實驗項目- 指向函式之指標的陣列

一、 本節目的：

- 指標以及指標運算子
- 使用函式指標

二、 設計重點：

- 利用指標來以傳參考呼叫的方式傳遞引數給函式

三、 實驗題目：

- 中文課本 p7-55 習題 7.25，重新撰寫圖 6.22 的程式(中文課本 p6-42，CH3 投影片-p44)，改寫為使用選單驅動式的介面。程式應提供如下的四種選項給使用者：

```
Enter a choice:
  0  Print the array of grades
  1  Find the minimum grade
  2  Find the maximum grade
  3  Print the average on all tests for each student
  4  End program
```

使用指向式之指標的陣列有一項限制，那便是所有的指標必須具有相同的型別。因此，圖 6.22(中文課本 p6-42，CH3 投影片-p44)裡的指標都必須修改成回傳型別相同，而且參數的型別和個數也都相同。請將函式 minimum 和 maximum 修改成印出最小和最大的數值，且不傳回任何值。對於選項 3，修改圖 6.22(中文課本 p6-42，CH3 投影片-p44)的 average 函式，使之印出每個學生的平均成績。函式 average 必須沒有回傳值，而且它的參數必須和 printArray、minimum 和 maximum 函式一樣。請將指向這四個函式的指標存在 processGrades 陣列裡，然後以使用者輸入的選擇做為下標，來呼叫每一個函式。

- 習題 7.25 與圖 6.22(中文課本 p6-42，CH3 投影片-p44)最大的差別，在於習題 7.25 以選單方式呈現，可無限次的出現選單讓使用者重複選擇要執行的項目，直到使用者選擇離開程式才結束。而圖 6.22(中文課本 p6-42，CH3 投影片-p44)則是一次就將所有功能執行完印出，並不能讓使用者選擇執行部分功能輸出。

四、 **程式解說：**

- 此程式定義了四個函式 minimum、maximum、average、printArray (第 7~10 行)，每個函式皆有三個參數。

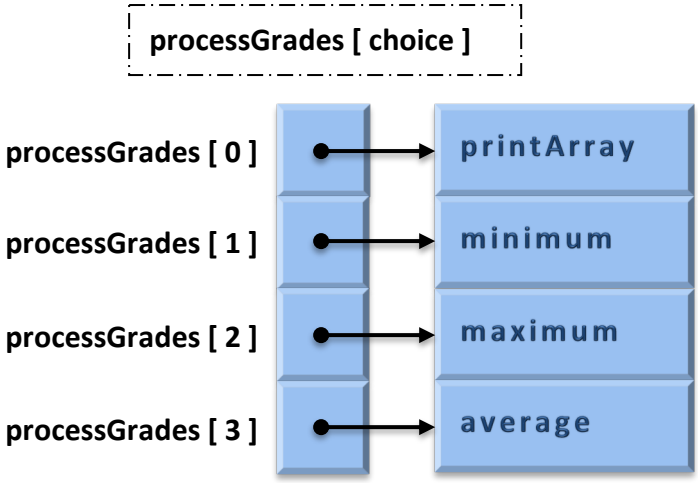
```
7   void minimum(int grades[][EXAMS], int pupils, int tests);
8   void maximum(int grades[][EXAMS], int pupils, int tests);
9   void average(int grades[][EXAMS], int pupils, int tests);
10  void printArray(int grades[][EXAMS], int pupils, int tests);
11  void printMenu();
```

- 四個函式的指標存放在陣列 processGrades 裡，宣告如下(第 20~21 行)

```
20      void(*processGrages[4])(int[STUDENTS][EXAMS], int, int)
21          = { printArray,minimum,maximum,average };
```

- 函式陣列 processGrades 裡位址 0 放置對應的函式 printArray
  位址 1 放置對應的函式 minimum
  位址 2 放置對應的函式 maximum
  位址 3 放置對應的函式 average
  (如下圖所示)

