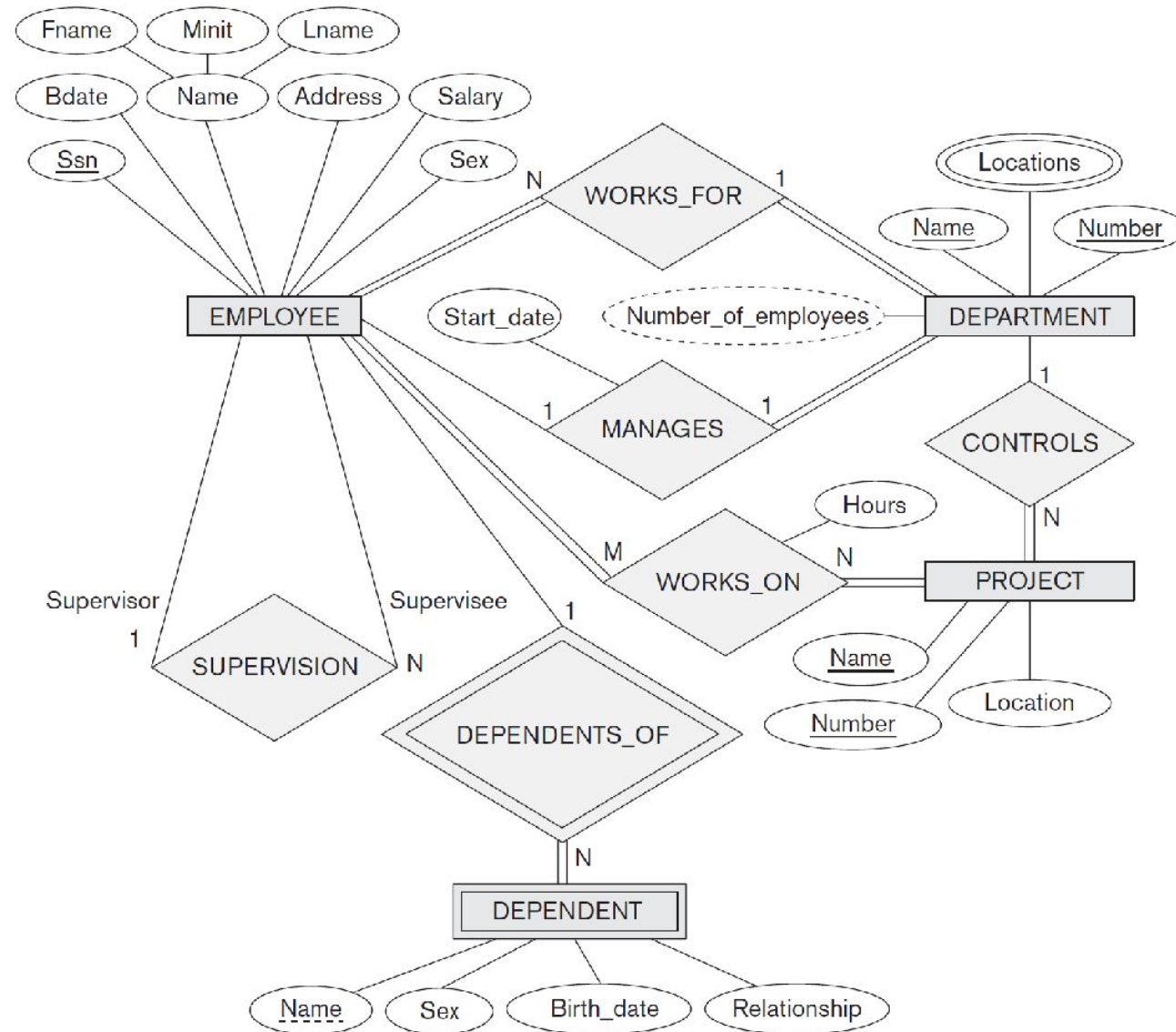


Reduction of ER Model to Relational Model

ER-to-Relational Mapping Algorithm

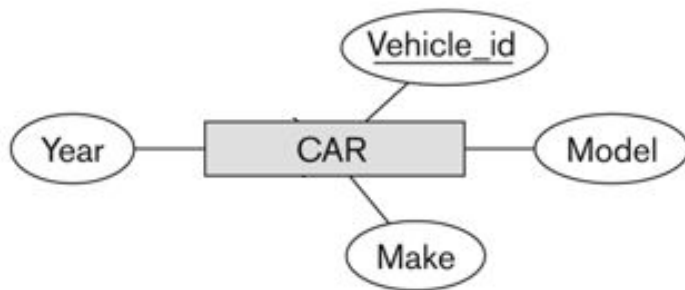
- ☐ Mapping of Regular Entity Types
- ☐ Mapping of Weak Entity Types
- ☐ Mapping of Binary 1:1 Relation Types
- ☐ Mapping of Binary 1:N Relationship Types
- ☐ Mapping of Binary M:N Relationship Types
- ☐ Mapping of Multivalued attributes
- ☐ Mapping of N-ary Relationship Types
- ☐ Options for Mapping Specialization or Generalization
- ☐ Mapping of Aggregation

