



DATABASE SYSTEMS

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Conversion to Relational Model

Exercise

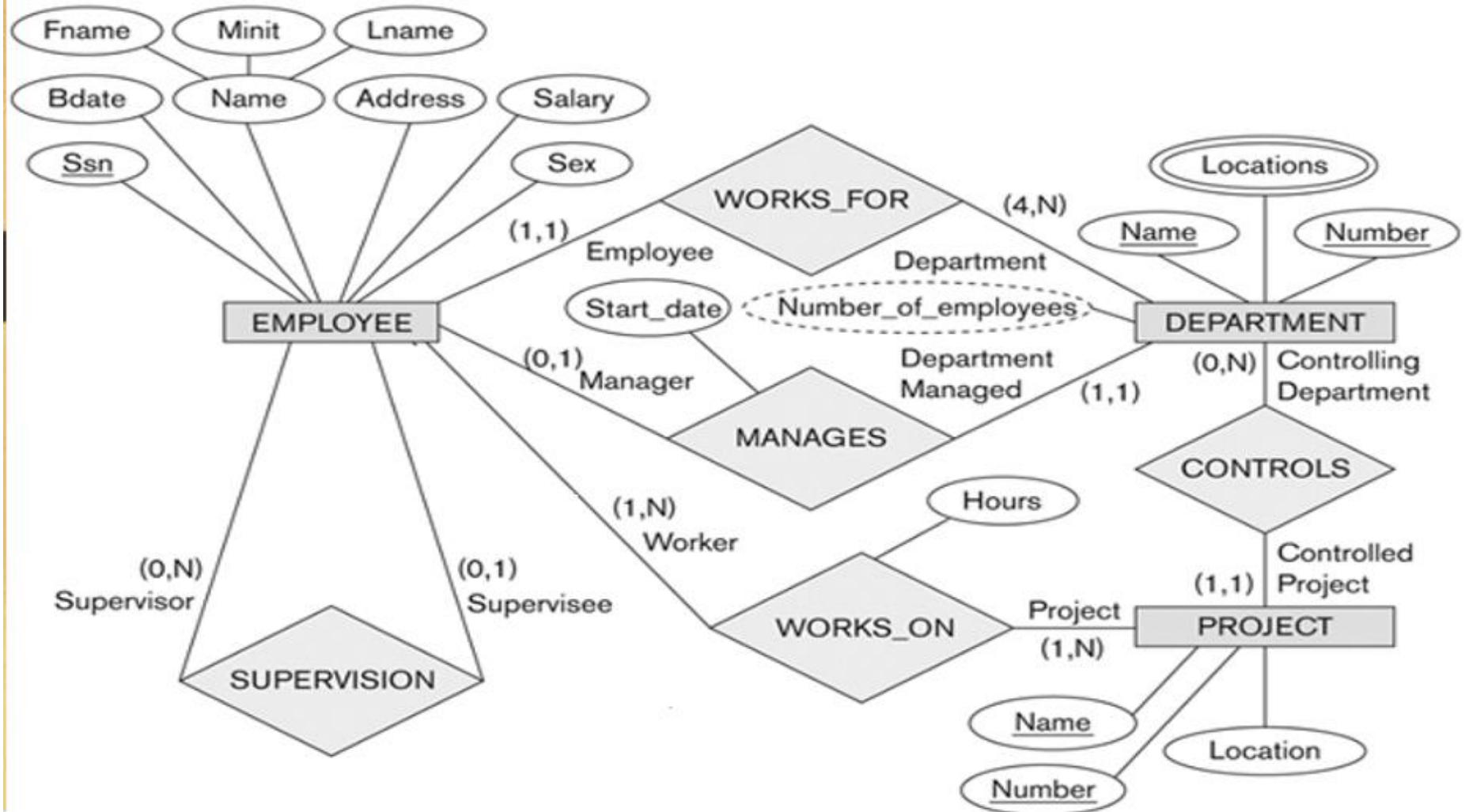
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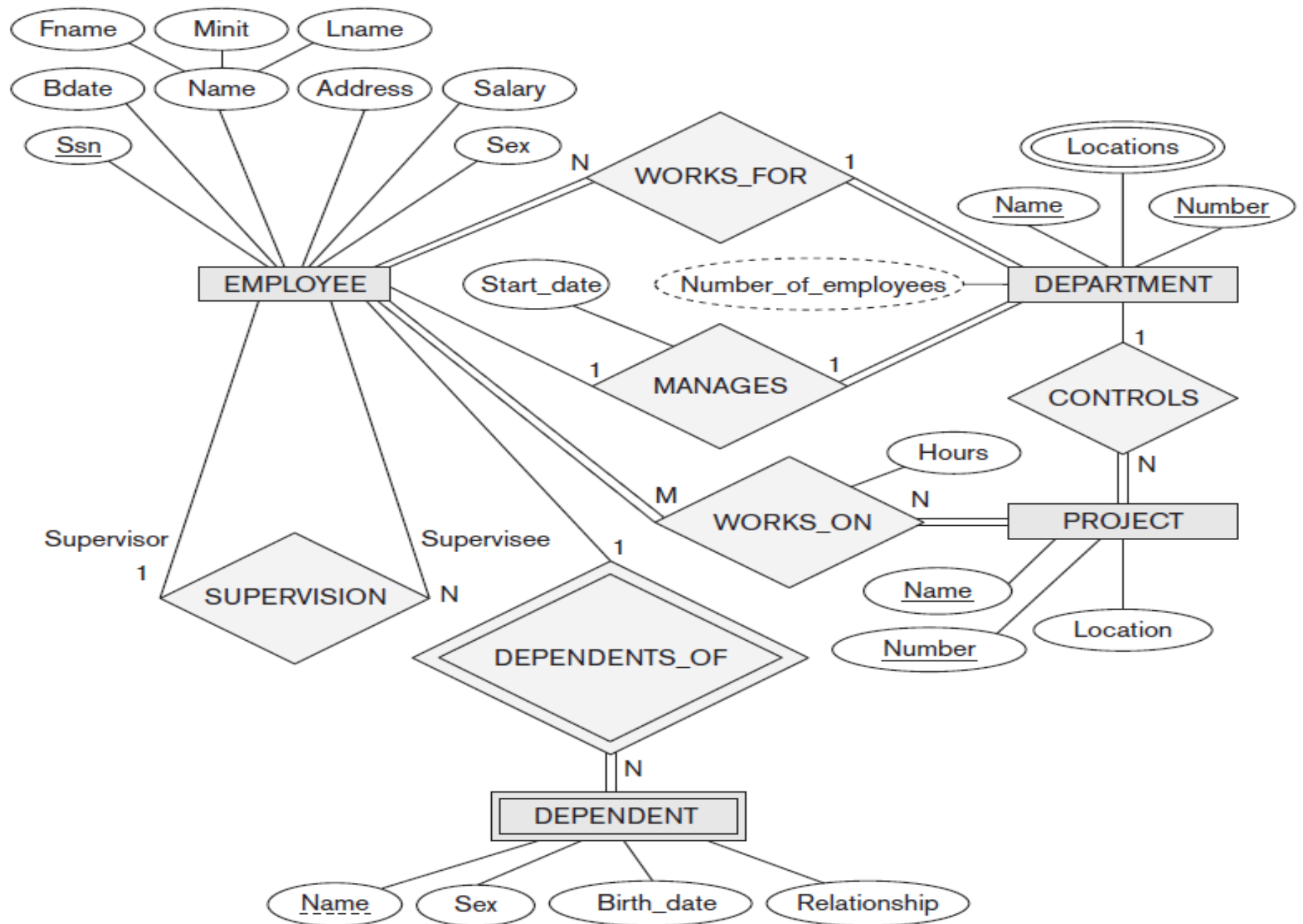
- ABC Company wants to create an information system for HR system, The COMPANY database keeps track of a company's employees, departments, and projects. The requirements gathered are:
- The company is organized into departments. Each department has a unique name, a unique number, and a particular employee who manages the department. We keep track of the start date when that employee began managing the department. A department may have several locations.
- A department controls a number of projects, each of which has a unique name, a unique number, and a single location.
- We store each employee's name, Social Security number, address, salary, sex (gender), and birth date. An employee is assigned to one department, but may work on several projects, which are not necessarily controlled by the same department. We keep track of the current number of hours per week that an employee works on each project. We also keep track of the direct supervisor of each employee (who is another employee).

Example Attribute of a Relationship Type:

Hours of **WORKS_ON** and Start Date of **MANAGES**

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Database Design Process

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1. Requirements Analysis

2. Conceptual Design

3. Logical, Physical,
Security, etc.

1. Requirements analysis

- ▣ What is going to be stored?
- ▣ How is it going to be used?
- ▣ What are we going to do with the data?
- ▣ Who should access the data?

Technical and non-technical people are involved

Database Design Process

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1. Requirements Analysis

2. Conceptual Design

3. Logical, Physical,
Security, etc.

2. Conceptual Design

- ▣ A high-level description of the database
- ▣ Sufficiently precise that technical people can understand it
- ▣ But, not so precise that non-technical people can't participate

This is where E/R fits in.

