CHAPTER 5

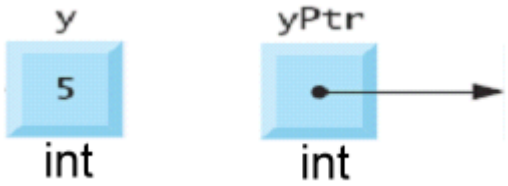
Points(ch7)

Points

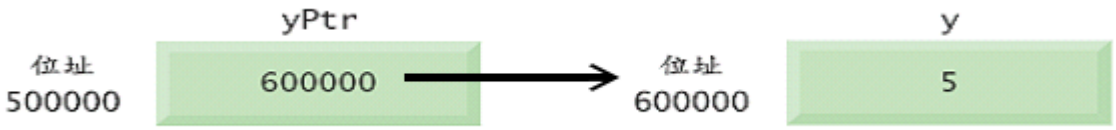
- 指標變數(pointers)主要存放記憶體位址的變數，不是存放一般資料內容，主要存放位址
- Pointers could make parameter passing of functions more efficient
  - Call by value (傳值)
    - 函數呼叫: function(a, b)
    - 函數定義: void function(int x, int y)
  - Call by address (傳位址)
    - 函數呼叫: function(&a, &b)
    - 函數定義: void function(int * x, int *y)
  - Call by reference (傳參考)
    - 函數呼叫: function(a, b)
    - 函數定義: void function(int &x, int &y)

Points

- *運算子
  - 間接運算子 (indirection operator)或反參考運算子 (dereferencing operator)
  - 傳回其運算元 (即指標) 所指向的物件的數值
- &運算子
  - 取址運算子 (address operator)
  - 傳回運算元的位址運算
- 舉例來說，我們假設以下的定義
  - `int y = 5;` //變數y是一個整數
    `int *yPtr;` //指定變數yPtr的型別為 int *
    //指標變數yPtr為一個整數的指標



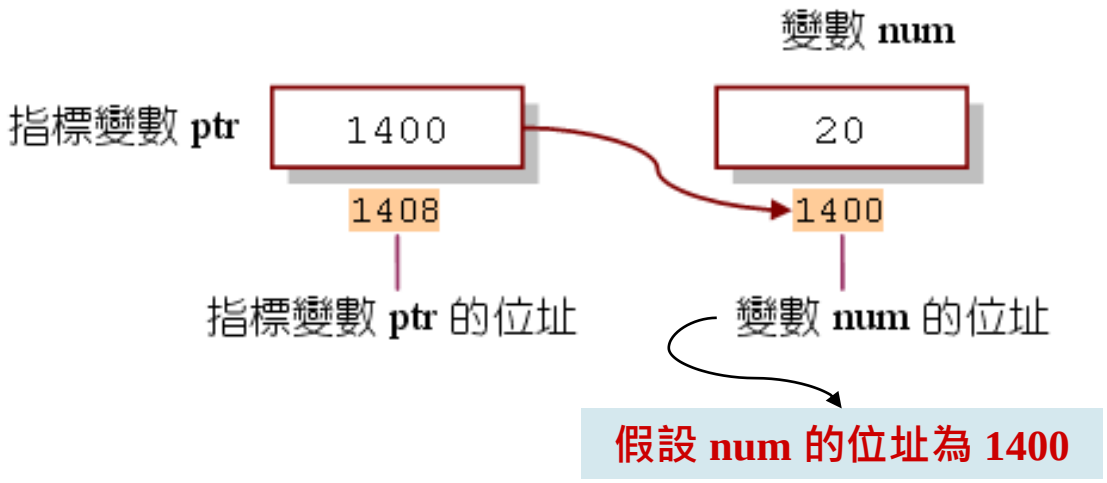
  - 敘述式
  - yPtr = &y; //會將變數y的位址指定給指標變數yPtr



Points

- 指標基本運算圖例

```
int num=20;
int *ptr;

ptr=&num;
```

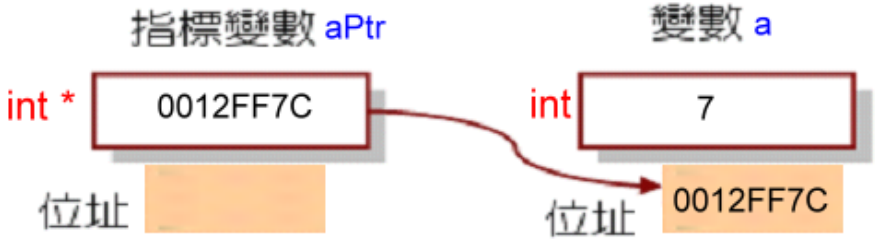


Points

- 整數指標變數(int *)與整數變數(int)

```c
#include <stdio.h>
#include <stdlib.h>

int main(void)
{
    int a;
    int *aPtr;

    a=7;
    aPtr=&a;

    printf("The address of a is %p"
        "\nThe value of aPtr is %p",&a,aPtr);

    printf("\n\nThe value of a is %d"
        "\nThe value of *aPtr is %d",a,*aPtr);

    printf("\n\nShowing that * and & are complements of "
        "each other\n&*aPtr = %p"
        "\n*&aPtr = %p\n",&*aPtr,*&aPtr);
    system("pause");
    return 0;
}
```

