Mapping ER-EER to Relational Model

ER to Relational Mapping

How do we convert an ER Model into a Relational Model??

Simple!!

Basic Ideas:

- Build a table for *each entity set*
- Build a table for *each relationship* set *if necessary* (more on this later)
- Make a column in the table for *each attribute* in the entity set
- Composite and Multivalue Attributes
- Primary Key

ER to Relational Mapping

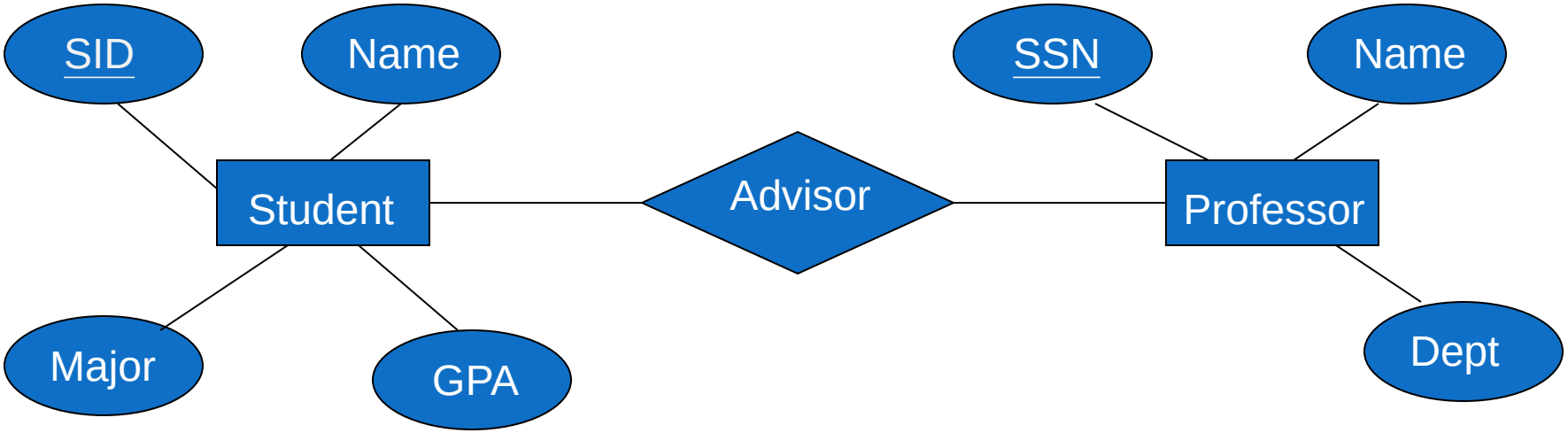
ER-to-Relational Mapping Algorithm

- Step 1: Mapping of Regular Entity Types
- Step 2: Mapping of Weak Entity Types
- Step 3: Mapping of Binary 1:1 Relationship 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: Mapping of Specialization or Generalization
- Step 9: Mapping of Union Types (Categories)

Mapping – Strong Entity Set

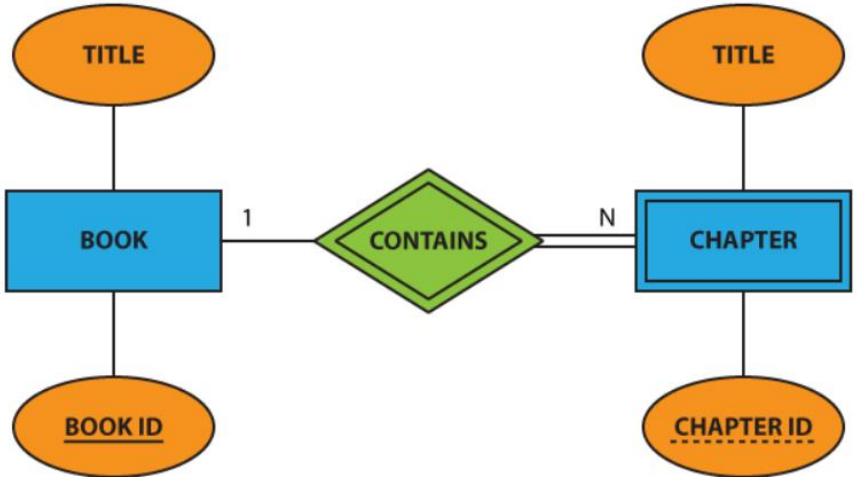


SID	Name	Major	GPA
1234	John	CS	2.8
5678	Mary	EE	3.6

SSN	Name	Dept
9999	Smith	Math
8888	Lee	CS

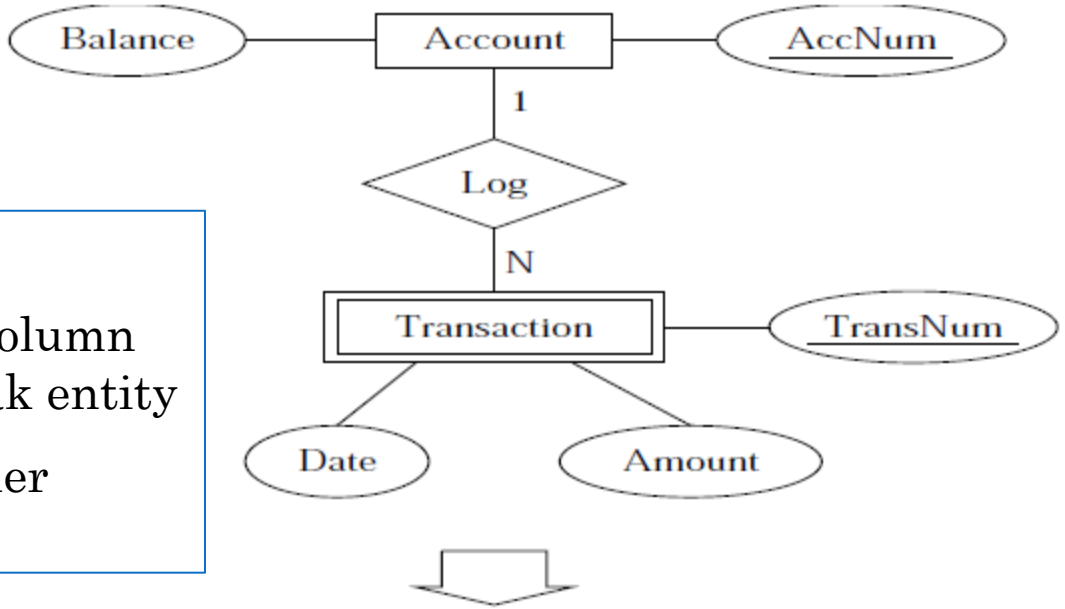
Mapping of Weak Entity

- Weak Entity Set *cannot exists alone*
- To build a table for weak entity set
  - Construct a table with one column for each attribute in the weak entity
  - Add a column for the primary key of the ***Owner*** of the Weak Entity
  - Primary Key of the weak entity
    - = Discriminator + foreign key



Mapping - Weak Entity Set

Example:



Mapping Rule

- Construct a table with one column for each attribute in the weak entity
- Add primary key of the Owner Entity in the table

Account

AccNum	Balance

Transaction

TransNum	AccNum	Date	Amount

Mapping of Relationships

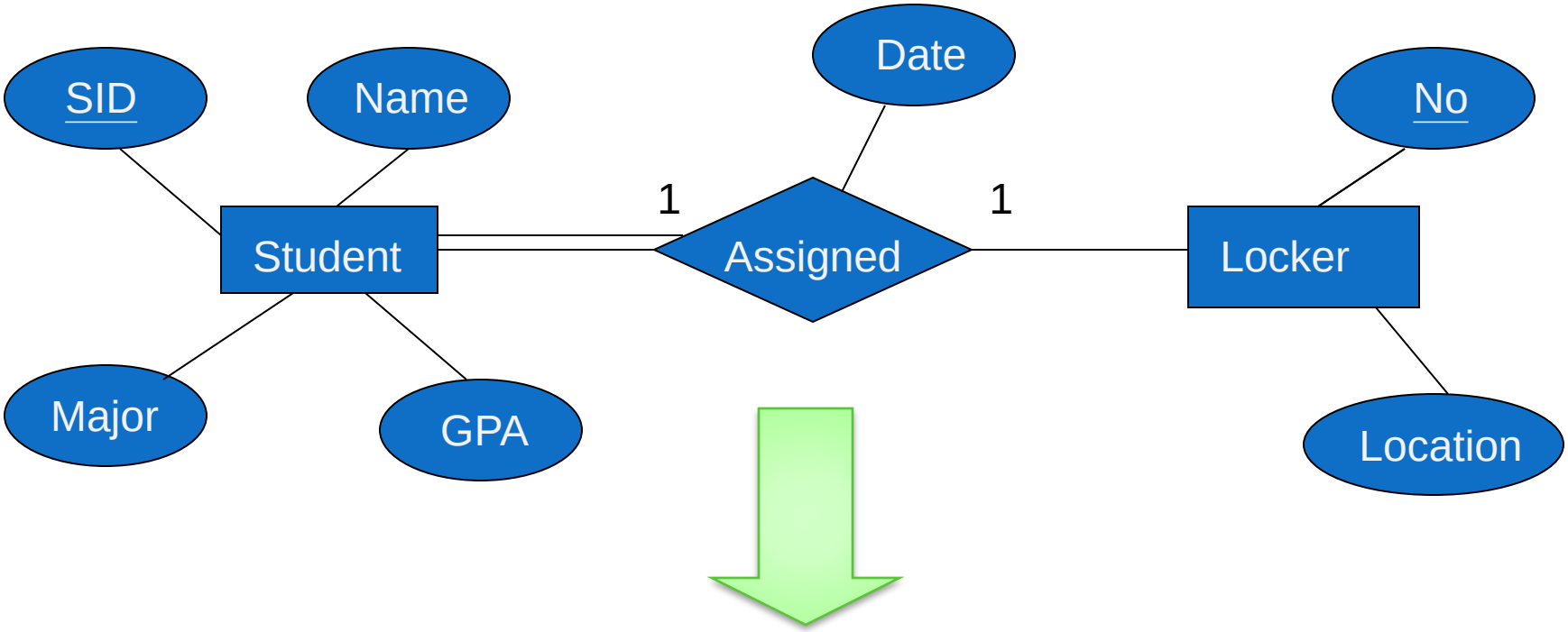
Unary/Binary Relationship set

- Depends on the cardinality and participation constraints

N-ary (multiple) Relationship set

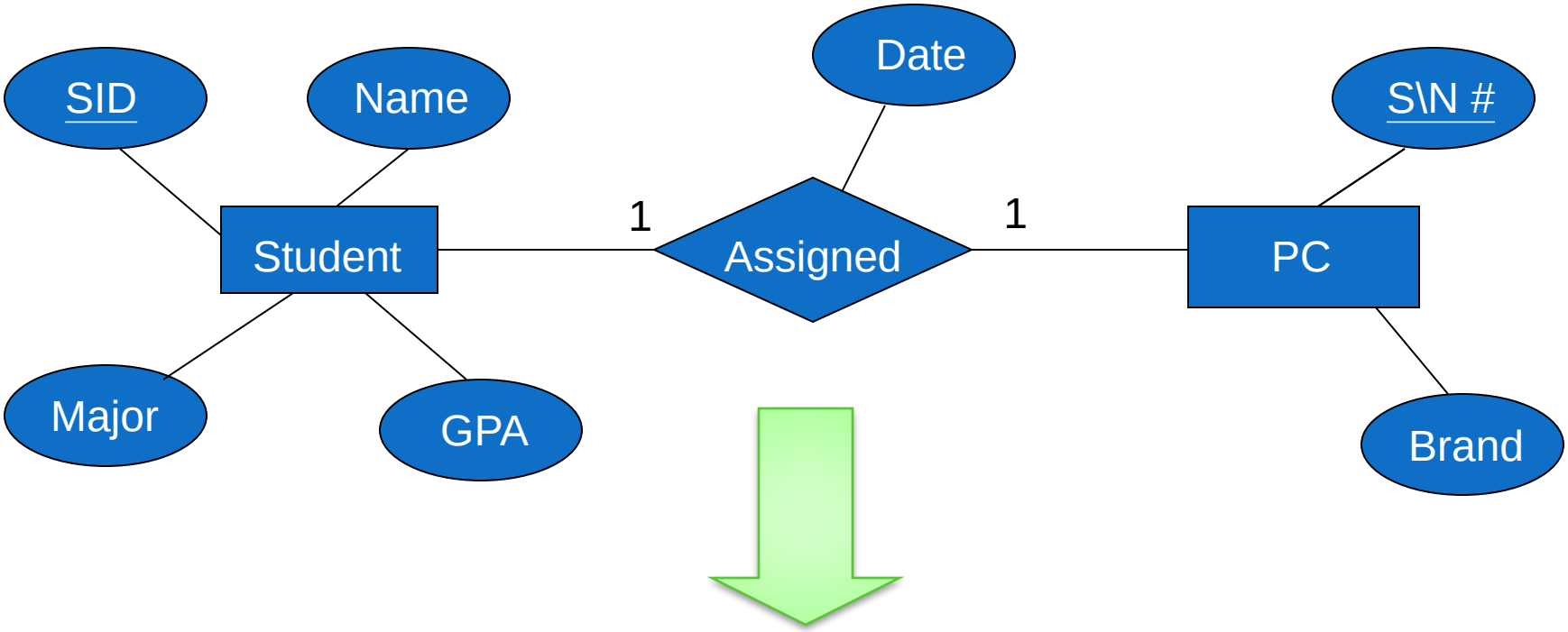
Identifying Relationship

Example: Foreign Key Approach



SID	Name	GPA	Major	No	Date
9999	Bart	3.2	CS	11289	12-09-09
8888	Lisa	4.0	EE	12345	14-02-10

