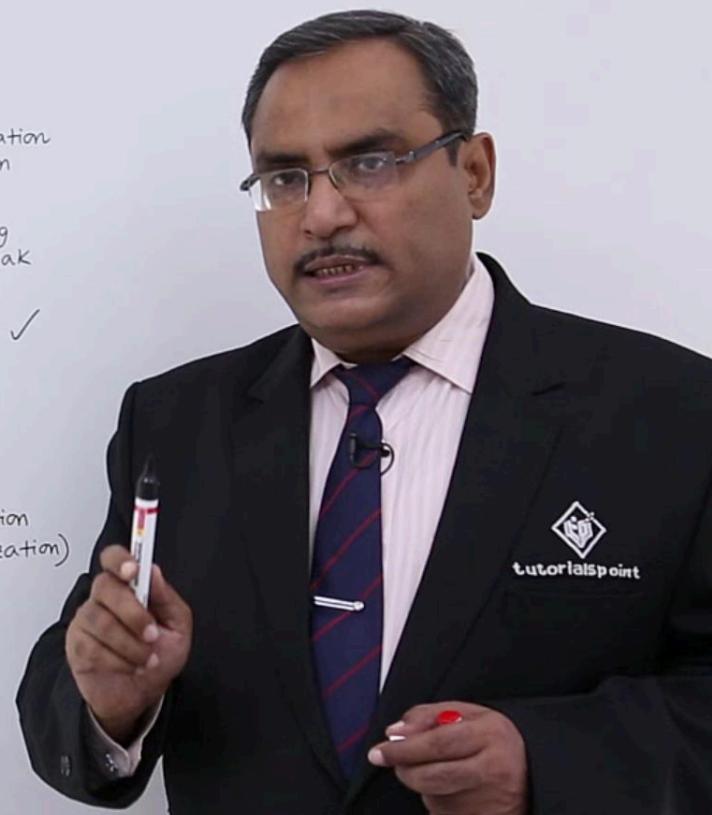
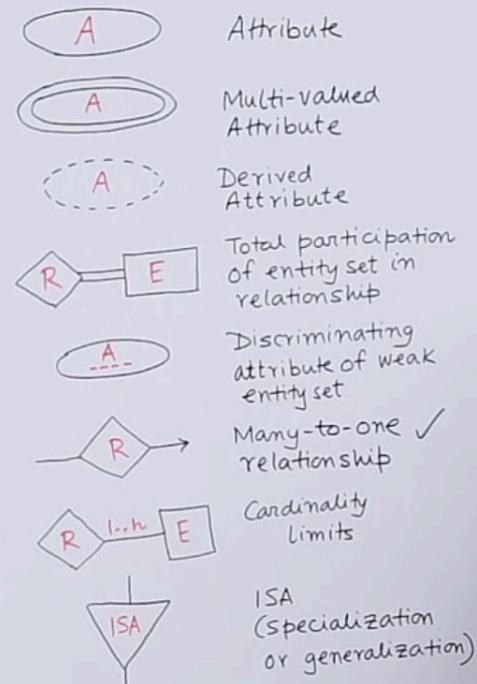
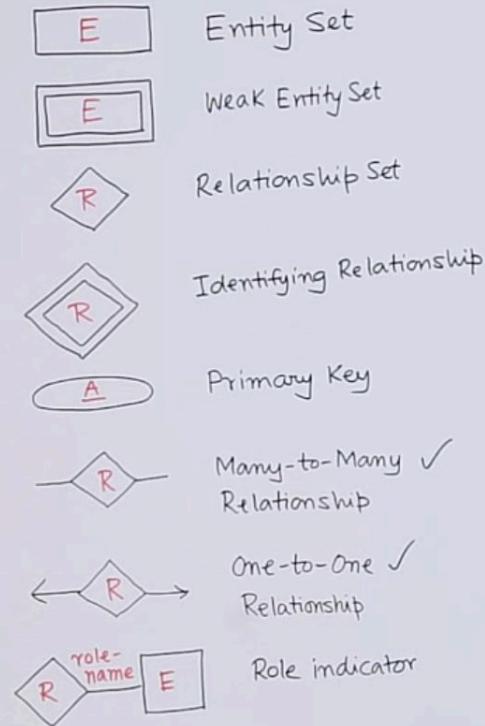


Symbols in ER-Diagram

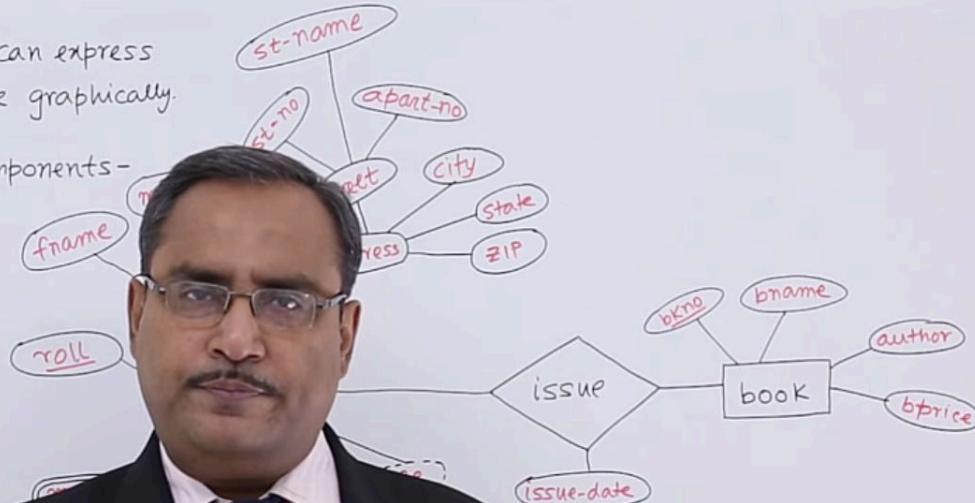


Entity Relationship Diagram

Entity Relationship Diagram (E-R Diagram) can express the overall logical structure of a database graphically.

E-R Diagram consists of following major components-

- * Rectangles
- * Ellipse
- * Diamonds
- * Lines
- * Double Ellipses
- * Dashed Ellipses
- * Double Lines
- * Double Rectangles

