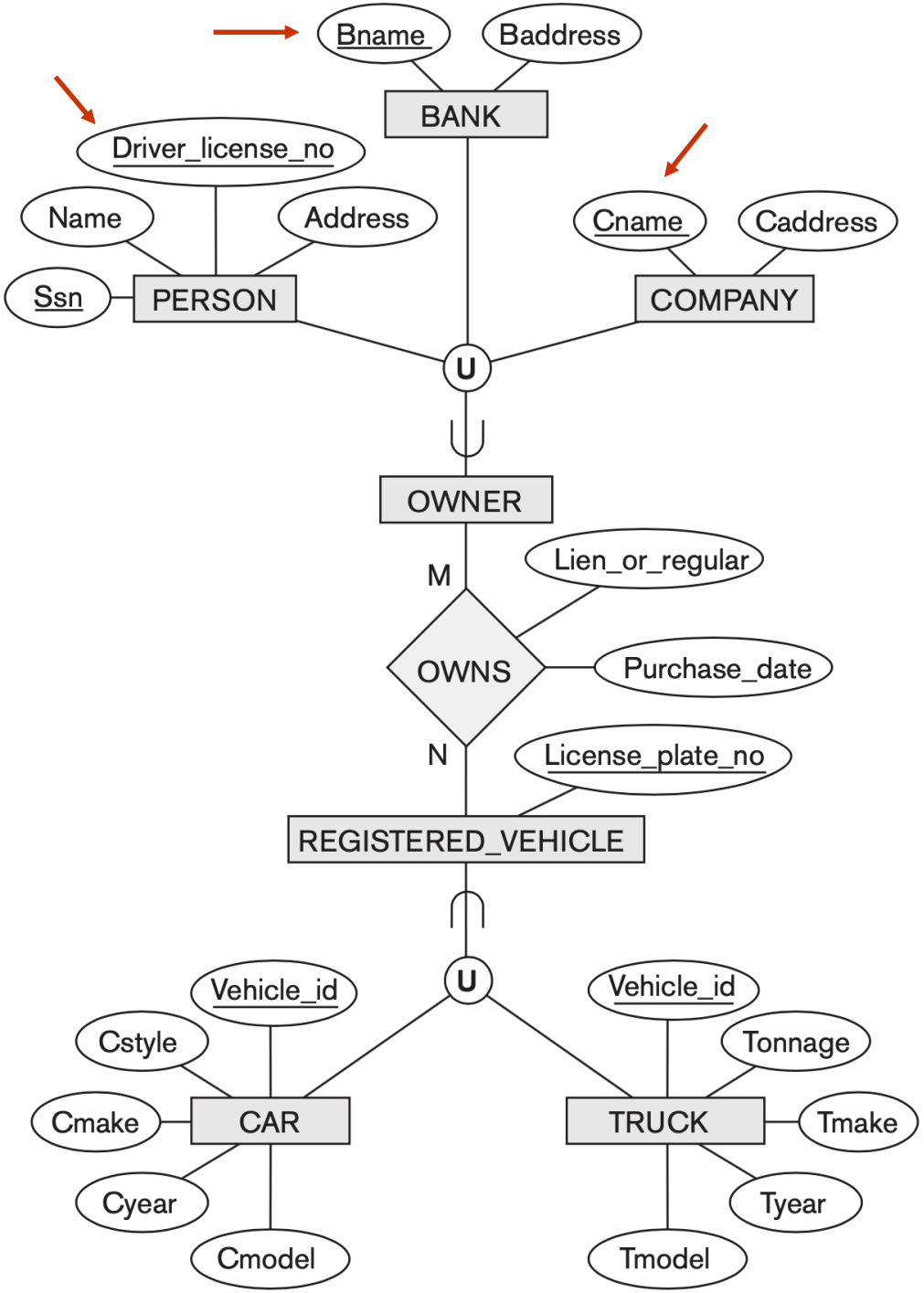
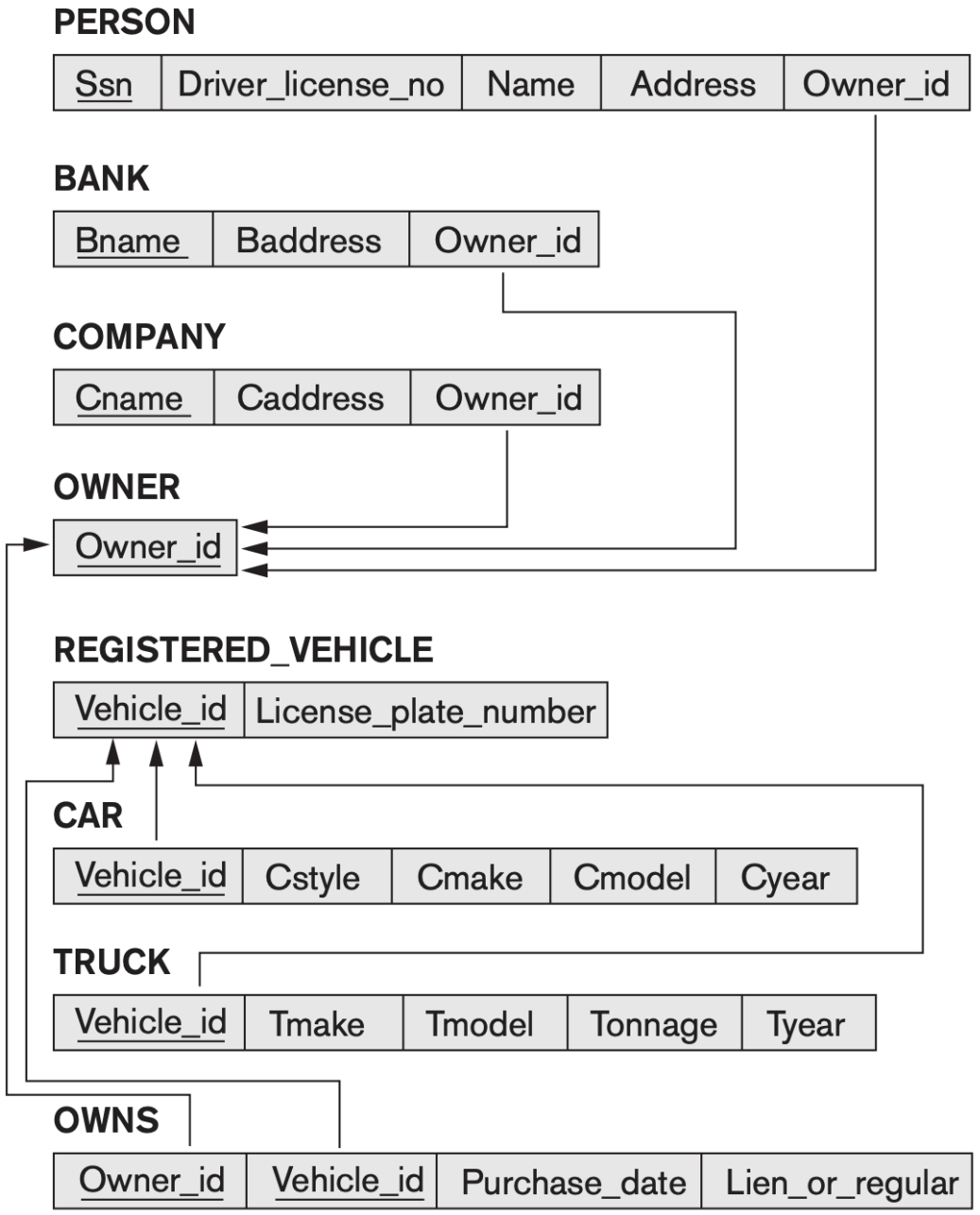


Figure 4.8
Two categories (union types): OWNER and REGISTERED_VEHICLE.

Figure 9.7
Mapping the EER categories (union types) in Figure 4.8 to relations.



Summary

- Using this algorithm, we can convert the "conceptual schema design" from an ER model to a relational database schema