Basic Object Design

C++ Object Oriented Programming

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NTOUCS

Contents

- Object Oriented Analysis/Design

Contents

- Object Oriented Analysis/Design
- Elements of a well-designed class

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- Object Oriented Analysis/Design
- Elements of a well-designed class
  - Strong Cohesion

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- Object Oriented Analysis/Design
- Elements of a well-designed class
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  - Completeness and Convenience

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  - Loose Coupling

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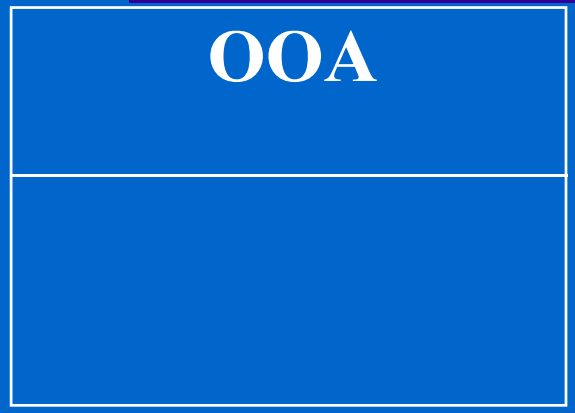
  - Noun-verb analysis example
  - Tentative classes

Object Oriented Analysis/Design

Object Oriented Analysis/Design



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  - What are the classes in the system?
  - What are the operations and attributes?
  - What are the inheritance relationships?

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  - How is the system constructed with the objects?

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What objects do I need to implement the system?	How do I integrate the objects to make the system work?	How do I use the programming lang to create each object?

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  - What are the inheritance relationships?
- Object-Oriented Design (OOD)
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  - identification of any super-classes.

  specification of the behaviors of the identified classes.

Basic Object Design

Objects in general have two important properties:

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  - a lecture theatre "knows" its location, capacity etc.

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  - a student "knows" his name, address, age, ID, courses studied ...
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The information that an object maintains determines its state.

The individual components of information are known as the objects ***attributes***.

Basic Object Design (cont'd)

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The actions that an object can perform are known as its behaviours.

When applying an ***object-orientated analysis & design*** to a problem specification we ***identify objects***, ***record their states***, and ***specify their behaviours***.

Specifying Good Objects

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Cohesion

- A good class describes a single abstraction

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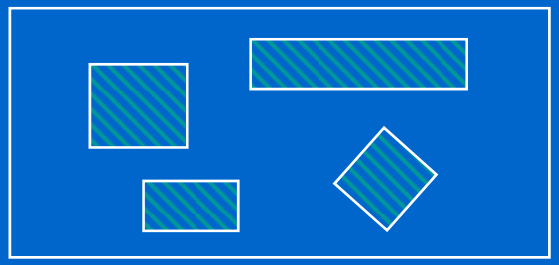

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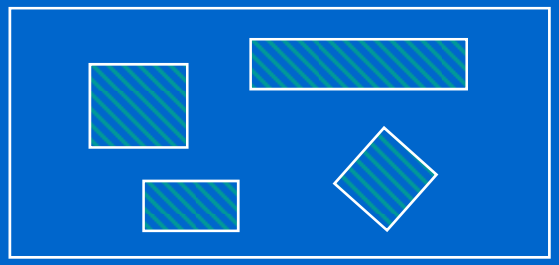

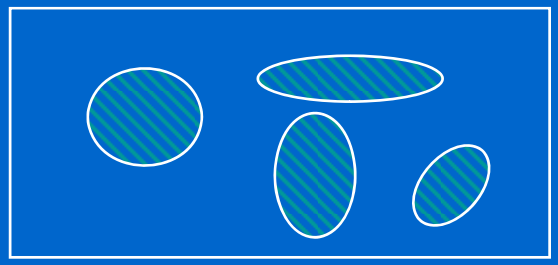

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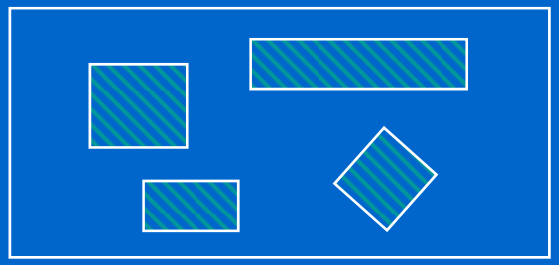

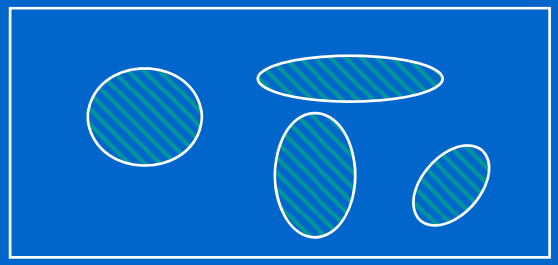

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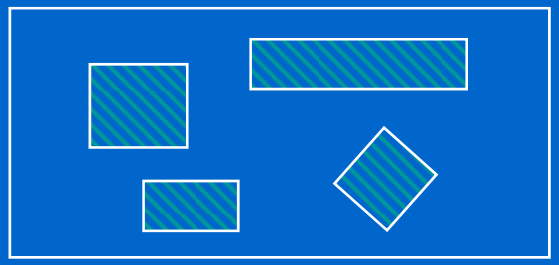

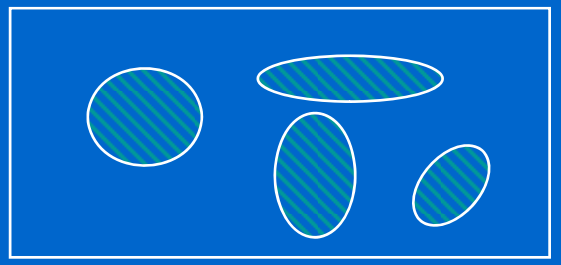

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class Mail {
public:
    void sendMessage() const;
    void receiveMessage();
    void displayMessage() const;
    void processCommand();
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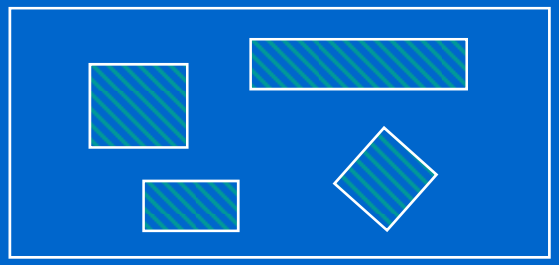

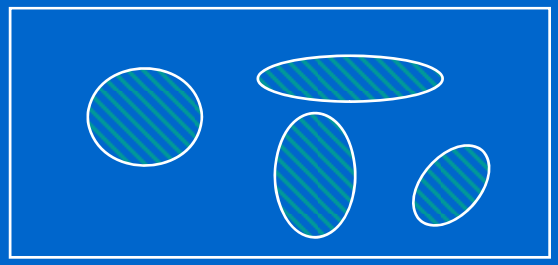

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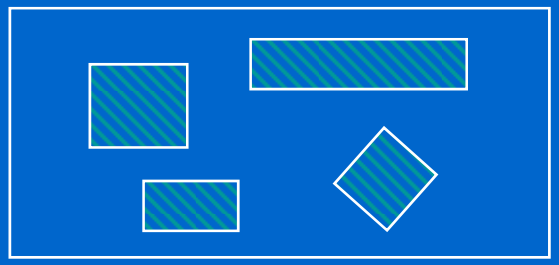

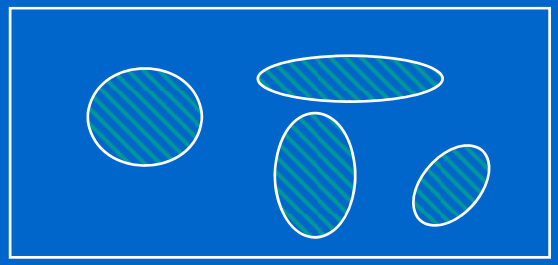

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Why does this class lack cohesion?

- To achieve good cohesion, you must classify objects into groups with **close functionalities**.

Completeness and Convenience

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class String {
public:
   String(char *inputData);
   void displayString() const;
   char getLetter(int slot) const;
   char getLength() const;
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  - What would be **desirable** but not **essential** features?

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char getLetter(int slot) const;
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char getPreviousLetter() const;
char getNextLetter() const;
char findLetter(char letter) const; // find first occurrence of letter
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  - A class stuffed with **unnecessary** features is not convenient.

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class Data {
public:
   Data(); ~Data();
   Data(char *name, int weight, int height);
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   void setHeight(int height);
   int returnWeight();
   int getSize();
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   void drawLine(int x, int y); // absolute coordinate
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Without these descriptions, it is hard to guess what functions of this class are about.

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Coupling

- Classes with many interconnections are *highly coupled*.

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   fileReferenceNum
public:
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```
class Math { // returns sine or cosine of current data in file
public:
   double sine(Input source, long &fileReferenceNum);
   double cosine(Input source, long &fileReferenceNum);
};
```

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```
void main() {
   Math mathObject;
   Input inputObject;
   long fileReferenceNum = 0; // do not forget initialization
   cout << mathObject.sine(inputObject, fileReferenceNum);
}
```

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class Input { // returns data from file at location
   fileReferenceNum
public:
   double readFromFile(long &fileReferenceNum);
};
```

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class Math { // returns sine or cosine of current data in file
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   double sine(Input source, long &fileReferenceNum);
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Reduce Coupling

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class Input {
public:
   Input();  // will set m_refNum to zero
   double readFromFile();
private:     // will take care of m_refNum
   int m_refNum;
};
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```
class Math {
public:
   Math(Input &);
   double sine();       // will handle m_data
   double cosine();     // automatically
private:
   Input m_data;
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   double cosine();     // automatically
private:
   Input m_data;
};
```

```
void main() {
   Input inputObject;
   Math mathObject(inputObject);
   cout << mathObject.sine();
}
```

Reduce Coupling

- Encapsulation reduces coupling

```
class Input {
public:
   Input();  // will set m_refNum to zero
   double readFromFile();
private:     // will take care of m_refNum
   int m_refNum;
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- Avoid passing a great amount of data across object boundaries. Object should provide abstract and simple services.

- As opposed to the *data flow* design methodology, in which data flows along processing units, object oriented/based programming design objects to keep and handle data intelligently. Put all responsible objects together with close links for accomplishing a specific work without looking into their detailed processed data.

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- What about the data members?
  These are hashed out after all the CRC cards have been prepared.

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Constructors	**Default set the array to size 0** **Non default sets the array to a size specified by the client**
Destructors	**Deletes the memory associated with the array**
Operations **Mutators** **Accessors**	 **Insert data into a specified slot** **Retrieve data from a specified slot**
Fields	**m_dataSize** **m_data**

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- Codes

```
class Array {
public:
   Array();
   Array(int arraySize);
   ~Array();
   void insertElement(int element, int slot);
   int getElement(int slot) const;
private:
   int m_dataSize;
   int *m_data;
};
```

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```
/* function: getElement
 * Usage: value = getElement(slot);
 * ----------------------------------
 * Returns the integer in the array corresponding to slot.
 * The first element is slot zero.  If the slot is out of range
 * kError is returned, which is currently zero.
 */
int Array::getElement(int slot) {
}
```

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  "That's a fundamental question for which there is no easy answer." -- R. Gabriel, designer of Common Lisp Object System (CLOS)

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- **Verb analysis**: **assign students, input sections, rank by preference, collect into database, indicate database is complete, optimize results, store results in file**

Tentative Classes

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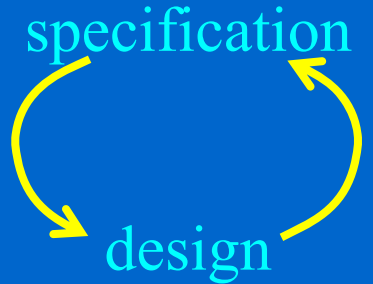

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- 昨天我去剪頭髮，看到店裡的客人蠻多的，就問店員：現在可以馬上剪嗎？店員回答我：可以啊。在我坐下來後，店員走到我旁邊問我：你有指定的設計師嗎？我想了想回答他：沒有耶，都可以。隨後有一位帥哥來幫我洗頭髮，洗幾下之後，他就問我：這樣的力道可以嗎？本來想跟他說用力一點，但又怕太用力會抓破頭皮，所以就跟他說：很好。洗完頭後，另一位設計師來幫我剪頭髮，首先他問我說：你要剪什麼樣的髮型？我跟他說：剪短一點就好。其實目的是剪短一點可以再撐三四個月不用剪頭髮。他又問：短一點就好嗎？我當下覺得，他可能不清楚我說的短是多短，所以我就說：可以很短沒關係。

範例一

- 昨天我去剪頭髮，看到店裡的客人蠻多的，就問店員：現在可以馬上剪嗎？店員回答我：可以啊。在我坐下來後，店員走到我旁邊問我：你有指定的設計師嗎？我想了想回答他：沒有耶，都可以。隨後有一位帥哥來幫我洗頭髮，洗幾下之後，他就問我：這樣的力道可以嗎？本來想跟他說用力一點，但又怕太用力會抓破頭皮，所以就跟他說：很好。洗完頭後，另一位設計師來幫我剪頭髮，首先他問我說：你要剪什麼樣的髮型？我跟他說：剪短一點就好。其實目的是剪短一點可以再撐三四個月不用剪頭髮。他又問：短一點就好嗎？我當下覺得，他可能不清楚我說的短是多短，所以我就說：可以很短沒關係。剪完我滿意的長度的頭髮後，我拿著帳單去櫃檯買單，問店員多少錢？他回答我說：**350**元，於是我拿一千元給他找，他找我 **650**元，收下錢，我便踏著輕快的腳步回家去了。

範例一 (cont'd)

- 物件:

範例一 (cont'd)

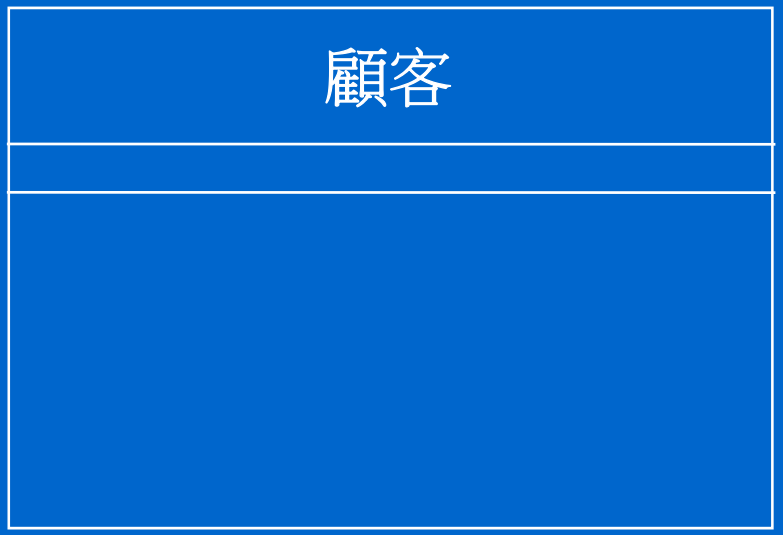
- 物件: 店員, 設計師, 顧客 (帳單, 發票)