Example: Relationship Relation



SID	S\N#	Date
9999	07	12-08-09
8888	05	15-07-10

* **Primary key can be either *SID* or S\N#**

Mapping Relationship Set unary/Binary Relationship

1-1 relationship without total participation

- **Relationship relation:** Build a table
  - Add columns for each participating entity's primary key.
  - Also add the attributes of the relationship. ***(cross-reference)***

1-1 relationship with one total participation

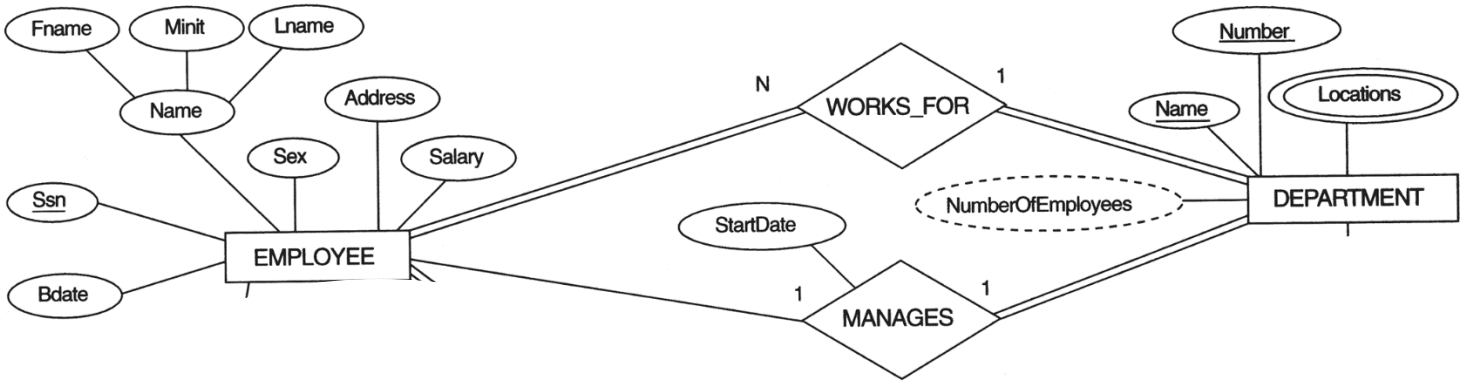
- **Foreign key approach**:
  - Add primary key of the entity without total participation in the table of the entity with total participation.

Merged relation (alternate mapping):

- merge the two entities and the relationship into a single relation *(used when both participations are total)*.

FIGURE 7.1

THE ER CONCEPTUAL SCHEMA DIAGRAM FOR THE COMPANY DATABASE.



Mapping Relationship Set 1-N
Binary Relationship

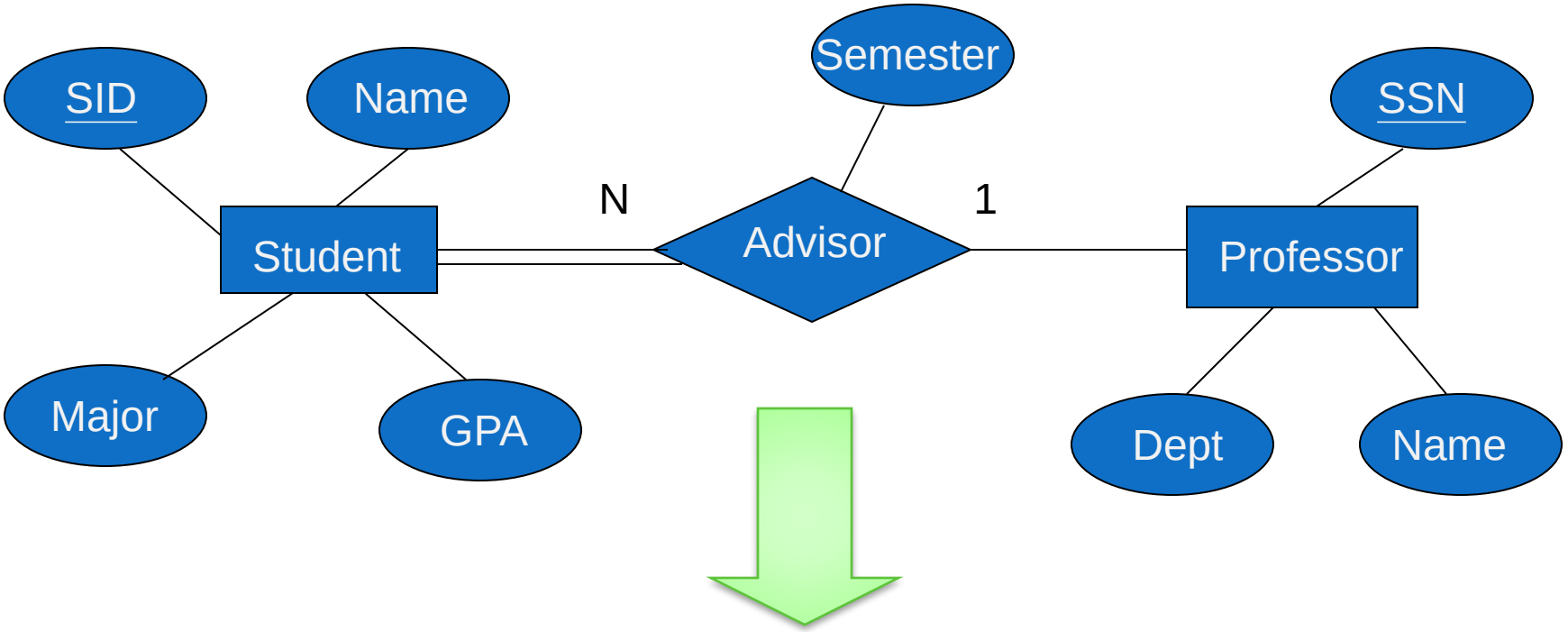
1-N relationship without total participation

- Same as 1-1 relationship
- **Relationship relation:** Build a table
  - Add columns for each participating entity's primary key.
  - Also add the attributes of the relationship.

1-N with total participation on N side

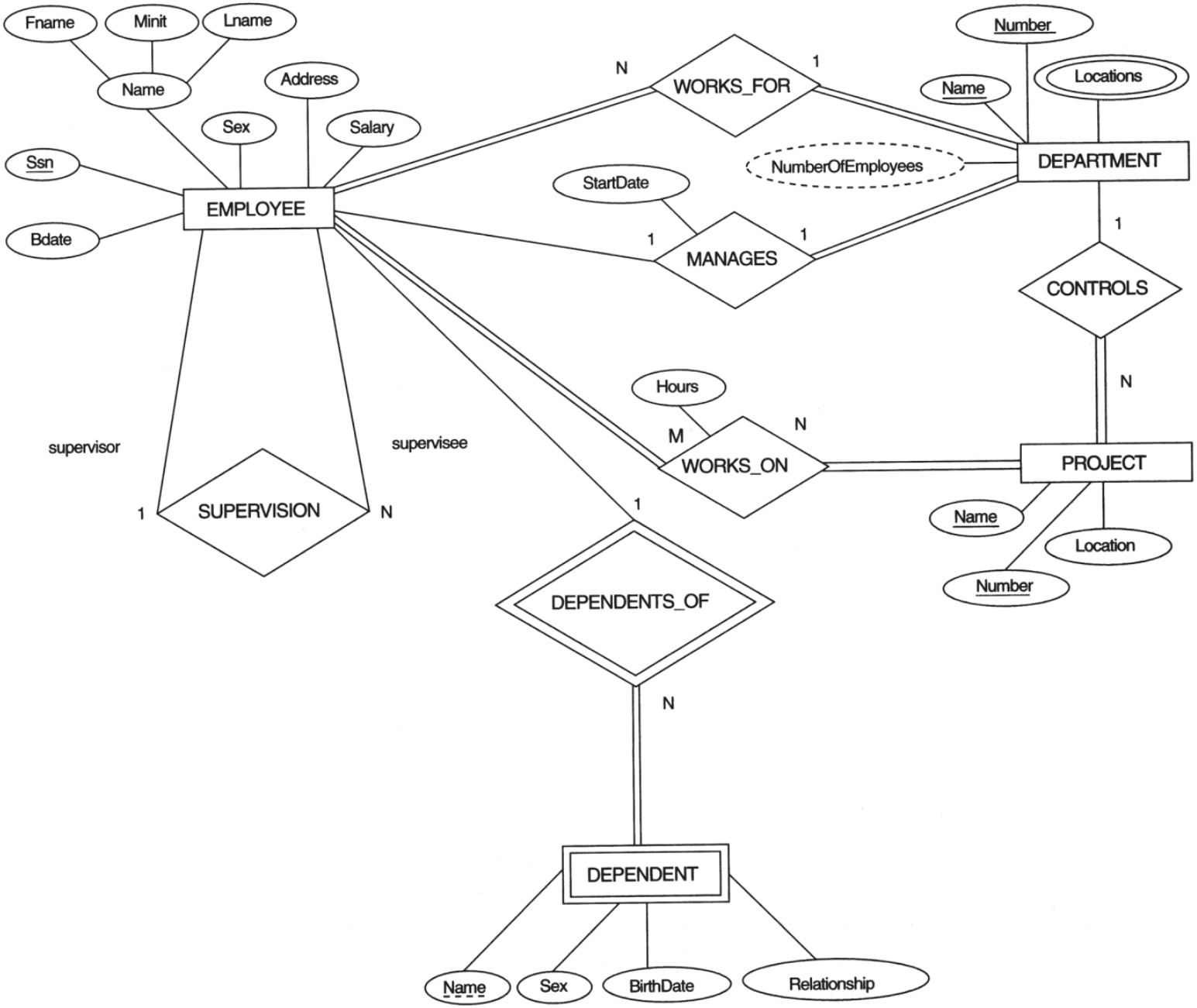
- **Foreign key approach :**
  - Add a column in the table of the entity on the **N** side, put in there the primary key of the entity on the **1** side.

Example – 1:N Relationship Set



SID	Name	Major	GPA	Pro_SSN	Ad_Sem
9999	Ali	EE	3.0	123-456	Fall 2009
8888	Aliya	CS	3.8	567-890	Fall 2008

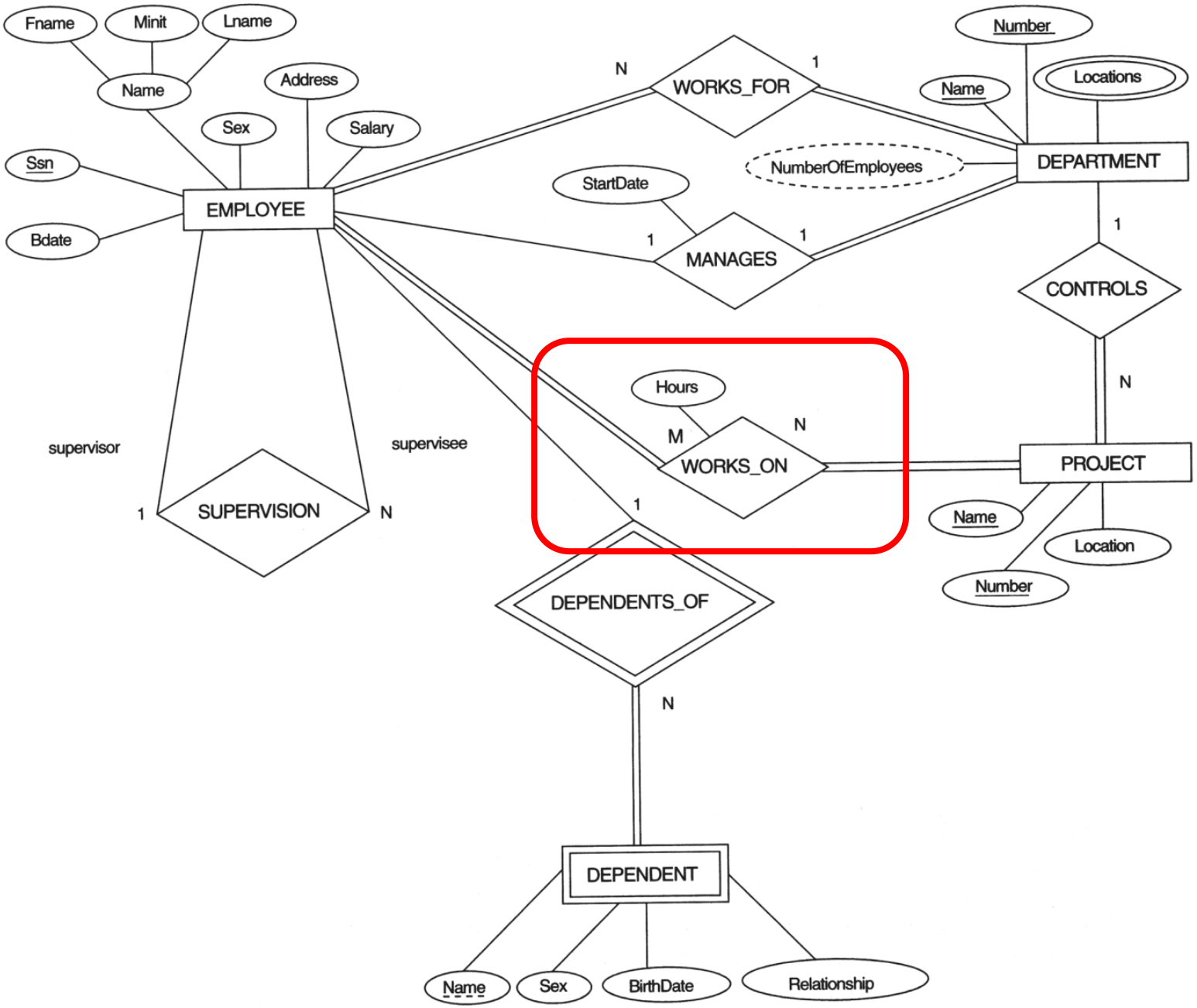
* Primary key of this table is *SID*


Fname
Minit
Lname
Name
Address
Sex
Salary
Ssn
Bdate
EMPLOYEE
N
WORKS_FOR
1
Number
Name
Locations
DEPARTMENT
NumberOfEmployees
StartDate
1
MANAGES
1
1
CONTROLS
N
Hours
M
N
WORKS_ON
PROJECT
Name
Location
Number
supervisor
supervisee
1
SUPERVISION
N
1
DEPENDENTS_OF
N
DEPENDENT
Name
Sex
BirthDate
Relationship

