5. 陣列 & 字串

(使用C)

作者：劉宸均

為什麼需要陣列？

如果要記錄5個整數：

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```
int a1;

int a2;

int a3;

int a4;

int a5;
```

10個呢？

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```
int a1;
int a2;
int a3;
int a4;
int a5;
int a6;
int a7;
int a8;
int a9;
int a10;
```

200個呢？

200個呢？

int a1;	int a21;	int a41;	int a61;	int a81;	int a101;	int a121;	int a141;	int a161;	int a181;
int a2;	int a22;	int a42;	int a62;	int a82;	int a102;	int a122;	int a142;	int a162;	int a182;
int a3;	int a23;	int a43;	int a63;	int a83;	int a103;	int a123;	int a143;	int a163;	int a183;
int a4;	int a24;	int a44;	int a64;	int a84;	int a104;	int a124;	int a144;	int a164;	int a184;
int a5;	int a25;	int a45;	int a65;	int a85;	int a105;	int a125;	int a145;	int a165;	int a185;
int a6;	int a26;	int a46;	int a66;	int a86;	int a106;	int a126;	int a146;	int a166;	int a186;
int a7;	int a27;	int a47;	int a67;	int a87;	int a107;	int a127;	int a147;	int a167;	int a187;
int a8;	int a28;	int a48;	int a68;	int a88;	int a108;	int a128;	int a148;	int a168;	int a188;
int a9;	int a29;	int a49;	int a69;	int a89;	int a109;	int a129;	int a149;	int a169;	int a189;
int a10;	int a30;	int a50;	int a70;	int a90;	int a110;	int a130;	int a150;	int a170;	int a190;
int a11;	int a31;	int a51;	int a71;	int a91;	int a111;	int a131;	int a151;	int a171;	int a191;
int a12;	int a32;	int a52;	int a72;	int a92;	int a112;	int a132;	int a152;	int a172;	int a192;
int a13;	int a33;	int a53;	int a73;	int a93;	int a113;	int a133;	int a153;	int a173;	int a193;
int a14;	int a34;	int a54;	int a74;	int a94;	int a114;	int a134;	int a154;	int a174;	int a194;
int a15;	int a35;	int a55;	int a75;	int a95;	int a115;	int a135;	int a155;	int a175;	int a195;
int a16;	int a36;	int a56;	int a76;	int a96;	int a116;	int a136;	int a156;	int a176;	int a196;
int a17;	int a37;	int a57;	int a77;	int a97;	int a117;	int a137;	int a157;	int a177;	int a197;
int a18;	int a38;	int a58;	int a78;	int a98;	int a118;	int a138;	int a158;	int a178;	int a198;
int a19;	int a39;	int a59;	int a79;	int a99;	int a119;	int a139;	int a159;	int a179;	int a199;
int a20;	int a40;	int a60;	int a80;	int a100;	int a120;	int a140;	int a160;	int a180;	int a200;

200個呢？

int a1; int a21; int a41; int a61; int a81; int a101; int a121; int a141; int a161; int a181;
int a2; int a22; int a42; int a62; int a82; int a102; int a122; int a142; int a162; int a182;
int a3; int a23; int a43; int a63; int a83; int a103; int a123; int a143; int a163; int a183;
int a4; int a24; int a44; int a64; int a84; int a104; int a124; int a144; int a164; int a184;
int a5; int a25; int a45; int a65; int a85; int a105; int a125; int a145; int a165; int a185;
int a6; int a26; int a46; int a66; int a86; int a106; int a126; int a146; int a166; int a186;
int a7; int a27; int a47; int a67; int a87; int a107; int a127; int a147; int a167; int a187;
int a8; int a28; int a48; int a68; int a88; int a108; int a128; int a148; int a168; int a188;
int a9; int a29; int a49; int a69; int a89; int a109; int a129; int a149; int a169; int a189;
int a10; int a30; int a50; int a70; int a90; int a110; int a130; int a150; int a170; int a190;
int a11; int a31; int a51; int a71; int a91; int a111; int a131; int a151; int a171; int a191;
int a12; int a32; int a52; int a72; int a92; int a112; int a132; int a152; int a172; int a192;
int a13; int a33; int a53; int a73; int a93; int a113; int a133; int a153; int a173; int a193;
int a14; int a34; int a54; int a74; int a94; int a114; int a134; int a154; int a174; int a194;
int a15; int a35; int a55; int a75; int a95; int a115; int a135; int a155; int a175; int a195;
int a16; int a36; int a56; int a76; int a96; int a116; int a136; int a156; int a176; int a196;
int a17; int a37; int a57; int a77; int a97; int a117; int a137; int a157; int a177; int a197;
int a18; int a38; int a58; int a78; int a98; int a118; int a138; int a158; int a178; int a198;
int a19; int a39; int a59; int a79; int a99; int a119; int a139; int a159; int a179; int a199;
int a20; int a40; int a60; int a80; int a100; int a120; int a140; int a160; int a180; int a200;