The ER conceptual schema diagram for the COMPANY database



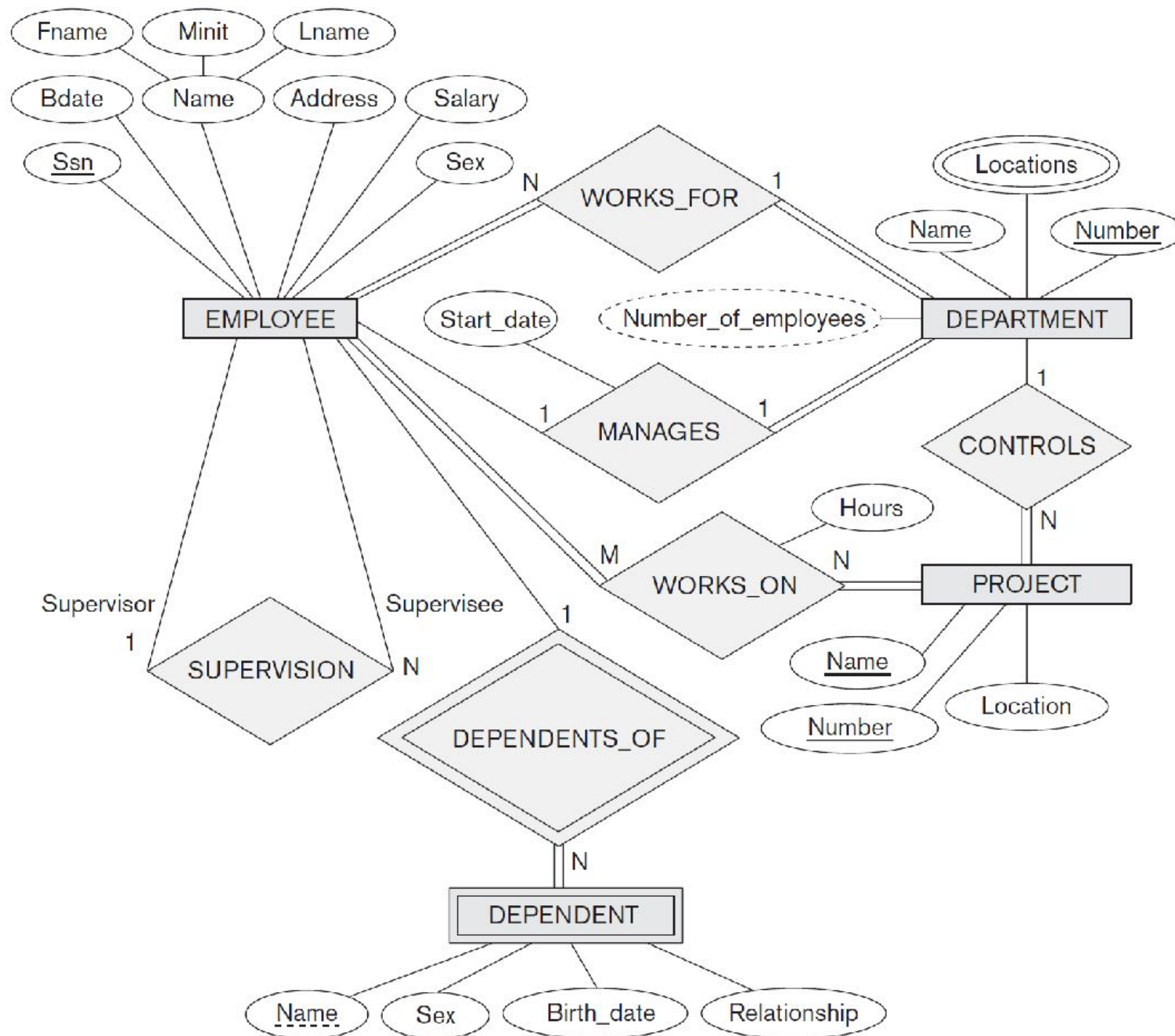
Mapping of Regular Entity Types

- ☐ For each regular (strong) entity type E in the ER schema, create a relation R that includes all the simple attributes of E .
- ☐ Include only the simple component attributes of a composite attribute.
- ☐ Choose one of the key attributes of E as the primary key for R .
- ☐ If the chosen key of E is a composite, then the set of simple attributes that form it will together form the primary key of R .