範例一 (cont'd)

- 物件: 店員, 設計師, 顧客 (帳單, 發票)
- 類別圖:

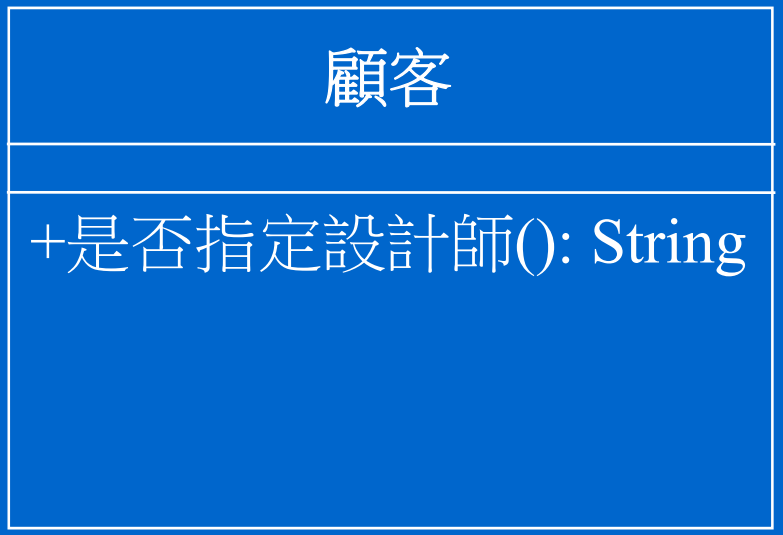
範例一 (cont'd)

- 物件: 店員, 設計師, 顧客 (帳單, 發票)
- 類別圖:



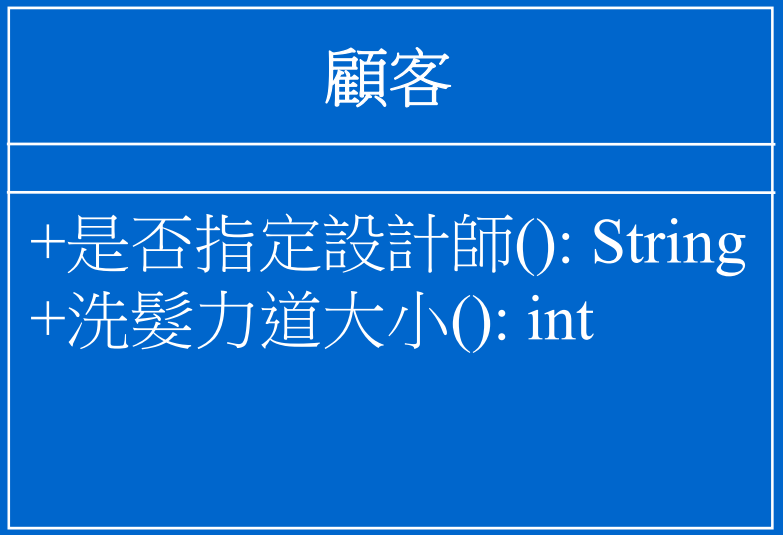
範例一 (cont'd)

- 物件: 店員, 設計師, 顧客 (帳單, 發票)
- 類別圖:



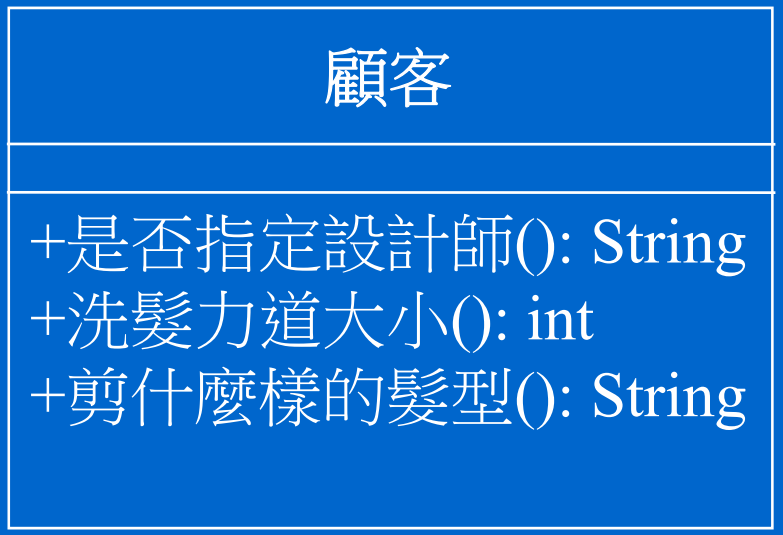
範例一 (cont'd)

- 物件: 店員, 設計師, 顧客 (帳單, 發票)
- 類別圖:



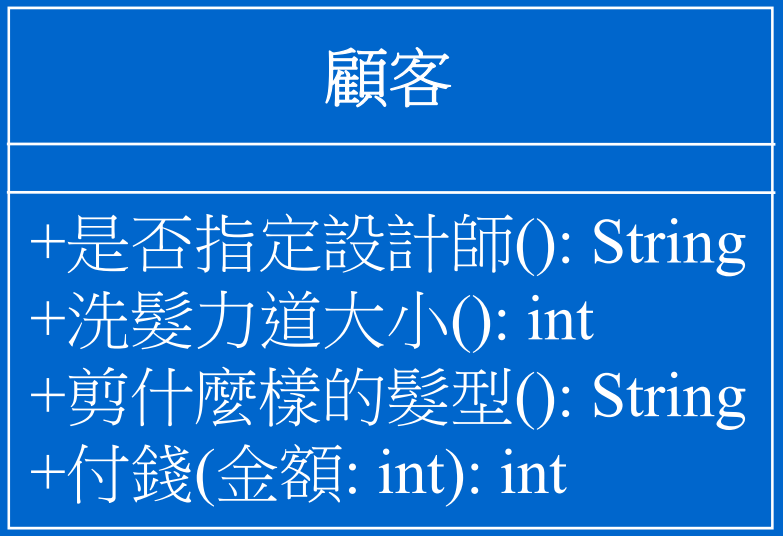
範例一 (cont'd)

- 物件: 店員, 設計師, 顧客 (帳單, 發票)
- 類別圖:



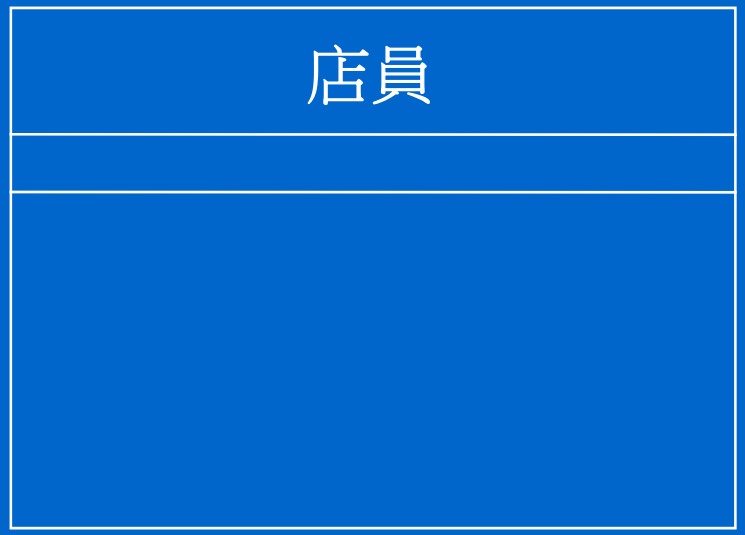
範例一 (cont'd)

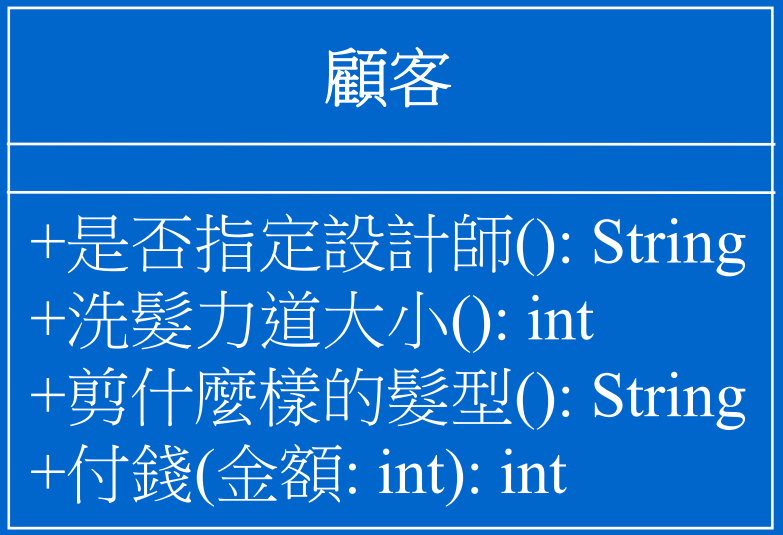
- 物件: 店員, 設計師, 顧客 (帳單, 發票)
- 類別圖:



範例一 (cont'd)

- 物件: 店員, 設計師, 顧客 (帳單, 發票)
- 類別圖:





範例一 (cont'd)

- 物件: 店員, 設計師, 顧客 (帳單, 發票)
- 類別圖:

範例一 (cont'd)

- 物件: 店員, 設計師, 顧客 (帳單, 發票)
- 類別圖:

範例一 (cont'd)

- 物件: 店員, 設計師, 顧客 (帳單, 發票)
- 類別圖:

範例一 (cont'd)

- 物件: 店員, 設計師, 顧客 (帳單, 發票)
- 類別圖:

店員
+可以馬上剪嗎(): boolean +洗頭髮(): void +多少錢(帳單: int): int +找錢(金額: int): int

顧客
+是否指定設計師(): String +洗髮力道大小(): int +剪什麼樣的髮型(): String +付錢(金額: int): int

範例一 (cont'd)

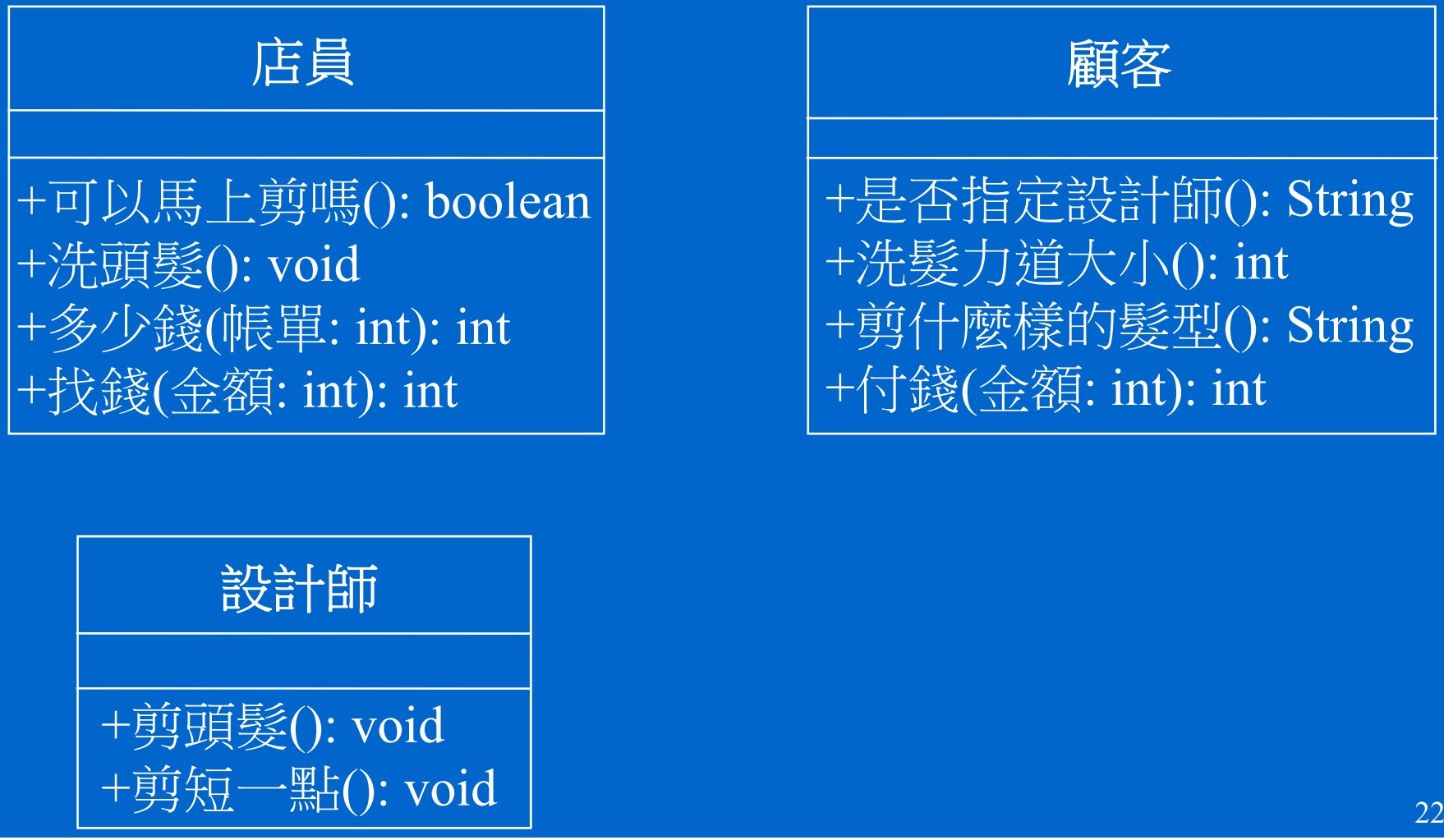
- 物件: 店員, 設計師, 顧客 (帳單, 發票)
- 類別圖:

範例一 (cont'd)

- 物件: 店員, 設計師, 顧客 (帳單, 發票)
- 類別圖:

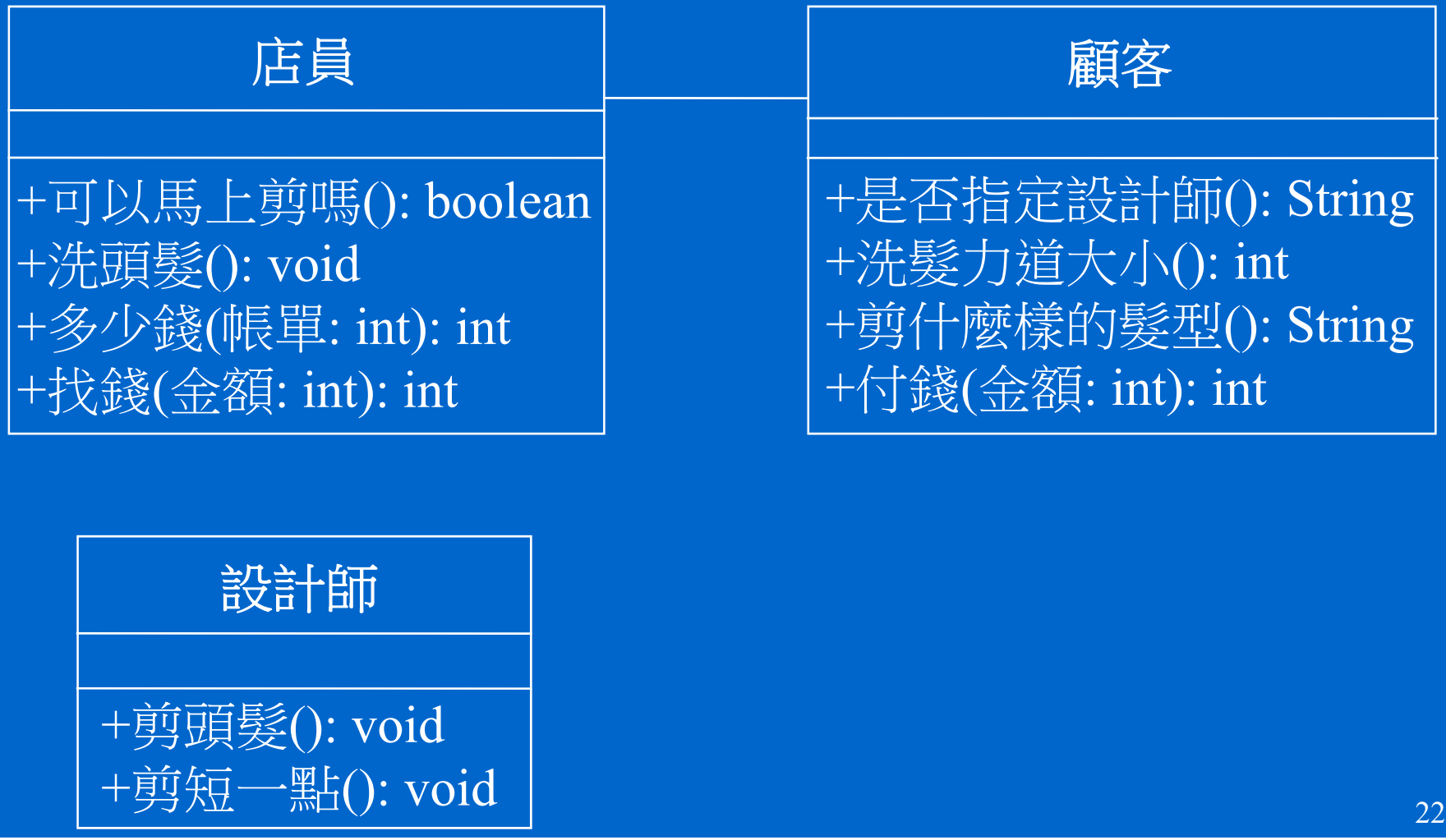
範例一 (cont'd)

- 物件: 店員, 設計師, 顧客 (帳單, 發票)
- 類別圖:



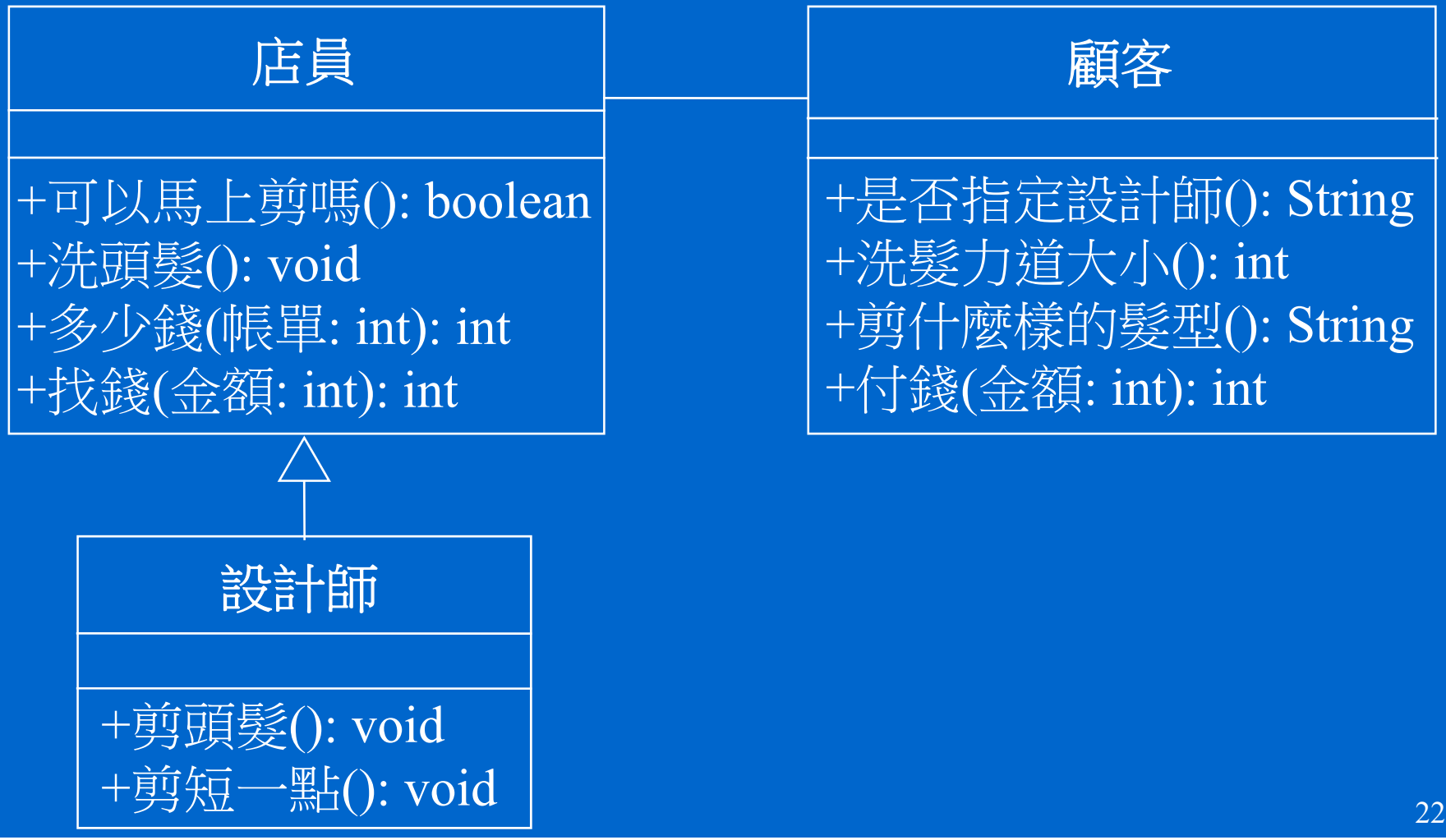
範例一 (cont'd)

- 物件: 店員, 設計師, 顧客 (帳單, 發票)
- 類別圖:



範例一 (cont'd)

- 物件: 店員, 設計師, 顧客 (帳單, 發票)
- 類別圖:



範例二

- 賣場裡販賣各種電腦零件：主機板、記憶體、螢幕、**CPU** 等等

範例二

- 賣場裡販賣各種電腦零件：主機板、記憶體、螢幕、**CPU** 等等
- 顧客購買電腦零件，如果是會員可以打八折，但特價品不打。每週會選部分產品為特價品，特價方式有兩種：打八五折或買二送一。

範例二

- 賣場裡販賣各種電腦零件：主機板、記憶體、螢幕、**CPU** 等等
- 顧客購買電腦零件，如果是會員可以打八折，但特價品不打。每週會選部分產品為特價品，特價方式有兩種：打八五折或買二送一。
- 店員薪水有兩種：時薪制與銷售額抽成計酬制。

範例二

- 賣場裡販賣各種電腦零件：主機板、記憶體、螢幕、**CPU** 等等
- 顧客購買電腦零件，如果是會員可以打八折，但特價品不打。每週會選部分產品為特價品，特價方式有兩種：打八五折或買二送一。
- 店員薪水有兩種：時薪制與銷售額抽成計酬制。
  - 時薪制 - 依照工作時數給錢，

範例二

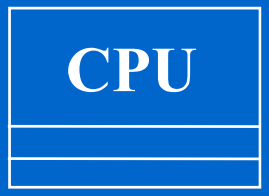
- 賣場裡販賣各種電腦零件：主機板、記憶體、螢幕、CPU 等等
- 顧客購買電腦零件，如果是會員可以打八折，但特價品不打。每週會選部分產品為特價品，特價方式有兩種：打八五折或買二送一。
- 店員薪水有兩種：時薪制與銷售額抽成計酬制。
  - 時薪制 - 依照工作時數給錢，
  - 銷售額抽成計酬制 - 根據賣出零件的價錢乘上一定的百分比為酬勞。

範例二

- 賣場裡販賣各種電腦零件：主機板、記憶體、螢幕、CPU 等等
- 顧客購買電腦零件，如果是會員可以打八折，但特價品不打。每週會選部分產品為特價品，特價方式有兩種：打八五折或買二送一。
- 店員薪水有兩種：時薪制與銷售額抽成計酬制。
  - 時薪制 - 依照工作時數給錢，
  - 銷售額抽成計酬制 - 根據賣出零件的價錢乘上一定的百分比為酬勞。
- 設計每次交易的金額、一天營業的總金額，以及兩個員工– 一為銷售額抽成計酬制一為時薪制 – 一天的薪水。

範例二 (cont'd)

範例二 (cont'd)

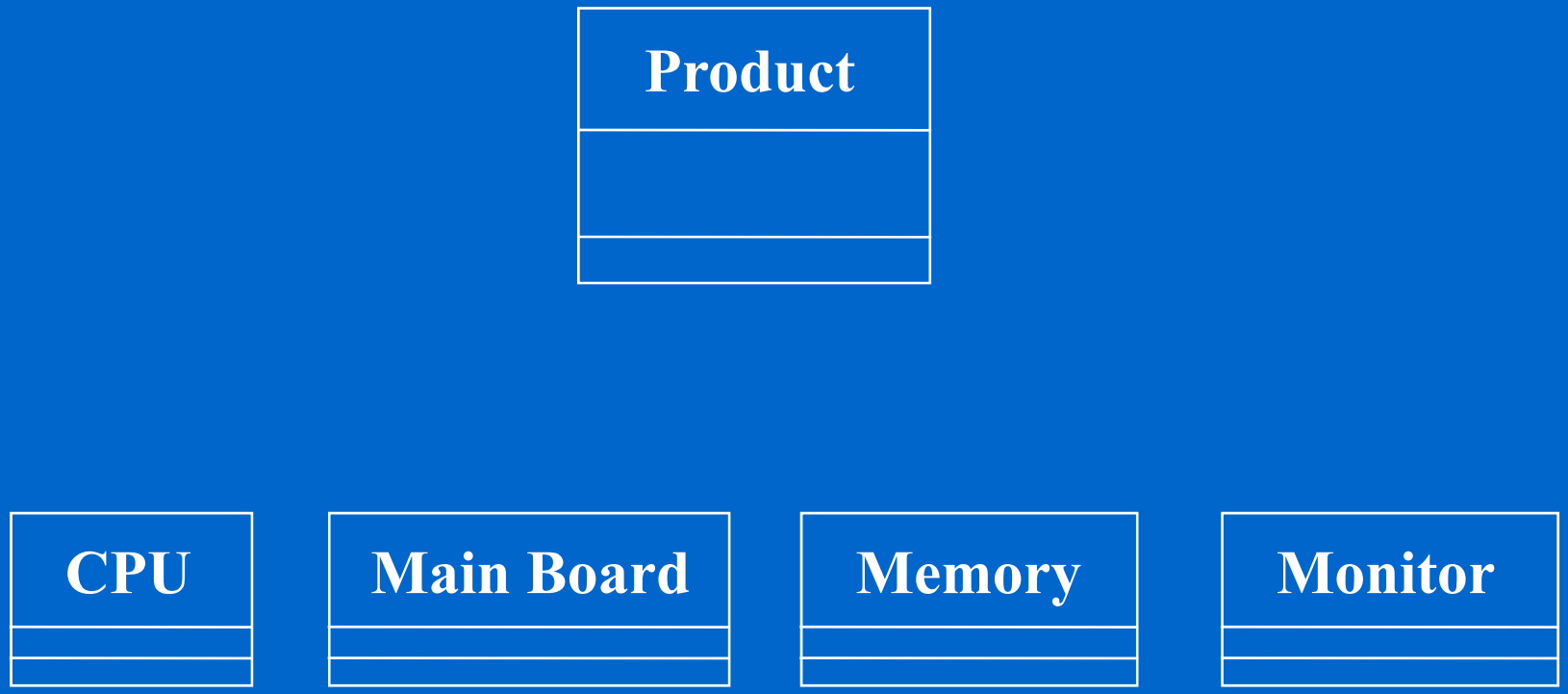


範例二 (cont'd)