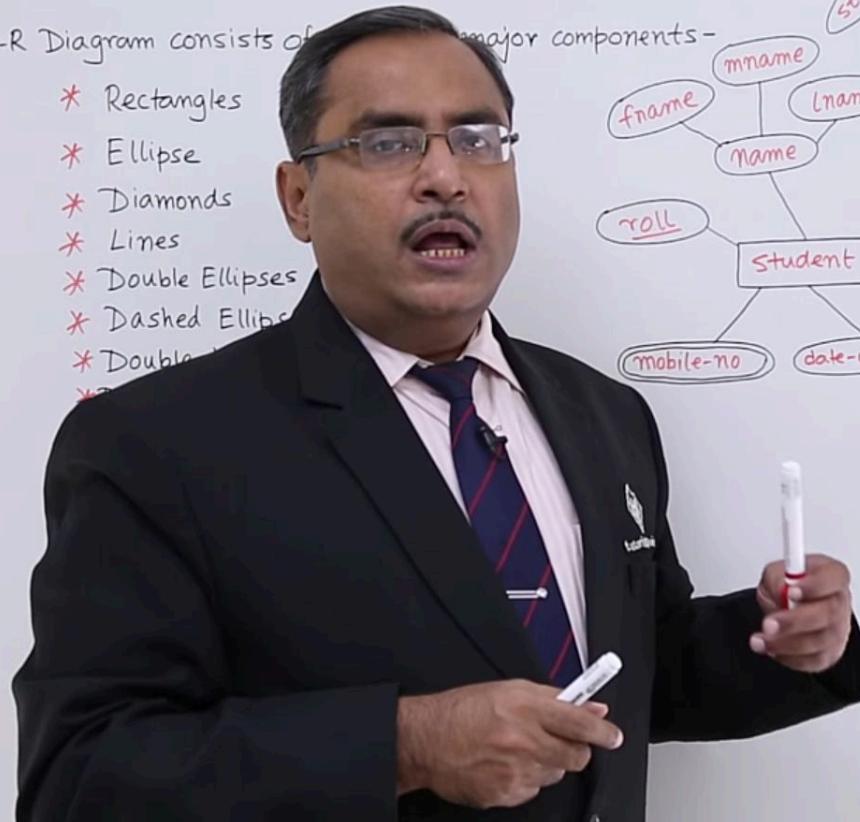
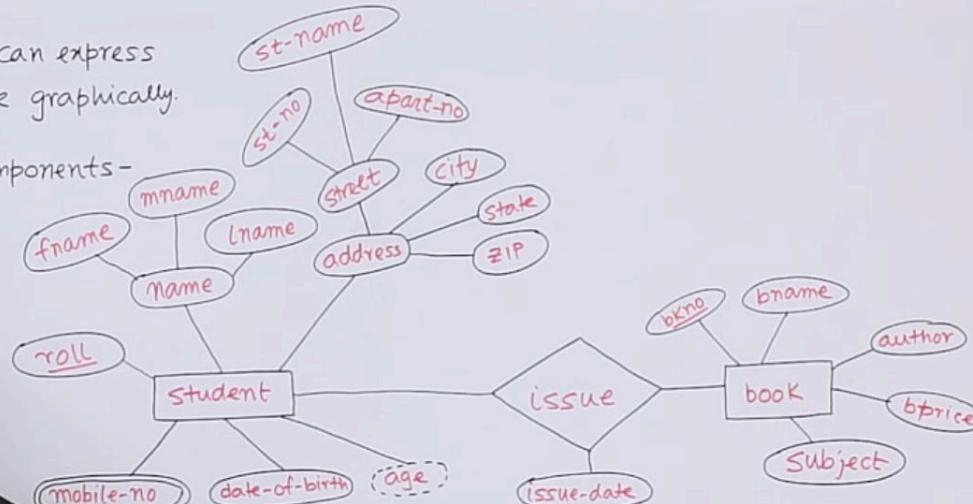


Entity Relationship Diagram

Entity Relationship Diagram (E-R Diagram) can express the overall logical structure of a database graphically.

E-R Diagram consists of major components -

- * Rectangles
 - * Ellipse
 - * Diamonds
 - * Lines
 - * Double Ellipses
 - * Dashed Ellipses
 - * Double



Relational Database Design by ER to Realtional Mapping



Outline

- **ER-to-Relational Mapping Algorithm**
 - Step 1: Mapping of Regular Entity Types
 - Step 2: Mapping of Weak Entity Types
 - Step 3: Mapping of Binary 1:1 Relation Types
 - Step 4: Mapping of Binary 1:N Relationship Types.
 - Step 5: Mapping of Binary M:N Relationship Types.
 - Step 6: Mapping of Multivalued attributes.
 - Step 7: Mapping of N-ary Relationship Types.

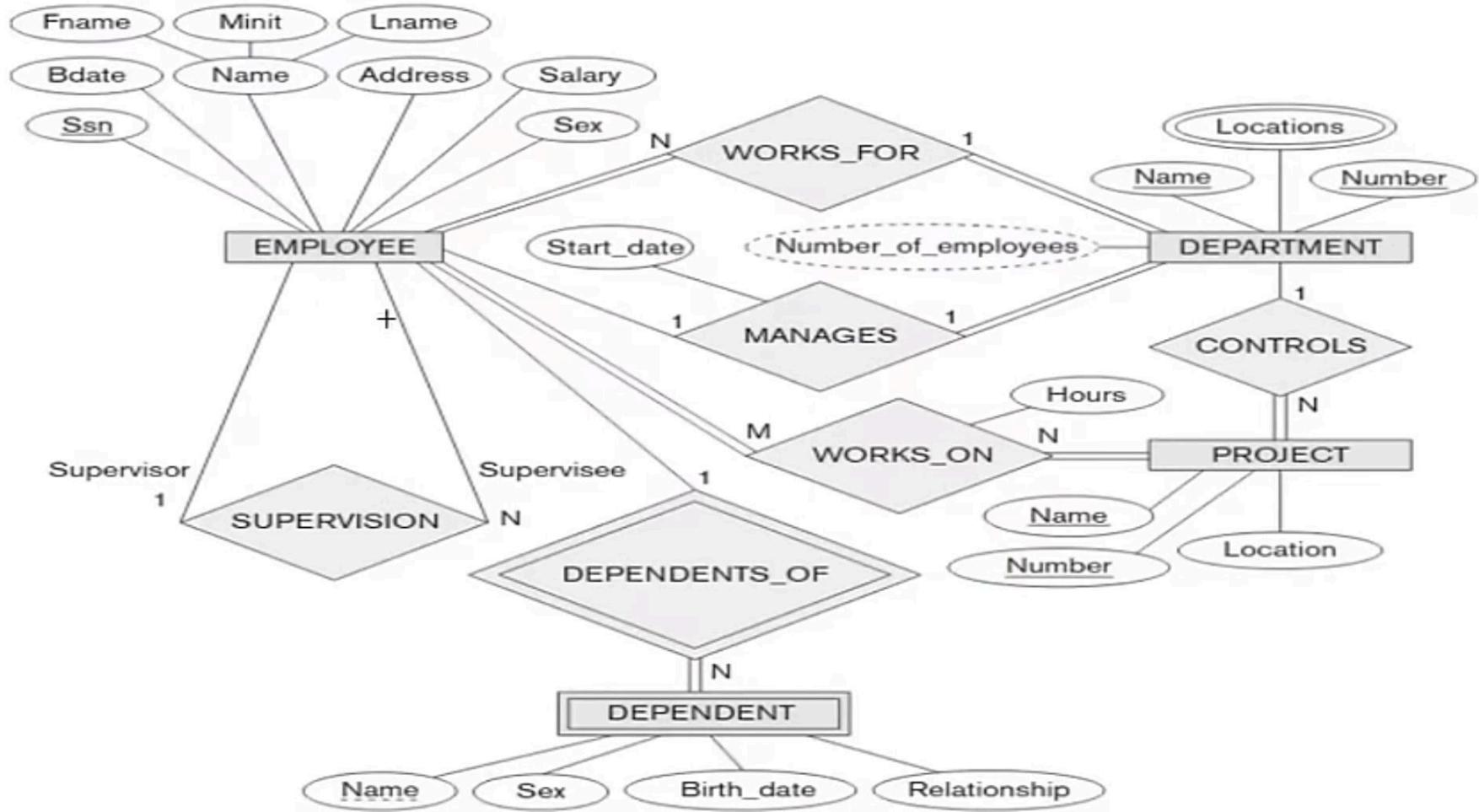
+



View key concept



The ER conceptual schema diagram for the COMPANY database.