Database Design Process

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1. Requirements Analysis

2. Conceptual Design

3. Logical, Physical, Security,
etc.

3. More:

- Logical Database Design
- Physical Database Design
- Security Design

CONVERTING ERD INTO RELATIONAL MODEL

ER- to- Relational Mapping

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- 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

ER Diagrams into Relations

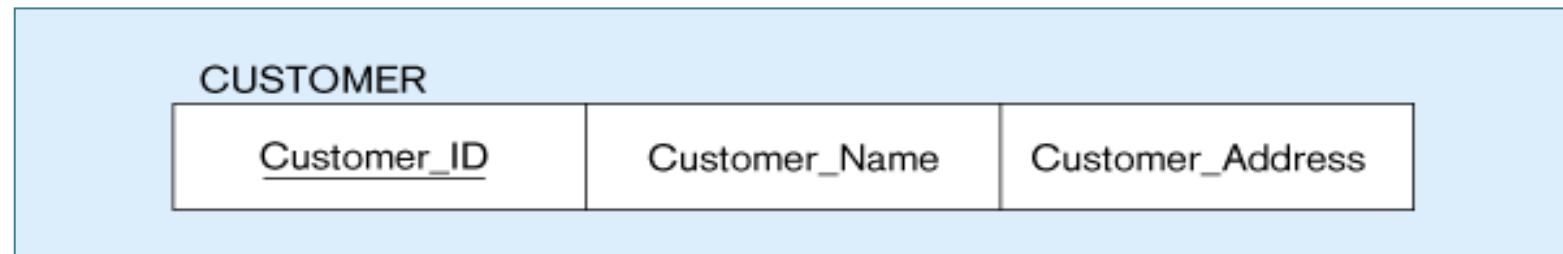
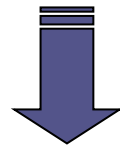
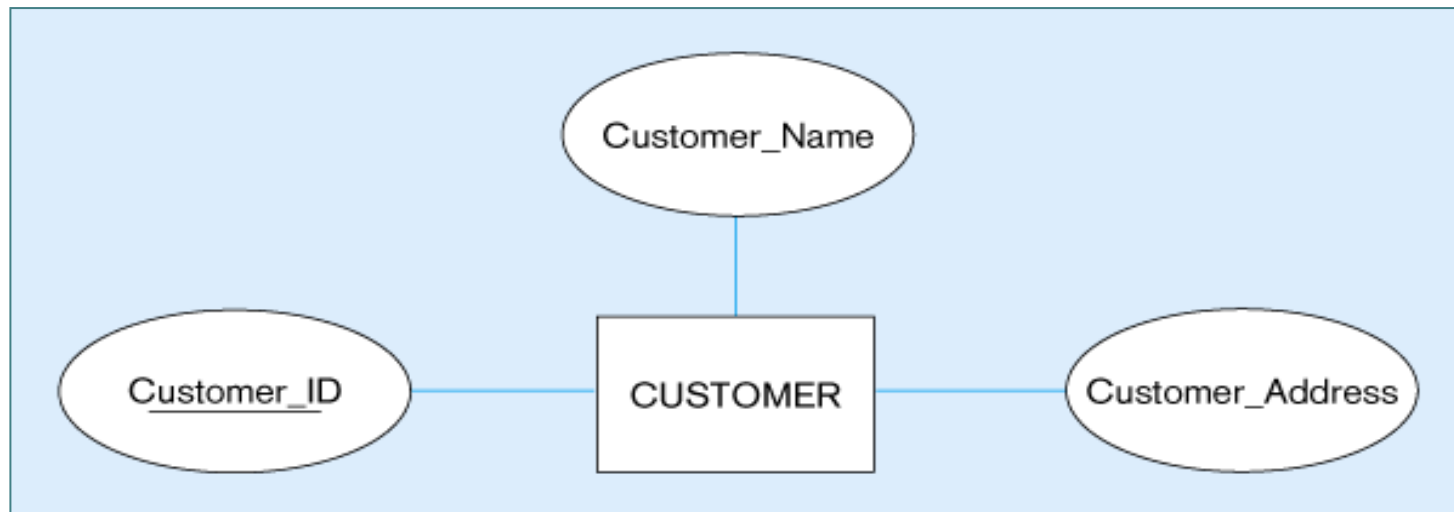
10

Mapping Regular Entities to Relations

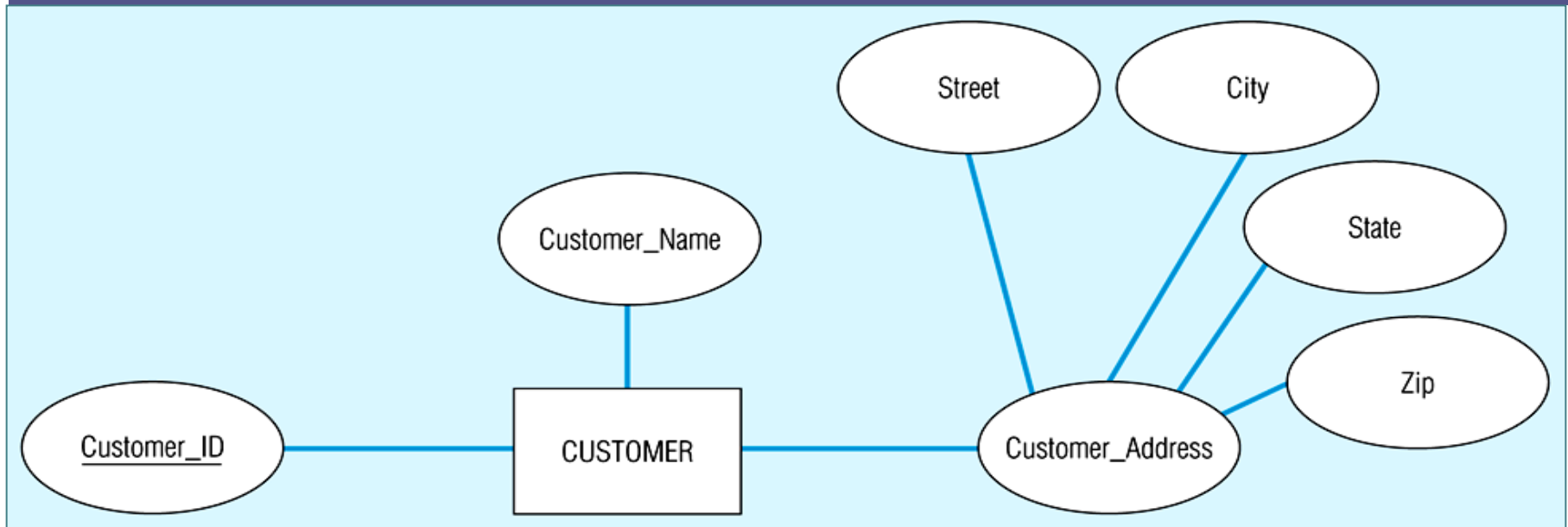
1. Simple attributes: E-R attributes map directly into the **relation**
2. Composite attributes: Use only their simple, component attributes
3. Multi-valued Attribute - Becomes a separate **relation** with a foreign key taken from the superior entity

Mapping a regular entity

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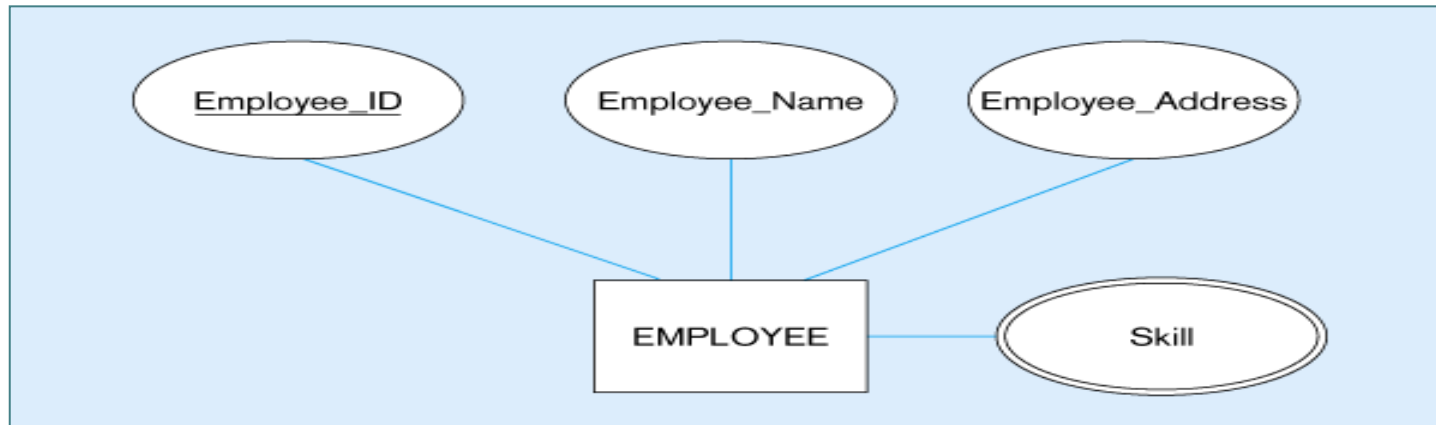
Mapping a composite attribute



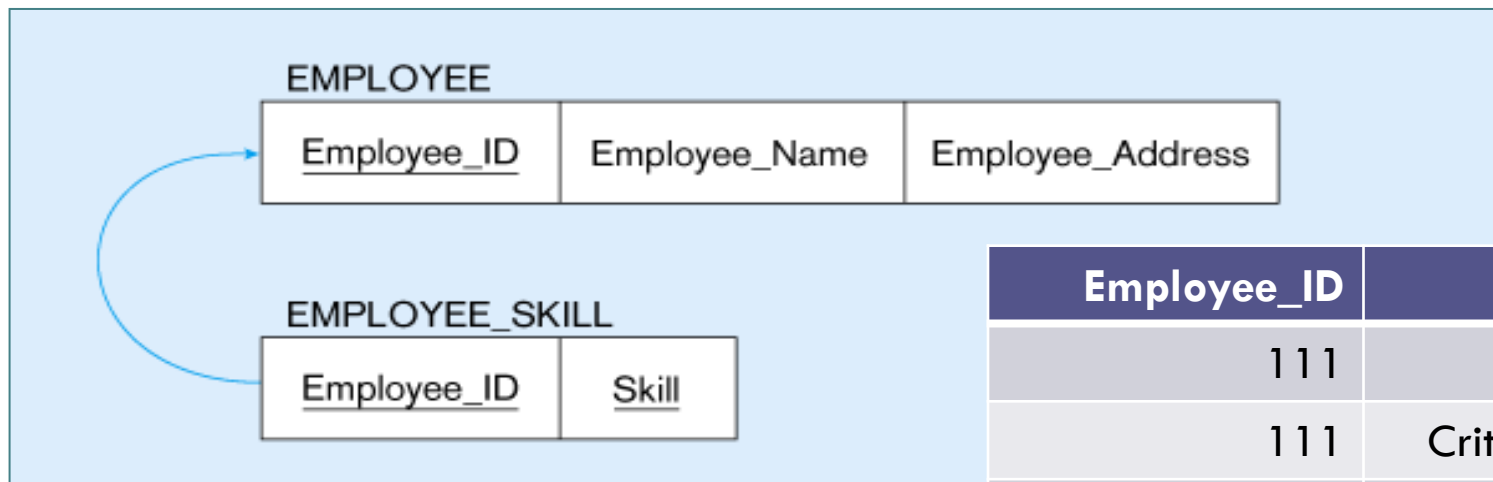
CUSTOMER					
<u>Customer_ID</u>	Customer_Name	Street	City	State	Zip

Mapping a Multivalued attribute

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Multivalued attribute becomes a separate relation with foreign key



