Unit 3

Entity-Relationship Model

Outline

❖ **The Entity-Relationship Model**

- Basic Elements of the ER Model
  - Entities, Relationships, Rings ,Attributes
- Other Elements of the ER Model
  - Generalization hierarchies
  - Subsets
  - Composite attributes
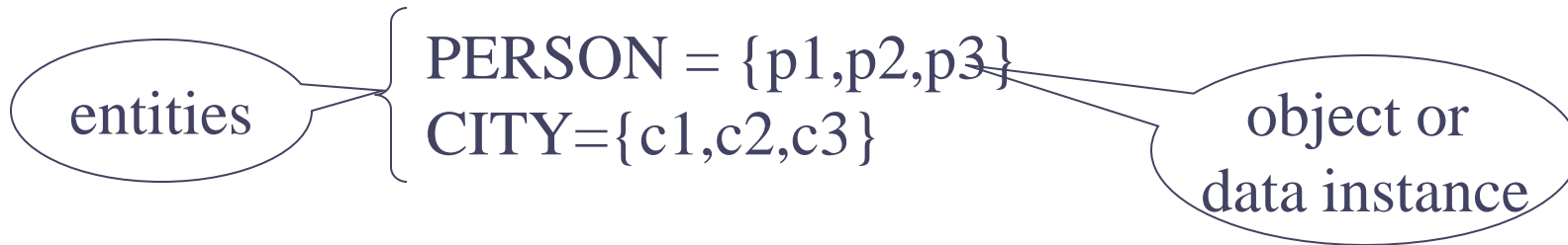 - Identifiers
  - Weak entity

❖ **Reading the ER Diagrams**

The Entity-Relationship Model

❖ A *database* can be modeled as:
- a collection of entities,
- relationships among entities.

❖ Basic elements of ER model
- Entities
- Relationships
- Rings
- Attributes

Entity

👉 Entity is a class of real-world objects.

entities
PERSON = {p1,p2,p3}
CITY={c1,c2,c3}
object or data instance

PERSON

CITY

⇨用矩形表示 entity

Relationship

👉 Relationship is the aggregation of two or more entities.

LIVES_IN={<p1,c1>, <p2,c3>,<p3,c3>}
　　表達某人住在某城市的關係

aggregation object

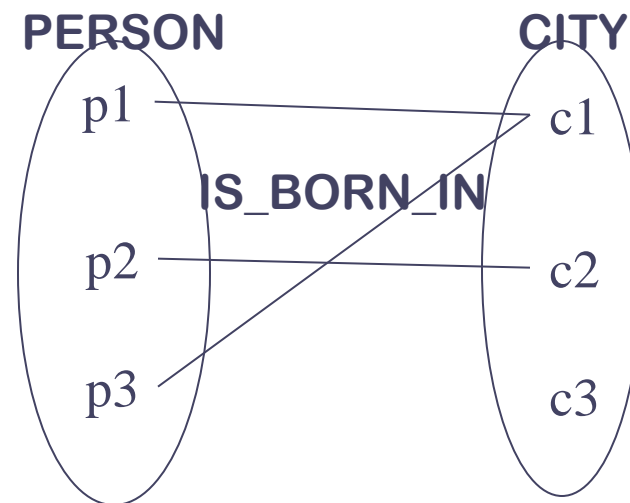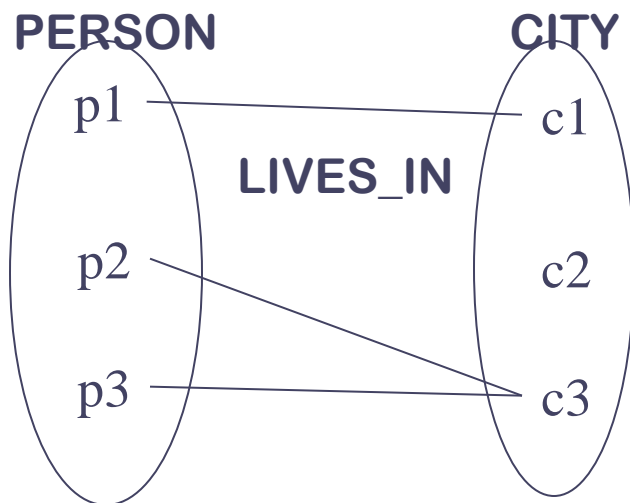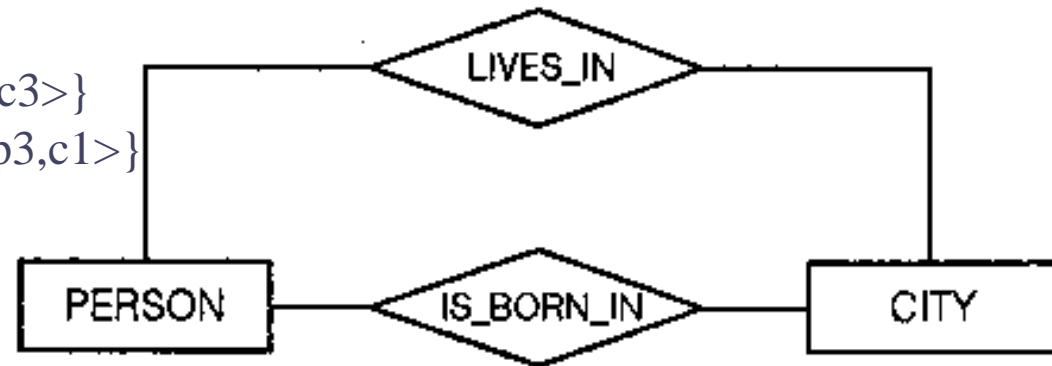IS_BORN_IN={<p1,c1>,<p2,c2>,<p3,c1>}
　　表達某人在某城市出生的關係

用菱形表示 relationship

◁ LIVES_IN ▷　◁ IS_BORN_IN ▷

PERSON = {p1,p2,p3}
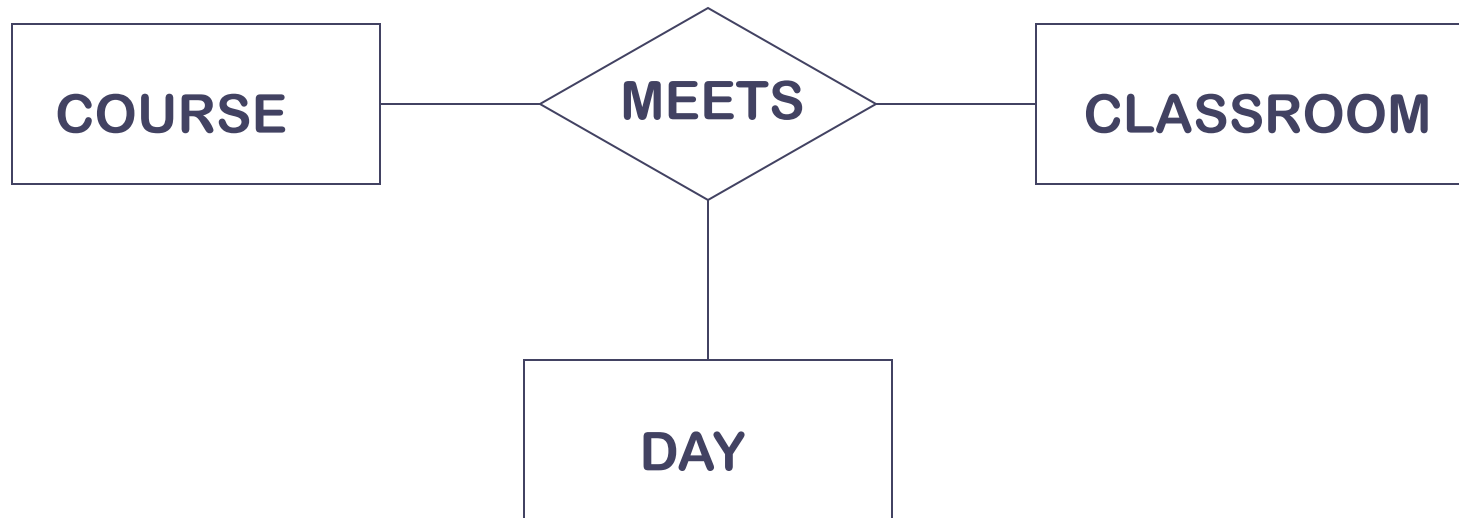CITY={c1,c2,c3}
LIVES_IN={<p1,c1>, <p2,c3>,<p3,c3>}
IS_BORN_IN={<p1,c1>,<p2,c2>,<p3,c1>}