CAR

Vehicle_Id	Model	Make	Year
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Mapping of Regular Entity Types

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary
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DEPARTMENT

Dname	<u>Dnumber</u>
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PROJECT

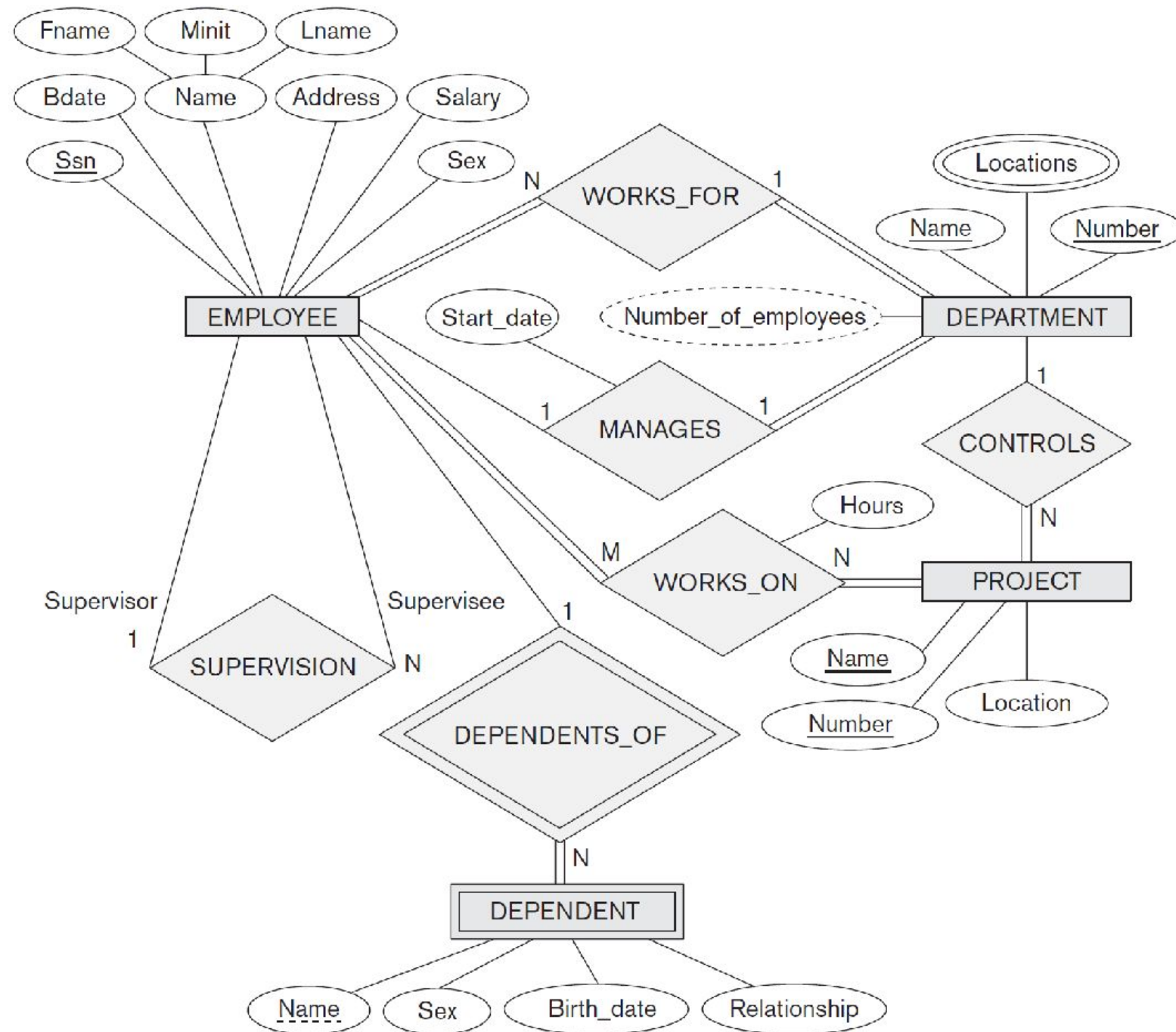
Pname	<u>Pnumber</u>	Plocation
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❑ Example

- We create the relations EMPLOYEE, DEPARTMENT, and PROJECT in the relational schema corresponding to the regular entities in the ER diagram.
- SSN, DNUMBER, and PNUMBER are the primary keys for the relations EMPLOYEE, DEPARTMENT, and PROJECT as shown.

Mapping of Weak Entity Types

- ❑ For each weak entity type W in the ER schema with owner entity type E , create a relation R and include all simple attributes (or simple components of composite attributes) of W as attributes of R .
- ❑ Include as foreign key attributes of R the primary key attribute(s) of the relation(s) that correspond to the owner entity type(s).
- ❑ The primary key of R is the combination of the primary key(s) of the owner(s) and the partial key of the weak entity type W , if any.
- ❑ If there is a weak entity type E_2 whose owner is also a weak entity type E_1 , then E_1 should be mapped before E_2 to determine its primary key first.