Employee_ID	Skill
111	Leadership
111	Critical thinking
112	Problem solving

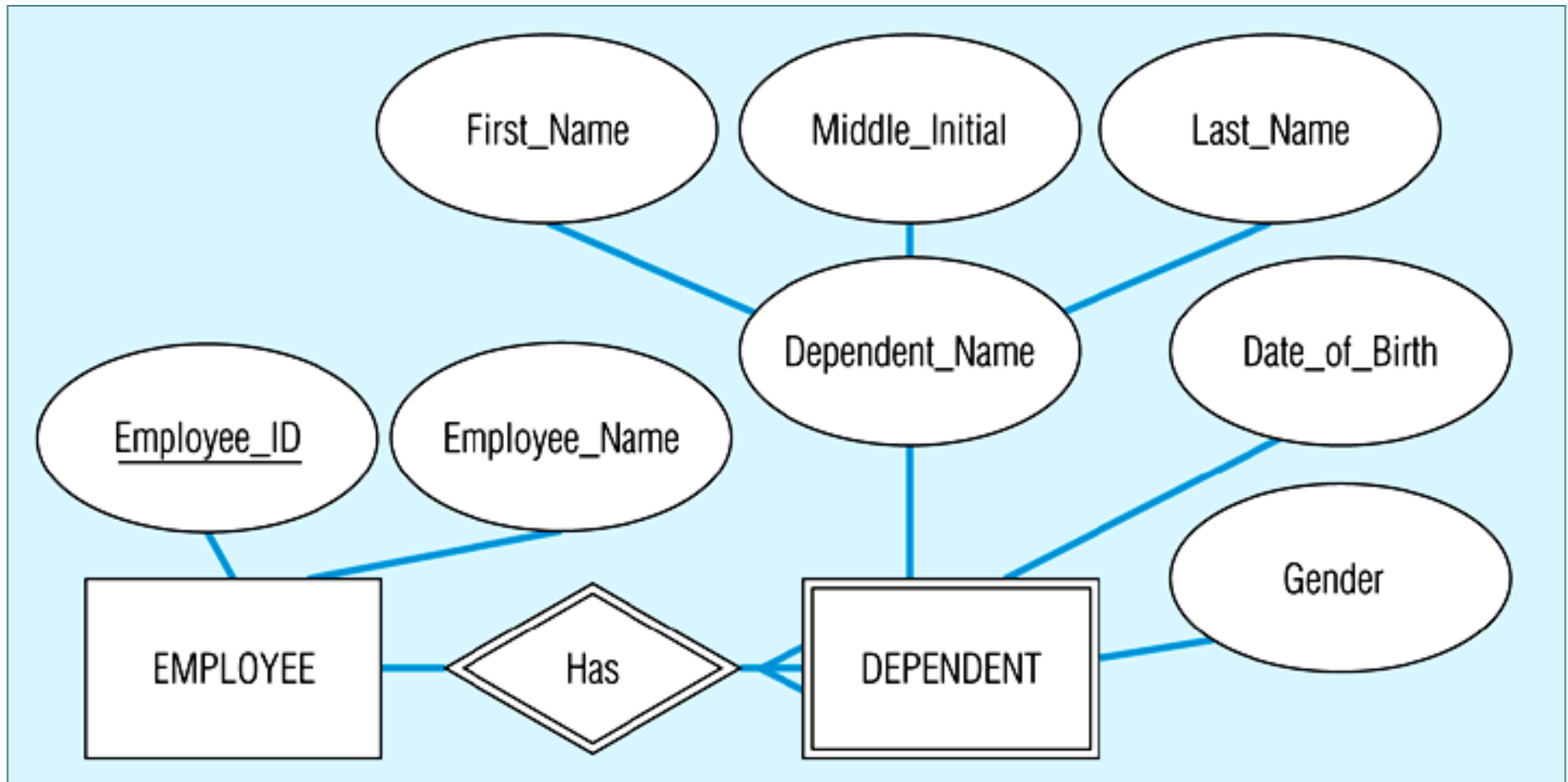
Mapping Weak Entities

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- ▣ Weak Entity becomes a separate relation with a foreign key taken from the superior entity
- ▣ Primary key composed of:
 - Partial identifier of weak entity
 - Primary key of identifying relation (strong entity)

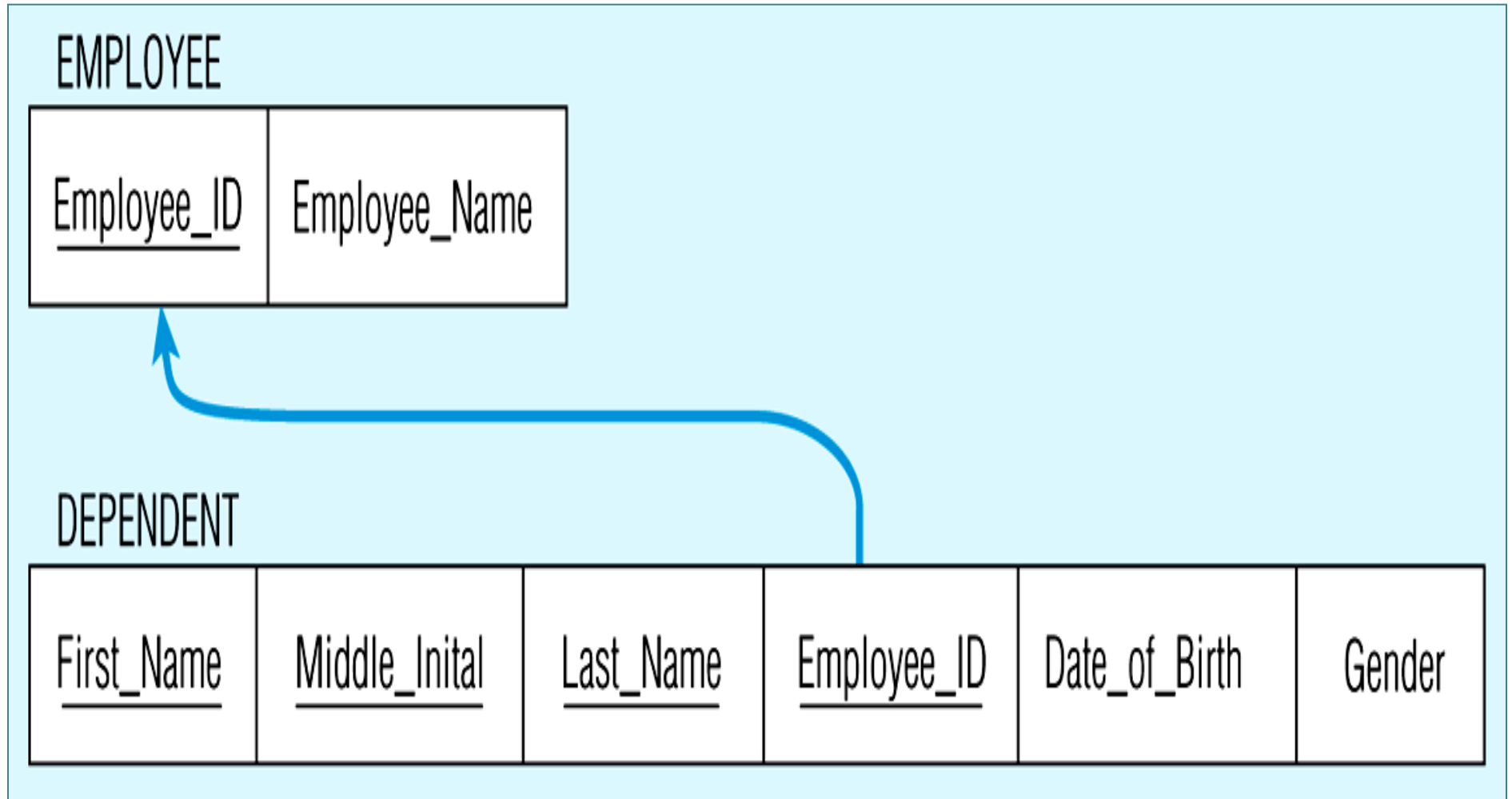
Mapping a weak entity

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Relations resulting from weak entity

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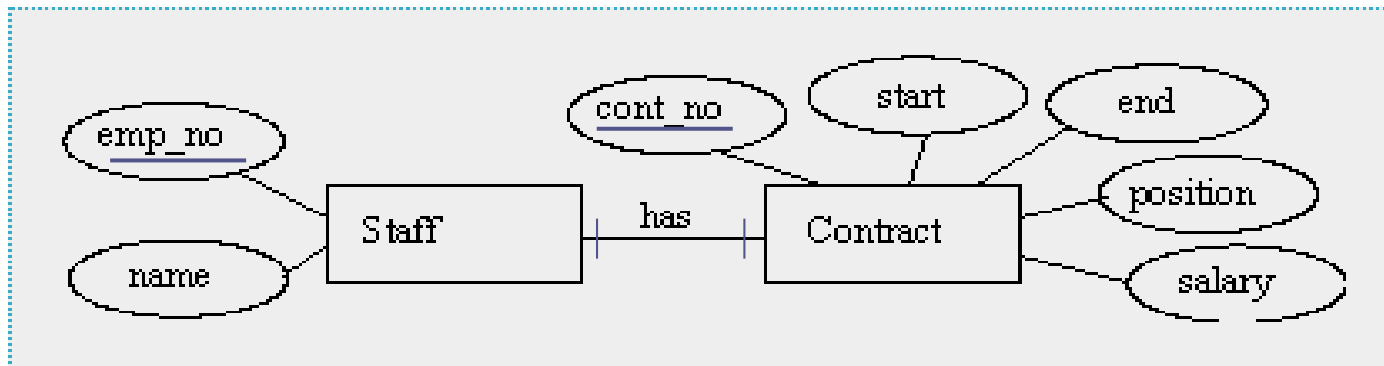
Mapping Relations

Mapping Binary Relationships

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□ One-to-One Relationship

- The primary key of one entity type comes the foreign key in the other.
- It does not matter which way around it is done but you should not have a foreign key in each entity.



