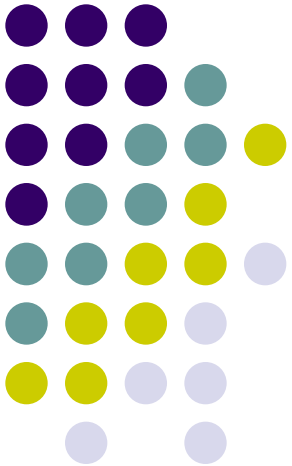
解構元與拷貝建構元

認識解構元

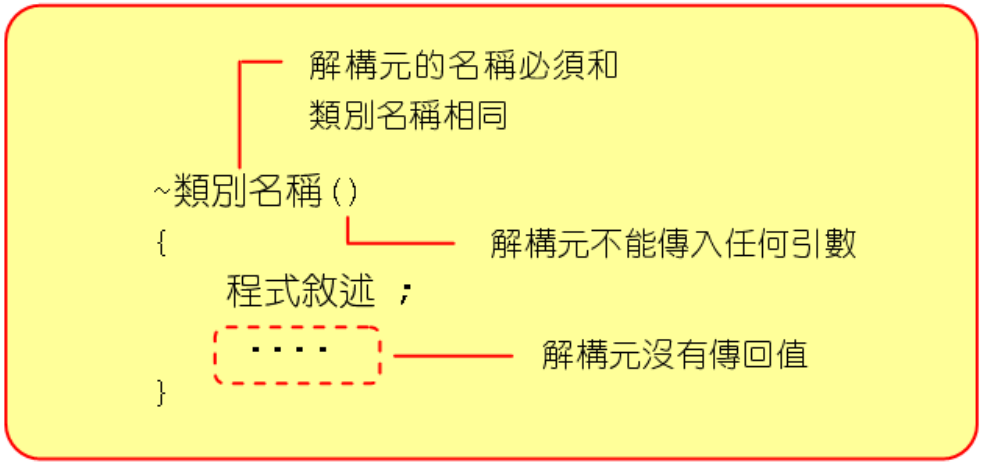
學習動態記憶體配置與解構元的關係

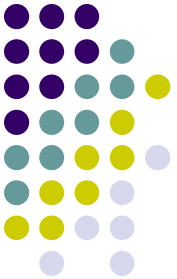
使用拷貝建構元



解構元

- 建構元是在物件初次被建立時呼叫
- 解構元是在物件被銷毀（destroy）時呼叫
- 銷毀指的是釋放物件原先所佔有的記憶空間
- 解構元的名稱和類別的名稱相同，之前必須加上一個 ~（tilde）符號
- 解構元的定義格式

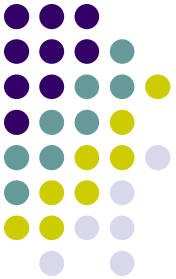




解構元的使用 (1/2)

- 下面的範例裡加入一個解構元，以便觀察它的運作

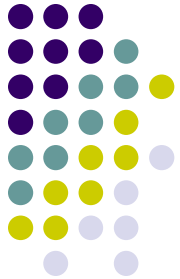
```
01  // prog14_1, 解構元的使用
02  #include <iostream>
03  #include <cstdlib>
04  using namespace std;
05  class CWin                    // 定義視窗類別 CWin
06  {
07     private:
08       char id;
09       int width, height;
10
11     public:
12       CWin(char i,int w,int h):id(i),width(w),height(h)
13       {
14          cout << "建構元被呼叫了..." << endl;
15       }
16       ~CWin()                  // 解構元
17       {
18          cout << "解構元被呼叫了， Win " << this->id << "被銷毀了.." << endl;
19          system("pause");
20       }
```



解構元的使用 (2/2)

```
21        void show member(void)
22        {
23           cout << "Window " << id << ": ";
24           cout << "width=" << width << ", height=" << height << endl;
25        }
26    };
27
28    int main(void)
29    {
30       CWin win1('A',50,40);
31       CWin win2('B',40,50);
32       CWin win3('C',60,70);
33       CWin win4('D',90,40);
34
35       win1.show member();
36       win2.show member();
37
38       system("pause");
39       return 0;
40    }
```

```
/* prog14_1 OUTPUT-------------
建構元被呼叫了...
建構元被呼叫了...
建構元被呼叫了...
建構元被呼叫了...
Window A: width=50, height=40
Window B: width=40, height=50
請按任意鍵繼續 . . .    ———————— 執行第 38 行的結果
解構元被呼叫了，Win D 被銷毀了..  ——— win4 被銷毀，這是執行第 18 行的結果
請按任意鍵繼續 . . .    ———————— 執行第 19 行的結果
解構元被呼叫了，Win C 被銷毀了..  ——— win3 被銷毀，這是執行第 18 行的結果
請按任意鍵繼續 . . .    ———————— 執行第 19 行的結果
解構元被呼叫了，Win B 被銷毀了..  ——— win2 被銷毀，這是執行第 18 行的結果
請按任意鍵繼續 . . .    ———————— 執行第 19 行的結果
解構元被呼叫了，Win A 被銷毀了..  ——— win1 被銷毀，這是執行第 18 行的結果
請按任意鍵繼續 . . .    ———————— 執行第 19 行的結果
------------------------------*/
```



