# 第三章 細部檢視類別

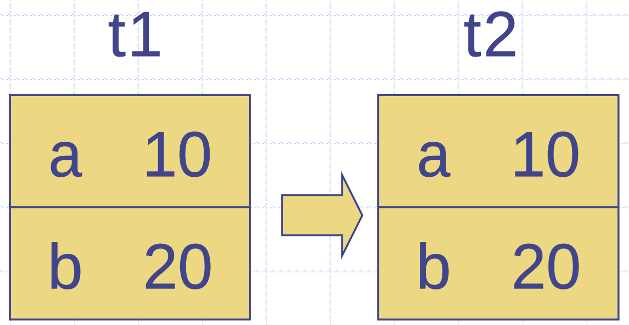
- 3-1 指定物件
- 3-2 傳遞物件給函數
- 3-3 從函數中傳回物件
- 3-4 簡介夥伴函數

## 3-1 指定物件

- 物件之間的指定(assignment)運算
  - int x = 5, y ;
  - y = x ;
  - myclass ob1, ob2 ;
  - ob1 = ob2 ; // what happen?

# What happen?

bit-wise copy (逐位元的複製)



```
struct test { int a , b ;} ;
void main() {
    test t1, t2 ;
    t1.a = 10; t1.b = 20 ;
    t2 = t1 ;
    cout << t2.a << " " << t2.b <<endl ;
}
```

# 物件間的指定(assignment)

```
#include <iostream>
using namespace std ;
class myclass {
      int a, b ;
public:
    myclass(){}
      myclass(int x, int y) {a = x; b = y ;}
      void show() { cout << a << "  "<< b ;}
} ;
void main() {
      myclass ob1(5, 3), ob2;
      ob2 = ob1 ;ob2.show() ;
}
```

Q1: Output?

Ans: bitwise copy for all data members

Q2: 這個程式有無bug?

## 範例一：指定敘述是否需同一類型?

```
class myclass {int a, b ; public: void show();};
    void myclass::show(){cout<<a<<b<<endl;}
class yourclass{ int a, b; public: void show();} ;
    void yourclass ::show(){cout<<a<<b<<endl;}
int main() {
    myclass ob1 ;
    yourclass ob2;
    ob1 = ob2 ;
    return 0 ;
}
```

## 範例二: 物件中有複合資料

```
class stack {
   int stk[10] ;
   int tos;
 public:
   stack(){
         tos=0;
        for(int i=0;i<10;i++)
         stk[i]=0;
   } void push(int num)
   {
     stk[tos]=num;
     tos++;
   }
int pop()
   {
         return stk[--tos];

       }

void print()
       {
         for(int i=0;i<tos;i++
         cout<<stk[i]<<endl;
       }
} ;
```

## 範例二: 物件中有複合資料

```
int main() {
    stack s1, s2 ;
    s1.push(10); s1.push(20); s1.print() ;
    s2 = s1 ; s2.print() ; return 0 ;
}
```

# 範例三: 如果物件中有指標

Q: 以下程式會發生哪些問題?

