Unit 2

Data Modeling Concepts

A ***model*** is a representation of real-world objects and events, and their associations.

A ***data model*** (資料模型) is a collection of concepts that can be used to describe a set of data and operations to manipulate the data.

Purpose ⇨ To represent data.

To be understandable.

Outline

- Abstractions
  - Classification
  - Aggregation
  - Generation
- Mapping among classes
  - Binary aggregation
  - N-ary aggregation
    - Concept of cardinality
  - Coverage properties
- Model, Schema, and Data instance

Abstractions (概念抽取)

- Abstraction 是建立資料模型的重要方法
  - 把某些物件(object)的特性抽出，去掉不相關的特性，把抽象概念用某些重要的特徵來具體化。

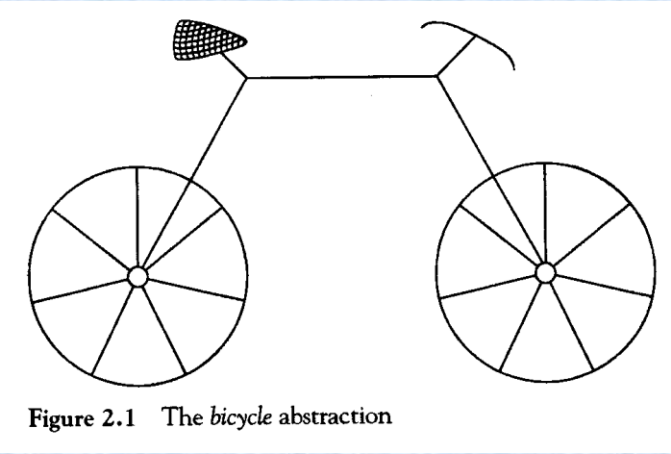


Figure 2.1 The *bicycle* abstraction

腳踏車的
鍊子？踏板？煞車？

Abstractions

- Three types of abstractions:
  - classification（分類性）
    - *is_member_of*
  - aggregation（聚合性）
    - *is_part_of*
  - generalization（一般性）
    - *is_a*

Classification （分類性）

分類性---把某些具有共同特性的物件(object)歸屬於同一類別 (class).

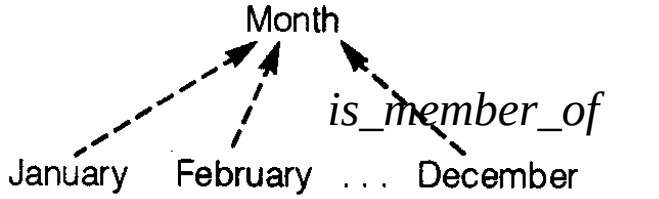


Figure 2.2 An example of classification

Object : **January, February**, . . .

