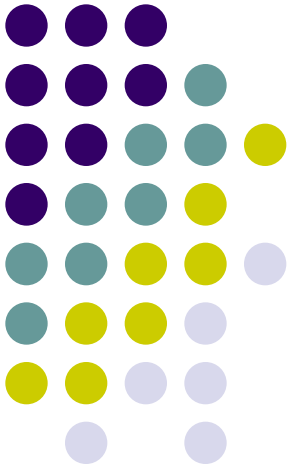
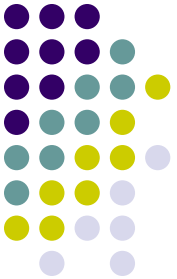
第十五章
運算子的多載

認識運算子的多載

學習「+」的多載

熟悉「=」的多載



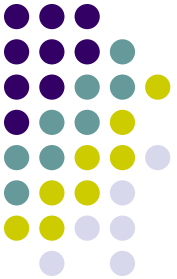


運算子的多載 (1/2)

- 運算子的多載，是指同一運算子在不同的時機，可進行不同的工作
- 「>」運算子的多載

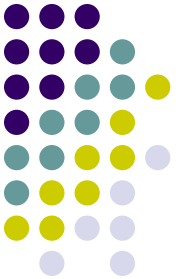
```
5 > 7;                  // 判別整數 5 是否大於 7
win1 > win2;            // 判別 win1 與 win2 物件面積的大小
```

  - 「>」運算子經重新定義後，可用來判別數字的大小，也可用來判別物件面積大小的做法，即稱為「>」運算子的多載（overloading）



運算子的多載 (2/2)

- 不能多載的運算子
  - ::　　範籌解析運算子（scope resolution operator）
  - ?:　　條件運算子（conditional operator）
  - .　　成員存取運算子（direct member selection operator）
  - sizeof　　運算子（sizeof operator）



「>」運算子的多載 (1/4)

- 為運算子定義多載函數

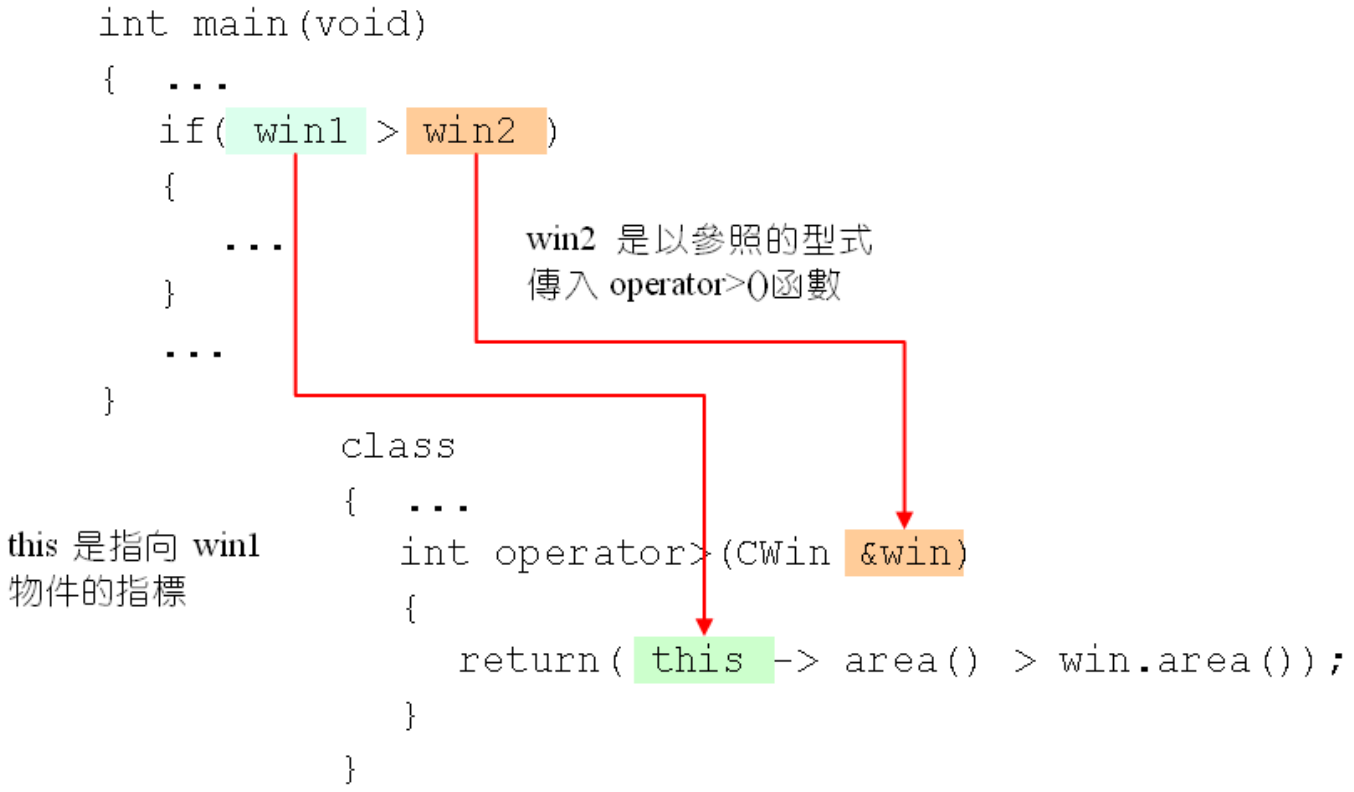
```
01   int operator>(CWin &win)          // 定義運算子「>」的多載
02   {
03       return( this->area() > win.area());
04   }
```