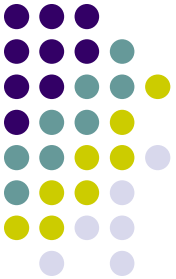
解構元的位置

- 在類別內部宣告解構元的原型

```
~CWin();      // 解構元的原型
```

- 在類別外面定義解構元時，要指明其所屬的建構元

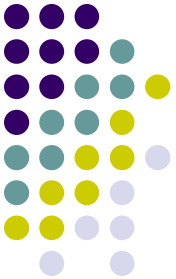
```
CWin::~CWin()
{
    // 解構元的程式碼
}
```



固定空間的記憶體配置 (1/2)

- 先看一個簡單的例子，此例無關動態記憶體配置

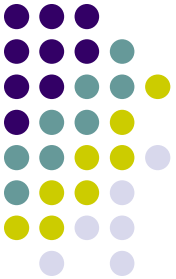
```
01  // prog14_2, 固定空間的記憶體配置
02  #include <iostream>
03  #include <cstdlib>
04  using namespace std;
05  class CWin                          // 定義視窗類別 CWin
06  {
07     private:
08       char id,title[20];
09
10     public:
11       CWin(char i='D', char *text="Default window"):id(i)
12       {
13          strcpy(title,text);      // 將 text 指向的字串拷貝到 title 陣列裡
14       }
15       ~CWin()                        // 解構元
16       {
17          cout << "解構元被呼叫了，Win " << this->id << "被銷毀了.." << endl;
18          system("pause");
19       }
```



固定空間的記憶體配置 (2/2)

```
20        void show(void)           // 顯示 id 與 title 成員
21        {
22           cout << "Window " << id << ": " << title << endl;
23        }
24    };
25
26    int main(void)
27    {
28       CWin win1('A',"Main window");
29       CWin win2('B');
30
31       win1.show();
32       win2.show();
33
34       cout << "sizeof(win1)= " << sizeof(win1) << endl;
35       cout << "sizeof(win2)= " << sizeof(win2) << endl;
36
37       system("pause");
38       return 0;
39    }
```

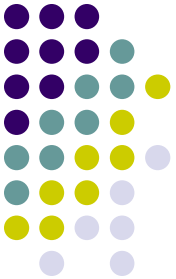
```
/* prog14_2 OUTPUT-------------

Window A: Main window
Window B: Default window
sizeof(win1)= 21
sizeof(win2)= 21
請按任意鍵繼續 . . .
解構元被呼叫了，Win B 被銷毀了..
請按任意鍵繼續 . . .
解構元被呼叫了，Win A 被銷毀了..
請按任意鍵繼續 . . .
-----------------------------*/
```



使用動態記憶體配置 (1/3)

- 下面的範例將prog14_2改以動態的方式來配置記憶體

```
01  // prog14_3, 使用動態記憶體配置
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;                    // 宣告 title 為指向字元陣列的指標
09
10    public:
11      CWin(char i='D', char *text="Default window"):id(i)
12      {
13        title=new char[strlen(text)+1];           // 配置記憶體空間
14        strcpy(title,text);
15      }
16      ~CWin()                             // 解構元的原型
17      {
18        cout << "解構元被呼叫了，Win " << this->id << "被銷毀了.." << endl;
19        delete [] title;                  // 釋放 title 所指向的記憶體空間
20        system("pause");
21      }
```



使用動態記憶體配置 (2/3)