  當使用者輸入 0~3 任一數字時，會對應到相對位址的函式



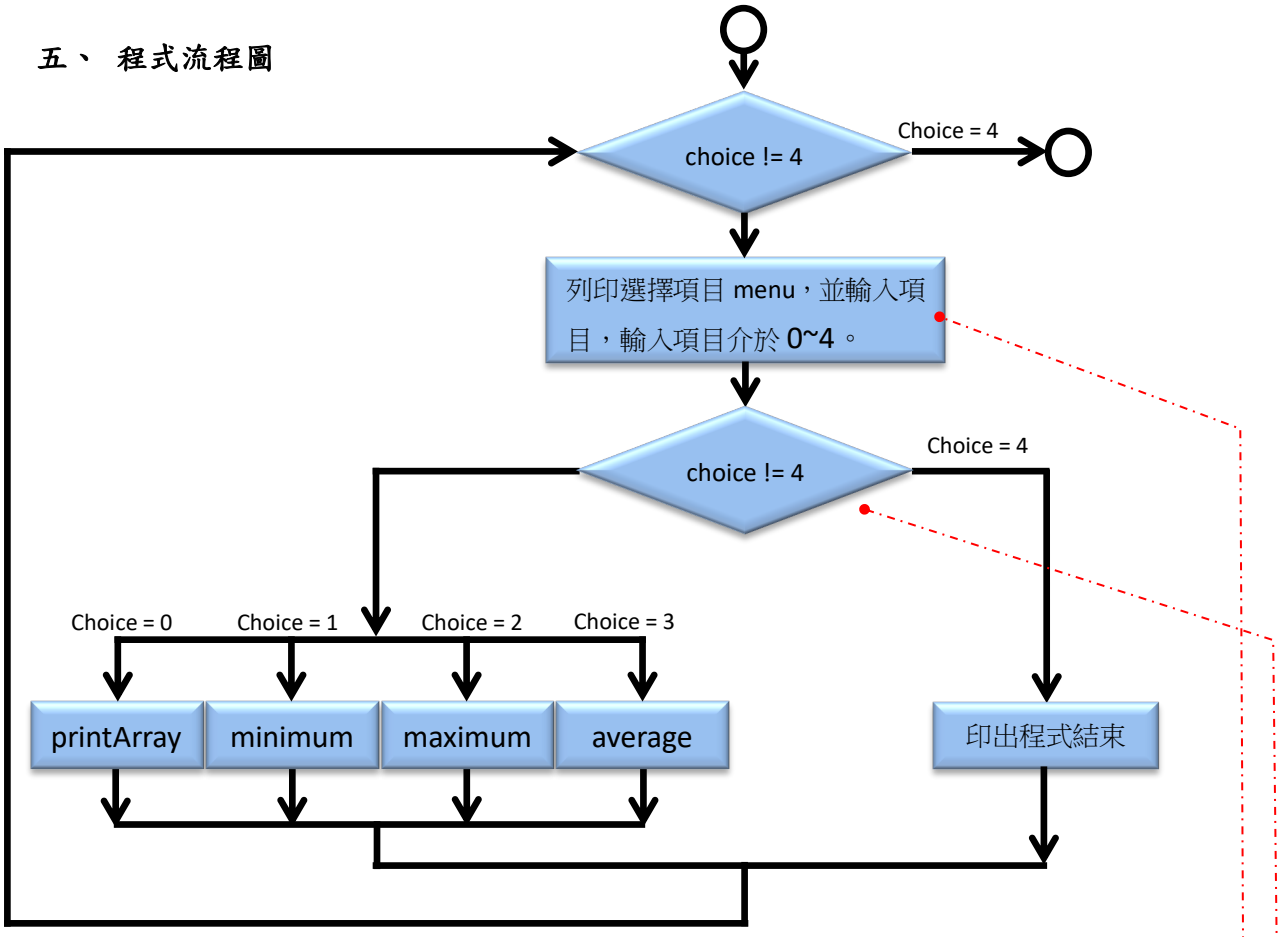
- 假如使用者輸入 2，choice = 2，因為 choice ≠ 4，所以執行第 33 行，根據函式陣列 processGrades 宣告(第 20~21 行)，可以知道當

  choice = 2 時，即 processGrades[2]對應到的函式為 maximum，
  第 33 行可以等效為 maximum(studentGrades , STUDENTS , EXAMS);