Staff(emp_no, name, **contract_no)**

Contract(cont_no, start, end, position, salary)

or

Staff(emp_no, name)

Contract(cont_no, start, end, position, salary, **emp_no)**

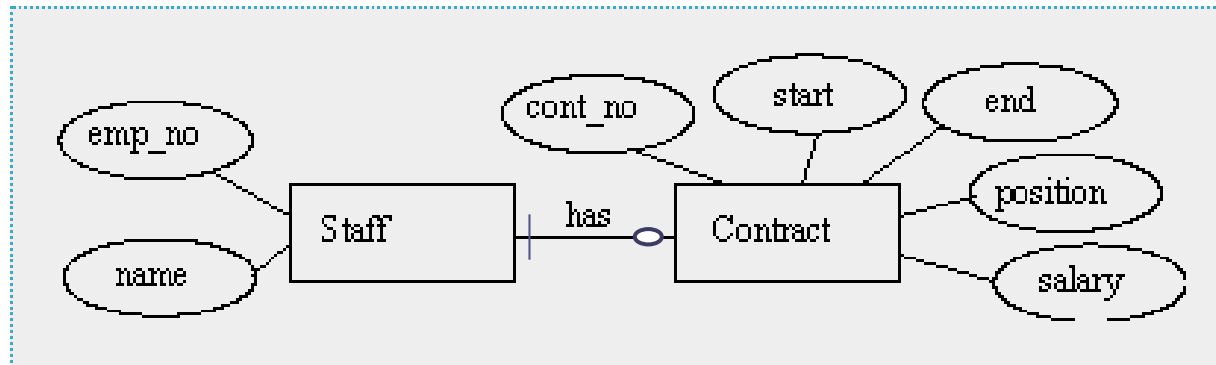
Mapping Binary Relationships

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□ One-to-One Relationship

▣ one side is **mandatory**

Primary key on the mandatory side becomes a foreign key on the optional side



Staff(emp_no, name)

Contract(cont_no, start, end, position, salary, *emp_no*)

We should put FK in optional side to avoid nulls

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Foreign key in Staff:

Contract Table:

Cont_no	Start	End	Position	Salary
11	1 st Jan 2001	10 th Jan 2001	Lecturer	£2.00

Staff Table:


Empno	Name	Contract No
10	Gordon	11
11	Andrew	NULL



However, Foreign key in Contract:

Contract Table:

Cont_no	Start	End	Position	Salary	Empno
11	1 st Jan 2001	10 th Jan 2001	Lecturer	£2.00	10

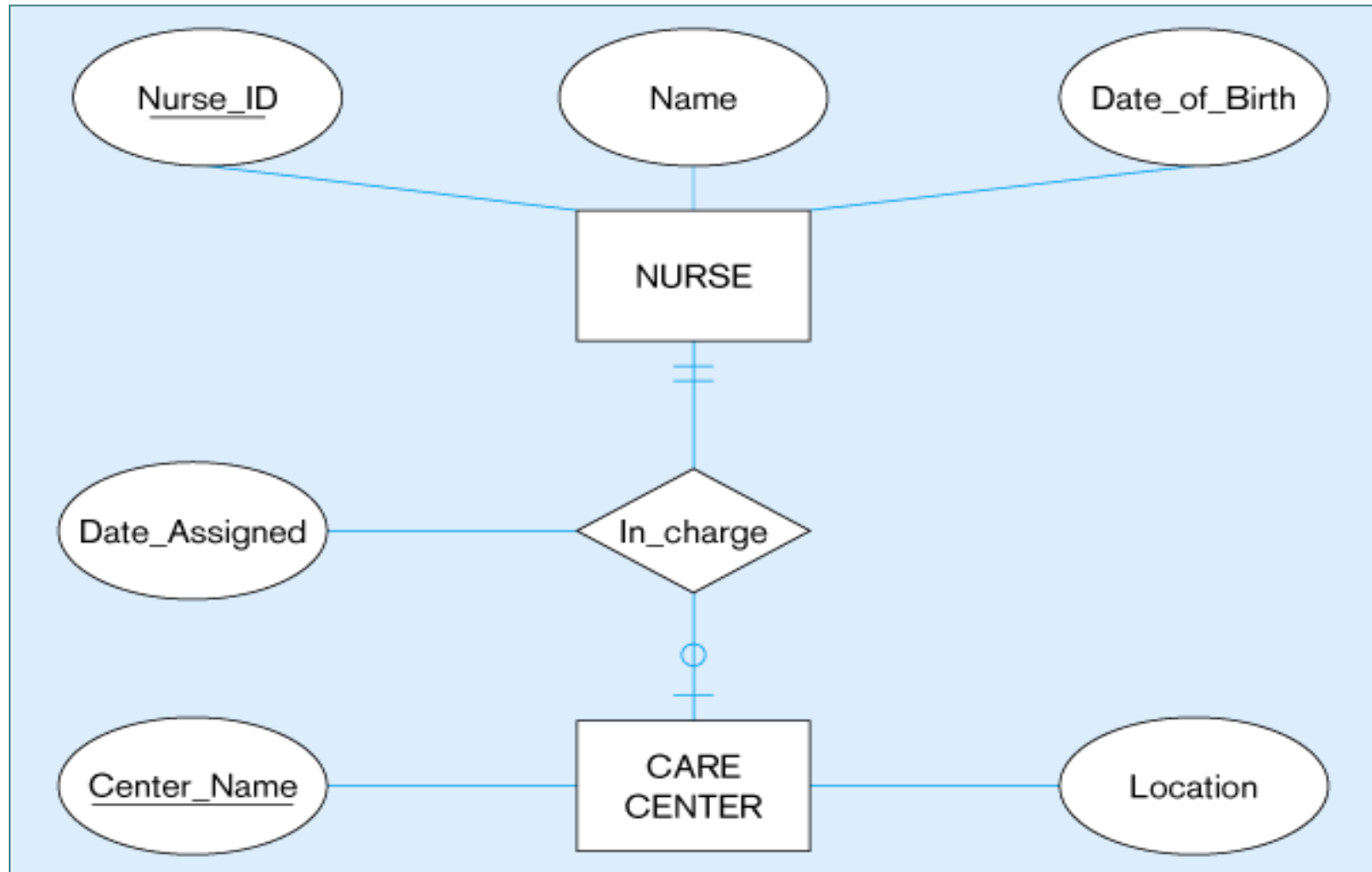


Staff Table:

Empno	Name
10	Gordon
11	Andrew

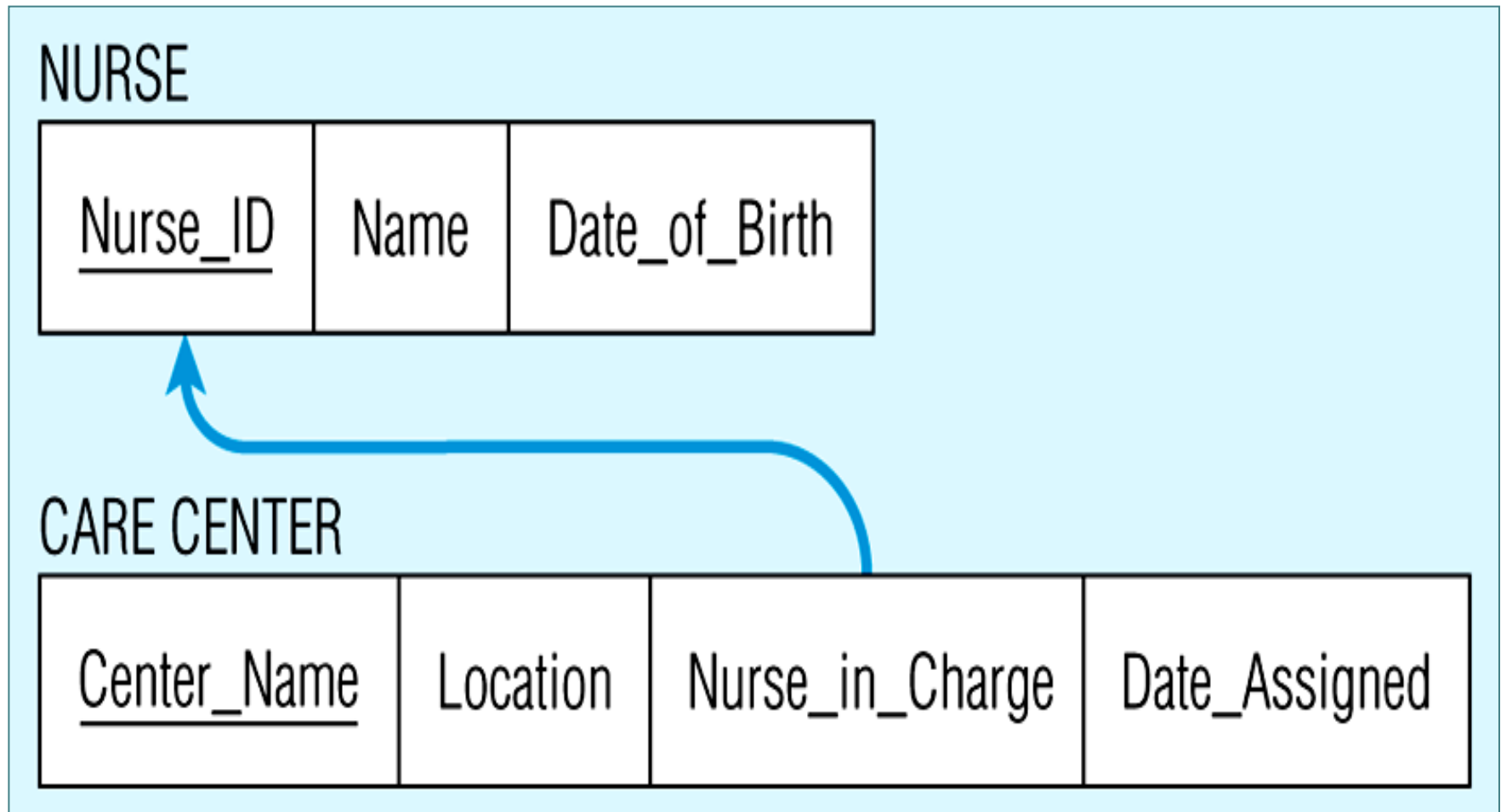
Mapping a binary 1:1 relationship

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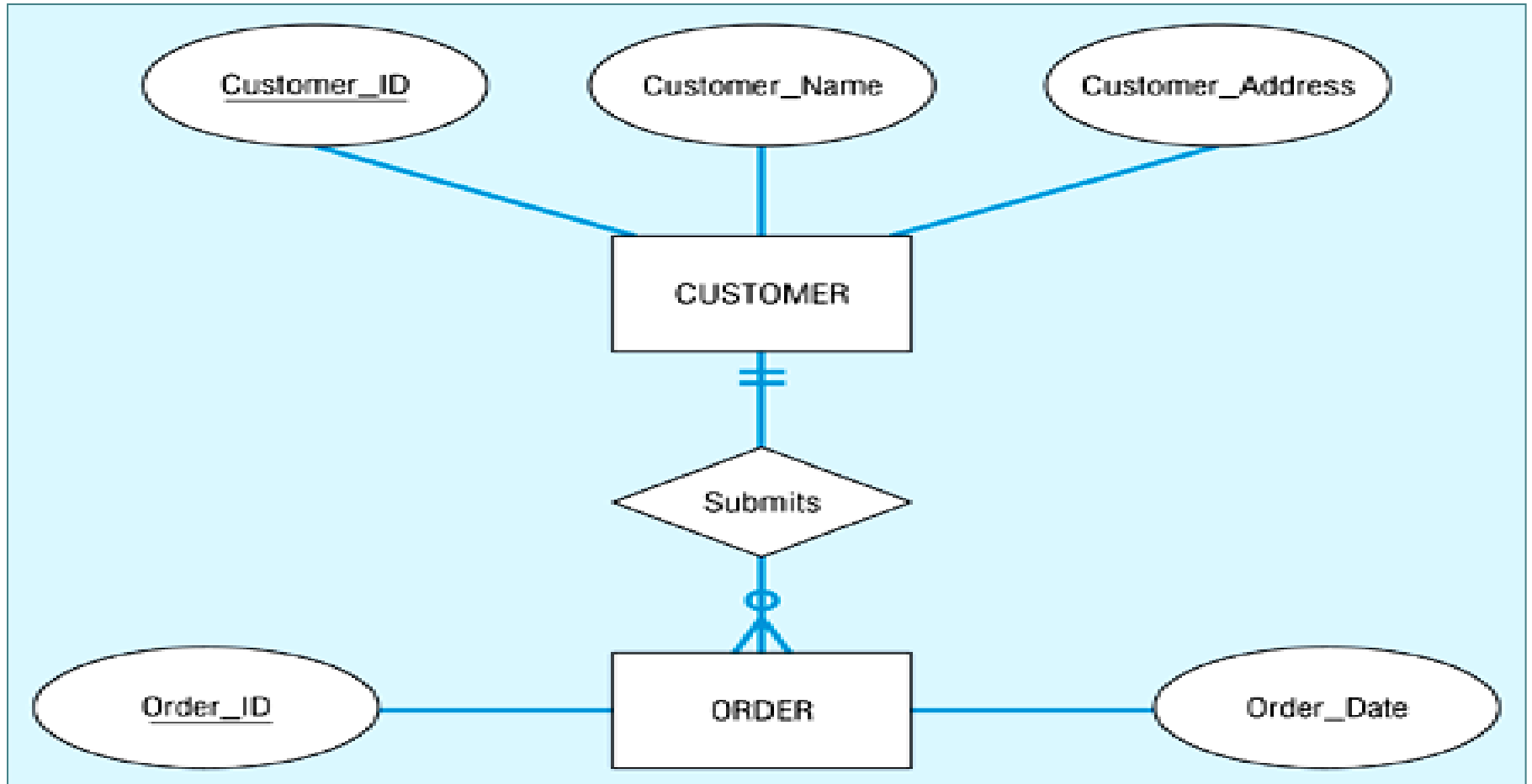
Mapping a binary 1:1 relationship

22



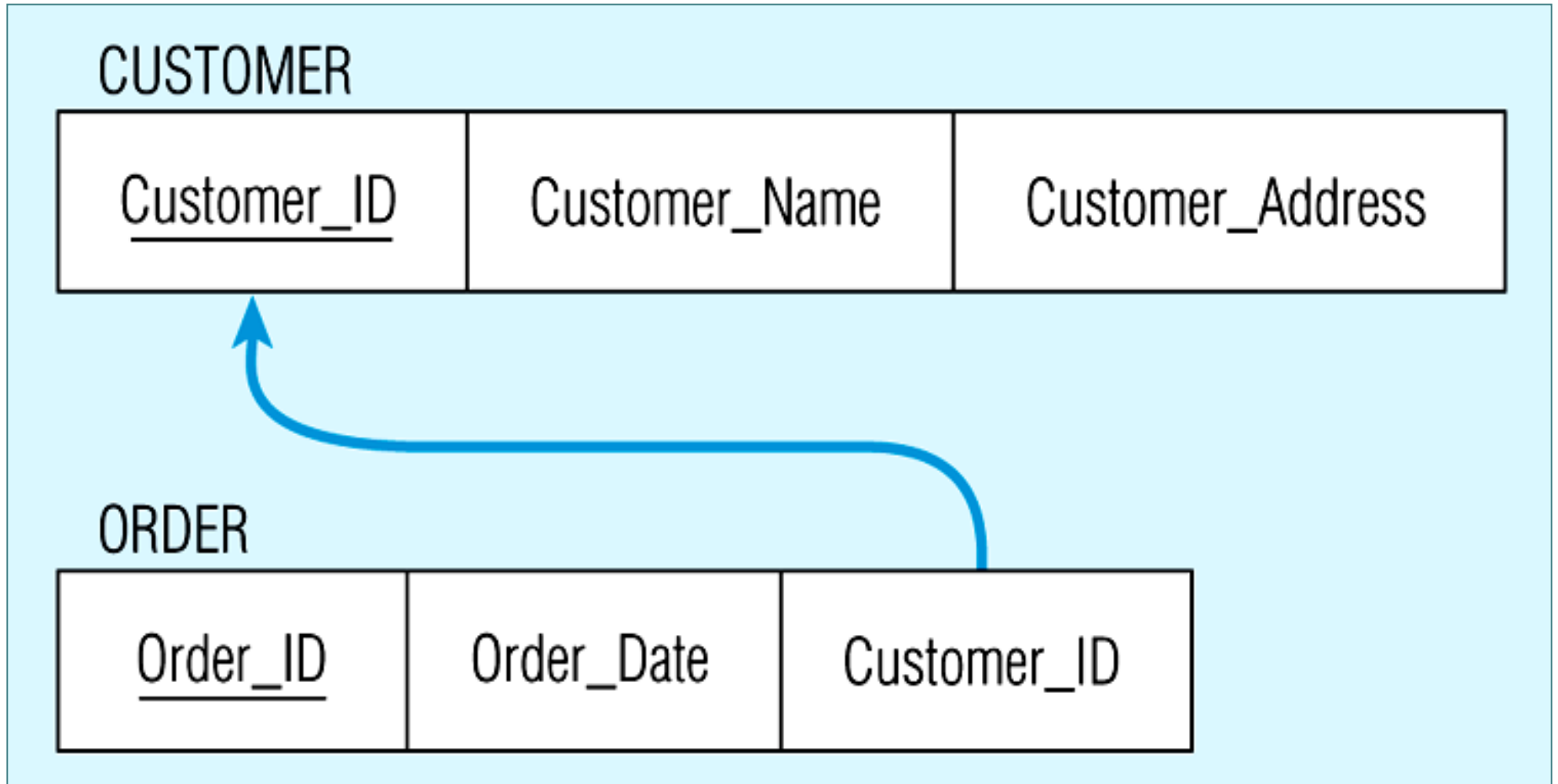
Mapping a 1:M relationship

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Mapping a 1:M relationship

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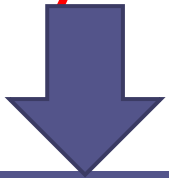


Mapping Binary Relationships

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□ One-to-Many Relationship

Primary key on the one side becomes a foreign key on the many side



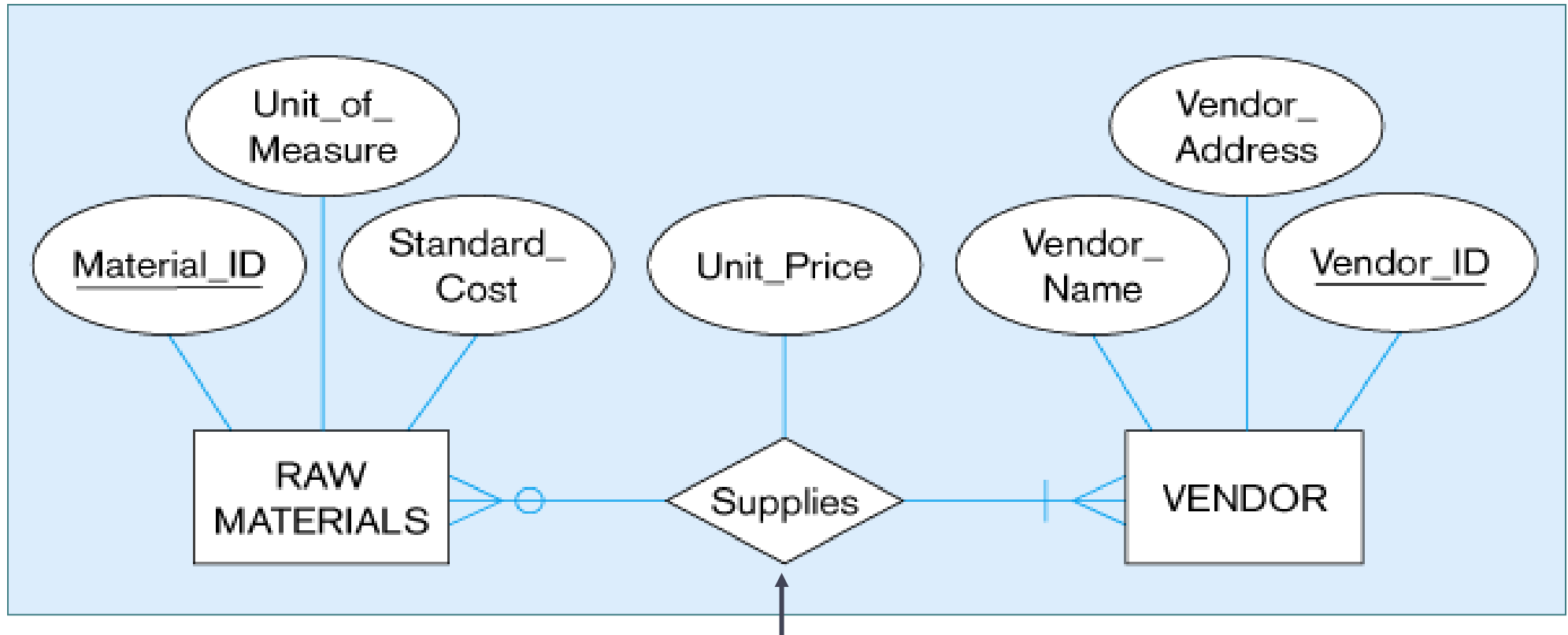
OrderID	orderdate
102	22/5/2020
100	22/2/2020
101	25/9/2020