Class: **Month**

January *is_member_of* **Month**

(歸屬於**)** 用 ---表示

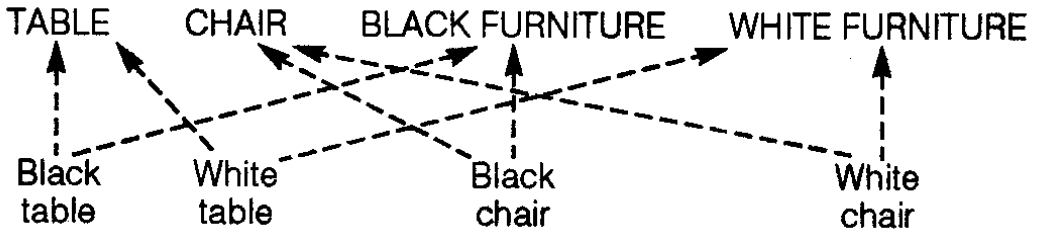


Figure 2.3 Multiple classifications for the same real-world objects

Object Black table 歸屬於 TABLE

Object Black table 也歸屬於 BLACK FURNITURE

Aggregation（聚合性）

聚合性--- 用數個類別組成一個新類別

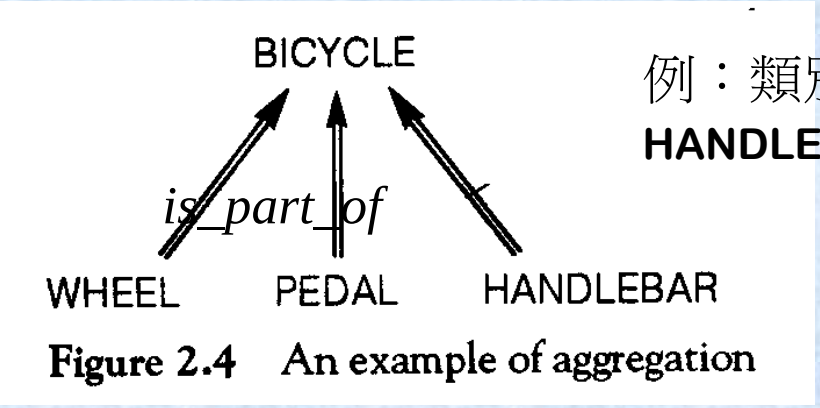


Figure 2.4 An example of aggregation

例：類別 **BICYCLE** 是由 **WHEEL, PEDAL** 和 **HANDLEBAR** 三個類別組合而成的。

PEDAL *is_part_of* **BICYCLE**

(一部份）用 ⟹ 表示

傳統檔案設計的觀念

- 用傳統檔案設計的觀念看分類性與聚合性

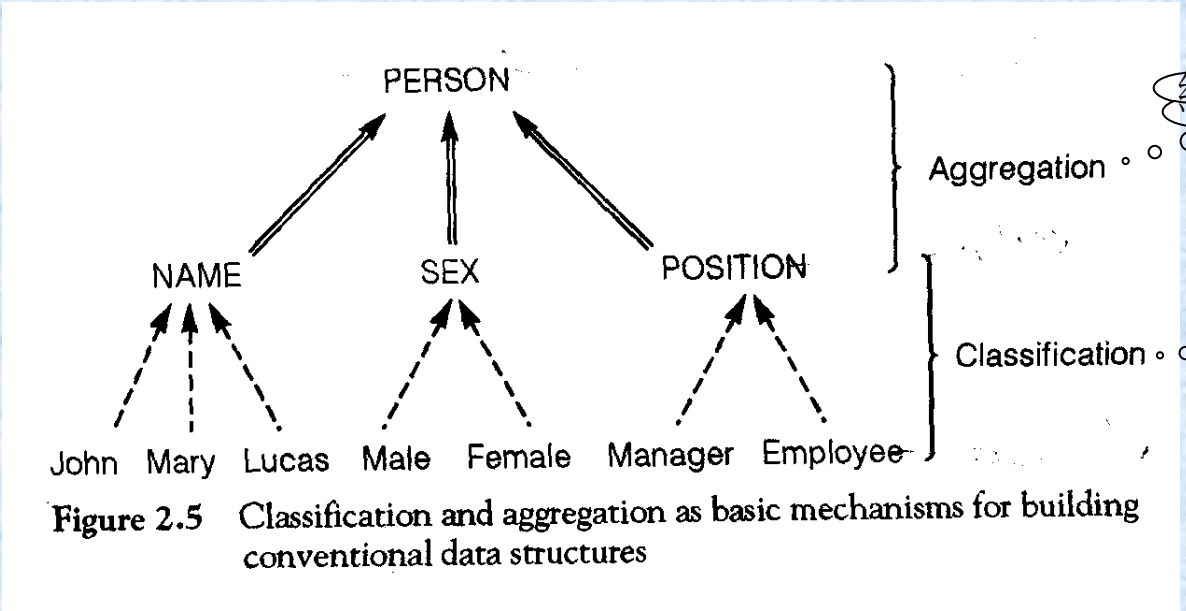


Figure 2.5 Classification and aggregation as basic mechanisms for building conventional data structures

- 習慣上 物件 (object) 名稱用小寫
  類別 (class) 名稱用大寫

Generalization （一般性）

一般性---把某些類別中的共同特性抽出，形成一共同類別。

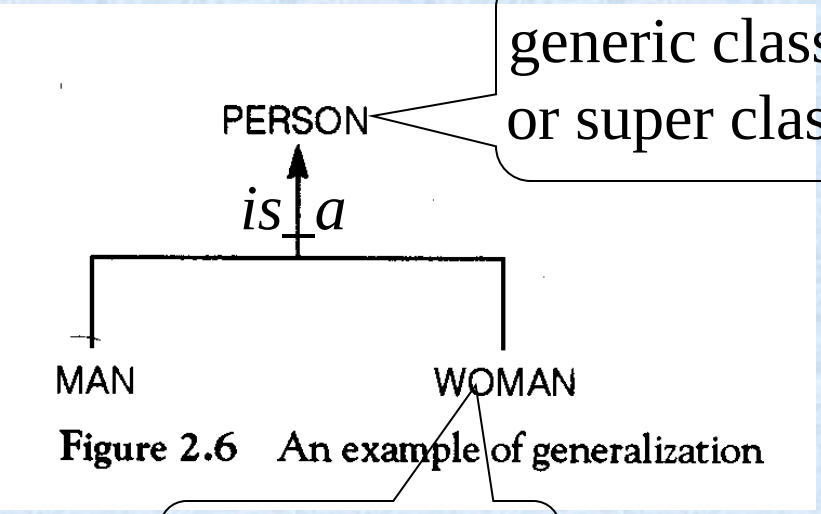


Figure 2.6 An example of generalization

- **MAN**, **PERSON** and **WOMAN** are classes.
- **MAN** *is_a* **PERSON**
  WOMAN *is_a* **PERSON**

Generalization （一般性）

⌦ 在 generic class 中, 所有的概念、特性都會繼承給 subset class.

