# Chapter 2
# Data Modeling

*Fundamentals of Database Management Systems,*
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# Chapter Objectives

- Explain the concept and practical use of data modeling.

- Recognize which relationships in the business environment are unary, binary, and ternary relationships.

- Describe one-to-one, one-to-many, and many-to-many unary, binary, and ternary relationships.

- Recognize and describe intersection data.

- Model data in business environments by drawing entity-relationship diagrams that involve unary, binary, and ternary relationships.
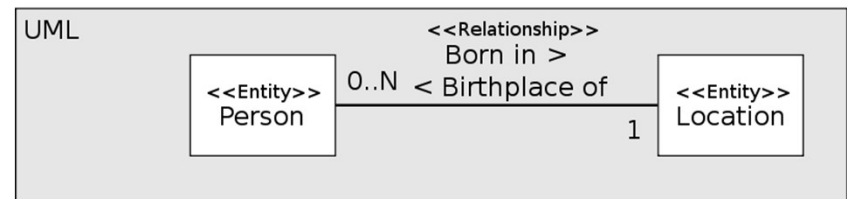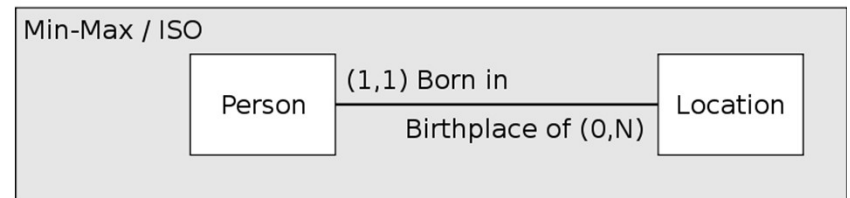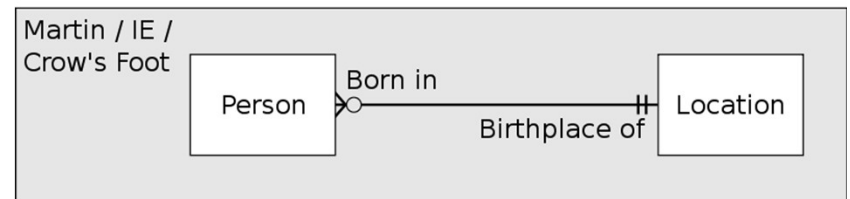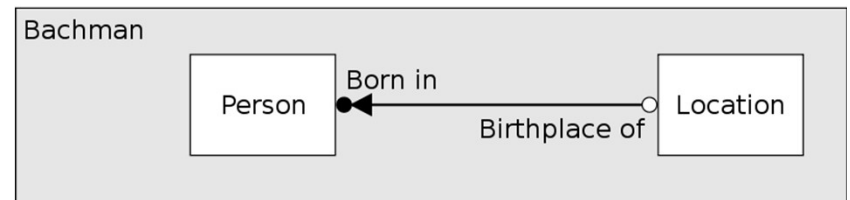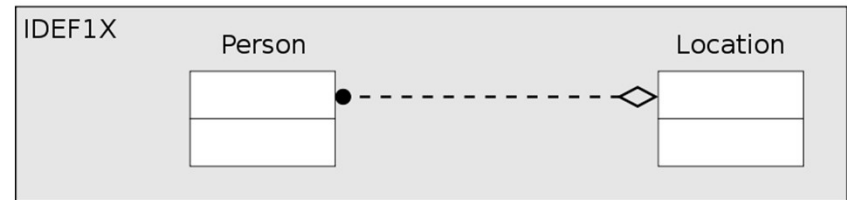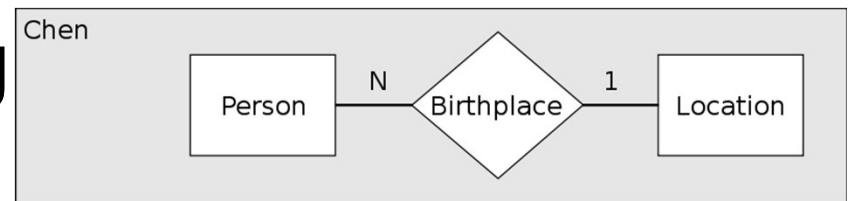
# Essence of Data Modeling

- Data modeling is the process of creating a visual representation of a system to illustrate the types of data used and stored within the system, the relationships among these data types, the ways the data can be grouped and organized and its formats and attributes.

- Exploring the different ways that entities can relate to each other as they always do in the real world.

- Devising a way of recording, of diagramming, the entities and the ways in which they interrelate in the business environment.

- It is a diagramming technique. Diagrams Entities with Attributes and the Relationship between the entities.

# Essence of Data Modeling

♦ There are many variations of E-R diagrams in use.

♦ We will use the E-R diagramming technique provided by Microsoft Visio with the "crow's foot" variation.

**OTHER RELATIONSHIP CARDINALITY NOTATION**

| Notation | Zero or One Relation-ship | One and Only One | Zero or Many Relation-ship | One or Many Relation-ship |
|---|---|---|---|---|
| Crow's Foot Notation | | | | |
| Arrow Notation | | | | |
| Bachman Notation | | | | |
| ADW | | | | |
| Oracle | | | | |

**Chen**

Person —N— Birthplace —1— Location

**IDEF1X**

Person ●- - - - - -◇ Location

**Bachman**

Person ●◄— Born in / Birthplace of —○ Location

**Martin / IE / Crow's Foot**

Person ○<— Born in / Birthplace of —H Location

**Min-Max / ISO**

Person —(1,1) Born in / Birthplace of (0,N)— Location

**UML**

<<Relationship>>
Born in >
<<Entity>> Person —0..N < Birthplace of / 1— <<Entity>> Location

# E-R Model Entity (and its attributes)



One Salesperson

| SALESPERSON | |
|---|---|
| **PK** | **Salesperson Number** |
| | Salesperson Name Commission Percentage Year of Hire |

- Rectangular shape
- Salesperson = a type of entity
- Entity Class Vs Entity Instance

- Name of entity is in caps above the separator line.
- Entity type's attributes are shown below the separator line.