當然不是

所以我們需要

陣列

何謂陣列？

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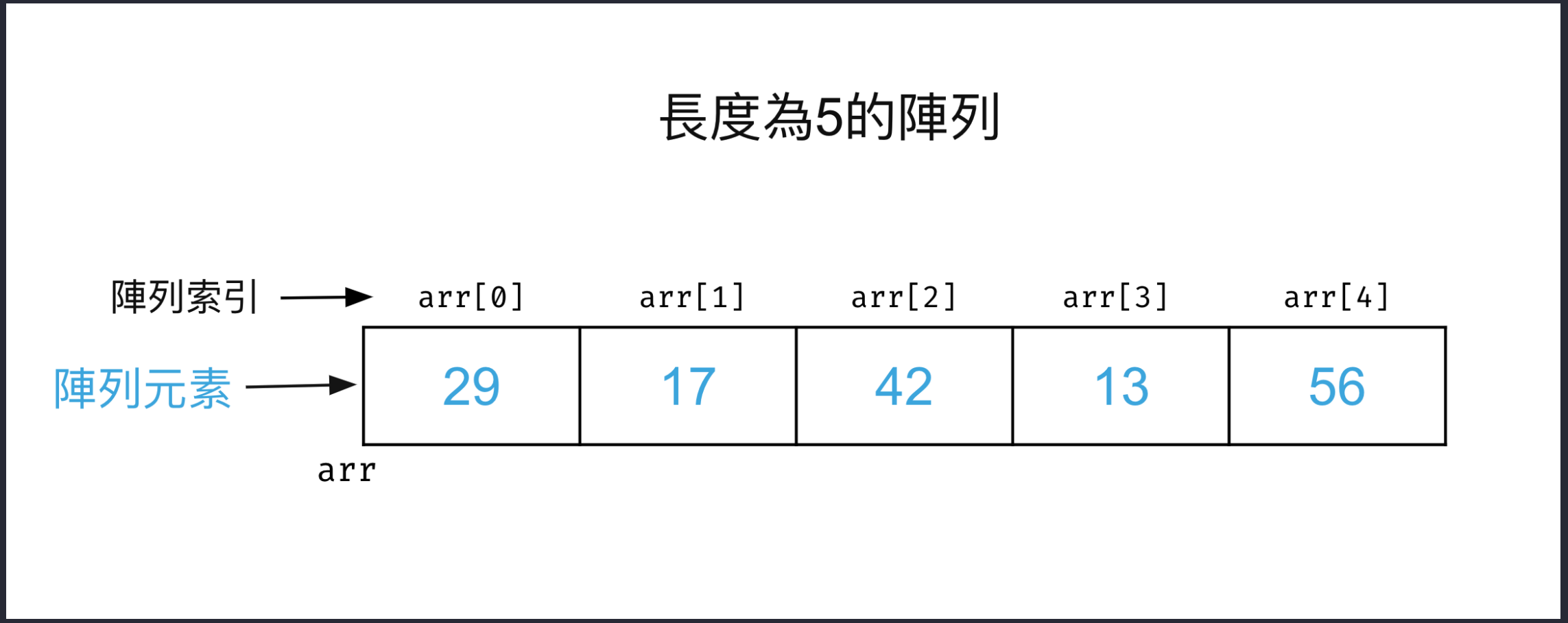
陣列(array) 是一種用來儲存資料的資料結構

陣列中的每個元素都是相同的資料型態

利用 **索引(index)** 就可以找出對應的元素(element)



- 因此一個長度為5的陣列就有索引為0, 1, 2, 3, 4的五個元素

*陣列的第一個元素是從0開始的

陣列的特性：

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  所有元素都是相同類型的，例如整數、浮點數、字元等。

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- **連續的記憶體空間**
  陣列的元素在記憶體中是連續存放的。
- **索引訪問**
  每個元素都有一個唯一的索引，可以使用索引來訪問和修改特定位置的元素。
  例如：`arr[3]`, `arr[0]`

  *索引值必 > 0

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- **相同類型的元素**
  所有元素都是相同類型的，例如整數、浮點數、字元等。
- **連續的記憶體空間**
  陣列的元素在記憶體中是連續存放的。
- **索引訪問**
  每個元素都有一個唯一的索引，可以使用索引來訪問和修改特定位置的元素。
  例如：`arr[3]`, `arr[0]`

  *索引值必 > 0
- **固定大小**
  陣列在創建時需要指定大小，且一旦分配了大小，通常不能動態改變。

陣列的宣告：

- 創建一個整數(int)陣列

```
// 給定數值編譯器自動判斷陣列大小
int integerArray[] = {2,7,6,8,3};

// 創建一個長度5的int陣列，不給定初始值
int integerArray2[5];

// 創建一個長度5的int陣列，給定預設初始值(0)
int integerArray3[5]={};

// 創建一個長度5的int陣列，給定某些初始值，其它為0
int integerArray3[5]={2,3}; // 2,3,0,0,0
```

- 創建一個浮點(float/double)陣列

```
float arr1[] = {2.3, 5.4, 9.3, 8.03};
double arr2[] = {8.3, 2.7, 3.6};
```

Array 範例1

```c
#include <stdio.h>
int main(){
    int arr[5] = {2,4,7,8,3};
    for (int i=0; i<5; i++){
        printf("%d ", arr[i]);
    }
    printf("\n");
    return 0;
}
```

Array 範例1

```c
#include <stdio.h>
int main(){
    int arr[5] = {2,4,7,8,3};
    for (int i=0; i<5; i++){
        printf("%d ", arr[i]);
    }
    printf("\n");
    return 0;
}
```