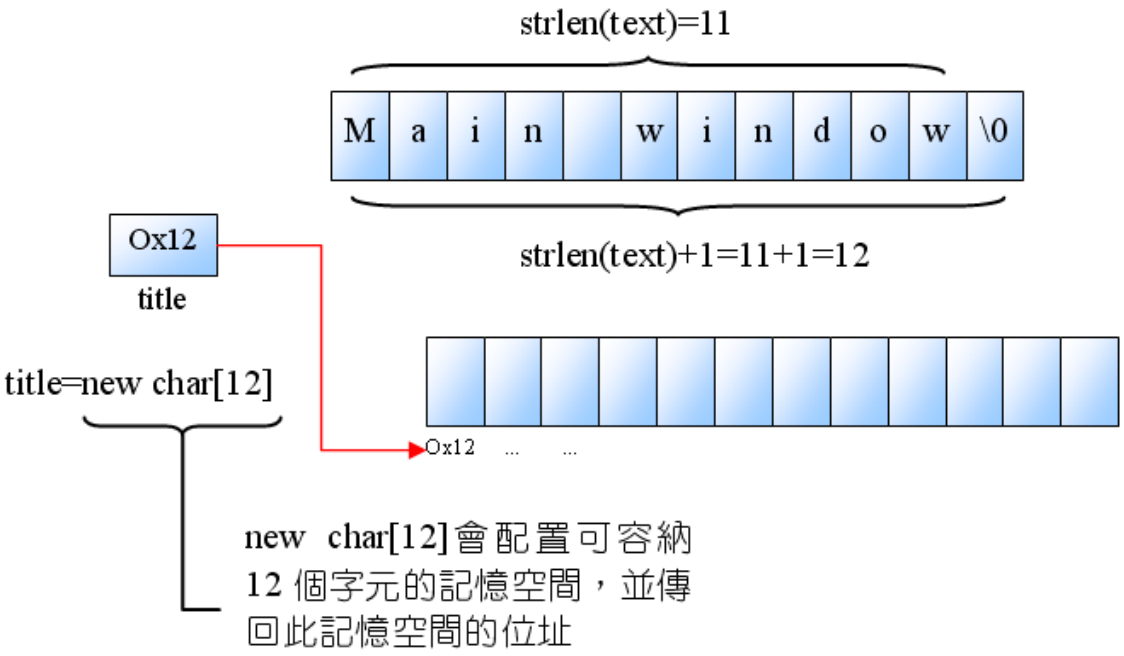
- 原始程式編譯及連結的過程

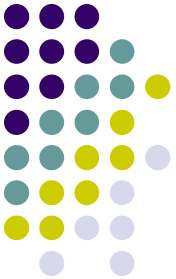
```
22        void show(void)
23        {
24           cout << "Window " << id << ": " << title << endl;
25        }
26    };
27
28    int main(void)
29    {
30       CWin win1('A',"Main window");
31       CWin win2('B');
32
33       win1.show();
34       win2.show();
35       cout << "sizeof(win1)= " << sizeof(win1) << endl;
36       cout << "sizeof(win2)= " << sizeof(win2) << endl;
37
38       system("pause");
39       return 0;
40    }
```

```
/* prog14_3 OUTPUT------------
Window A: Main window
Window B: Default window
sizeof(win1)= 8
sizeof(win2)= 8
請按任意鍵繼續 . . .
解構元被呼叫了，Win B 被銷毀了..
請按任意鍵繼續 . . .
解構元被呼叫了，Win A 被銷毀了..
請按任意鍵繼續 . . .
-----------------------------*/
```

使用動態記憶體配置 (3/3)

- 下圖為prog14_3中，記憶空間配置過程的說明



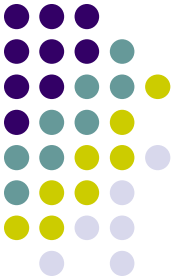


錯誤的使用動態記憶體配置 (1/2)

- 下面的範例修改自prog14_3，這是個錯誤的示範

```
01  // prog14_4, 使用動態記憶體配置, 錯誤的示範
02  #include <iostream>
03  #include <cstdlib>
04  using namespace std;
05
06  // 將 prog14_3 CWin 類別的定義放在這裡
07
08  int main(void)
09  {
10     CWin win1('A',"Main window");
11     CWin *ptr;                          // 宣告 ptr 為指向 CWin 物件的指標
12     ptr=new CWin('B');                  // 建立新的物件，並讓 ptr 指向它
13
14     win1.show();                        // 以 win1 物件呼叫 show()函數
15     ptr->show();                        // 以 ptr 指標呼叫 show()函數
16
17     system("pause");
18     return 0;
19  }
```

```
/* prog14_4 OUTPUT-----------

Window A: Main window
Window B: Defaule window
請按任意鍵繼續 . . .
解構元被呼叫了，Win A 被銷毀了..
請按任意鍵繼續 . . .
----------------------------*/
```

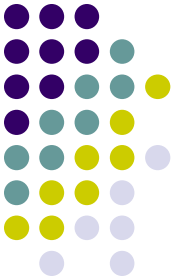


錯誤的使用動態記憶體配置 (2/2)

- 下面的範例是更正過後的程式碼

```
01  // prog14_5, 使用動態記憶體配置
02  #include <iostream>
03  #include <cstdlib>
04  using namespace std;
05
06  // 將 prog14_3 CWin 類別的定義放在這裡
07
08  int main(void)
09  {
10     CWin win1('A',"Main window");
11     CWin *ptr;
12     ptr=new CWin('B');
13
14     win1.show();
15     ptr->show();
16
17     system("pause");
18
19     delete ptr;                          // 釋放 ptr 所指向物件之記憶體
20
21     return 0;
22  }
```

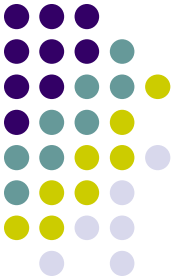
```
/* prog14_5 OUTPUT-----------

Window A: Main window
Window B: Defaule window
請按任意鍵繼續 . . .
解構元被呼叫了，Win B 被銷毀了..
請按任意鍵繼續 . . .
解構元被呼叫了，Win A 被銷毀了..
請按任意鍵繼續 . . .
-----------------------------*/
```