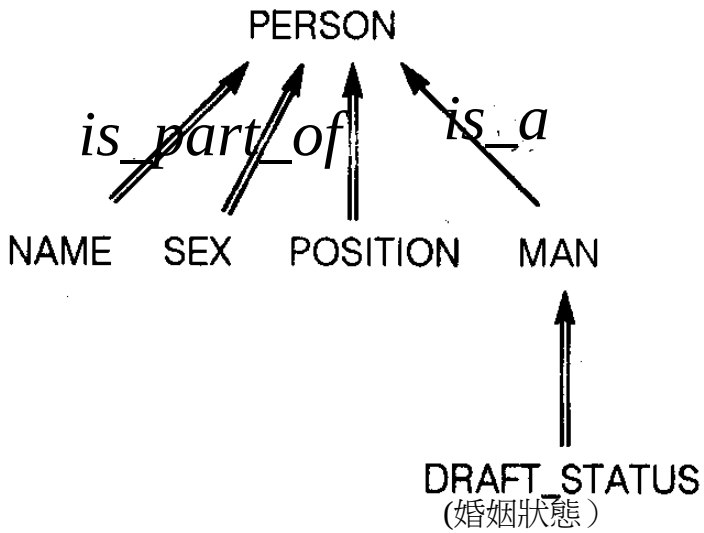


Figure 2.7 Inheritance with generalization abstractions

⌦ **PERSON** 由 **NAME, SEX, POSITION** 聚合而成.

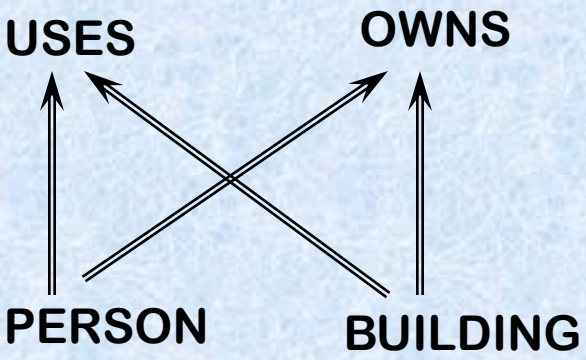
⌦ **MAN** 是 **PERSON** 的一種，所以 **MAN**亦具有**NAME, SEX, POSITION** 這三種類別屬性, 外加 **DRAFT_STATUS.**

Exercise

Consider a type of object in your room (a table, the bed, a chair), and show how it can be represented by using each one of the abstraction mechanisms discussed.

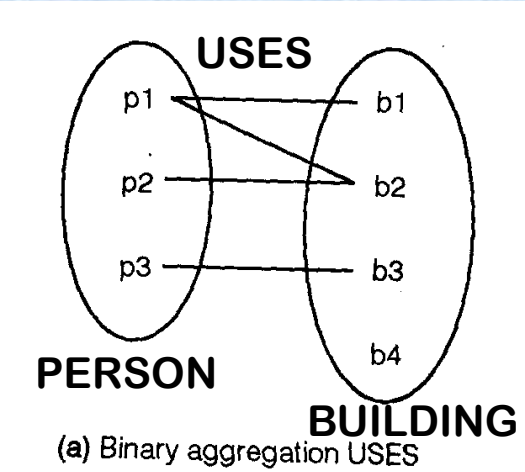
Mapping Among Classes

- Binary Aggregation (二元對應關係)
  - 把兩個類別放在一起，形成一個對應關係(relationship)。

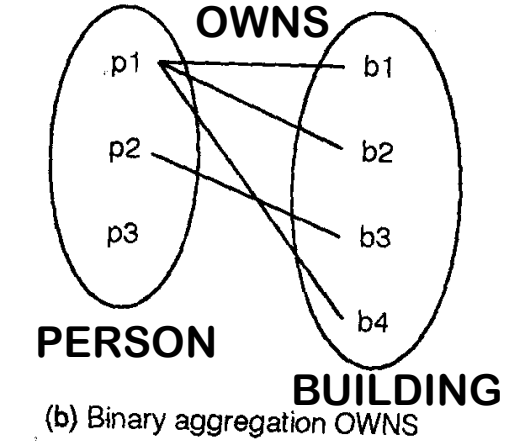


⌦ **PERSON** 和 **BUILDING** 有 **USES** 的關係，**USES** 是由 **PERSON** 和 **BUILDING** 聚合而成的。