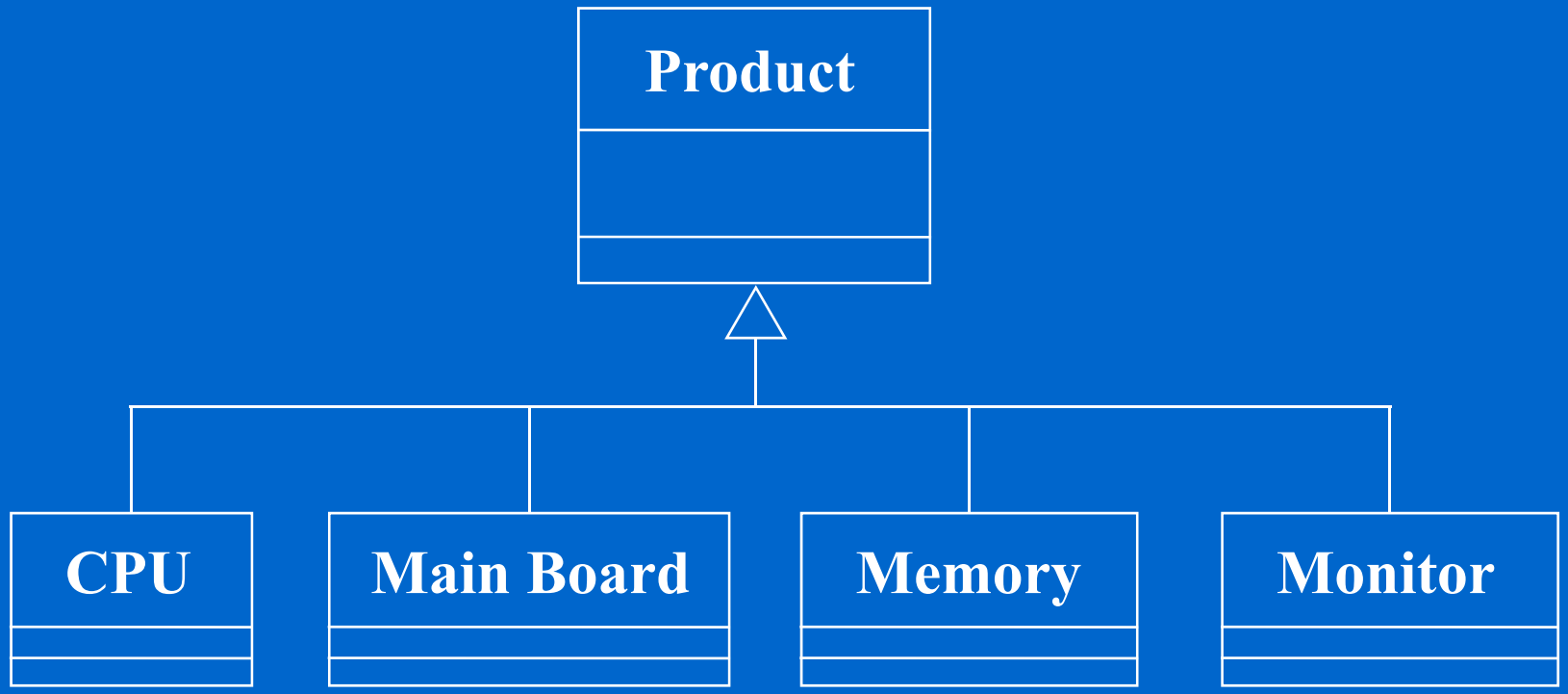
範例二 (cont'd)

範例二 (cont'd)

範例二 (cont'd)



範例二 (cont'd)



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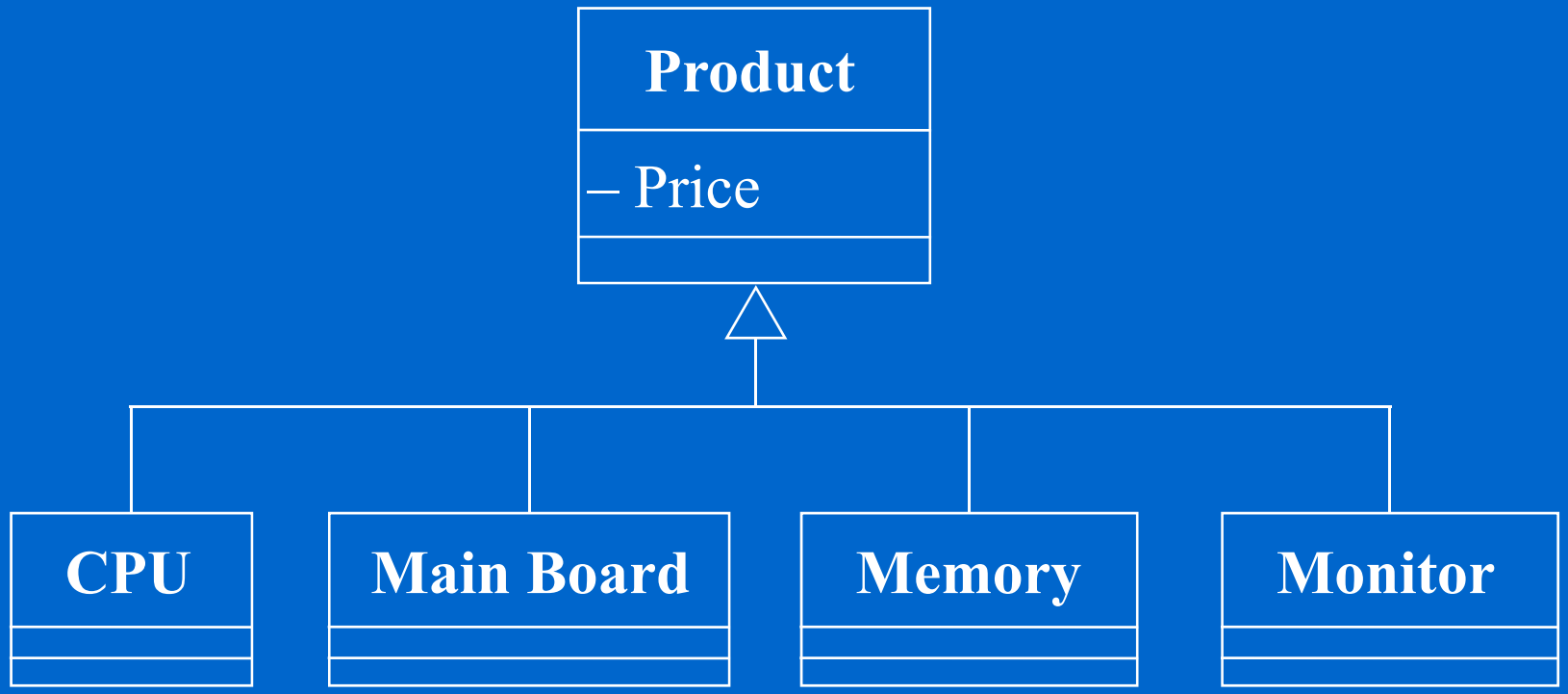


範例二 (cont'd)

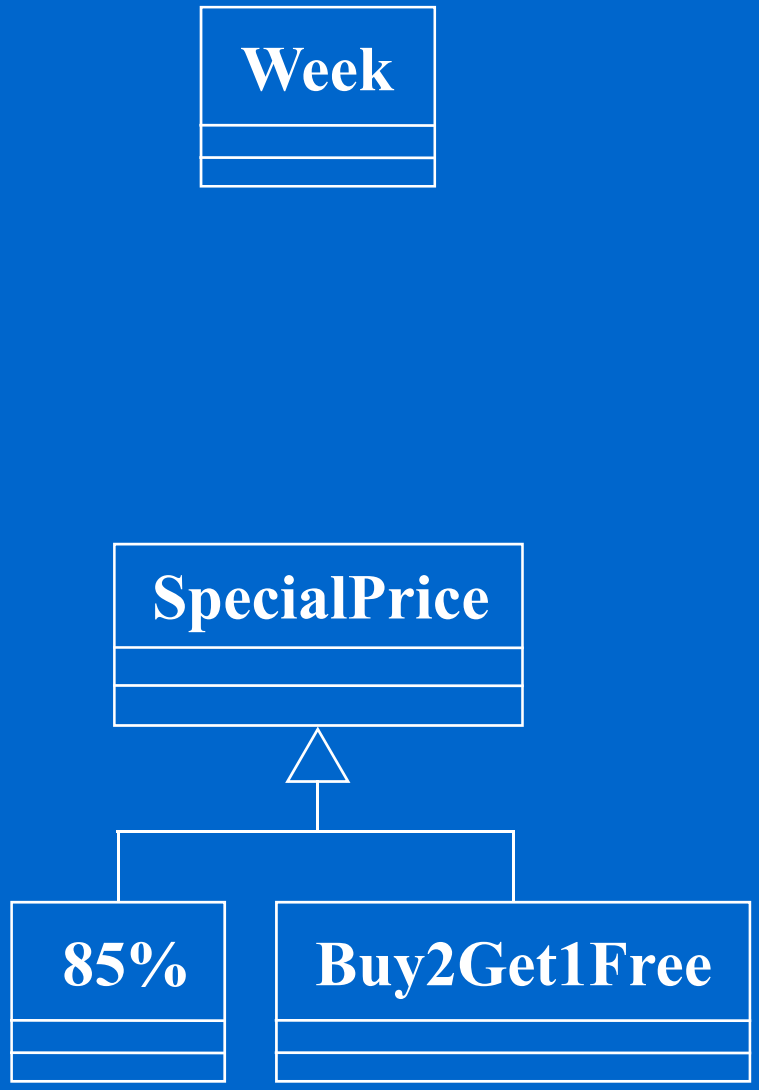
範例二 (cont'd)

範例二 (cont'd)

範例二 (cont'd)

範例二 (cont'd)

範例二 (cont'd)



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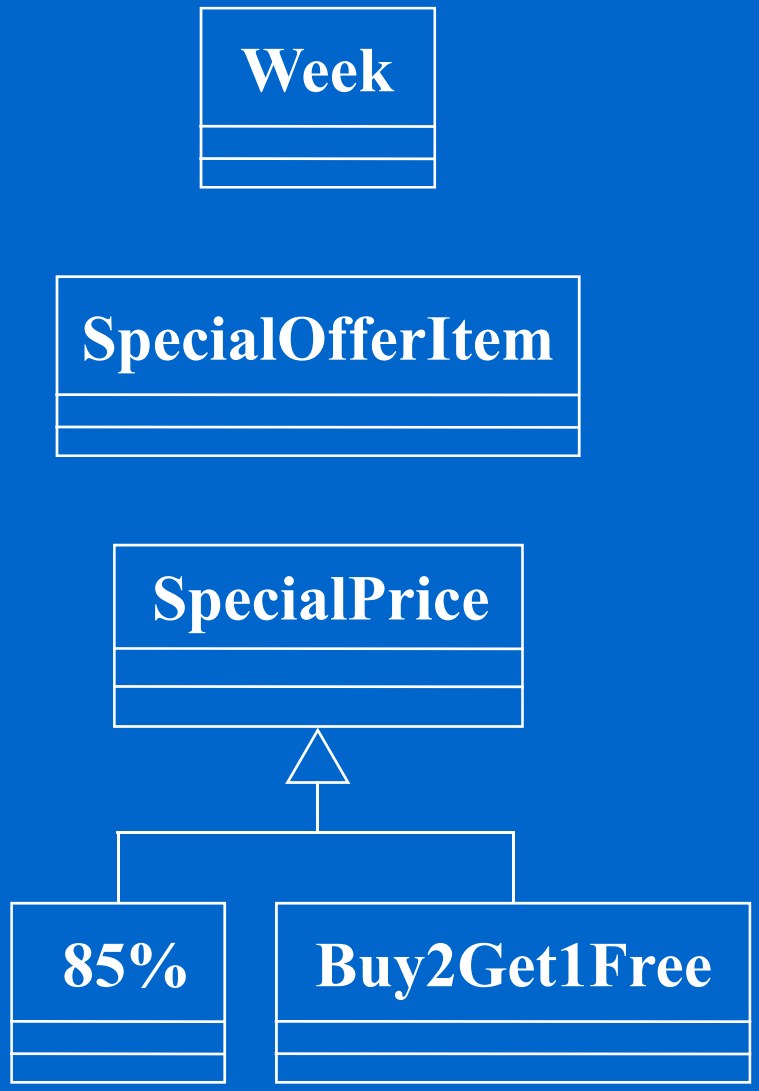

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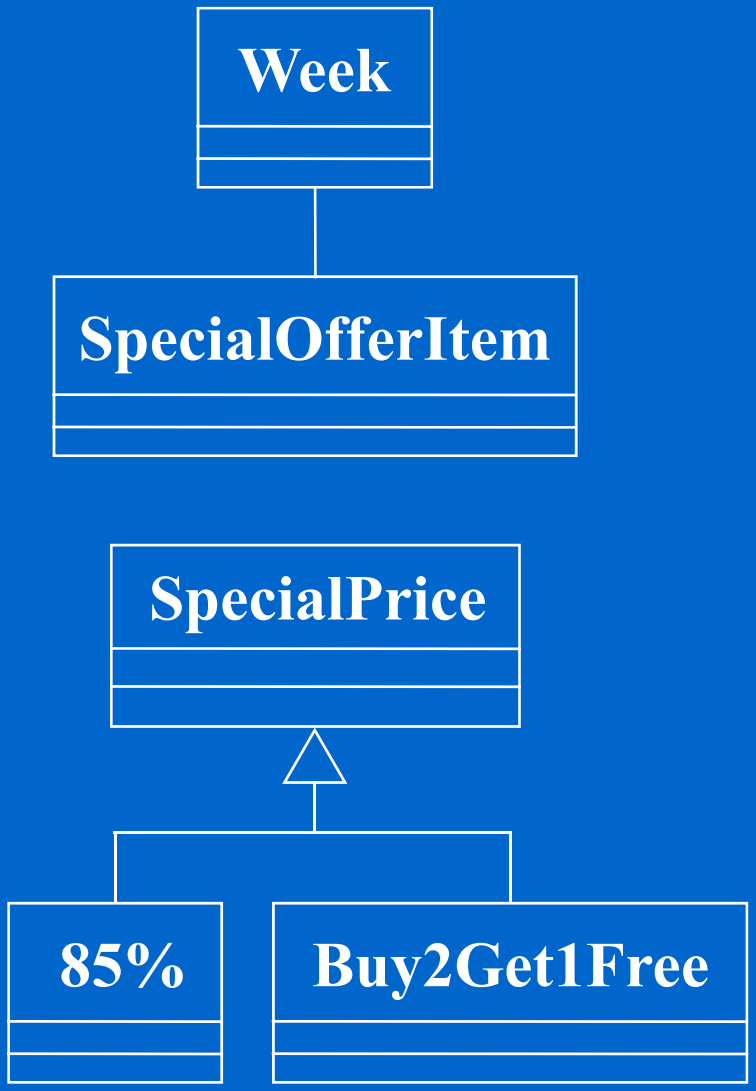