印出：

```
2 4 7 8 3
```

Array 範例2.1

```c
#include <stdio.h>
int main(){
    int arr[4];
    for (int i=0; i<4; i++){
        scanf("%d", &arr[i]);
    }

    int sum = 0;
    for (int i=0; i<4; i++){
        sum += arr[i];
    }

    printf("sum = %d\n", sum);
    printf("avg = %d\n", sum/4);
    return 0;
}
```

輸入：

```
5 13 4 9
```

Array 範例2.1

```c
#include <stdio.h>
int main(){
    int arr[4];
    for (int i=0; i<4; i++){
        scanf("%d", &arr[i]);
    }

    int sum = 0;
    for (int i=0; i<4; i++){
        sum += arr[i];
    }

    printf("sum = %d\n", sum);
    printf("avg = %d\n", sum/4);
    return 0;
}
```

輸入：

```
5 13 4 9
```

輸出：

```
sum = 31
avg = 7
```

Array 範例2.2

```c
#include <stdio.h>
int main(){
    int arr[4];
    for (int i=0; i<4; i++){
        scanf("%d", &arr[i]);
    }

    int sum = 0;
    for (int i=0; i<4; i++){
        sum += arr[i];
    }

    printf("sum = %d\n", sum);
    printf("avg = %.2lf\n", (double)sum/4);
    return 0;
}
```

輸入：

```
5 13 4 9
```

Array 範例2.2

```c
#include <stdio.h>
int main(){
    int arr[4];
    for (int i=0; i<4; i++){
        scanf("%d", &arr[i]);
    }

    int sum = 0;
    for (int i=0; i<4; i++){
        sum += arr[i];
    }

    printf("sum = %d\n", sum);
    printf("avg = %.2lf\n", (double)sum/4);
    return 0;
}
```

輸入：

```
5 13 4 9
```

輸出：

```
sum = 31
avg = 7.75
```

字串

字串是什麼？

其實字串就是一種字元陣列

字串的宣告

```
char s[] = {'a', 'p', 'p', 'l', 'e', '\0'};
```

`\0` 是結束字元，代表字串結尾。

```
char s[] = "apple";
```

與上面相同效果

字串範例1：

```c
#include <stdio.h>
int main(){
    char s1[] = "Hello, World";
    char s2[] = {'H', 'E', 'L', 'L', 'O', '\0'};

    printf("%c %c\n", s1[4], s2[1]);
    printf("%s\n", s1);
    printf("%s\n", s2);

    return 0;
}
```

字串範例1：

```c
#include <stdio.h>
int main(){
    char s1[] = "Hello, World";
    char s2[] = {'H', 'E', 'L', 'L', 'O', '\0'};

    printf("%c %c\n", s1[4], s2[1]);
    printf("%s\n", s1);
    printf("%s\n", s2);

    return 0;
}
```

輸出：

```
o E
Hello, World
HELLO
```

字串範例2：

```c
#include <stdio.h>
int main(){
    char myStr[20];
    scanf("%s", myStr);
    printf("Hi, %s\n", myStr);
    return 0;
}
```

輸入：

```
C_String
```

字串範例2：

```c
#include <stdio.h>
int main(){
    char myStr[20];
    scanf("%s", myStr);
    printf("Hi, %s\n", myStr);
    return 0;
}
```

輸入：

```
C_String
```

index	0	1	2	3	4	5	6	7	8	9	10	...	19
內容	'C'	'_'	'S'	't'	'r'	'i'	'n'	'g'	'\0'	undefined	undefined	...	undefined

字串範例2：

```c
#include <stdio.h>
int main(){
    char myStr[20];
    scanf("%s", myStr);
    printf("Hi, %s\n", myStr);
    return 0;
}
```

輸入：

```
C_String
```

輸出：

```
Hi, C_String
```

index	0	1	2	3	4	5	6	7	8	9	10	...	19
內容	'C'	'_'	'S'	't'	'r'	'i'	'n'	'g'	'\0'	undefined	undefined	...	undefined

補充：其它字串相關函式

```
// 使用以下函式需要引入此標頭檔
#include <string.h>
```

```
// 將一字串之內容複製到另一字串
strcpy(destination, source);

// 比較字串之字典序
strcmp(s1, s2)

// 將s2的內容加到s1之後
strcat(s1, s2);
```

6. 指標
Pointers

(使用C)

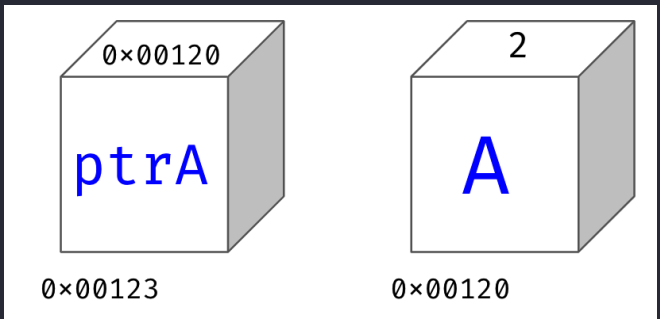
作者：劉宸均

何謂指標？

一種特殊的變數，它存儲的是一個記憶體位址

```c
#include <stdio.h>
int main(){
    int A = 3;
    int *ptrA;
    ptrA = &A; //A在記憶體中的位址
}
```