Binary Aggregation



(a) Binary aggregation USES



(b) Binary aggregation OWNS

USES={(p1,b1),(p1,b2),(p2,b2),(p3,b3)}
p1 使用 b1,b2
p2 使用 b2
p3 使用 b3

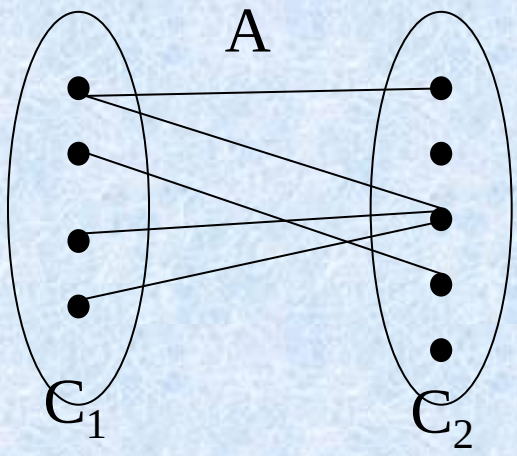
USES
- 每個人一定要有房子住
- 每個房子不一定要有人住

OWNS
- 不是每個人都擁有房子
- 每個房子一定要有主人

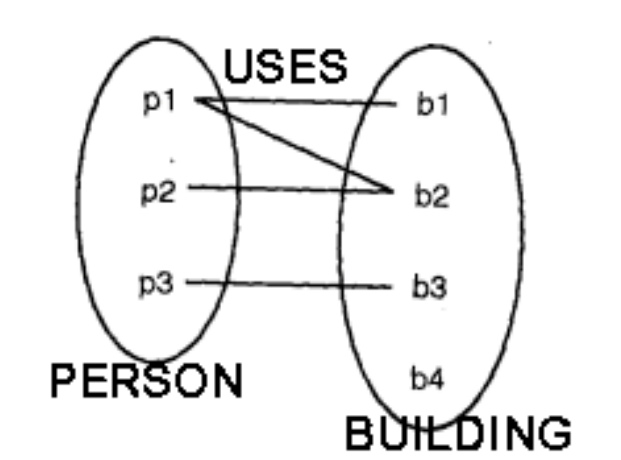
Cardinality

Let A is the binary aggregation of classes C_1 and C_2

- Minimal cardinality
  - min-card(C_1 ,A) = m 代表C_1的每個元素發生在A的最小個數.
- Maximal cardinality
  - max-card(C_1 ,A) = n 代表C_1的每個元素發生在A的最大個數.



Minimal Cardinality

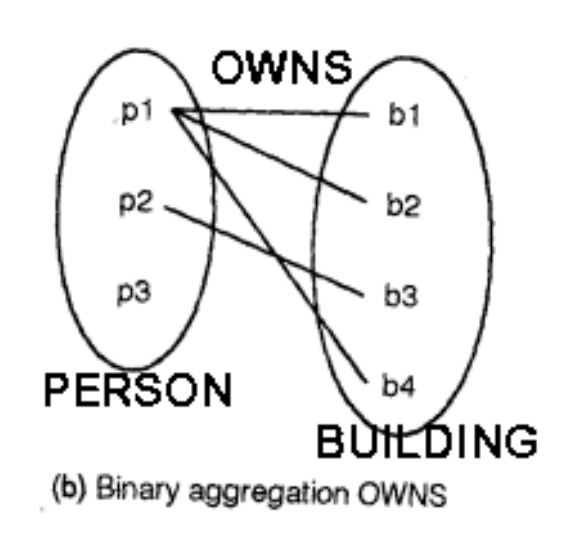


(a) Binary aggregation USES

- 若 min_card(C_1, A)=0 則稱 C_1 是選擇性參與 A (optional participation).
- 若 min_card(C_1, A)>0 則稱 C_1 是必要性參與 A (mandatory participation).

- min_card(**PERSON, USES**)=1
  每個人一定要有房子住
- min_card(**BUILDING, USES**)=0
  房子可以沒人住, 也可以有人住.

Maximal Cardinality



(b) Binary aggregation OWNS

- 若假設一間房子最多可以有兩個屋主, 則 max_card(**BUILDING, OWNS**)=2.
- 若假設每個人最多可以有三間房子, 則 max_card(**PERSON, OWNS**) = 3.
- 若假設每間房子只能有一個屋主, 且至少要有一個屋主, 則

  max_card(**BUILDING, OWNS**)=1.

  min_card(**BUILDING, OWNS**)=1.

  可簡寫為 card(**BUILDING, OWNS**)=(1,1).

- min_card & max_card 可以簡寫為 card(C_1 ,A)=(m,n).