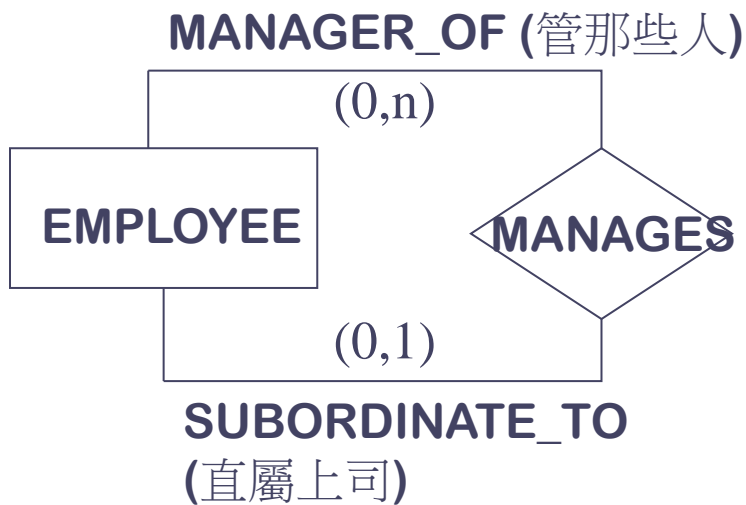MEETS 為 relationship 表達出某課程星期幾在哪個教室上課

Ring

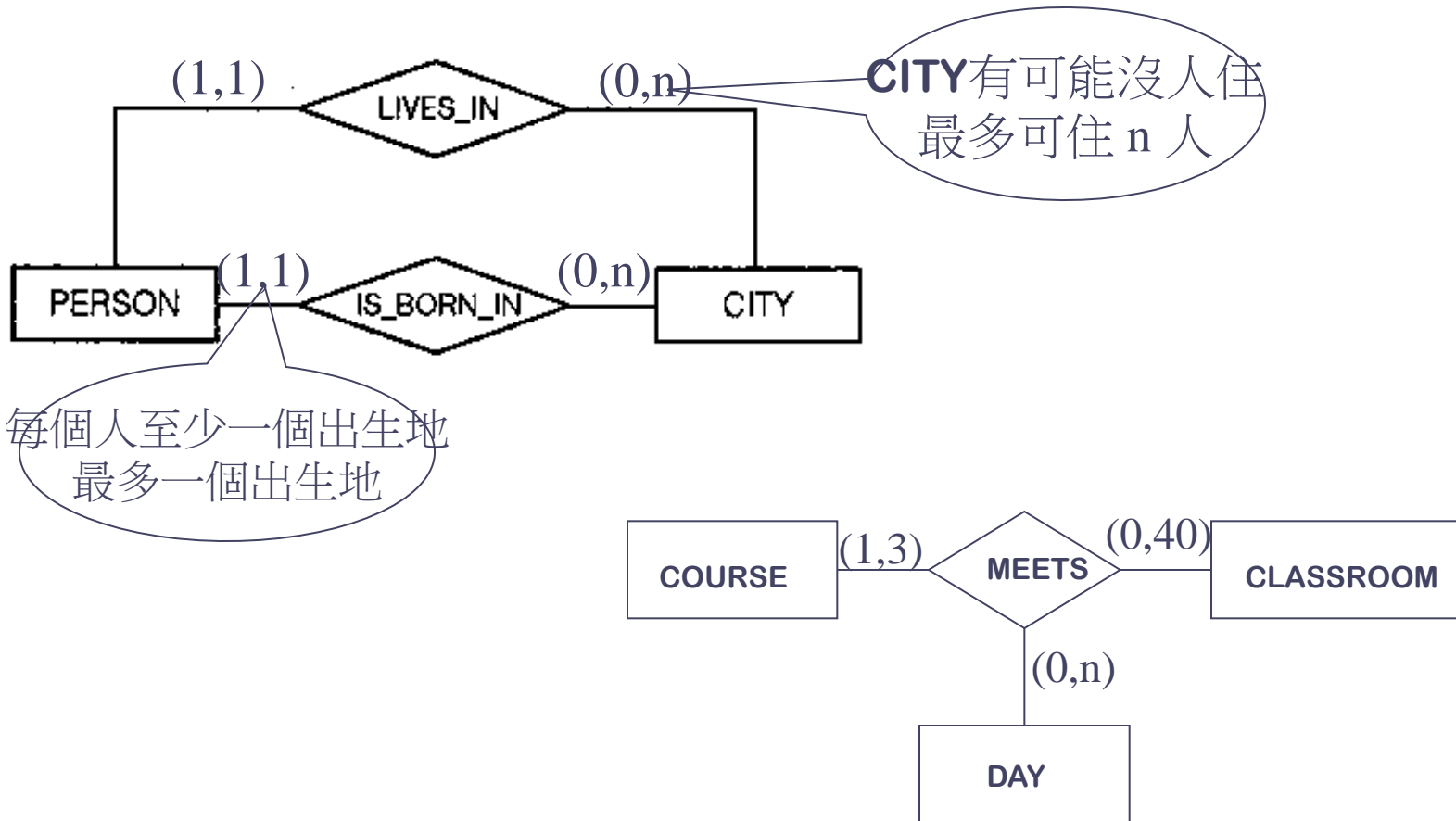👉 Binary relationship connecting an entity to itself. (recursive relationship)

MANAGER_OF (管那些人**)**

(0,n)

EMPLOYEE **MANAGES**

(0,1)

SUBORDINATE_TO
(直屬上司**)**

✔若 **EMPLOYEE** 包含有九個 objects 如下:
EMPLOYEE={p1,p2,p3,p4,p5,p6,p7,p8,p9}

p1

p2   p3   p4

p5   p6   p7   p8   p9
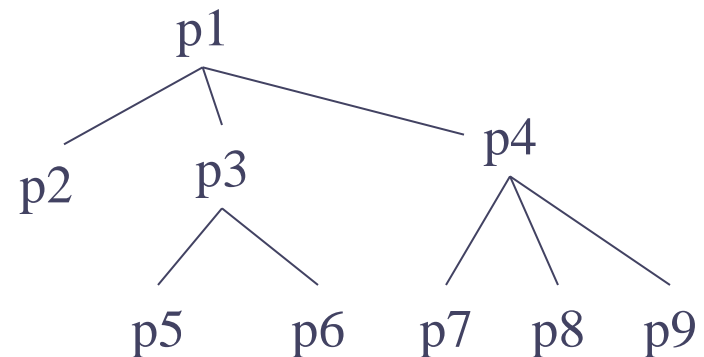
MANAGES={(p1,p2),(p1,p3),(p1,p4),(p3,p5),(p3,p6),(p4,p7),(p4,p8),(p4,p9)}