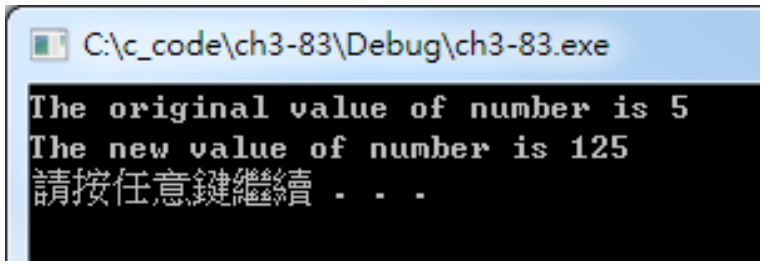
```
C:\c_code\ch3-82\Debug\ch3-82.exe
The address of a is 001CFD74
The value of aPtr is 001CFD74

The value of a is 7
The value of *aPtr is 7

Showing that * and & are complements of each other
&*aPtr = 001CFD74
*&aPtr = 001CFD74
請按任意鍵繼續 . . .
```



Points

- 函數的傳值呼叫 (call by value)

```
1  #include <stdio.h>
2  #include <stdlib.h>
3
4  int cubeByValue(int n);
5
6  int main(void)
7  {
8      int number=5;
9      printf("The original value of number is %d", number);
10
11     number=cubeByValue(number);
12
13     printf("\nThe new value of number is %d\n", number);
14     system("pause");
15     return 0;
16 }
17
18 int cubeByValue(int n)
19 {
20     return n * n * n;
21 }
```



Points

- 函數的傳值呼叫 (call by value)

步驟 1: 在main呼叫cubeByValue之前:

```
int main( void )
{
   int number = 5;

   number = cubeByValue( number );
}
```

number: 5

```
int cubeByValue( int n )
{
   return n * n * n;
}
```

n: undefined

步驟 2: 在cubeByValue接收呼叫之後:

```
int main( void )
{
   int number = 5;

   number = cubeByValue( number );
}
```

number: 5

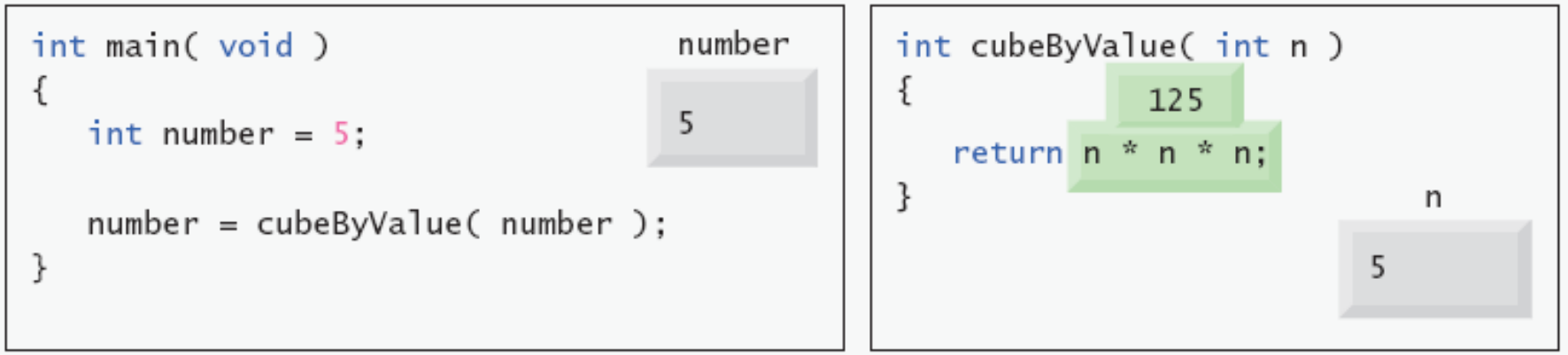
```
int cubeByValue( int n )
{
   return n * n * n;
}
```

