

# CMSC 127

## Data Modeling Using the Entity Relationship Model

**Reginald Neil C. Recario**

Institute of Computer Science  
University of the Philippines Los Baños



# Overview

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- The ER Model
- ER Model Definition of Terms
- Entity, Entity Type, Entity Set and Relationship
- ER Model Constraints
- Design Issues

# ER Model Concepts

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## □ ***Entity***

- ▣ A specific object or thing in the real world with an independent existence

## □ ***Attribute***

- ▣ A property used to describe an entity

# ER Model Concepts

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- A specific entity will have a value for each of its attributes.
- Each attribute has a *value set* (or data type) associated with it – e.g. integer, string, subrange, enumerated type, ...

# ER Model Concepts

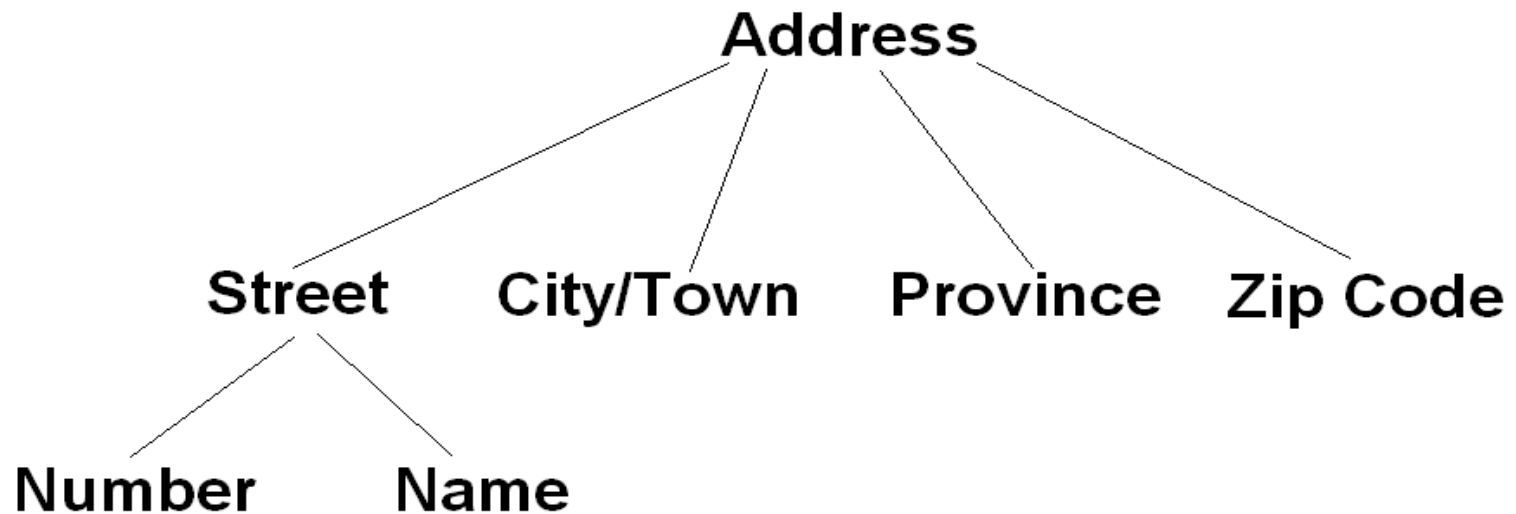
## □ *Simple*

- ▣ An attribute that is atomic or not divisible

## □ *Composite*

- ▣ An attribute that is made up of several components or parts

# Example of a composite attribute



# Types of Attributes

## □ ***Single-valued***

- ▣ Each entity has only one value for this kind of attribute.

## □ ***Multivalued***

- ▣ An entity may have multiple values for this attribute.

# Types of Attributes

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## □ *Derived*

- ▣ Can be determined or computed based from the value of other attributes



# Types of Attributes

- In general, composite and multi-valued attributes may be nested arbitrarily to any number of levels, although this is rare.
  - ▣ For example, PreviousDegrees of a STUDENT is a composite multi-valued attribute denoted by {PreviousDegrees (College, Year, Degree, Field)}.
  - ▣ Multiple PreviousDegrees values can exist.
  - ▣ Also called as **complex attribute**

# Entity Set

- An **entity set** is a collection of all entities of a particular entity type in the database at any point in time.
- Usually, same name is used to refer to both the entity type and the entity set.

# Key Attributes

- A **key attribute** is an attribute whose values are distinct for each individual entity in the entity set.
- It is used to identify each entity uniquely.
- A key attribute may be composite.
- An entity type may have more than one key.

# Displaying an Entity type

- An entity type is displayed in a rectangular box.
- Attributes are displayed in ovals.
  - ▣ Each attribute is connected to its entity type.
  - ▣ Components of a composite attribute are connected to the oval representing the composite attribute.

# Displaying an Entity type

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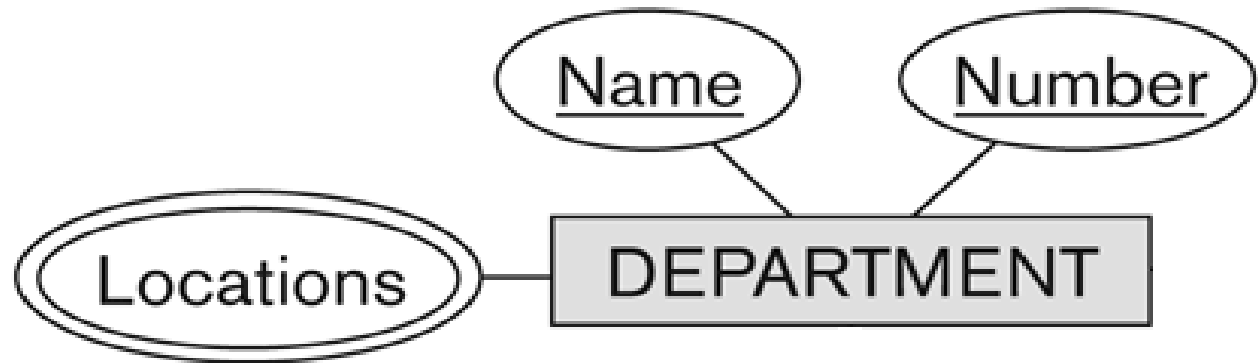
- ▣ Each key attribute is underlined.
- ▣ Multivalued attributes are displayed in double ovals.
- ▣ Derived attributes are represented by dashed ovals.

# An Entity type

- ENTITY TYPES

- ▣ DEPARTMENT

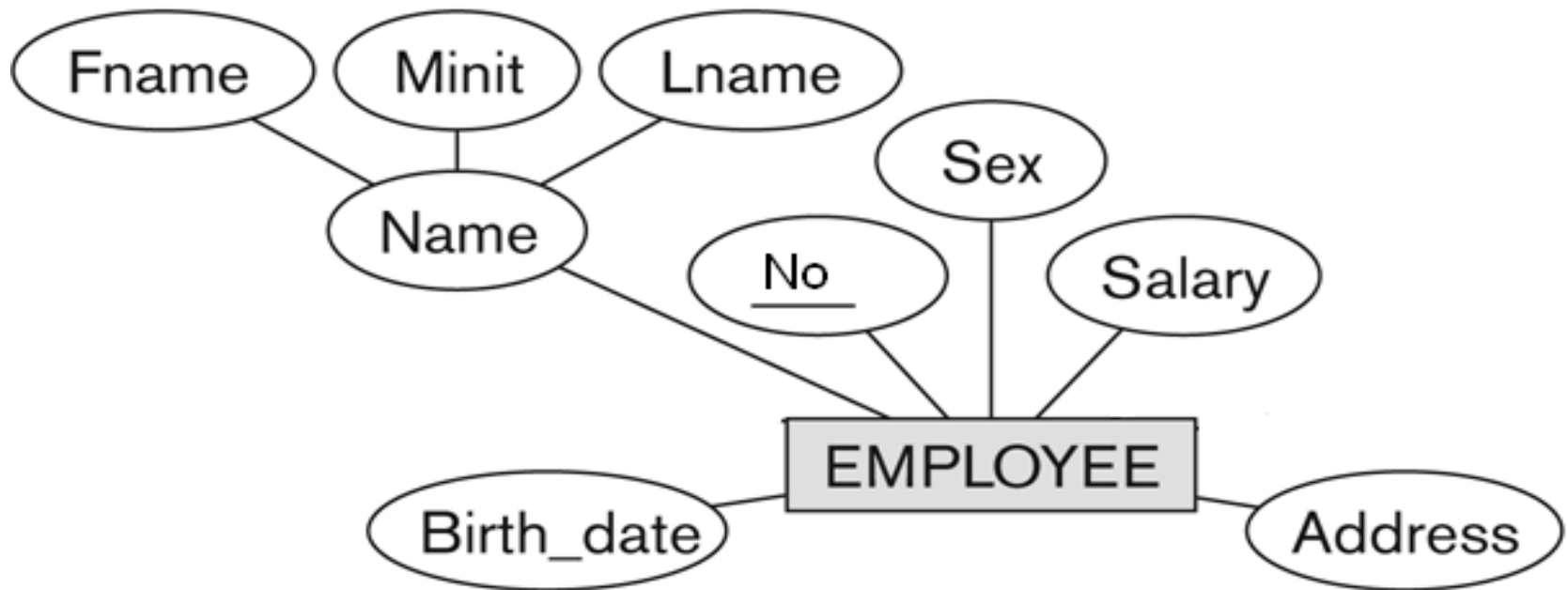
- Name, number, locations



# An Entity type

## □ EMPLOYEE

- ▣ Name, number, address, salary, sex, and birthdate



# Relationships and Relationship Types

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- A *relationship* is an association among several entities.
- Relationships of the same type are grouped or typed into a *relationship type*.