Cardinality on relationship

(1,1)   LIVES_IN   (0,n)

CITY有可能沒人住
最多可住 n 人

PERSON

(1,1)   IS_BORN_IN   (0,n)   CITY

每個人至少一個出生地
最多一個出生地

COURSE   (1,3)   MEETS   (0,40)   CLASSROOM

(0,n)
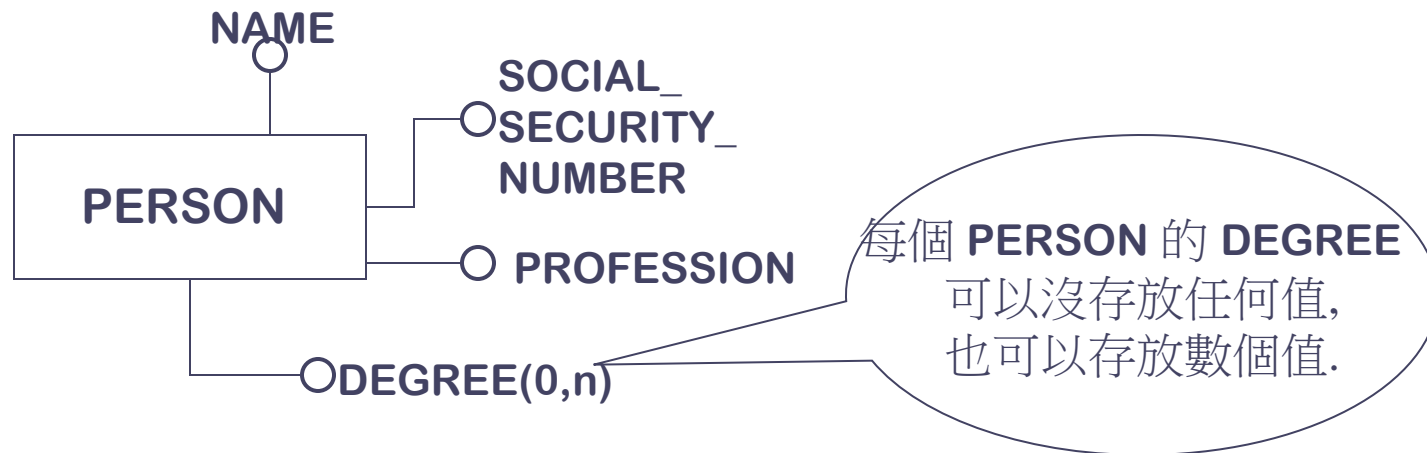
DAY

Attributes

☛ Attributes represent elementary properties of entities or relationships.

- Attributes 也有 min-max card
  - min(A,E) 代表 attribute A 的值對應於 entity E 中的 object 出現的<u>最少</u>次數.
  - max(A,E) 代表 attribute A 的值對應於 entity E 中的 object 出現的<u>最多</u>次數.

NAME

SOCIAL_ SECURITY_ NUMBER

PERSON

PROFESSION

DEGREE(0,n)

每個 **PERSON** 的 **DEGREE** 可以沒存放任何值, 也可以存放數個值.

Cardinality on Attributes

❖ 若 min(A,E)=0 則該 attribute 為 optional,
  - 即該attribute 可以是 NULL value.
❖ 若 min(A,E)=1 則該 attribute 為 mandatory,
  - 即該attribute 的值一定要存在.
  - Primary key 即為一例.
❖ 若max(A,E)=1則該 attribute 為 single value.
  若max(A,E)>1則該 attribute 為 multi-value.
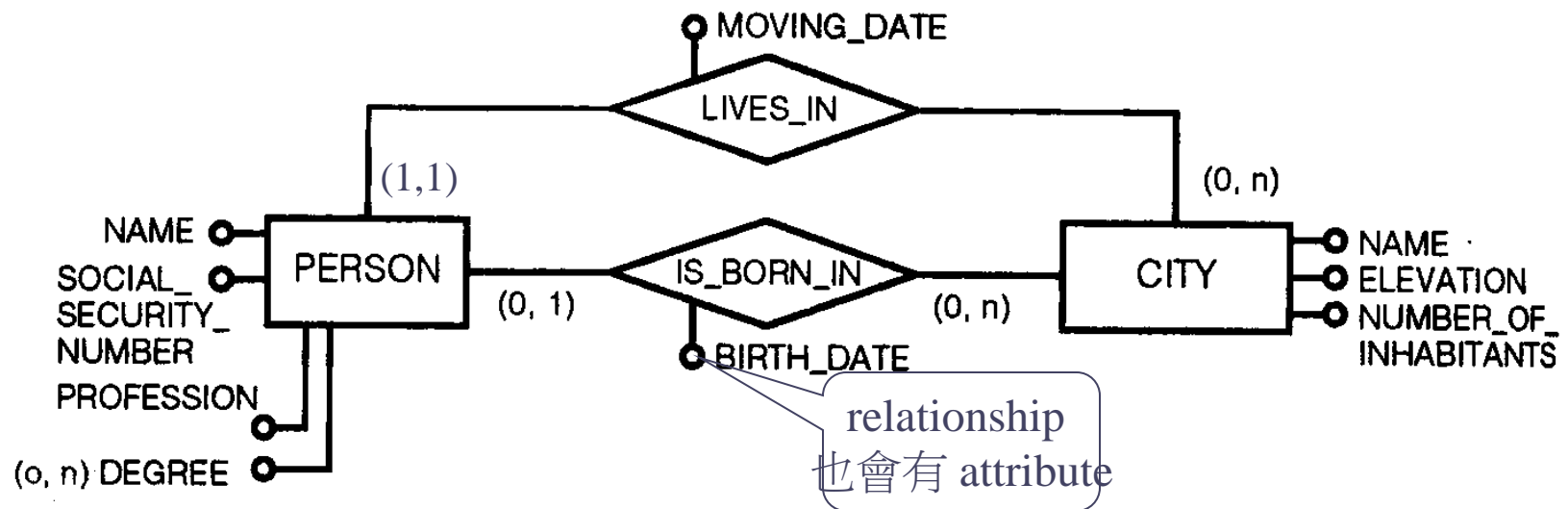❖ Attributes cardinality 通常不標出,預設值為 card(1,1) .