<u>Cid</u>	name	address	order
111	Ahmed Ali	Giza	100
111	Ahmed Ali	Giza	101
111	Ahmed Ali	Giza	102

<u>Cid</u>	name	address
111	Ahmed Ali	Giza
128	Ali	Giza
189	Mahmoud	Giza

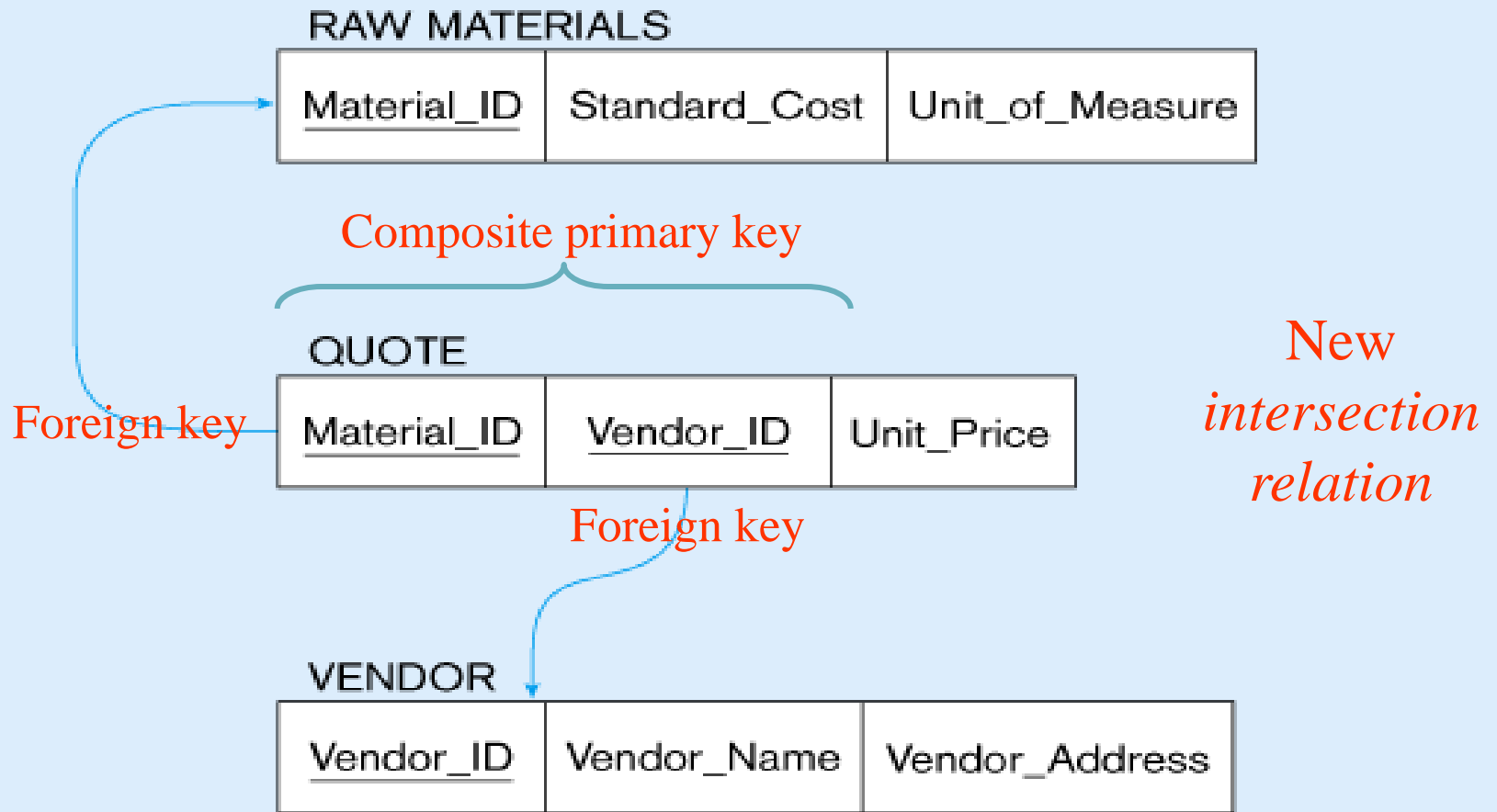
OrderID	orderdate	CID
100	22/2/2020	100
101	25/9/2020	100

Mapping an M:N relationship



The *Supplies* relationship will need to become a separate relation

Mapping an M:N relationship



Mapping Binary Relationships

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□ Many-to-Many Relationship

Create a ***new relation*** with the primary keys of the two entities as its primary key

Mapping Associative Entities

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Identifier Not Assigned

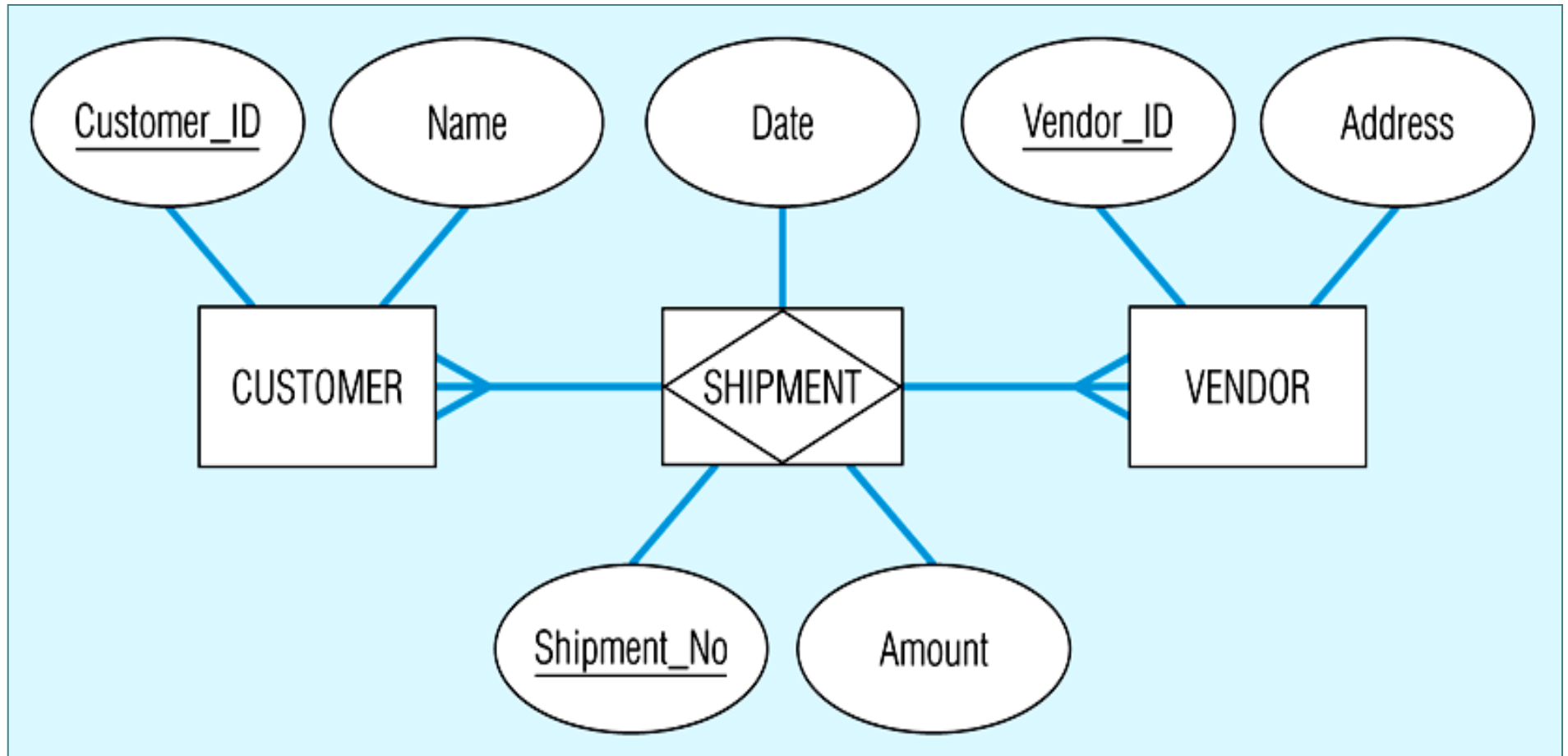
- Default primary key for the association relation is composed of the primary keys of the two entities (as in M:N relationship)

□ Identifier Assigned

- It is natural and familiar to end-users
- Default identifier may not be unique

Mapping an associative entity

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Mapping an associative entity

CUSTOMER

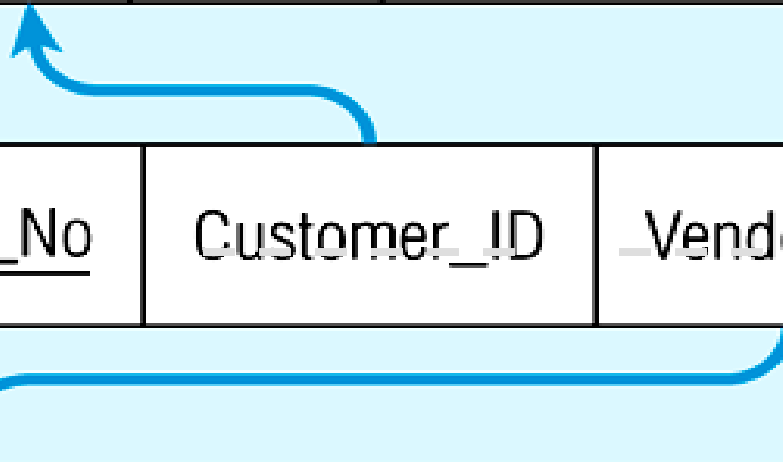
<u>Customer_ID</u>	Name	(Other Attributes)
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SHIPMENT

<u>Shipment_No</u>	Customer_ID	Vendor_ID	Date	Amount
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VENDOR

<u>Vendor_ID</u>	Address	(Other Attributes)
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Mapping Unary Relationships