Mapping of Weak Entity Types

□ Example

- Create the relation DEPENDENT correspond to the weak entity type DEPENDENT.
- Include the primary key SSN of the EMPLOYEE relation as a foreign key attribute of DEPENDENT (renamed to ESSN).
- The primary key of the DEPENDENT relation is the combination {ESSN, DEPENDENT_NAME} because DEPENDENT_NAME is the partial key of DEPENDENT.

DEPENDENT

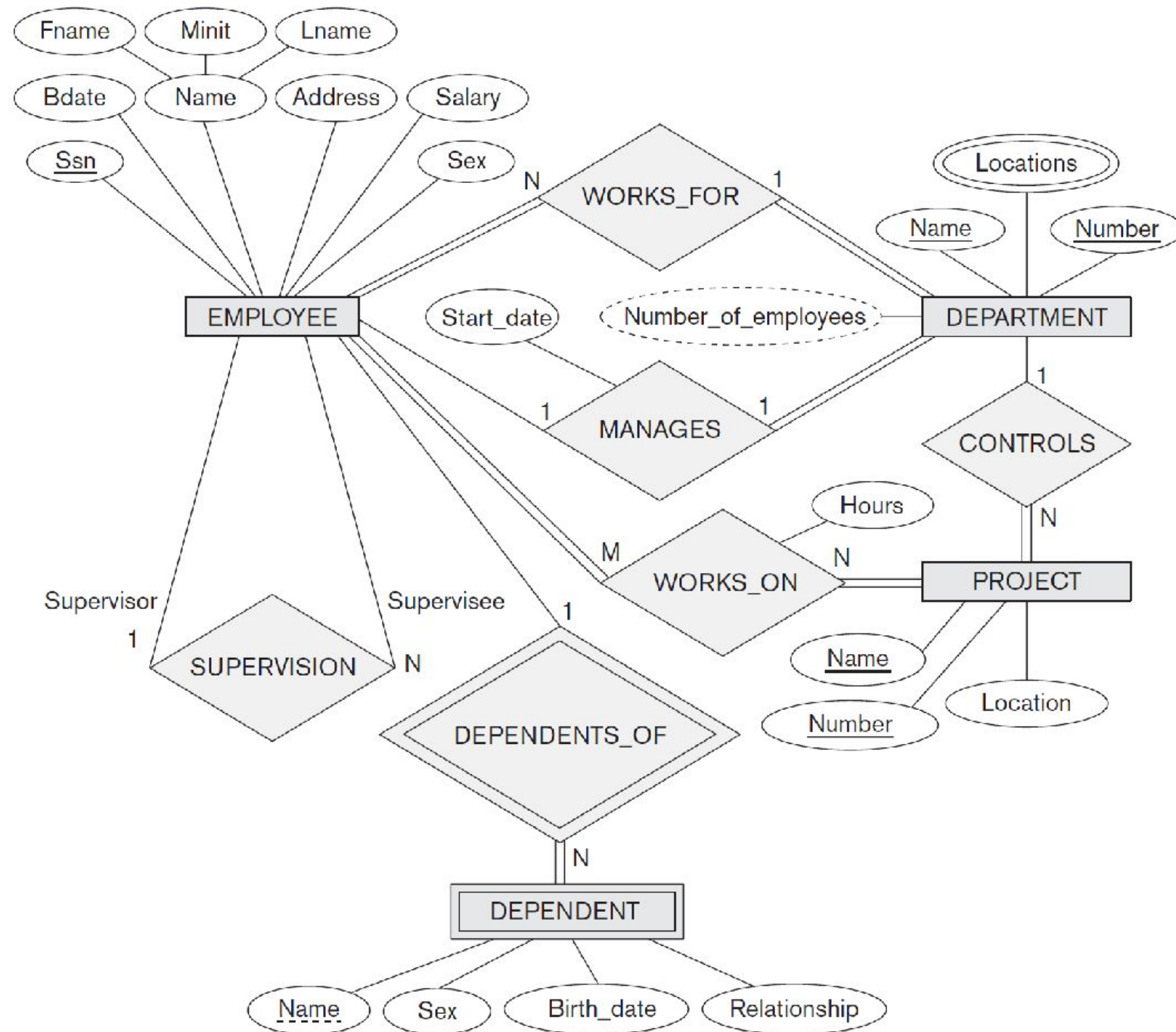
<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
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Mapping of Binary 1:1 Relationship Types

- ❑ For each binary 1:1 relationship type R in the ER schema, identify the relations S and T that correspond to the entity types participating in R.
- ❑ There are three possible approaches:
 - **Foreign Key (2 relations) approach:** Choose one of the relations, say S and include a foreign key in S the primary key of T. It is better to choose an entity type with total participation in R in the role of S.
 - **Example**
 - 1:1 relation MANAGES is mapped by choosing the participating entity type DEPARTMENT to serve in the role of S, because its participation in the MANAGES relationship type is total.
 - Include the primary key of the EMPLOYEE relation as foreign key in the DEPARTMENT relation.
 - Include simple attribute Start_date of MANAGES relationship type in DEPARTMENT relation.

