Slide 1

204320 - Database Management

Chapter 9

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

Adapted for 204320

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Chapter 9 Outline

- Relational Database Design Using ER-to-Relational Mapping
- Relational Database Design Using EER-to-Relational Mapping

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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

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Relational Database Design Using ER-to-Relational Mapping

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

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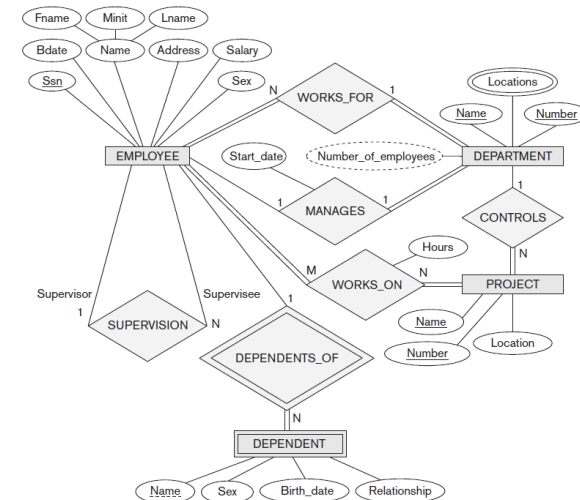
EMPLOYEE

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.

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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 <u>regular entity type</u>, <u>create a relation *R* that includes all the simple attributes of *E*</u>
  - Called **entity relations**
    - Each tuple represents an entity instance

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

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

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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:** e.g. Employee manages department (total participation : every department has a manager, PK Employee → FK in Department, otherwise a lot of NULL in Employee)
    - **Merged relationship approach:** when both entities are total participation
    - **Cross reference or relationship relation approach:**
      create third relation and keeps PK of both entities, disadvantage: have one more table and join is needed to join data from both

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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*
  - Alternative approach
    - Use the **relationship relation** (cross-reference) option as in the third option for binary 1:1 relationships
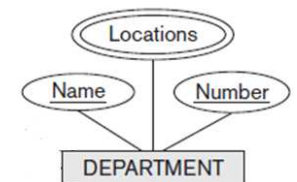
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ER-to-Relational Mapping Algorithm (cont'd.)

- 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

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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

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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
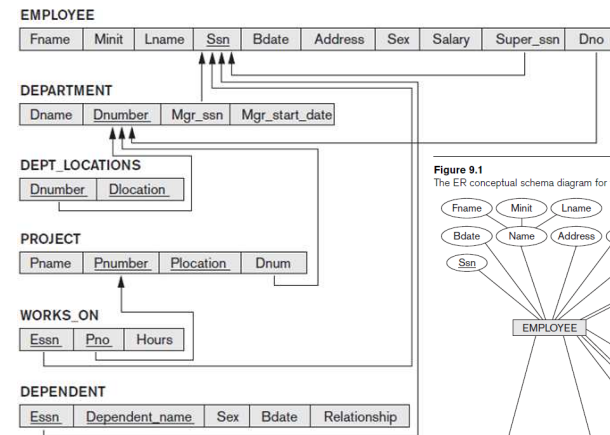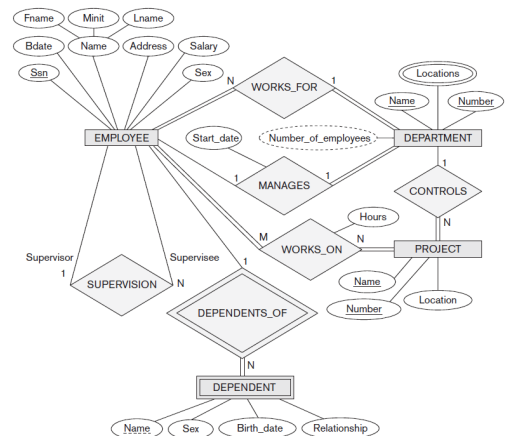 - Represented by having two attributes *A* and *B*: one a primary key and the other a foreign key

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

Mapping EER Model Constructs to Relations

- Extending ER-to-relational mapping algorithm
- **Step 8:** Options for Mapping Specialization or Generalization, **Convert each** specialization with *m* subclasses {S1, S2, ..., Sm} and (generalized) superclass C, where the attributes of C are {k, a1, ...an} and k is the (primary) key, into relation schemas using one of the following 4 options: 8A – 8D
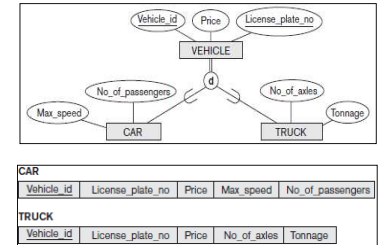

Mapping of Specialization or Generalization

Option 8A: Multiple relations superclass and subclasses.