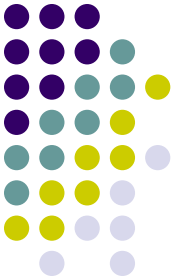
- 呼叫operator>() 函數

```
win1.operator>(win2);  // 呼叫 operator>()函數
win1 > win2;           // 此敘述會呼叫 operator>()函數
```

「>」運算子的多載 (2/4)

- 下圖說明在operator>() 函數裡，引數傳遞的情形



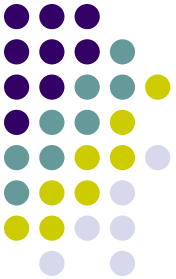


「>」運算子的多載 (3/4)

- 下面是將運算子「>」多載的範例

```
01  // prog15_1, 運算子「>」多載的範例
02  #include <iostream>
03  #include <cstdlib>
04  using namespace std;
05  class CWin                                    // 定義視窗類別 CWin
06  {
07     private:
08       char id;
09       int width, height;
10
11     public:
12       CWin(char i,int w,int h):id(i),width(w),height(h) // 建構元
13       {}
14
15       int operator>(CWin &win)                 // 定義運算子「>」的多載
16       {
17          return(this->area() > win.area());
18       }
19       int area(void)
20       {
21          return width*height;
22       }
23  };
```

```
/* prog15_1 OUTPUT--------

win1 is larger than win2
-------------------------*/
```



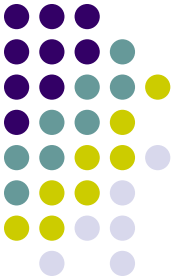
「>」運算子的多載 (4/4)

```
24
25  int main(void)
26  {
27     CWin win1('A',70,80);
28     CWin win2('B',60,90);
29
30     if(win1>win2)                        // 判別 win1 與 win2 物件面積的大小
31        cout << "win1 is larger than win2" << endl;
32     else
33        cout << "win2 is larger than win1" << endl;
34
35     system("pause");
36     return 0;
37  }
```

```
/* prog15_1 OUTPUT--------
win1 is larger than win2
-------------------------*/
```

第 30 行的判斷敘述也可以把它寫成

```
if(win1.operator>(win2))     // 呼叫 operator>()函數
```



再把operator>()函數多載 (1/5)