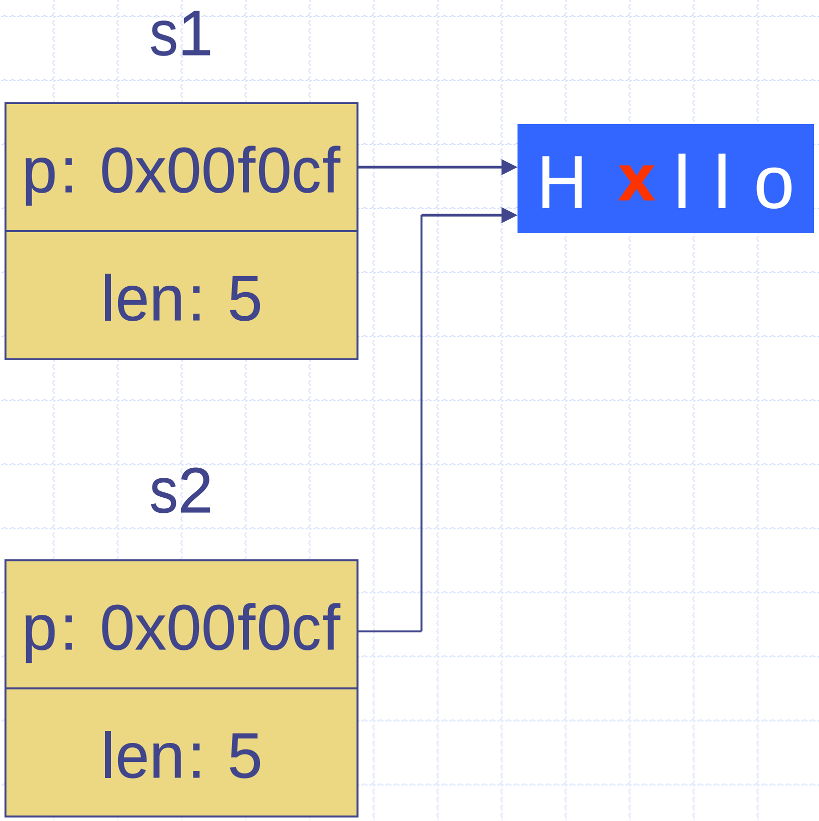
```
class strtype {
     char *p ; int len ;
public:
     strtype(){
        p=new char[10];
        len=1;
        p[0]='\0';
     }
     strtype(char *s) {
            p = new char[strlen(s)+1];
         len=strlen(s)+1;
            p=strcpy(p, s) ;
     }      ~strtype() { delete[] p ; }
     void setChar(int pos, char c) { p[pos] = c ; }
      void show(){ cout<<len<<endl;}
} ;
void main() {
     strtype s1(“Hello”), s2 ;
     s2 = s1 ;
     s2.setChar(1, ‘x’) ; s1.show() ;
}
```

# 範例三: Problem 1

strtype s1(“Hello”), s2;

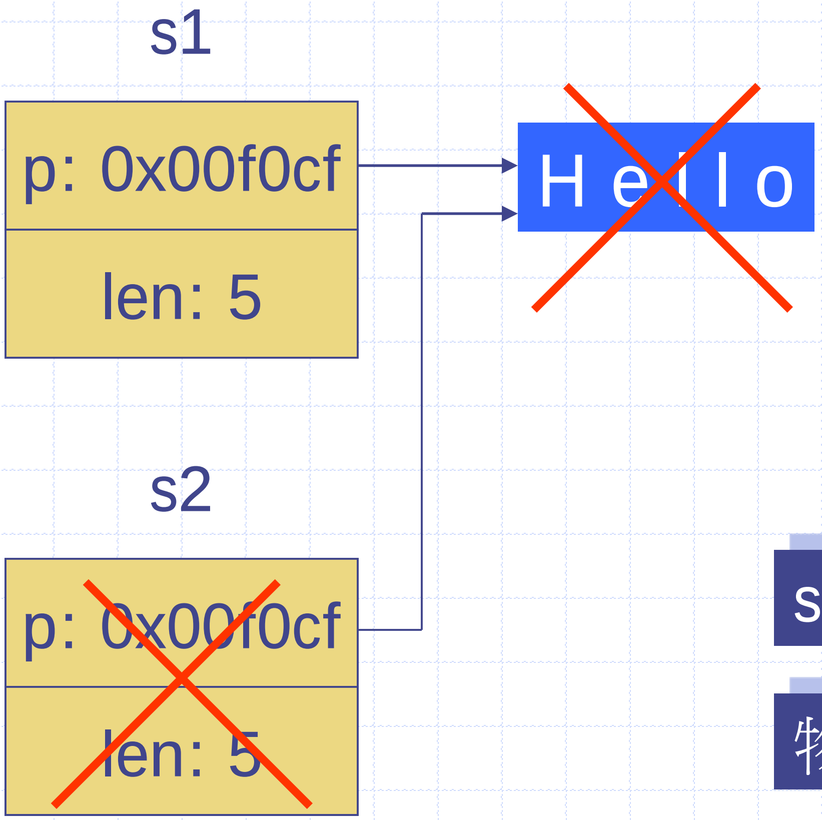
(1)執行  s2 = s1 ;

(2)執行 s2.setChar(1,’x’)



What’s wrong?