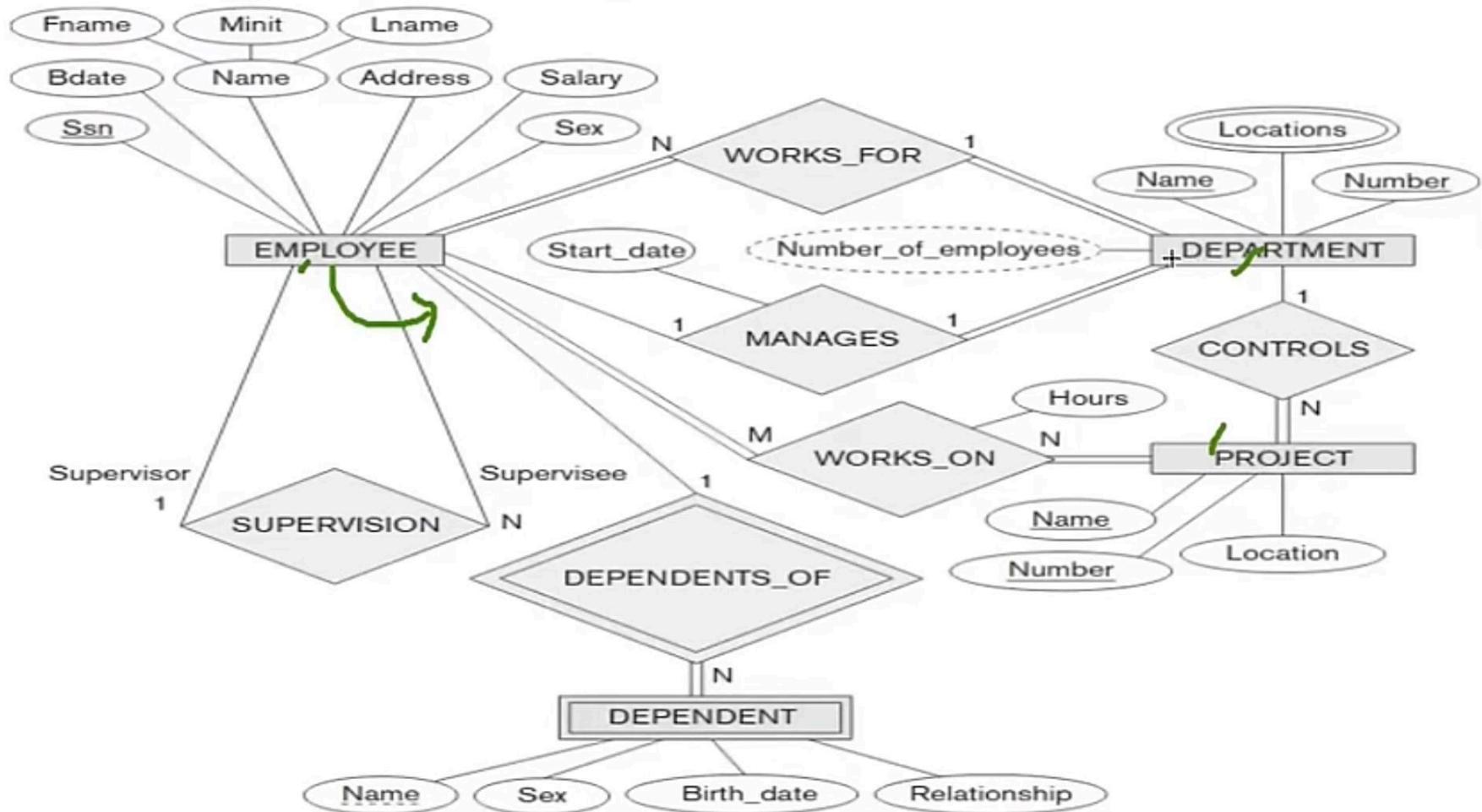


ER-to-Relational Mapping Algorithm

- **Step 1: Mapping of Regular Entity Types.**
 - For each regular (strong) entity type E in the ER diagram, create a relation R that includes all the simple attributes of E.
 - Choose one of the key attributes of E as the primary key for R.
 - If the chosen key of E is composite, the set of simple attributes that form it will together form the primary key of R.
- **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.



The ER conceptual schema diagram for the COMPANY database.



ER-to-Relational Mapping Algorithm

Step 1: Mapping of Regular Entity Types.

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary
-------	-------	-------	-----	-------	---------	-----	--------

DEPARTMENT

Dname	Dnumber
-------	---------

PROJECT

Pname	Pnumber	Plocation
-------	---------	-----------

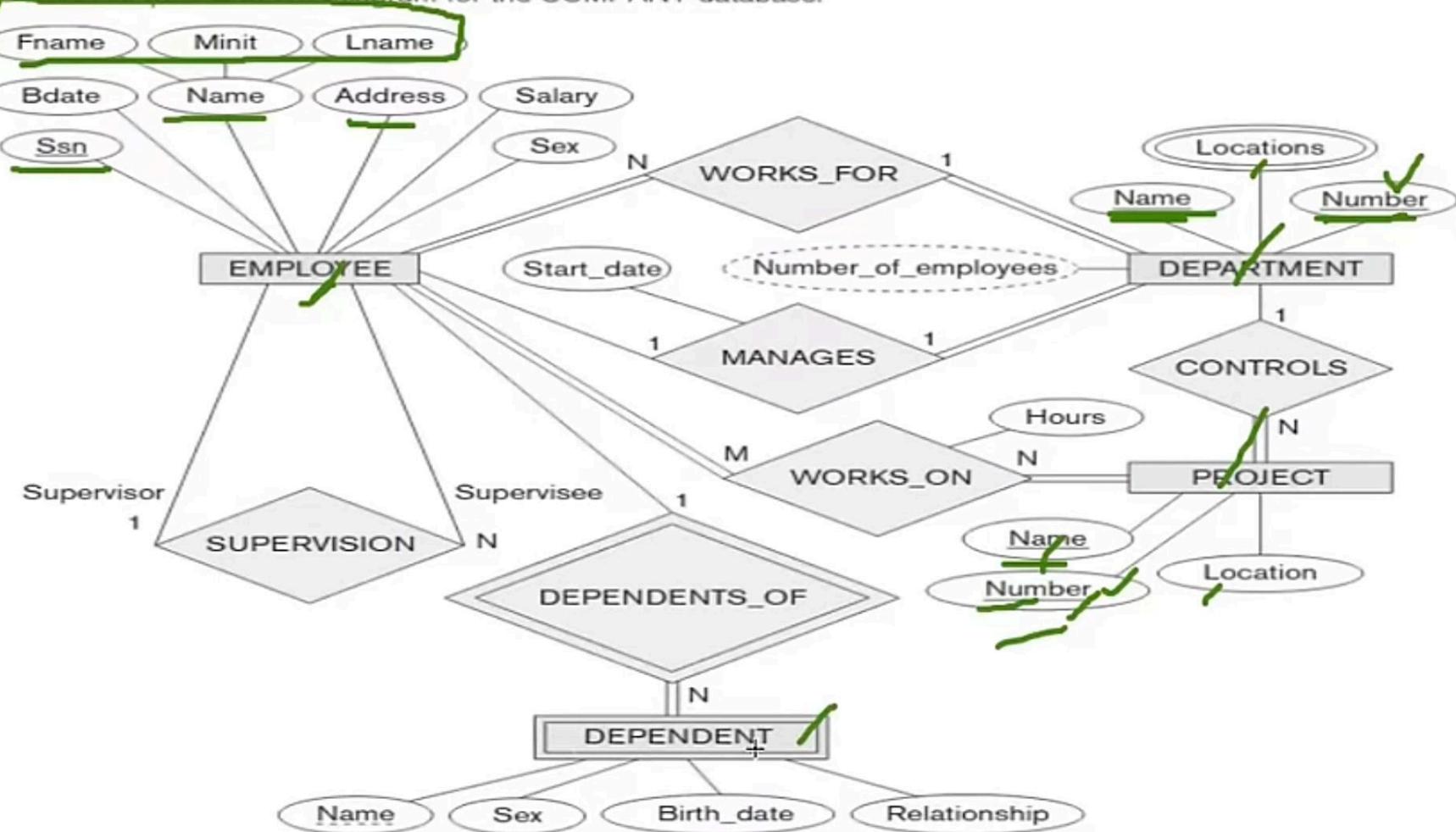


ER-to-Relational Mapping Algorithm

- **Step 2: Mapping of Weak Entity Types**
 - For each weak entity type W in the ER schema with owner entity type E, create a relation R & include all simple attributes (or simple components of composite attributes) of W as attributes of R.
 - Also, 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.
- **Example:** Create the relation DEPENDENT in this step to 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.