預設的拷貝建構元 (1/3)

- 藉由拷貝建構元，我們可以利用已建立的物件為初值來建立另一個物件

```
CWin win1('A',50,40);     // 建立 win1 物件

CWin win2(win1);     // 以 win1 的內容為初值來建立 win2 物件
```



預設的拷貝建構元 (2/3)

- 下面的範例說明如何在程式中呼叫預設的拷貝建構元

```
01  // prog14_6, 預設的拷貝建構元
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)
13      {
14         cout << "建構元被呼叫了..." <<endl;
15      }
16      void show member(void)
17      {
18         cout << "Window " << id << ": ";
19         cout << "width=" << width << ", height=" << height << endl;
20      }
21  };
```

```
/* prog14_6 OUTPUT----------
建構元被呼叫了...
Window A: width=50, height=40
Window A: width=50, height=40
----------------------------*/
```

預設的拷貝建構元 (3/3)

```
/* prog14_6 OUTPUT----------
建構元被呼叫了...
Window A: width=50, height=40
Window A: width=50, height=40
---------------------------*/
```

```
22
23  int main(void)
24  {
25     CWin win1('A',50,40);              // 建立 win1 物件
26     CWin win2(win1);                   // 呼叫預設的拷貝建構元
27
28     win1.show member();
29     win2.show member();
30
31     system("pause");
32     return 0;
33  }
```

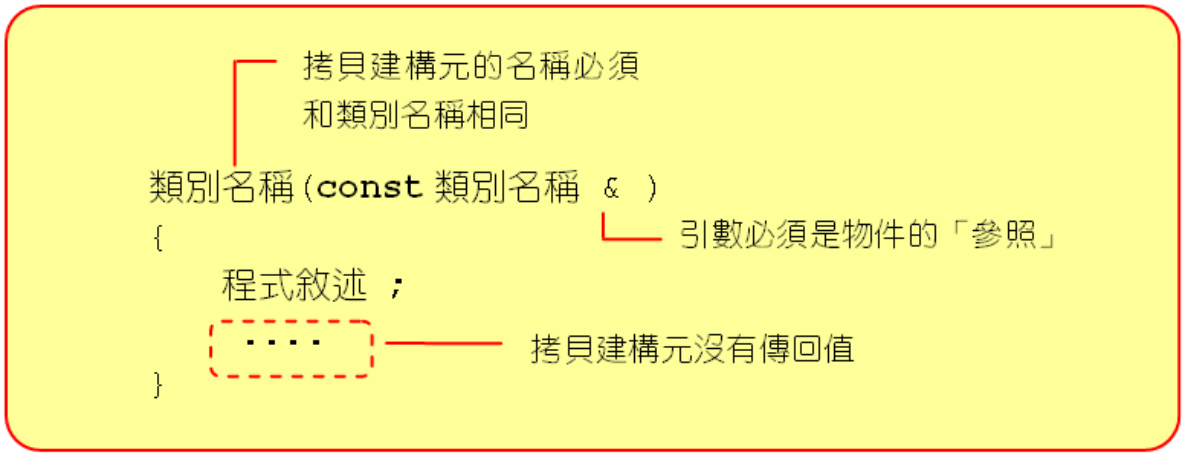
- 從prog14_6輸出結果可以得知
  - 編譯器幫我們提供拷貝建構元
  - 拷貝建構元可用來拷貝一個已存在物件之成員給新建的物件

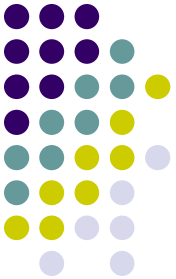
26 行呼叫預設拷貝建構元的敘述可改寫成：

```
CWin win2=win1;   // 以 win1 物件的內容為初值來建立 win2 物件
```

撰寫自己的拷貝建構元 (1/3)

- 要自行提供拷貝建構元，必須以下面的語法來定義



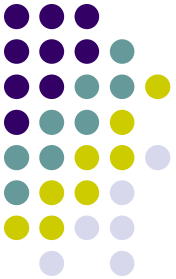


撰寫自己的拷貝建構元 (2/3)

- 下面的程式碼是加入拷貝建構元的範例

```
01  // prog14_7, 撰寫自己的拷貝建構元
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)
13       {
14          cout << "建構元被呼叫了..." << endl;
15       }
16       CWin(const CWin &win)              // 定義拷貝建構元
17       {
18          cout << "拷貝建構元被呼叫了..." << endl;
19          id=win.id;
20          width=win.width;      } 拷貝資料成員
21          height=win.height;
22       }
```