- 在prog15_1裡，不能在main() 裡撰寫下面兩種敘述

(1) win1 > 7000; // 在prog15_1裡，不能比較面積與常數的大小

(2) 7000 > win1; // 同上，但常數是置於「>」符號的前面

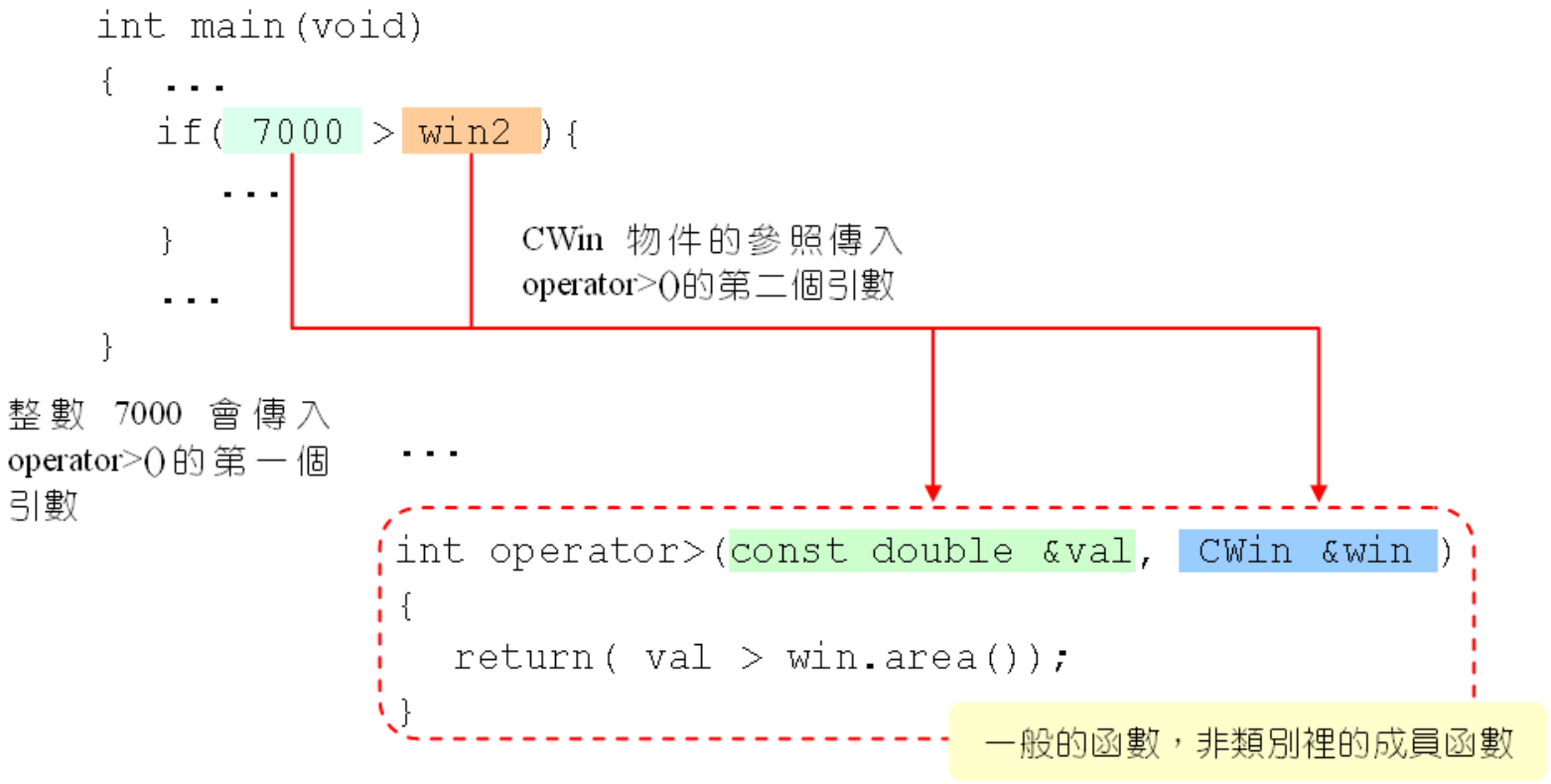
解決的方式是，再定義一個operator() 函數

接收整數常數的參照

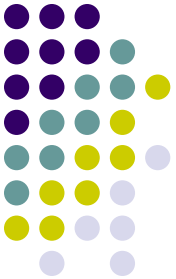
```
int operator>(const int &var)
{
   return(this->area() > var);
}
```

再把operator>()函數多載 (2/5)

- 有兩個引數的operator>() 函數，引數接收的情形如下



再把operator>()函數多載 (3/5)



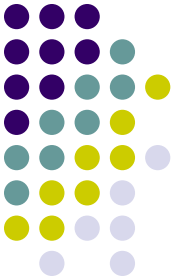
- prog15_2是使用operator>() 函數的完整範例

```
01  // prog15_2, 運算子多載的範例(二)
02  #include <iostream>
03  #include <cstdlib>
04  using namespace std;
05  class CWin
06  {
07     private:
08       char id;
09       int width, height;
10
11     public:
12       CWin(char i,int w,int h):id(i),width(w),height(h) // 建構元
13       {}
14       int operator>(CWin &win)
15       {
16          return(this->area() > win.area());
17       }
18       int operator>(const int &var)
19       {
20          return(this->area() > var);
21       }
```

第一個 operator>()函數

第二個 operator>()函數

```
/* prog15_2 OUTPUT----------

win1 is larger than win2
win1 is smaller than 7000
win2 is smaller than 4500
----------------------------*/
```

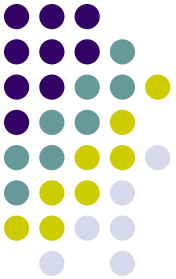


再把operator>()函數多載 (4/5)

```
22        int area(void)
23        {
24           return width*height;
25        }
26    };
27
28    int operator>(const int &var, CWin &win)
29    {
30       return( var > win.area());
31    }
32
33    int main(void)
34    {
35       CWin win1('A',70,80);
36       CWin win2('B',60,70);
37
38       if(win1>win2)                    // 呼叫第一個 operator>()函數
39          cout << "win1 is larger than win2" << endl;
40       else
41          cout << "win1 is smaller than win2" << endl;
42
```

```
/* prog15_2 OUTPUT----------
win1 is larger than win2
win1 is smaller than 7000
win2 is smaller than 4500
----------------------------*/
```

第三個 operator>()函數，注意這個函數定義在 CWin 類別之外，因此它是一般的函數



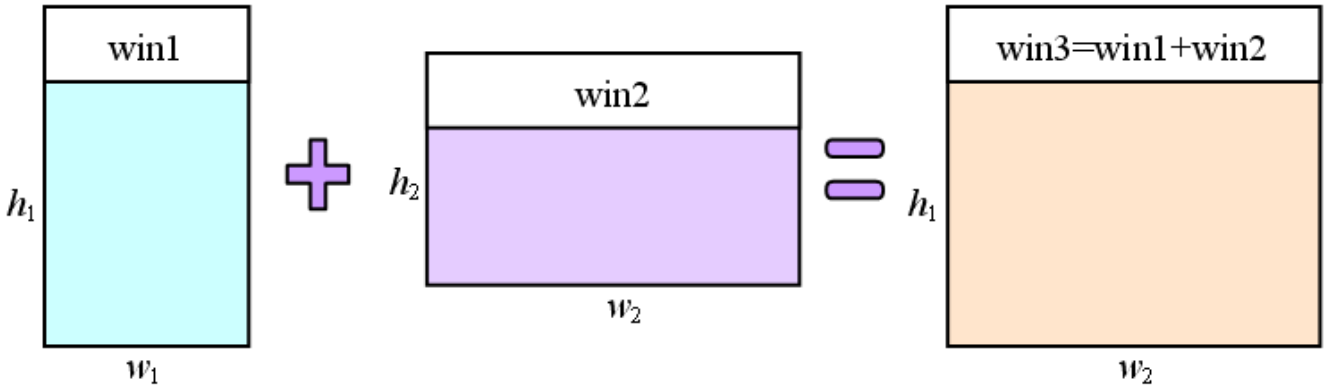
再把operator>()函數多載 (5/5)

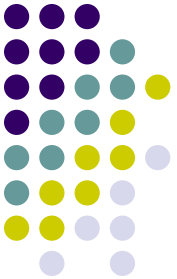
```
43      if(win1>7000)                       // 呼叫第二個 operator>()函數
44         cout << "win1 is larger than 7000" << endl;
45      else
46         cout << "win1 is smaller than 7000" << endl;
47
48      if(4500>win2)                       // 呼叫第三個 operator>()函數
49         cout << "win2 is smaller than 4500" << endl;
50      else
51         cout << "win2 is larger than 4500" << endl;
52
53      system("pause");
54      return 0;
55   }
```

```
/* prog15_2 OUTPUT----------

win1 is larger than win2
win1 is smaller than 7000
win2 is smaller than 4500
---------------------------*/
```