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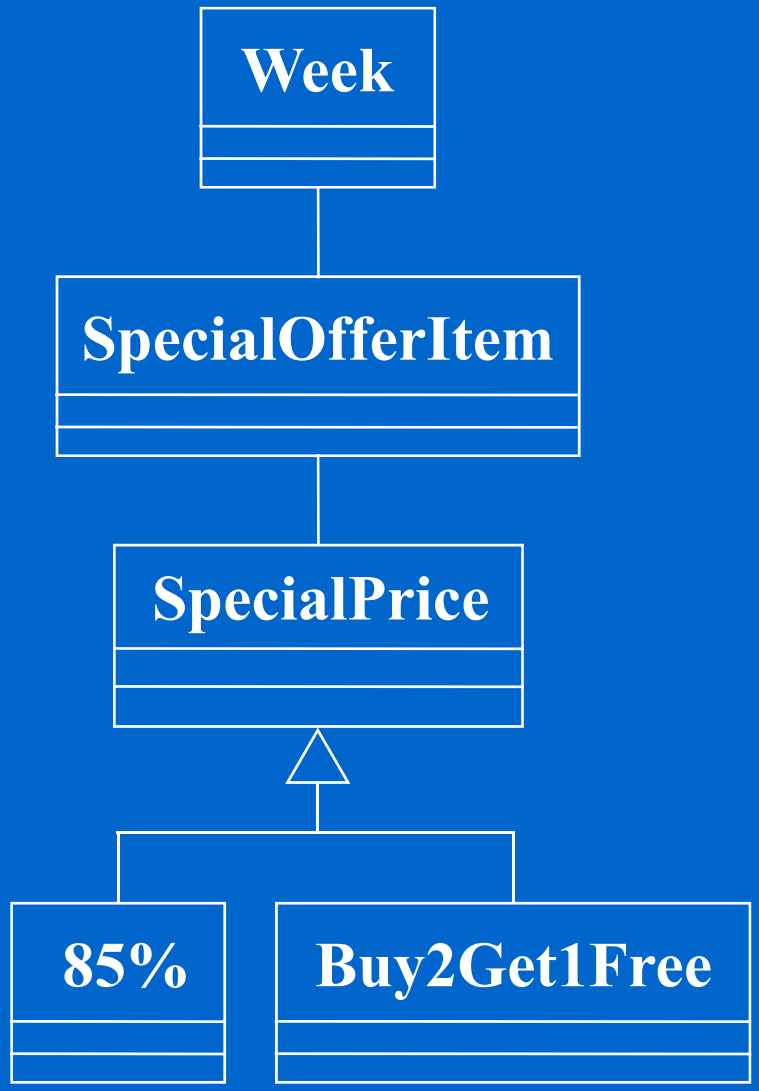


範例二 (cont'd)

範例二 (cont'd)

範例二 (cont'd)

PerHour
– rate

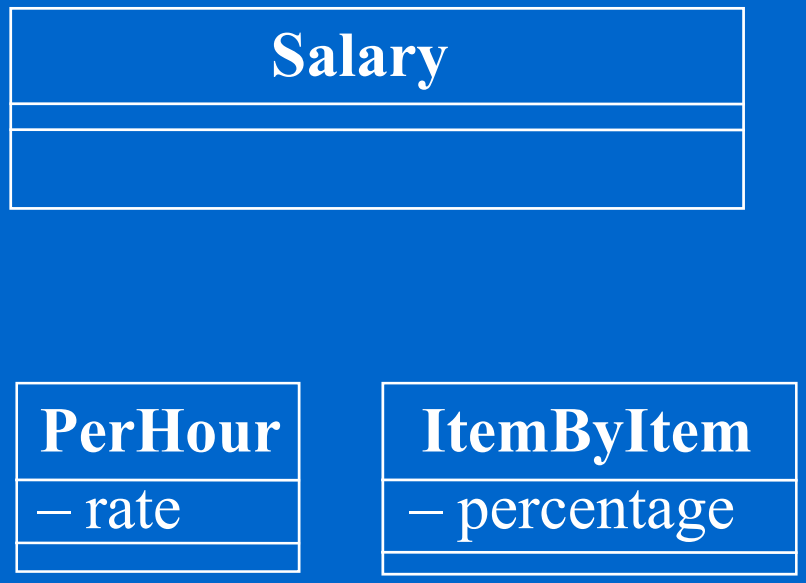
範例二 (cont'd)

範例二 (cont'd)

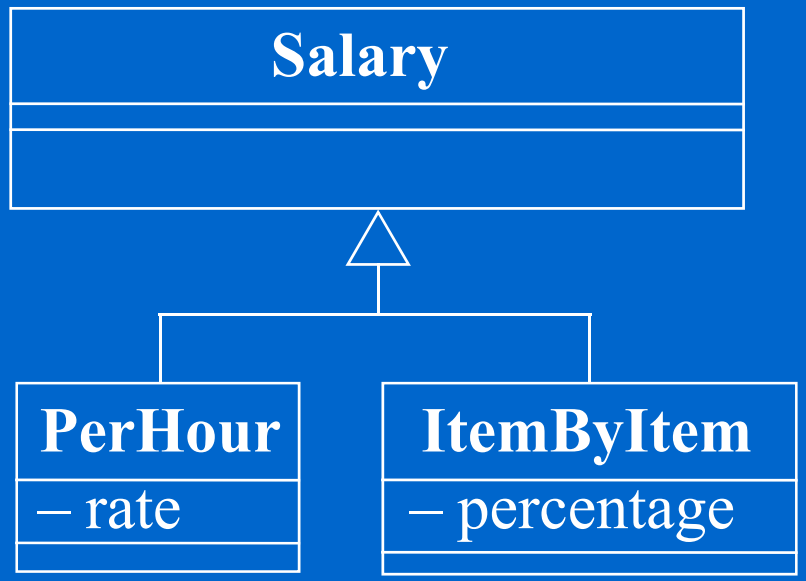
PerHour
– rate

ItemByItem
– percentage

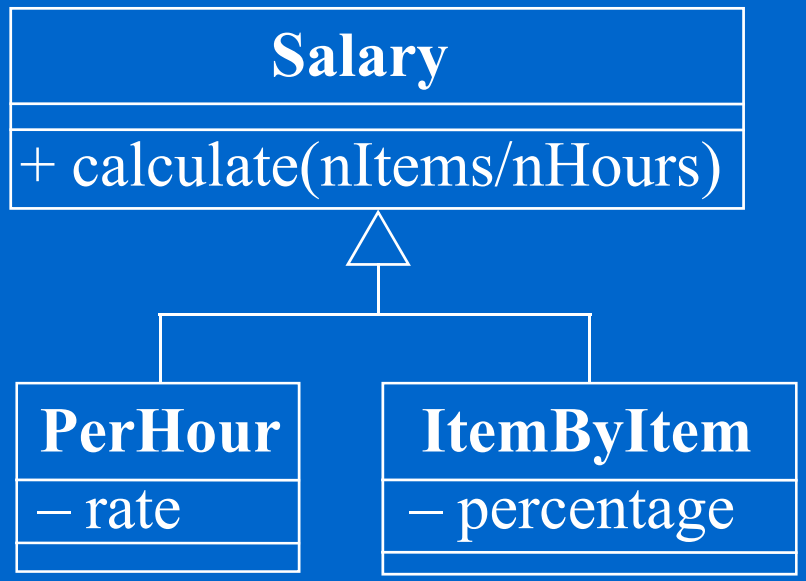
範例二 (cont'd)



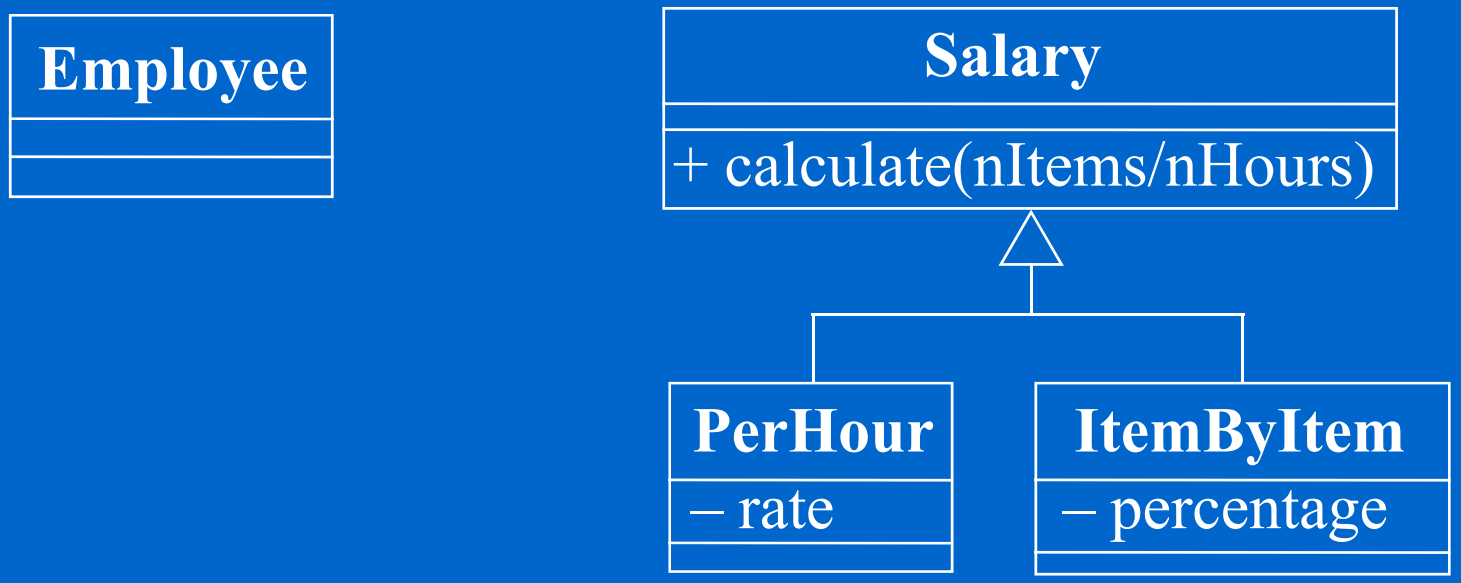
範例二 (cont'd)



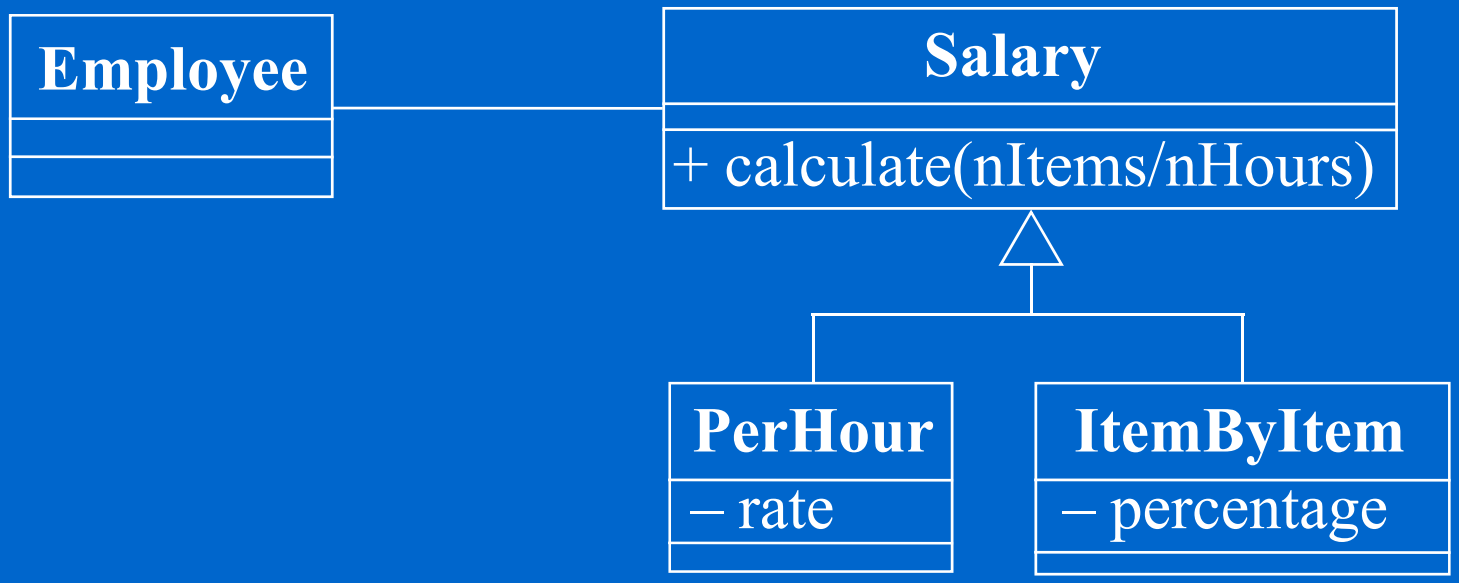
範例二 (cont'd)


Salary
+ calculate(nItems/nHours)
PerHour
– rate
ItemByItem
– percentage

範例二 (cont'd)


Employee
Salary
+ calculate(nItems/nHours)
PerHour
– rate
ItemByItem
– percentage

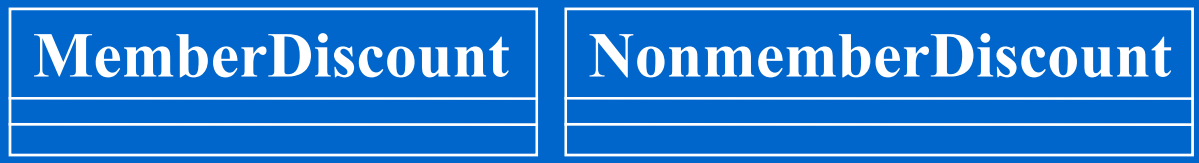
範例二 (cont'd)


Employee
Salary
+ calculate(nItems/nHours)
PerHour
– rate
ItemByItem
– percentage

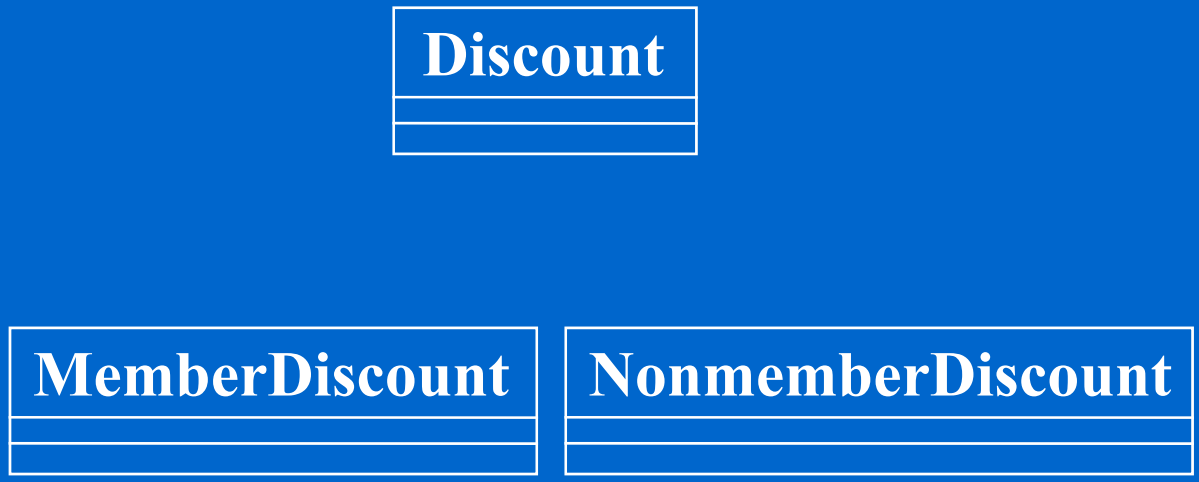
範例二 (cont'd)