`&`：取址運算子



由於指標本身也是資料的一種，因此他也具有一般資料所有的資訊：

- 名稱：ptrA
- 資料型態：int *
- 資料內容：0x00120
- ptrA本身記憶體位置：0x00123

指標範例1

```c
#include <stdio.h>
int main(){
    int A = 3;
    int *ptrA = &A;

    printf("%d\n", *ptrA);
    *ptrA = 50;
    printf("%d\n", A);
}
```

`*` 取值運算子

指標範例1

```c
#include <stdio.h>
int main(){
    int A = 3;
    int *ptrA = &A;

    printf("%d\n", *ptrA);
    *ptrA = 50;
    printf("%d\n", A);
}
```

`*ptrA` 就是 A

`*` 取值運算子

指標範例1

```c
#include <stdio.h>
int main(){
    int A = 3;
    int *ptrA = &A;

    printf("%d\n", *ptrA);
    *ptrA = 50;
    printf("%d\n", A);
}
```

`*` 取值運算子

`*ptrA` 就是 A

`*ptrA = 50`
透過(*ptrA)去更動A的值。

指標範例1

```c
#include <stdio.h>
int main(){
    int A = 3;
    int *ptrA = &A;

    printf("%d\n", *ptrA);
    *ptrA = 50;
    printf("%d\n", A);
}
```

`*` 取值運算子

`*ptrA` 就是 A

`*ptrA = 50`
透過(*ptrA)去更動A的值。

指標範例1

```c
#include <stdio.h>
int main(){
    int A = 3;
    int *ptrA = &A;

    printf("%d\n", *ptrA);
    *ptrA = 50;
    printf("%d\n", A);
}
```

`*` 取值運算子

`*ptrA` 就是 A

`*ptrA = 50`
透過(*ptrA)去更動A的值。

輸出：

```
3
50
```

陣列的運作原理

```
int arr[10];
```

`arr` 是一個指標，指向陣列頭所在位址

`arr` 是 `arr[0]` 的所在位址

`arr+1` 是 `arr[1]` 的所在位址

`arr+2` 是 `arr[2]` 的所在位址

`*arr` 就是 `arr[0]`

`*(arr+1)` 就是 `arr[1]`

`*(arr+2)` 就是 `arr[2]`

指標與陣列 範例1

```c
#include <stdio.h>
int main(){
    int arr[5];
    for (int i=0; i<5; i++)
        scanf("%d", arr+i); // 和 &arr[i] 一樣
    for (int i=0; i<5; i++)
        printf("%d ", *(arr+i)); // 和 arr[i] 一樣
    printf("\n");
    return 0;
}
```

輸入：

```
3 7 2 9 4
```

指標與陣列 範例1

```c
#include <stdio.h>
int main(){
    int arr[5];
    for (int i=0; i<5; i++)
        scanf("%d", arr+i); // 和 &arr[i] 一樣
    for (int i=0; i<5; i++)
        printf("%d ", *(arr+i)); // 和 arr[i] 一樣
    printf("\n");
    return 0;
}
```

輸入：

```
3 7 2 9 4
```

指標與陣列 範例1

```c
#include <stdio.h>
int main(){
    int arr[5];
    for (int i=0; i<5; i++)
        scanf("%d", arr+i); // 和 &arr[i] 一樣
    for (int i=0; i<5; i++)
        printf("%d ", *(arr+i)); // 和 arr[i] 一樣
    printf("\n");
    return 0;
}
```

輸入：

```
3 7 2 9 4
```

指標與陣列 範例1

```c
#include <stdio.h>
int main(){
    int arr[5];
    for (int i=0; i<5; i++)
        scanf("%d", arr+i); // 和 &arr[i] 一樣
    for (int i=0; i<5; i++)
        printf("%d ", *(arr+i)); // 和 arr[i] 一樣
    printf("\n");
    return 0;
}
```

輸入：

```
3 7 2 9 4
```

指標與陣列 範例1

```c
#include <stdio.h>
int main(){
    int arr[5];
    for (int i=0; i<5; i++)
        scanf("%d", arr+i); // 和 &arr[i] 一樣
    for (int i=0; i<5; i++)
        printf("%d ", *(arr+i)); // 和 arr[i] 一樣
    printf("\n");
    return 0;
}
```

輸入：

```
3 7 2 9 4
```

輸出：

```
3 7 2 9 4
```

指標與陣列 範例2

```c
#include <stdio.h>
int main(){
    int arr[5] = {9, 3, 1, 0, 8};
    printf("%d\n", *(arr+1));
    printf("%d\n", *arr+1);

    return 0;
}
```

指標與陣列 範例2

```c
#include <stdio.h>
int main(){
    int arr[5] = {9, 3, 1, 0, 8};
    printf("%d\n", *(arr+1));
    printf("%d\n", *arr+1); // (*arr)+1

    return 0;
}
```