The ER conceptual schema diagram for the COMPANY database.



ER-to-Relational Mapping Algorithm

Step 2: Mapping of Weak Entity Types

DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
+				

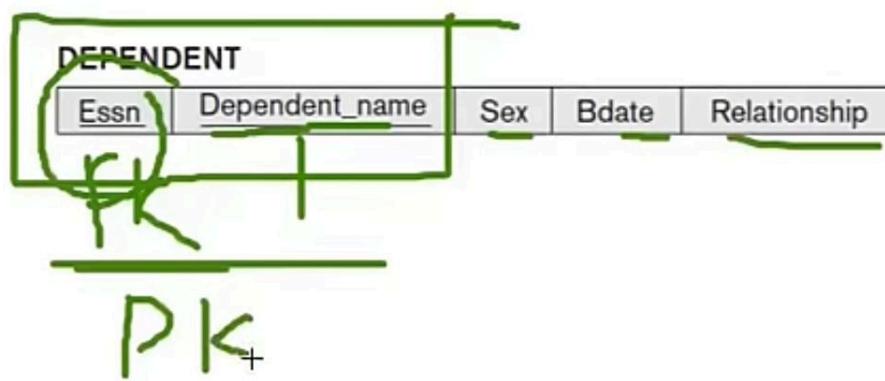


View key concept



ER-to-Relational Mapping Algorithm

Step 2: Mapping of Weak Entity Types



ER-to-Relational Mapping Algorithm

- **Step 3: Mapping of Binary 1:1 Relation 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.
 - 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.



ER-to-Relational Mapping Algorithm

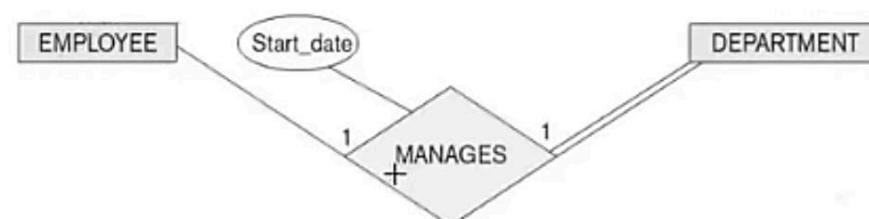
Step 3: Mapping of Binary 1:1 Relation Types

DEPARTMENT

Dname	Dnumber
-------	---------

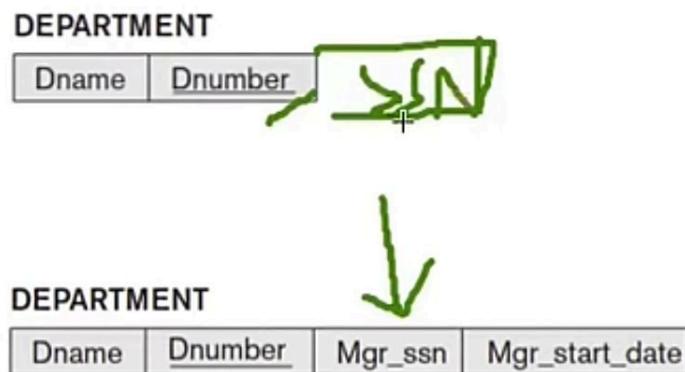
DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date
-------	---------	---------	----------------



ER-to-Relational Mapping Algorithm

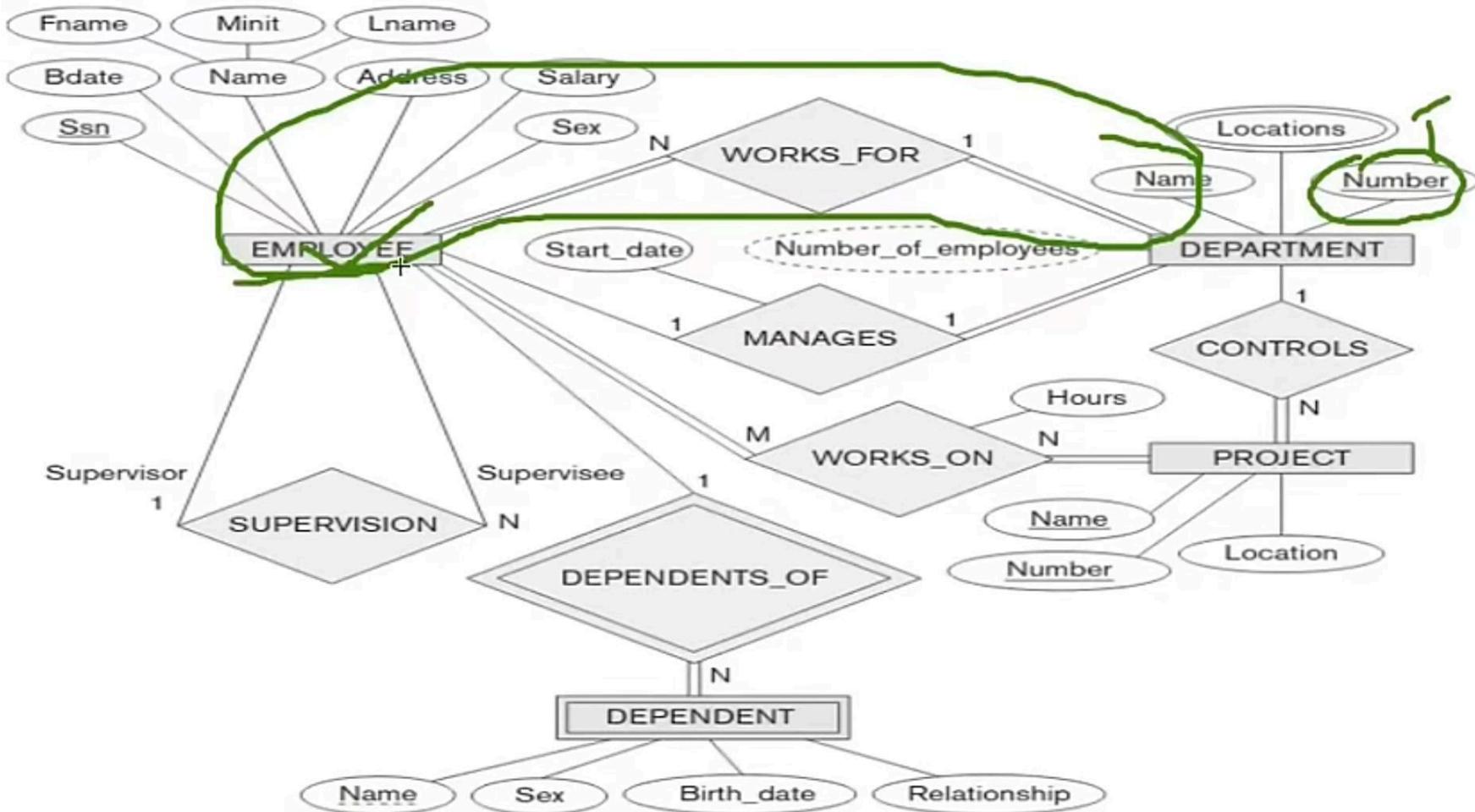
Step 3: Mapping of Binary 1:1 Relation Types



ER-to-Relational Mapping Algorithm

- **Step 4: 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 in the figure.
 - For WORKS_FOR we include the primary key DNUMBER of the DEPARTMENT relation as foreign key in the EMPLOYEE relation and call it DNO.