DEPARTMENT

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date
-------	----------------	---------	----------------

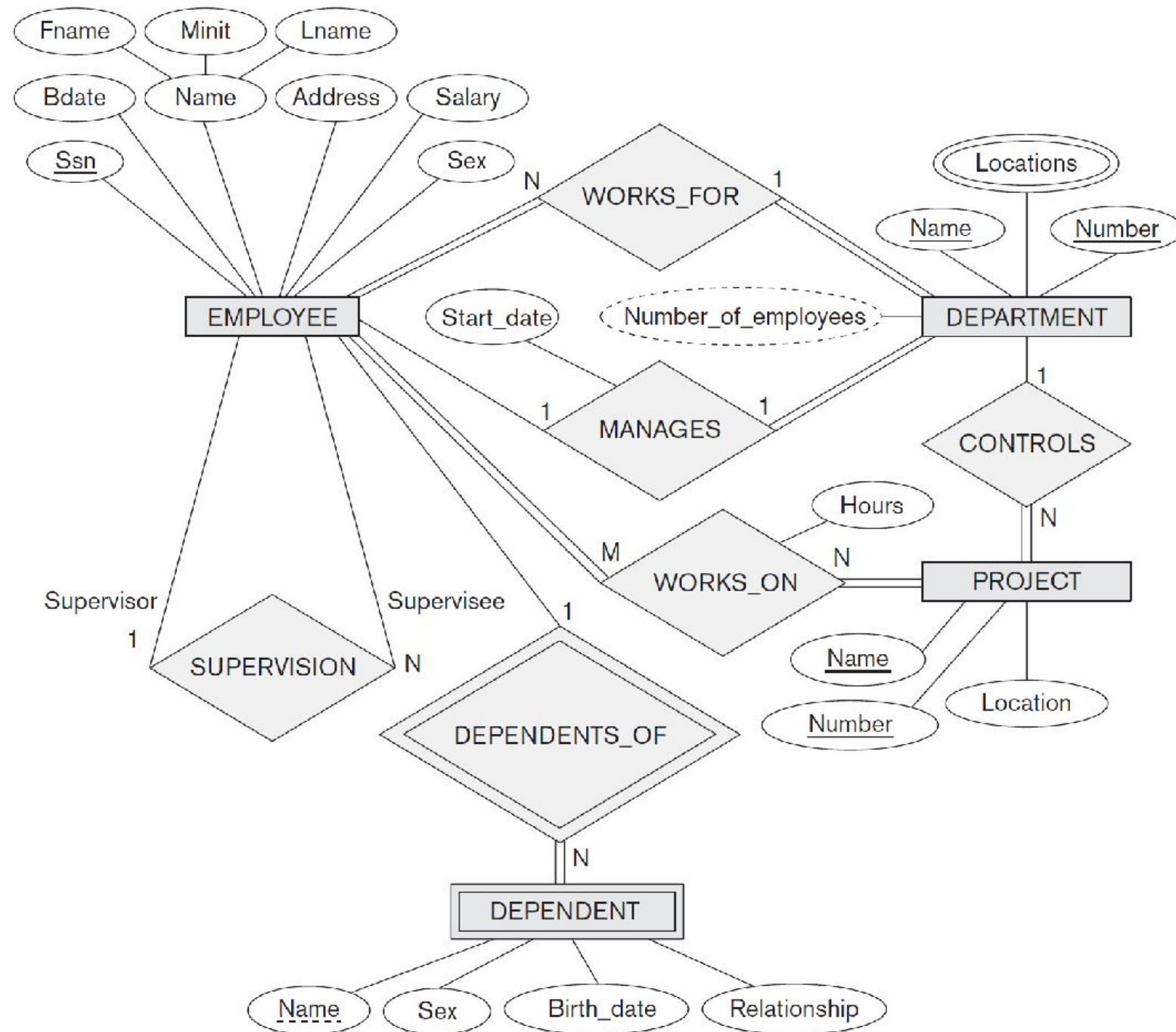


Mapping of Binary 1:1 Relationship Types

- ❑ **Merged relation (1 relation) option:** An alternate mapping of a 1:1 relationship type is possible by merging the two entity types and the relationship into a single relation. This may be appropriate when both *participations are total*.
- ❑ **Cross-reference or relationship relation (3 relations) option:** The third alternative is to set up a third relation R for the purpose of cross-referencing the primary keys of the two relations S and T representing the entity types.