輸出：

```
3
10
```

二維陣列

```
int arr[3][4]; // 3x4 2d array. (3 rows, 4 columns)
```

row column

4 columns

3 rows

	column 0	column 1	column 2	column 3
row 0	arr[0][0]	arr[0][1]	arr[0][2]	arr[0][3]
row 1	arr[1][0]	arr[1][1]	arr[1][2]	arr[1][3]
row 2	arr[2][0]	arr[2][1]	arr[2][2]	arr[2][3]

二維陣列

```
int mtx[2][3] = { {1, 4, 2}, {3, 6, 8} };
```

	COLUMN 0	COLUMN 1	COLUMN 2
ROW 0	1	4	2
ROW 1	3	6	8

在記憶體中的排列方式：

mtx[0][0]	mtx[0][1]	mtx[0][2]	mtx[1][0]	mtx[1][1]	mtx[1][2]
1	4	2	3	6	8
mtx[0]	mtx[0]+1	mtx[0]+2	mtx[1]	mtx[1]+1	mtx[1]+2

二維陣列 範例1

```c
#include <stdio.h>
int main(){
    int A[2][3] = {
        {0, 1, 2},
        {3, 4, 5}
    };
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("%d ", A[i][j]);
        }
        printf("\n");
    }
    return 0;
}
```

二維陣列 範例1

```c
#include <stdio.h>
int main(){
    int A[2][3] = {
        {0, 1, 2},
        {3, 4, 5}
    };
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("%d ", A[i][j]);
        }
        printf("\n");
    }
    return 0;
}
```

輸出：

```
0 1 2
3 4 5
```

二維陣列 範例2

給定由 `0` 與 `1` 組成的 $N \times N$ 矩陣，
判斷 `1` 有幾條長度為 N 的連線，並輸出連線的數量。

輸入共有 $N + 1$ 行
第一行給定 N
第 2 行到第 $N + 1$ 行
給定由 `0` 與 `1` 組成的
$N \times N$ 矩陣

範例輸入：

```
5
1 0 1 0 1
1 1 1 1 1
1 0 1 0 0
1 1 0 1 1
1 0 0 0 1
```

範例輸出：

```
4
```

```c
#include <stdio.h>
int main(){
    int N;
    scanf("%d", &N);
    int A[N][N];
    for (int i = 0; i < N; i++) {
        for (int j = 0; j < N; j++) {
            scanf("%d", &A[i][j]);
        }
    }

    int cnt = 0;

    // 判斷橫向
    for (int row=0; row<N; row++) {
        int len = 0;
        for (int col=0; col<N; col++) {
            if (A[row][col] == 1)
```

```c
#include <stdio.h>
int main(){
    int N;
    scanf("%d", &N);
    int A[N][N];
    for (int i = 0; i < N; i++) {
        for (int j = 0; j < N; j++) {
            scanf("%d", &A[i][j]);
        }
    }

    int cnt = 0;

    // 判斷橫向
    for (int row=0; row<N; row++) {
        int len = 0;
        for (int col=0; col<N; col++) {
            if (A[row][col] == 1)
```

```
    int N;
    scanf("%d", &N);
    int A[N][N];
    for (int i = 0; i < N; i++) {
        for (int j = 0; j < N; j++) {
            scanf("%d", &A[i][j]);
        }
    }

    int cnt = 0;

    // 判斷橫向
    for (int row=0; row<N; row++) {
        int len = 0;
        for (int col=0; col<N; col++) {
            if (A[row][col] == 1)
                len++;
        }
        if (len == N)
```

```
    }

    int cnt = 0;

    // 判斷橫向
    for (int row=0; row<N; row++) {
        int len = 0;
        for (int col=0; col<N; col++) {
            if (A[row][col] == 1)
                len++;
        }
        if (len == N)
            cnt++;
    }

    // 判斷直向
    for (int col=0; col<N; col++) {
        int len = 0;
        for (int row=0; row<N; row++) {
```

```
            if (len == N)
                cnt++;
        }

        // 判斷直向
        for (int col=0; col<N; col++) {
            int len = 0;
            for (int row=0; row<N; row++) {
                if (A[row][col] == 1)
                    len++;
            }
            if (len == N)
                cnt++;
        }

        // 判斷對角
        int len = 0;
        for (int i=0; i<N; i++) {
            if (A[i][i] == 1)
```

```
36      // 判斷對角
37      int len = 0;
38      for (int i=0; i<N; i++) {
39          if (A[i][i] == 1)
40              len++;
41      }
42      if (len == N)
43          cnt++;
44
45      len = 0;
46      for (int i=0; i<N; i++) {
47          if (A[i][N-1-i] == 1)
48              len++;
49      }
50      if (len == N)
51          cnt++;
52
53      printf("%d\n", cnt);
```

```
39          if (A[i][i] == 1)
40              len++;
41      }
42      if (len == N)
43          cnt++;
44
45      len = 0;
46      for (int i=0; i<N; i++) {
47          if (A[i][N-1-i] == 1)
48              len++;
49      }
50      if (len == N)
51          cnt++;
52
53      printf("%d\n", cnt);
54
55      return 0;
56  }
```

```c
#include <stdio.h>
int main(){
    int N;
    scanf("%d", &N);
    int A[N][N];
    for (int i = 0; i < N; i++) {
        for (int j = 0; j < N; j++) {
            scanf("%d", &A[i][j]);
        }
    }

    int cnt = 0;

    // 判斷橫向
    for (int row=0; row<N; row++) {
        int len = 0;
        for (int col=0; col<N; col++) {
            if (A[row][col] == 1)
```