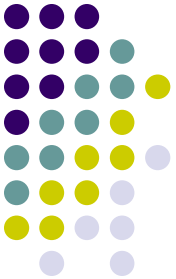
```
/* prog14_7 OUTPUT----------
建構元被呼叫了...
拷貝建構元被呼叫了...
Window A: width=50, height=40
Window A: width=50, height=40
----------------------------*/
```



撰寫自己的拷貝建構元 (3/3)

```
23        void show member(void)
24        {
25           cout << "Window " << id << ": ";
26           cout << "width=" << width << ", height=" << height << endl;
27        }
28    };
29
30    int main(void)
31    {
32       CWin win1('A',50,40);
33       CWin win2(win1);                    // 呼叫拷貝建構元
34
35       win1.show member();
36       win2.show member();
37
38       system("pause");
39       return 0;
40    }
```

```
/* prog14_7 OUTPUT----------

建構元被呼叫了...
拷貝建構元被呼叫了...
Window A: width=50, height=40
Window A: width=50, height=40
----------------------------*/
```

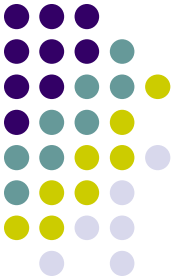


錯誤的使用拷貝建構元 (1/6)

- 下面的範例修改自prog14_3，其中加入拷貝建構元

```
01  // prog14_8, 錯誤示範，未撰寫拷貝建構元而使用預設的版本
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          cout << "建構元被呼叫了..." << endl;
14          title=new char[strlen(text)+1];          // 配置記憶空間
15          strcpy(title,text);
16       }
17       CWin(const CWin &win)
18       {
19          cout<< "拷貝建構元被呼叫了..." <<endl;
20          id=win.id;
21          title=win.title;
22       }
```

拷貝資料成員



錯誤的使用拷貝建構元 (2/6)

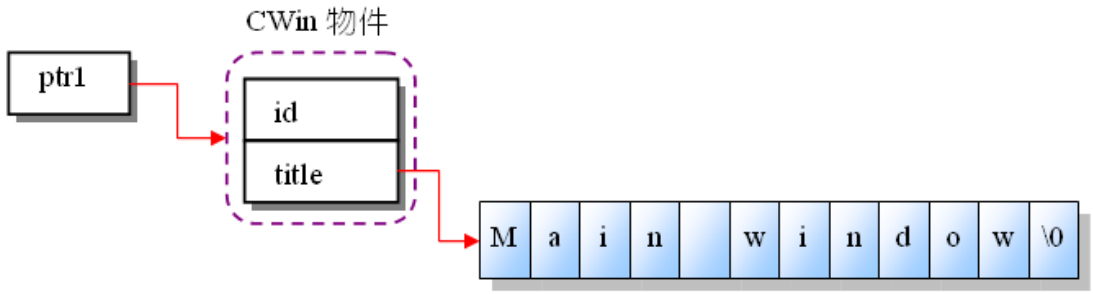
```
23        ~CWin()                       // 解構元的原型
24        {
25           delete [] title;
26        }
27        void show(void)
28        {
29           cout << "Window " << id << ": " << title << endl;
30        }
31    };
32
33    int main(void)
34    {
35       CWin *ptr1=new CWin('A',"Main window");
36       CWin *ptr2=new CWin(*ptr1);  // 以ptr1所指向的物件為初值建立新物件
37
38       ptr1->show();
39       ptr2->show();
40
41       delete ptr1;                  // 釋放ptr1所指向的記憶空間
42       cout << "將ptr1所指向的物件刪除後..." << endl;
43       ptr2->show();
44
45       delete ptr2;                  // 釋放ptr2所指向的記憶空間
46       system("pause");
47       return 0;
48    }
```

```
/* prog14_8 OUTPUT-----------
建構元被呼叫了...
拷貝建構元被呼叫了...
Window A: Main window
Window A: Main window
將ptr1所指向的物件刪除後...
Window A:
----------------------------*/
```

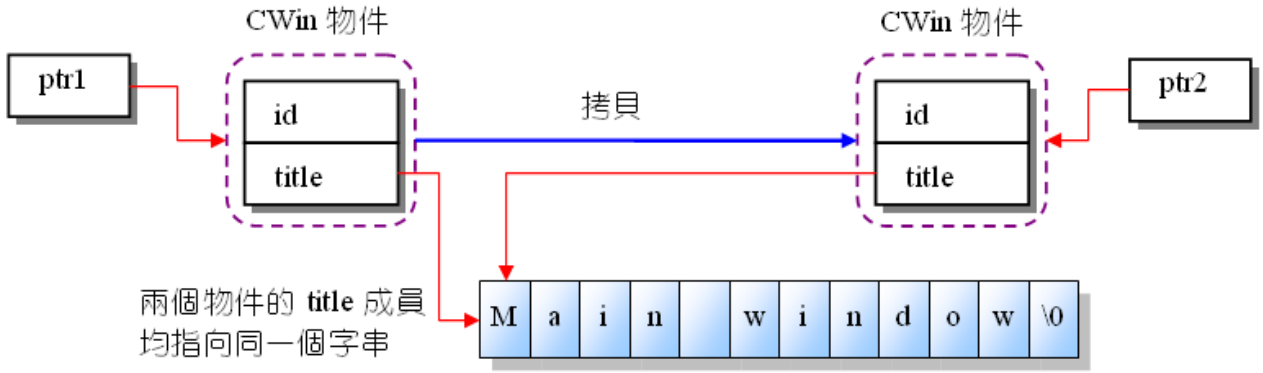
錯誤的使用拷貝建構元 (3/6)