An ER schema example

Figure 2.20 An ER schema with entities, relationships, and attributes

➤ Attribute 一定要從某定義域(domain)裏抽出其值.
例：年齡 $domain = \{x \,|\, 0 \leq x \leq 125, x \in I\}$
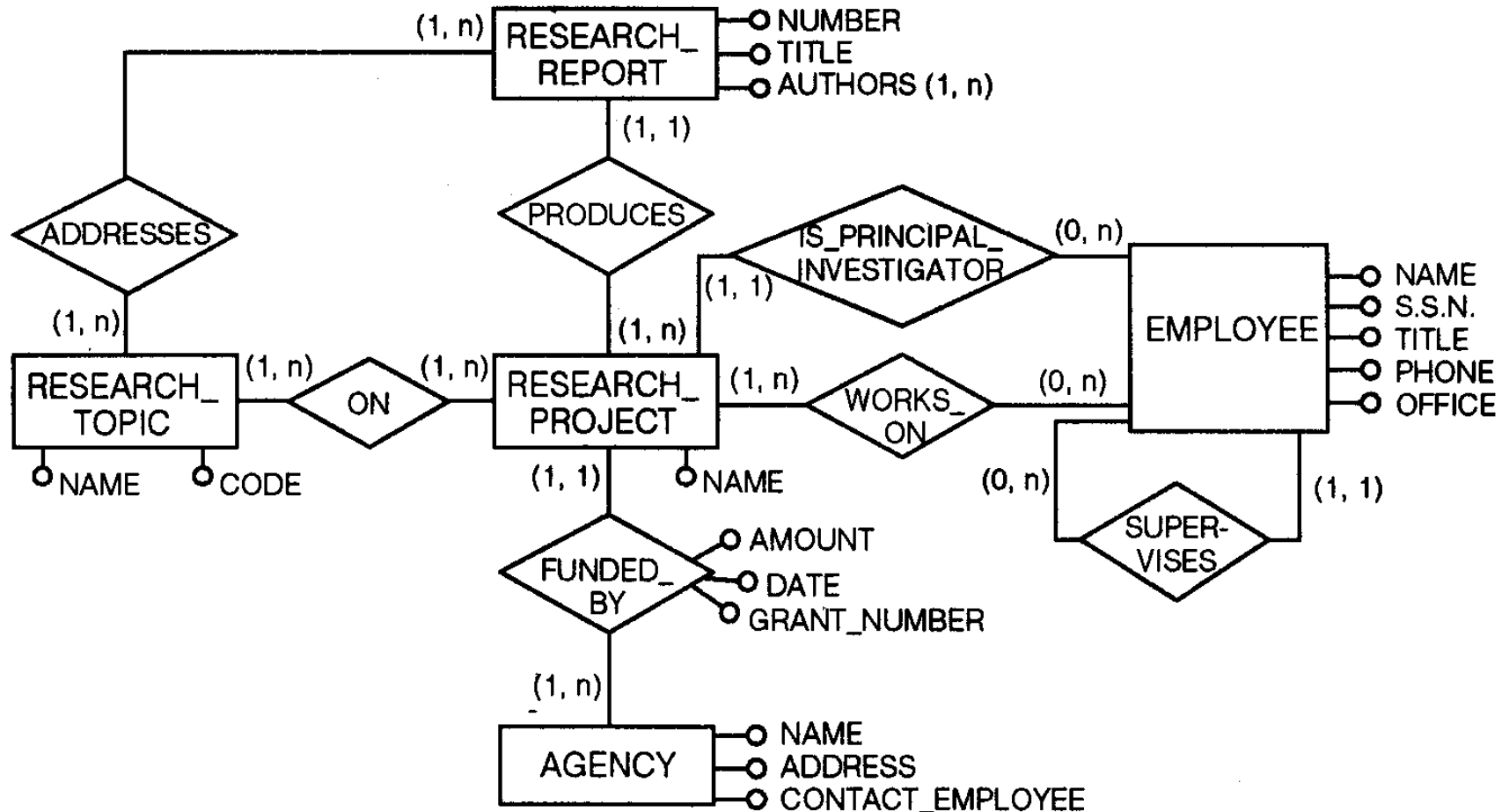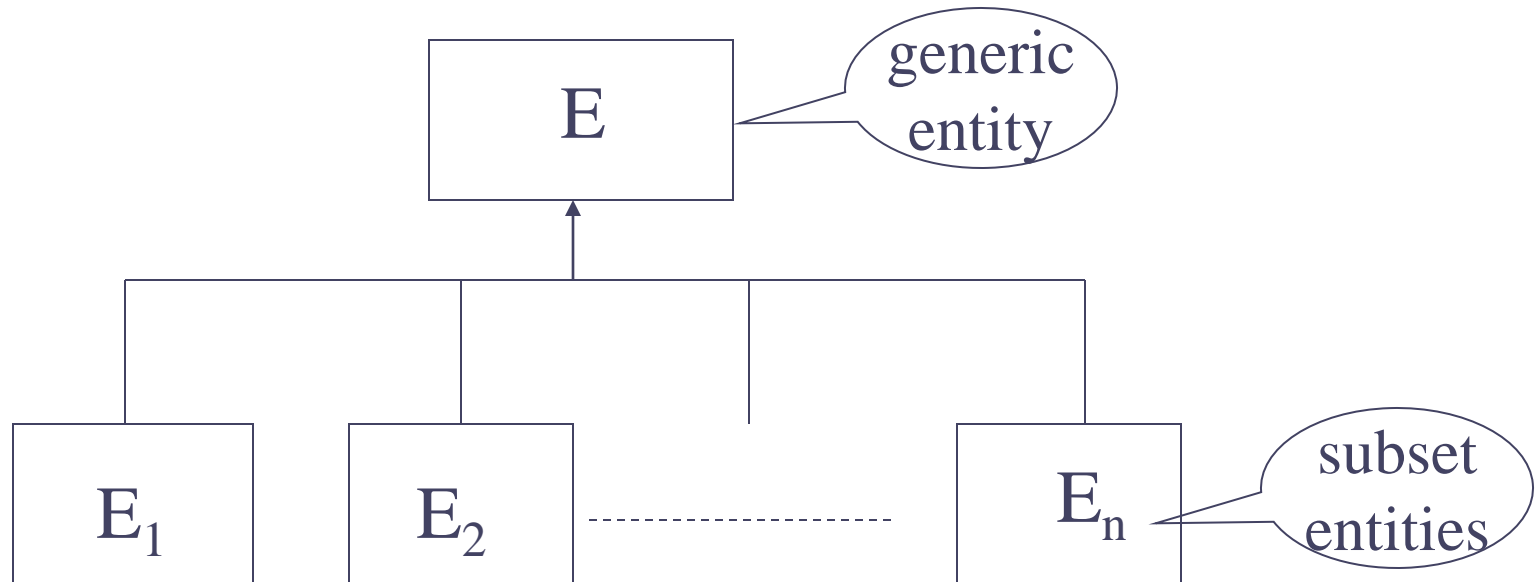
An ER diagram example

Figure 2.35 Research projects database

Generalization Hierarchies

👉 An Entity E is a generalization of a group of entities $E_1, E_2, ..., E_n$, if each object of class $E_1, E_2, ..., E_n$ is also an object of class E.