7. 函式

Functions

(使用C)

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為什麼需要函式？

- 減少撰寫重覆的程式碼
- 將程式碼以有意義的方式組織起來
- 在相同的流程下，可藉由參數調整程式的行為
- 在呼叫函式不變的狀況下，可以直接修改程式。

函式的宣告與定義

回傳值型態 函式名稱 (參數)

有回傳值：

回傳一個int的型態

```
int add(int a, int b){
    return a + b;
}
```

無回傳值

```
void printSquare(int x){
    printf("%d\n", x*x);
}
```

可以直接將函式加在主程式前面

```c
#include <stdio.h>
int add(int a, int b){
    return a + b;
}

int main(){
    int x, y;
    scanf("%d %d", &x, &y);
    printf("%d\n", add(x, y));
    return 0;
}
```

將函式在主程式前先宣告，在尾端定義

```c
#include <stdio.h>
int add(int, int);

int main(){
    int x, y;
    scanf("%d %d", &x, &y);
    printf("%d\n", add(x, y));
    return 0;
}

int add(int a, int b){
    return a + b;
}
```

可以直接將函式加在主程式前面

```c
#include <stdio.h>
int add(int a, int b){
    return a + b;
}

int main(){
    int x, y;
    scanf("%d %d", &x, &y);
    printf("%d\n", add(x, y));
    return 0;
}
```

將函式在主程式前先宣告，在尾端定義

```c
#include <stdio.h>
int add(int, int);

int main(){
    int x, y;
    scanf("%d %d", &x, &y);
    printf("%d\n", add(x, y));
    return 0;
}

int add(int a, int b){
    return a + b;
}
```

函式範例1

```c
#include <stdio.h>
void A(){
    printf("You called A()\n");
    return;
}
int B(){
    printf("You called B()\n");
    return 3;
}
float C(){
    printf("You called C()\n");
    return 5.6;
}
int main(){
    A();
    printf("%d\n", B());
    printf("%f\n", C());
    return 0;
}
```

輸出：

函式範例1

```c
#include <stdio.h>
void A(){
    printf("You called A()\n");
    return;
}
int B(){
    printf("You called B()\n");
    return 3;
}
float C(){
    printf("You called C()\n");
    return 5.6;
}
int main(){
    A();
    printf("%d\n", B());
    printf("%f\n", C());
    return 0;
}
```

輸出：

```
You called A()
```

函式範例1

```c
#include <stdio.h>
void A(){
    printf("You called A()\n");
    return;
}
int B(){
    printf("You called B()\n");
    return 3;
}
float C(){
    printf("You called C()\n");
    return 5.6;
}
int main(){
    A();
    printf("%d\n", B());
    printf("%f\n", C());
    return 0;
}
```

輸出：

```
You called A()
You called B()
3
```

函式範例1

```c
#include <stdio.h>
void A(){
    printf("You called A()\n");
    return;
}
int B(){
    printf("You called B()\n");
    return 3;
}
float C(){
    printf("You called C()\n");
    return 5.6;
}
int main(){
    A();
    printf("%d\n", B());
    printf("%f\n", C());
    return 0;
}
```

輸出：

```
You called A()
You called B()
3
You called C()
5.6
```

函式範例1

```c
#include <stdio.h>
void A(){
    printf("You called A()\n");
    return;
}
int B(){
    printf("You called B()\n");
    return 3;
}
float C(){
    printf("You called C()\n");
    return 5.6;
}
int main(){
    A();
    printf("%d\n", B());
    printf("%f\n", C());
    return 0;
}
```

輸出：

```
You called A()
You called B()
3
You called C()
5.6
```

變數範圍

Variable scope

區域變數與全域變數

- Global variable:

可以在任何地方存取

- Local variable:

只能在函式內存取

輸出：

```
globalVar = 10
localVar = 30
globalVar = 11
localVar = 20
```

```c
#include <stdio.h>
int globalVar = 10;
void func();
int main(){
    int localVar = 20;
    func();
    printf("globalVar = %d\n", globalVar++);
    printf("localVar = %d\n", localVar);
    return 0;
}
void func(){
    int localVar = 30;
    printf("globalVar = %d\n", globalVar++);
    printf("localVar = %d\n", localVar);
    return;
}
```

全域變數、區域變數範例

```c
#include <stdio.h>
int s = 1;
void fun1(){
    int s = 2;
    s++;
    printf("in fun1(): s = %d\n", s);
    return;
}
void fun2(){
    printf("in fun2(): s = %d\n", s++);
    printf("in fun2(): s = %d\n", s);
    return;
}
int main(){
    printf("s = %d\n", s);
    fun1();
    printf("s = %d\n", s);
    fun2();
    printf("s = %d\n", s);
    return 0;
}
```

輸出：

全域變數、區域變數範例

```c
#include <stdio.h>
int s = 1;
void fun1(){
    int s = 2;
    s++;
    printf("in fun1(): s = %d\n", s);
    return;
}
void fun2(){
    printf("in fun2(): s = %d\n", s++);
    printf("in fun2(): s = %d\n", s);
    return;
}
int main(){
    printf("s = %d\n", s);
    fun1();
    printf("s = %d\n", s);
    fun2();
    printf("s = %d\n", s);
    return 0;
}
```