The ER conceptual schema diagram for the COMPANY database.



ER-to-Relational Mapping Algorithm

Step 4: Mapping of Binary 1:N Relationship Types.

EMPLOYEE

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

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
-------	-------	-------	------------	-------	---------	-----	--------	-----------	-----

PROJECT

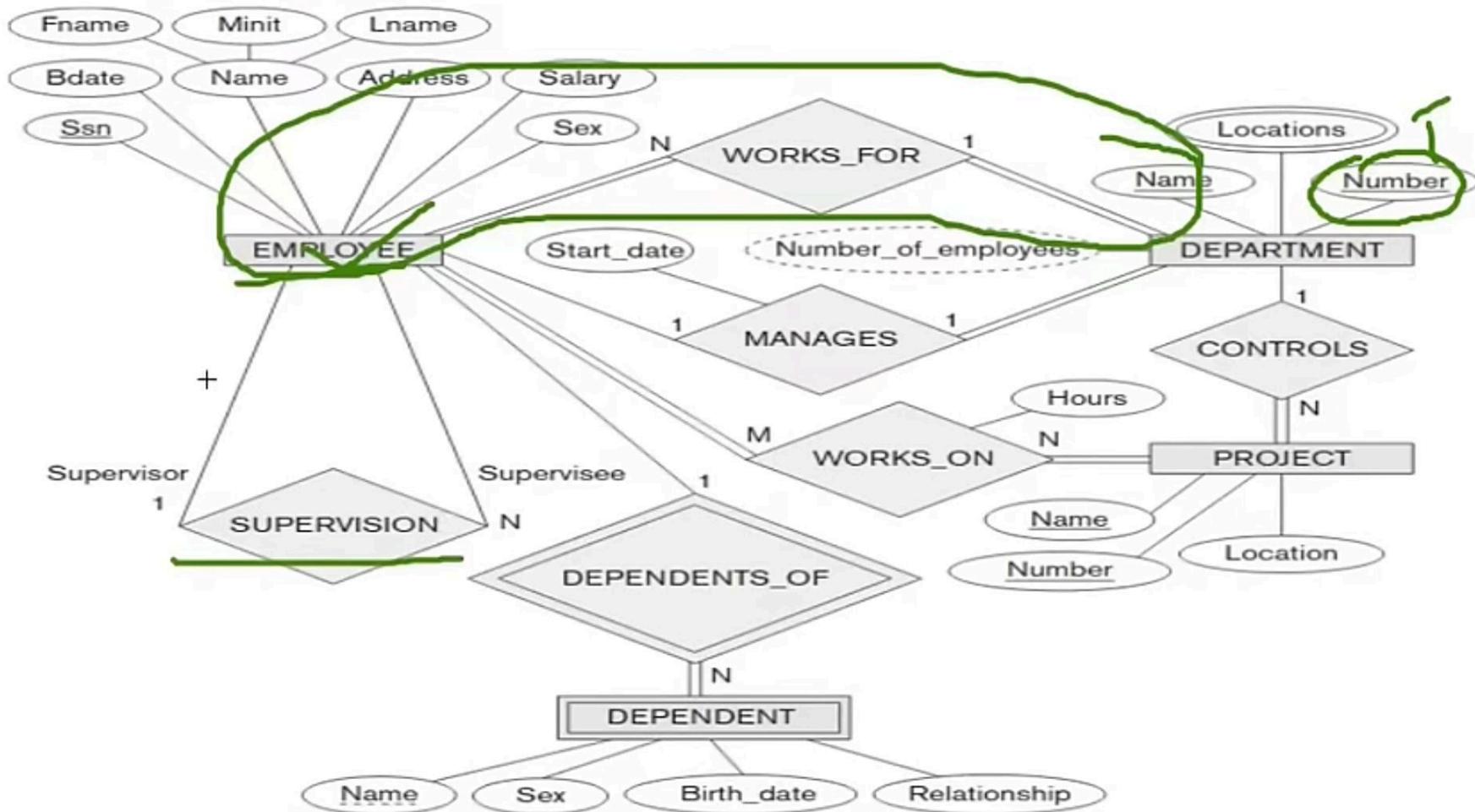
Pname	<u>Pnumber</u>	Plocation
-------	----------------	-----------

PROJECT

Pname	<u>Pnumber</u>	Plocation	Dnum
-------	----------------	-----------	------



The ER conceptual schema diagram for the COMPANY database.



ER-to-Relational Mapping Algorithm

Step 4: Mapping of Binary 1:N Relationship Types.

EMPLOYEE

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

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	<u>Super_ssn</u>	<u>Dno</u>
-------	-------	-------	------------	-------	---------	-----	--------	------------------	------------



PROJECT

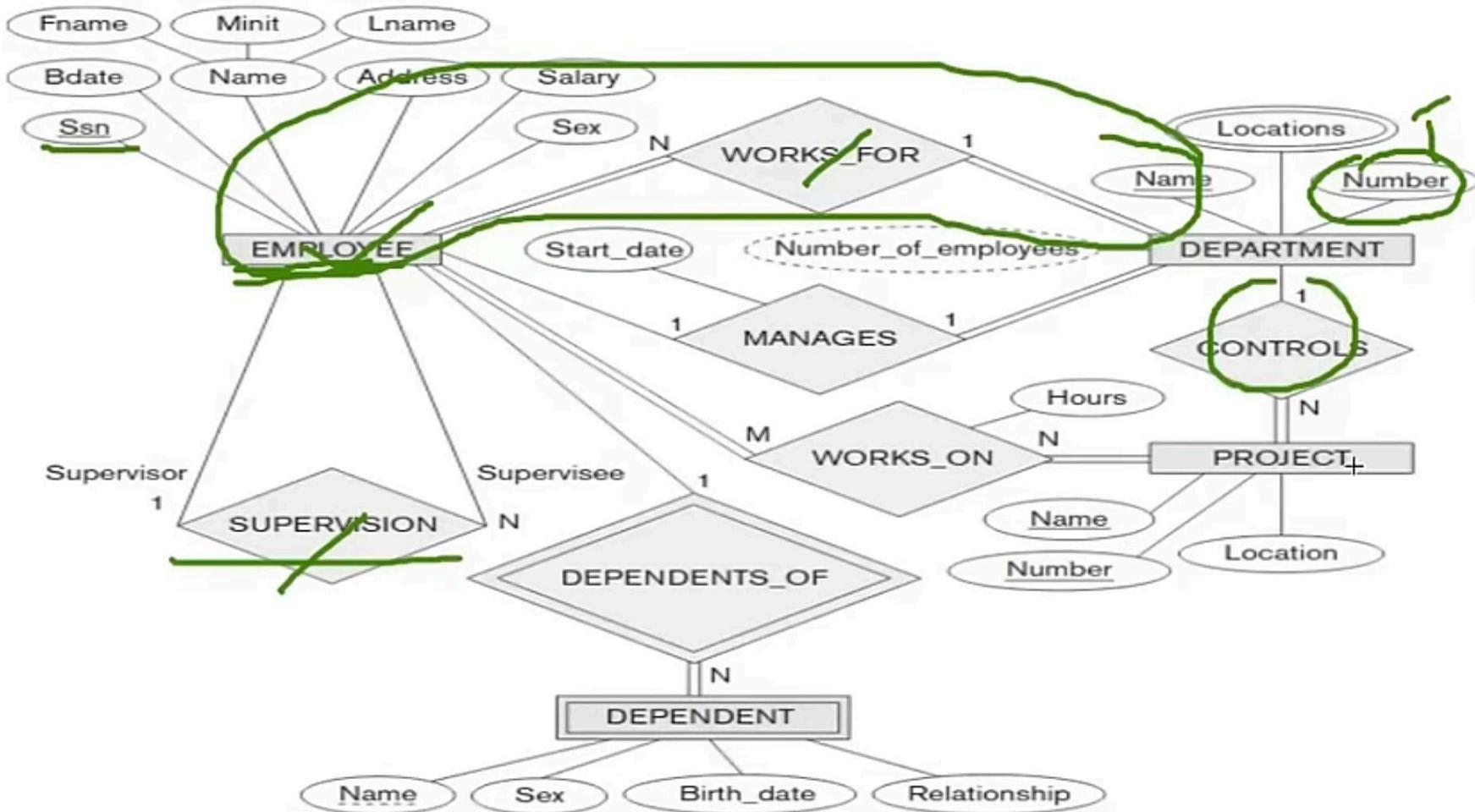
Pname	<u>Pnumber</u>	Plocation
-------	----------------	-----------

PROJECT

Pname	<u>Pnumber</u>	Plocation	Dnum
-------	----------------	-----------	------



The ER conceptual schema diagram for the COMPANY database.