Mapping Relationship Set N-M unary/Binary Relationship

N:M relationship

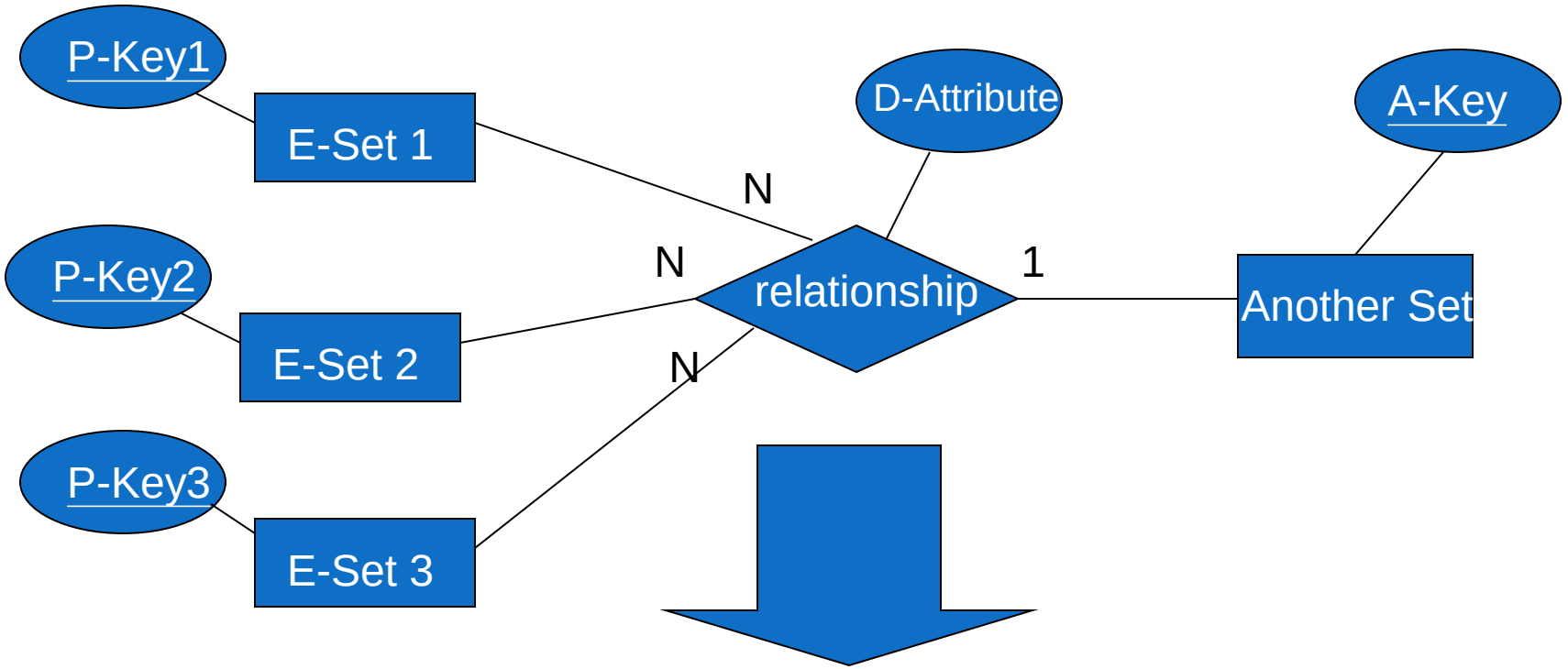
- **Relationship relation:** Build a table
  - add columns for each participating entity's primary key.
  - Also add the attributes of the relationship.
- ***Primary key*** of this new table is the union of the foreign keys of both entity sets.
- Note No Foreign Key approach is possible…


Fname
Minit
Lname
Name
Address
Sex
Salary
Ssn
Bdate
EMPLOYEE
N
WORKS_FOR
1
Number
Name
Locations
DEPARTMENT
NumberOfEmployees
StartDate
1
MANAGES
1
1
CONTROLS
N
Hours
M
N
WORKS_ON
PROJECT
Name
Location
Number
supervisor
supervisee
1
SUPERVISION
N
1
DEPENDENTS_OF
N
DEPENDENT
Name
Sex
BirthDate
Relationship

Mapping Relationship Set
N-ary Relationship

- *Intuitively Simple*
  - Build a new table, add primary keys of all participating entity sets.
  - Add attributes of the relationship set
  - The primary key of this new table is the union of all primary keys of entities that are on **N** side
  - That is it, we are done.

Example – N-ary Relationship Set

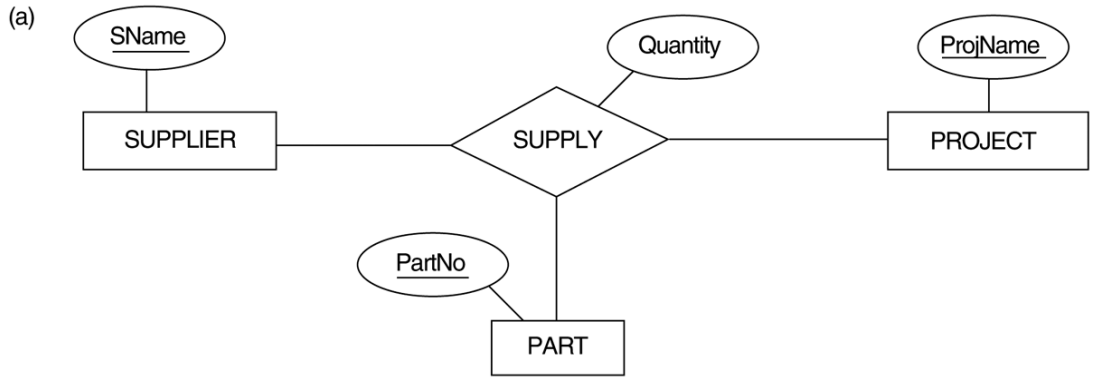


P-Key1	P-Key2	P-Key3	A-Key	D-Attribute
9999	8888	7777	6666	Yes
1234	5678	9012	3456	No

* Primary key of this table is *P-Key1 + P-Key2 + P-Key3*

FIGURE 4.11

TERNARY RELATIONSHIP TYPES. (A) THE SUPPLY RELATIONSHIP.



SUPPLIER

SNAME	. . .

PROJECT

PROJNAME	. . .

PART

PARTNO	. . .

SUPPLY

SNAME	PROJNAME	PARTNO	QUANTITY

Representing Relationship
Identifying Relationship

Don't create a table for the identifying relationship

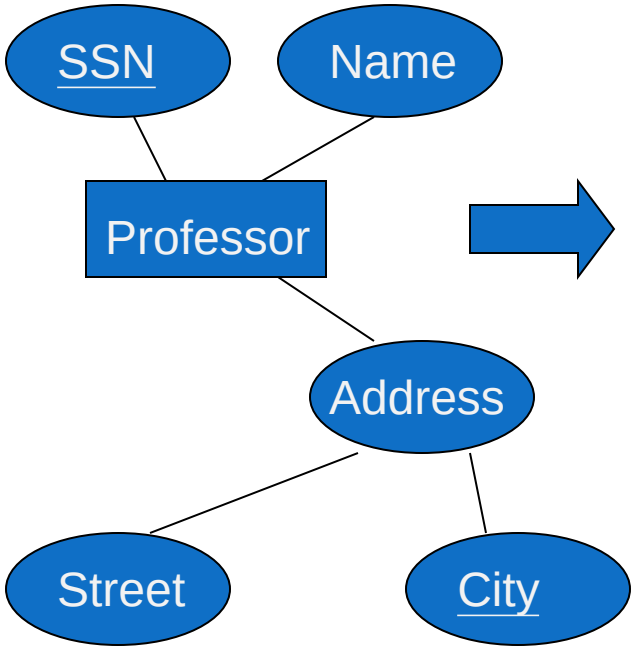
As we have built a table for the corresponding weak entity

- **WHY ?**
  - A special case of 1:N with total participation
  - Reduce Redundancy

Representing Composite Attribute

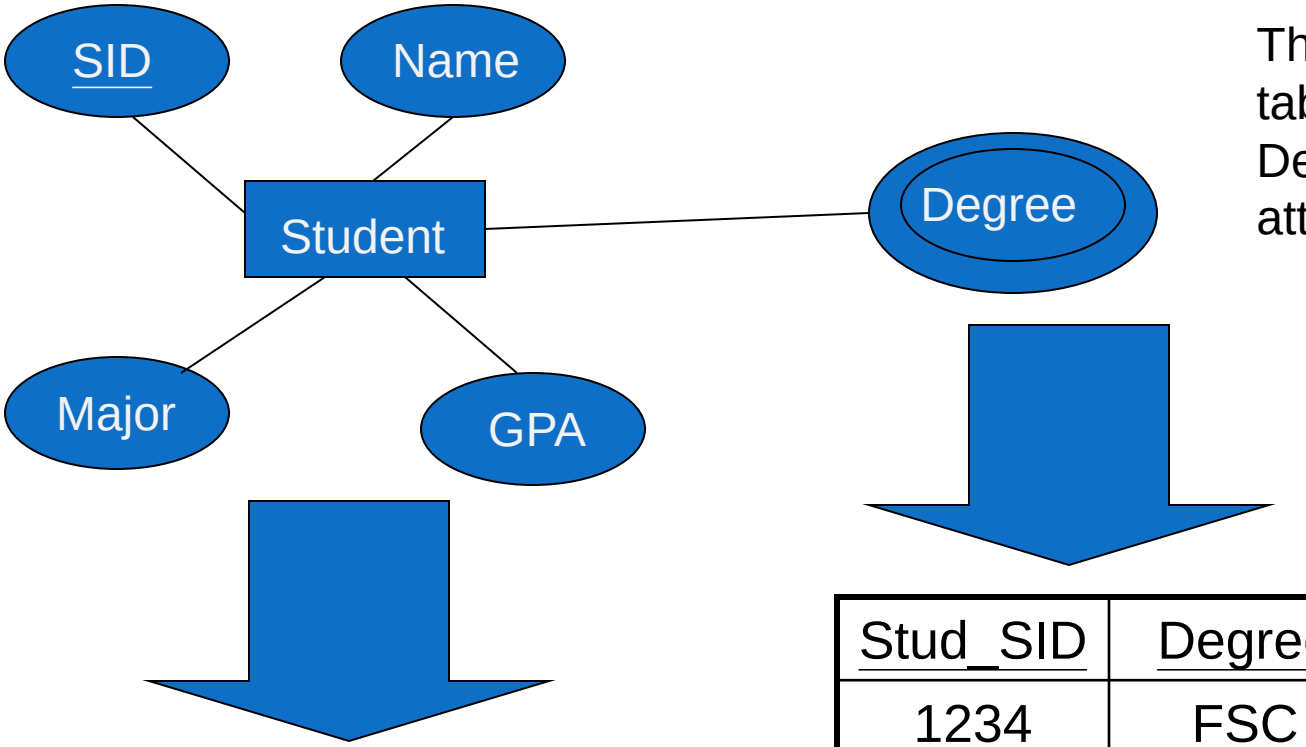
One column for each component attribute

NO column for the composite attribute itself



SSN	Name	Street	City
9999	Dr. Smith	50 1st St.	Fake City
8888	Dr. Lee	1 B St.	San Jose