輸出：

全域變數、區域變數範例

```c
#include <stdio.h>
int s = 1;
void fun1(){
    int s = 2;
    s++;
    printf("in fun1(): s = %d\n", s);
    return;
}
void fun2(){
    printf("in fun2(): s = %d\n", s++);
    printf("in fun2(): s = %d\n", s);
    return;
}
int main(){
    printf("s = %d\n", s);
    fun1();
    printf("s = %d\n", s);
    fun2();
    printf("s = %d\n", s);
    return 0;
}
```

輸出：

全域變數、區域變數範例

```c
#include <stdio.h>
int s = 1;
void fun1(){
    int s = 2;
    s++;
    printf("in fun1(): s = %d\n", s);
    return;
}
void fun2(){
    printf("in fun2(): s = %d\n", s++);
    printf("in fun2(): s = %d\n", s);
    return;
}
int main(){
    printf("s = %d\n", s);
    fun1();
    printf("s = %d\n", s);
    fun2();
    printf("s = %d\n", s);
    return 0;
}
```

輸出：

```
s = 1
```

全域變數、區域變數範例

```c
#include <stdio.h>
int s = 1;
void fun1(){
    int s = 2;
    s++;
    printf("in fun1(): s = %d\n", s);
    return;
}
void fun2(){
    printf("in fun2(): s = %d\n", s++);
    printf("in fun2(): s = %d\n", s);
    return;
}
int main(){
    printf("s = %d\n", s);
    fun1();
    printf("s = %d\n", s);
    fun2();
    printf("s = %d\n", s);
    return 0;
}
```

輸出：

```
s = 1
```

全域變數、區域變數範例

```c
#include <stdio.h>
int s = 1;
void fun1(){
    int s = 2;
    s++;
    printf("in fun1(): s = %d\n", s);
    return;
}
void fun2(){
    printf("in fun2(): s = %d\n", s++);
    printf("in fun2(): s = %d\n", s);
    return;
}
int main(){
    printf("s = %d\n", s);
    fun1();
    printf("s = %d\n", s);
    fun2();
    printf("s = %d\n", s);
    return 0;
}
```

輸出：

```
s = 1
```

全域變數、區域變數範例

```c
#include <stdio.h>
int s = 1;
void fun1(){
    int s = 2;
    s++;
    printf("in fun1(): s = %d\n", s);
    return;
}
void fun2(){
    printf("in fun2(): s = %d\n", s++);
    printf("in fun2(): s = %d\n", s);
    return;
}
int main(){
    printf("s = %d\n", s);
    fun1();
    printf("s = %d\n", s);
    fun2();
    printf("s = %d\n", s);
    return 0;
}
```

輸出：

```
s = 1
```

全域變數、區域變數範例

```c
#include <stdio.h>
int s = 1;
void fun1(){
    int s = 2;
    s++;
    printf("in fun1(): s = %d\n", s);
    return;
}
void fun2(){
    printf("in fun2(): s = %d\n", s++);
    printf("in fun2(): s = %d\n", s);
    return;
}
int main(){
    printf("s = %d\n", s);
    fun1();
    printf("s = %d\n", s);
    fun2();
    printf("s = %d\n", s);
    return 0;
}
```

輸出：

```
s = 1
in fun1(): s = 3
```

全域變數、區域變數範例

```c
#include <stdio.h>
int s = 1;
void fun1(){
    int s = 2;
    s++;
    printf("in fun1(): s = %d\n", s);
    return;
}
void fun2(){
    printf("in fun2(): s = %d\n", s++);
    printf("in fun2(): s = %d\n", s);
    return;
}
int main(){
    printf("s = %d\n", s);
    fun1();
    printf("s = %d\n", s);
    fun2();
    printf("s = %d\n", s);
    return 0;
}
```

輸出：

```
s = 1
in fun1(): s = 3
```

全域變數、區域變數範例

```c
#include <stdio.h>
int s = 1;
void fun1(){
    int s = 2;
    s++;
    printf("in fun1(): s = %d\n", s);
    return;
}
void fun2(){
    printf("in fun2(): s = %d\n", s++);
    printf("in fun2(): s = %d\n", s);
    return;
}
int main(){
    printf("s = %d\n", s);
    fun1();
    printf("s = %d\n", s);
    fun2();
    printf("s = %d\n", s);
    return 0;
}
```

輸出：

```
s = 1
in fun1(): s = 3
s = 1
```

全域變數、區域變數範例

```c
#include <stdio.h>
int s = 1;
void fun1(){
    int s = 2;
    s++;
    printf("in fun1(): s = %d\n", s);
    return;
}
void fun2(){
    printf("in fun2(): s = %d\n", s++);
    printf("in fun2(): s = %d\n", s);
    return;
}
int main(){
    printf("s = %d\n", s);
    fun1();
    printf("s = %d\n", s);
    fun2();
    printf("s = %d\n", s);
    return 0;
}
```