# 範例三: Problem 2



```
void main() {
    strtype s1(“Hello”);
    strtype s2 ;
    s2 = s1 ;
}
```

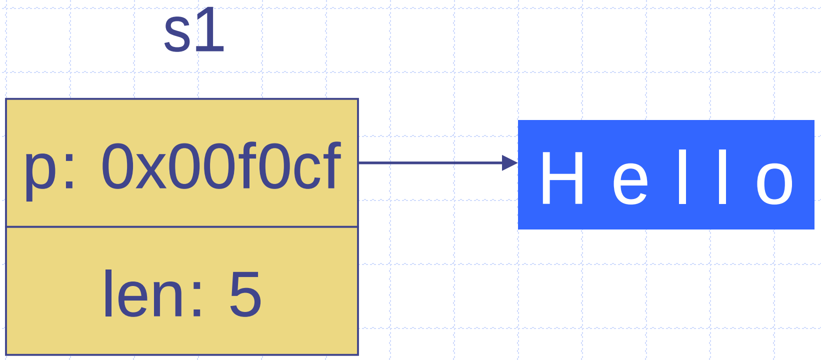
s1, s2何時被消滅?

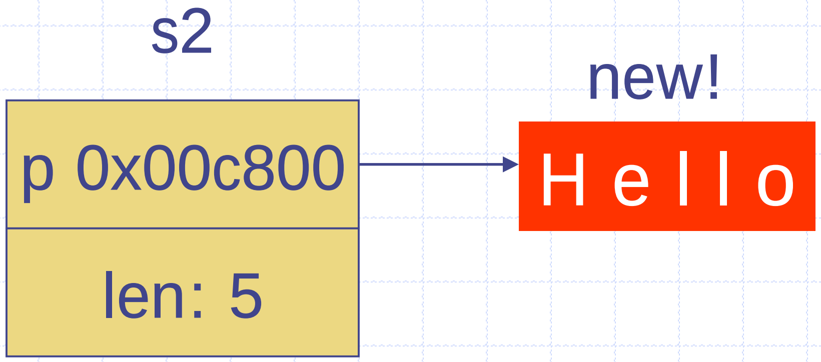
物件消滅時會發生何事?

# 解决方式

```
void main() {
    strtype s1(“Hello”) ;
    strtype s2 ;
    s2 = s1 ;
}
```

```
void main() {
    strtype s1(“Hello”) ;
    strtype s2 ;
    s2.set(s1);
}
```





## 解決方式

- 請寫operator=

```
class strtype{
  ……
  strtype& operator=(const strtype& s) {
    p = new char[s.len+1] ;
    strcpy(p, s.p) ;
    len = s.len ;
    return *this ;
  }
} ;
```

# 解決方式

```
class strtype {
    char *p ; int len ;
public:
    strtype(){
        p=new char[10];
        len=1;
        p[0]='\0';
    }
    strtype(char *s)
   {
p = new char[strlen(s)+1];
        len=strlen(s)+1;
          p=strcpy(p, s) ;
    }
```

Q: 以下程式會發生哪些問題?

```
~strtype() { delete[] p;  }
 strtype& operator=(const strtype& s)
{
  p = new char[s.len+1] ;
  strcpy(p, s.p) ;
  len = s.len ;
  return *this ;
          }
void setChar(int pos, char c) { p[pos]
= c ; }
 void show(){ cout<<len<<endl;}
} ;
```

## 解決方式

```
void main() {
   strtype s1(“Hello”), s2 ;
   s2 = s1 ;
   s2.setChar(1, ‘x’) ;
   s1.show() ;
}
```

## 3-2 傳遞物件給函數

- 回想從前: 參數傳遞的方式

```
void main() {
    int x=5 ; fun1(x); fun2(&x); fun3(x) ;
}
void fun1(int a) {…}  // call by ???
void fun2(int *p) {…} // call by ???
void fun3(int &r) {…} // call by ???
```