ER-to-Relational Mapping Algorithm

Step 4: Mapping of Binary 1:N Relationship Types.

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary
-------	-------	-------	-----	-------	---------	-----	--------

EMPLOYEE +

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno
-------	-------	-------	-----	-------	---------	-----	--------	-----------	-----

↓
FK
↓

PROJECT

Pname	Pnumber	Plocation
-------	---------	-----------

PROJECT

Pname	Pnumber	Plocation	Dnum
-------	---------	-----------	------

↓
FK

ER-to-Relational Mapping Algorithm

- **Step 5: Mapping of Binary M:N Relationship Types.**
 - For each regular binary M:N relationship type R, create a new relation S to represent R.
 - 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:** The M:N relationship type WORKS ON from the ER diagram is mapped by creating a relation WORKS_ON in the relational database schema.
 - The primary keys of the PROJECT and EMPLOYEE relations are included as foreign keys in WORKS_ON and renamed PNO and ESSN, respectively.
 - Attribute HOURS in WORKS ON represents the HOURS attribute of the relation type. The primary key of the WORKS ON relation is the combination of the foreign key attributes {ESSN, PNO}.



ER-to-Relational Mapping Algorithm

Step 5: Mapping of Binary M:N Relationship Types.

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno
-------	-------	-------	-----	-------	---------	-----	--------	-----------	-----



PROJECT

Pname	Pnumber	Plocation	Dnum
-------	---------	-----------	------

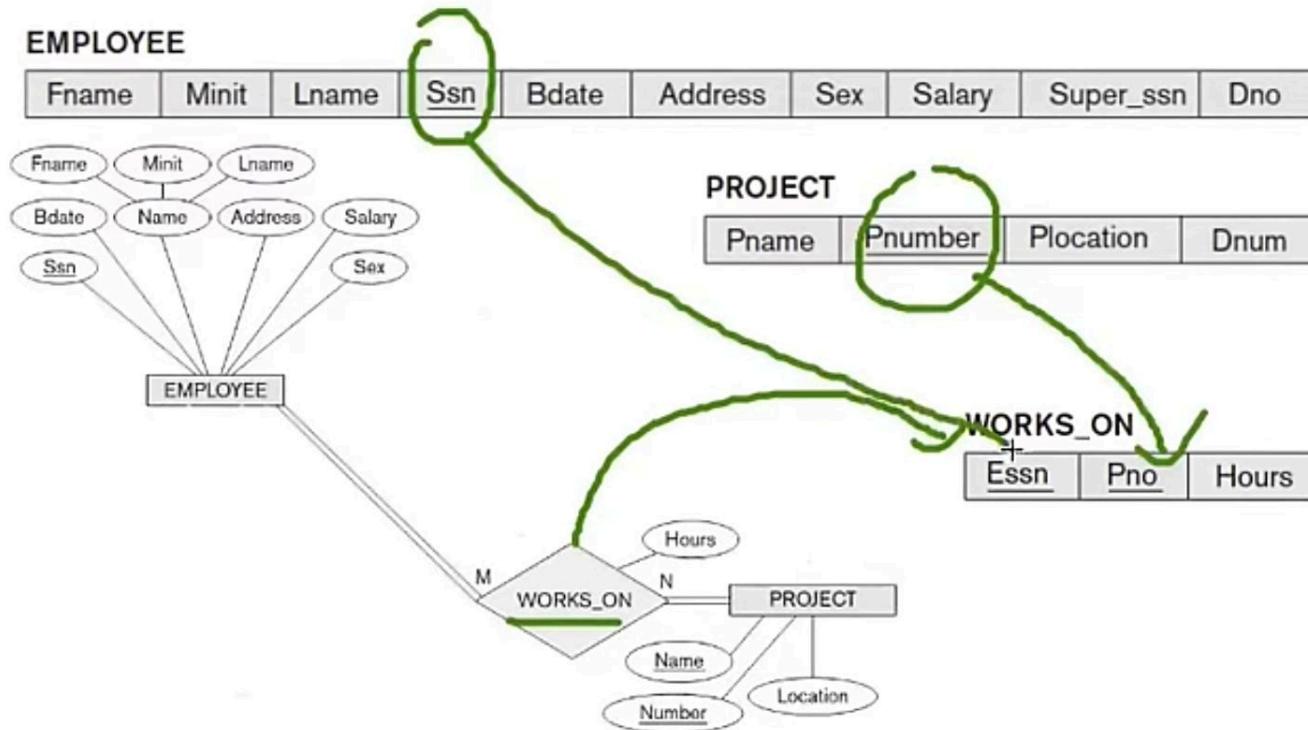
WORKS_ON

Essn	Pno	Hours
------	-----	-------



ER-to-Relational Mapping Algorithm

Step 5: Mapping of Binary M:N Relationship Types.