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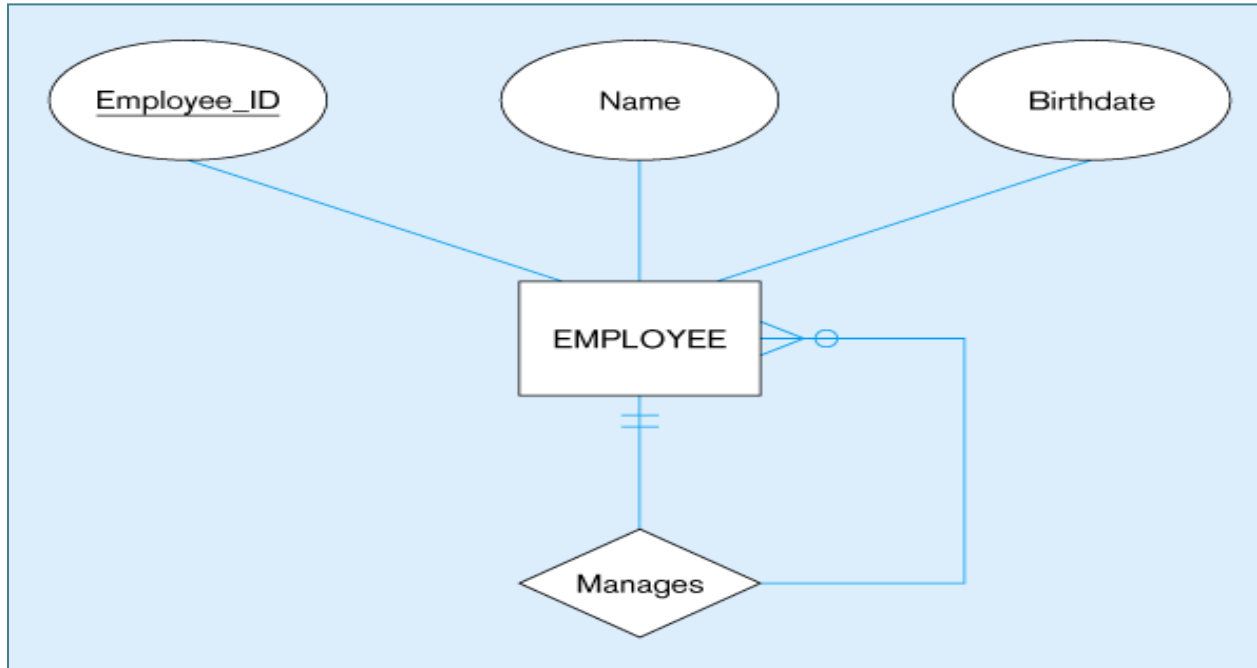
One-to-Many - Recursive foreign key in the same relation

- ▣ Many-to-Many - Two relations:

- One for the entity type

- One for an associative relation in which the primary key has two attributes, both taken from the primary key of the entity

Mapping a unary 1:N relationship

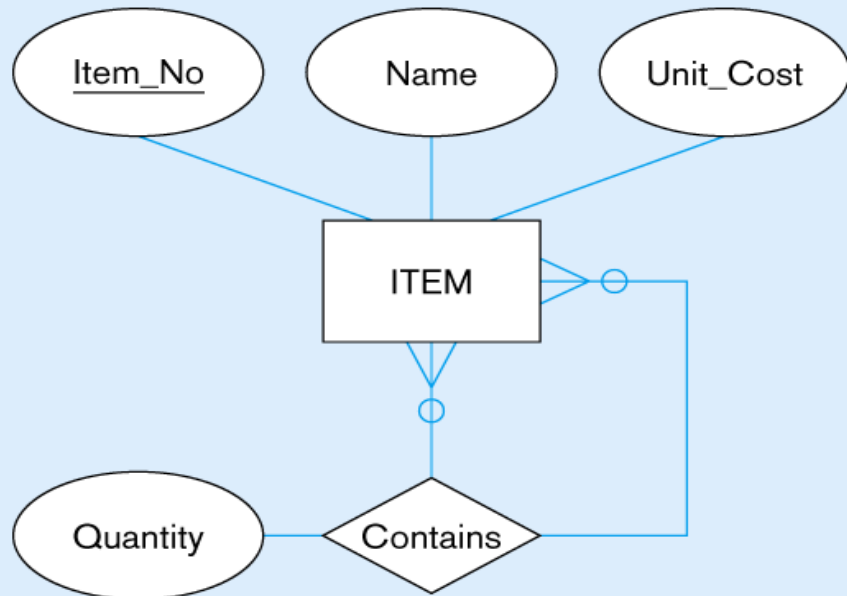


EMPLOYEE

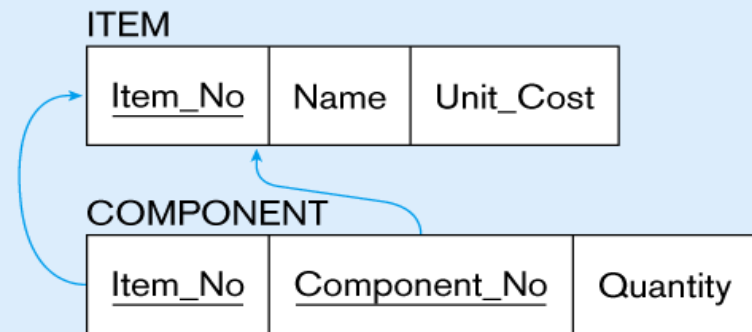
<u>Employee_ID</u>	Name	Birthdate	<u>Manager_ID</u>
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Mapping a unary M:N relationship

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Bill-of-materials
relationships (M:N)