- Attributes:
  - Key attributes
    - Uniqueness (Emirates ID)
    - Composite key (Flight Number +Flight Date)
  - Non-Key attributes
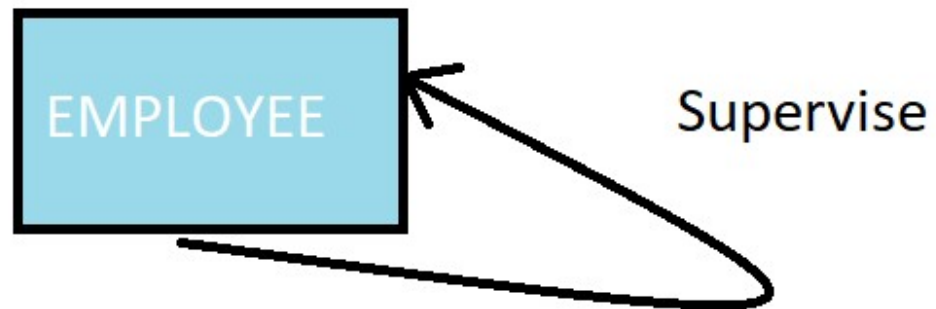- PK and boldface denote the attribute(s) that constitute the entity type's **unique identifier**.

# Relationships

- Relationships are Associations between entities
- The degree of a relationship is the number of entity types that participate in a relationship.
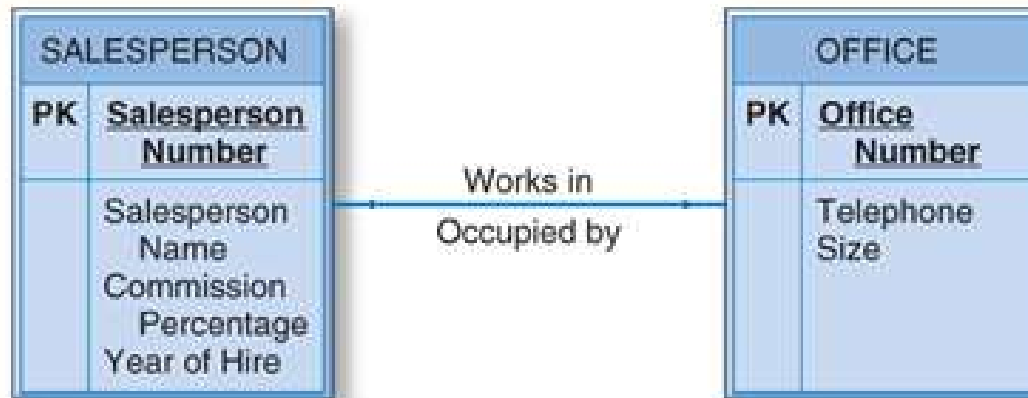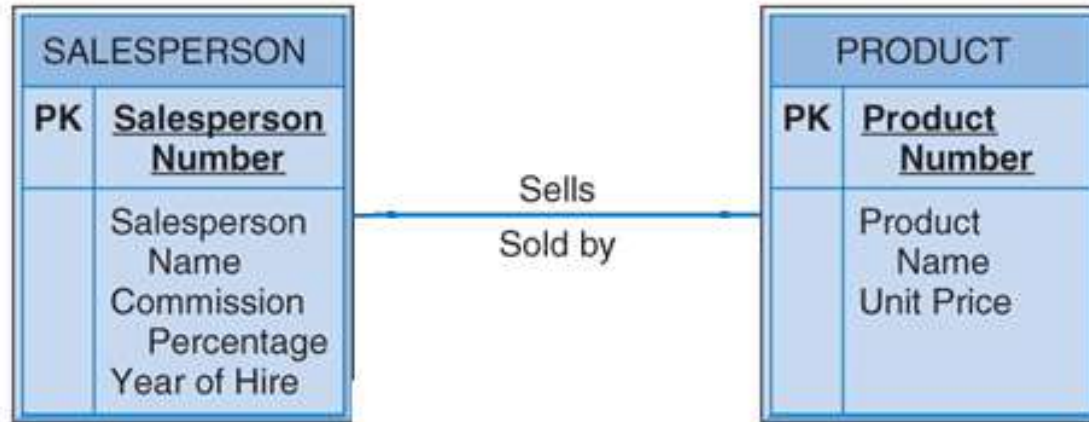- Different kinds: The three most common degree relationships in ER models are
  - Binary relationships
  - Unary relationships
  - Ternary relationships
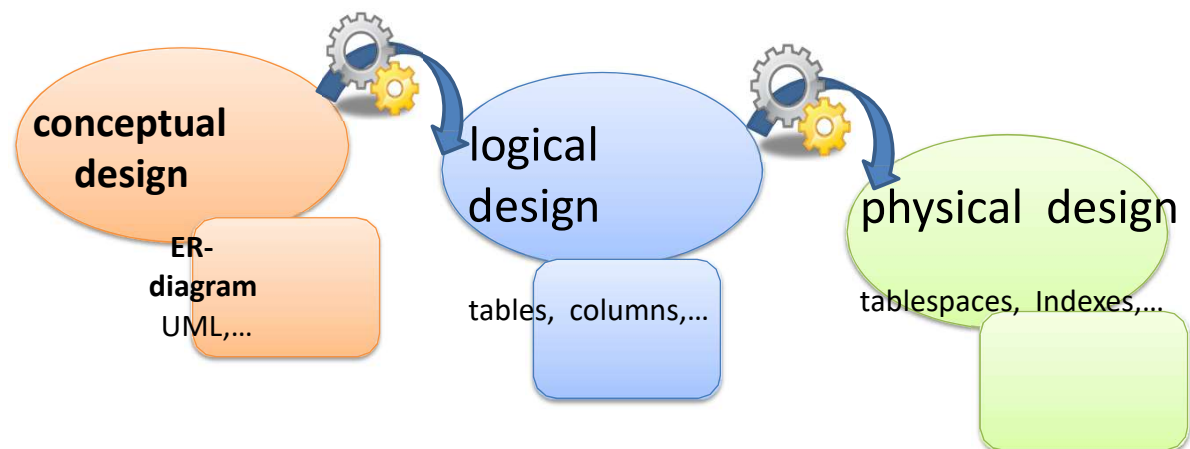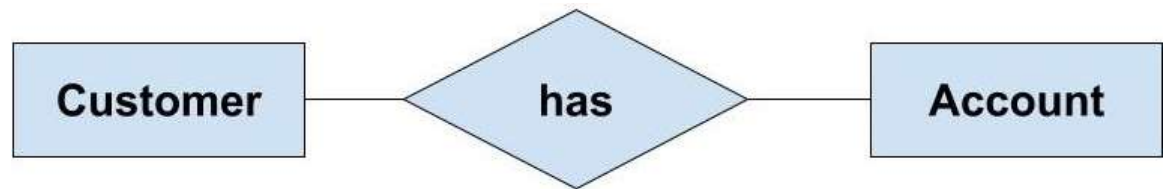
| Customer | has | Account |

conceptual design

ER-diagram
UML,...