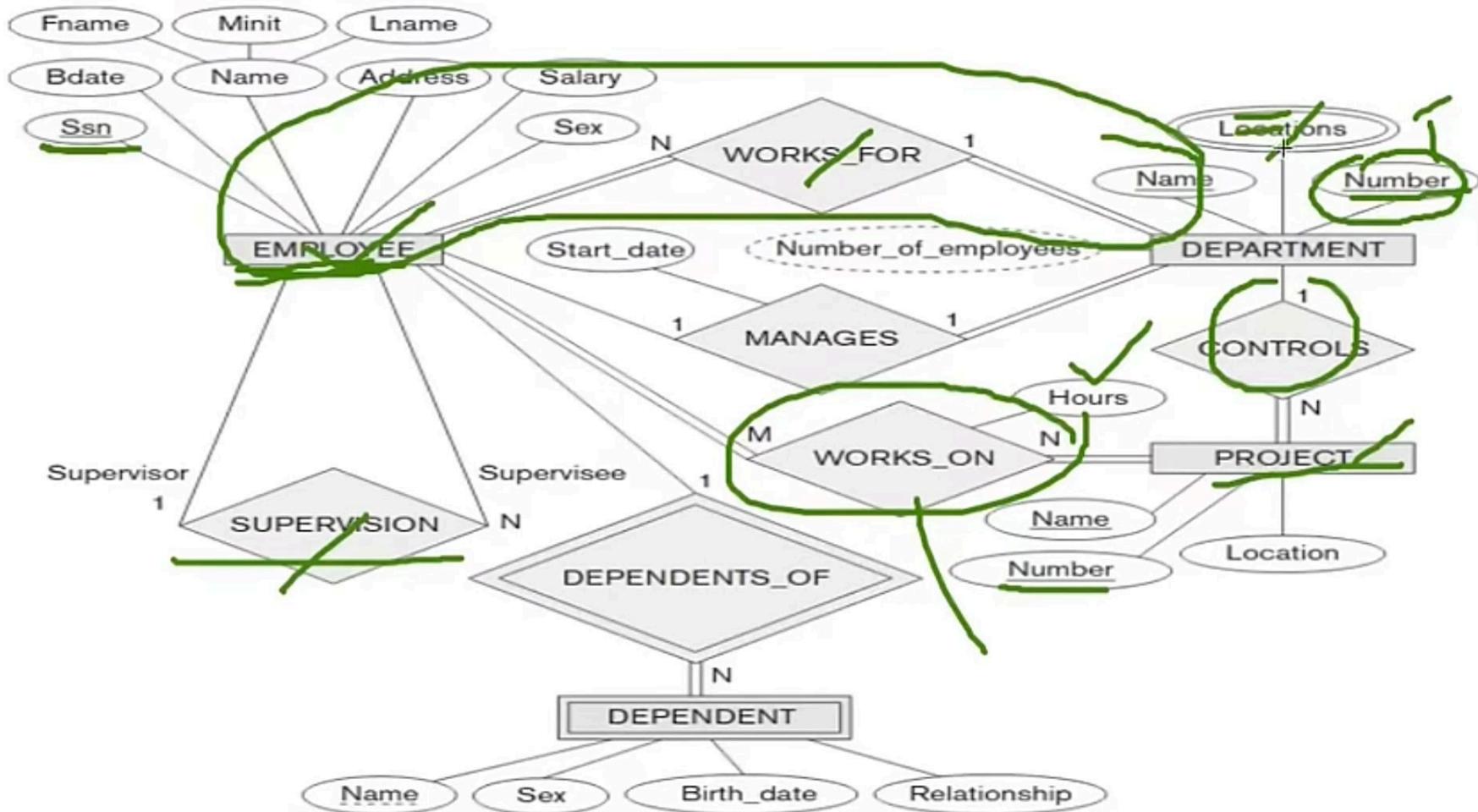


ER-to-Relational Mapping Algorithm

- **Step 6: Mapping of Multivalued attributes.**
 - For each multivalued attribute A, create a new relation R.
 - This relation R will include an attribute corresponding to A, plus the primary key attribute K-as a foreign key in R-of the relation that represents the entity type or relationship type that has A as an 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.
 - The attribute DLOCATION represents the multivalued attribute LOCATIONS of DEPARTMENT, while DNUMBER-as foreign key-represents the primary key of the DEPARTMENT relation.
 - The primary key of R is the combination of {DNUMBER, DLOCATION}.



The ER conceptual schema diagram for the COMPANY database.

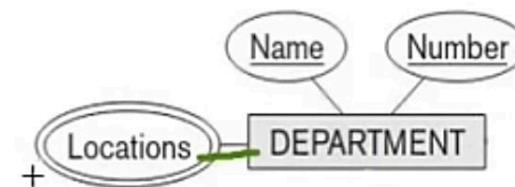


ER-to-Relational Mapping Algorithm

Step 6: Mapping of Multi valued attributes.

DEPT_LOCATIONS

Dnumber	Dlocation
---------	-----------

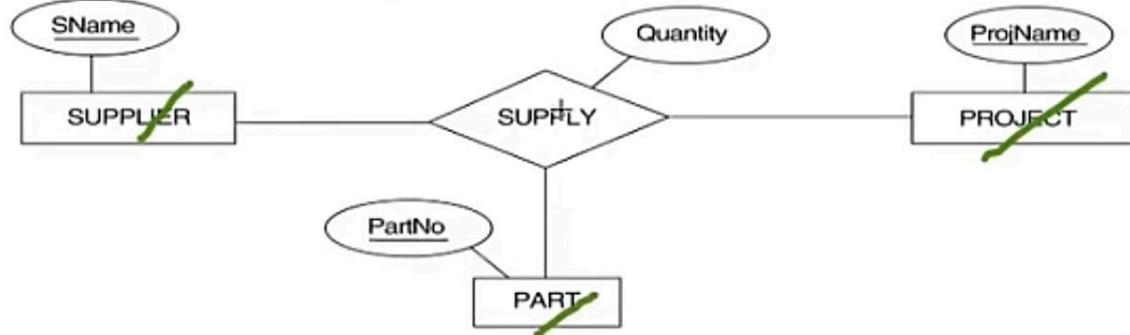


ER-to-Relational Mapping Algorithm

- **Step 7: 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.
 - Also include any simple attributes of the n-ary relationship type (or simple components of composite attributes) as attributes of S.
- **Example:** The relationship type SUPPY in the ER on the next slide.
 - This can be mapped to the relation SUPPLY shown in the relational schema, whose primary key is the combination of the three foreign keys {SNAME, PARTNO, PROJNAME}



(a)



SUPPLIER

<u>SNAME</u>	...
--------------	-----

PROJECT

<u>PROJNAME</u>	...
-----------------	-----

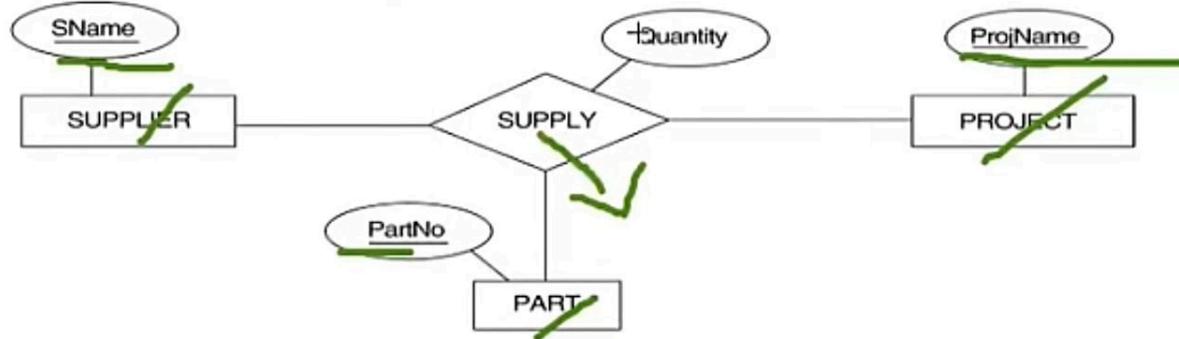
PART

<u>PARTNO</u>	...
---------------	-----

SUPPLY

<u>SNAME</u>	<u>PROJNAME</u>	<u>PARTNO</u>	<u>QUANTITY</u>
--------------	-----------------	---------------	-----------------

(a)



SUPPLIER

<u>SNAME</u>	...
--------------	-----

PROJECT

<u>PROJNAME</u>	...
-----------------	-----

PART

<u>PARTNO</u>	...
---------------	-----

SUPPLY

<u>SNAME</u>	<u>PROJNAME</u>	<u>PARTNO</u>	<u>QUANTITY</u>
--------------	-----------------	---------------	-----------------

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



Summary

- **ER-to-Relational Mapping Algorithm**
 - +
 - Step 1: Mapping of Regular Entity Types
 - Step 2: Mapping of Weak Entity Types
 - Step 3: Mapping of Binary 1:1 Relation Types
 - Step 4: Mapping of Binary 1:N Relationship Types.
 - Step 5: Mapping of Binary M:N Relationship Types.
 - Step 6: Mapping of Multivalued attributes.
 - Step 7: Mapping of N-ary Relationship Types.



- **ER-to-Relational Mapping Algorithm**

- Step 1: Mapping of Regular Entity Types
- Step 2: Mapping of Weak Entity Types
- Step 3: Mapping of Binary 1:1 Relation Types
- Step 4: Mapping of Binary 1:N Relationship Types.
- Step 5: Mapping of Binary M:N Relationship Types.
- Step 6: Mapping of Multivalued attributes.
- Step 7: Mapping of N-ary Relationship Types.