Generalization Hierarchies An Example

sex
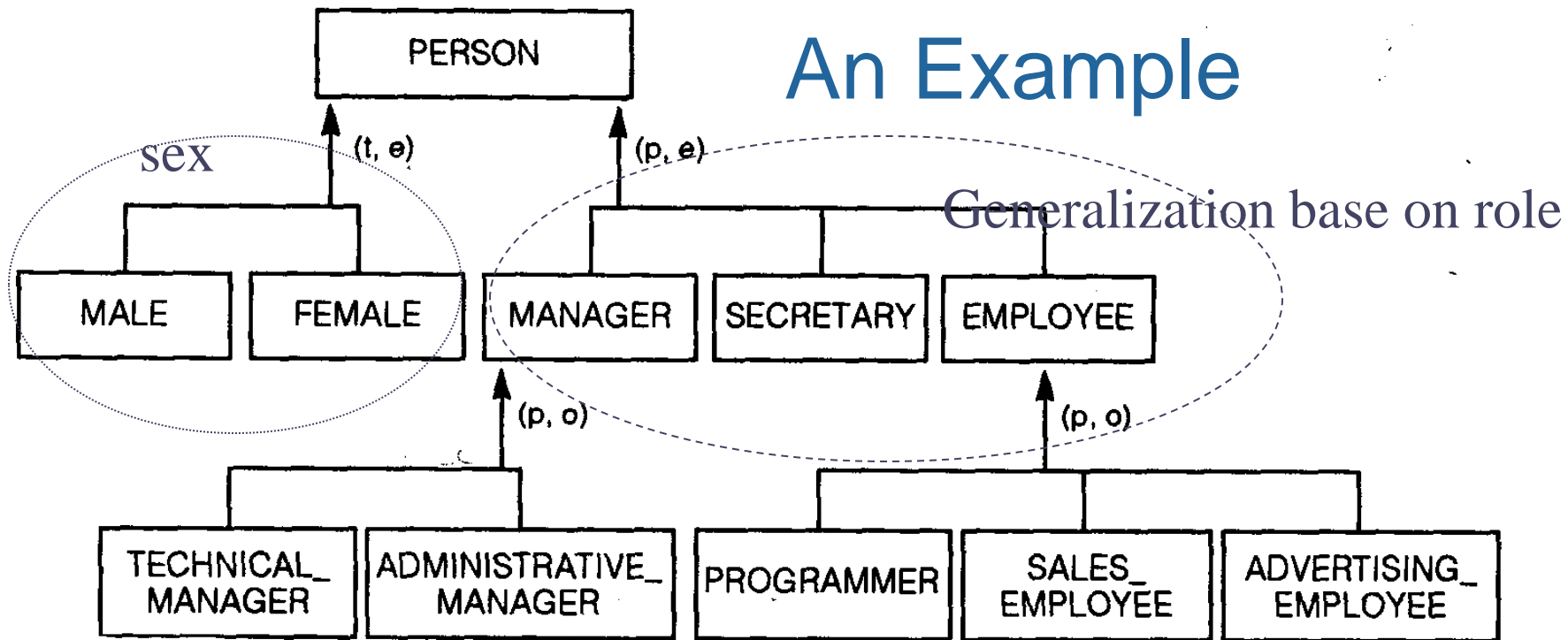
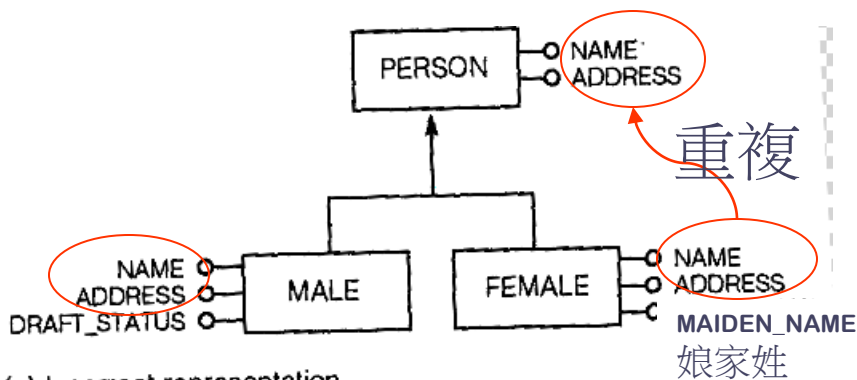Generalization base on role

Figure 2.23 Generalization hierarchy for the entity PERSON

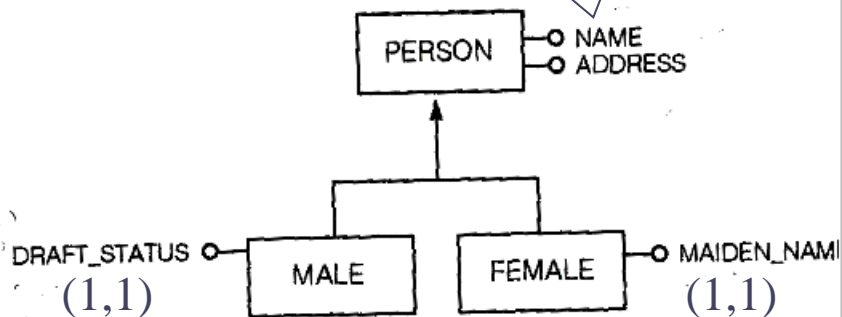➤ 考慮 coverage ➔ t/p 代表 total/partial

e/o 代表 exclusive/overlap

Generalization Hierarchies

Generic entity 中定義的 attribute, relationship &
generalization 都會自動繼承給它的 subset entities.

把共同的特性往 generic entity 放

重複

MAIDEN_NAME
娘家姓

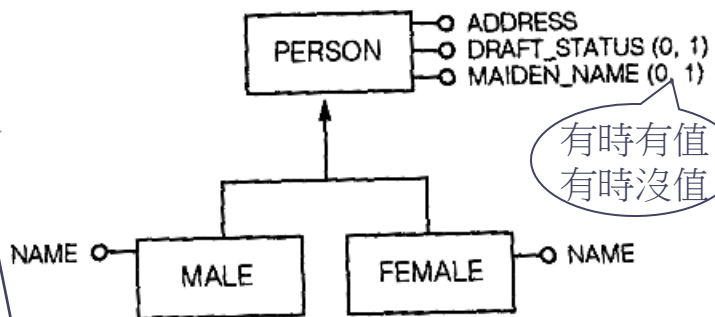(a) Incorrect representation

不理

有時有值
有時沒值

(b) Incorrect representation

(c) Correct representation

正確的表達方式

Subsets

☛ 只有一個 subset entity, 為 generalization 的特例, coverage 一定是 (p,e).

WORKER

PERMANENT WORKER

○ **DATE_OF_CONFIRMATION** (批准)
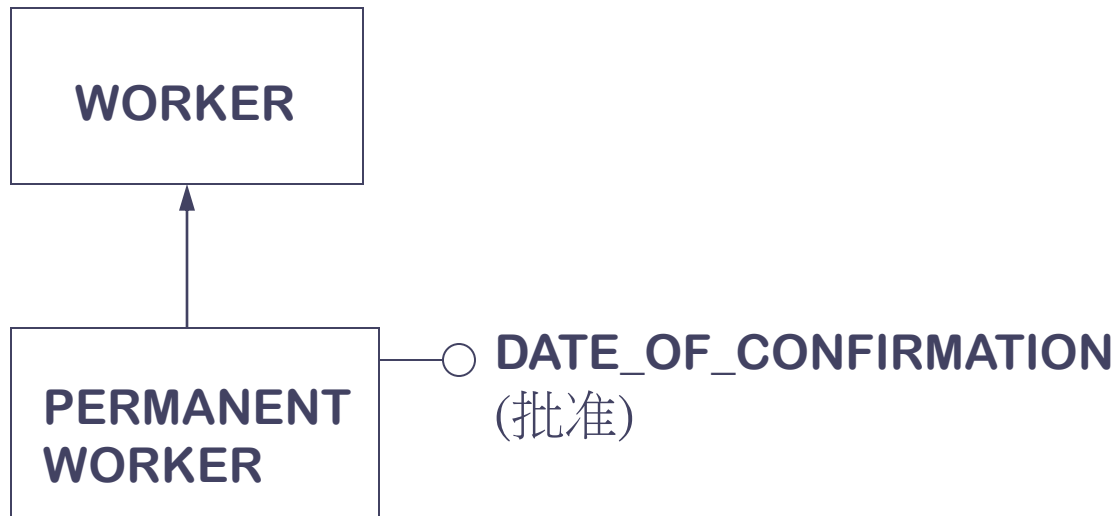
Composite Attributes

➡ 具有密切關係且常一起使用的一群 attributes.

用 ⬭—< 表示

NAME   SEX

PERSON —(0,1)— ADDRESS — STREET
                        CITY
                        STATE
                        COUNTRY

給 min-max card 時以整個 composite attribute 為單位定義.