logical design

tables, columns,...
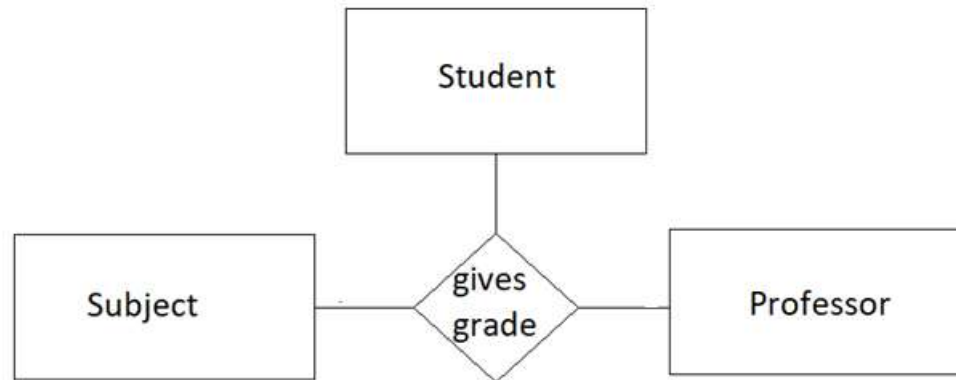
physical design

tablespaces, Indexes,...

# Unary Relationship

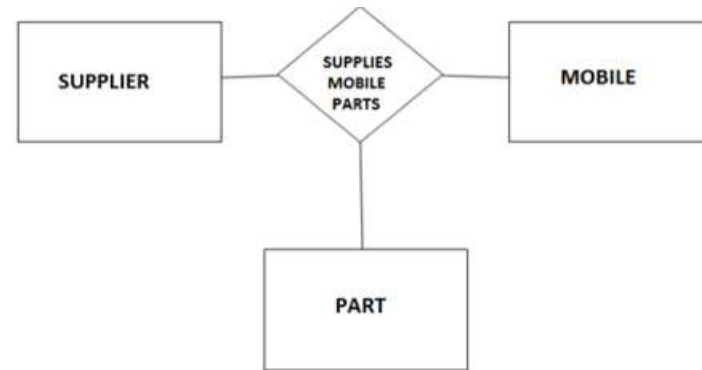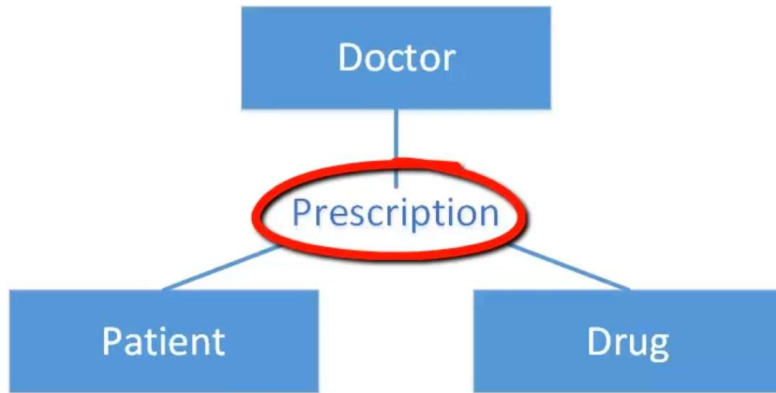# Binary Relationship

# Ternary Relationship
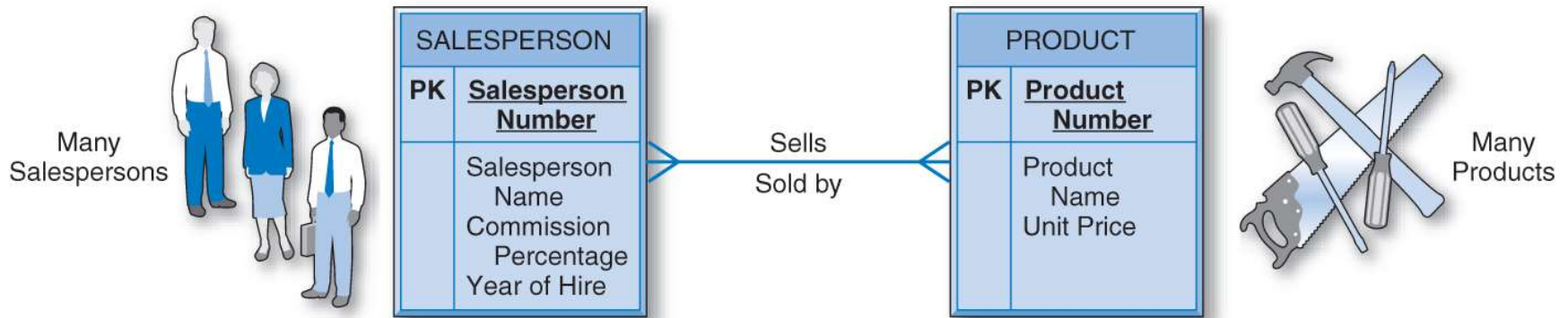
# Binary Relationships



- Simplest kind of relationship
- Relationship between two entity types
- A salesperson "sells" products or products are "sold" by salespersons

# Cardinality

- Represents the maximum number of entities that can be involved in a particular relationship.
  - One-to-One Binary Relationship
  - One-to-Many Binary Relationship
  - Many-to-Many Binary Relationship