「+」的多載

- 定義CWin物件的相加
  - （取其width與height成員較大者）

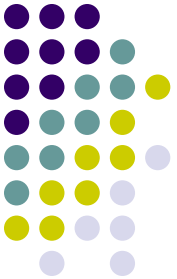




「+」運算子多載的實例 (1/2)

下面的程式是「+」運算子多載的實例

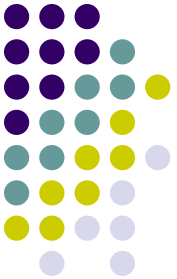
```
01  // prog15_3,「+」運算子多載的範例
02  #include <iostream>
03  #include <cstdlib>
04  using namespace std;
05  class CWin                                  // 定義視窗類別 CWin
06  {
07     private:
08       char id;                                    /* prog15_3 OUTPUT-------------
09       int width, height;
10                                                   Window D: width=70, height=90
11     public:                                       ------------------------------*/
12       CWin(char i='D',int w=10,int h=10):id(i),width(w),height(h)
13       {}
14
15       CWin operator+(CWin &win)          // 定義「+」運算子的多載
16       {
17          int w,h;
18          w = this->width > win.width ? this->width : win.width;
19          h = this->height > win.height ? this->height : win.height;
20          return CWin('D',w,h);           // 呼叫建構元建立並傳回新的物件
21       }
```



「+」運算子多載的實例 (2/2)

```
22        void show member(void)
23        {
24           cout << "Window " << id << ": ";
25           cout << "width=" << width << ", height=" << height << endl;
26        }
27    };
28
29    int main(void)
30    {
31       CWin win1('A',70,80);
32       CWin win2('B',60,90);
33       CWin win3;
34
35       win3=win1+win2;                    // 物件的加法運算
36       win3.show member();
37
38       system("pause");
39       return 0;
40    }
```

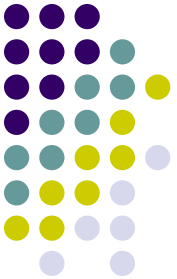
```
/* prog15_3 OUTPUT-------------
Window D: width=70, height=90
-------------------------------*/
```



簡單的範例 (1/6)

- 如果物件裡的成員包含有指標，或是以動態記憶體方式配置變數時，使用預設的設定運算子「=」可能會發生錯誤

```
01  // prog15_4, 使用預設的設定運算子所發生的錯誤
02  #include <iostream>
03  #include <cstdlib>
04  using namespace std;
05  class CWin                                  // 定義視窗類別 CWin
06  {
07     private:
08       char id, *title;
09
10     public:
11       CWin(char i='D', char *text="Default window"):id(i)
12       {
13          title=new char[50];                 // 配置可容納 50 個字元的記憶空間
14          strcpy(title,text);                 // 將text所指向的字串拷貝給 title
15       }
```



簡單的範例 (2/6)

```
16        void set data(char i, char *text)
17        {
18           id=i;
19           strcpy(title,text);          // 將text所指向的字串拷貝給title
20        }
21        void show(void)
22        {
23           cout << "Window " << id << ": " << title << endl;
24        }
25
26        ~CWin(){ delete [] title; }
27
28        CWin(const CWin &win)
29        {
30           id=win.id;
31           strcpy(title,win.title);
32        }
33    };
34
```

```
/* prog15_4 OUTPUT---------
Window A: Main window
Window D: Default window

設定 win1=win2 之後...
Window D: Default window
Window D: Default window

更改 win1 的資料成員之後...
Window B: Hello window
Window D: Hello window
--------------------------*/
```

簡單的範例 (3/6)

```
35  int main(void)
36  {
37     CWin win1('A',"Main window");
38     CWin win2;
39
40     win1.show();
41     win2.show();
42
43     win1=win2;                          // 設定 win1=win2
44     cout << endl << "設定 win1=win2 之後..." << endl;
45     win1.show();
46     win2.show();
47
48     win1.set_data('B',"Hello window");
49     cout << endl << "更改 win1 的資料成員之後..." << endl;
50     win1.show();
51     win2.show();
52
53     system("pause");
54     return 0;
55  }
```

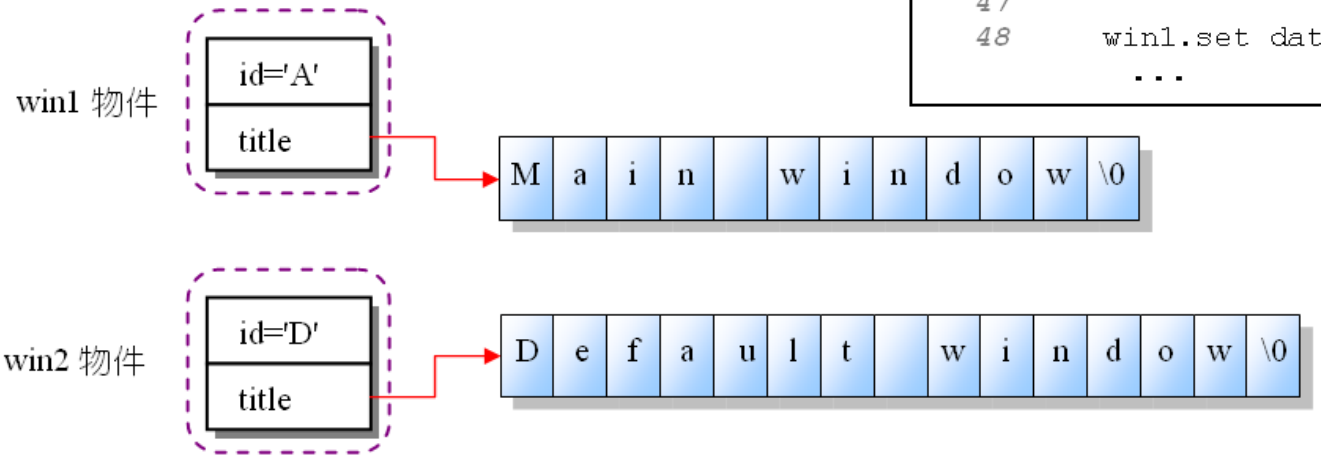
```
/* prog15_4 OUTPUT---------

Window A: Main window
Window D: Default window

設定 win1=win2 之後...
Window D: Default window
Window D: Default window

更改 win1 的資料成員之後...
Window B: Hello window
Window D: Hello window
--------------------------*/
```