Create a relation L for C with attributes Attrs(L) = {k, a1, ..., an} and PK(L) = k. Create a relation Li for each subclass Si, 1 ≤ i ≤ m, with the attributes Attrs(Li) = {k} ∪ {attributes of Si} and PK(Li) = k. This option works for any specialization (total or partial, disjoint or overlapping).
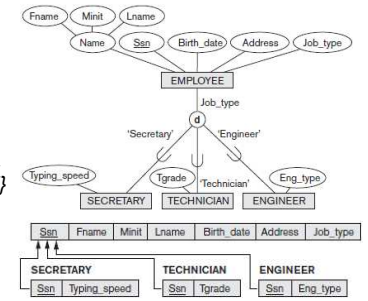
Option 8B: Multiple relations— subclass relations only.

Create a relation Li for each subclass Si, 1 ≤ i ≤ m, with the attributes Attrs(Li) = {attributes of Si} ∪ {k, a1, ..., an} and PK(Li) = k. This option only works for a specialization whose subclasses are total (every entity in the superclass must belong to (at least) one of the subclasses). Additionally, it is only recommended if the specialization has the disjointedness constraint. If the specialization is overlapping, the same entity may be duplicated in several relations.


Mapping of Specialization or Generalization

Option 8C: Single relation with one type attribute

Create a single relation L with attributes Attrs(L) = {k, a1, ..., an} ∪ {attributes of S1} ∪ ... ∪ {attributes of Sm} ∪ {t} and PK(L) = k.

The attribute t is called <u>a type (or discriminating) attribute whose value indicates the subclass to which each</u> tuple belongs, if any. This option works only for a specialization whose subclasses are disjoint, and has the potential for generating many NULL values if many specific attributes exist in the subclasses.
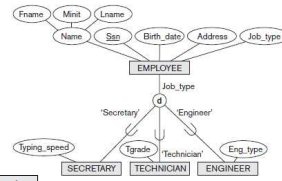
Option 8D: Single relation with multiple type attributes

Create a single relation schema L with attributes Attrs(L) = {k, a1, ..., an} ∪ {attributes of S1} ∪ ... ∪ {attributes of Sm} ∪ {t1, t2, ..., tm} and PK(L) = k. Each ti, 1 ≤ i ≤ m, is <u>a Boolean type attribute indicating whether a tuple belongs to subclass Si</u>. This option is used for a specialization whose subclasses are overlapping (but will also work for a disjoint specialization).
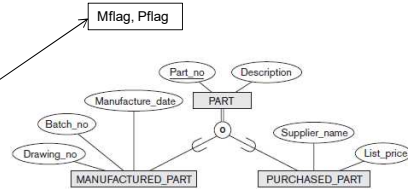
Mapping of Shared Subclasses (Multiple Inheritance)

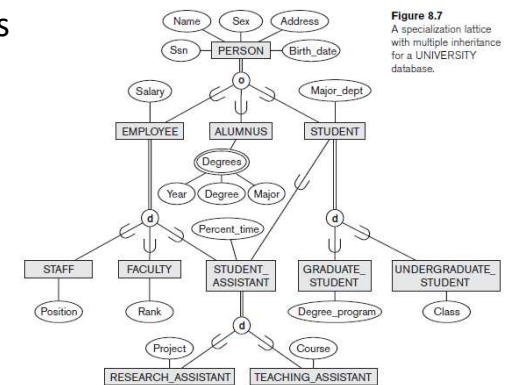- Apply any of the options discussed in step 8 to a shared subclass

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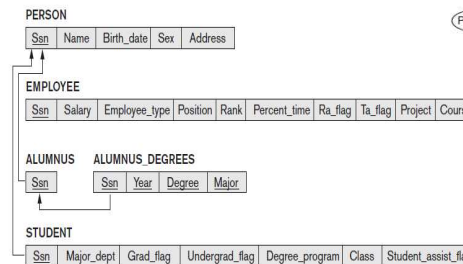A specialization lattice with multiple inheritance for a UNIVERSITY database.

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
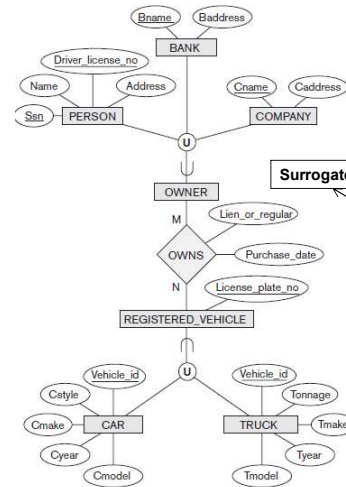 - Specify a new key attribute
    - **Surrogate key**

Figure 8.8
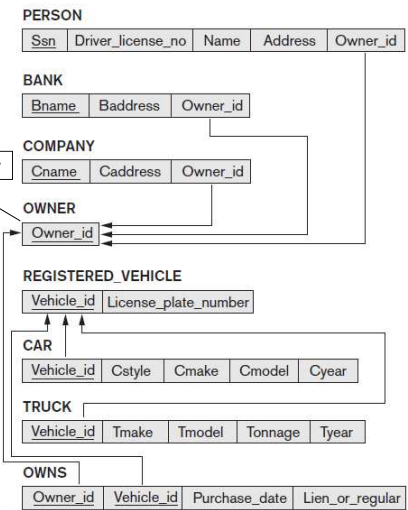Two categories (union types): OWNER and REGISTERED_VEHICLE.

Surrogate key

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

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