Example – Multivalue attribute

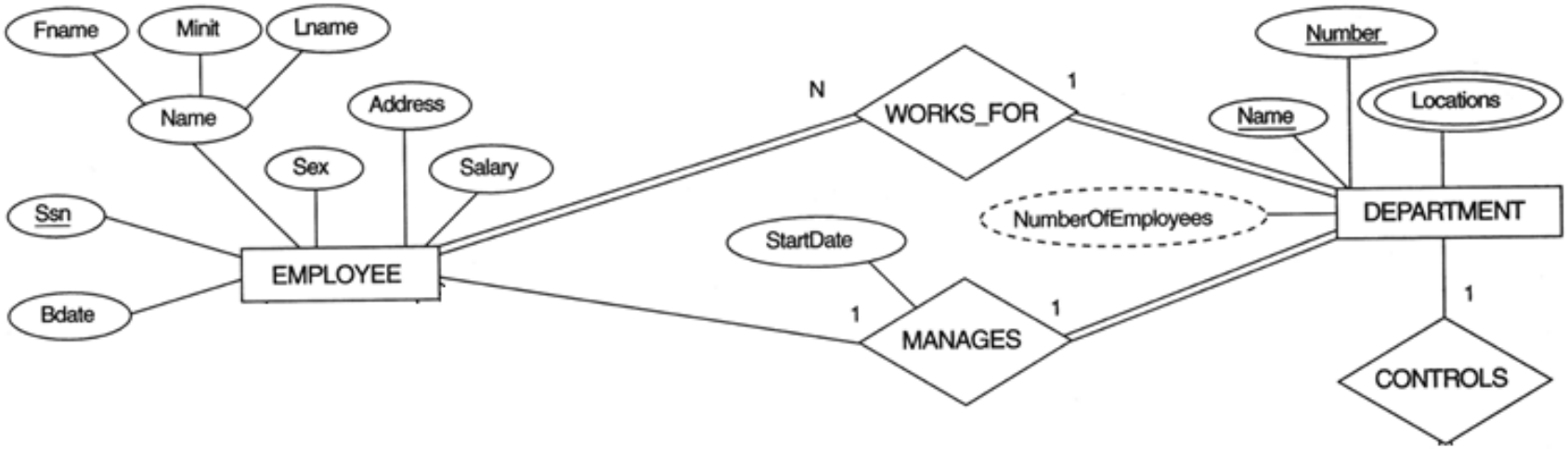


The primary key for this table is Student_SID + Degree, the union of all attributes

SID	Name	Major	GPA
1234	Javed	CS	2.8
5678	Saif	EE	3.6

Stud_SID	Degree
1234	FSC
1234	BS
5678	BS
5678	MS
5678	FA

Example – Multivalue attribute



DEPT_LOCATIONS

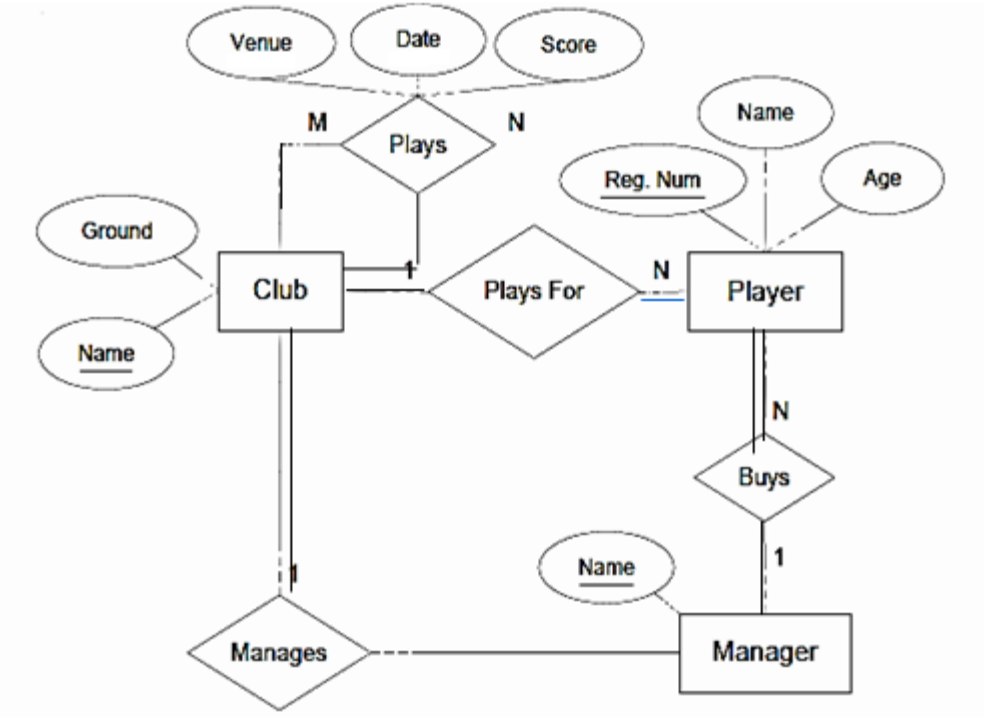
Dnumber	Dlocation

Correspondence between ER Model & Relational Model

ER Model	Relational Model
1. Entity type	1. Entity relation
2. 1:1 or 1:N relationship type	2. Foreign key (or relationship relation)
3. M:N relationship type	3. Relationship relation and two foreign keys
4. *n*-ary relationship type	4. Relationship relation and n foreign keys
5. Simple attribute	5. Attribute
6. Composite attribute	6. Set of simple component attributes
7. Multivalued attribute	7. Relation and foreign key
8. Value set	8. Domain
9. Key attribute	9. Primary (or secondary) key

ER to Relational: Example Football Club

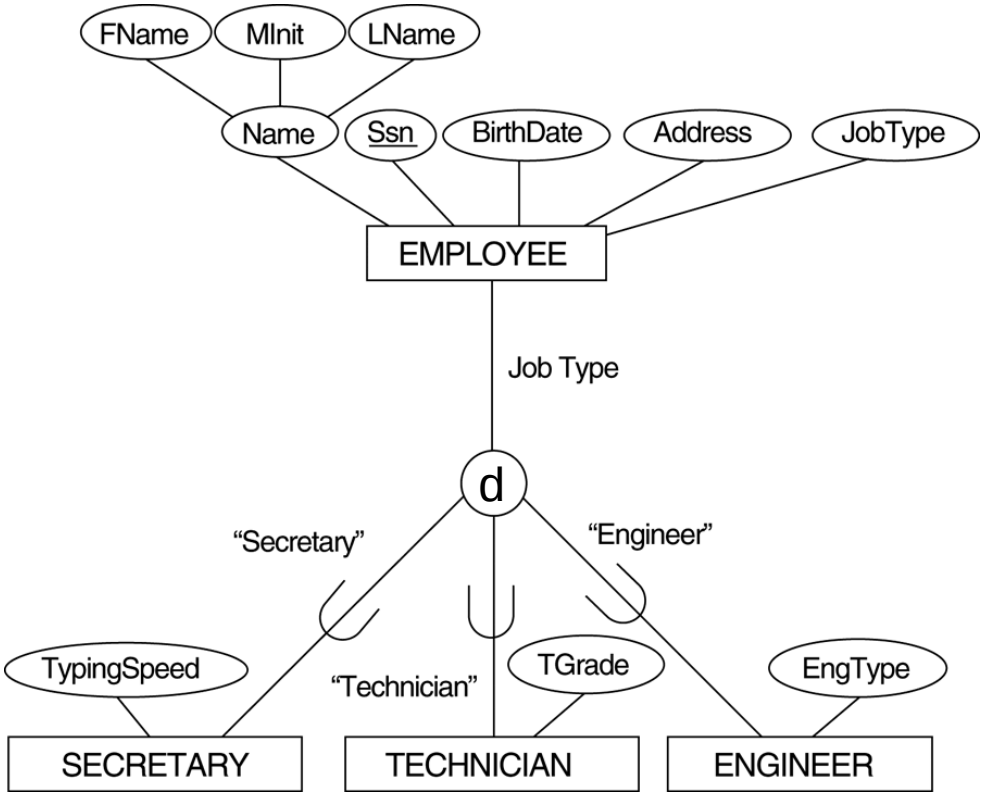
"A football club has a name and a ground and is made up of players. A player can play for only one club. A manager, represented by his name manages a club. A footballer has a registration number, name and age. A club manager also buys players. Each club plays against other clubs in the league and matches have a date, venue and score."



Mapping EER Model Constructs to Relations

- For Mapping Specialization or Generalization we have four options:
  - Multiple relations-Superclass and subclasses
  - Multiple relations-Subclass relations only
  - Single relation with one type attribute
  - Single relation with multiple type attributes

ATTRIBUTE-DEFINED SPECIALIZATION ON JOBTYPE



(a)

EMPLOYEE

SSN	FName	MInit	LName	BirthDate	Address	JobType

SECRETARY

SSN	TypingSpeed

TECHNICIAN

SSN	TGrade

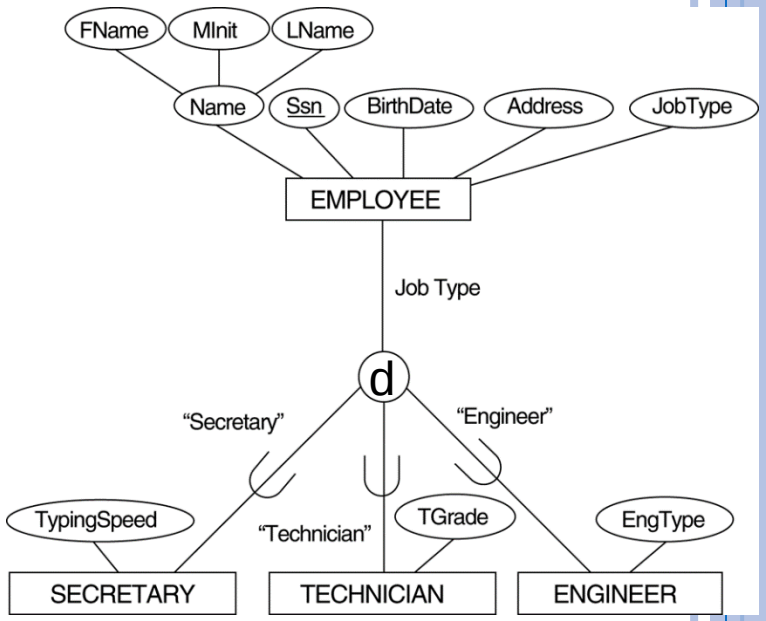
ENGINEER

SSN	EngType

Mapping EER Model Constructs to Relations

Multiple relations- Superclass & Subclasses

- Create a relation for the Superclass
- Create a relation for each subclass and also include the primary key of the Superclass
- This option works for **any specialization** (***total or partial, disjoint or over-lapping***).



(a)

EMPLOYEE

SSN	FName	MInit	LName	BirthDate	Address	JobType

SECRETARY

SSN	TypingSpeed

TECHNICIAN

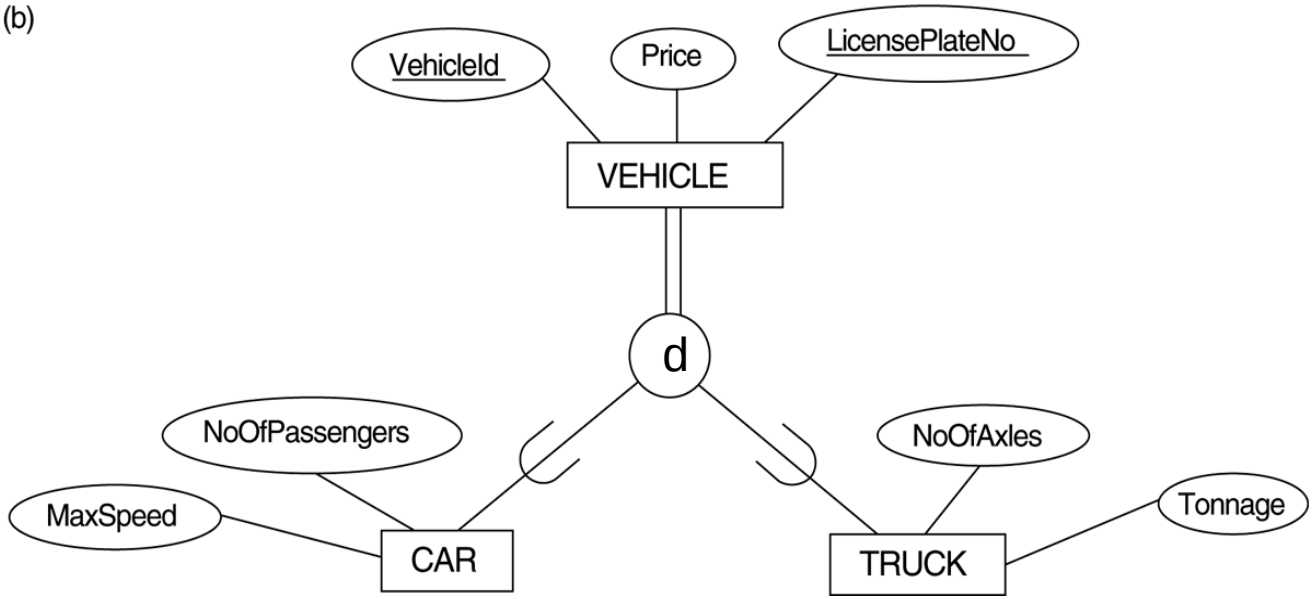
SSN	TGrade

ENGINEER

SSN	EngType

Generalizing CAR and TRUCK into the superclass VEHICLE.