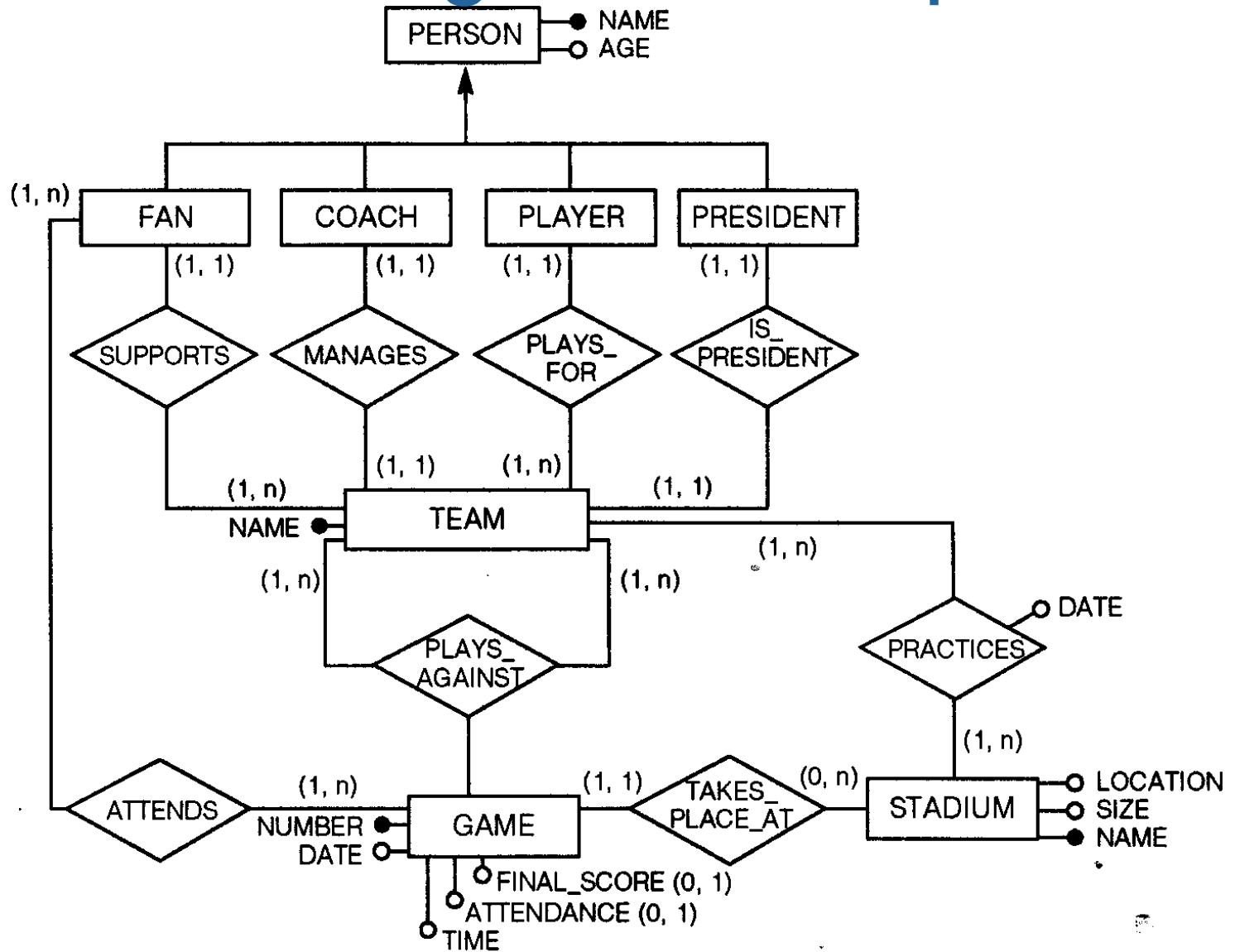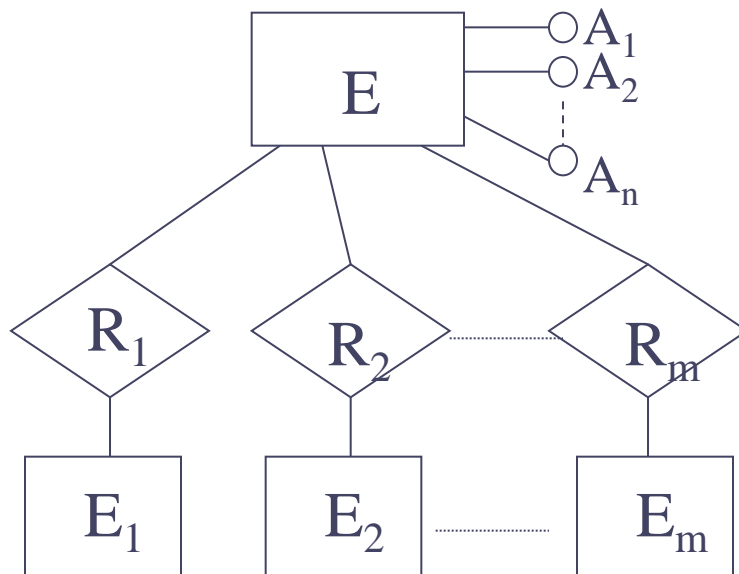# An ER diagram example

2013/6

Figure 2.34 Football database

Identifiers

👉 A collection of attributes or a collection of entities related to E having the property of uniquely determining all the instance of E.

$$I = \{A_1, ..., A_n, E_1, ..., E_m\}, n \geq 0, m \geq 0, n + m \geq 1$$

I is an identifier of E if the following properties hold:
1. There can not be two instances of E having the same identifier value.
2. If we drop any attribute A_i or entity E_i from the identifier I, property 1 no longer holds.

Identifiers

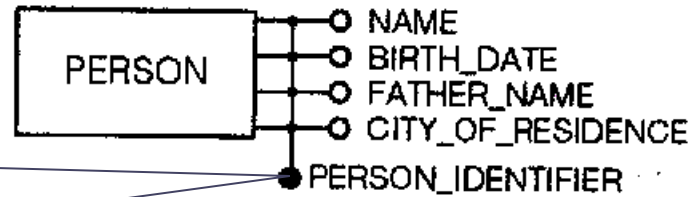$$I = \{A_1, ..., A_n, E_1, ..., E_m\}$$

❖ Identifier 中的每個 attribute 不可以有 null value, 即 card(E, A_i)=(1,1).

❖ An identifier is <u>simple</u> if *n+m=1;*

     it is <u>composite</u> if *n+m>1*.

❖ An identifier is <u>internal</u> if *m=0*;

     it is <u>external</u> if *n=0*.

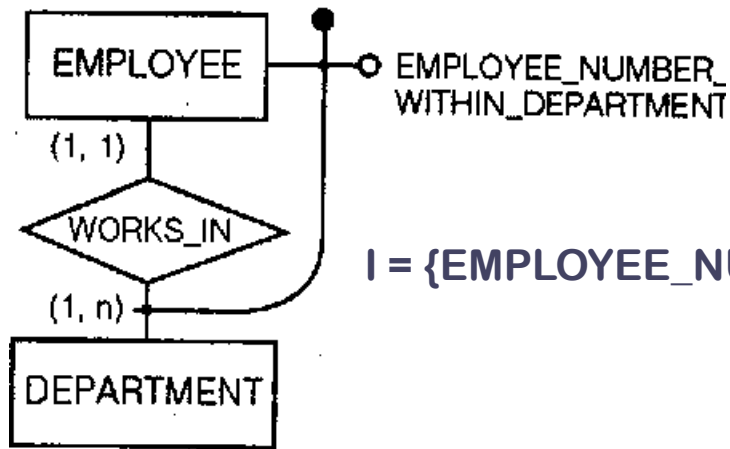❖ An identifier is <u>mixed</u> if *n>0* and *m>0*.