# Relationship Degree

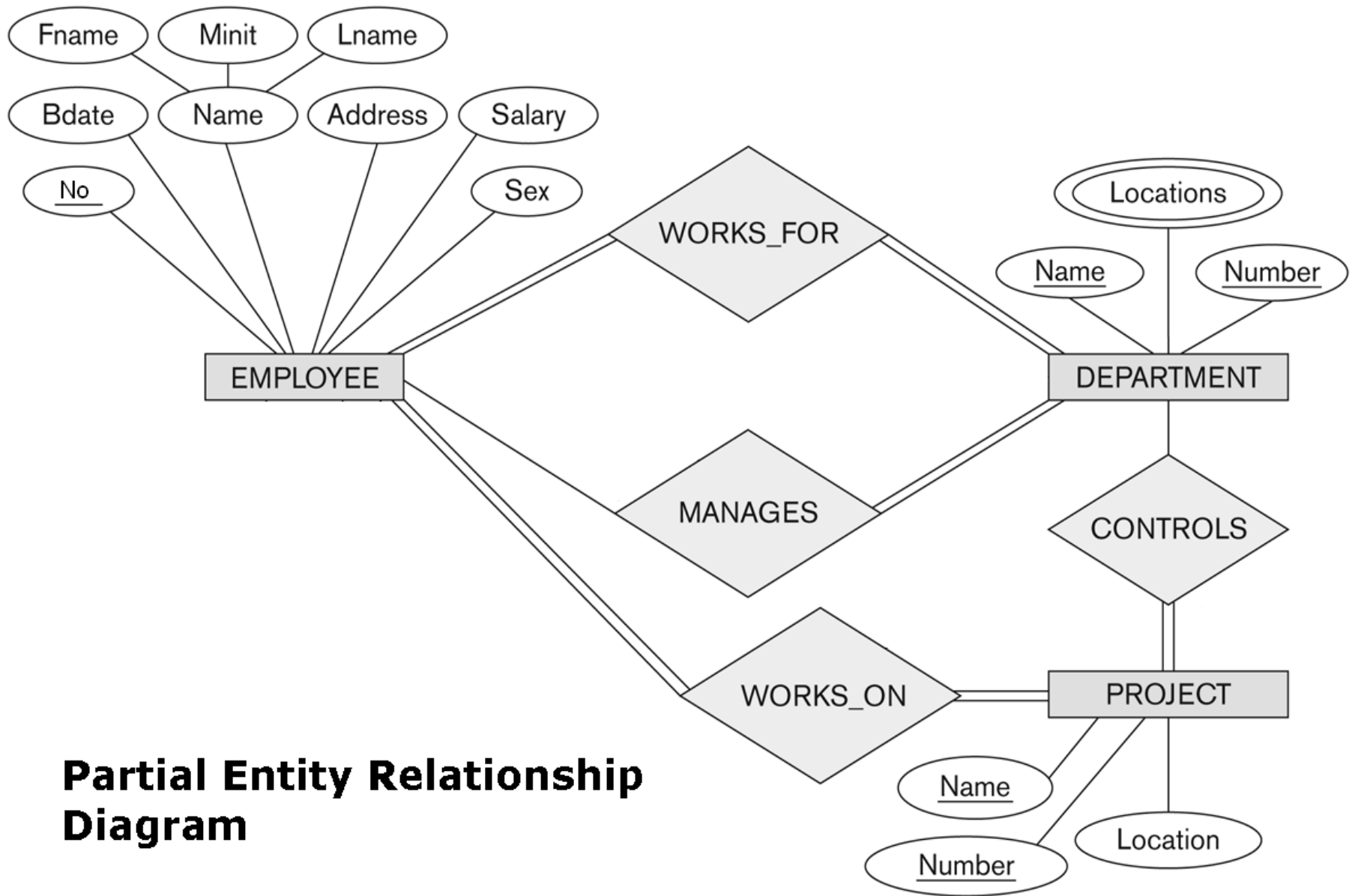
- The **degree of a relationship type** is the number of participating entity types.
- A relationship type of degree two is called a **binary relationship** while one of degree three is called a **ternary**.
- ▣ WORKS\_FOR is binary relationship

# COMPANY Database Relationship Types

- There should be six relationship types
  - ▣ WORKS\_FOR (between EMPLOYEE, DEPARTMENT)
  - ▣ MANAGES (also between EMPLOYEE, DEPARTMENT)
  - ▣ CONTROLS (between DEPARTMENT, PROJECT)
  - ▣ WORKS\_ON (between EMPLOYEE, PROJECT)
  - ▣ SUPERVISION (between EMPLOYEE (as subordinate), EMPLOYEE (as supervisor))
  - ▣ DEPENDENTS\_OF (between EMPLOYEE, DEPENDENT)

# Displaying a Relationship Type

- A relationship type is represented as follows:
  - ▣ Diamond-shaped box is used to display a relationship type.
  - ▣ Connected to the participating entity types via straight lines.



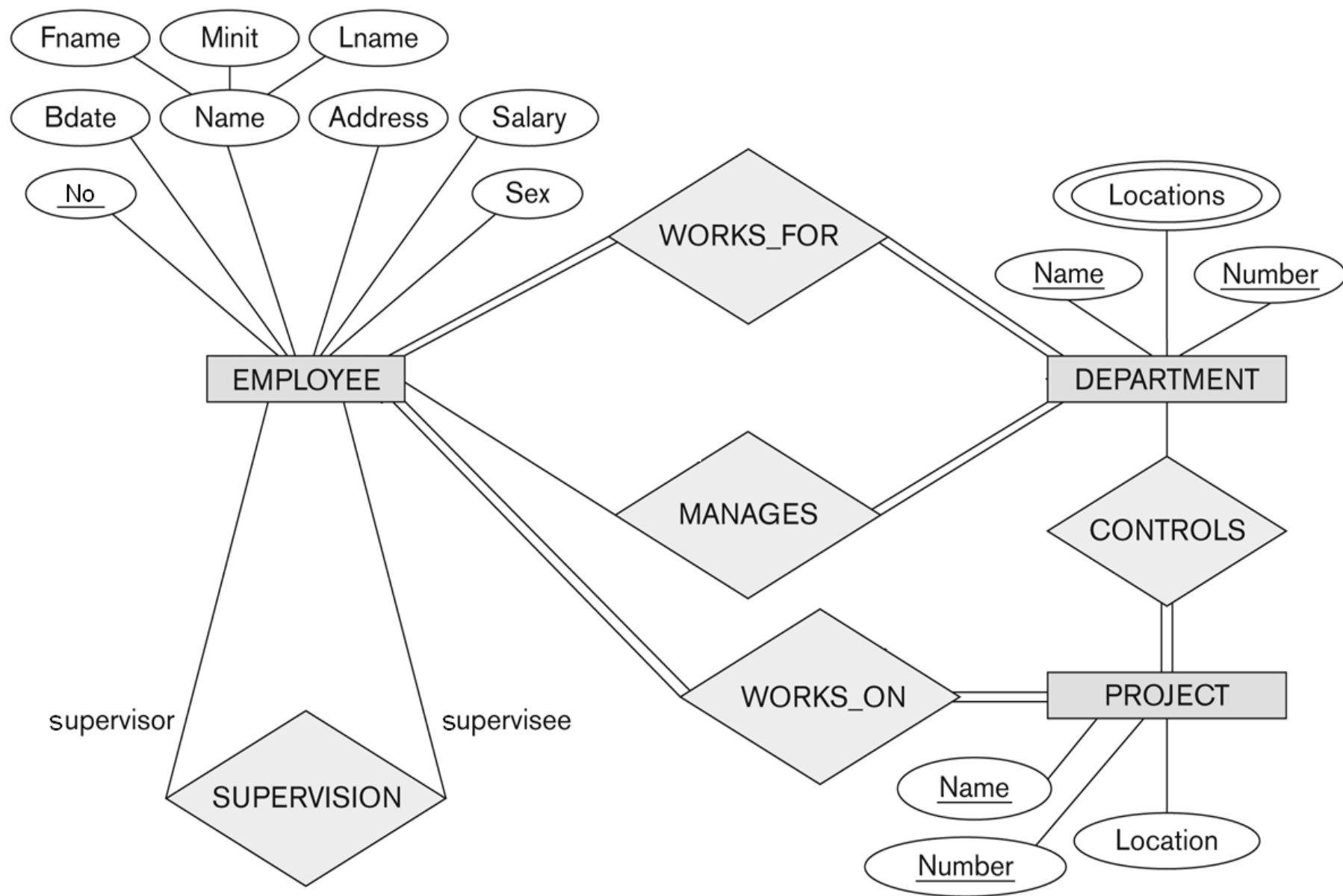
**Partial Entity Relationship Diagram**

# On Relationship Types

- More than one relationship type can exist between the **same** participating entity types.
  - ▣ e.g. MANAGES and WORKS\_FOR
  - ▣ Different meanings and different relationship instances

# Recursive Relationship Type

- A relationship type that associates entities which are members of the same entity type
- e.g. SUPERVISION
- **Roles** must be specified to distinguish the meaning of each participation.
- EMPLOYEE participates twice in two distinct roles:
  - ▣ supervisor (or boss) role
  - ▣ supervisee (or subordinate) role