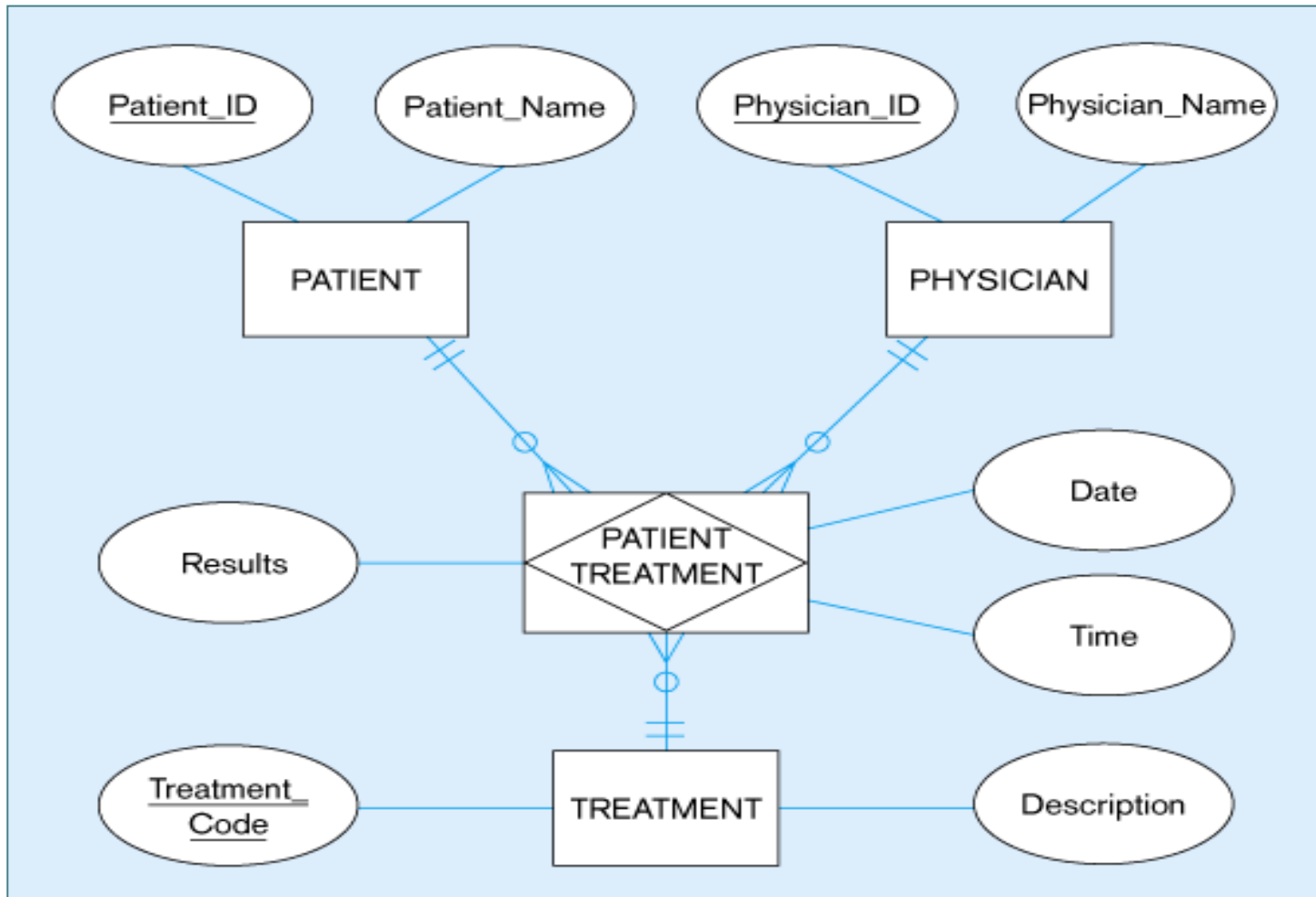


Mapping n-ary Relationships

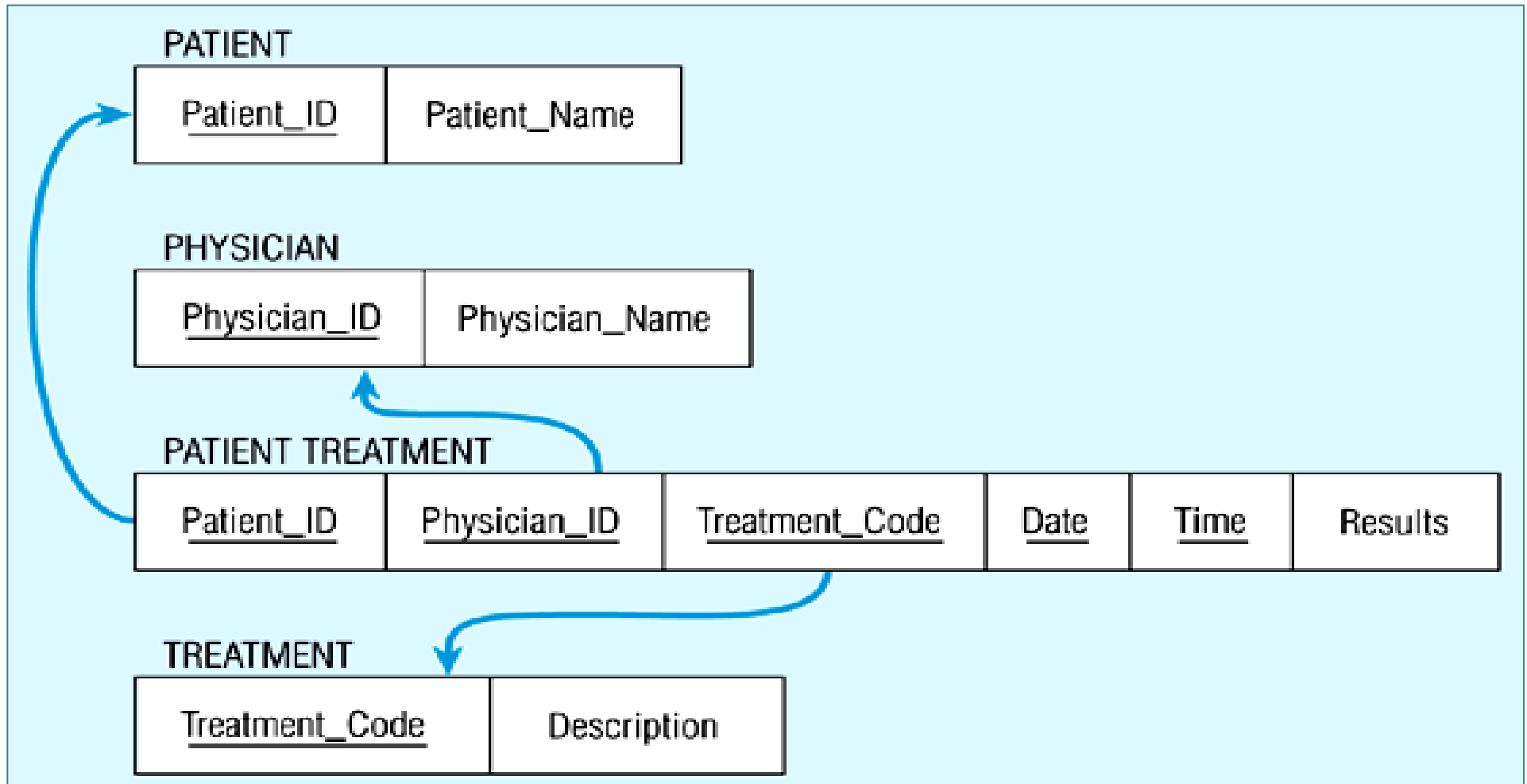
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- ▣ One relation for each entity and one for the associative entity
- ▣ Associative entity has foreign keys to each entity in the relationship

Mapping a ternary relationship



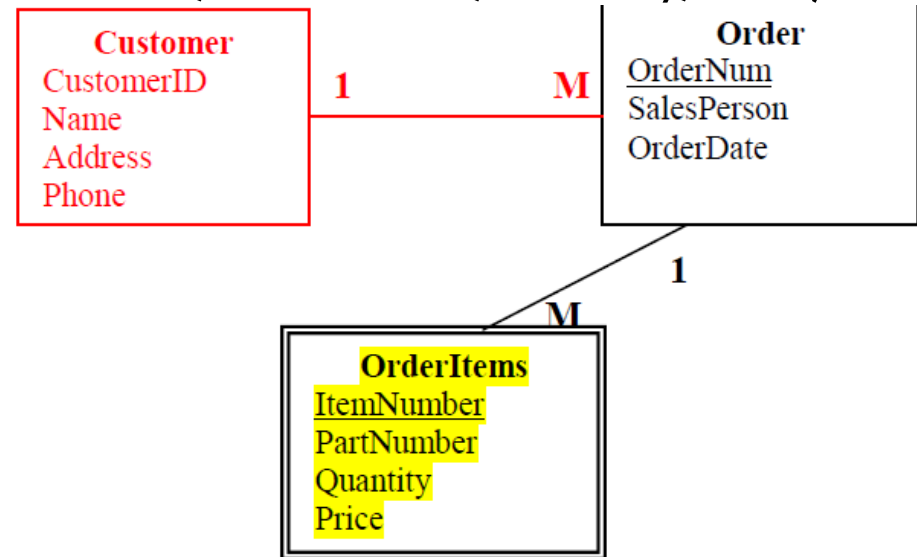
Mapping a ternary relationship



Lecture Exercise

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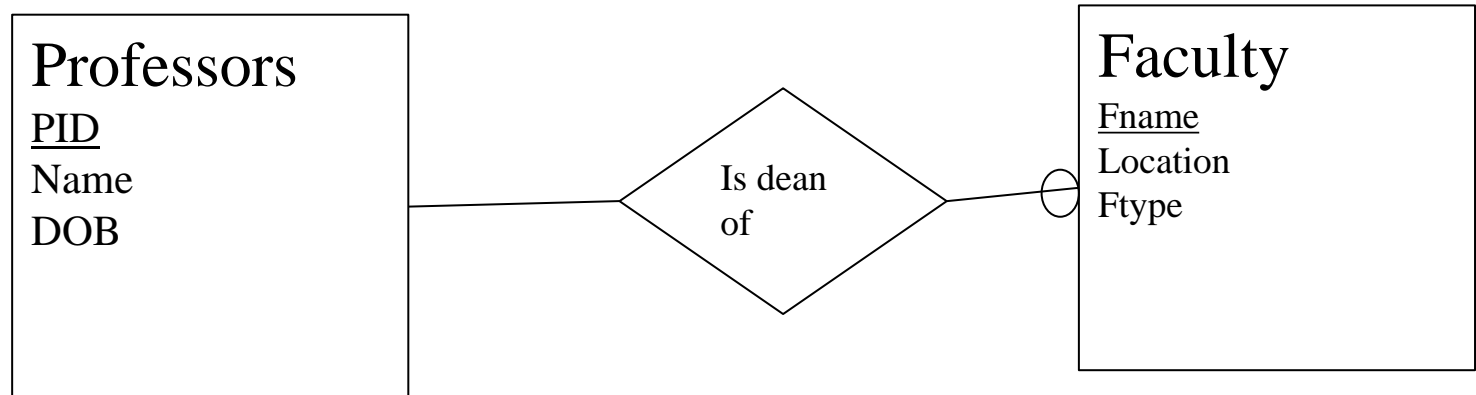
- Write the relational schema for this ER diagram
- Customer(CustomerID , Name, Address , Phone).
- Order (OrderNum ,OrderDate , SalesPerson, CustomerID(fk)).
- ORDERITEMS (OrderNumber(fk), ItemNumber, PartNumber, Quantity, Price).



Exercise

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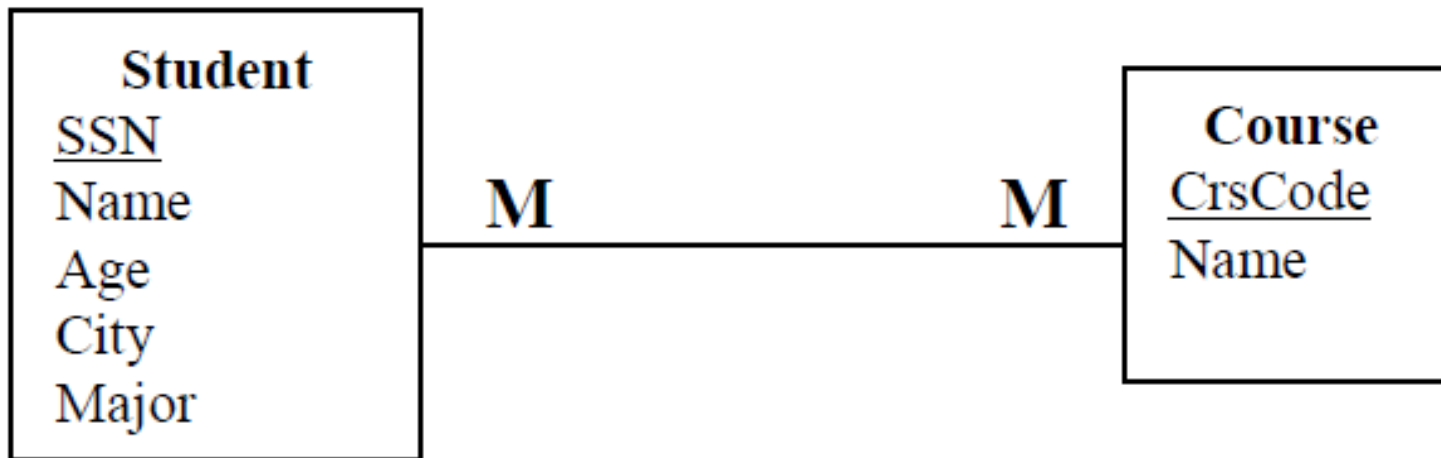
- Primary key on the mandatory side becomes a foreign key on the optional side
- Professor(PID,Name,DOB)
- Faculty(Fname,Location,Ftype,DID(fk))



Exercise

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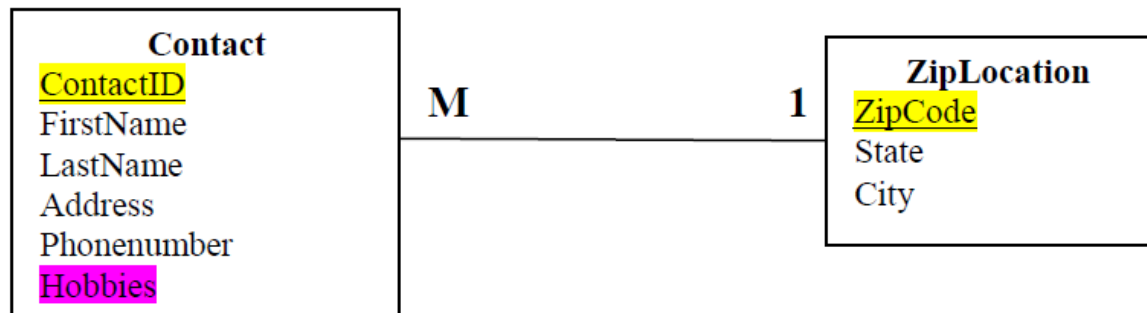
- Student(SSN,Name,Age,City,Major)
- Course(CrsCode,Name)
- Course_Student(SSN (fk), CrsCode(fk))



Exercise

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- Hobbies is a multivalued attributes
- Contact(ContactID,FirstName,LastName,Address,Phonenumber,ZipCode(fk))
- ZipLocation(ZipCode,State,City)
- Hobbies(ContactID(fk),Hobby)



Write the relational schema

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- Part(Number,Name,Description).
- Project(ProjectNumber,Name,Budget)
- Supplier(SupplierID,Name,Address)
- Provide(ProjectNumber,Number,SupplierID,Quantity,Price)