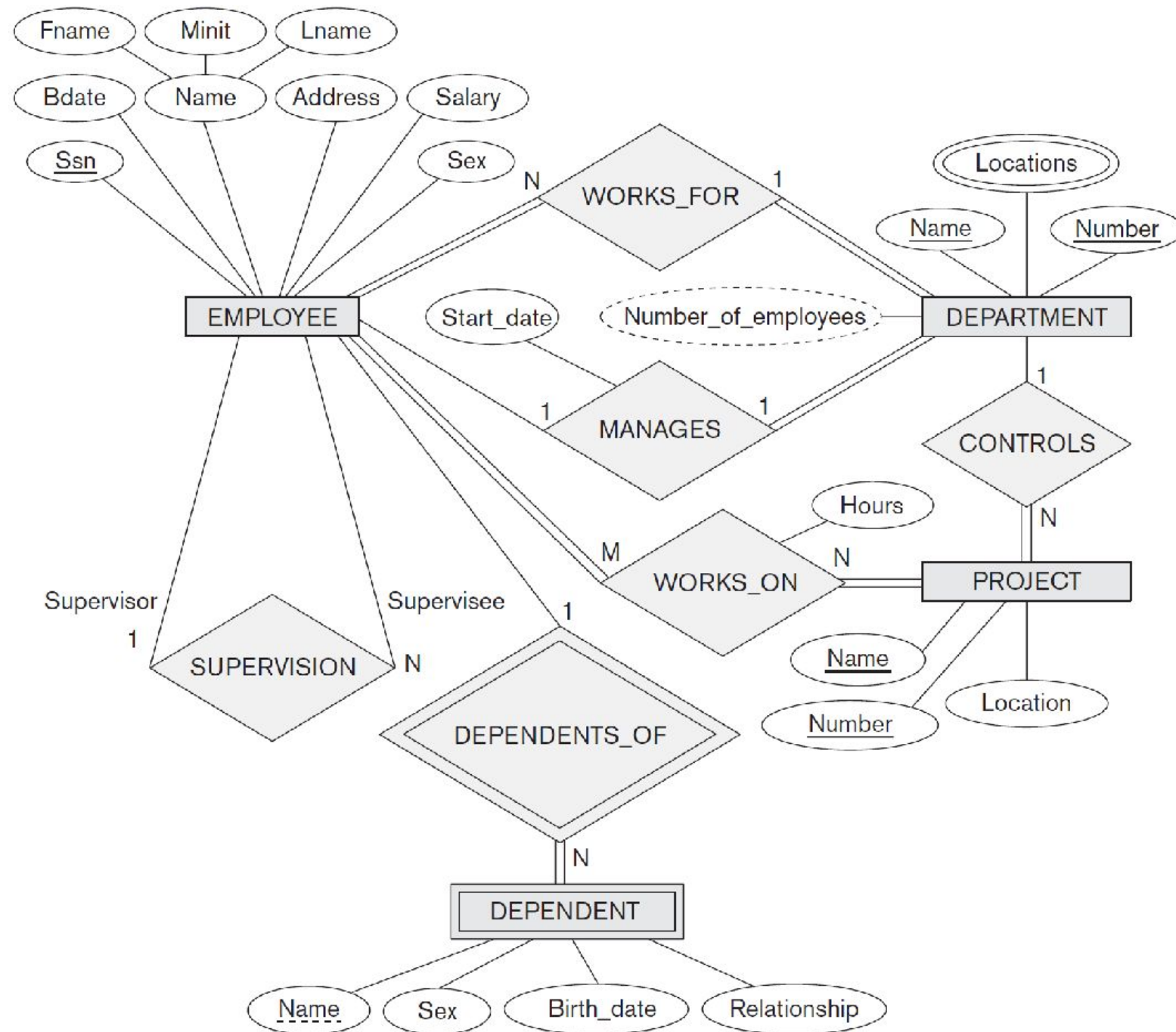
Mapping of Binary 1:N Relationship Types

- ❑ For each regular binary 1:N relationship type R, identify the relation S that represent the participating entity type at the N-side of the relationship type.
- ❑ Include as foreign key in S the primary key of the relation T that represents the other entity type participating in R.
- ❑ Include any simple attributes of the 1:N relation type as attributes of S.
- ❑ **Example**
 - 1:N relationship types WORKS_FOR, CONTROLS, and SUPERVISION.
 - For WORKS_FOR we include the primary key DNUMBER of the DEPARTMENT relation as foreign key in the EMPLOYEE relation.



Mapping of Binary M:N Relationship Types

- ❑ For each regular binary M:N relationship type R, create a new relation S to represent R. This is a *relationship relation*.
- ❑ Include as foreign key attributes in S the primary keys of the relations that represent the participating entity types; *their combination will form the primary key* of S.
- ❑ Also include any simple attributes of the M:N relationship type (or simple components of composite attributes) as attributes of S.
- ❑ **Example**
 - M:N relationship type WORKS_ON is mapped by creating a relation WORKS_ON in relational database schema.
 - The primary keys of the PROJECT and EMPLOYEE relations are included as foreign keys in WORKS_ON.
 - Attribute HOURS in WORKS_ON represents the HOURS attribute of the relation type. The primary key of the WORKS_ON relation is combination of foreign key attributes {ESSN, PNO}.