範例二 (cont'd)

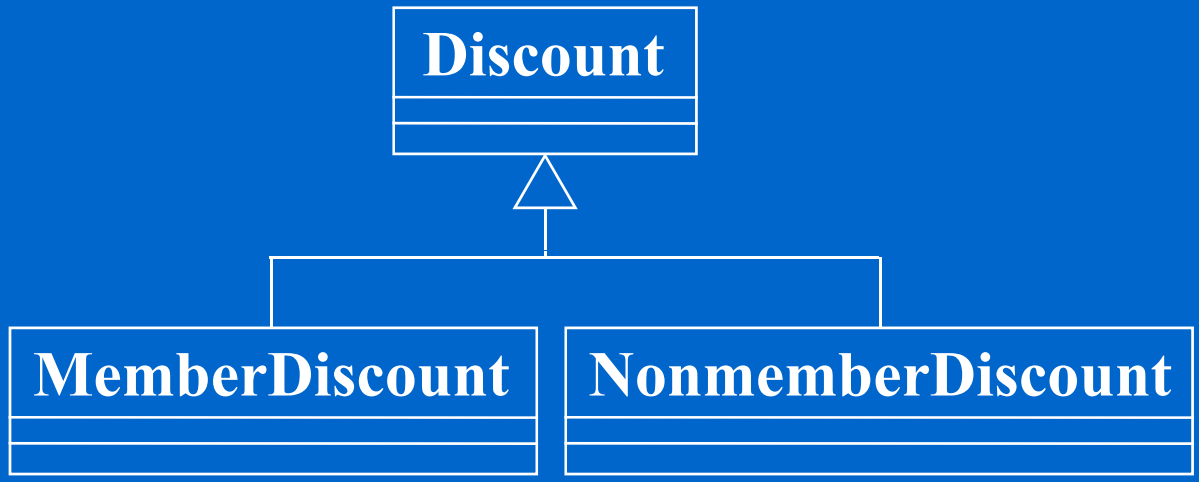
範例二 (cont'd)



範例二 (cont'd)



範例二 (cont'd)



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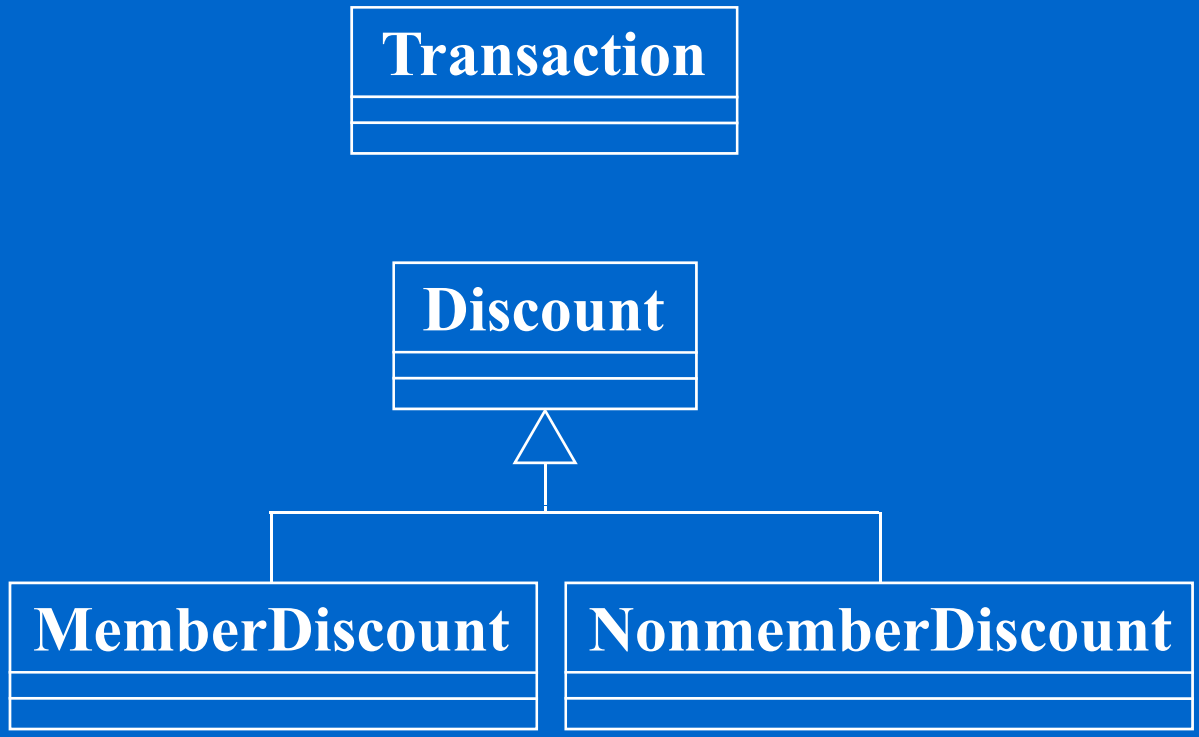
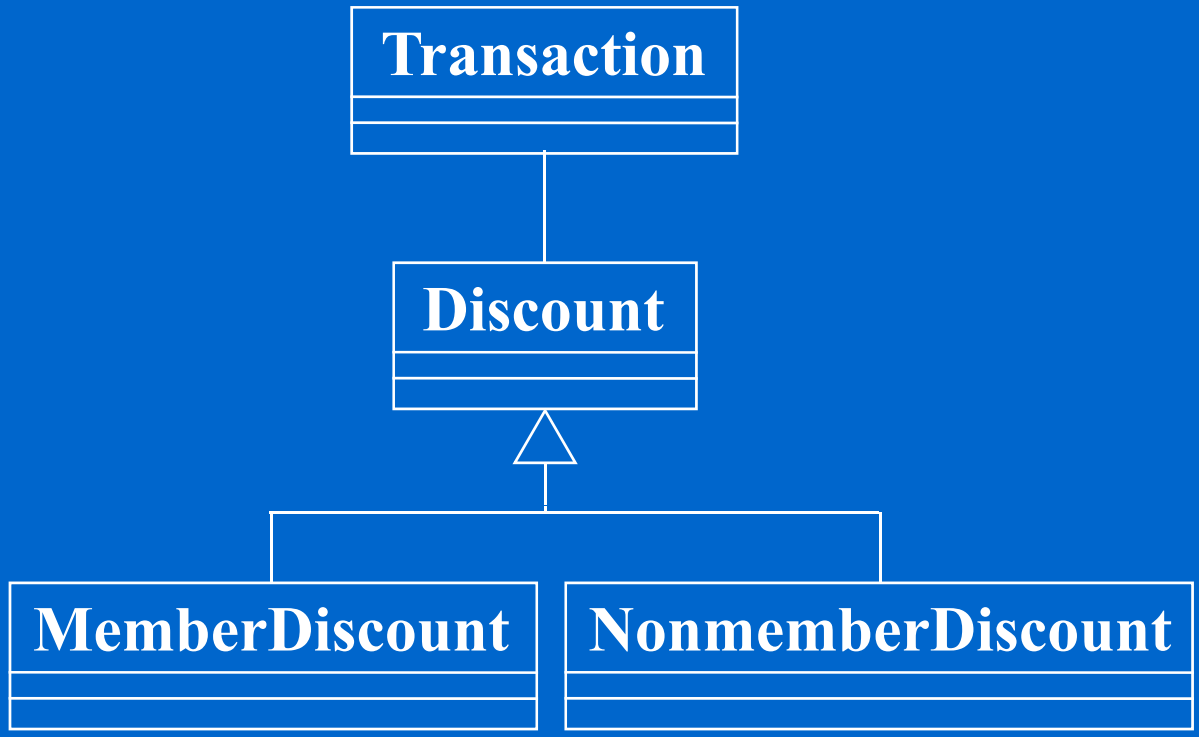
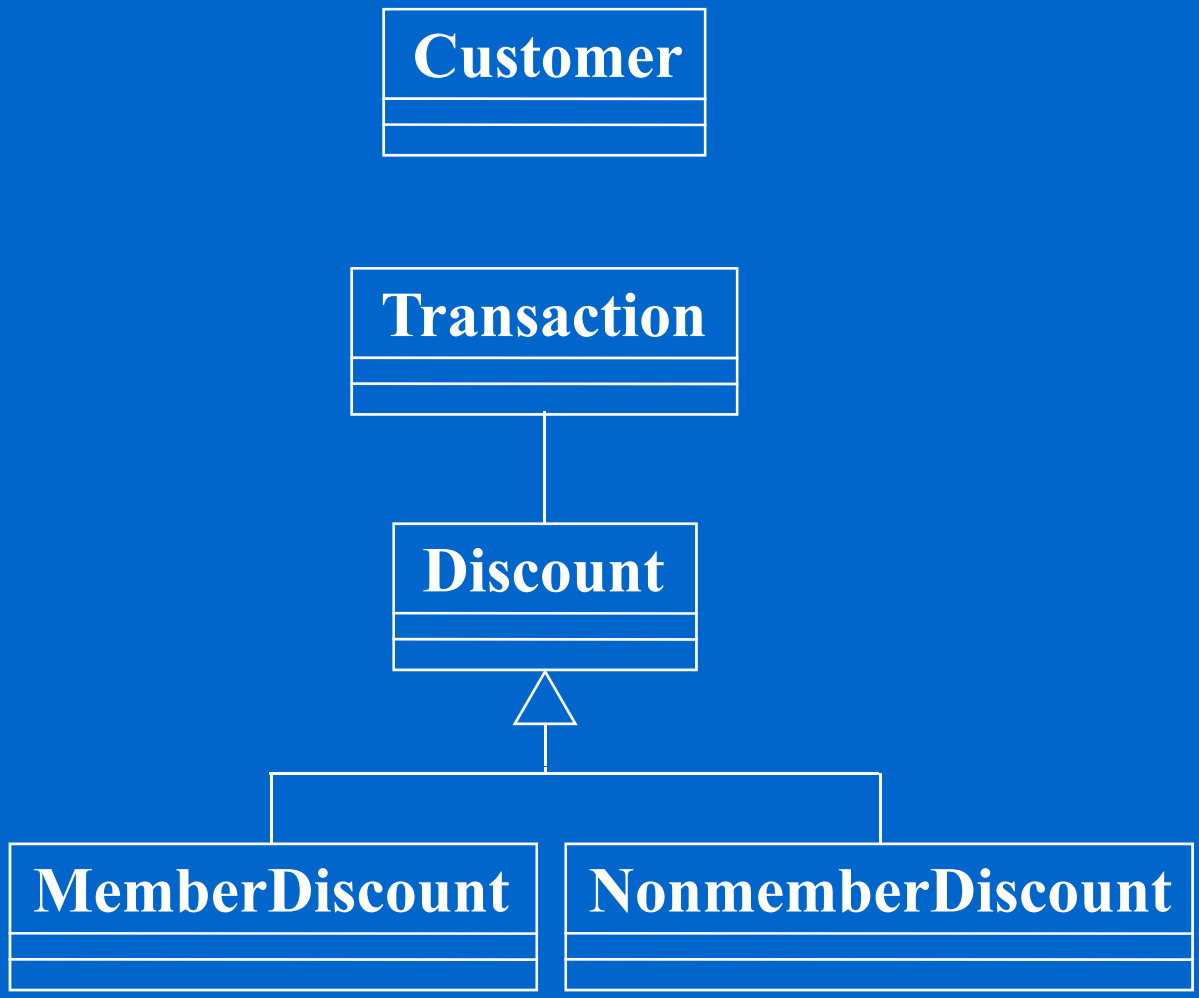

Transaction
Discount
MemberDiscount
NonmemberDiscount

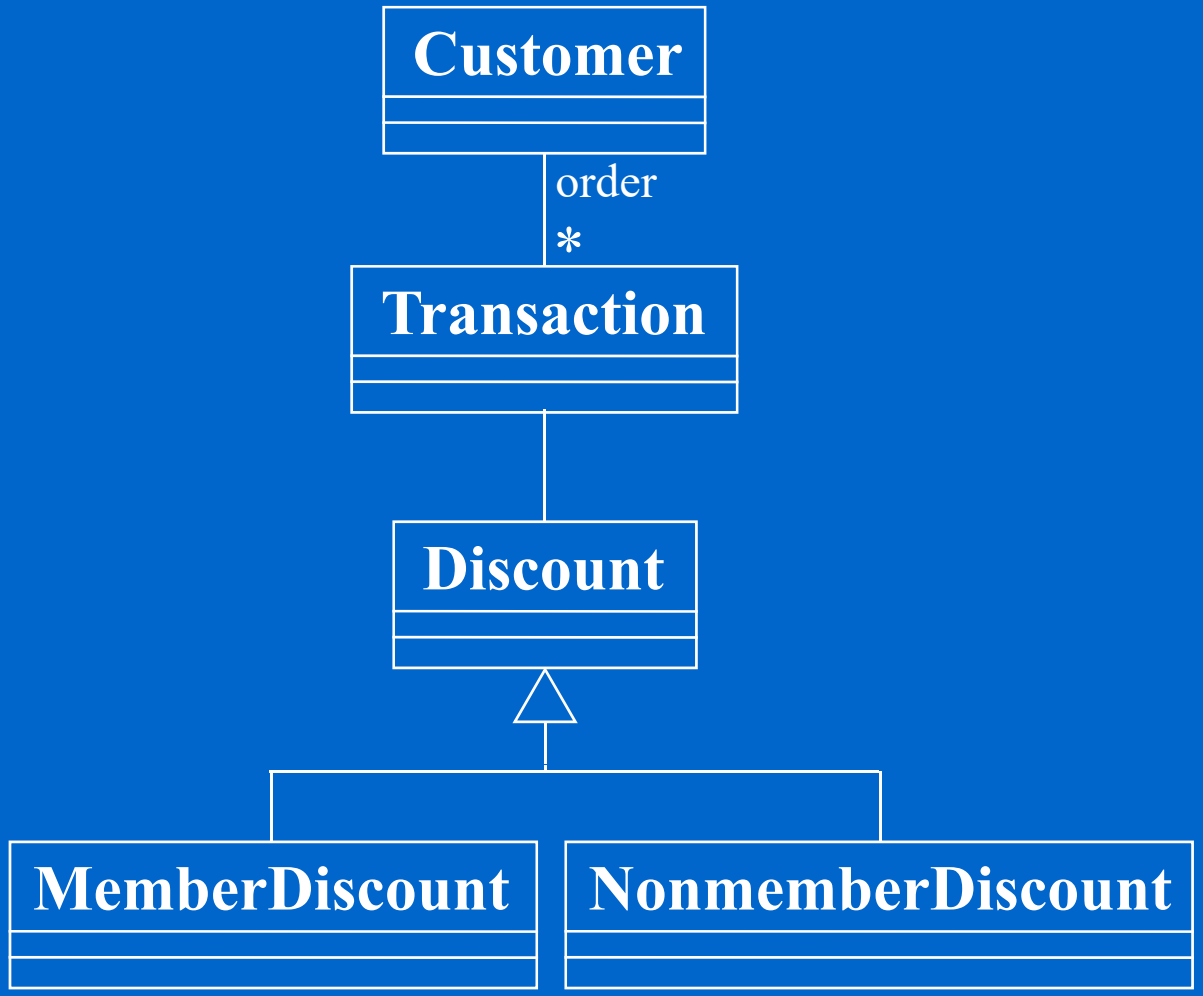
範例二 (cont'd)