簡單的範例 (4/6)

- 下圖是執行完37~38行後的結果

```
35  int main(void)
36  {
37      CWin win1('A',"Main window");
38      CWin win2;
39
40      win1.show();
41      win2.show();
42
43      win1=win2;   // 設定 win1=win2
44      cout << endl << "設定 win1=win2 之後...";
45      win1.show();
46      win2.show();
47
48      win1.set data('B',"Hello window");
          ...
```

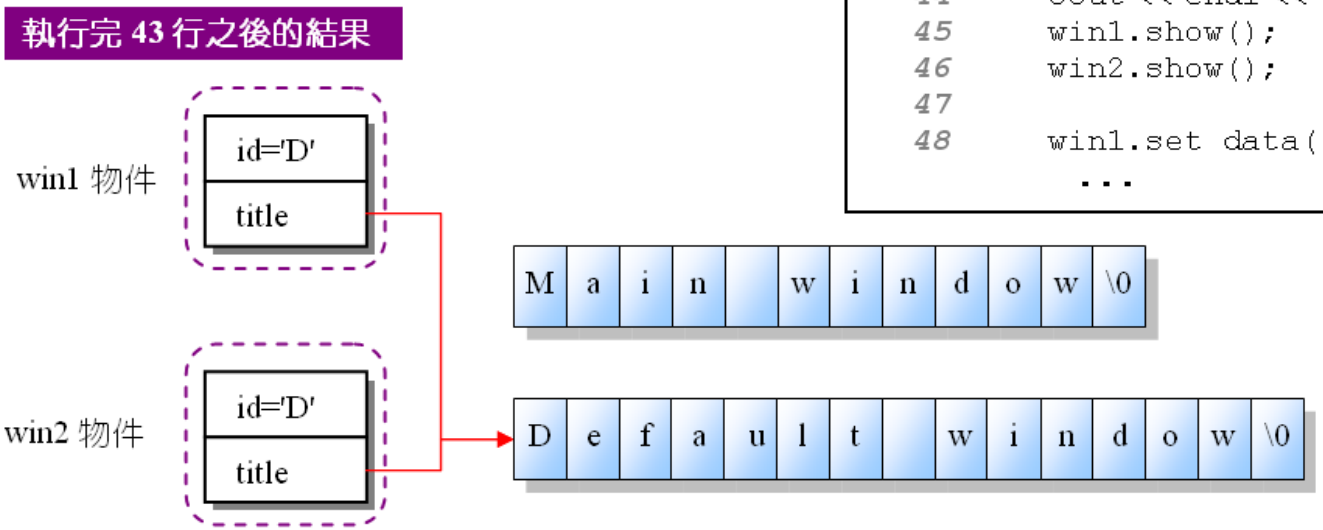
執行完 37~38 行之後的結果



簡單的範例 (5/6)

- 下圖是執行完43行後的結果

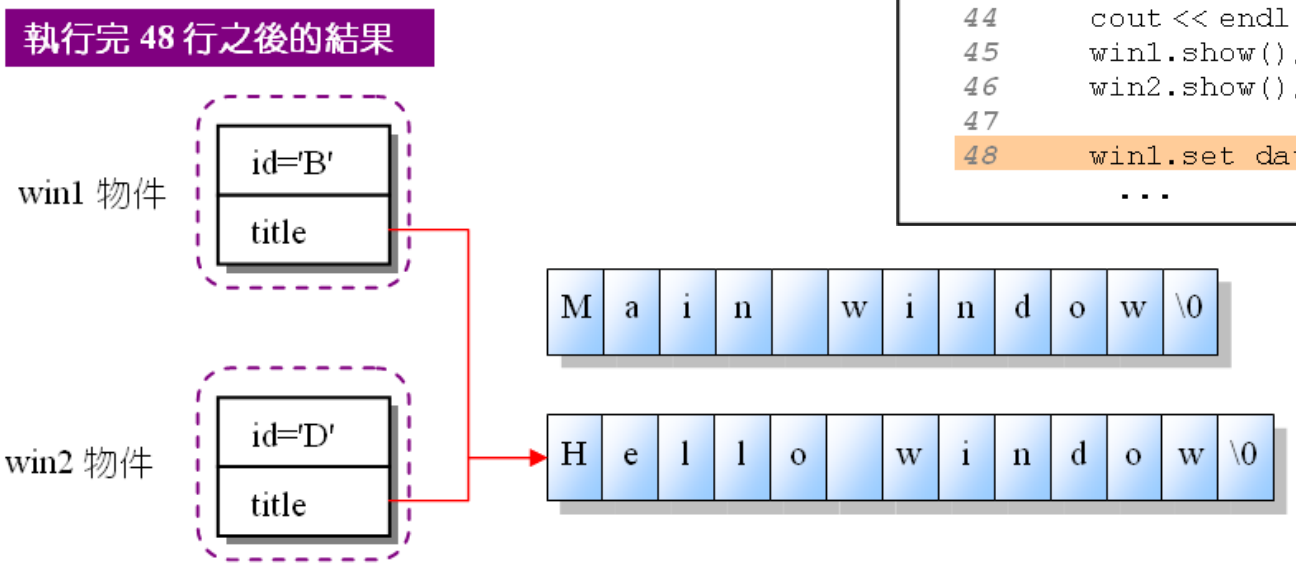
```
35  int main(void)
36  {
37      CWin win1('A',"Main window");
38      CWin win2;
39
40      win1.show();
41      win2.show();
42
43      win1=win2;   // 設定 win1=win2
44      cout << endl << "設定 win1=win2 之後...";
45      win1.show();
46      win2.show();
47
48      win1.set data('B',"Hello window");
          ...
```