(b)



(b) CAR

VehicleId	LicensePlateNo	Price	MaxSpeed	NoOfPassengers

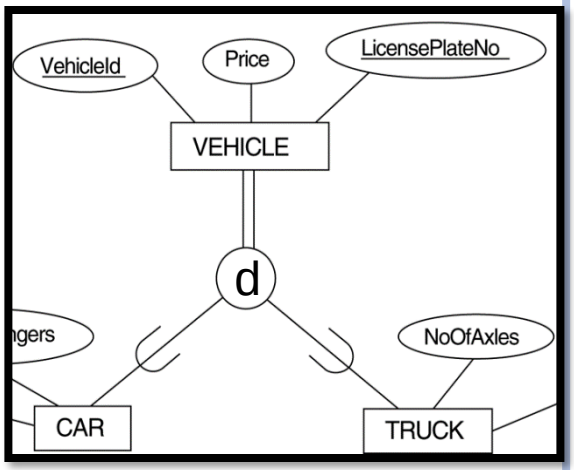
TRUCK

VehicleId	LicensePlateNo	Price	NoOfAxles	Tonnage

Mapping EER Model Constructs to Relations

Multiple Relations-Subclass only

- Create a relation for each subclass
  - include the attributes of the superclass in each subclass relation
- Works only in for specialization where **subclasses are total**
  - Every entity in the superclass must belong to at least one of the subclasses.
- It is preferred that subclasses are **disjoint**
  - to avoid redundancy
- ***How to get all entities*** ?
  - Need Outer join (or full outer join) to get all entities



(b)

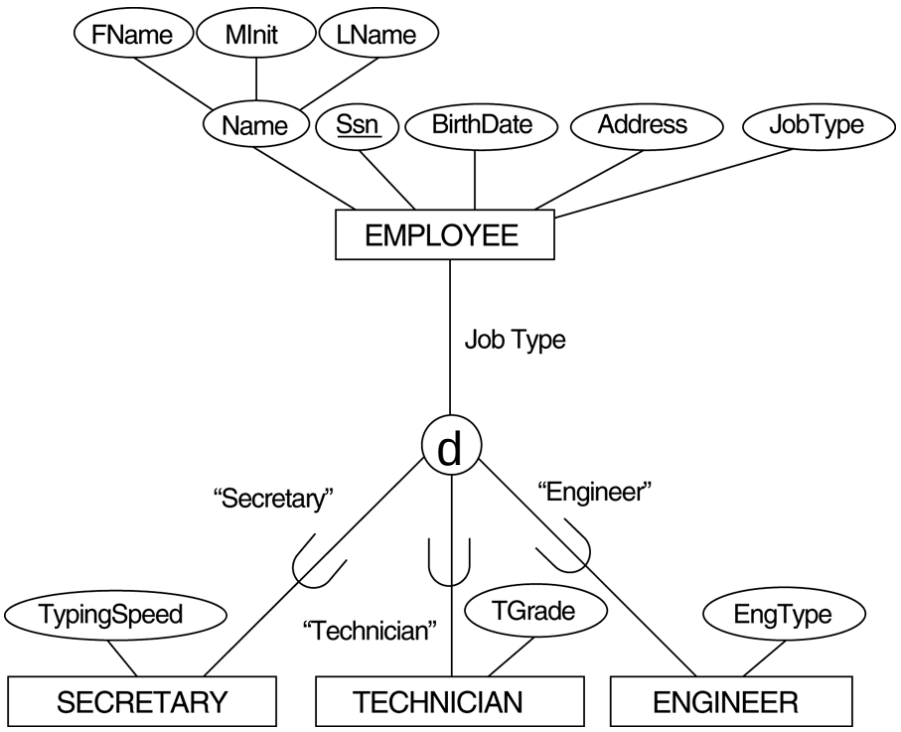
CAR

VehicleId	LicensePlateNo	Price	MaxSpeed	NoOfPassengers

TRUCK

VehicleId	LicensePlateNo	Price	NoOfAxles	

ATTRIBUTE-DEFINED SPECIALIZATION ON JOBTYPE



(c) EMPLOYEE

SSN	FName	MInit	LName	BirthDate	Address	JobType	TypingSpeed	TGrade	EngType

Mapping EER Model Constructs to Relations

Single relation with one type attribute

- Create a single relation for superclass and all of the subclasses
- The new relation includes the attributes of superclass and all the attributes of each subclass
- The relation also includes **an attribute (type)** that indicates the subclass to which each tuple belongs
- ***Not recommended if subclasses have many attributes***
- This option works only for a specialization whose subclasses are ***disjoint***

(c)

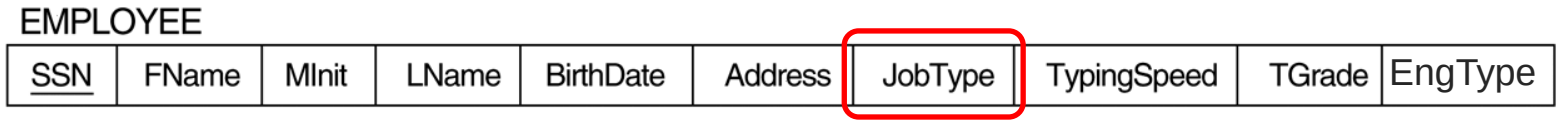
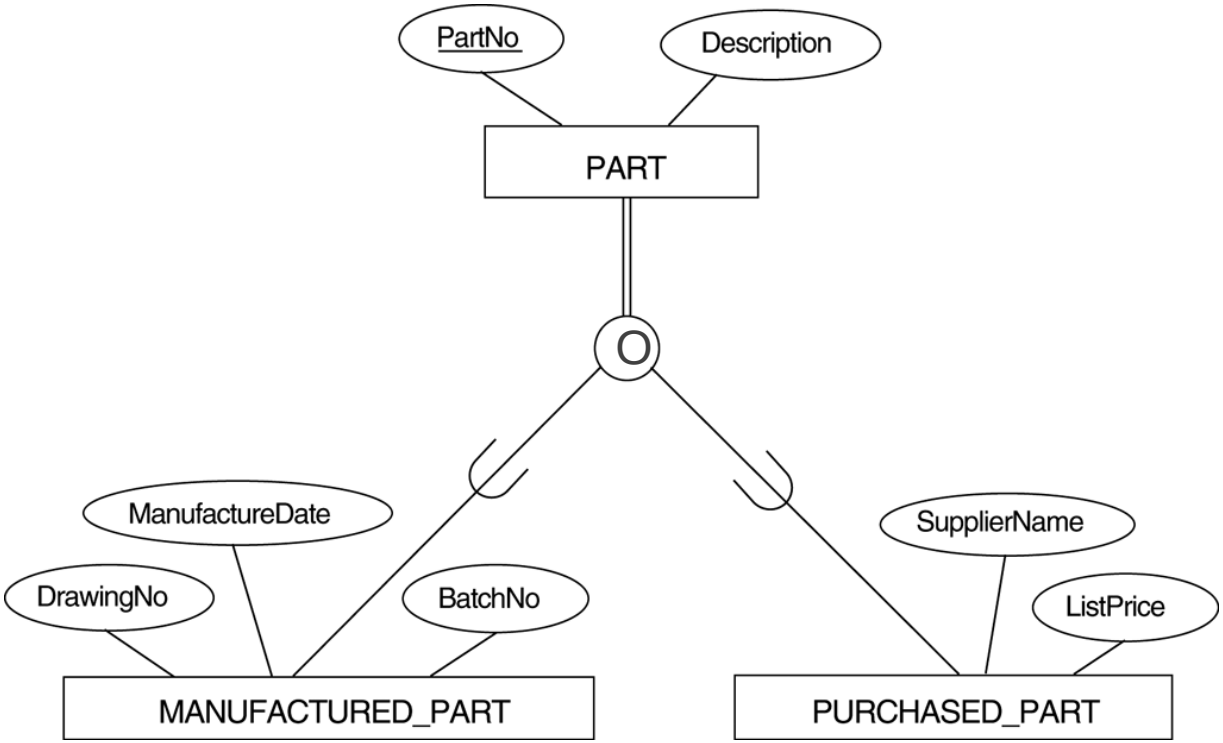


FIGURE 4.5
EER DIAGRAM NOTATION FOR AN OVERLAPPING SPECIALIZATION.



(d) PART

PartNo	Description	MFlag	DrawingNo	ManufactureDate	BatchNo	PFlag	SupplierName	ListPrice

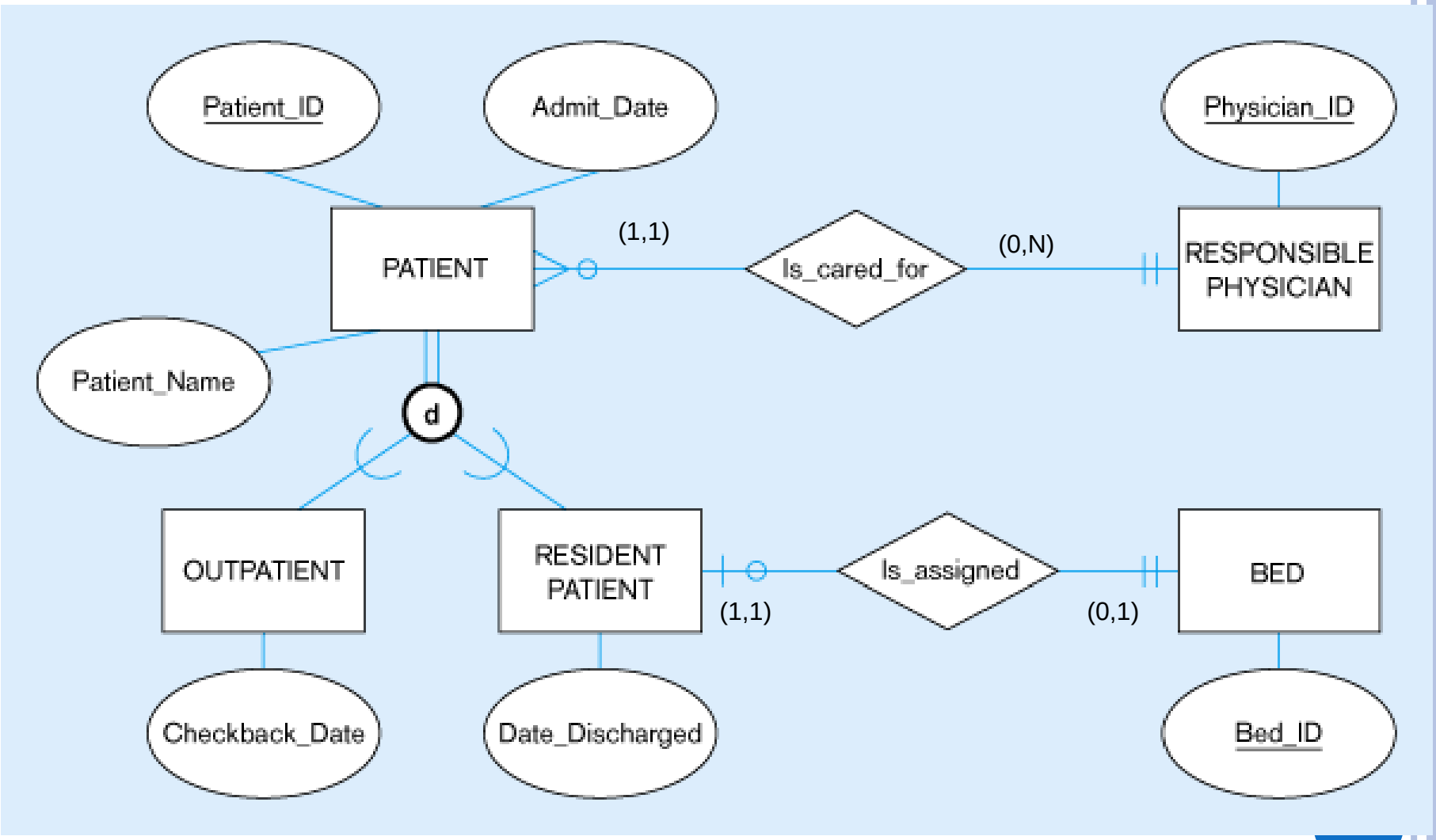
Mapping EER Model Constructs to Relations

- **Single relation with multiple type attributes**
  - Create a single relation for superclass and all of the subclasses
  - The new relation includes the attributes of superclass and all the attributes of each subclass
  - The relation also includes **m type attributes**, where m is the no of subclasses.
    - Each is a boolean type attribute indicating whether a tuple belongs to the i^{th} subclass.
  - This option is for **overlapping subclasses** (but will work for a disjoint subclasses).