- **Mapping EER Model Constructs to Relations**

- Step 8: Options for Mapping Specialization or Generalization.
- Step 9: Mapping of Union Types (Categories).

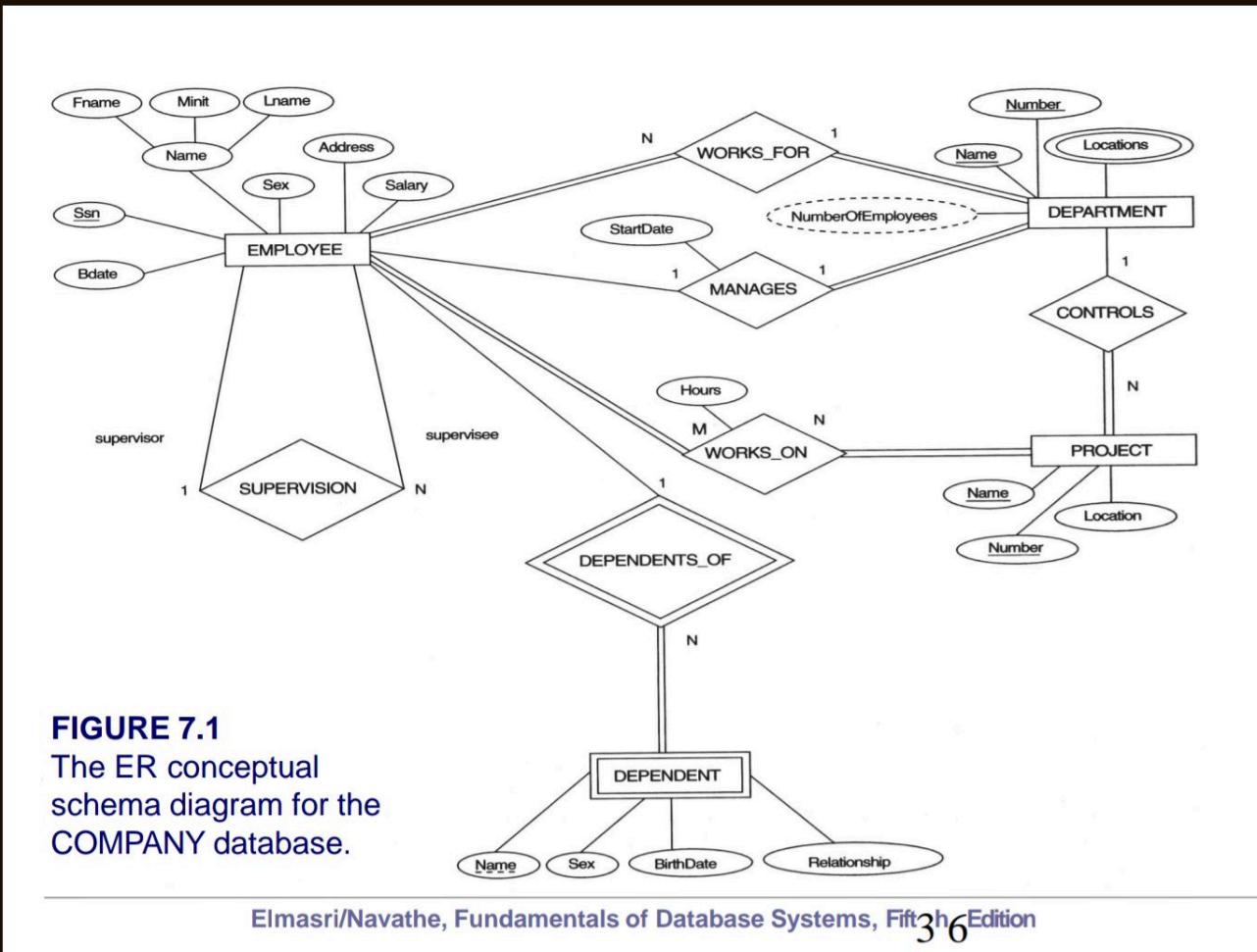
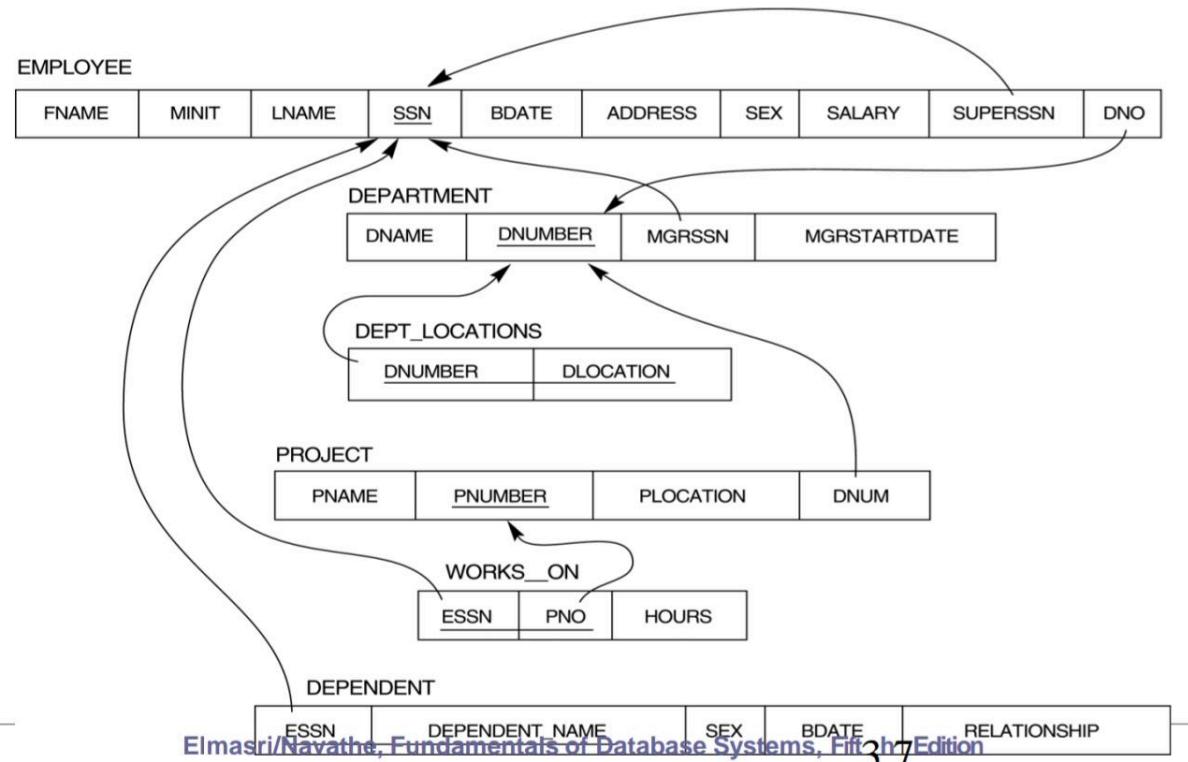


FIGURE 7.2

Result of mapping the COMPANY ER schema into a relational schema.



Summary of Mapping constructs and constraints

Table 7.1 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
<i>n</i> -ary relationship type	“Relationship” relation and <i>n</i> 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

Advantages of relational model:

1. Data independence: shows clear boundary between logical and physical aspects of database management
2. Simplicity: simple structure so easy to use and communicate to wide variety of users in an enterprise
3. Set processing: facilities for manipulation of a set of records at a time
4. Sound theoretical background: to provide theoretical background for the database management system.