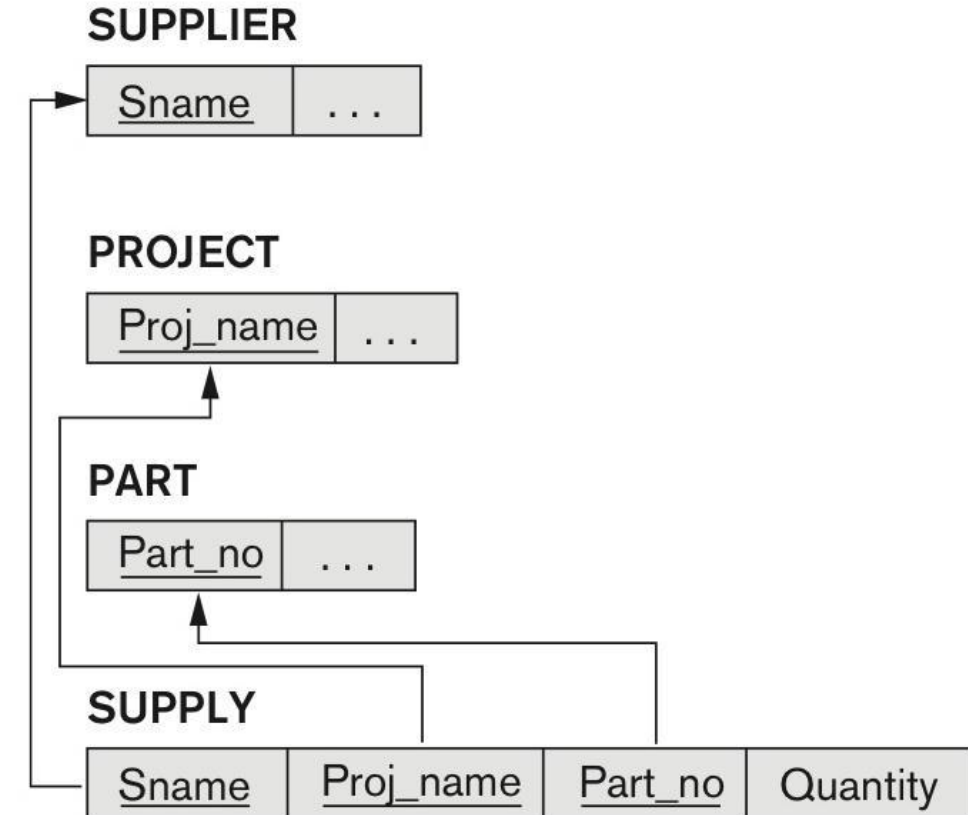
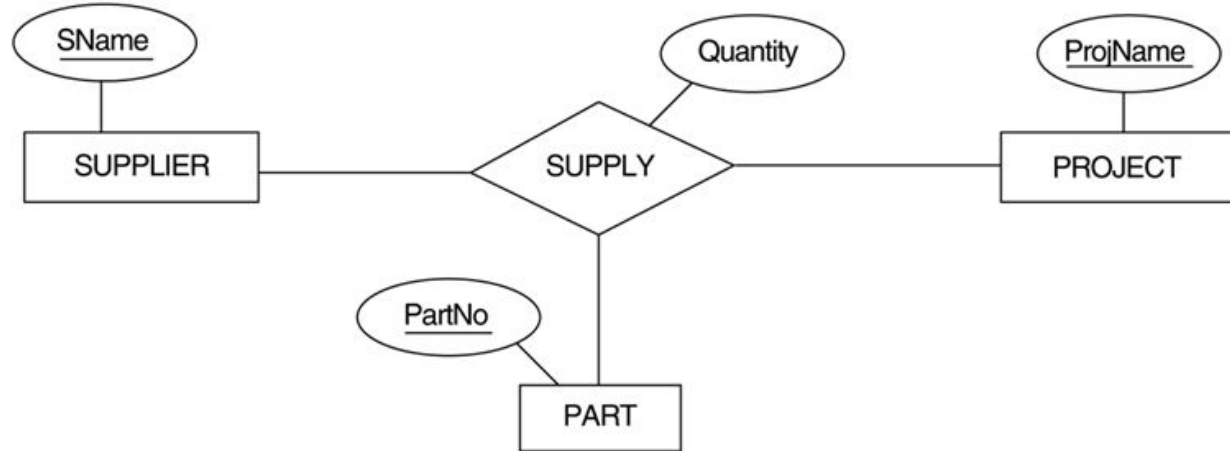
Mapping of Multivalued attributes

- ❑ For each multivalued attribute A, create a new relation R.
- ❑ R will include an attribute corresponding to A, plus the primary key attribute K as foreign key in R of the relation that represents the entity type or relationship type that has A as a multivalued attribute.
- ❑ The primary key of R is the combination of A and K.
- ❑ If the multivalued attribute is composite, we include its simple components.
- ❑ **Example**
 - The relation DEPT_LOCATIONS is created.
 - DLOCATION represents the multivalued attribute LOCATIONS of DEPARTMENT, while DNUMBER as foreign key represents primary key of DEPARTMENT relation.
 - Primary key of R is the combination of {DNUMBER, DLOCATION}.