  而去呼叫執行函式 maximum

```
32      if (choice != 4) {
33          (*processGrages[choice])(studentGrades, STUDENTS, EXAMS);
34      }
35      else {
36          printf("\tProgram Ended. \n");
37      }
```

五、 程式流程圖




```
27          do {
28              printMenu();
29              scanf_s("%d", &choice);
30          } while (choice < 0 || choice>4);
```

```
32          if (choice != 4) {
33              (*processGrages[choice])(studentGrades, STUDENTS, EXAMS);
34          }
35          else {
36              printf("\tProgram Ended. \n");
37          }
```

choice=0，函式 printArray

choice=1，函式 minimum

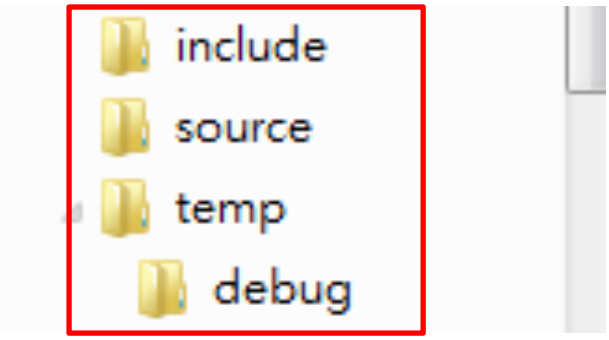
choice=2，函式 maximum

choice=3，函式 average

六、 設計步驟：

1. 建立新的空專案

   Step1-在 C:\c_code 資料夾內新增名為“Ch5_Lab1”的資料夾，再於 Ch5_Lab1 資料夾內分別建立 include、source、temp 等資料夾，建立後需要在 temp 資料夾內新增名為“debug”的資料夾，建立完成後如下圖