# One-to-One Binary Relationship

- 1-1

- A single occurrence of one entity type can be associated with a single occurrence of the other entity type and vice versa.
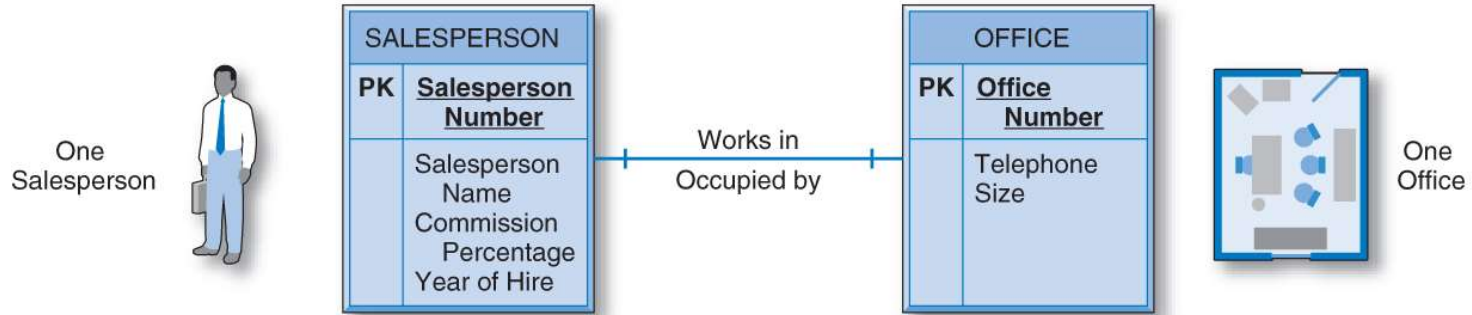
# One-to-Many Binary Relationship

- 1-M

- Use "crow's foot" to represent the multiple association.

- "many" = the maximum number of occurrences that can be involved, means a number that can be 1, 2, 3, ... n.
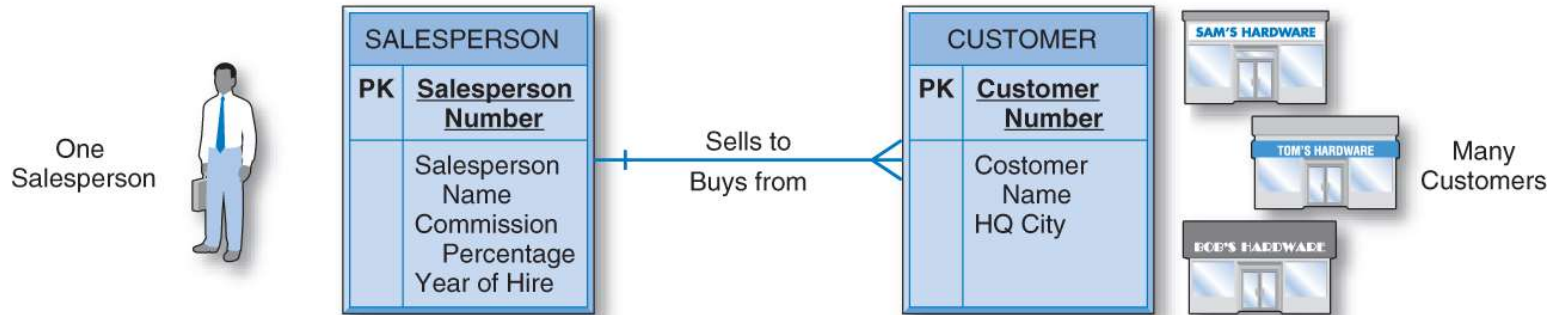
# Many-to-Many Binary Relationship

- M-M

- "many" can be either an exact number or have a known maximum.

# Cardinality



(a.) One-to-one (1–1) binary relationship



(b.) One-to-many (1–M) binary relationship



(c.) Many-to-many (M–M) binary relationship

# Modality

- The minimum number of entity occurrences that can be involved in a relationship.
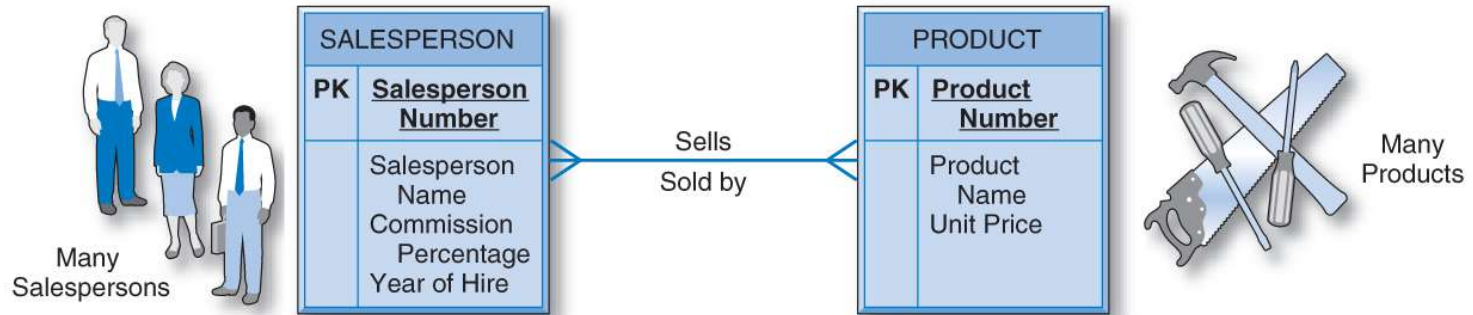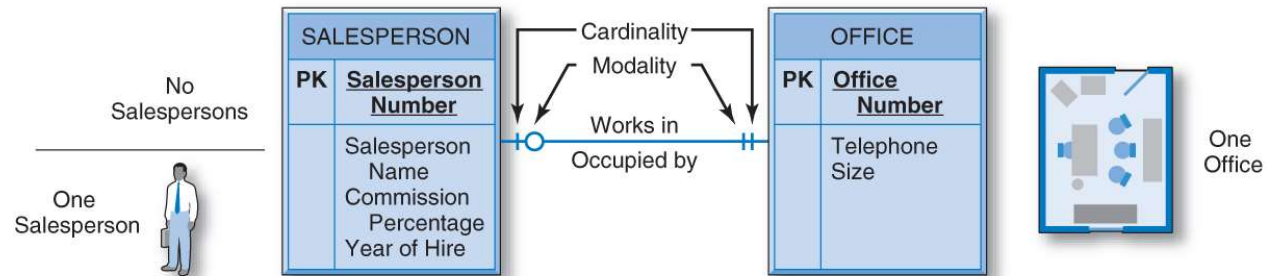- "inner" symbol on E-R diagram ("outer" symbol is cardinality)