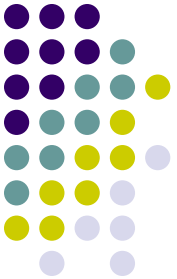


簡單的範例 (6/6)

- 下圖是執行完48行後的結果

```
35  int main(void)
36  {
37     CWin win1('A',"Main window");
38     CWin win2;
39
40     win1.show();
41     win2.show();
42
43     win1=win2;   // 設定 win1=win2
44     cout << endl << "設定 win1=win2 之後...";
45     win1.show();
46     win2.show();
47
48     win1.set_data('B',"Hello window");
          ...
```



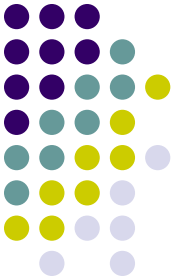


修正錯誤 (1/6)

- 下面的範例，是使用設定運算子來修正錯誤

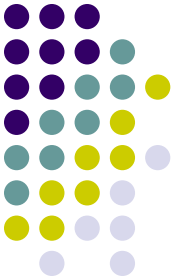
```
01  // prog15_5, 使用設定運算子來修正錯誤
02  #include <iostream>
03  #include <cstdlib>
04  using namespace std;
05  class CWin    // 定義視窗類別 CWin
06  {
07     private:
08       char id, *title;
09
10     public:
11       CWin(char i='D', char *text="Default window"):id(i)
12       {
13          title=new char[50];
14          strcpy(title,text);
15       }
16       void set data(char i, char *text)
17       {
18          id=i;
19          strcpy(title,text);
20       }
```

```
/* prog15_5 OUTPUT-------

Window A: Main window
Window D: Default window

設定 win1=win2 之後...
Window D: Default window
Window D: Default window

更改 win1 的資料成員之後...
Window B: Hello window
Window D: Default window
------------------------*/
```



修正錯誤 (2/6)

```
21        void operator=(const CWin &win)    // 定義設定運算子「=」的多載
22        {
23           id=win.id;
24           strcpy(this->title,win.title);  // 字串拷貝
25        }
26        void show(void)
27        {
28           cout << "Window " << id << ": " << title << endl;
29        }
30
31        ~CWin(){ delete [] title; }        // 解構元
32
33        CWin(const CWin &win)              // copy constructor
34        {
35           id=win.id;
36           strcpy(title,win.title);        // 拷貝建構元
37        }
38    };
39
40    int main(void)
41    {
```



修正錯誤 (3/6)

```
42      CWin win1('A',"Main window");
43      CWin win2;
44
45      win1.show();
46      win2.show();
47
48      win1=win2;
49      cout << endl << "設定 win1=win2 之後..." << endl;
50      win1.show();
51      win2.show();
52
53      win1.set data('B',"Hello window");
54      cout << endl << "更改 win1 的資料成員之後..." << endl;
55      win1.show();
56      win2.show();
57
58      system("pause");
59      return 0;
60  }
```

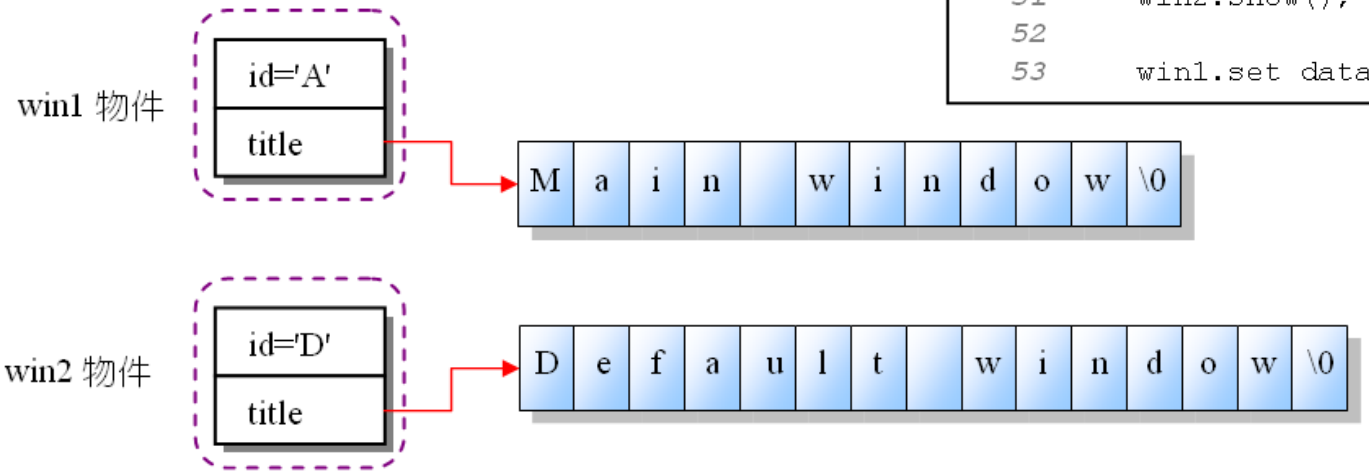
```
/* prog15_5 OUTPUT-------

Window A: Main window
Window D: Default window

設定 win1=win2 之後...
Window D: Default window
Window D: Default window

更改 win1 的資料成員之後...
Window B: Hello window
Window D: Default window
------------------------*/
```