## 基礎: 物件的生成與constructors

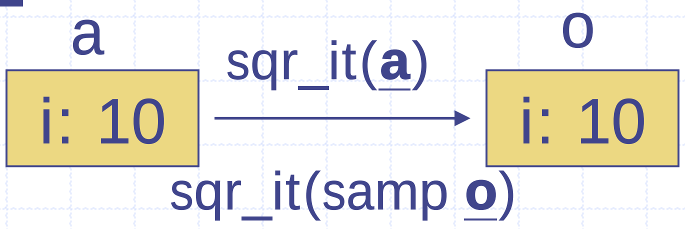
```
class samp {
    int i ;
public:
    samp() { i = 0 ; }
    samp(int n) { i = n ;}
    samp(const samp& s) { i = s.i ;}
    show() { cout << i << endl ; }
};
void main() {
    samp ob1, ob2(3), ob3(ob2) ;
    ……
}
```

# 範例一:

呼叫 sqr_it(a)後
(1) 生成物件 o
(2) o將會以a為初值
(3) 同 <u>samp o(a) ;</u>
→ 會呼叫那一種constructor?
→ 沒有對應的constructor該如何?

```
class samp {
        int i ;
    public:
        samp(int n) { i = n ;}
        int get_i() { return i ;}
} ;
int sqr_it(samp o) { return o.get_i()*o.get_i() ; }
void main() {
        samp a(10);
        cout << sqr_it(a) << endl ;
        cout<< a.get_i()<<endl;
}
```

call-by-value



# Constructor vs.函數呼叫

呼叫時, 哪一個建構子會被呼叫?

```
class samp {
        int i ;
    public:
    samp(int n) { i = n ;}
    samp(const samp& s) { cout << “copy\n”; i = s.i ;}
    int get_i() { return i ;}
} ;
int sqr_it(samp o) { return o.get_i()*o.get_i() ; }
void main() {
        samp a(10);
        cout << sqr_it(a) << endl ;
}
```

Copy constructor

# EX: 哪一個constructor被呼叫?

呼叫時, 哪一個建構子會被呼叫?

```
class samp {
        int i ;
    public:
    samp(int n) { i = n ;}
    samp(const samp& s) { cout << “copy\n”; i = s.i ;}
    int get_i() { return i ;}
} ;
int sqr_it(samp o) { return o.get_i()*o.get_i() ; }
void main() {
        samp a(10);
        cout << sqr_it(12) << endl ;
}
```

samp(int n)

# 範例二: 程式的輸出為何?

```
class samp {
    int i ;
public:
    samp(int n) { i = n ;}      void set(int n) { i = n ;}
    int get_i() { return i; }   void print() { cout << i; }
} ;
void sqrt_it(samp o) {o.set(o.get_i() * o.get_i()) ; }
void main() {
    samp a(10) ; sqrt_it(a) ; a.print() ;
}
```

# 範例三:程式的輸出為何?

呼叫時, 哪一個建構子會被呼叫?

指標之外，有無其他選擇?

```
class samp {
    int i ;
public:
    samp(int n) { i = n ;}      void set(int n) { i = n ;}
    int get_i() { return i; }   void print() { cout << i; }
} ;
void sqrt_it(samp *o) {o->set(o->get_i() * o->get_i()) ; }
void main() {                    100
    samp a(10) ; sqrt_it(&a) ; a.print() ;
}
```

# EX: call-by-reference

呼叫時, 哪一個建構子會被呼叫?

```
class samp {
    int i ;
public:
    samp(int n) { i = n ;}      void set(int n) { i = n ;}
    int get_i() { return i; }   void print() { cout << i; }
} ;
void sqrt_it(samp& o) {o.set(o.get_i() * o.get_i()) ; }
void main() {                  100
    samp a(10) ; sqrt_it(a) ; a.print() ;
}
```