n: 5

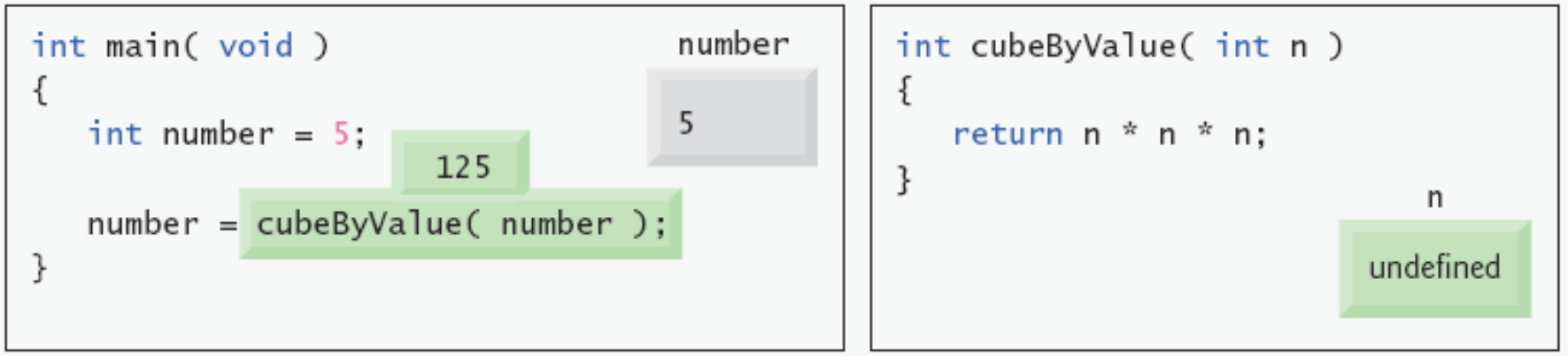
Points

- 函數的傳值呼叫 (call by value)

步驟 3: 在cubeByValue為參數n計算立方值之後，並在cubeByValue返回main之前:



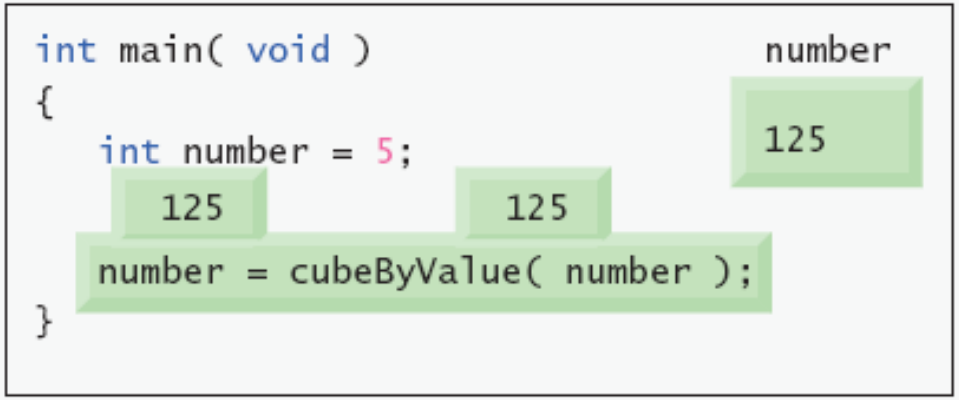
步驟 4: 在cubeByValue返回main之後，並在將結果設定給number之前:

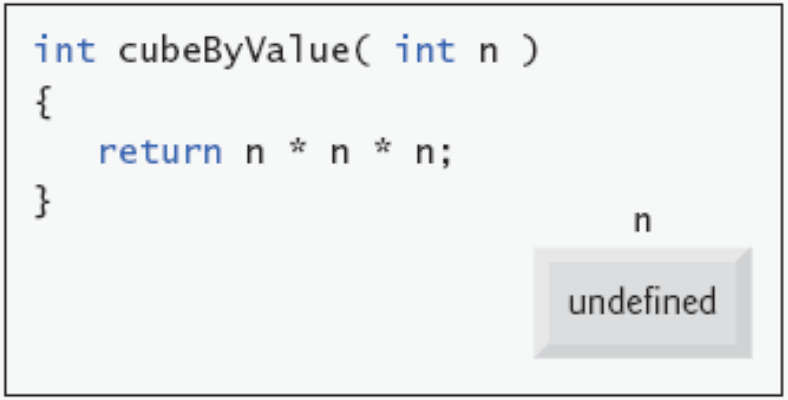


Points

- 函數的傳值呼叫 (call by value)

步驟 5: 在main完成number的設值動作之後:

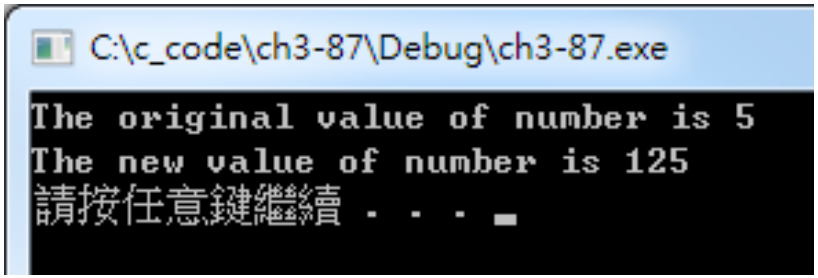




Points

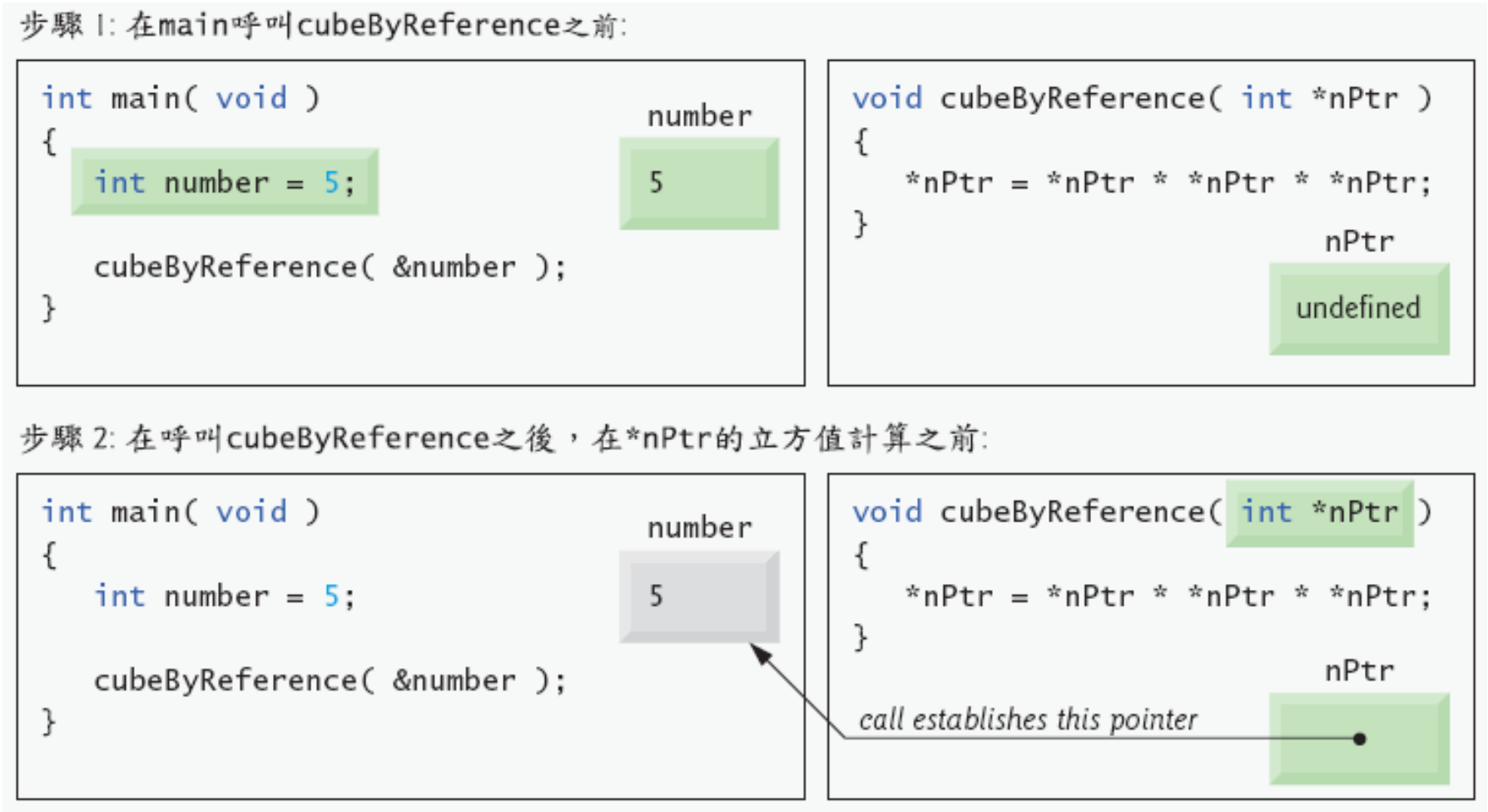
- 函數的傳位址呼叫 (call by address)

```
1  #include <stdio.h>
2  #include <stdlib.h>
3
4  void cubeByReference( int *nPtr );
5
6  int main (void)
7  {
8       int number = 5;
9       printf("The original value of number is %d", number);
10
11      cubeByReference( &number );
12
13      printf("\nThe new value of number is %d\n", number);
14      system("pause");
15      return 0;
16 }
17
18 void cubeByReference(int *nPtr)
19 {
20      *nPtr = *nPtr * *nPtr * *nPtr;
21 }
```