(d) PART

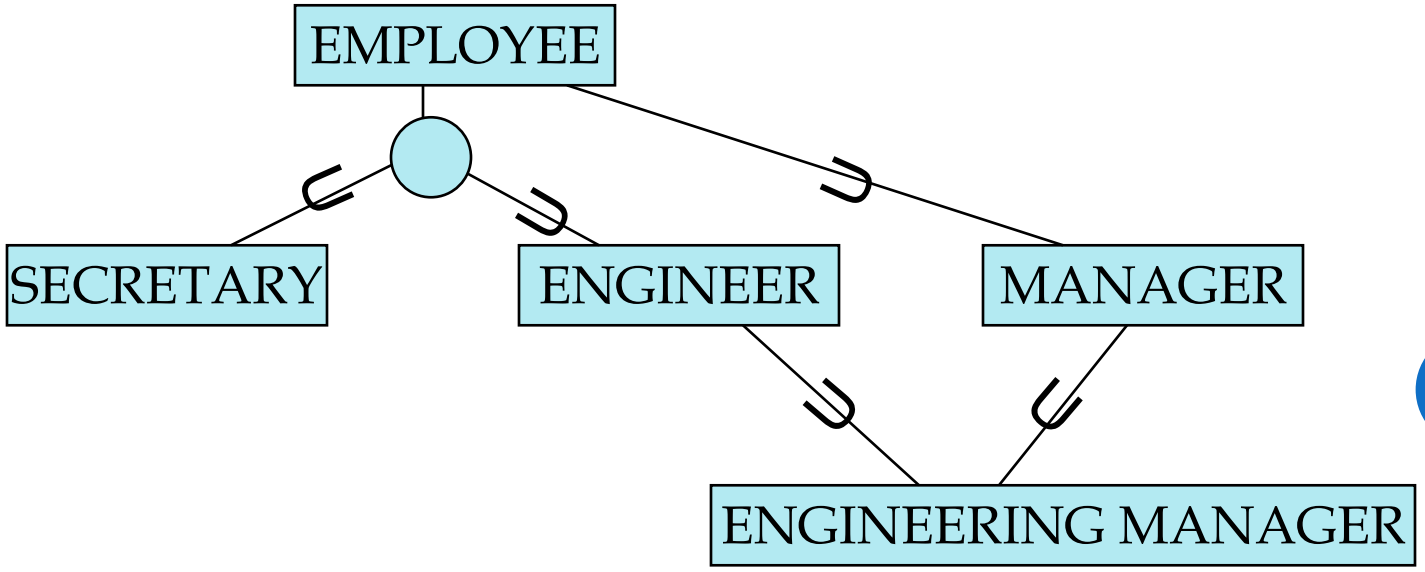
PartNo	Description	MFlag	DrawingNo	ManufactureDate	BatchNo	PFlag	SupplierName	ListPrice

Example

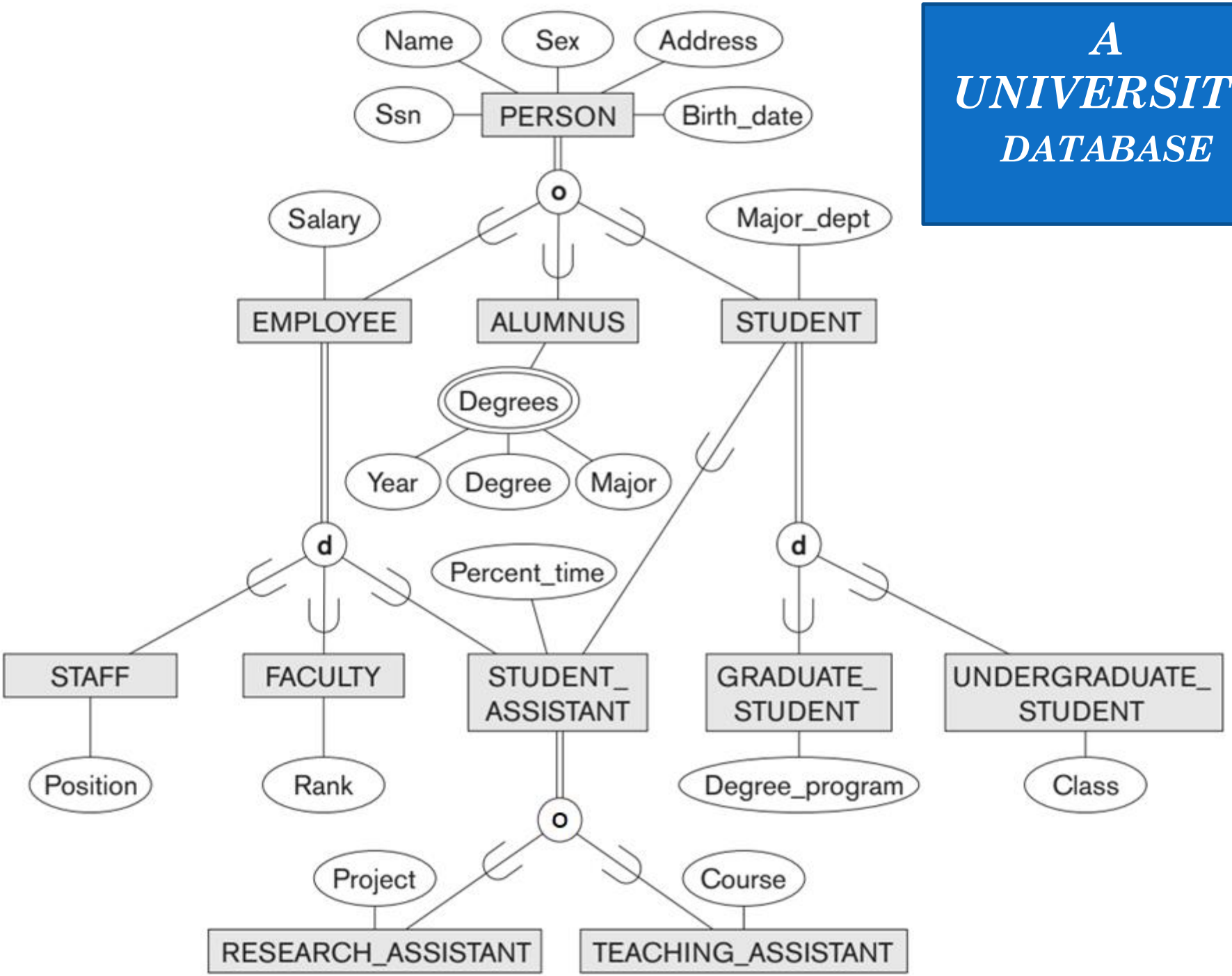

Patient_ID
Admit_Date
Physician_ID
PATIENT
(1,1)
Is_cared_for
(0,N)
RESPONSIBLE PHYSICIAN
Patient_Name
d
OUTPATIENT
RESIDENT PATIENT
(1,1)
Is_assigned
(0,1)
BED
Checkback_Date
Date_Discharged
Bed_ID

Mapping of Shared Subclasses (Multiple Inheritance)

- A shared subclass, is a subclass of several classes, indicating multiple inheritance.
- These classes must all have the same key attribute. WHY ?
  - Otherwise, the shared subclass would be modeled as a category.
- We can apply any of the four options discussed before to a shared subclass, subject to the restriction.



A UNIVERSITY DATABASE



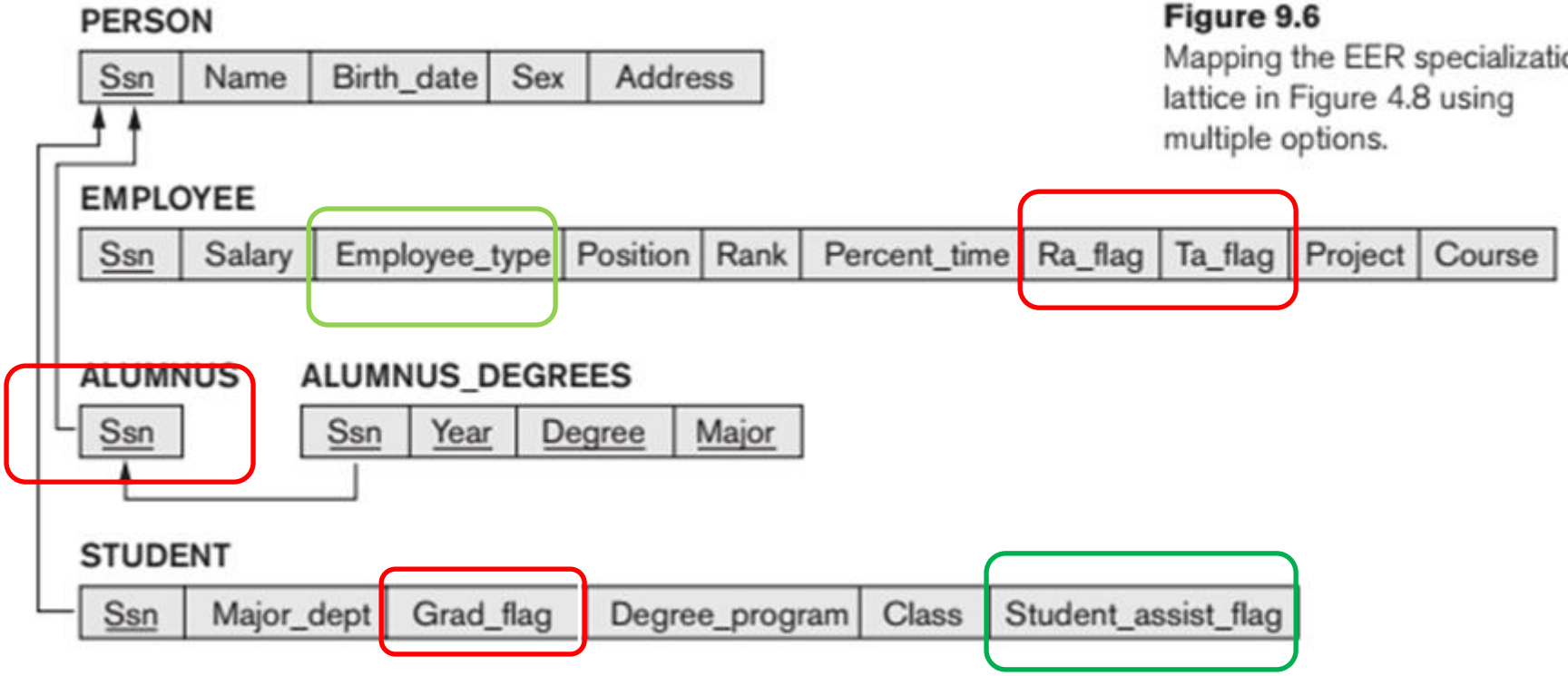
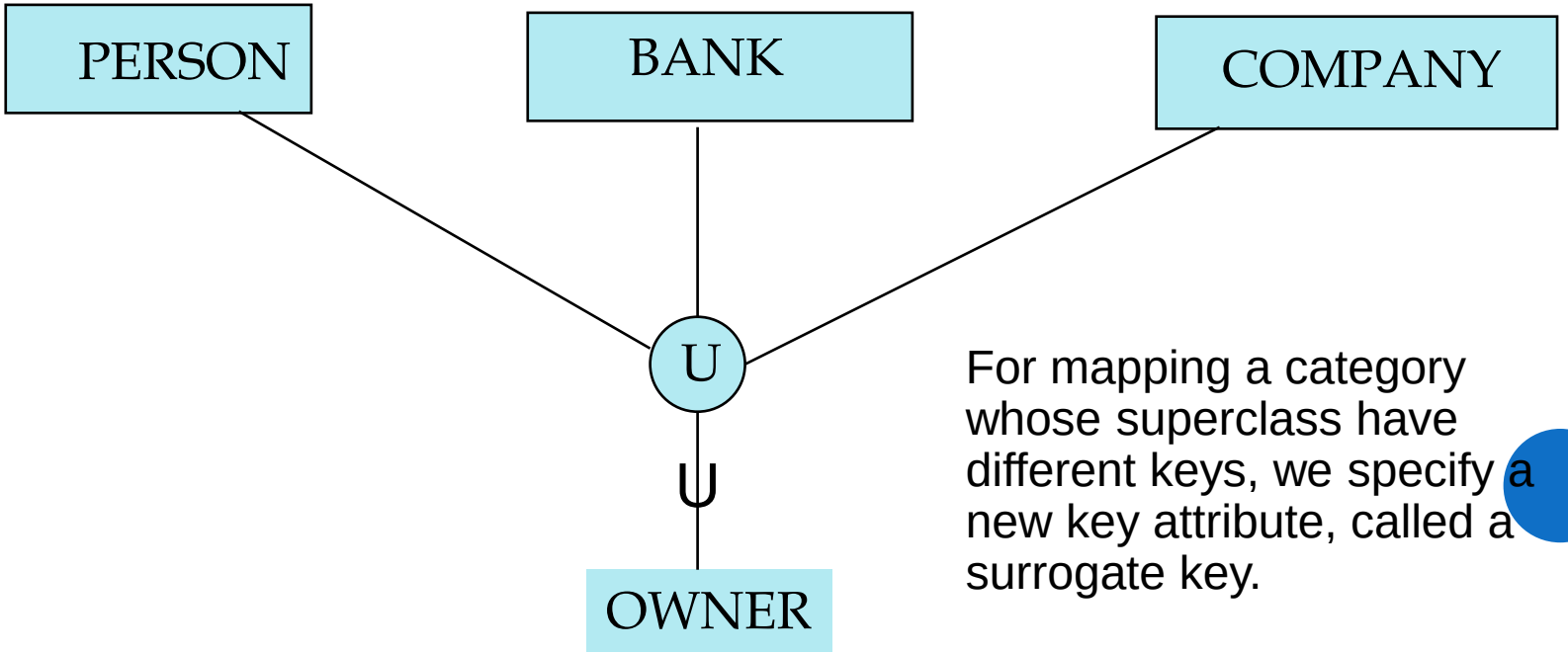


Figure 9.6
Mapping the EER specialization lattice in Figure 4.8 using multiple options.