修正錯誤 (4/6)

- 下圖為執行完42~43行後的結果

```
40  int main(void)
41  {
42      CWin win1('A',"Main window");
43      CWin win2;
44
45      win1.show();
46      win2.show();
47
48      win1=win2;
49      cout << endl << "設定 win1=win2 之後...";
50      win1.show();
51      win2.show();
52
53      win1.set data('B',"Hello window");
```

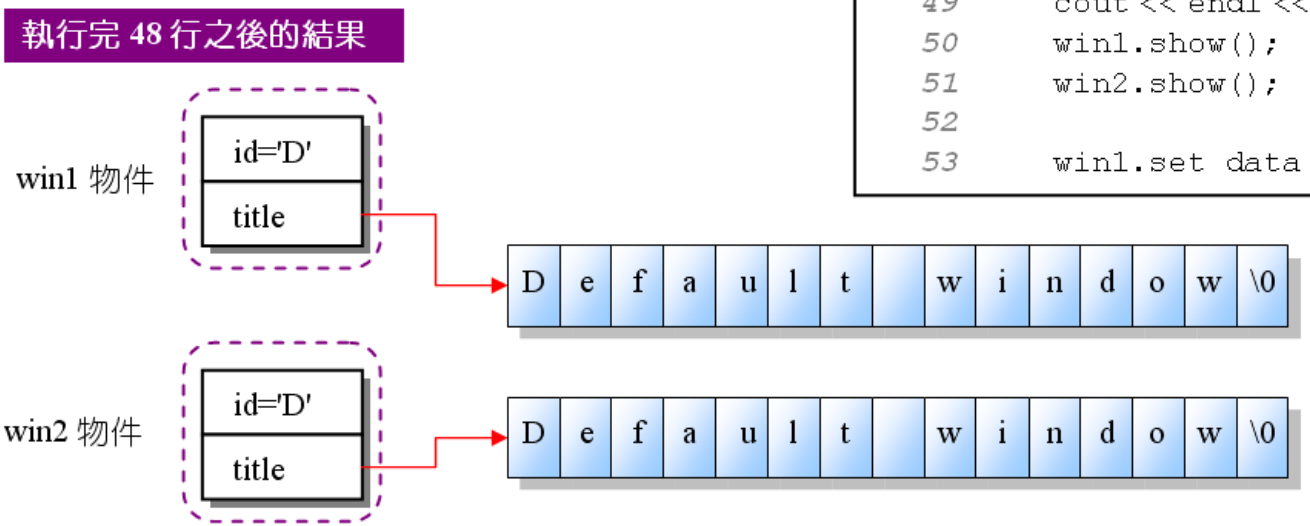
執行完 42~43 行之後的結果



修正錯誤 (5/6)

- 下圖為執行完48行後的結果

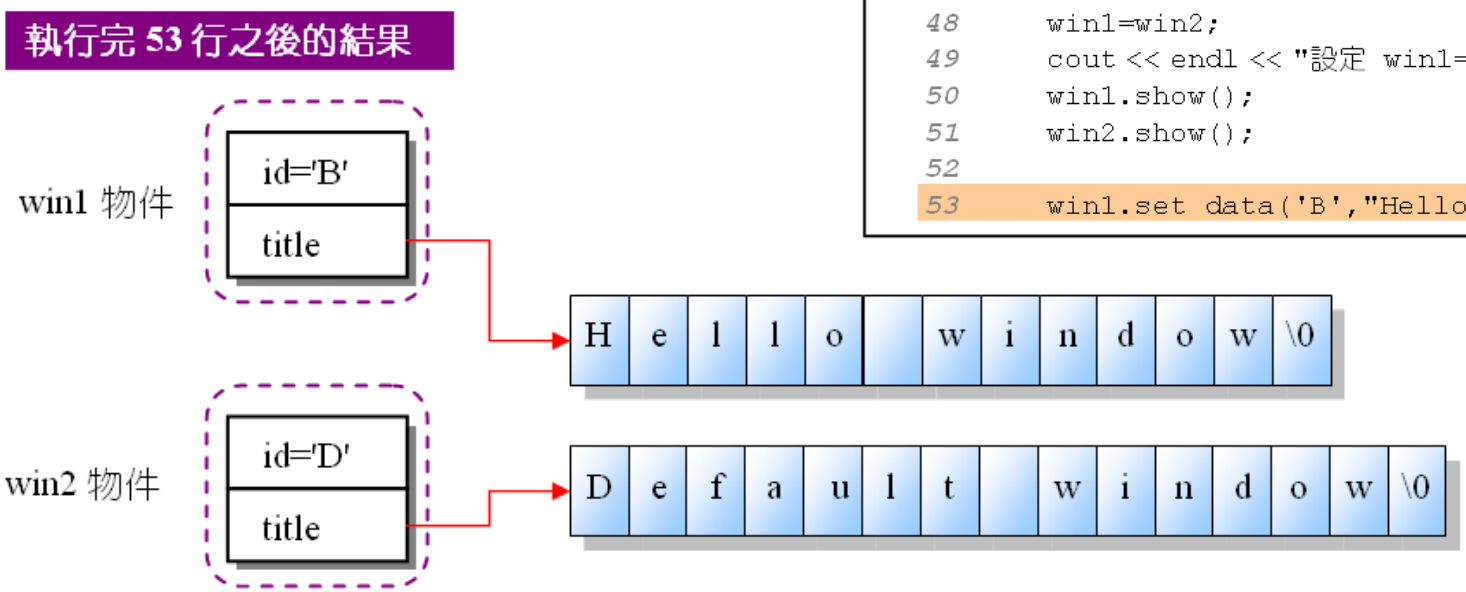
```
40  int main(void)
41  {
42     CWin win1('A',"Main window");
43     CWin win2;
44
45     win1.show();
46     win2.show();
47
48     win1=win2;
49     cout << endl << "設定 win1=win2 之後...";
50     win1.show();
51     win2.show();
52
53     win1.set_data('B',"Hello window");
```