Mapping of N-ary Relationship Types

- ❑ For each n-ary relationship type R, where $n > 2$, create a new relationship S to represent R.
- ❑ Include as foreign key attributes in S the primary keys of the relations that represent the participating entity types.
- ❑ Include any simple attributes of the n-ary relationship type (or simple components of composite attributes) as attributes of S.
- ❑ **Example**
 - The relationship type SUPPLY in next slide.
 - This can be mapped to relation SUPPLY shown in the relational schema, whose primary key is combination of three foreign keys {SNAME, PARTNO, PROJNAME}.

Mapping of N-ary Relationship Types



Correspondence between ER and Relational Models

ER MODEL

Entity type

1:1 or 1:N relationship type

M:N relationship type

n -ary relationship type

Simple attribute

Composite attribute

Multivalued attribute

Value set

Key attribute

RELATIONAL MODEL

Entity relation

Foreign key (or *relationship* relation)

Relationship relation and *two* foreign keys

Relationship relation and n foreign keys

Attribute

Set of simple component attributes

Relation and foreign key

Domain

Primary (or secondary) key

Mapping of Specialization/Generalization

❑ Method 1:

- Form a schema for higher-level entity
- Form a schema for each lower-level entity set, include primary key of higher-level entity set and local attributes

schema	attributes
person	ID, name, street, city
student	ID, tot_cred
employee	ID, salary

- Drawback: getting information about, an *employee* requires accessing two relations, one corresponding to low-level schema and one corresponding to high-level schema.

Mapping of Specialization/Generalization

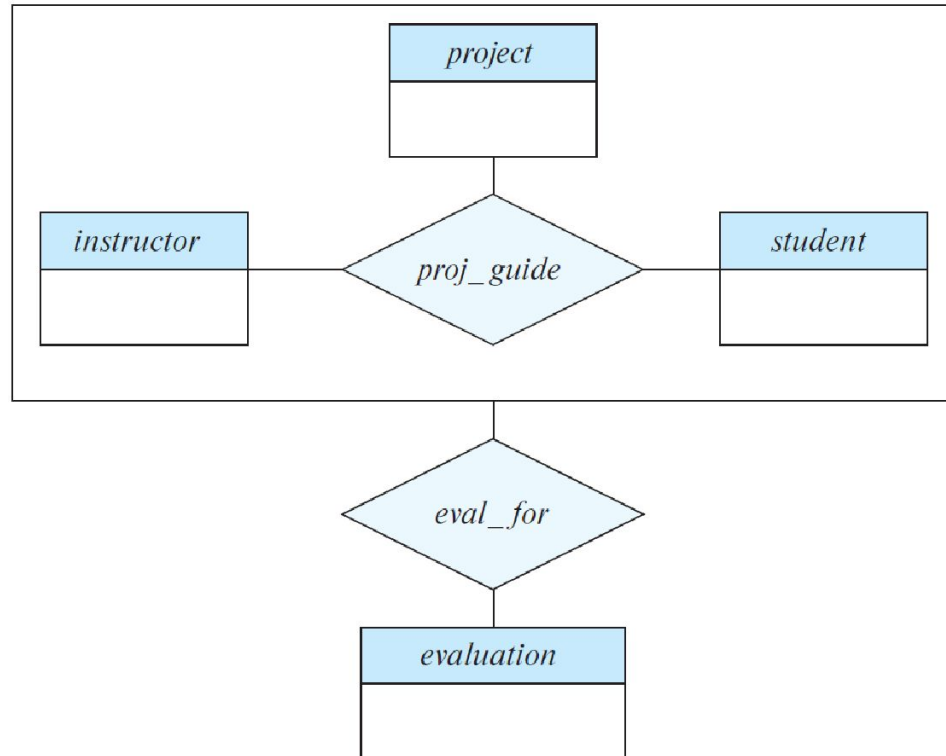
❑ Method 2

- Form a schema for each entity set with all local and inherited attributes.

schema	attributes
person	ID, name, street, city
student	ID, name, street, city, tot_cred
employee	ID, name, street, city, salary

- Drawback: *name*, *street* and *city* may be stored redundantly for people who are both students and employees.

Mapping of Aggregation



❑ To represent aggregation, create a schema containing

- Primary key of the aggregated relationship
- Primary key of the associated entity set
- Any descriptive attributes

❑ In our example:

- Schema eval_for is:

eval_for (s_ID, project_id, i_ID, evaluation_id)

- The schema proj_guide is redundant.