Points

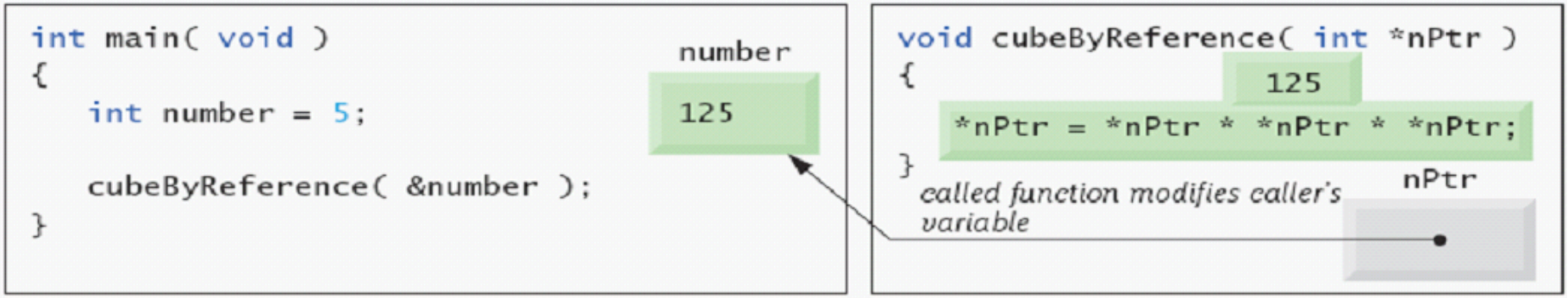
- 函數的傳位址呼叫 (call by address)



Points

- 函數的傳位址呼叫 (call by address)

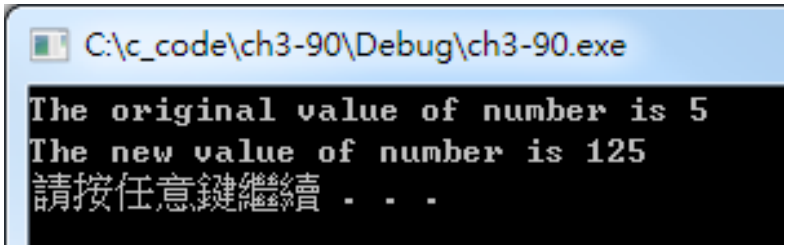
步驟 3: 在*nPtr的立方值計算之後，在程式控制權回到main之前:



Points

- 函數的傳參考呼叫 (call by reference)
  - C沒有支援call by reference, 需要把main.c改成main.cpp

```
1  #include <stdio.h>
2  #include <stdlib.h>
3
4  void cubeByReference( int &nPtr );
5
6  int main (void)
7  {
8      int number = 5;
9      printf("The original value of number is %d", number);
10
11     cubeByReference( number );
12
13     printf("\nThe new value of number is %d\n", number);
14     system("pause");
15     return 0;
16 }
17
18 void cubeByReference(int &nPtr)
19 {
20     nPtr = nPtr * nPtr * nPtr;
21 }
```



Points

- 氣泡排序 (bubble sort)使用call by address
  - 函數呼叫: swap(&array[j], &array[j+1])
  - 函數定義: void swap(int *element1Ptr, int *element2Ptr)

```
#include <stdio.h>
#include <stdlib.h>
#define SIZE 10

void bubbleSort(int * const array, const int size);

int main( void )
{
    int a[SIZE] = {2, 6, 4, 8, 10, 12, 89, 68, 45, 37};
    int i;

    printf("Data items in original order\n");

    for (i=0; i<SIZE; i++ )
    {
        printf("%4d",a[i]);
    }

    bubbleSort(a, SIZE);

    printf("\nData items in ascending order\n");

    for (i=0; i<SIZE; i++)
    {
        printf("%4d", a[i]);
    }

    printf("\n");
    system("pause");
    return 0;
}
```

Points

- 氣泡排序 (bubble sort)使用call by address
  - 函數呼叫: swap(&array[j], &array[j+1])
  - 函數定義: void swap(int *element1Ptr, int *element2Ptr)

```
32
33  void bubbleSort(int * const array, const int size)
34  {
35      void swap(int *element1Ptr, int *element2Ptr);
36      int pass;
37      int j;
38
39      for (pass=0; pass<size-1; pass++)
40      {
41          for (j=0; j<size-1; j++)
42          {
43              if (array[j] > array[j+1])
44              {
45                  swap( &array[j], &array[j+1]);
46              }
47          }
48      }
49  }
```

```
50
51  void swap(int *element1Ptr, int *element2Ptr)
52  {
53      int hold = *element1Ptr;
54      *element1Ptr = *element2Ptr;
55      *element2Ptr = hold;
56  }
```

```
C:\c_code\ch3-91\Debug\ch3-91.exe
Data items in original order
   2   6   4   8  10  12  89  68  45  37
Data items in ascending order
   2   4   6   8  10  12  37  45  68  89
請按任意鍵繼續 . . .
```