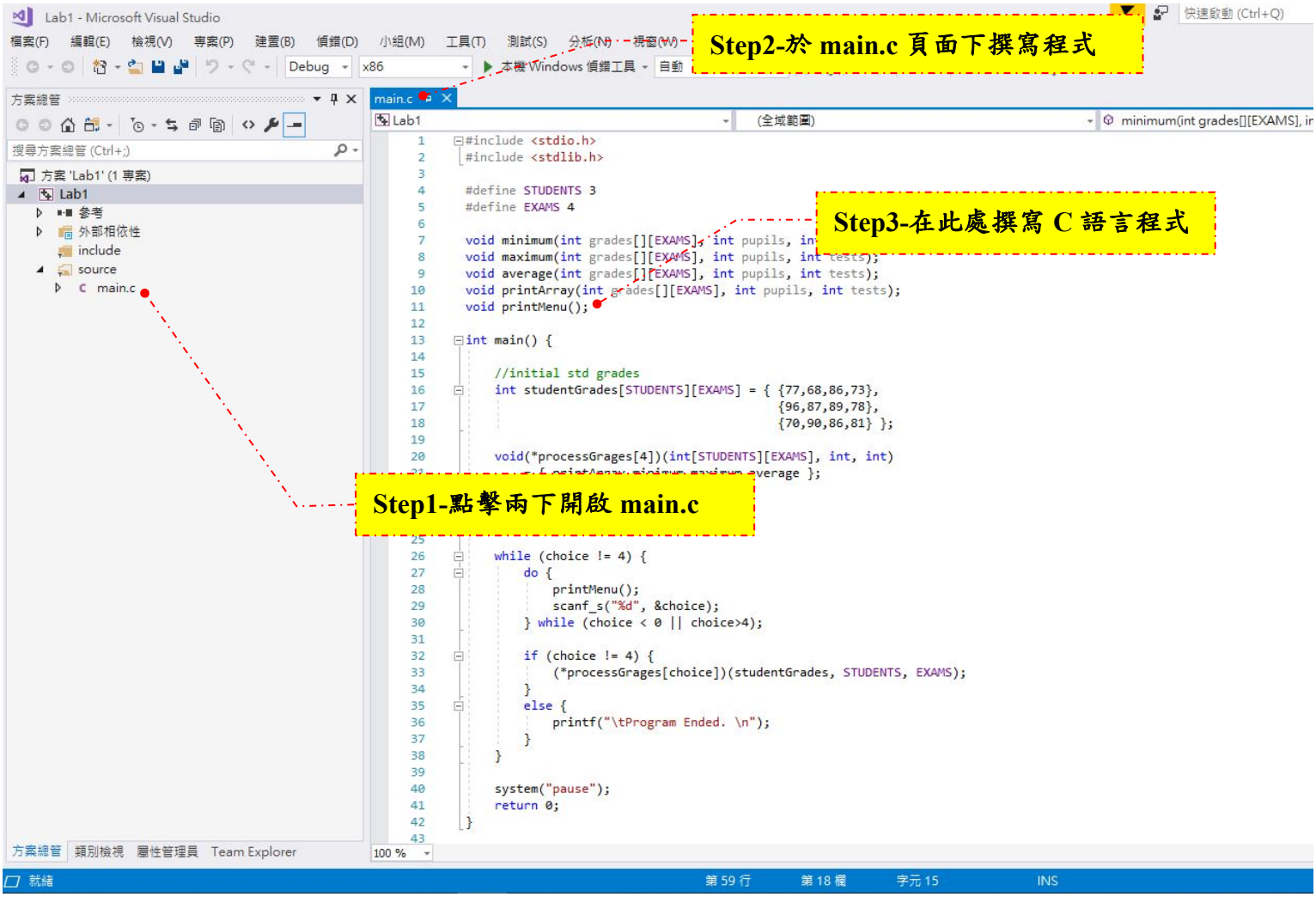


   Step2-參照 Ch1_Lab3 中“1.建立新的空專案”Step2~Step4，設定相關路徑位置為 C:\c_code\ Ch5_Lab1

2. 路徑設定、新增 .c 檔

   Step1-參照 Ch1_Lab3 中“2. 路徑設定、新增 .c 檔”Step1~Step8，新增 main.c 檔與設定相關屬性設定。

3. 撰寫 C 語言程式



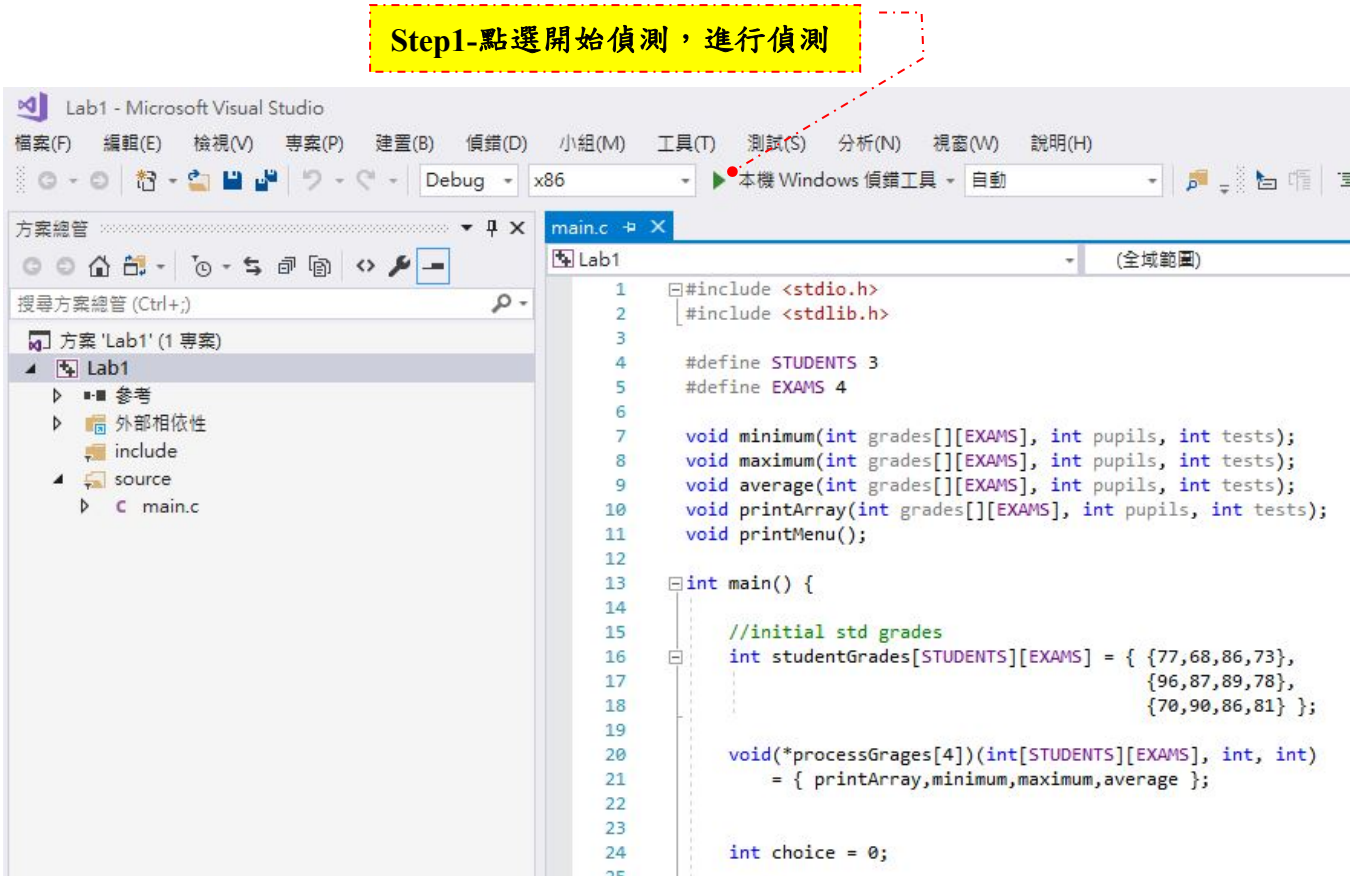
main.c 程式碼：

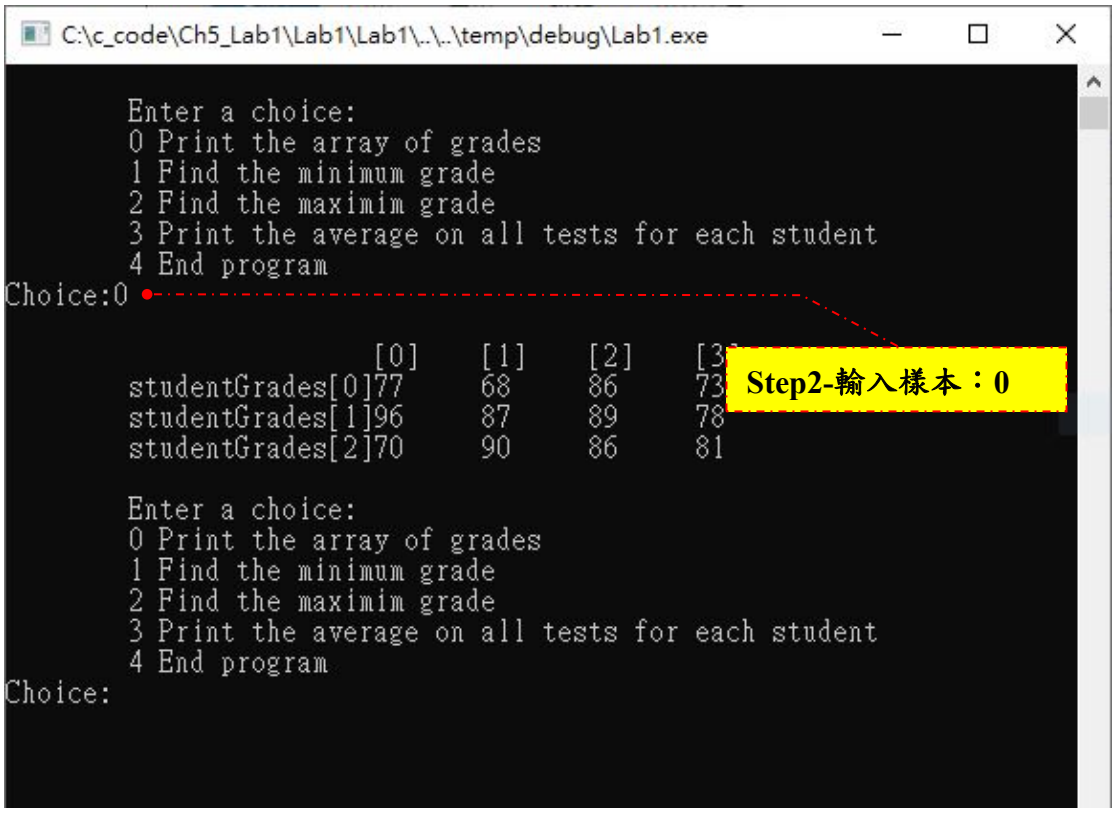
```c
#include <stdio.h>
#include <stdlib.h>

#define STUDENTS 3
#define EXAMS 4

void minimum(int grades[][EXAMS], int pupils, int tests);
void maximum(int grades[][EXAMS], int pupils, int tests);
void average(int grades[][EXAMS], int pupils, int tests);
void printArray(int grades[][EXAMS], int pupils, int tests);
void printMenu();

int main() {

    //initial std grades
    int studentGrades[STUDENTS][EXAMS] = { {77,68,86,73},
                                           {96,87,89,78},
                                           {70,90,86,81} };

    void(*processGrages[4])(int[STUDENTS][EXAMS], int, int)
        = { printArray,minimum,maximum,average };


    int choice = 0;

    while (choice != 4) {
        do {
            printMenu();
            scanf_s("%d", &choice);
        } while (choice < 0 || choice>4);

        if (choice != 4) {
            (*processGrages[choice])(studentGrades, STUDENTS, EXAMS);
        }
        else {
            printf("\tProgram Ended. \n");
        }
    }

    system("pause");
    return 0;
}
```