(a.) One-to-one (1–1) binary relationship
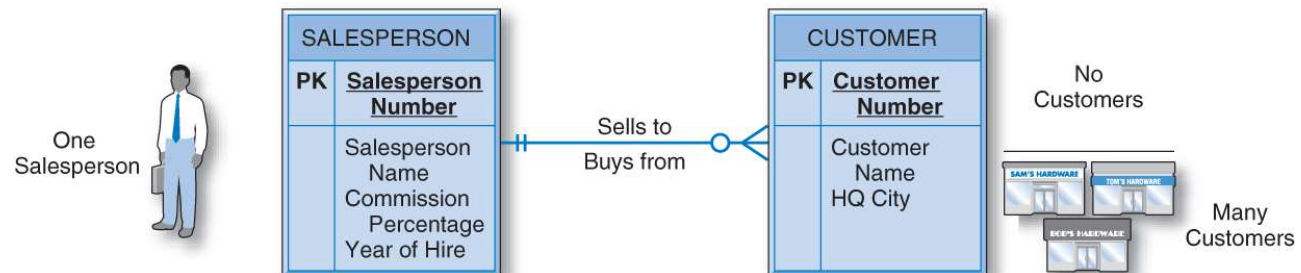
(b.) One-to-many (1–M) binary relationship
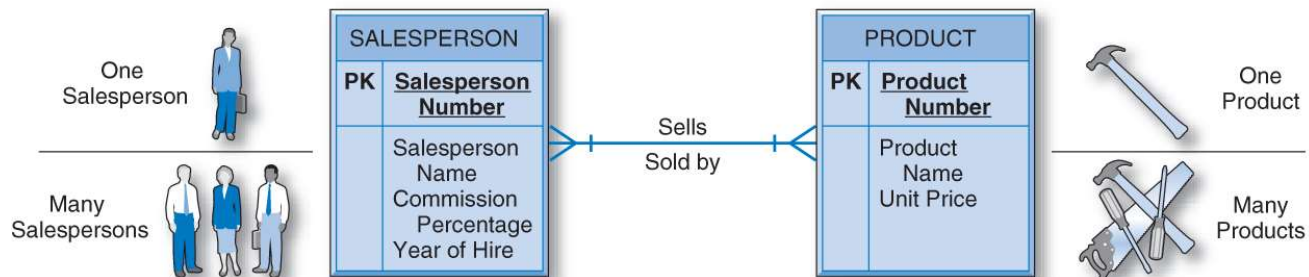
(c.) Many-to-many (M–M) binary relationship

# Intersection Data

- Describes the relationship between two entities.
- Used with many-to-many relationships.
- Represented on E-R diagram as an "associative entity"

**Many-to-Many Binary Relationship with Intersection Data**
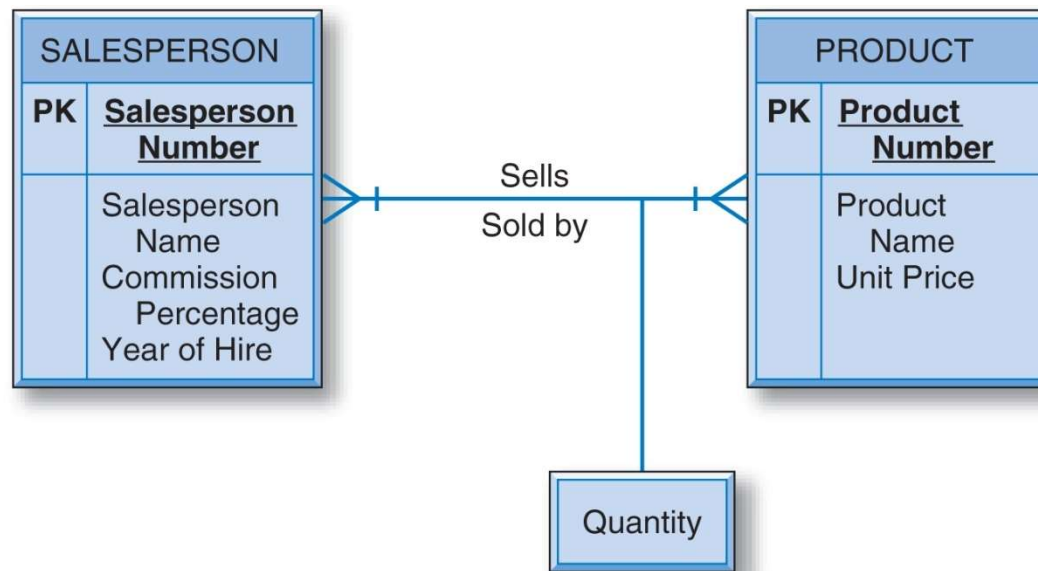


- For example, we know not only that salesperson 137 sold some of product 24013 but also how many units of that product that salesperson sold.

# Associative Entity

♦ Entities can have attributes; many-to-many relationships can have attributes.

♦ Many-to-many relationship may be treated similarly to Entities in an E-R-D.