**Partial ERD with Recursive Relationship**

# Constraints on Relationships

## □ *Cardinality Ratio*

- ▣ specifies the *maximum number* of relationship instances that an entity can participate in

## □ Types of cardinality ratios

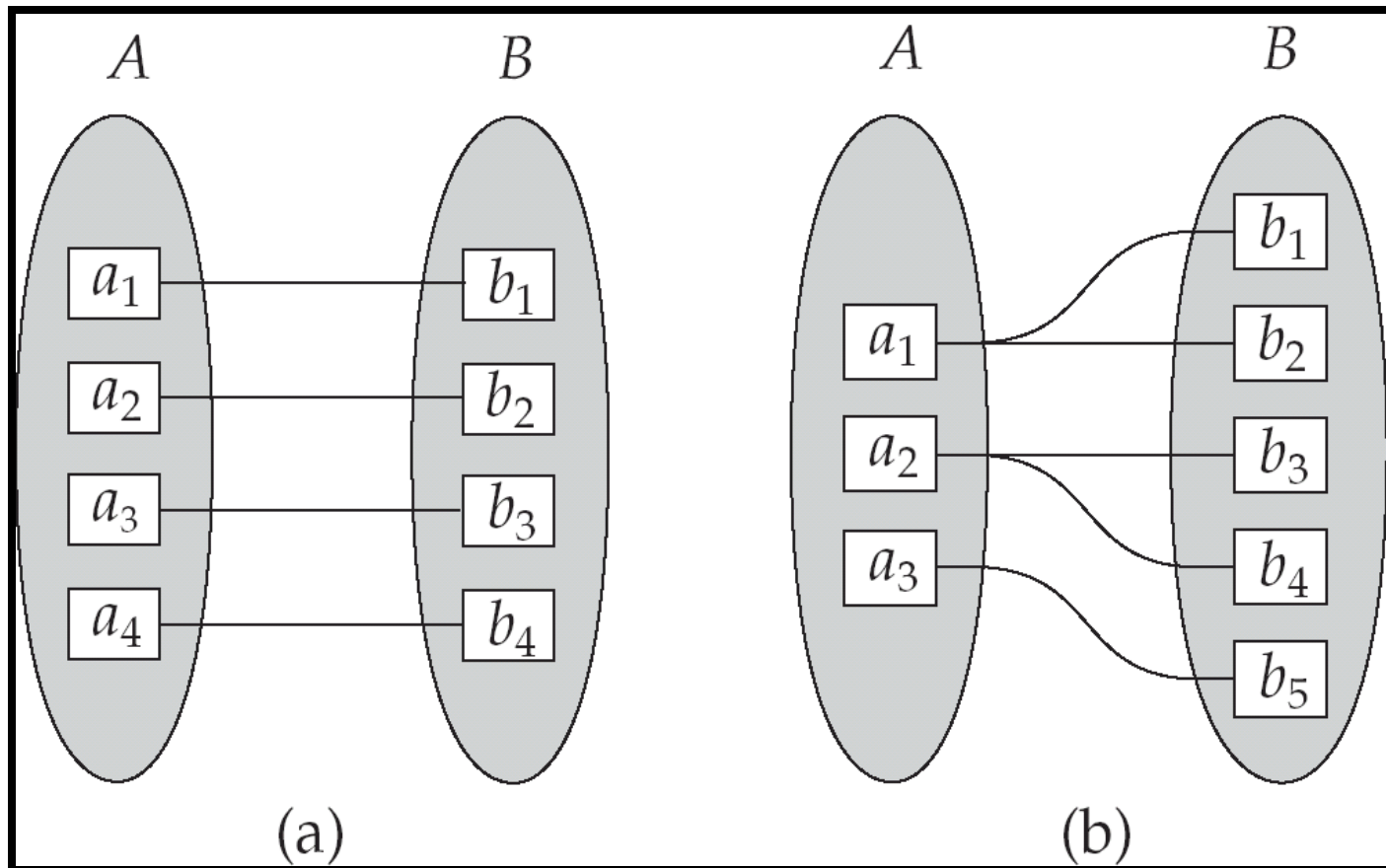
- ▣ One-to-one (1:1)

- ▣ One-to-many (1:N) or Many-to-one (N:1)

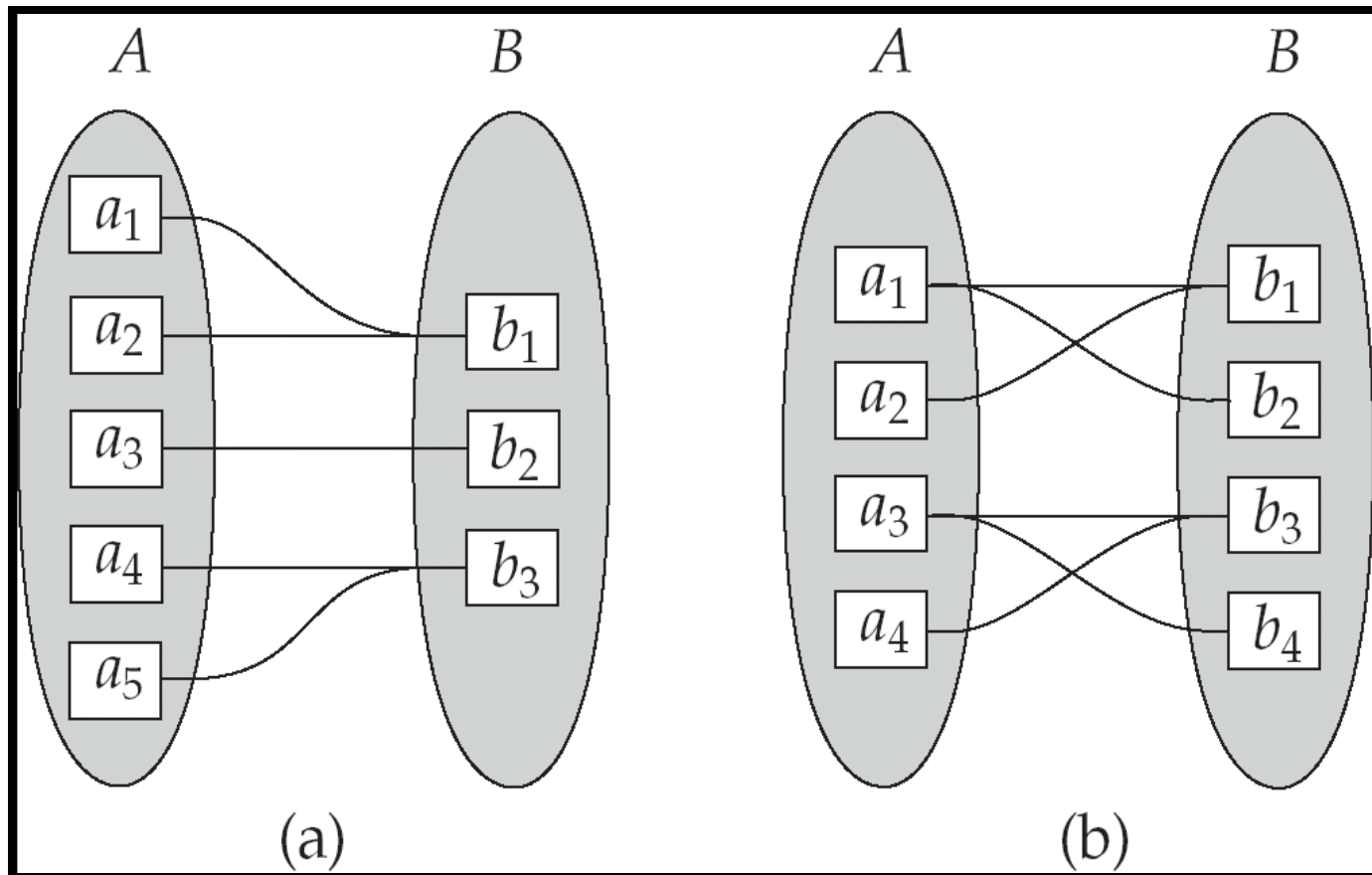
- ▣ Many-to-many (M:N) (N:M / N:N)



# 1:1 and 1:N



# N:1 and M:N



# Constraints on Relationships

## □ *Participation Constraint or Existence Dependency Constraint*

- ▣ Specifies whether the existence of an entity depends on its being related to another entity via the relationship type
- ▣ Specifies the *minimum number* of relationship instances that each entity can participate in
- ▣ Sometimes called the *minimum cardinality constraint*