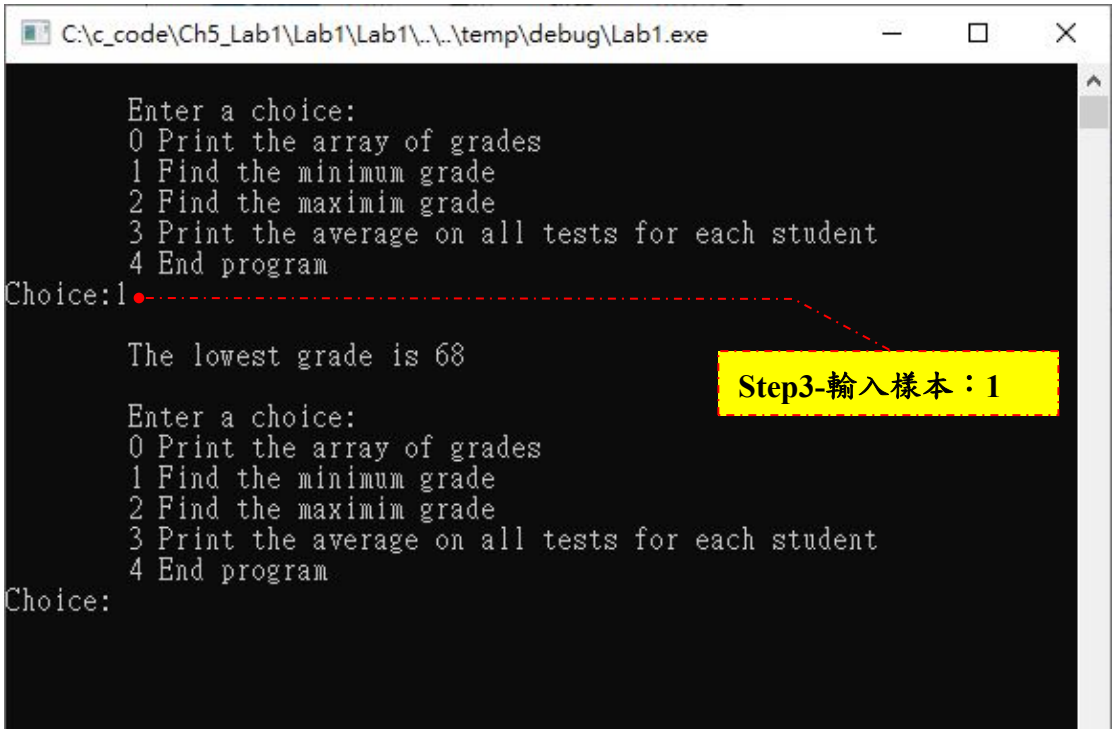
```
43
44  void minimum(int grades[][EXAMS], int pupils, int tests) {
45
46      int i, j;
47      int lowGrade = 100;
48
49      for (i = 0; i < pupils; i++) {
50
51          for (j = 0; j < tests; j++) {
52
53              if (grades[i][j] < lowGrade)
54                  lowGrade = grades[i][j];
55
56          }
57      }
58      printf("\n\tThe lowest grade is %d", lowGrade);
59      printf("\n");
60  }
61
62  void maximum(int grades[][EXAMS], int pupils, int tests) {
63
64      int i, j;
65      int highGrade = 0;
66
67      for (i = 0; i < pupils; i++) {
68
69          for (j = 0; j < tests; j++) {
70
71              if (grades[i][j] > highGrade)
72                  highGrade = grades[i][j];
73
74          }
75      }
76      printf("\n\tThe highest grade is %d", highGrade);
77      printf("\n");
78  }
79
80  void average(int grades[][EXAMS], int pupils, int tests) {
81
82      int i, j, total;
83      for (i = 0; i < pupils; i++) {
84
```