♦ The unique identifier of the associative entity is usually the combination of the unique identifiers of the two entities in the many-to-many relationship.
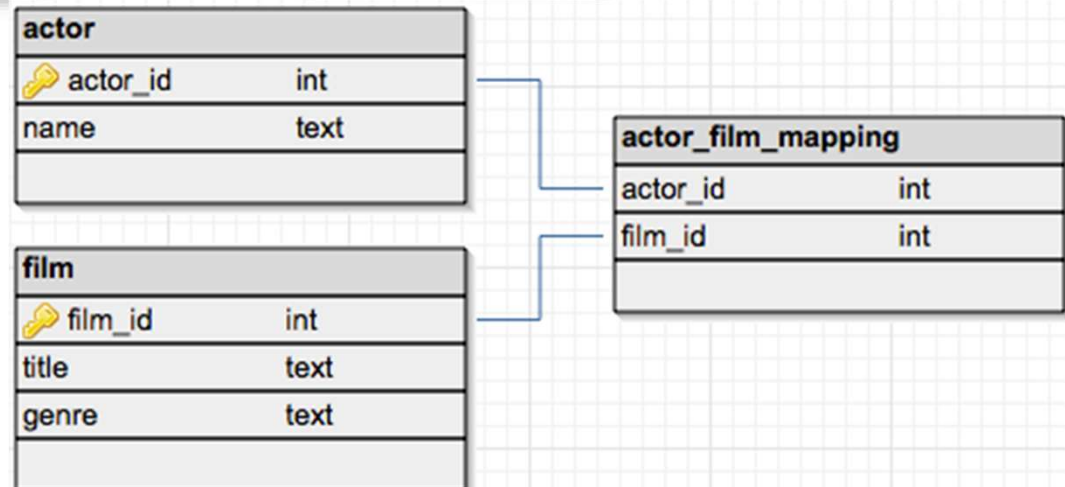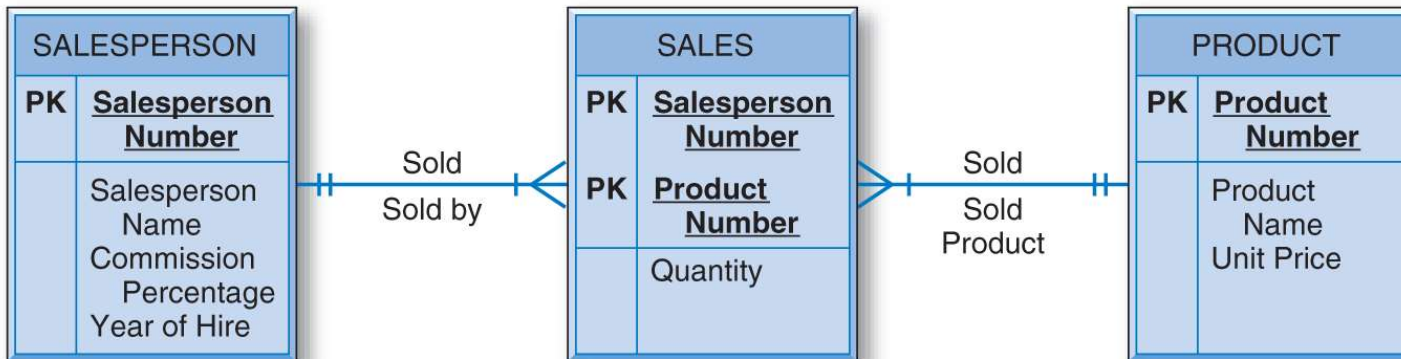
# Unary Relationships With Cardinality

♦ Associate occurrences of an entity type with other occurrences of the same entity type.

♦ Cardinality:
  ♠ One-to-One Unary Relationship
  ♠ One-to-Many Unary Relationship
  ♠ Many-to-Many Unary Relationship

♦ Unary Relationships



SALESPERSON
PK Salesperson Number
Salesperson Name
Commission Percentage
Year of Hire

One Salesperson
One Salesperson
Backs-up
Backed-up by

(a.) One-to-one (1–1) unary relationship

SALESPERSON
PK Salesperson Number
Salesperson Name
Commission Percentage
Year of Hire

No Salespersons
Many Salespersons
One Salesperson
Manages
Reports to

(b.) One-to-many (1–M) unary relationship

PRODUCT
PK Product Number
Product Name
Unit Price

No Products
Many Products
Part of
Includes

No Products
Many Products
Part of
Includes

COMPONENT
PK Product Number
PK Subassembly Number
Quantity

(c.) Many-to-many (M–M) unary relationship

# Ternary Relationship With Cardinality

♦ Involves three different entity types.



| | | | |
|---|---|---|---|
| CUSTOMER | | | |
| PK | Customer Number | | |
| | Customer Name HQ City | | |

One Customer

Many Customers

Purchased
Sold to

One Salesperson

Many Salespersons

| | | |
|---|---|---|
| SALESPERSON | | |
| PK | Salesperson Number | |
| | Salesperson Name Commission Percentage Year of Hire | |

Sold
Sold by

| | | |
|---|---|---|
| SALE | | |
| PK | Salesperson Number | |
| PK | Product Number | |
| PK | Customer Number | |
| | Date Quantity | |

Sold
Sold
Product

| | | |
|---|---|---|
| PRODUCT | | |
| PK | Product Number | |
| | Product Name Unit Price | |

One Product

Many Products

(a)

Technician —N—— uses

N (works-on)

N

Project —N— has —N— Notebook

N

(b)