# Types of Participation Constraints

## □ *Total*

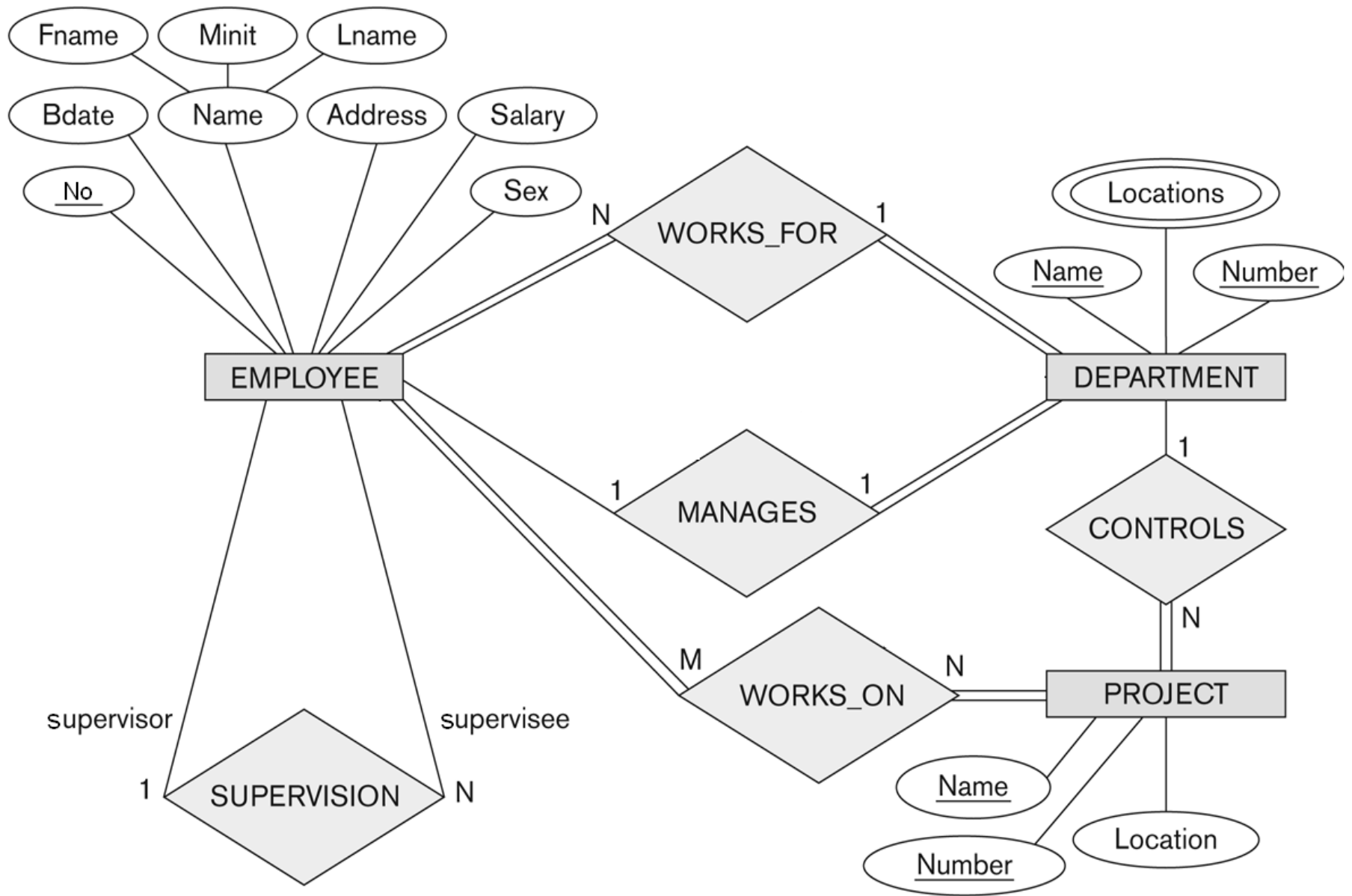
- ▣ Every entity in entity set  $E$  must participate in at least one relationship in relationship set  $R$

## □ *Partial*

- ▣ Only some entities in  $E$  participate in relationships in  $R$

# Notation for Constraints on Relationships

- Cardinality ratio (of a binary relationship): 1:1, 1:N, N:1, or M:N
  - ▣ Shown by placing appropriate numbers on the relationship edges
- Participation constraint (on each participating entity type): total or partial.
  - ▣ Total shown by double line, partial by single line



**Partial ERD with Constraints**

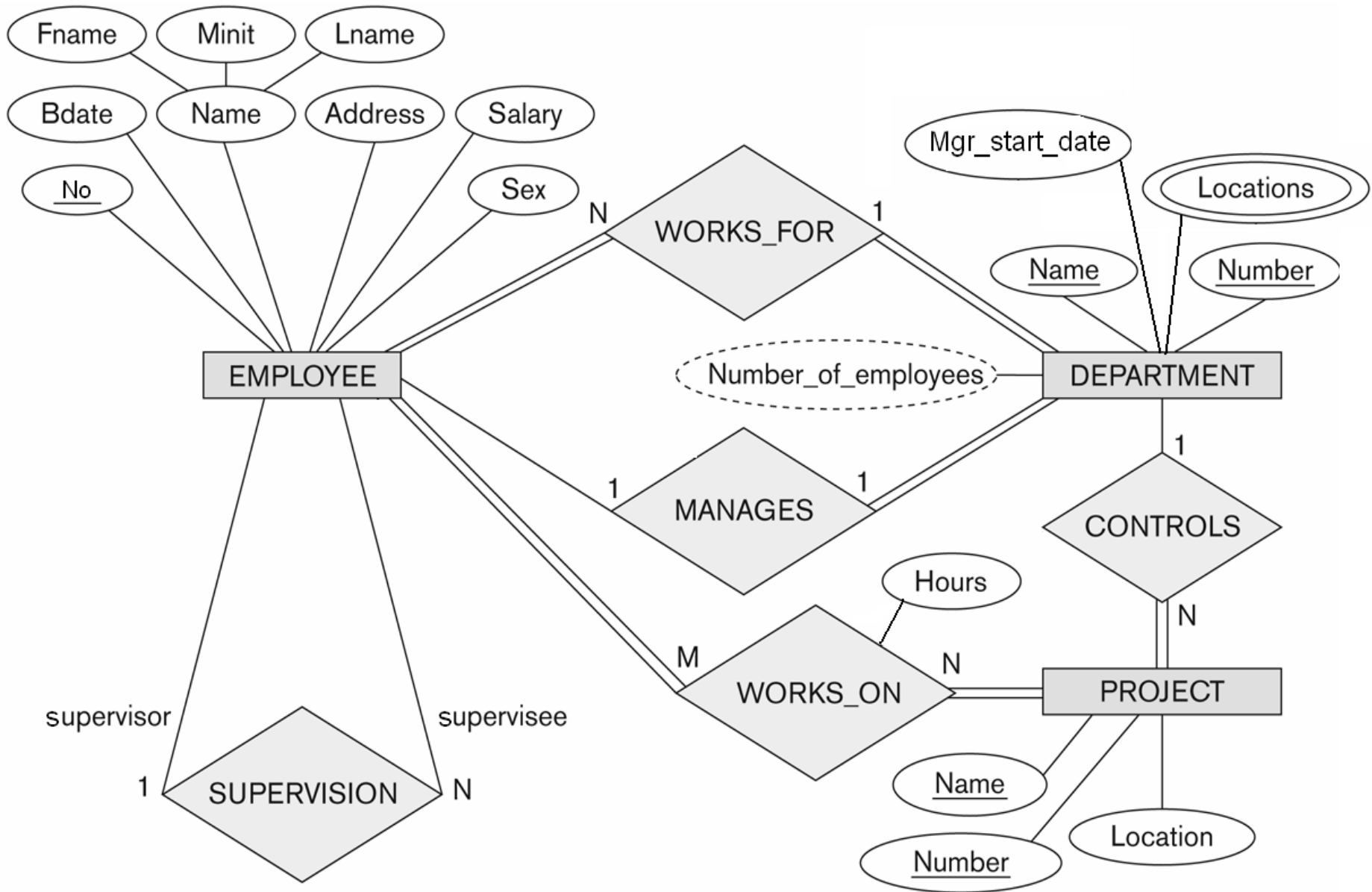
# Attributes of Relationship Types

- The value of these attributes depends on the combination of entities.
  - ▣ e.g. Hours (WORKS\_ON)
  - ▣ Mgr\_start\_date (MANAGES)
  - ▣ Number\_of\_employees (WORKS\_FOR)

# Placement of Relationship Attributes

- Depends on the cardinality ratio of the relationship
- If **M:N**, relationship attributes are connected to the relationship.
- If **1:N** or **N:1**, relationship attributes are transferred to the entity type on the N-side of the relationship.
- If **1:1**, relationship attributes are transferred to the entity type having a total participation in the relationship.





**Partial ERD with Relationship Attributes**

# Weak Entity Types

- An entity that does not have a key attribute
- Owner or Identifying Entity Type
  - ▣ Where the existence of a weak entity type depends on
- Identifying relationship type of the weak entity type
  - ▣ The relationship that associates the weak entity type to its identifying entity type

# Example of a weak entity type

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- Weak Entity Type: DEPENDENT
- Identifying Entity Type: EMPLOYEE
- Identifying Relationship Type:  
DEPENDENTS\_OF