Identifiers

(a) Simple, internal identifier

給 composite identifier 一個名字
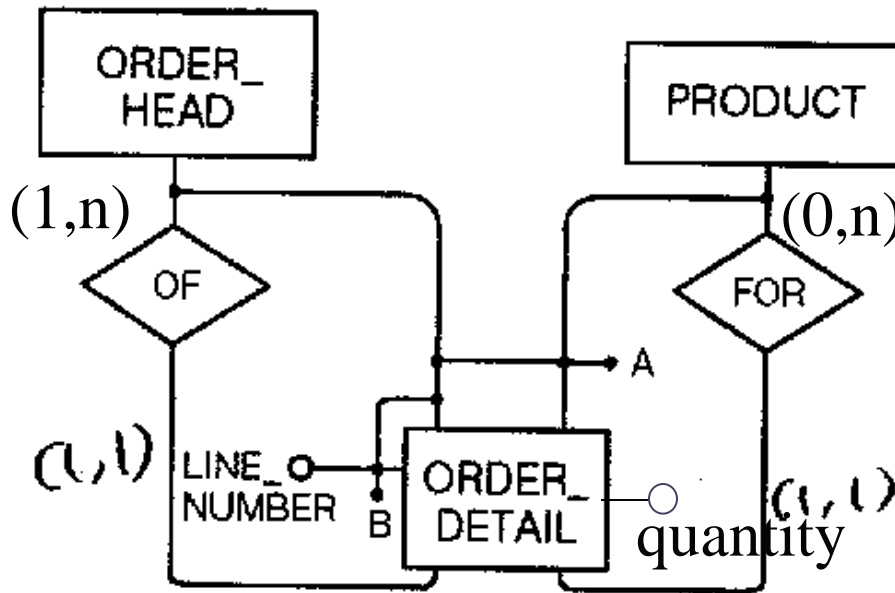
(b) Composite, internal identifier

I = {EMPLOYEE_NUMBER_WITHIN_DEPARTMENT, DEPARTMENT}

(c) Composite, external, mixed identifier

Identifiers

(d) Identifiers for the ORDER_DETAIL entity

假設
ORDER_HEAD+PRODUCT 決定唯一的 **ORDER_DETAIL**

A={ORDER_HEAD, PRODUCT}
A is external, composite.
B={LINE_NUMBER, ORDER_HEAD}
B is mixed, composite.

Weak Entity

❖ An entity that does not have a internal identifier is referred to as a *weak entity*.

❖ The existence of a weak entity depends on the existence of a strong entity; it must relate to the strong entity via a one-to-many

❖ The identifier of a weak entity is formed by the attributes of the strong entity on which the weak entity is existence dependent, plus the weak entity's attributes.

Symbols used in the ER model
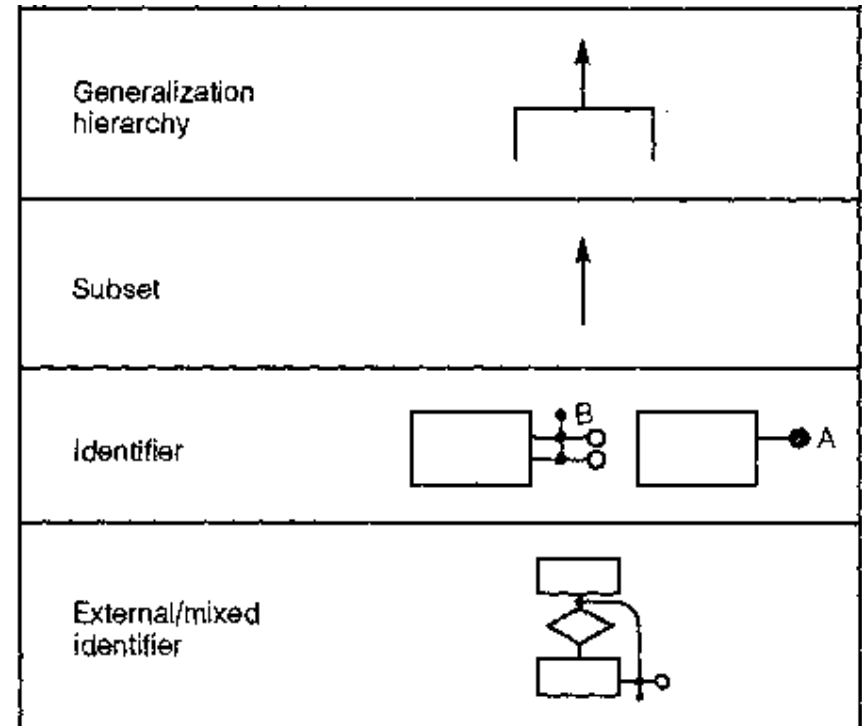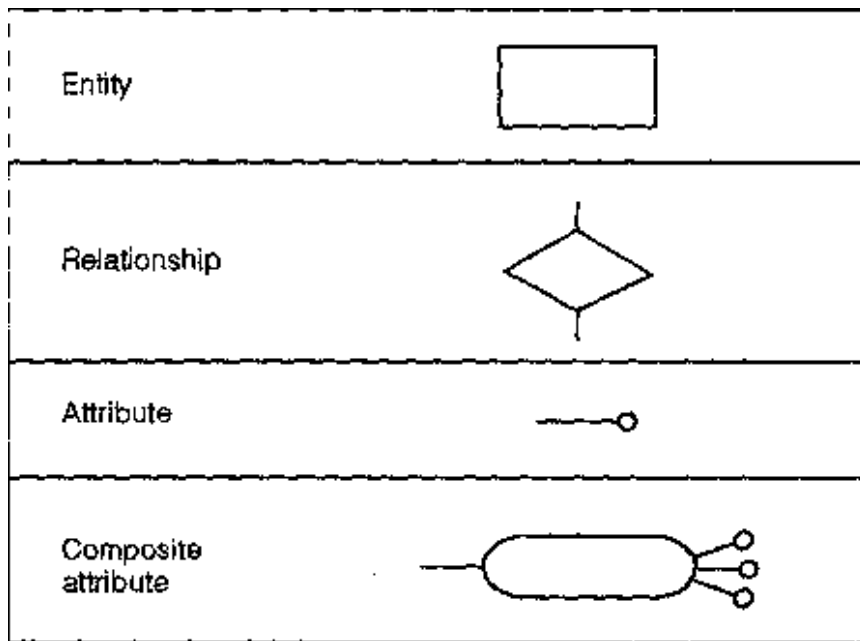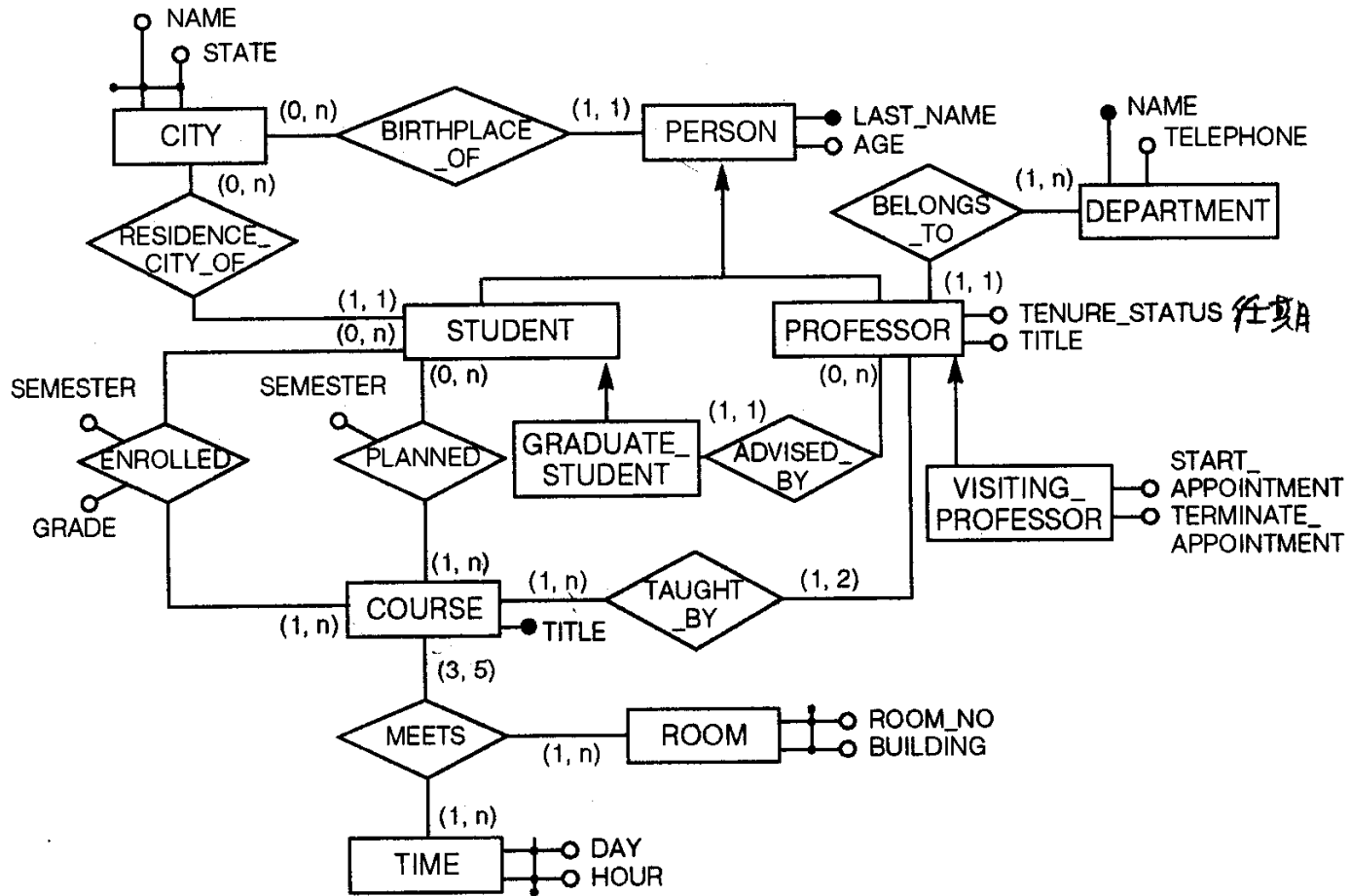
Reading the ER diagrams