Points

- 整個陣列會自動以傳位址呼叫(call by address)來傳遞
- 但個別的陣列元素是純量，如果程式只使用傳值呼叫來傳遞(call by value) ，無法真正的交換數值
- 陣列的元素，若要真正的交換數值，可以使用傳位址呼叫(call by address)
  - 函數呼叫: swap(&array[j], &array[j+1])
  - 函數定義: void swap(int *element1Ptr, int *element2Ptr)

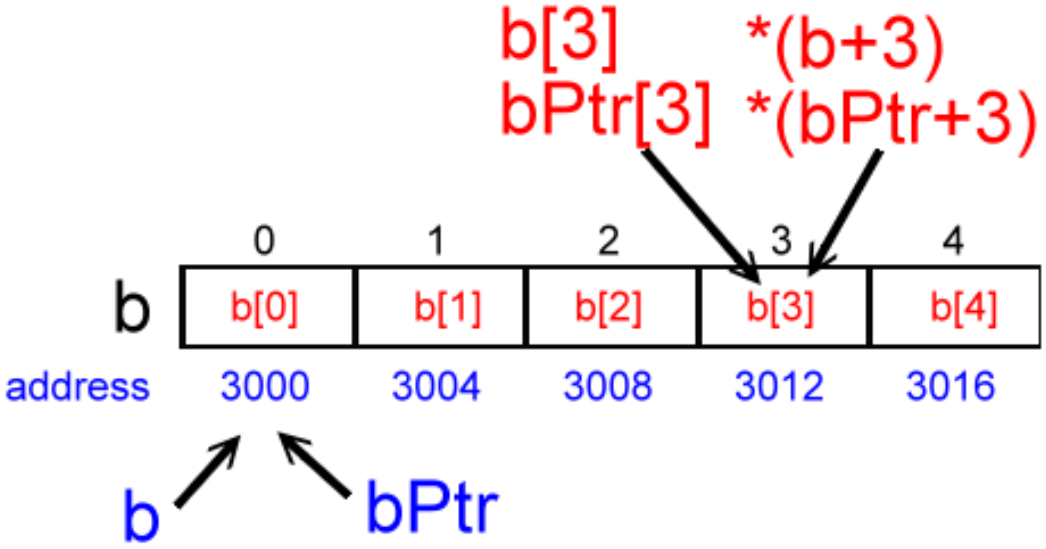
a[0]	a[1]	a[2]	a[3]	a[4]
26	5	81	7	63

	a[0]	a[1]	a[2]	a[3]	a[4]
i=0 j=0	5	26	81	7	63
j=1	5	26	81	7	63
j=2	5	26	7	81	63
j=3	5	26	7	63	81

Points

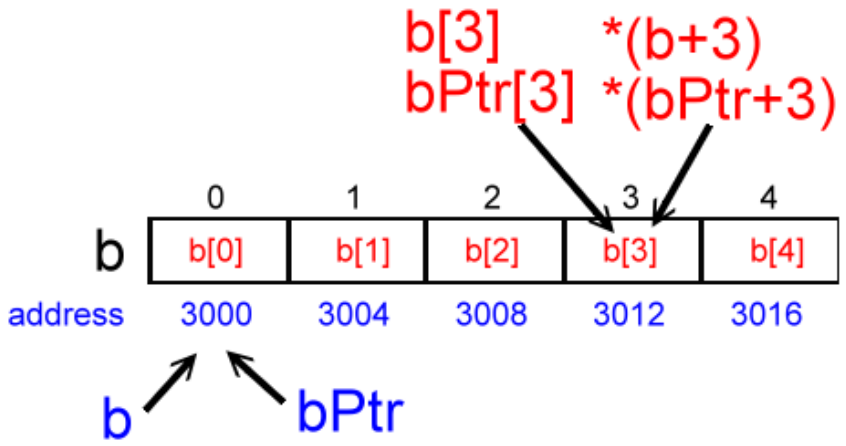
- 指標和陣列
  - 陣列的名稱可以想像是一個指向陣列第一個元素的指標
  - EX: b[5];

```
bPtr = b;  //  bPtr 指定陣列b的第一個元素位址
bPtr = &b[0]; //  bPtr 指定陣列b的第一個元素位址
*( bPtr +3)  //  代表b[3]裡面的元素
```