# Partial key

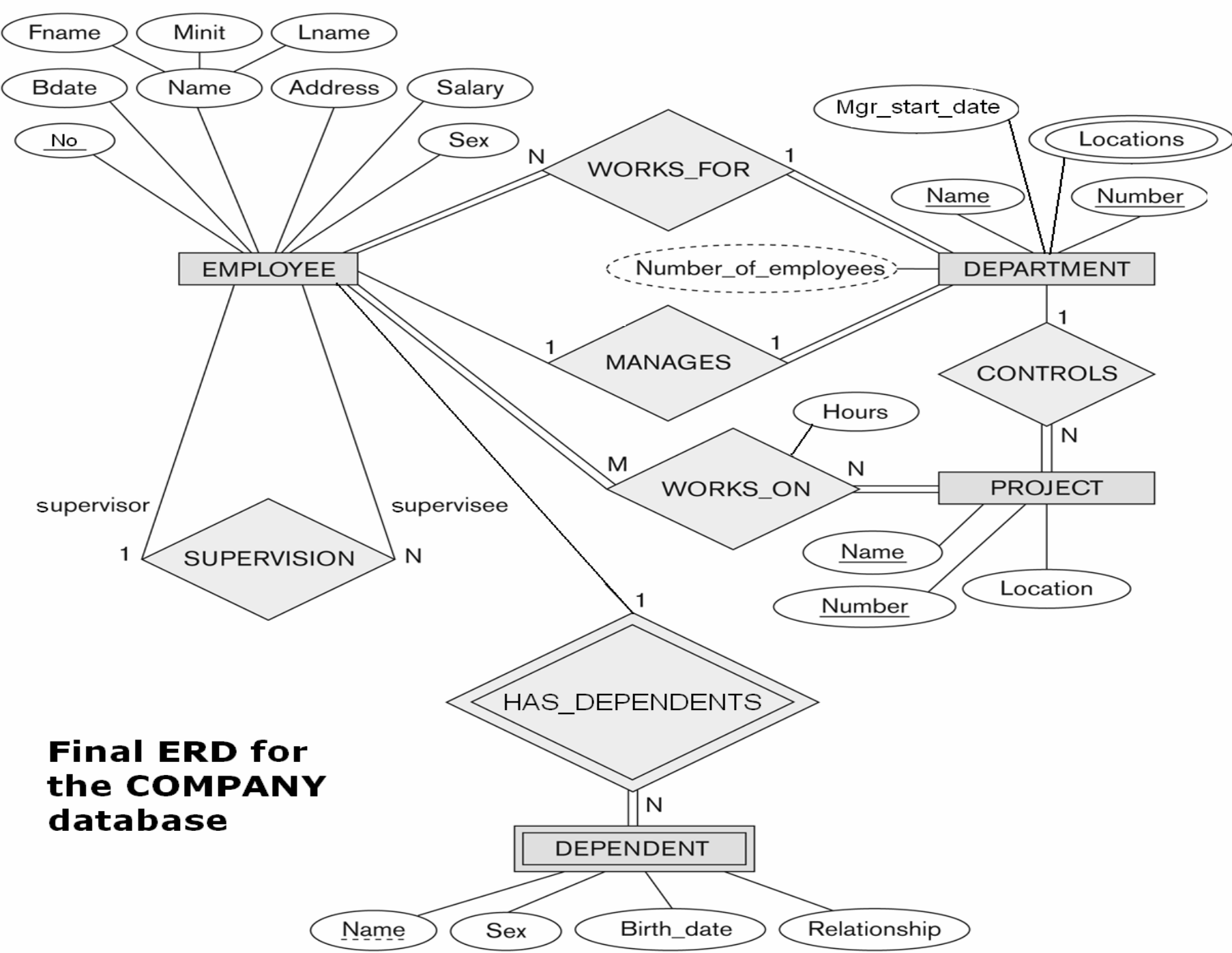
- the set of attributes that can uniquely identify weak entities that are related to the same owner entity.
- Also called as *discriminator*
- Entities belonging to a weak entity type are identified by the combination of:
  - ▣ A partial key of the weak entity type
  - ▣ The particular entity they are related to in the identifying entity type

# Example of a partial key

- ***Partial key: First Name***
- A DEPENDENT entity is identified by the dependent's first name, *and* the specific EMPLOYEE with whom the dependent is related.


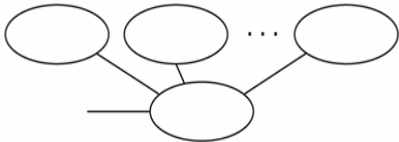
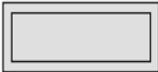

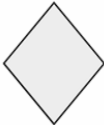
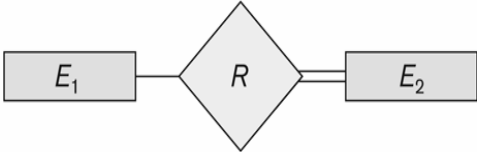

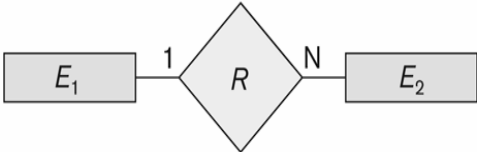



# Displaying a weak entity type

- Weak entity type is represented using a box(rectangle) surrounded by double lines.
- Its identifying relationship is displayed using diamonds which is also surrounded by double lines.
- Partial key attribute is underlined with a dashed or dotted line.



**Final ERD for  
the COMPANY  
database**

# Summary of notation for ER diagrams

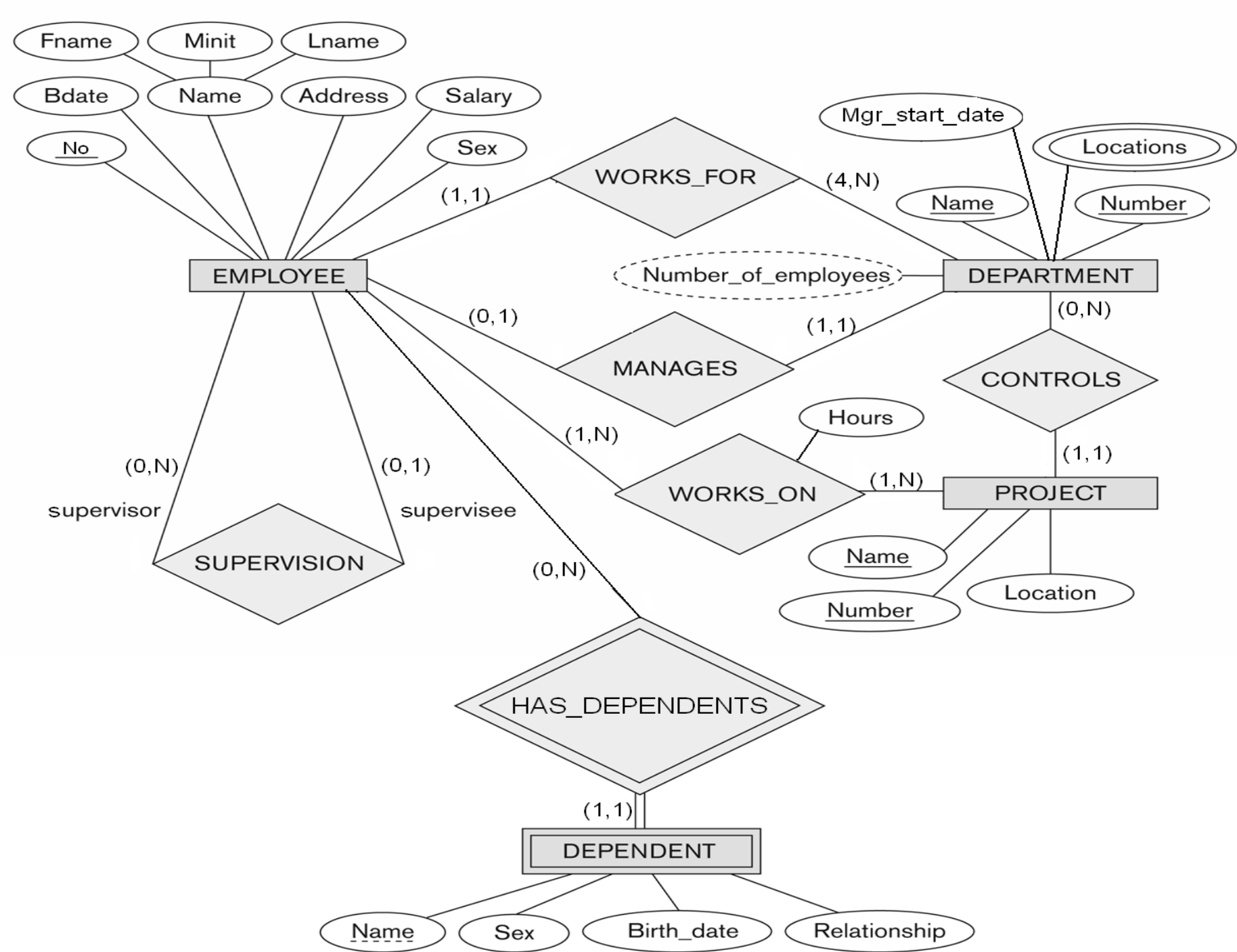
Symbol	Meaning		
	Entity		Composite Attribute
	Weak Entity		Derived Attribute
	Relationship		Total Participation of $E_2$ in $R$
	Identifying Relationship		Cardinality Ratio 1: N for $E_1:E_2$ in $R$
	Attribute		
	Key Attribute		
	Multivalued Attribute		



# Alternative (min, max) notation

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- Specifies that each entity  $e$  in  $E$  participates in at least *min* and at most *max* relationship instances in  $R$



# Design Convention

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- Naming

- ▣ Entity type: Singular

- Case

- ▣ Entity type: Uppercase
  - ▣ Relationship type: Uppercase
  - ▣ Attribute: First letter capitalized
  - ▣ Role name: Lowercase