Technician   Project

1   1

uses-notebook

1

Notebook

# Ternary Relationship

♦ One-to-Many relationship.
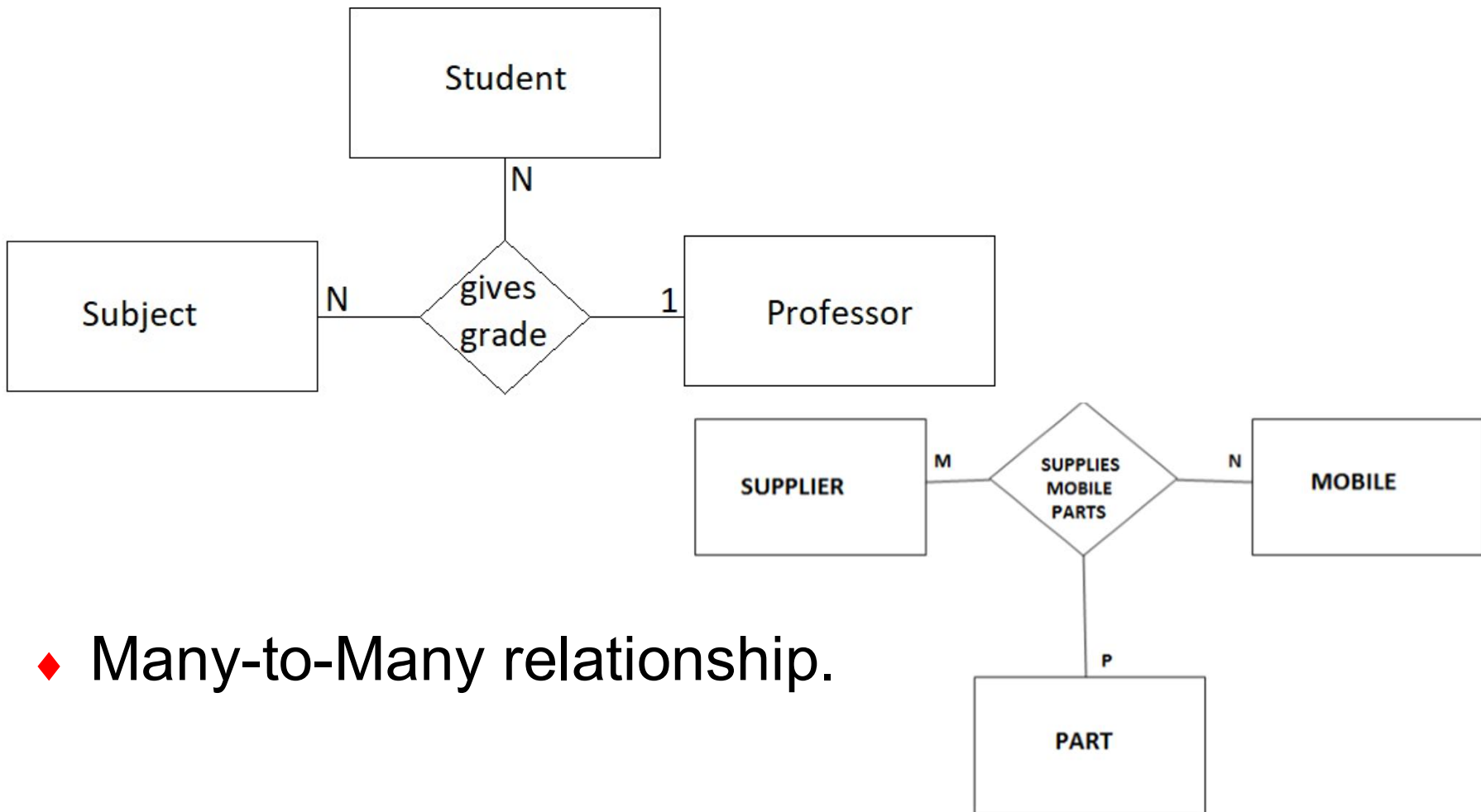


♦ Many-to-Many relationship.

# Good Reading Bookstores

Good Reading is a chain of bookstores that wants to keep track of the books that it sells, their publishers, their authors, and the customers who buy them.

- **The General Hardware Company E-R Diagram**

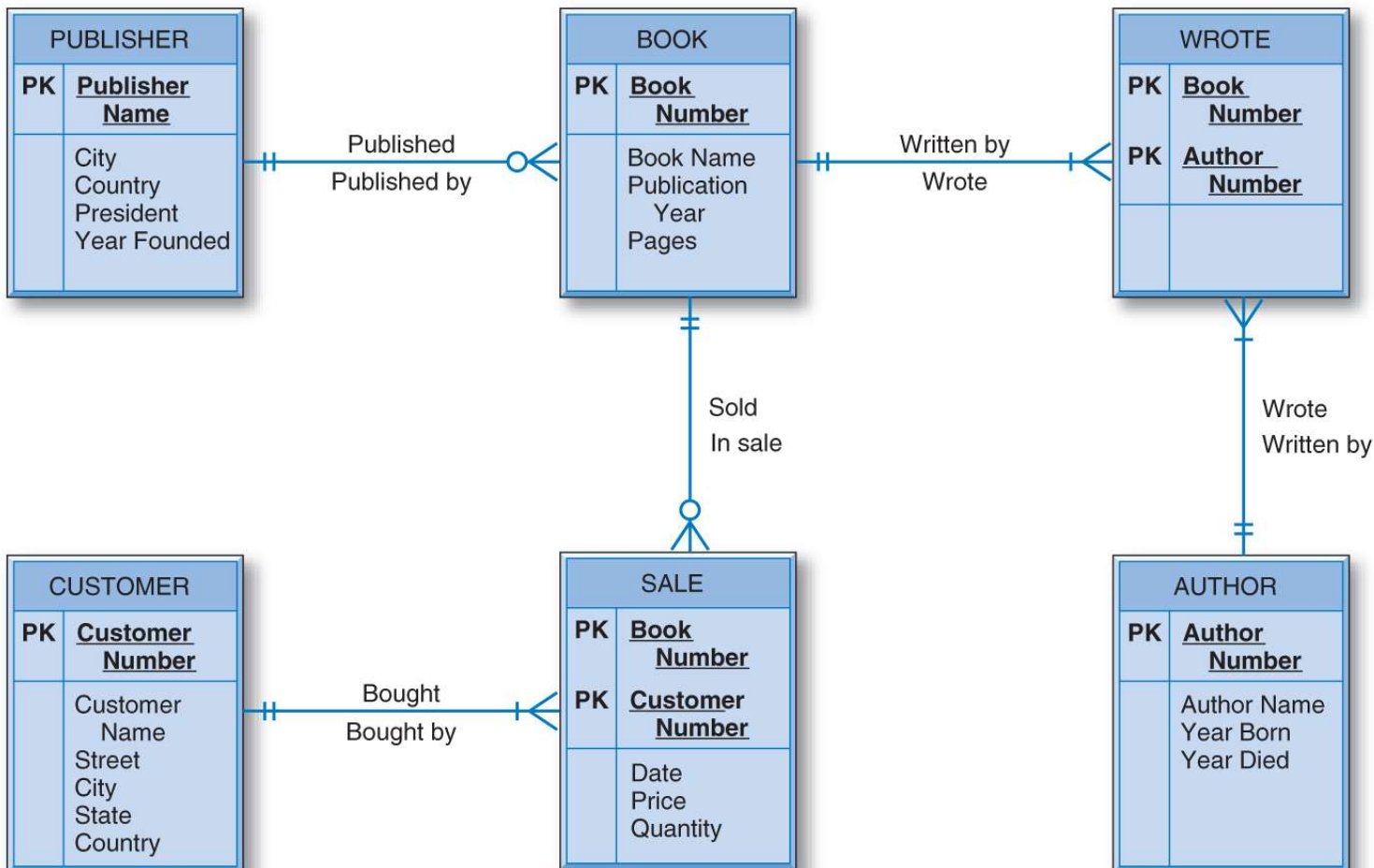- General Hardware is a wholesaler and distributor of various manufacturers' tools and other hardware products. Its customers are hardware and home improvement stores, which in turn sell the products at retail to individual consumers. Again, as a middleman it buys its goods from the manufacturers and then sells them to the retail stores.