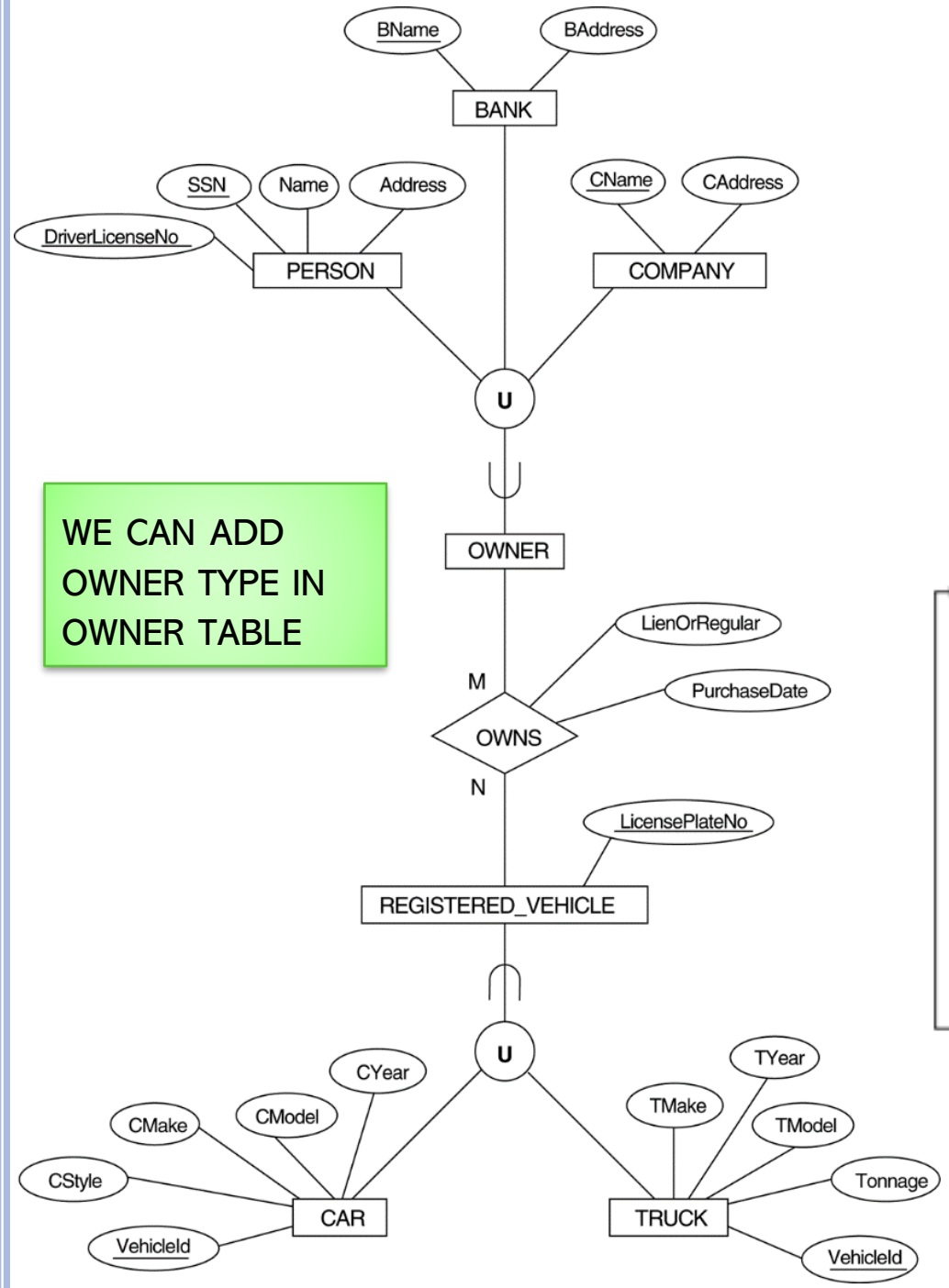
Mapping of Union Types (Categories)

- **Category (union type)**
  - A vehicle OWNER represents a subset of the *union* of the three superclasses COMPANY, BANK, and PERSON
  - A category member must exist in ***at least one*** of its superclasses
- **Difference from *shared subclass*, which is a:**
  - subset of the *intersection* of its superclasses
  - shared subclass member must exist in ***all*** of its superclasses

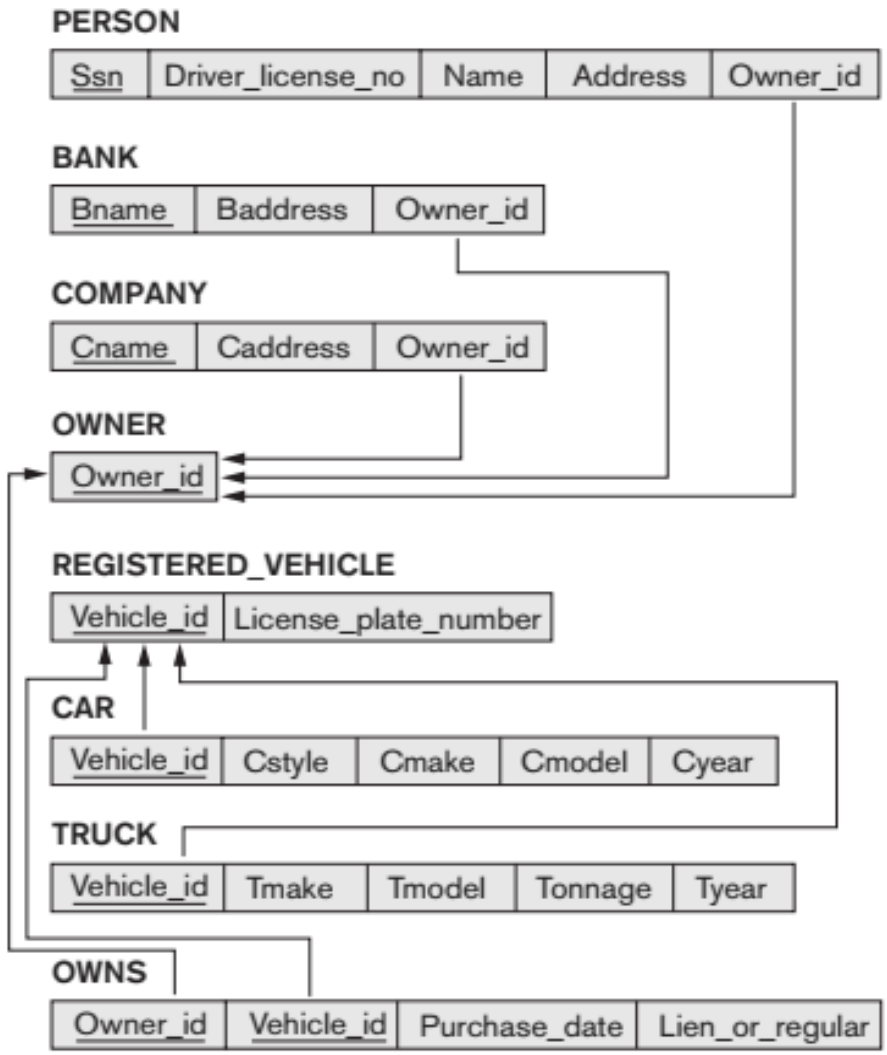


For mapping a category whose superclass have different keys, we specify a new key attribute, called a surrogate key.

Vehicle registration database

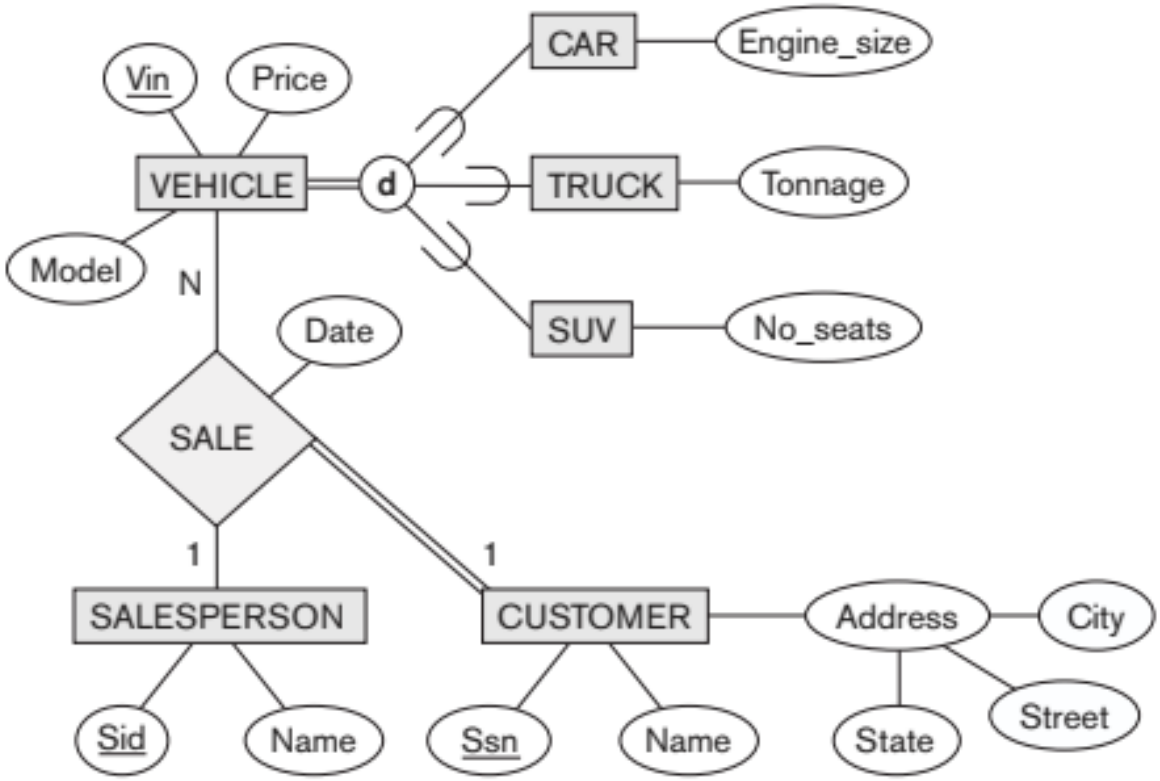


We can add owner type in owner table

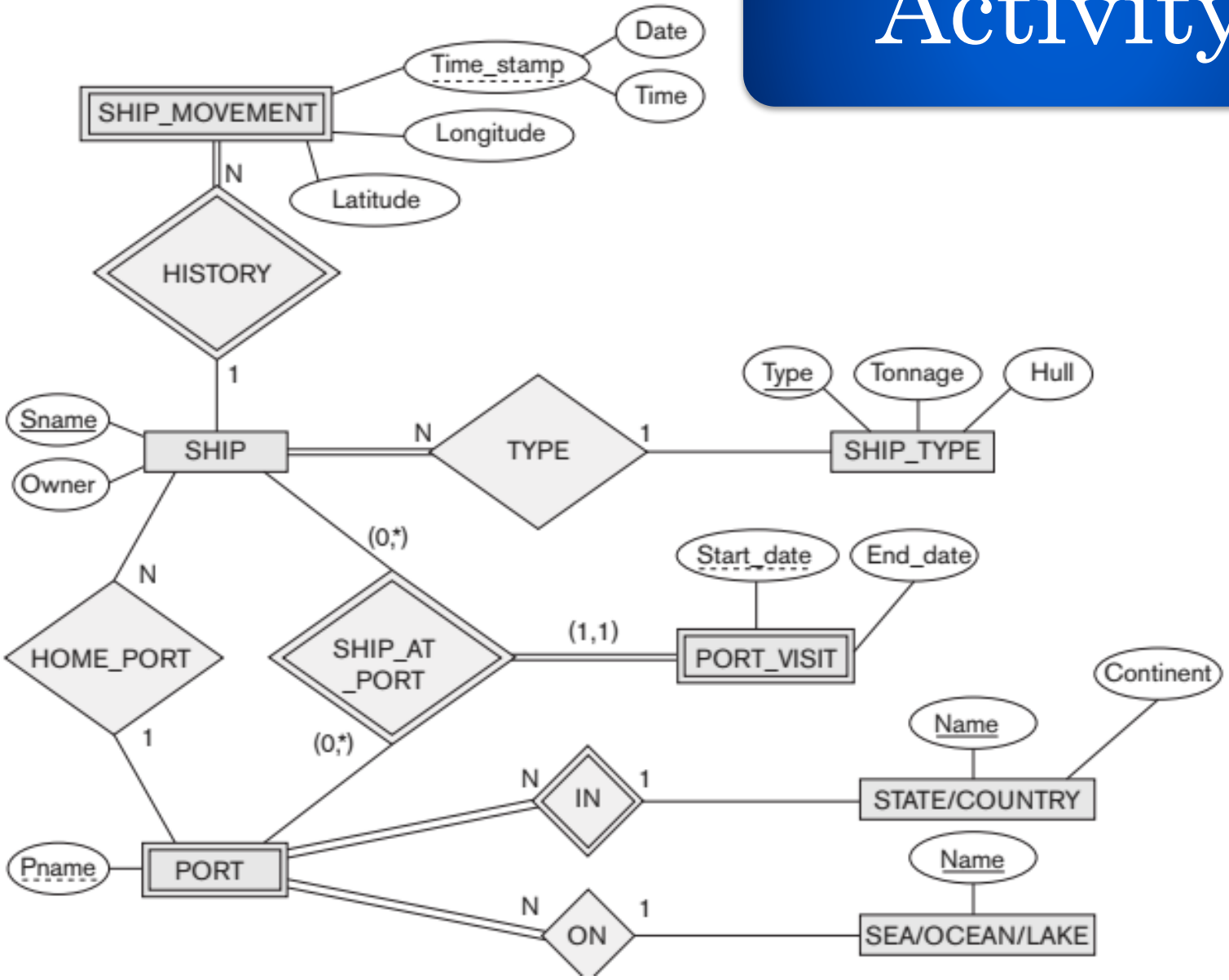


Can there be a CAR in this database that is not a Registered?