Points

- 指標和陣列

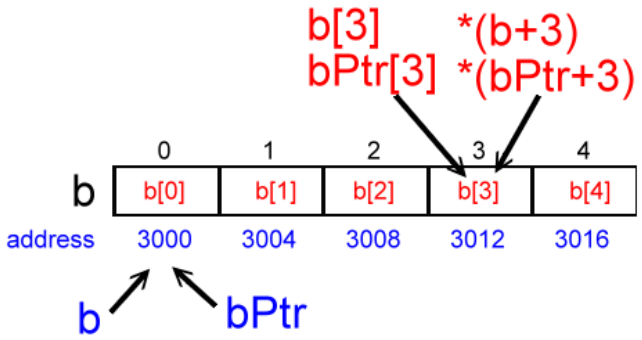



```c
#include <stdio.h>
#include <stdlib.h>

int main(void)
{
    int b[] = {10, 20, 30, 40};
    int *bPtr = b;
    int i;
    int offset;

    printf("Array b printed with:\nArray subscript notation\n");
    for (i=0;i<4;i++)
    {
        printf("b[%d] = %d\n", i, b[i]);
    }

    printf("\nPointer/offset notation where\n"
        "the pointer is the array name\n");
    for (offset=0;offset<4;offset++)
    {
        printf("*(b + %d) = %d\n",offset,*(b+offset));
    }
```

Points

- 指標和陣列

```
23
24      printf("\nPointer subscript notation\n");
25      for (i=0;i<4;i++)
26      {
27          printf("bPtr[%d] = %d\n",i,bPtr[i]);
28      }
29
30      printf("\nPointer/offset notation\n");
31      for (offset=0;offset<4;offset++)
32      {
33          printf("*(bPtr + %d) = %d\n",offset,*(bPtr+offset));
34      }
35
36      system("pause");
37      return 0;
38  }
```




```
C:\Users\Andy\Desktop\ch3-96\Debug\ch3-96.exe
Array subscript notation
b[0] = 10
b[1] = 20
b[2] = 30
b[3] = 40

Pointer/offset notation where
the pointer is the array name
*(b + 0) = 10
*(b + 1) = 20
*(b + 2) = 30
*(b + 3) = 40

Pointer subscript notation
bPtr[0] = 10
bPtr[1] = 20
bPtr[2] = 30
bPtr[3] = 40

Pointer/offset notation
*(bPtr + 0) = 10
*(bPtr + 1) = 20
*(bPtr + 2) = 30
*(bPtr + 3) = 40
請按任意鍵繼續 . . .
```

Points

- 指標陣列 (array of pointer)

```
const char *suit[ 4 ] = { "Hearts", "Diamonds", "Clubs", "Spades" };
```

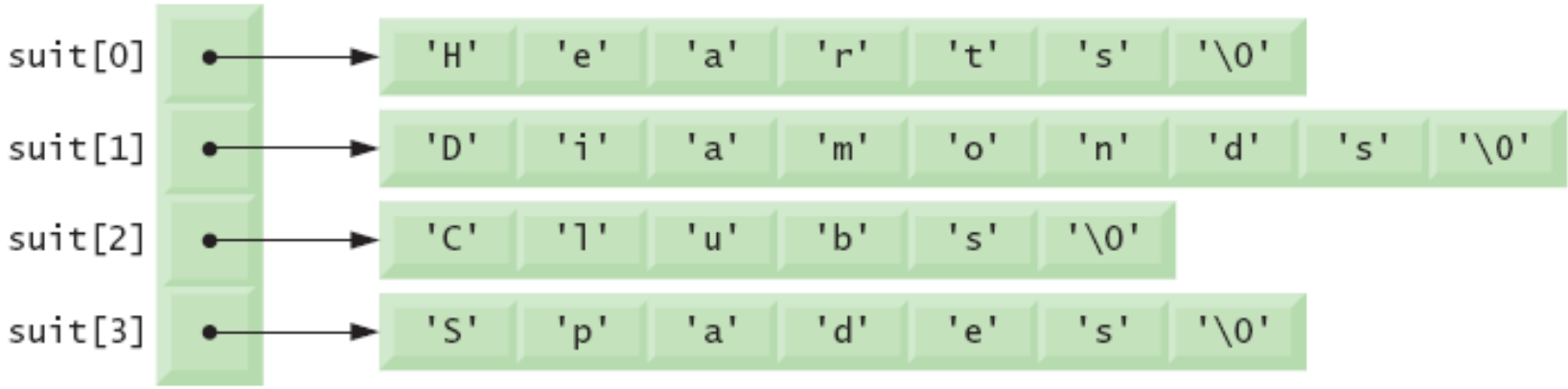
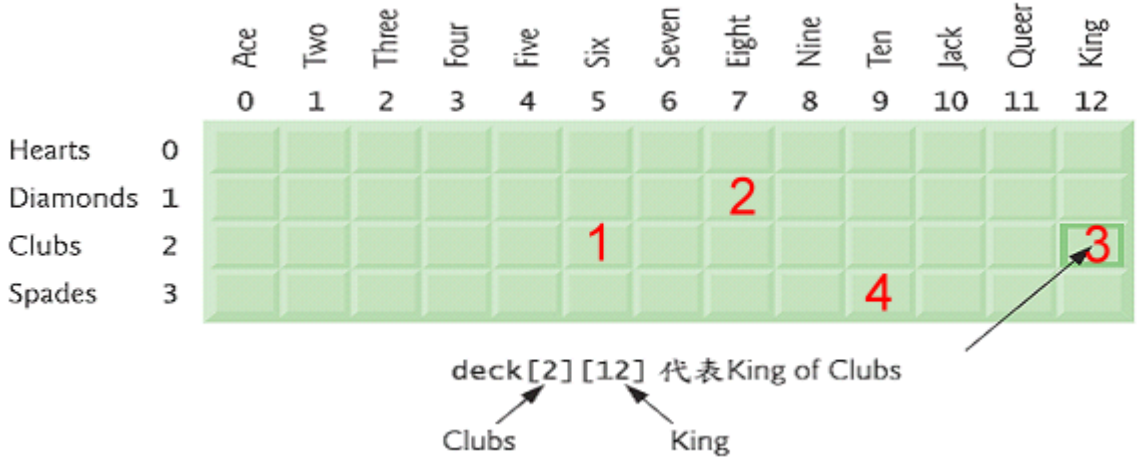