- Readability

- ▣ Left to right, Top to bottom

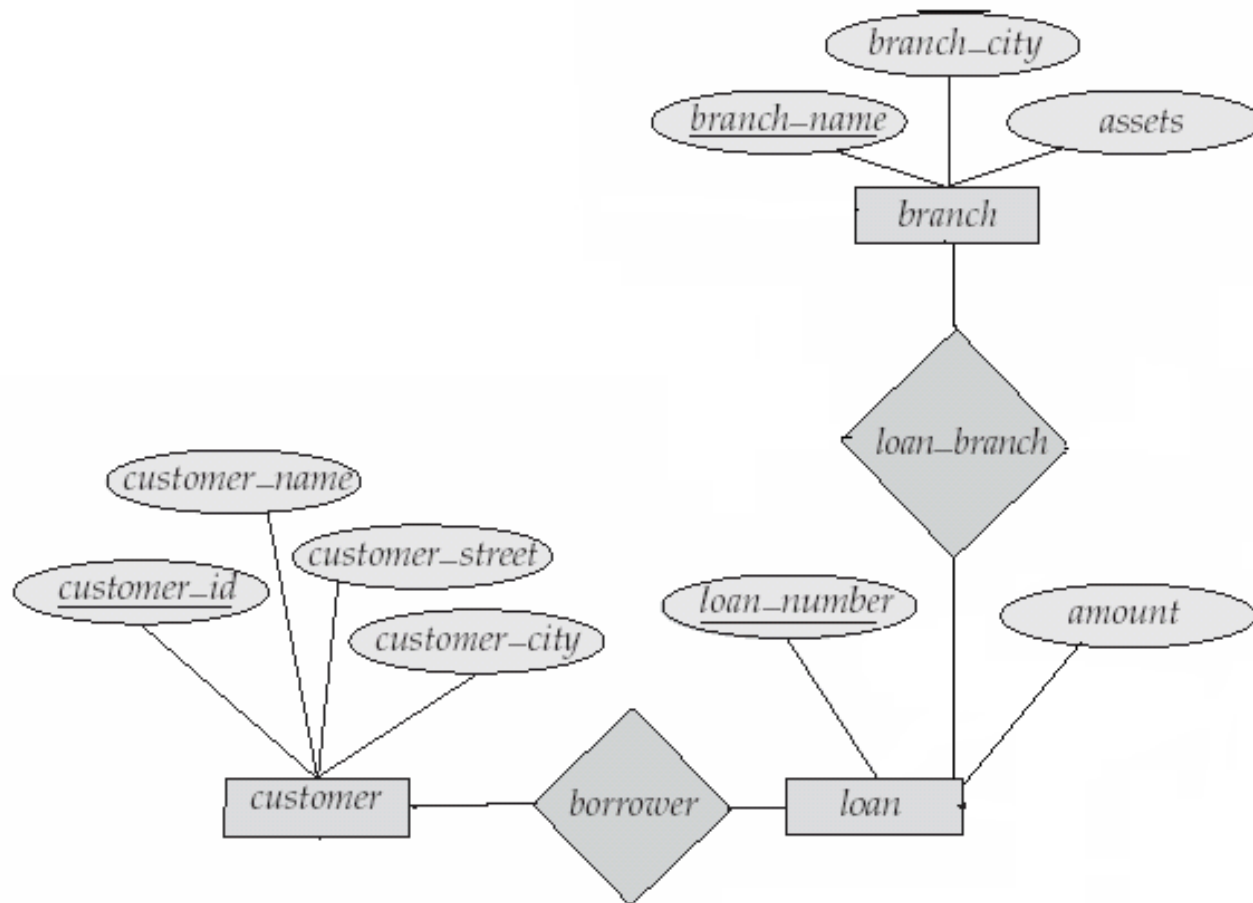
# Design Issues

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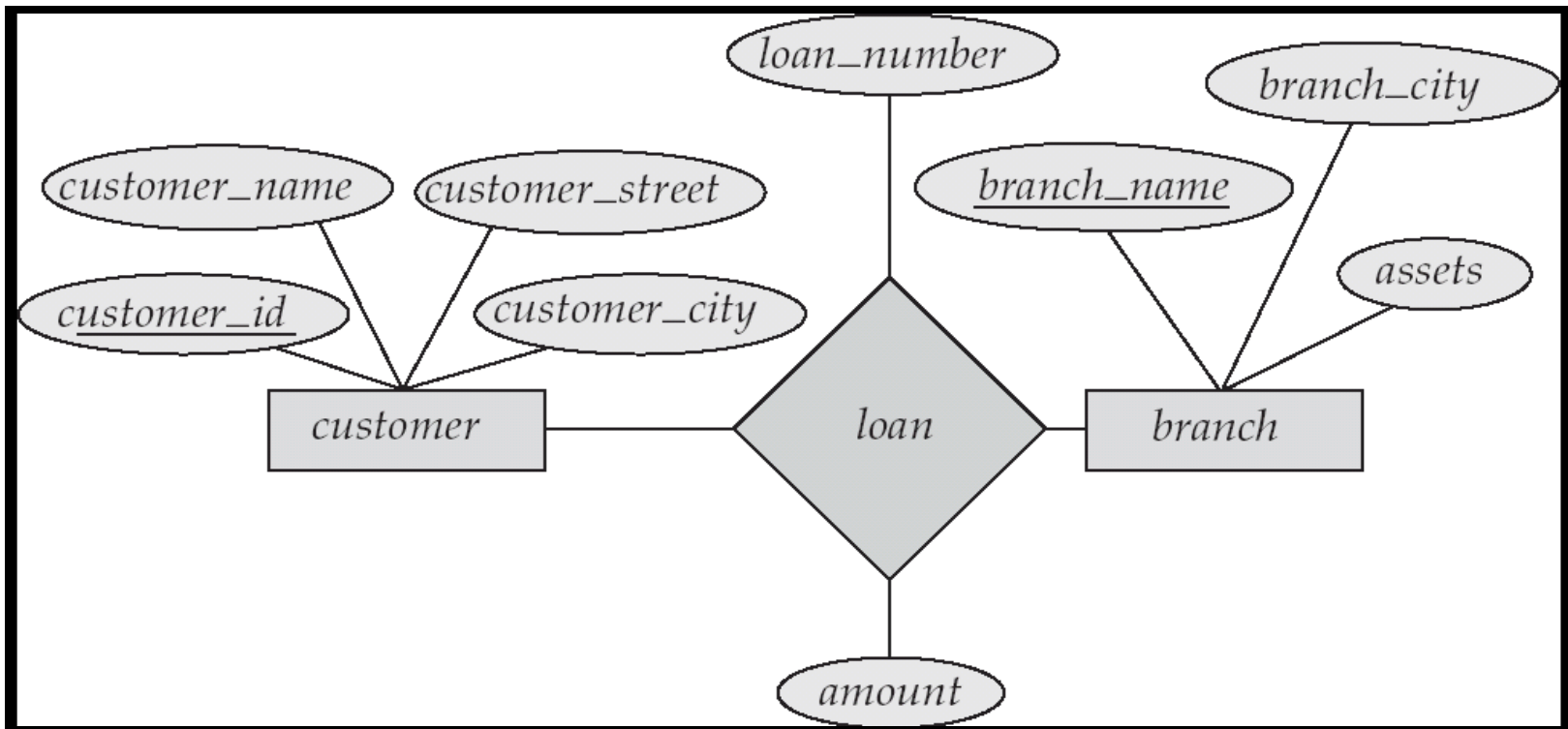
- Use of entity types vs. attributes
  - ▣ An attribute that exists in several entity types may be elevated to an entity type.
  - ▣ An entity type with only one attribute and participates in only one relationship may be reduced to an attribute.