Activity


CAR
Engine_size
Vin
Price
VEHICLE
d
TRUCK
Tonnage
Model
N
SUV
No_seats
Date
SALE
1
1
SALESPERSON
CUSTOMER
Address
City
Sid
Name
Ssn
Name
State
Street

Activity


SHIP_MOVEMENT
Time_stamp
Date
Time
Longitude
Latitude
N
HISTORY
1
SHIP
Sname
Owner
N
TYPE
1
Type
Tonnage
Hull
SHIP_TYPE
N
HOME_PORT
1
(0,*)
SHIP_AT
_PORT
(0,*)
Start_date
End_date
(1,1)
PORT_VISIT
Continent
Name
N
IN
1
STATE/COUNTRY
Pname
PORT
N
ON
1
Name
SEA/OCEAN/LAKE

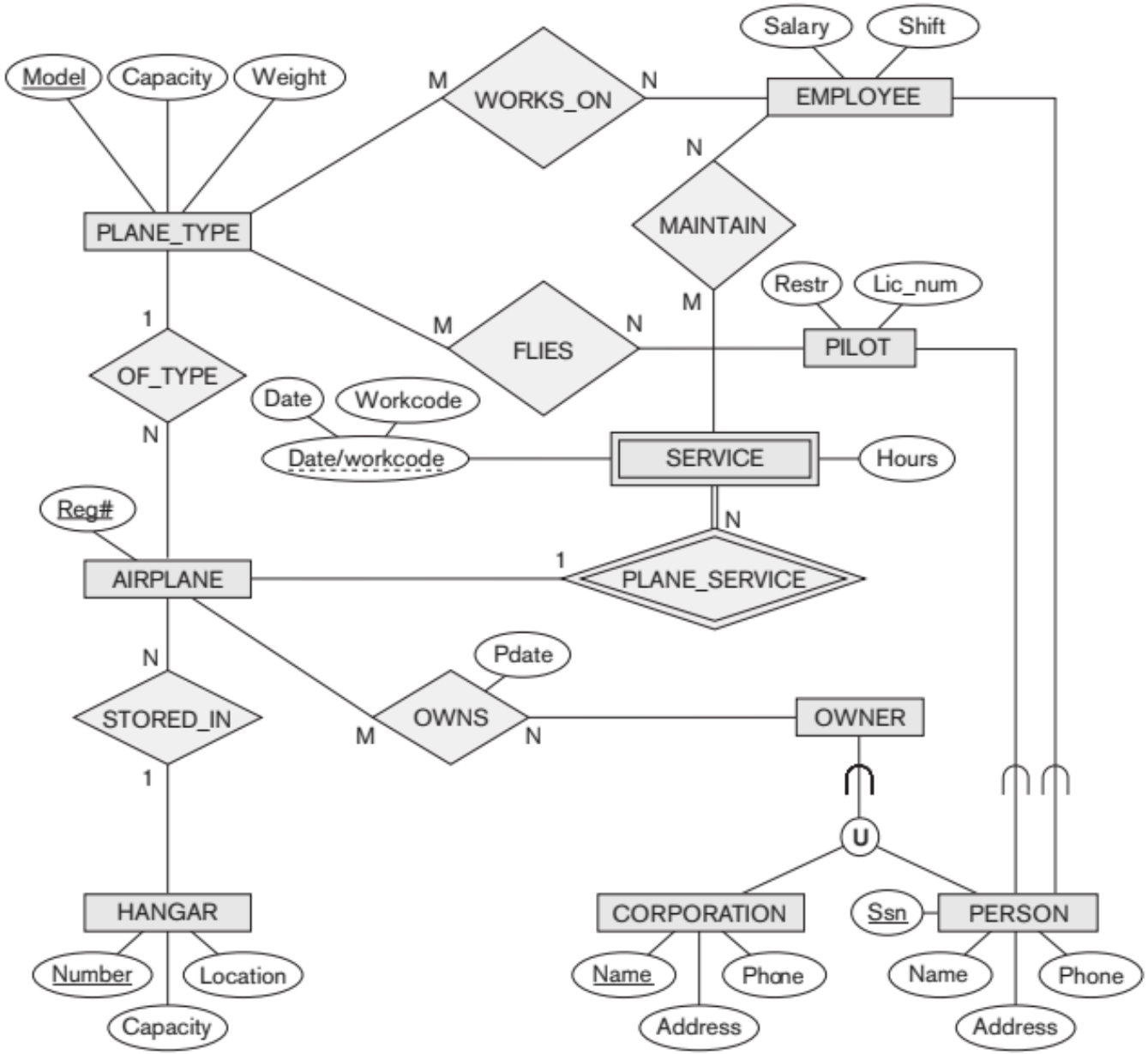


Figure 4.12
EER schema for a SMALL_AIRPORT database.

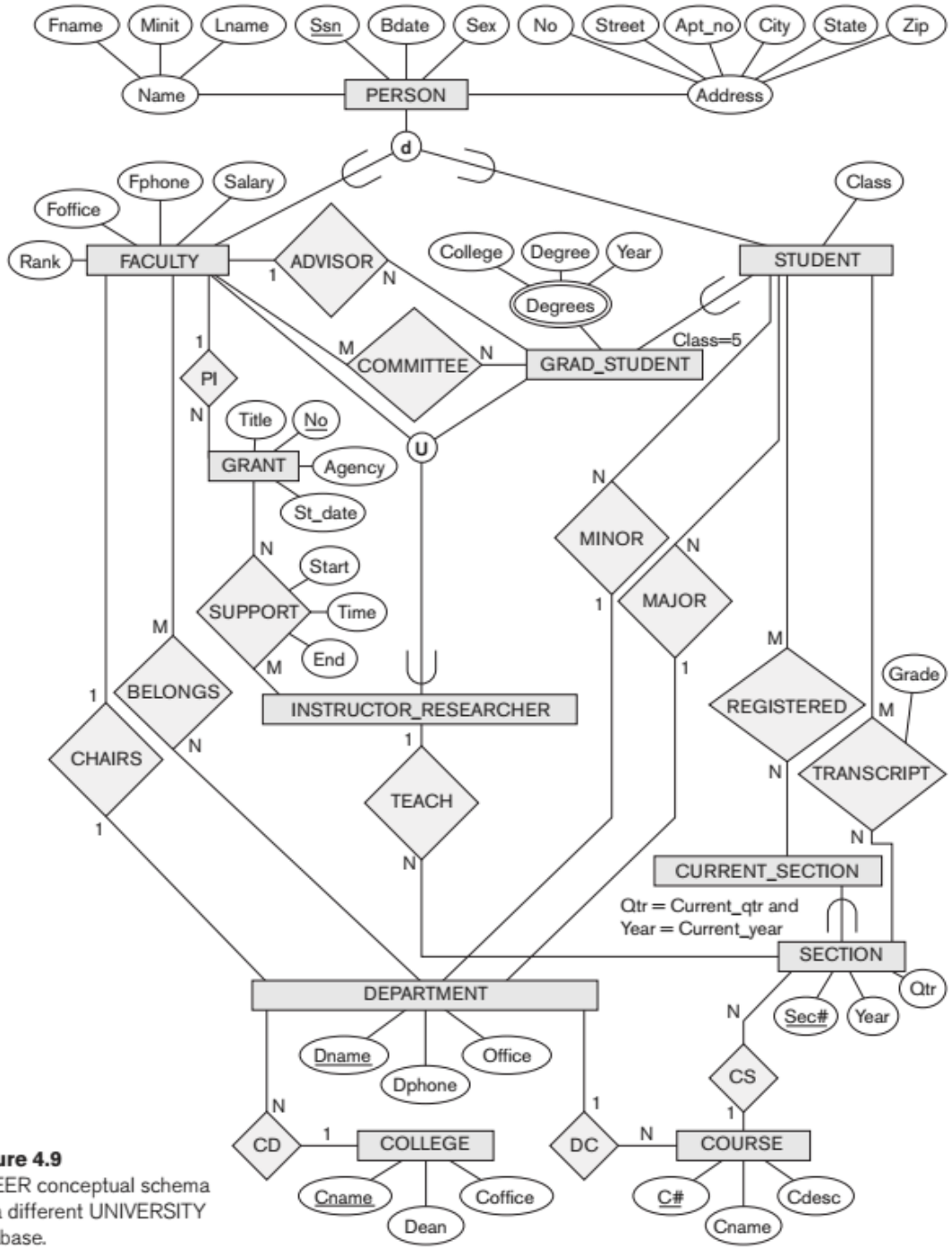
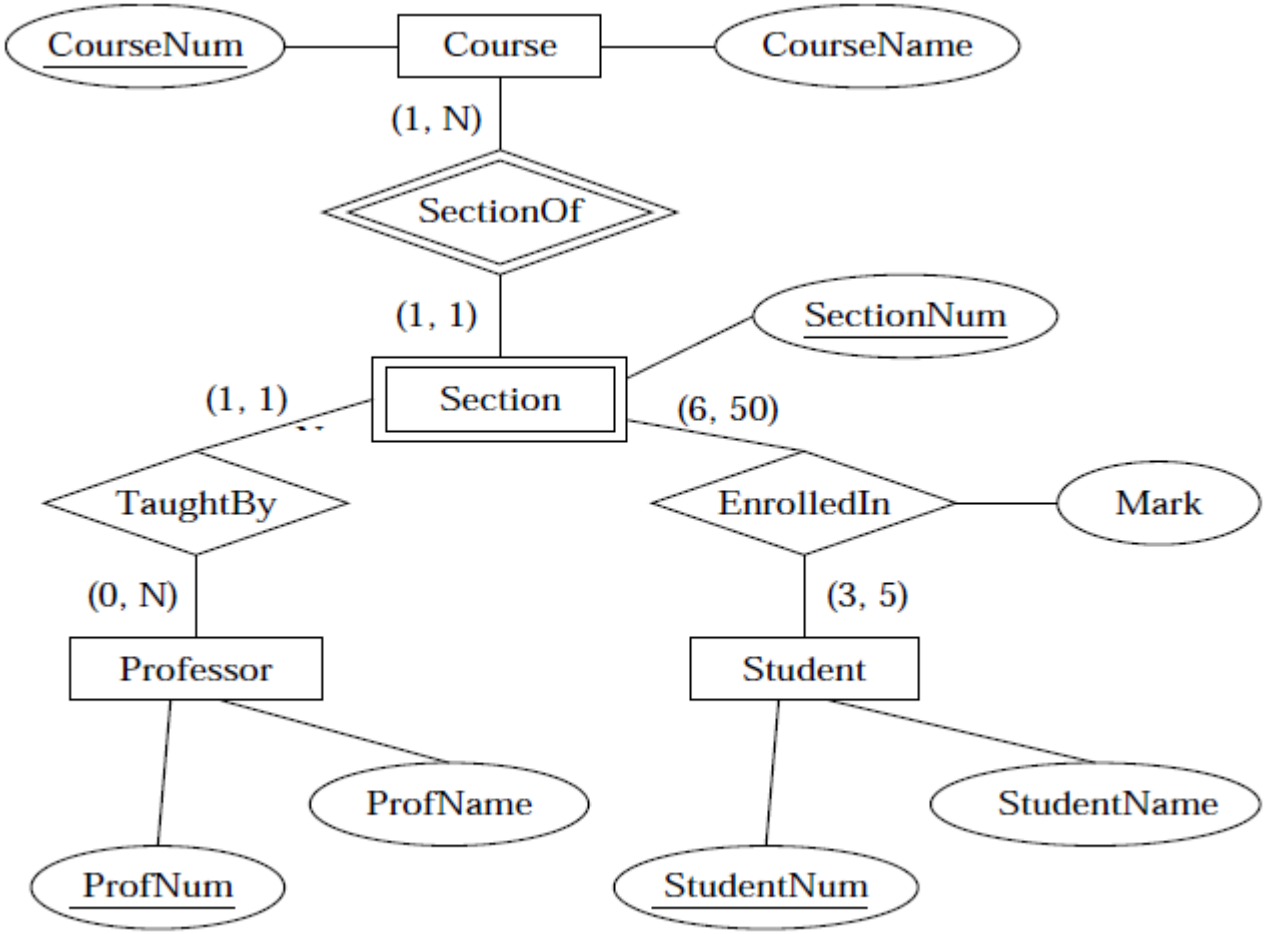


Figure 4.9
An EER conceptual schema for a different UNIVERSITY database.

Activity


CourseNum
Course
CourseName
(1, N)
SectionOf
(1, 1)
SectionNum
(1, 1)
Section
(6, 50)
TaughtBy
EnrolledIn
Mark
(0, N)
(3, 5)
Professor
Student
ProfName
StudentName
ProfNum
StudentNum