Cardinality Example

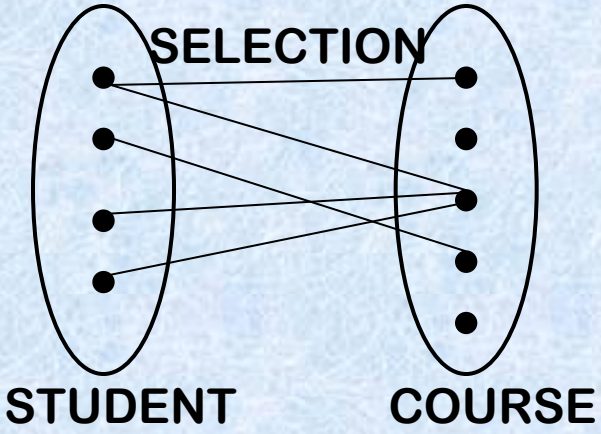


Figure of data instance

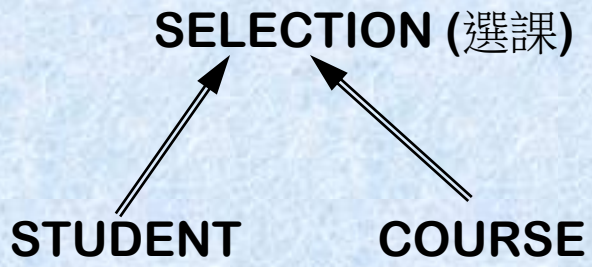
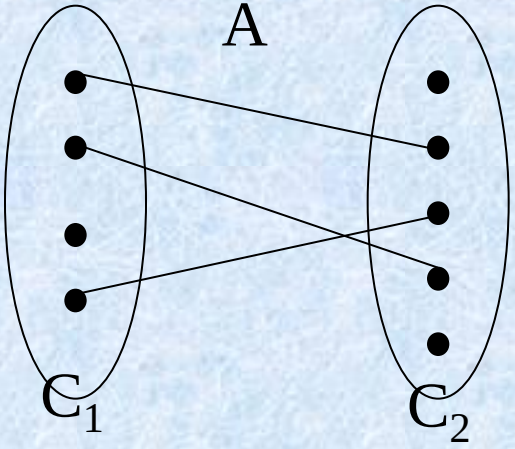


Figure of conceptual structure

max_card(**STUDENT, SELECTION**)=6
max_card(**COURSE, SELECTION**)=70
min_card(**STUDENT, SELECTION**)=2
min_card(**COURSE, SELECTION**)=15

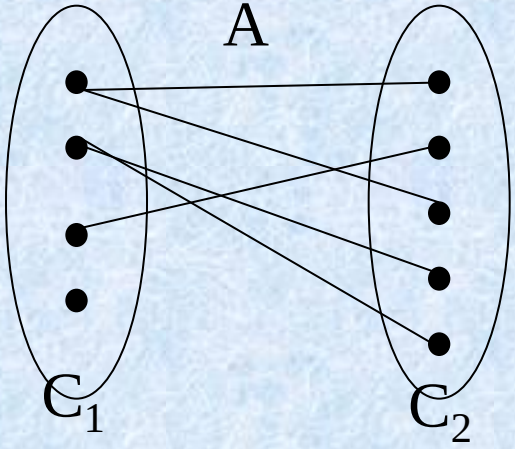
Aggregation Between Two Classes

(a) one-to-one



max_card(C_1,A)=1
max_card(C_2,A)=1

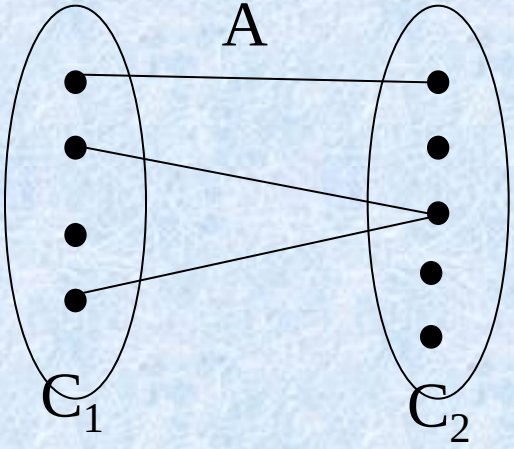
(b) one-to-many



max_card(C_1,A)=n
max_card(C_2,A)=1

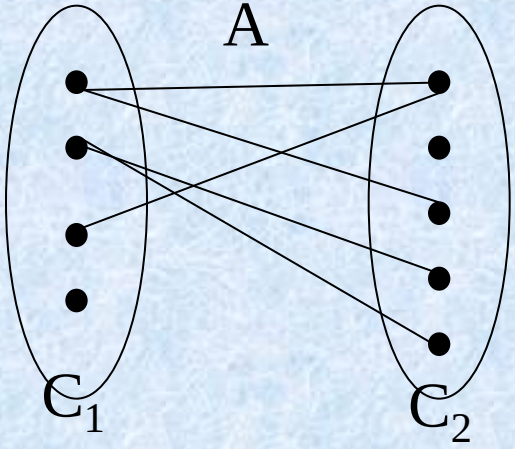
Aggregation Between Two Classes

(c) many-to-one



max_card(C_1,A)=1
max_card(C_2,A)=n

(d) many-to-many

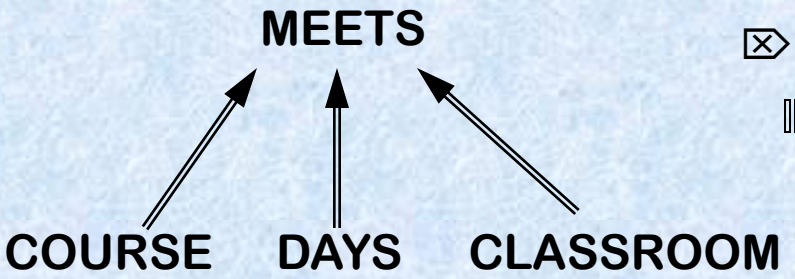


max_card(C_1,A)=n
max_card(C_2,A)=n

N-ary Aggregation (多元對應關係)