# Design Issues

- Use of entity types vs. relationship types



# Design Issues

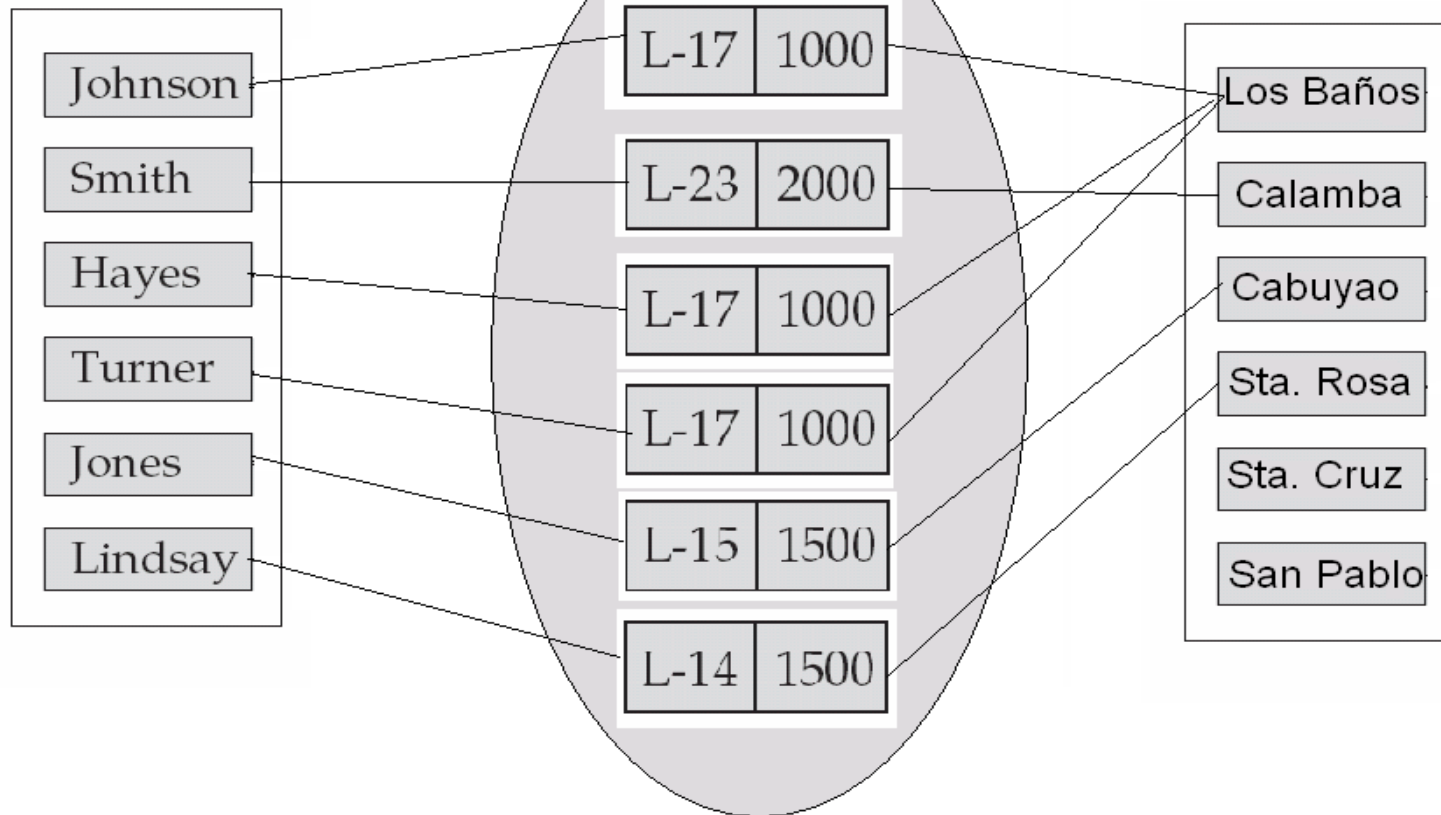


# LOAN (Relationship)

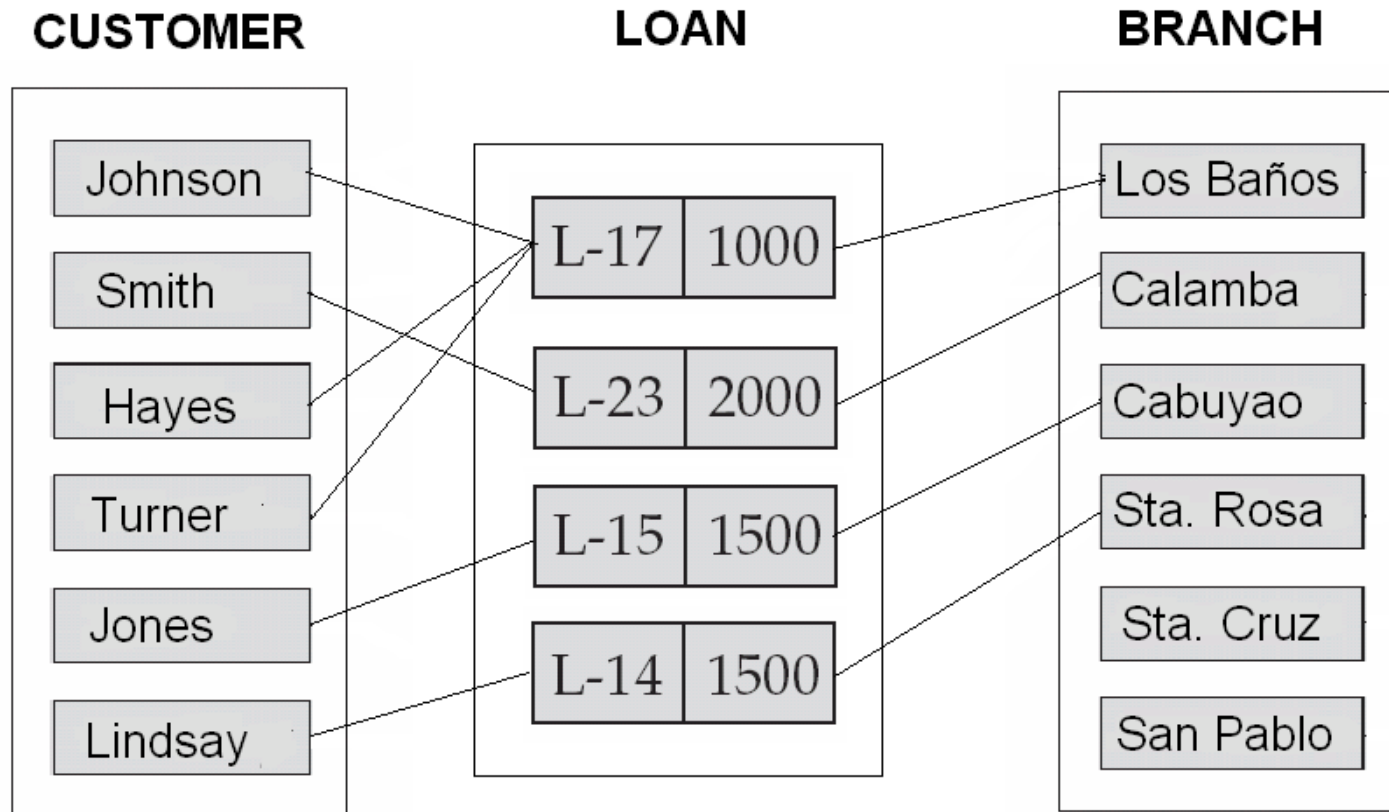
**CUSTOMER**

**LOAN NO | AMOUNT**

**BRANCH**



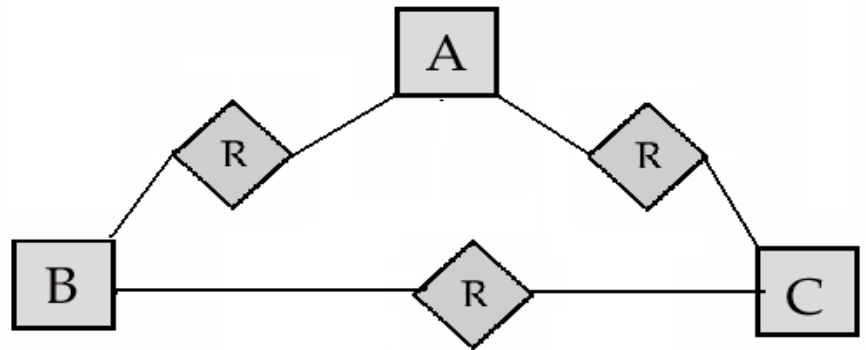
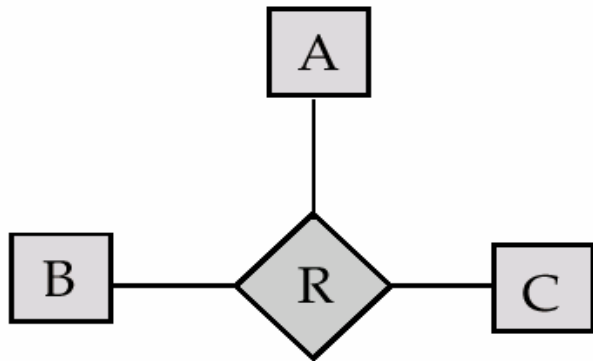
# LOAN (Entity)