Transaction
Discount
MemberDiscount
NonmemberDiscount

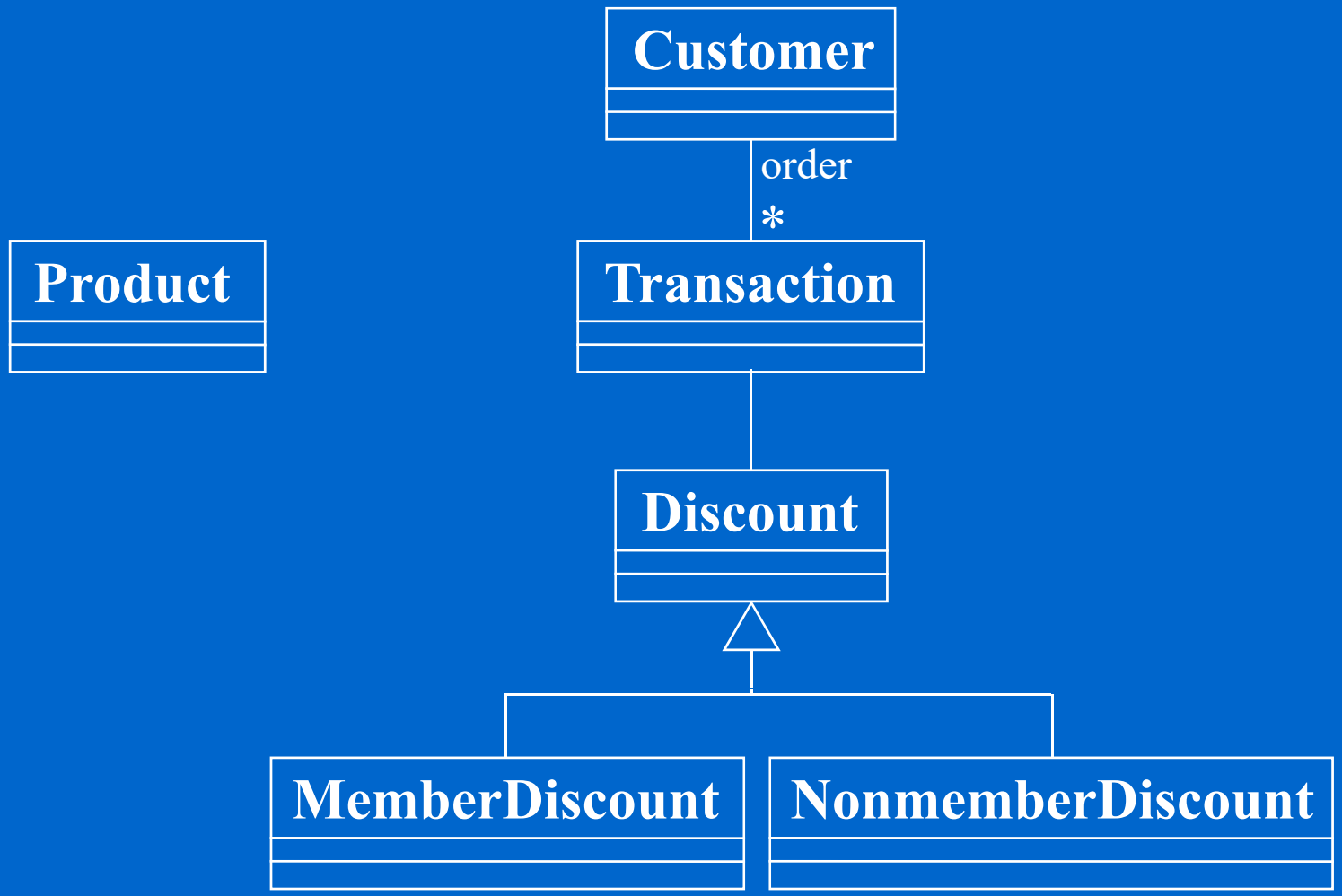
範例二 (cont'd)


Customer
Transaction
Discount
MemberDiscount
NonmemberDiscount

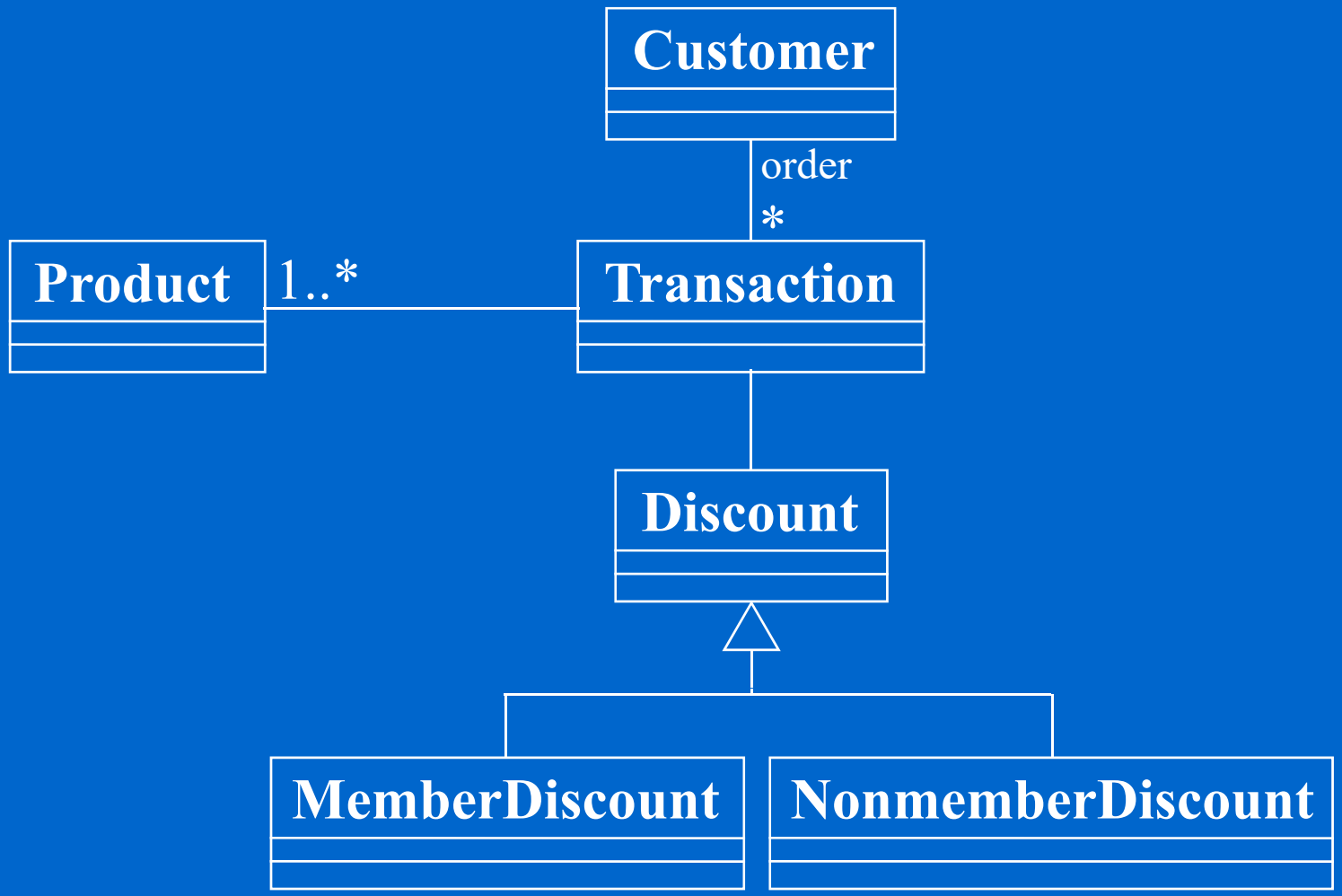
範例二 (cont'd)


Customer
order
*
Transaction
Discount
MemberDiscount
NonmemberDiscount

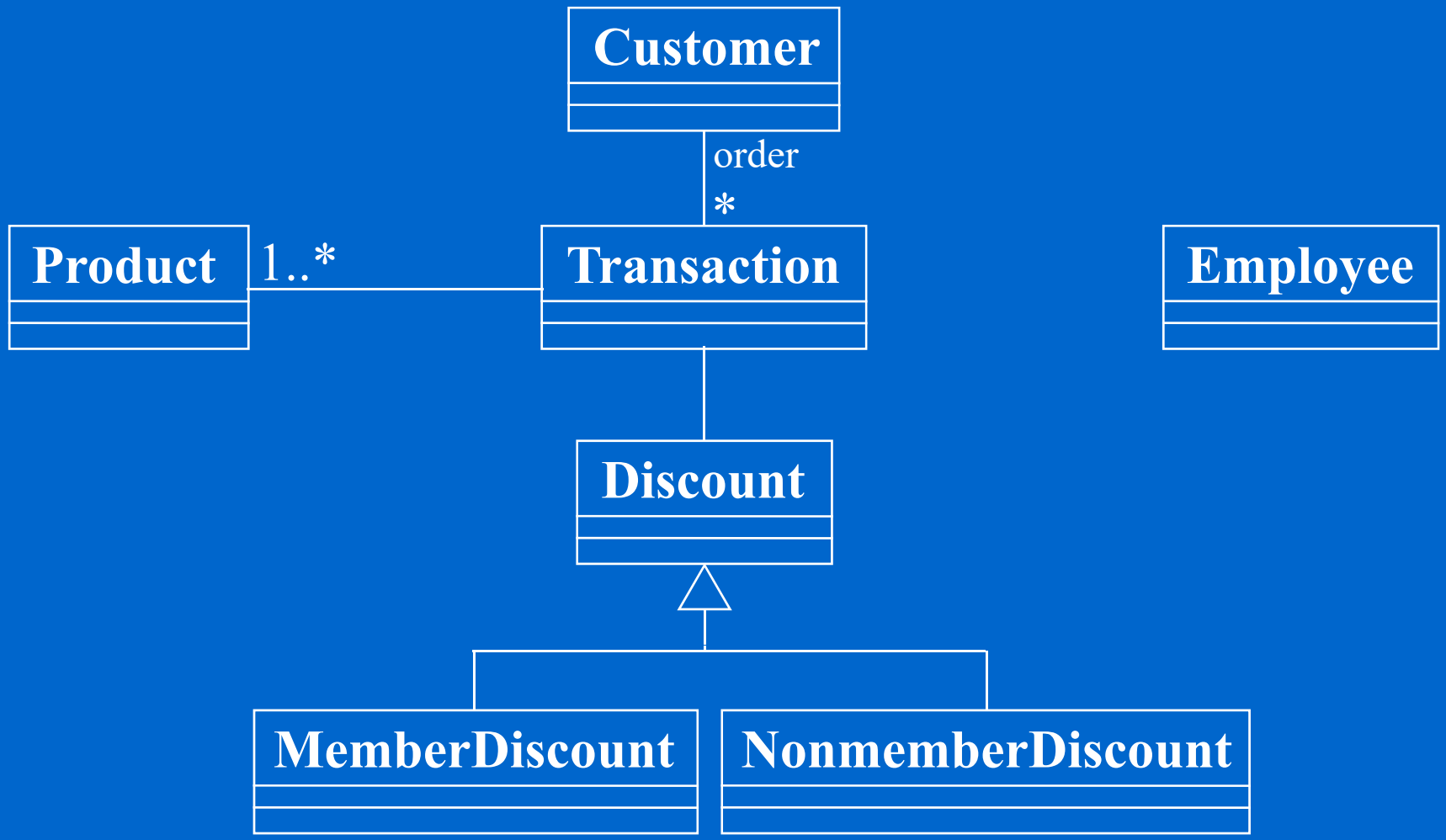
範例二 (cont'd)