- A is a ternary (三元) among classes O, P, Q

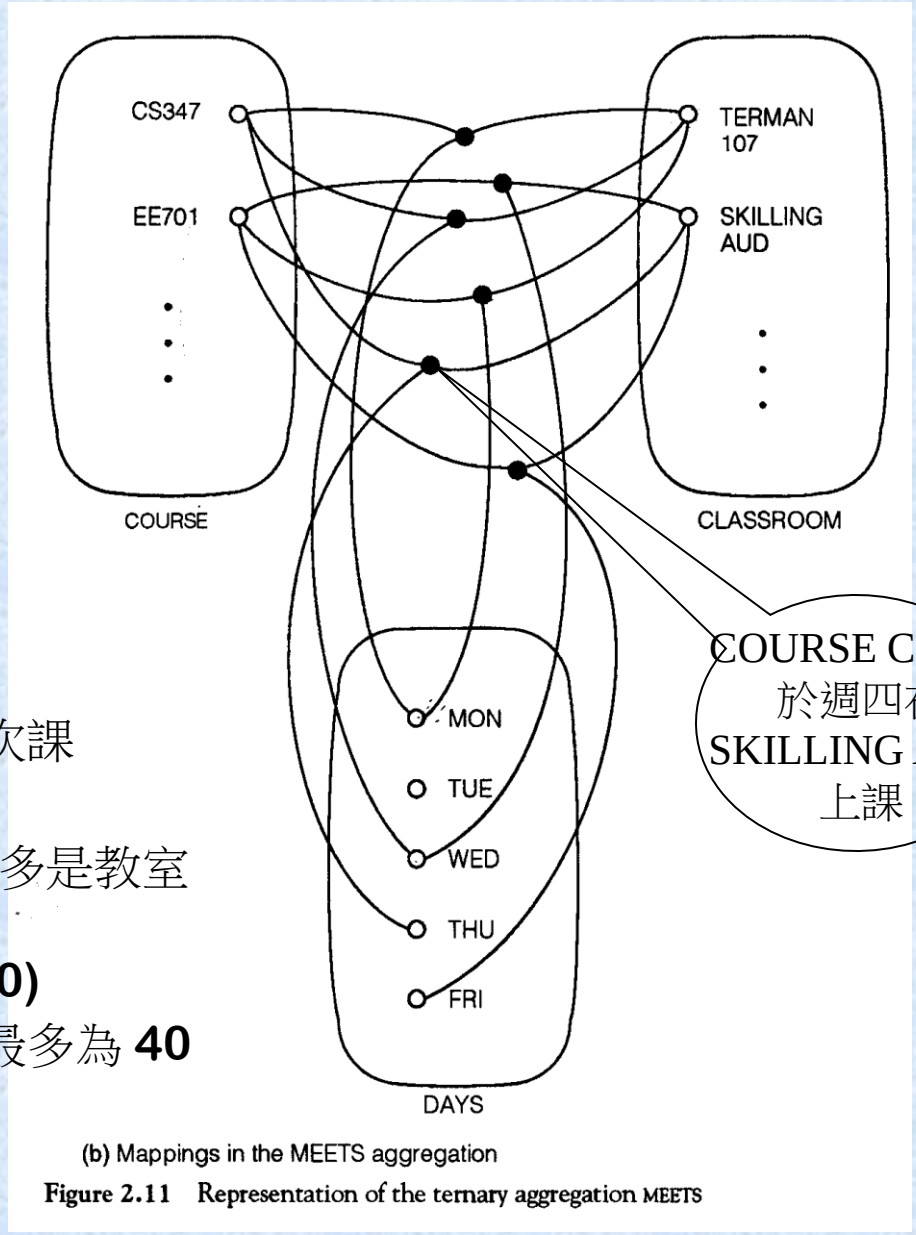
  then A={(o_1,p_1,q_1), (o_1,p_2,q_2),…}.