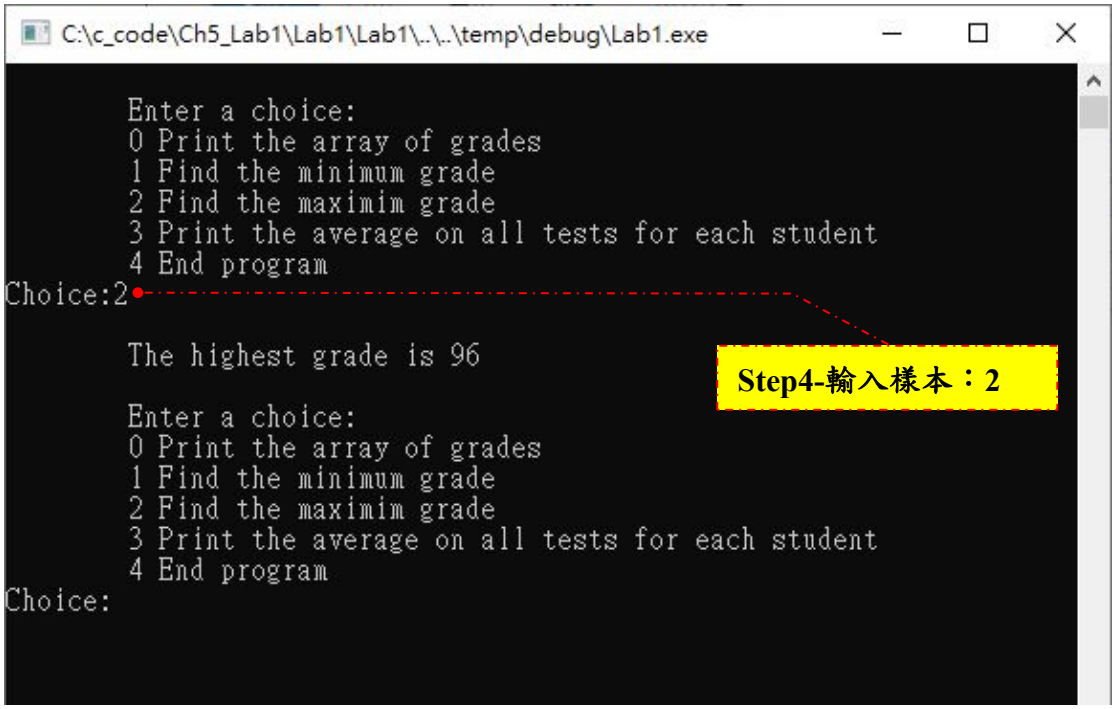
```
84
85              total = 0;
86              for (j = 0; j < tests; j++) {
87
88                  total += grades[i][j];
89
90              }
91              printf("\n\tThe average grade for student %d is %.1f"
92                  , i + 1, (double)total / tests);
93          }
94          printf("\n");
95      }
96
97      void printArray(int grades[][EXAMS], int pupils, int tests) {
98
99          int i, j;
100
101         printf("\n\t\t\t[0]    [1]    [2]    [3]");
102         for (i = 0; i < pupils; i++) {
103             printf("\n\tstudentGrades[%d]", i);
104             for (j = 0; j < tests; j++) {
105                 //允許輸入七個數值,-號代表靠左對齊
106                 printf("%-7d", grades[i][j]);
107             }
108         }
109         printf("\n");
110
111     }
112
113     void printMenu() {
114         printf("\n");
115         printf("\tEnter a choice:\n");
116         printf("\t0 Print the array of grades\n");
117         printf("\t1 Find the minimum grade\n");
118         printf("\t2 Find the maximim grade\n");
119         printf("\t3 Print the average on all tests for each student\n");
120         printf("\t4 End program\n");
121         printf("Choice:");
122     }
```