輸出：

```
s = 1
in fun1(): s = 3
s = 1
```

全域變數、區域變數範例

```c
#include <stdio.h>
int s = 1;
void fun1(){
    int s = 2;
    s++;
    printf("in fun1(): s = %d\n", s);
    return;
}
void fun2(){
    printf("in fun2(): s = %d\n", s++);
    printf("in fun2(): s = %d\n", s);
    return;
}
int main(){
    printf("s = %d\n", s);
    fun1();
    printf("s = %d\n", s);
    fun2();
    printf("s = %d\n", s);
    return 0;
}
```

輸出：

```
s = 1
in fun1(): s = 3
s = 1
in fun2(): s = 1
```

全域變數、區域變數範例

```c
#include <stdio.h>
int s = 1;
void fun1(){
    int s = 2;
    s++;
    printf("in fun1(): s = %d\n", s);
    return;
}
void fun2(){
    printf("in fun2(): s = %d\n", s++);
    printf("in fun2(): s = %d\n", s);
    return;
}
int main(){
    printf("s = %d\n", s);
    fun1();
    printf("s = %d\n", s);
    fun2();
    printf("s = %d\n", s);
    return 0;
}
```

輸出：

```
s = 1
in fun1(): s = 3
s = 1
in fun2(): s = 1
in fun2(): s = 2
```

全域變數、區域變數範例

```c
#include <stdio.h>
int s = 1;
void fun1(){
    int s = 2;
    s++;
    printf("in fun1(): s = %d\n", s);
    return;
}
void fun2(){
    printf("in fun2(): s = %d\n", s++);
    printf("in fun2(): s = %d\n", s);
    return;
}
int main(){
    printf("s = %d\n", s);
    fun1();
    printf("s = %d\n", s);
    fun2();
    printf("s = %d\n", s);
    return 0;
}
```

輸出：

```
s = 1
in fun1(): s = 3
s = 1
in fun2(): s = 1
in fun2(): s = 2
```

全域變數、區域變數範例

```c
#include <stdio.h>
int s = 1;
void fun1(){
    int s = 2;
    s++;
    printf("in fun1(): s = %d\n", s);
    return;
}
void fun2(){
    printf("in fun2(): s = %d\n", s++);
    printf("in fun2(): s = %d\n", s);
    return;
}
int main(){
    printf("s = %d\n", s);
    fun1();
    printf("s = %d\n", s);
    fun2();
    printf("s = %d\n", s);
    return 0;
}
```

輸出：

```
s = 1
in fun1(): s = 3
s = 1
in fun2(): s = 1
in fun2(): s = 2
s = 2
```

全域變數、區域變數範例

```c
#include <stdio.h>
int s = 1;
void fun1(){
    int s = 2;
    s++;
    printf("in fun1(): s = %d\n", s);
    return;
}
void fun2(){
    printf("in fun2(): s = %d\n", s++);
    printf("in fun2(): s = %d\n", s);
    return;
}
int main(){
    printf("s = %d\n", s);
    fun1();
    printf("s = %d\n", s);
    fun2();
    printf("s = %d\n", s);
    return 0;
}
```

輸出：

```
s = 1
in fun1(): s = 3
s = 1
in fun2(): s = 1
in fun2(): s = 2
s = 2
```

全域變數、區域變數範例

```c
#include <stdio.h>
int s = 1;
void fun1(){
    int s = 2;
    s++;
    printf("in fun1(): s = %d\n", s);
    return;
}
void fun2(){
    printf("in fun2(): s = %d\n", s++);
    printf("in fun2(): s = %d\n", s);
    return;
}
int main(){
    printf("s = %d\n", s);
    fun1();
    printf("s = %d\n", s);
    fun2();
    printf("s = %d\n", s);
    return 0;
}
```

輸出：

```
s = 1
in fun1(): s = 3
s = 1
in fun2(): s = 1
in fun2(): s = 2
s = 2
```

用函式傳遞變數

```c
#include <stdio.h>
int gcd(int a, int b){
    while (b != 0){
        int t = b;
        b = a % b;
        a = t;
    }
    return a;
}
int main(){
    printf("%d\n", gcd(30, 18));
    return 0;
}
```

輸出：

```
6
```

用函式傳遞陣列

```c
#include <stdio.h>
void printArr(int a[]){
    for(int i = 0; i < 5; i++){
        printf("%d ", a[i]);
    }
    printf("\n");
    return;
}

int main(){
    int arr[5] = {2, 1, 7, 4, 5};
    printArr(arr);
    return 0;
}
```

```c
#include <stdio.h>
void printArr(int* a){
    for(int i = 0; i < 5; i++){
        printf("%d ", a[i]);
    }
    printf("\n");
    return;
}

int main(){
    int arr[5] = {2, 1, 7, 4, 5};
    printArr(arr);
    return 0;
}
```

用函式傳遞字串

```c
#include <stdio.h>
void printStr(char* s){
    printf("%s\n", s);
    return;
}

int main(){
    char s[] = "Hello, World";
    printStr(s);
    return 0;
}
```

用函式傳遞指標

```c
#include <stdio.h>
void swap(int* a, int* b){
    int t = *a;
    *a = *b;
    *b = t;
    return;
}
int main(){
    int x = 3, y = 5;
    swap(&x, &y);
    printf("%d %d\n", x, y);
    return 0;
}
```

輸出：

```
5 3
```