圖 7.22　suit 陣列的圖形表示

Points

- 模擬發牌程式-指標陣列 (array of pointer)
  1. 首先設定deck[4][13]初始直都是0，尚未設定順序
     - int deck[4][13] ={0};
  2. 設定deck[4][13]出牌順序
     - shuffle(deck);
  3. 檢查deck[4][13]出牌順序，由1到52列印花色和大小
     - deal(deck);



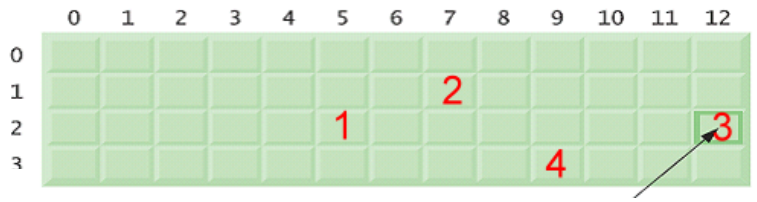
Points

- 模擬發牌程式-指標陣列 (array of pointer)

```
1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <time.h>
4
5  void shuffle(int wDeck[][13]);
6  void deal(const int wDeck[][13], const char *wFace[],
7              const char *wSuit[]);
8
9  int main(void)
10 {
11     const char *suit[4] = {"Hearts", "Diamonds", "Clubs", "Spades"};
12
13     const char *face[13] =
14         {"Ace", "Deuce", "Three", "Four",
15          "Five", "Six", "Seven", "Eight",
16          "Nine", "Ten", "Jack", "Queen", "King"};
17
18     int deck[4][13] = {0};
19
20     srand(time(0));
21
22     shuffle(deck);
23     deal(deck, face, suit);
24     system("pause");
25     return 0;
26 }
```

Points

- 模擬發牌程式-設定deck[4][13]出牌順序
  - while (wDeck[row][column] != 0;) //代表尚未給定順序牌號
  - wDeck[row][column] = card; //給定順序牌號,由小到大
    - wDeck[row][column] = 1;
    - ……
    - wDeck[row][column] = 52;




```
27
28  void shuffle(int wDeck[][13])
29  {
30      int row;
31      int column;
32      int card;
33
34      for (card=1;card<=52;card++)
35      {
36          do
37          {
38              row = rand() % 4;
39              column = rand() % 13;
40          } while(wDeck[row][column] != 0);
41
42          wDeck[row][column] = card;
43      }
44  }
```

Points

- 模擬發牌程式-檢查deck[4][13]出牌順序，由1到52列印花色和大小

```
45
46  void deal(const int wDeck[][13], const char *wFace[],
47              const char *wSuit[])
48  {
49      int card;
50      int row;
51      int column;
52
53      for (card=1;card<=52;card++)
54      {
55          for (row=0;row<=3;row++)
56          {
57              for (column=0;column<=12;column++)
58              {
59                  if (wDeck[row][column] == card)
60                  {
61                      printf("%5s of %-8s%c",wFace[column],wSuit[row],
62                          card % 2 == 0 ? '\n' : '\t' );
63                  }
64              }
65          }
66      }
67  }
```

Points

- 模擬發牌程式