- 某課程星期幾在哪間教室上課
  - ⇒ 產生一個 **MEETS** 元素

Ternary Aggregation Example

- 找某課程開課班級
- 找某教室上課情況
- 找某天上課課程及教室



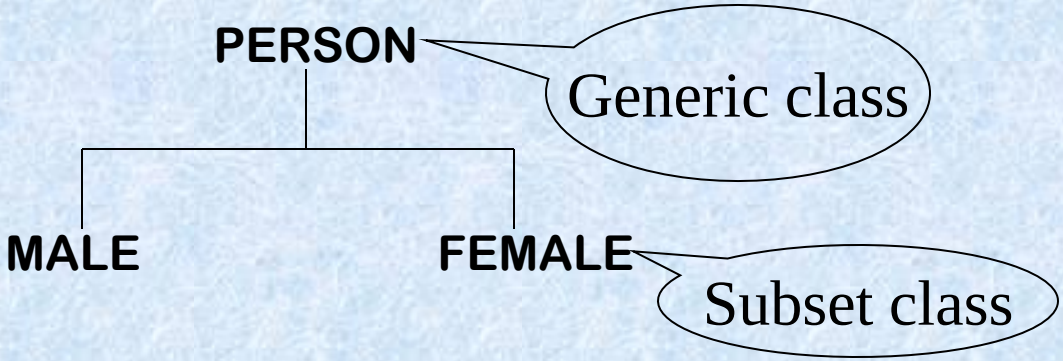
(b) Mappings in the MEETS aggregation

Figure 2.11 Representation of the ternary aggregation MEETS

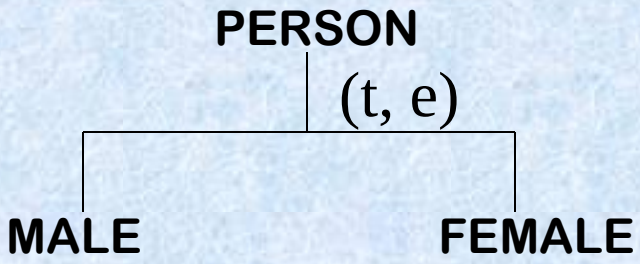
- **card(COURSE,MEETS)=(1,3)**
  每門課每週最少上一次課, 最多上**3**次課
- **card(DAY, MEETS)= (0,n)**
  一天之內可以有幾次課數不限, 但最多是教室個數乘以每天**8** 堂課
- **card(CLASSROOM, MEETS)=(0,40)**
  每個教室一週內使用堂數最少為**0**, 最多為 **40 (8x5).**

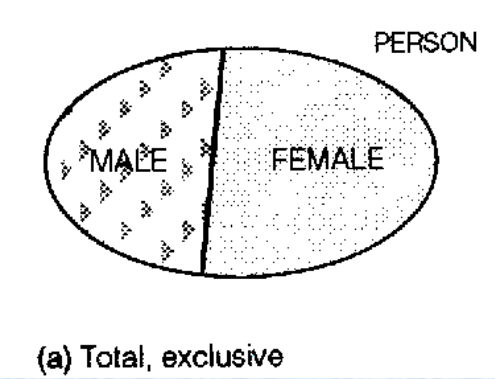
Mapping on Generalization

- About the mapping from the generic class to the subset classes
  - Coverage properties
    - total or partial coverage (t/p)
    - exclusive or overlapping coverage (e/o)



Mapping on Generalization

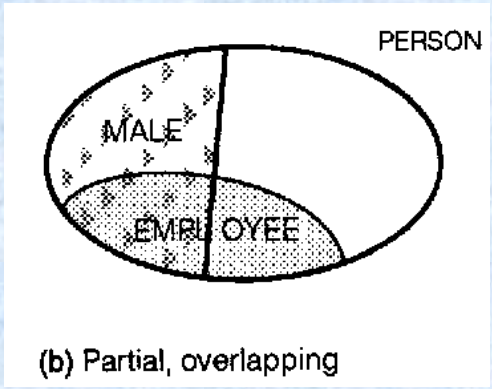




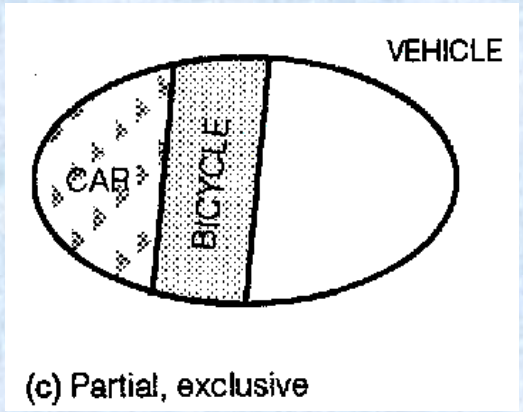
⌦ **MALE + FEMALE** 可以包括所有的 **PERSON** (total coverage).

⌦ **MALE** 和 **FEMALE** 是互斥的 (exclusive coverage).