Customer
order
*
Product
Transaction
Discount
MemberDiscount
NonmemberDiscount

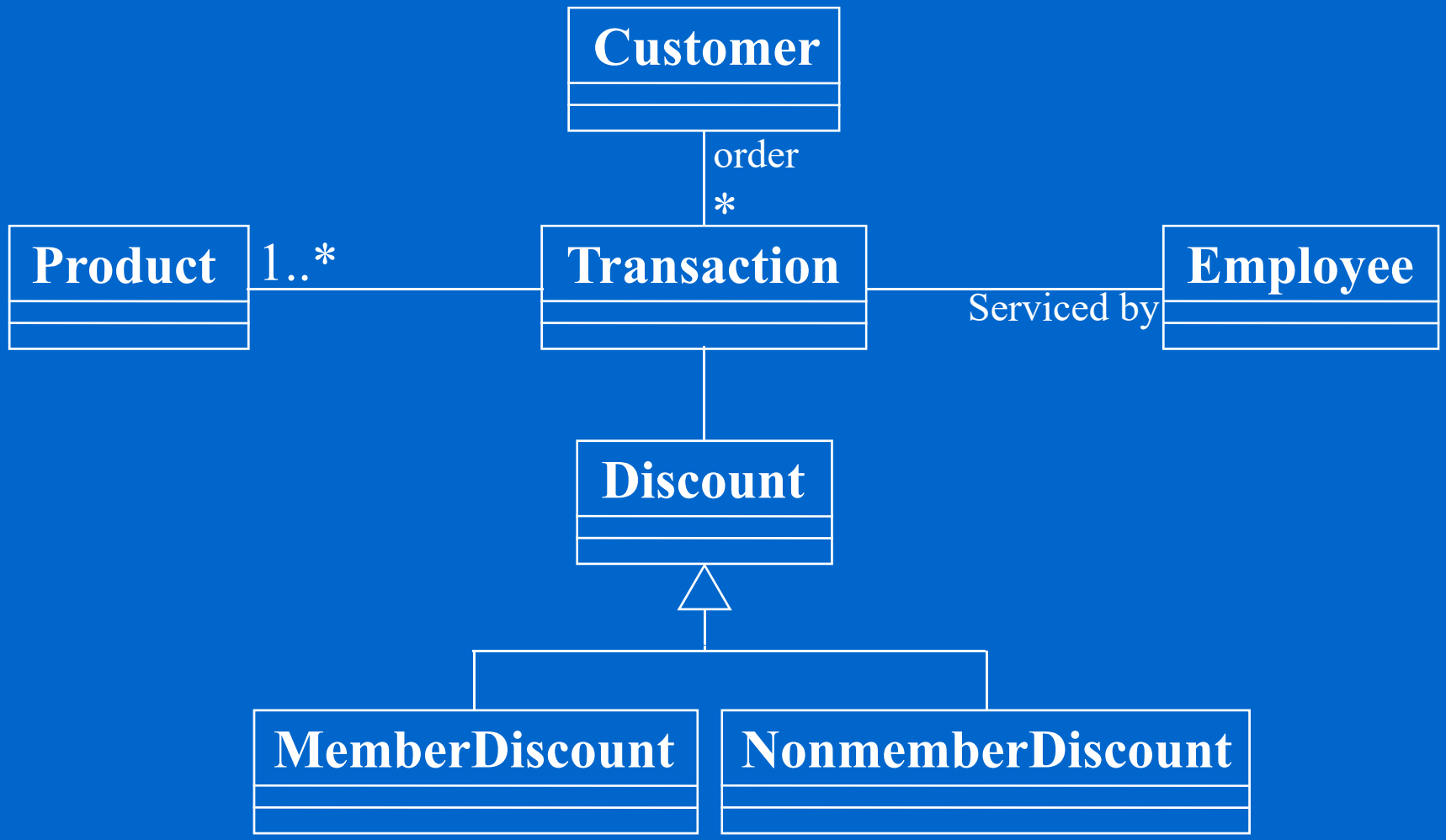
範例二 (cont'd)


Customer
order
*
Product
1..*
Transaction
Discount
MemberDiscount
NonmemberDiscount

範例二 (cont'd)

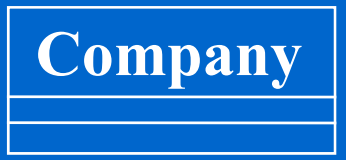

Customer
order
*
Product
1..*
Transaction
Employee
Discount
MemberDiscount
NonmemberDiscount

範例二 (cont'd)

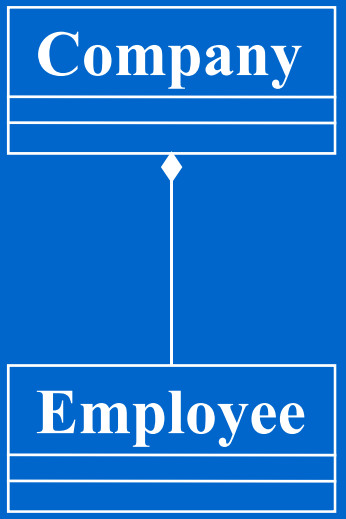

Customer
order
*
Product
1..*
Transaction
Serviced by
Employee
Discount
MemberDiscount
NonmemberDiscount

範例二 (cont'd)

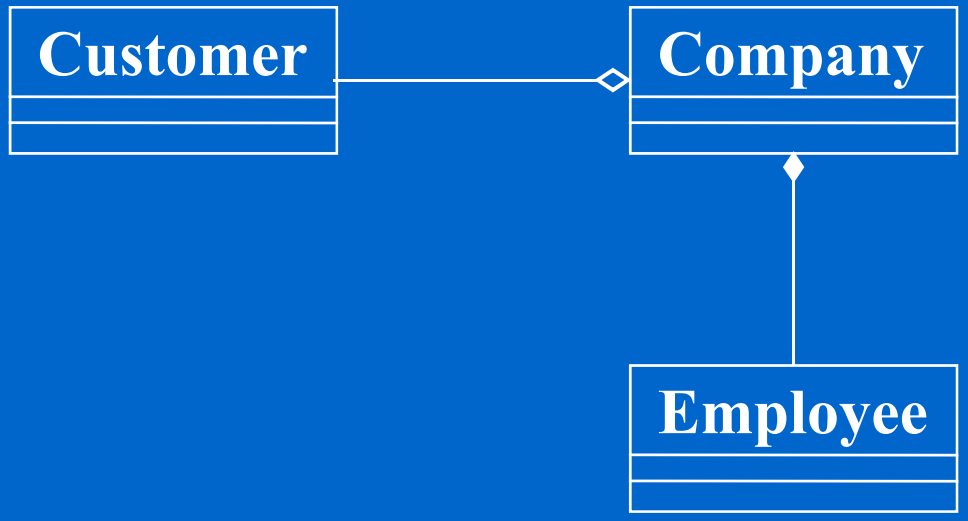
範例二 (cont'd)



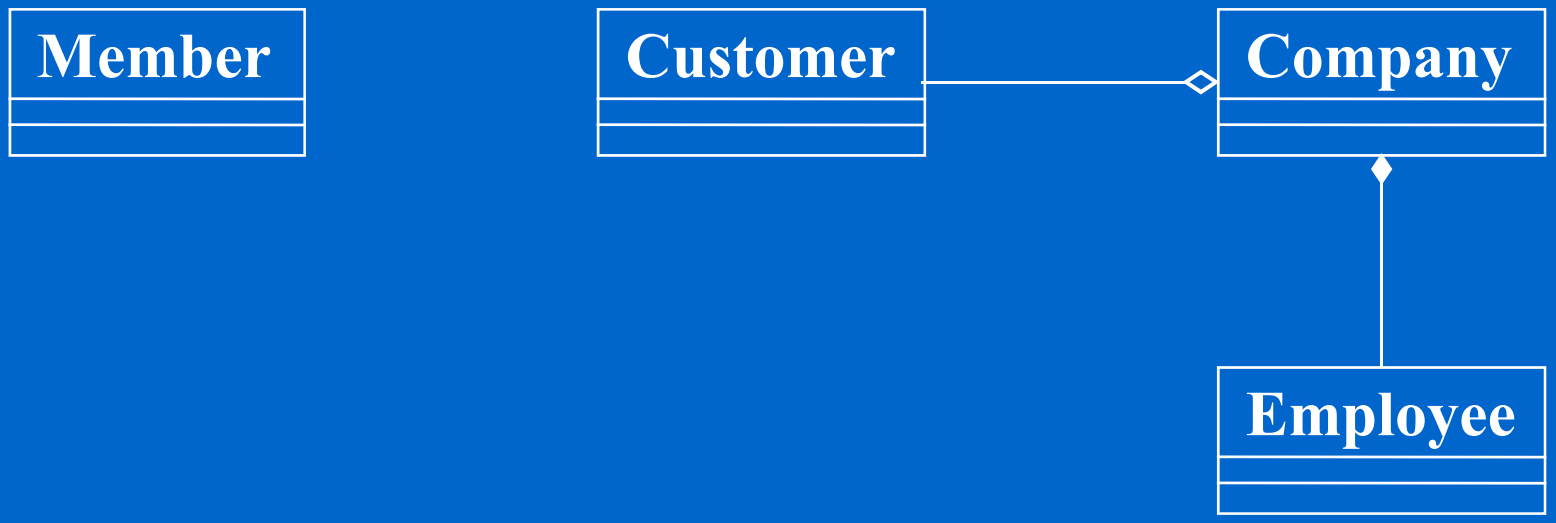
範例二 (cont'd)



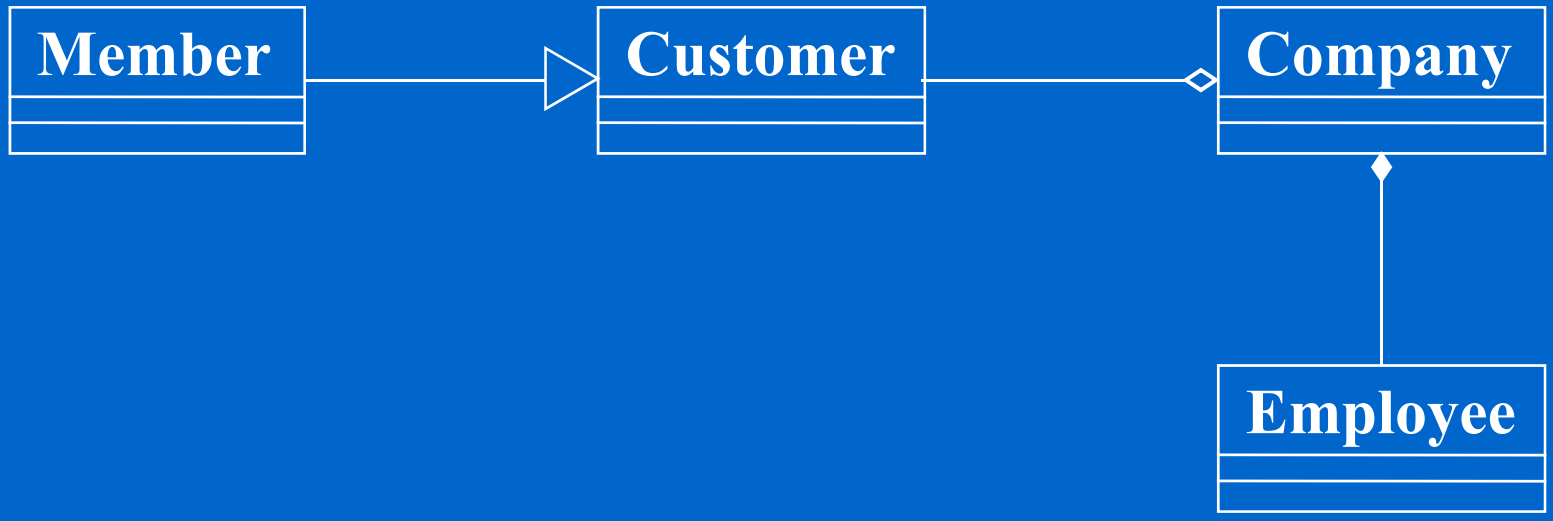
範例二 (cont'd)



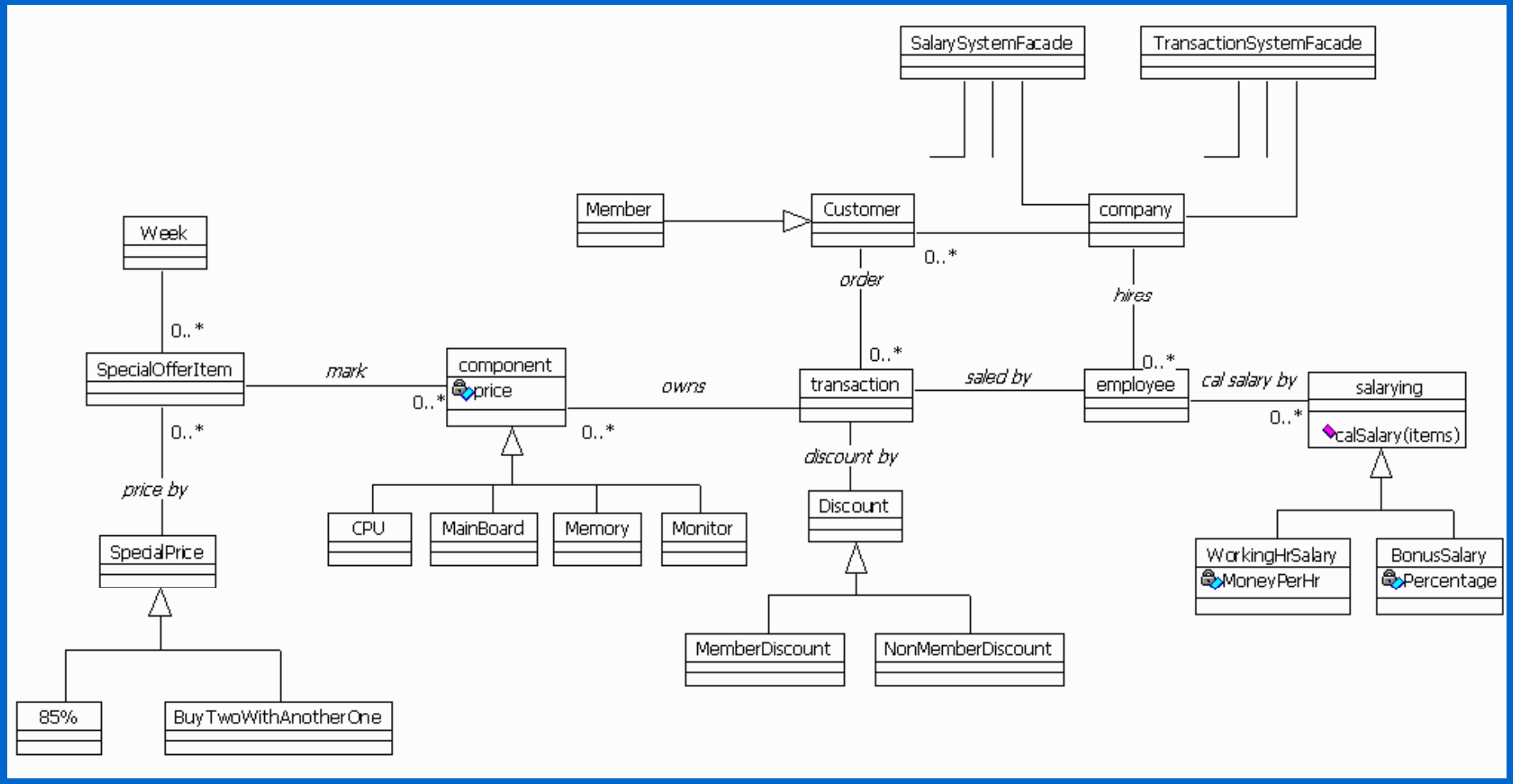
範例二 (cont'd)



範例二 (cont'd)



範例二 (cont'd)


SalarySystemFacade
TransactionSystemFacade
Member
Customer
company
Week
0..*
order
hires
SpecialOfferItem
mark
component
price
owns
transaction
saled by
employee
cal salary by
salarying
calSalary(items)
price by
discount by
Discount
CPU
MainBoard
Memory
Monitor
SpecialPrice
WorkingHrSalary
MoneyPerHr
BonusSalary
Percentage
MemberDiscount
NonMemberDiscount
85%
BuyTwoWithAnotherOne