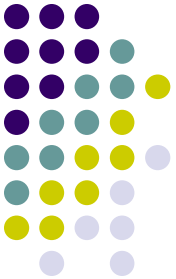
- 下圖為prog14_8記憶體空間配置的情形

```
CWin *ptr1=new CWin('A',"Main window");
```




```
CWin *ptr2=new CWin(*ptr1);
```



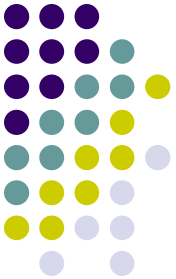


錯誤的使用拷貝建構元 (4/6)

- 下面的程式碼修正prog14_8的錯誤

```
01  // prog14_9, 自行撰寫拷貝建構元
02  #include <iostream>
03  #include <cstdlib>
04  using namespace std;
05  class CWin
06  {
07     private:
08       char id, *title;
09
10     public:
11       CWin(char i='D', char *text="Default window"):id(i)
12       {
13          cout << "建構元被呼叫了..." << endl;
14          title=new char[strlen(text)+1];          // 配置記憶空間
15          strcpy(title,text);
16       }
17       CWin(const CWin &win)
18       {
19          cout << "拷貝建構元被呼叫了..." << endl;
20          id=win.id;
21          title=new char[strlen(win.title)+1];     // 配置記憶空間
22          strcpy(title,win.title);
23       }
```

```
/* prog14_9 OUTPUT---------
建構元被呼叫了...
拷貝建構元被呼叫了...
Window A: Main window
Window A: Main window
將 ptr1 所指向的物件刪除後...
Window A: Main window
--------------------------*/
```



錯誤的使用拷貝建構元 (5/6)

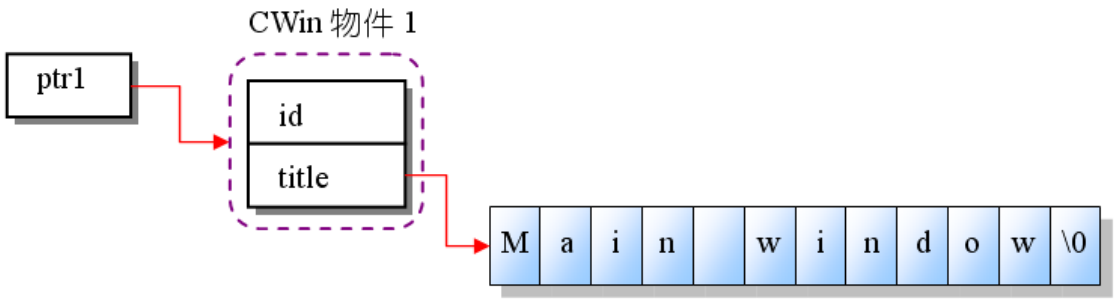
```
24        ~CWin()                                          // 解構元的原型
25        {
26           delete [] title;
27        }
28        void show(void)
29        {
30           cout << "Window " << id << ": " << title << endl;
31        }
32    };
33
34    int main(void)
35    {
36       CWin *ptr1=new CWin('A',"Main window");
37       CWin *ptr2=new CWin(*ptr1);
38
39       ptr1->show();
40       ptr2->show();
41
42       delete ptr1;
43       cout << "將ptr1 所指向的物件刪除後..." << endl;
44       ptr2->show();
45
46       delete ptr2;
47       system("pause");
48       return 0;
49    }
```

```
/* prog14_9 OUTPUT---------
建構元被呼叫了...
拷貝建構元被呼叫了...
Window A: Main window
Window A: Main window
將ptr1 所指向的物件刪除後...
Window A: Main window
---------------------------*/
```