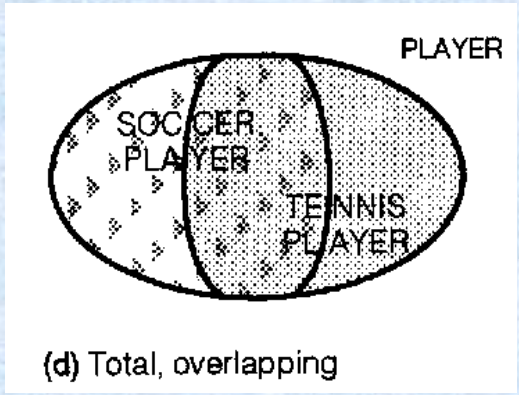
Mapping on Generalization



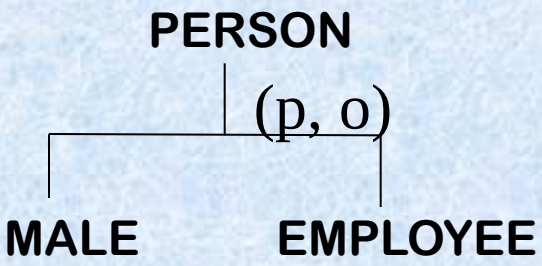
(b) Partial, overlapping

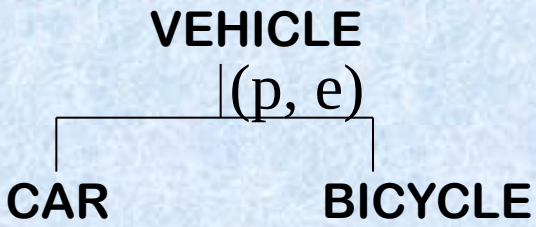


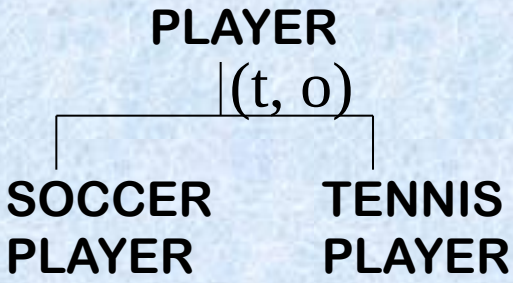
(c) Partial, exclusive



(d) Total, overlapping

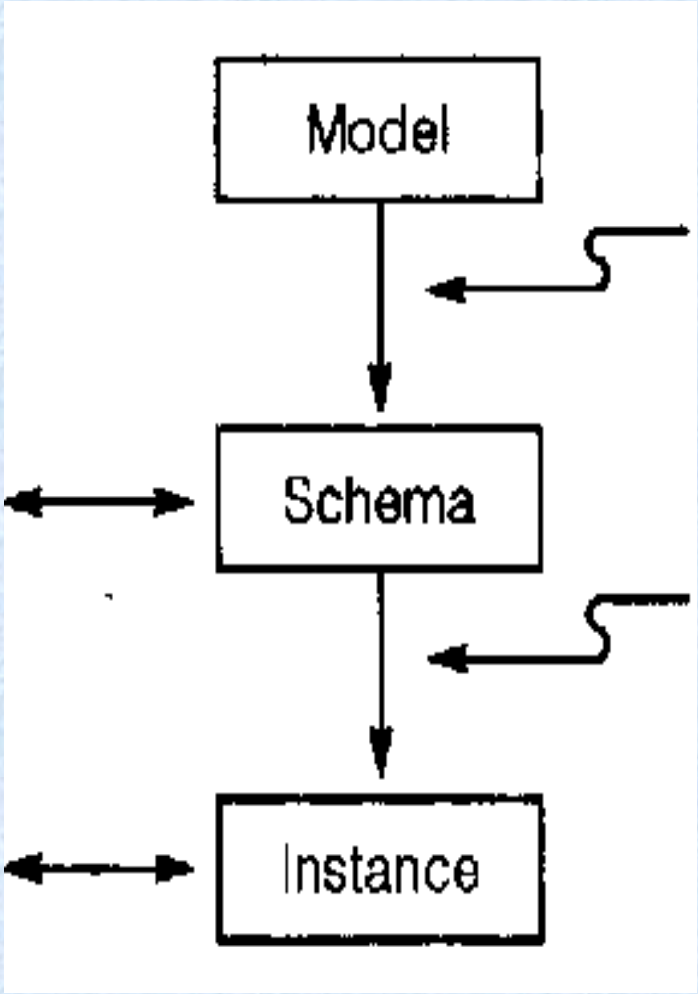






Model v.s. Schema

- Model 是一種工具，用來表達抽象觀念的一種方式。
  - 例如：地圖、五線譜、E-R model.
- Schema 是某一特定抽象觀念，用 model 表達出之架構。
  - 例如：台北市地圖、公司的人事組織圖、人事系統之 E-R diagram.
- Instance 是根據 schema 之架構下發生的資料值。



Model 提供表達資料的方法

看到資料的架構

Schema 提供資料架構與格式以便存入有效用的資料內容

看到資料值（隨時間會改變內容）

Example between Model, Schema and Instance

① Relation data model 是一種資料庫模型

② 用 relation data model 繪出一資料庫架構 (schema)

例：PERSON(Name, Sex, Address, ID-no)
CAR(Plate, Make, Color)
OWNS(ID-no, Plate)

③ 根據資料庫架構存放資料內容

CAR		
CA 13718	Maserall	White
FL 18MIAI	Porsche	Blue
CA CATA17	Datsun	White
FL 171899	Ford	Red

PERSON			
John Smith	M	11 West 12 St., Ft. Llauderdale	387-6713-362
Mary Smith	F	11 West 12 St., Ft. Llauderdale	389-4816-381
John Dole	M	1102 Ramona St., Palo Alto	391-3873-132

OWNS	
387-6713-362	FL 18MIAI
387-6713-362	FL 171899
391-3873-132	CA 13718
391-3873-132	CA CATA17

Exercises

1. Give some examples of generalization abstractions, and show how the inheritance property applies to you examples.
2. Discuss how coverage properties related to cardinality constraints. (*Hint*: interpret generalization hierarchies as special types of mapping among classes.)