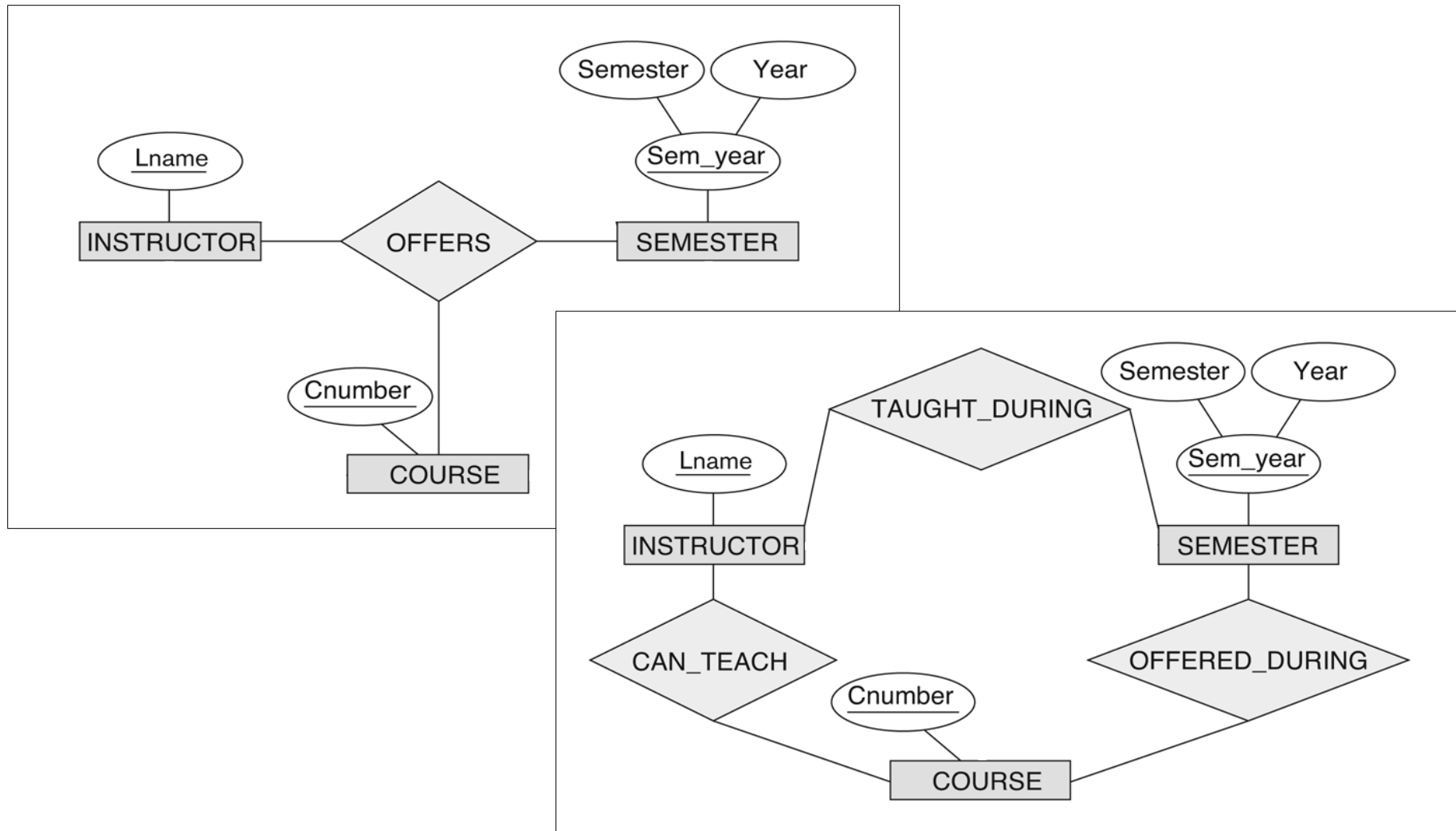


# Design Issues

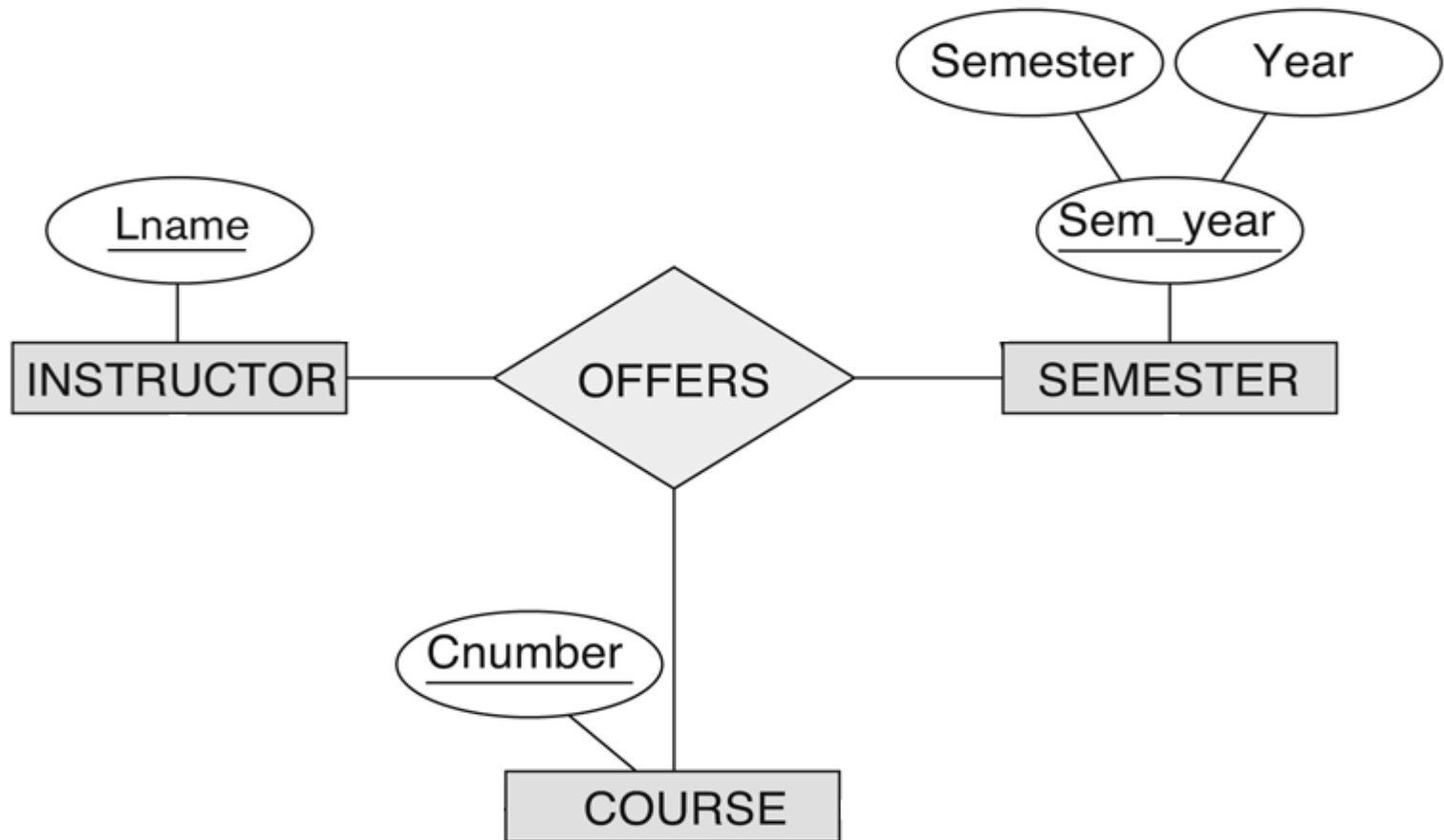
## □ Binary vs. n-ary relationship types



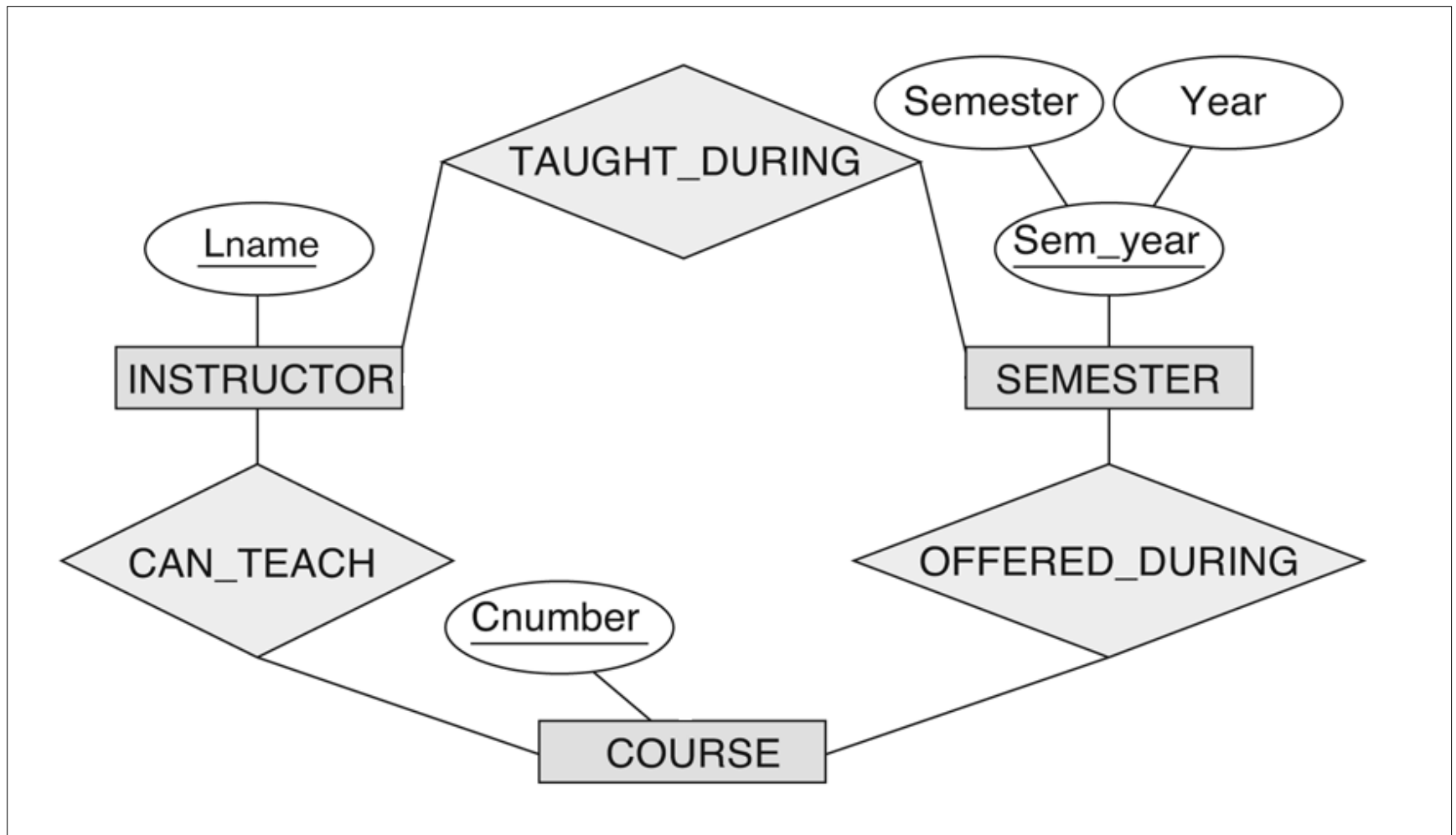
# Binary vs. ternary



# Binary vs. ternary



# Binary vs. ternary



# Reference(s):

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Fundamentals of Database Systems. 6th  
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