# 範例四: Copy Constructor 的重要性

```
class strtype {
    char *p ; int len ;
public:
    strtype(char *s) { p = new char[strlen(s)+1]; ……}
    ~strtype() { delete[] p ; }
    void setChar(int pos, char c) { p[pos] = c ; }
} ;
void showMsg(strtype s) { /* do something …*/ }
void main() {
    strtype s1(“NTU welcomes you!”) ;
    showMsg(s1) ;
}
```

no copy constructor: bitwise copy

## 結論

- 如果class中的資料成員牽涉到動態記憶體配置,則以下成員函數不可省:
  - copy constructor
  - operator=() 或 set()
- 儘量使用call-by-reference, why?
  - void showMsg(const strtype& str)；
  - void showMsg(strtype str)；

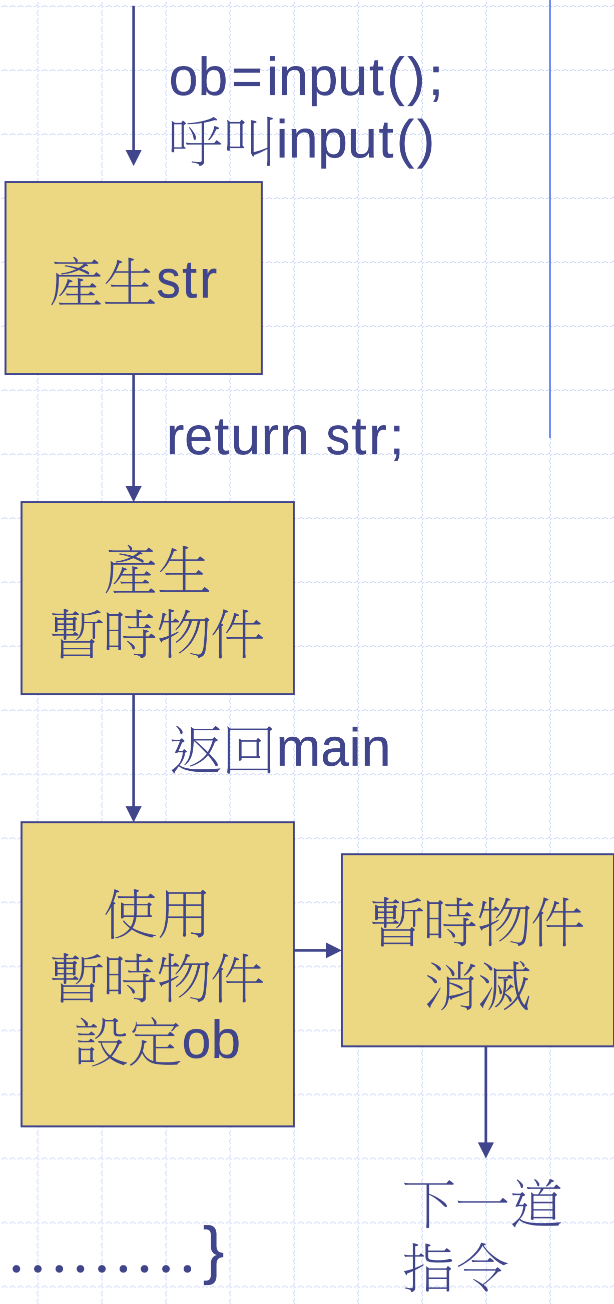
## 3-3 從函數中傳回物件

- 回想從前

```
void fun1() { …}
int fun2() {…}
double fun3() {…}
char *fun4() {…}
myclass fun5() {…….}
```

## 範例一

```
class samp {
    char s[80];
public:
    void show() {cout << s << endl ;}
    void set(char *str) {strcpy(s, str) ; }
} ;
samp input() {
    char s[80]; cin >> s ;
    samp str; str.set(s) ;
    return str ;
}
void main() { samp ob; ob = input(); ………}
```



## 描述

- 當物件被函數傳回時會自動建立一個暫時物件(temporary object)，內容即為回傳值(return value) 。

# 深入剖析物件的回傳

```
class samp {
    char s[80];
public:
    samp() {cout<<“default\n” ; }
    samp(const samp& ob) {
        cout<<“copy\n”; strcpy(s, ob.s) ; }
    ~samp() {cout << “destroy\n” ; }
    void show() {cout << s << endl ;}
    void set(char *str) {strcpy(s, str) ; }
} ;
samp input() { char s[80]; cin >> s ;
    samp str; str.set(s) ; return str;      copy constructor
}
void main() { samp ob; ob = input(); ob.show();}
```

## 範例二:

- 拜託你寫copy constructor好嗎?