修正錯誤 (6/6)

- 下圖為執行完53行後的結果

```
40  int main(void)
41  {
42     CWin win1('A',"Main window");
43     CWin win2;
44
45     win1.show();
46     win2.show();
47
48     win1=win2;
49     cout << endl << "設定 win1=win2 之後...";
50     win1.show();
51     win2.show();
52
53     win1.set data('B',"Hello window");
```



設定運算子多載的進階應用 (1/2)

- 如果想把設定運算子「=」多載成可以連續設值：

```
win1=win2=win3;          // 把win3的值設給win1與win2
```

可依下面的步驟進行設計：

- 先把win3的值設給win2，再把win2的值設給win1

```
win1=(win2=win3);
```

- 把上式改寫成：

```
win1=(win2.operator=(win3));
```

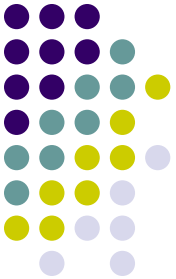
- 再改為成右邊的敘述：

以 win2 物件呼叫 operator=()函數，並傳入 win3 物件

```
win1.operator=(win2.operator=(win3));
```

以 win2.operator=(win3)的傳回值為引數，傳入由 win1 物件所呼叫的 operator=()函數

設定運算子多載的進階應用 (2/2)

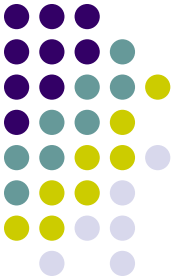


- 最後可以寫出「=」運算子的多載

傳回 CWin 物件的參照　　傳入 CWin 物件的參照

```
CWin & operator=( const CWin &win )
{
   id=win.id;
   strcpy(this->title,win.title);
   return *this;
}
```

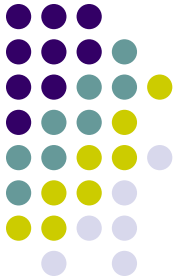
this 是指向呼叫此一函數的物件之指標，
因此*this 即代表呼叫此函數的物件



「=」運算子多載的範例 (1/3)

- 下面的程式修改自prog15_5，示範「=」運算子的多載

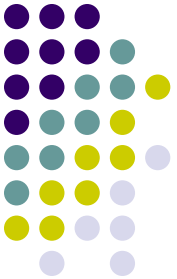
```
01  // prog15_6, 設定運算子多載的進階應用
02  #include <iostream>
03  #include <cstdlib>
04  using namespace std;
05  class CWin                                    // 定義視窗類別 CWin
06  {
07    private:
08      char id, *title;
09
10    public:
11      CWin(char i='D', char *text="Default window"):id(i)
12      {
13        title=new char[50];
14        strcpy(title,text);
15      }
16      void set data(char i, char *text)
17      {
18        id=i;
19        strcpy(title,text);
20      }
```



「=」運算子多載的範例 (2/3)

```
21        CWin &operator=(const CWin &win)   // 定義設定運算子「=」的多載
22        {
23           id=win.id;
24           strcpy(this->title,win.title);
25           return *this;
26        }
27        void show(void)
28        {
29           cout<<"Window "<< id <<": "<< title <<endl;
30        }
31
32        ~CWin(){ delete [] title; }
33
34        CWin(const CWin &win)                  // copy constructor
35        {
36           id=win.id;
37           strcpy(title,win.title);
38        }
39    };
40
41    int main(void)
42    {
```

```
/* prog15_6 OUTPUT----------------------

Window A: Main window
Window B: Big window
Window D: Default window
設定 win1=win2=win3,並更改 win1 的成員之後 ...
Window A: Hello window
Window D: Default window
Window D: Default window
----------------------------------------*/
```



「=」運算子多載的範例 (3/3)

```
41  int main(void)
42  {
43     CWin win1('A',"Main window");
44     CWin win2('B',"Big window");
45     CWin win3;
46
47     win1.show();
48     win2.show();
49     win3.show();
50
51     win1=win2=win3;                          // 設定 win1=win2=win3
52     win1.set_data('A',"Hello window");       // 修改 win1 的內容
53
54     cout << "設定 win1=win2=win3,並更改 win1 的成員之後 ..." << endl;
55     win1.show();
56     win2.show();
57     win3.show();
58
59     system("pause");
60     return 0;
61  }
```

建立三個物件

```
/* prog15_6 OUTPUT----------------------
Window A: Main window
Window B: Big window
Window D: Default window
設定 win1=win2=win3,並更改 win1 的成員之後 ...
Window A: Hello window
Window D: Default window
Window D: Default window
-------------------------------------*/
```


-The End-