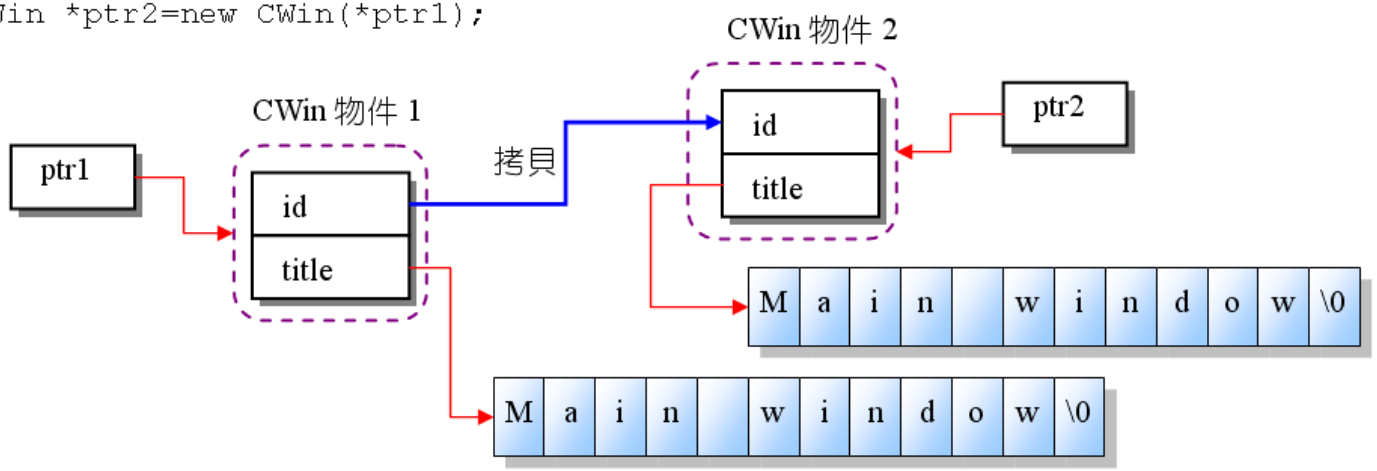
錯誤的使用拷貝建構元 (6/6)

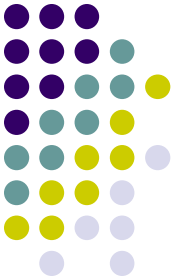
- 下圖為prog14_9執行時，指標與記憶體之配置情形

```
CWin *ptr1=new CWin('A',"Main window");
```




```
CWin *ptr2=new CWin(*ptr1);
```



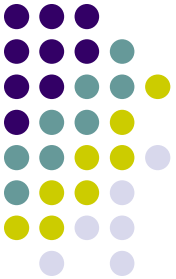


常犯的錯誤 (1/5)

- 下面的程式是未撰寫拷貝建構元的錯誤示範

```
01  // prog14_10, 錯誤示範，未撰寫拷貝建構元的錯誤
02  #include <iostream>
03  #include <cstdlib>
04  using namespace std;
05  class CWin
06  {
07     private:
08       char id, *title;
09
10     public:
11       CWin(char i='D', char *text="Defaule window"):id(i)
12       {
13          cout << "建構元被呼叫了..." << endl;
14          title=new char[strlen(text)+1];      // 配置記憶空間
15          strcpy(title,text);
16       }
17       ~CWin()                                 // 解構元的原型
18       {
19          delete [] title;
20       }
```

```
/* prog14_10 OUTPUT---
建構元被呼叫了...
Window A: Main window
Window A:
----------------------*/
```



常犯的錯誤 (2/5)