## 3-4 簡介夥伴函數 (friend functions)

- 什麼是夥伴函數?

```
class myclass {
        int n, d ;
public:
        myclass(int i, int j) { n = i; d = j ; }
} ;
bool isfactor(myclass ob) { return !(ob.n % ob.d) ;}
void main() {
        myclass ob(10, 2) ;
        if (isfactor(ob)) cout << " 2 是 10因數"  ;
}
```

## 甚麼是夥伴函數?

```
class myclass {
        int n, d ;
public:
        myclass(int i, int j) { n = i; d = j ; }
        friend bool isfactor(myclass ob) ;
} ;
bool isfactor(myclass ob) { return !(ob.n % ob.d) ;}
void main() {
        myclass ob(10, 2) ;
        if (isfactor(ob)) cout << "2 是 10因數"  ;
}
```

# 夥伴函數的用途

- 運算子超載(operator overloading)
  - operator+()
  - oprrator<<(), operator>>()
- 讓函數能存取二個多個不同類別的私用成員
  - 破壞封裝.......

# NOTE:

```
class myclass {
        int n, d ;
public:
        myclass(int i, int j) { n = i; d = j ; }
        friend bool isfactor(myclass ob) ;
} ;
bool isfactor(myclass ob) { return !(ob.n % ob.d) ;}
void main() {
        myclass ob(10, 2) ;
        if (isfactor(ob)) cout << “ 2 是 10因數”  ;
}
```

## NOTE:

- 夥伴函數不會被繼承
- 一個函數可以是多個類別的夥伴函數

## 範例一：多個類別的夥伴

```
class truck ; // why this?
class car {
   int speed;
public:
      car(int sp){speed=sp;}

      friend int sp_greater(car c, truck t) ;
} ;
class truck {
      int speed;
public:
      truck (int sp){speed=sp;}
      friend int sp_greater(car c, truck t) ;
} ;

int sp_greater(car c, truck t) { return c.speed-t.speed;}
```

## 範例一: 討論

- 一定要如此嗎? 破壞封裝精神

```
main()
{
  car c(60);
  truck t(50);
 cout<<sp_greater(c,t)<<endl;
}
```

## 範例二: 將其他類別的成員函數做為夥伴函數

```
class car;
class truck {
      int speed;
public:
      truck (int sp){speed=sp;}
      friend class car;
} ;
class car {
    int speed;
public:
      car(int sp){speed=sp;}
      int sp_greater(truck t){
                              return speed-t.speed; }
} ;
```

```
main()
{
  car c(60);
  truck t(50);
cout<<c.sp_greater(t)
<<endl;
}
```

## 範例三: friend 的有用之處

```
#include<iostream.h>
class frac {
    int q, p ;
public:
    frac(int n, int m){q=n;p=m;}
    friend ostream& operator<<(ostream& out,const frac& ob);

};
ostream& operator<<(ostream& out, const frac& ob){
        out<<ob.q<<"/"<<ob.p;
        return out;
}
void main() {
    frac f(3,5);
    cout<<f<<endl ; // f.print();
}
```

## NOTE:

```
#include<iostream.h>
// using namespace std;
class coord{
int x,y;
public:
  coord(){x=0;y=0;}
    coord(int a,int b){x=a;y=b;}
friend ostream &operator<<(ostream&stream,coord&
    ob);
friend istream &operator>>(istream &stream,coord
    &ob);
};
```

## NOTE:

```
ostream &operator<<(ostream &stream, coord& ob)
    {  stream<<ob.x<<" , "<<ob.y<<'\n';
       return stream;}
istream &operator>>(istream &stream, coord &ob)
    {  cout<<"Enter coordinates\n";
           stream>>ob.x>>ob.y;
       return stream;}
int main()
{
   coord a(1,1),b(2,3);
   cout<<a<<b;
   cin>>a;
   cout<<a;
   return 0;
}
```

## 課後練習 & 綜合學習