Figure 2.33   University database

Exercise

1. Read the ER schema of Figure 2.35, and give a narrative description of its content. Describe all features that you can observe.

2. Propose identifiers for the entities of the schema in Figure 2.35.

3. Change the schema of Figure 2.35 in order to include several properties of employees, like sex, nationality, and date of birth.

4. Change the schema of Figure 2.35 in order to include, for specific employees doing research, their current and past research fields. Would this require any additional identifiers in Figure 2.35?
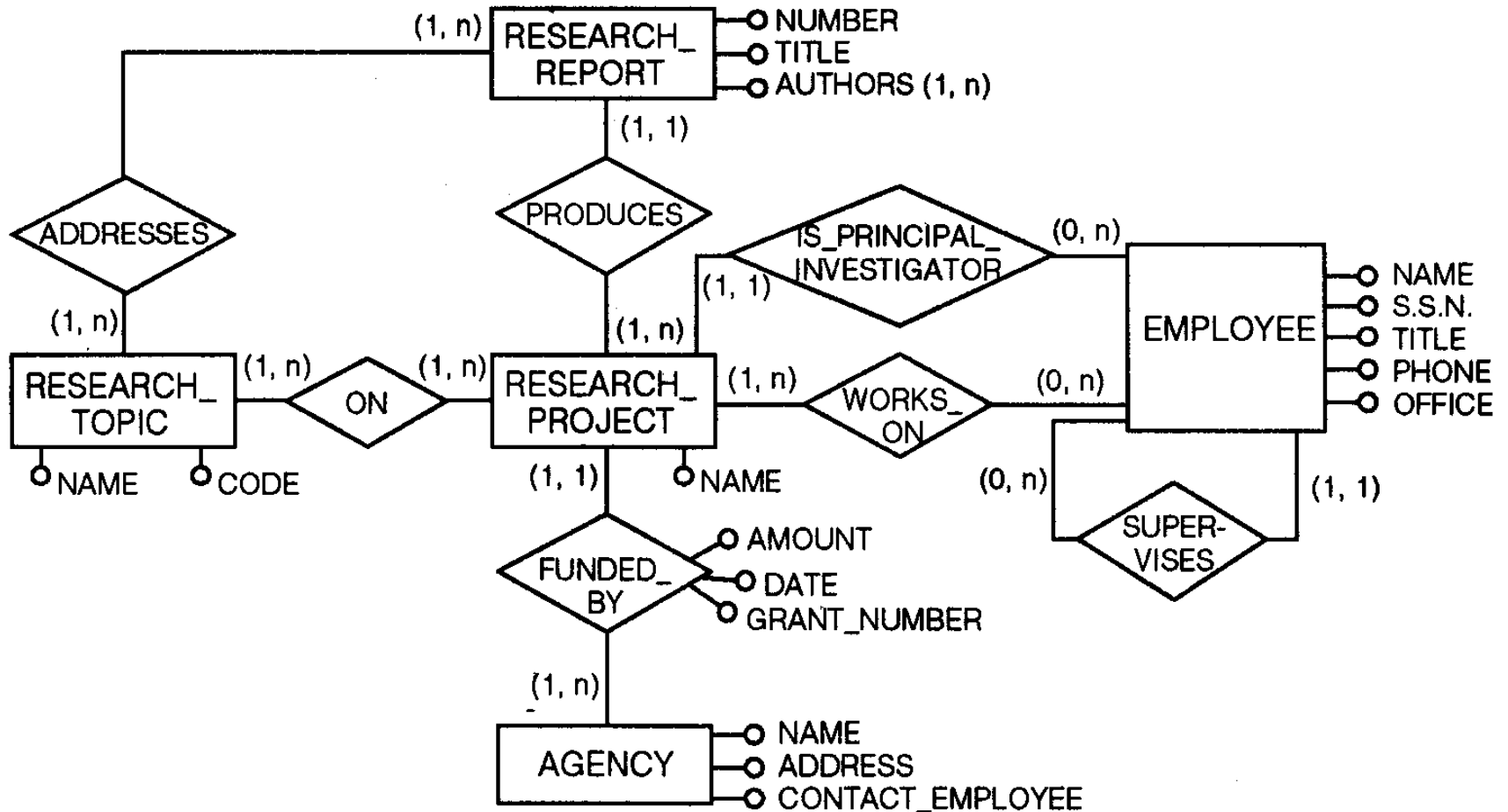
Figure 2.35　Research projects database

5. A database is being constructed to keep track of the teams and games of a sports league. A team has a number of players, not all of whom participate in each game. It is desired to keep track of the players participating in each game for each team, the positions they played in the that game, and the result of the game. Try to design an ER schema diagram for this application, stating any assumptions you make. Choose your favorite sport (soccer, football, baseball, …).