Customer Employee is a dependent entity.
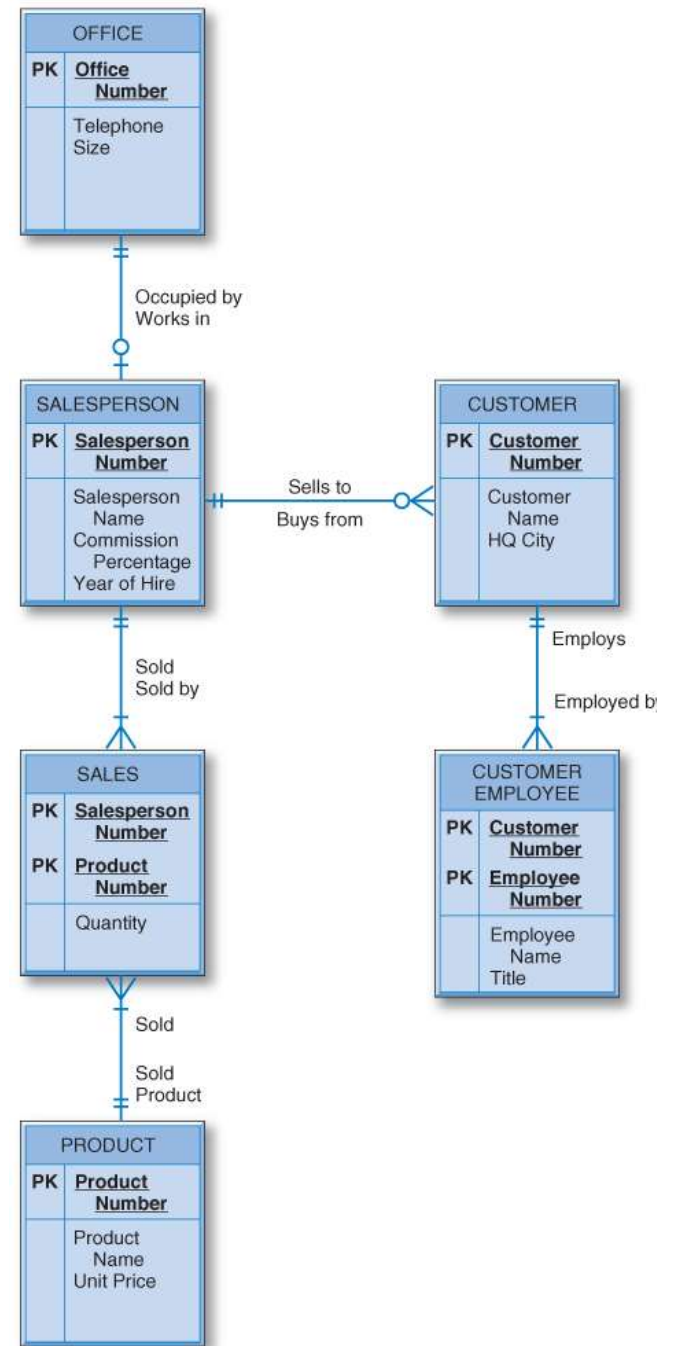
# World Music Association
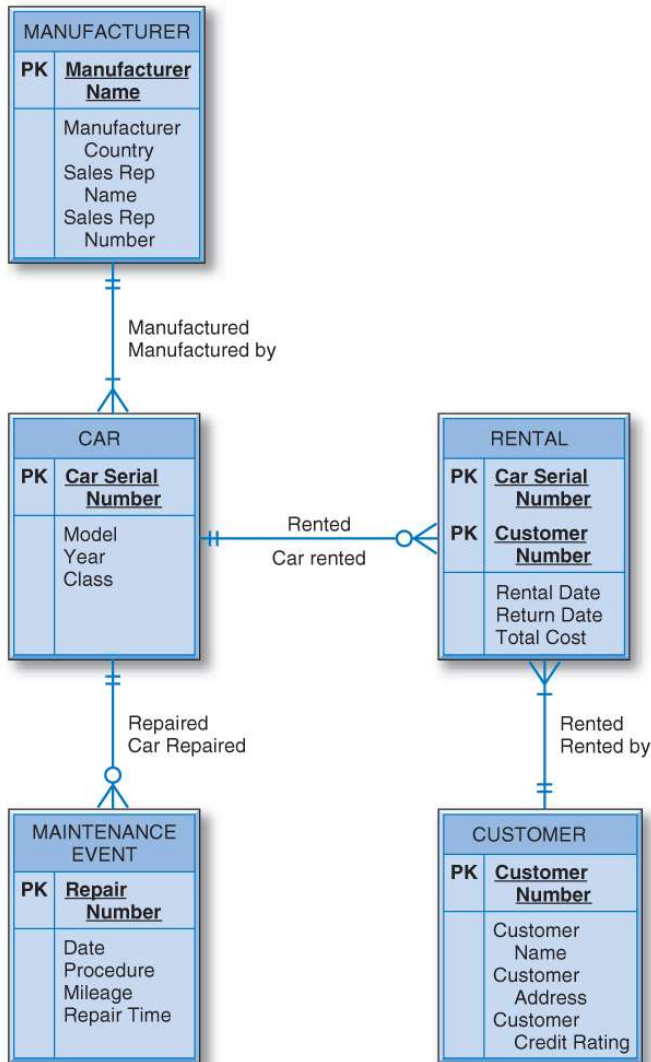
# Lucky Rent-A-Car



**MANUFACTURER**

| PK | Manufacturer Name |
|----|-------------------|
|    | Manufacturer Country |
|    | Sales Rep Name |
|    | Sales Rep Number |

Manufactured
Manufactured by

**CAR**

| PK | Car Serial Number |
|----|-------------------|
|    | Model |
|    | Year |
|    | Class |

Rented
Car rented

Repaired
Car Repaired

**RENTAL**

| PK | Car Serial Number |
|----|-------------------|
| PK | Customer Number |
|    | Rental Date |
|    | Return Date |
|    | Total Cost |

Rented
Rented by

**MAINTENANCE EVENT**

| PK | Repair Number |
|----|---------------|
|    | Date |
|    | Procedure |
|    | Mileage |
|    | Repair Time |

**CUSTOMER**

| PK | Customer Number |
|----|-----------------|
|    | Customer Name |
|    | Customer Address |
|    | Customer Credit Rating |

For More Information Click Here

Here is free tool for ERD

## Exercise:

**Define the relationships and add attributes to the entities**