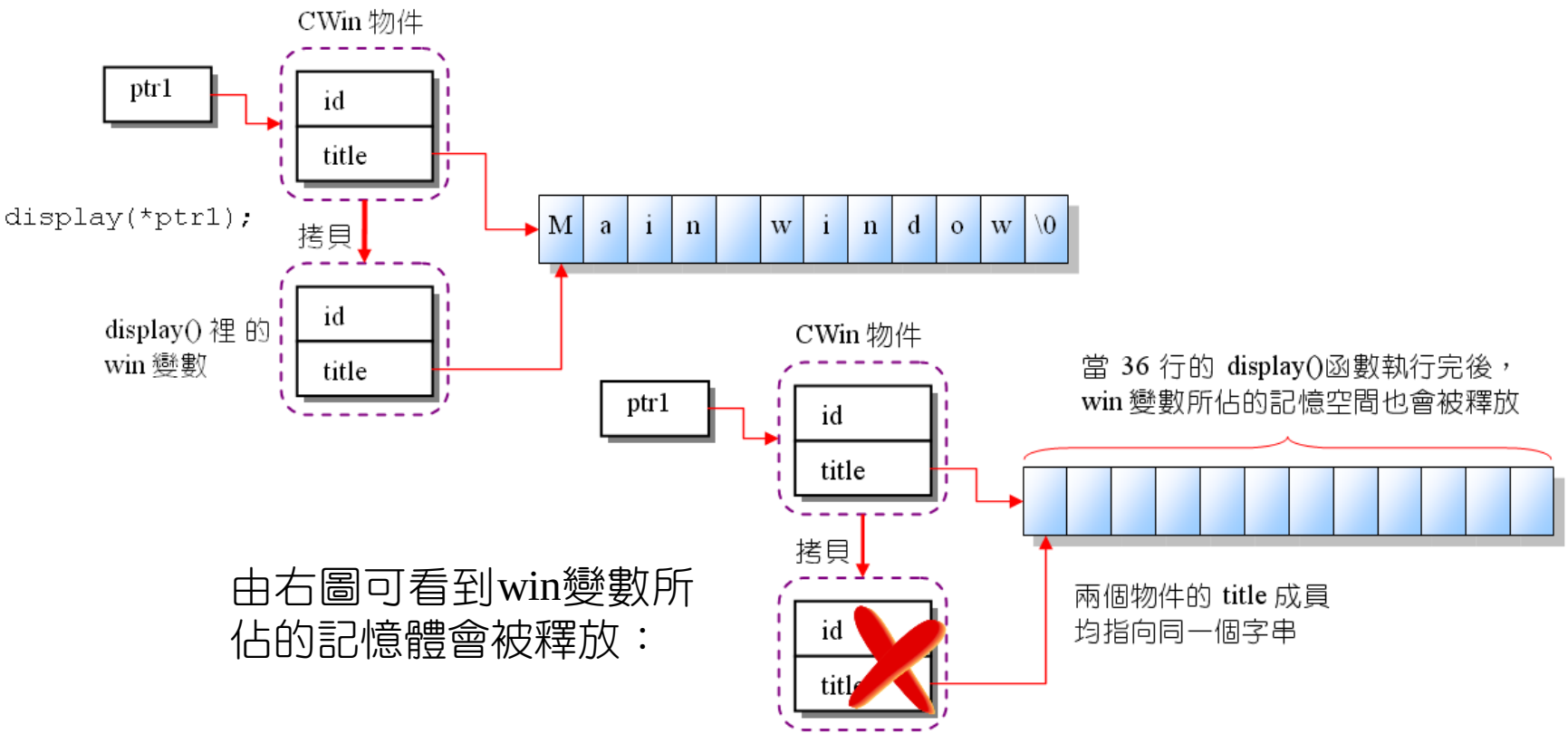
```
21        void show()
22        {
23           cout << "Window " << id << ": " << title << endl;
24        }
25    };
26
27    void display(CWin win)              // 用來呼叫CWin類別裡的show()函數
28    {
29       win.show();
30    }
31
32    int main(void)
33    {
34       CWin *ptr1=new CWin('A',"Main window");
35
36       display(*ptr1);
37       display(*ptr1);
38
39       delete ptr1;
40
41       system("pause");
42       return 0;
43    }
```

```
/* prog14_10 OUTPUT---
建構元被呼叫了...
Window A: Main window
Window A:
----------------------*/
```

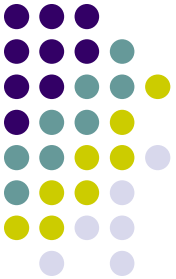
常犯的錯誤 (3/5)

- 執行36行時，指標與記憶體之配置情形

```
36      display(*ptr1);
```



由右圖可看到win變數所佔的記憶體會被釋放：

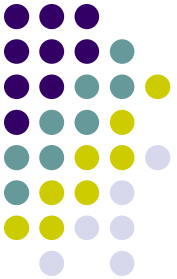


常犯的錯誤 (4/5)

- 下面的程式碼是修正prog14_10過後的版本

```
01  // prog14_11, 加入拷貝建構元來修正錯誤
02  #include <iostream>
03  #include <cstdlib>
04  using namespace std;
05  class CWin
06  {
07     private:
08       char id, *title;
09
10     public:
11       CWin(char i='D', char *text="Defaule window"):id(i)
12       {
13          cout << "建構元被呼叫了..." << endl;
14          title=new char[strlen(text)+1];      // 配置記憶空間
15          strcpy(title,text);
16       }
17       CWin(const CWin &win)
18       {
19          cout << "拷貝建構元被呼叫了..." << endl;
20          id=win.id;
21          title=new char[strlen(win.title)+1];     // 配置記憶空間
22          strcpy(title,win.title);
23       }
```

```
/* prog14_11 OUTPUT---------
建構元被呼叫了...
拷貝建構元被呼叫了...
Window A: Main window
拷貝建構元被呼叫了...
Window A: Main window
---------------------------*/
```



常犯的錯誤 (5/5)

```
24        ~CWin()                                    // 解構元的原型
25        {
26           delete [] title;
27        }
28        void show()
29        {
30           cout << "Window " << id << ": " << title << endl;
31        }
32    };
33
34    void display(CWin win)
35    {
36       win.show();
37    }
38
39    int main(void)
40    {
41       CWin *ptr1=new CWin('A',"Main window");
42
43       display(*ptr1);
44       display(*ptr1);
45
46       delete ptr1;
47
48       system("pause");
49       return 0;
50    }
```

```
/* prog14_11 OUTPUT---------
建構元被呼叫了...
拷貝建構元被呼叫了...
Window A: Main window
拷貝建構元被呼叫了...
Window A: Main window
----------------------------*/
```


-The End-