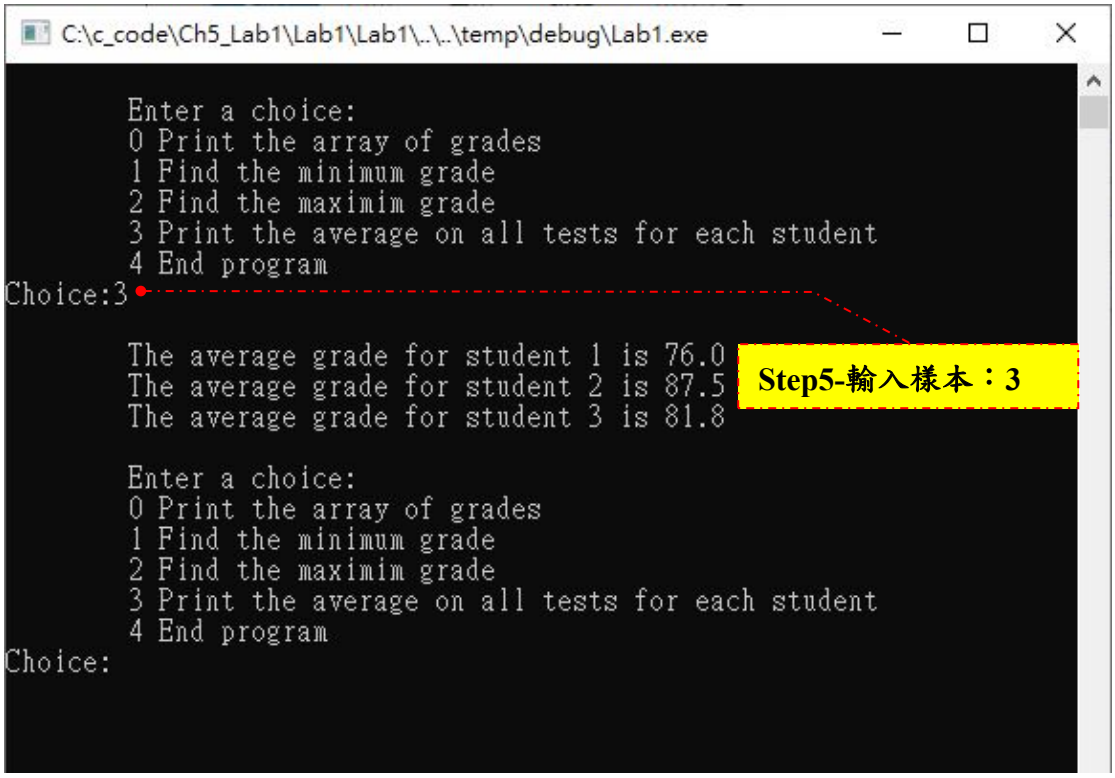
4. 執行與測試程式結果

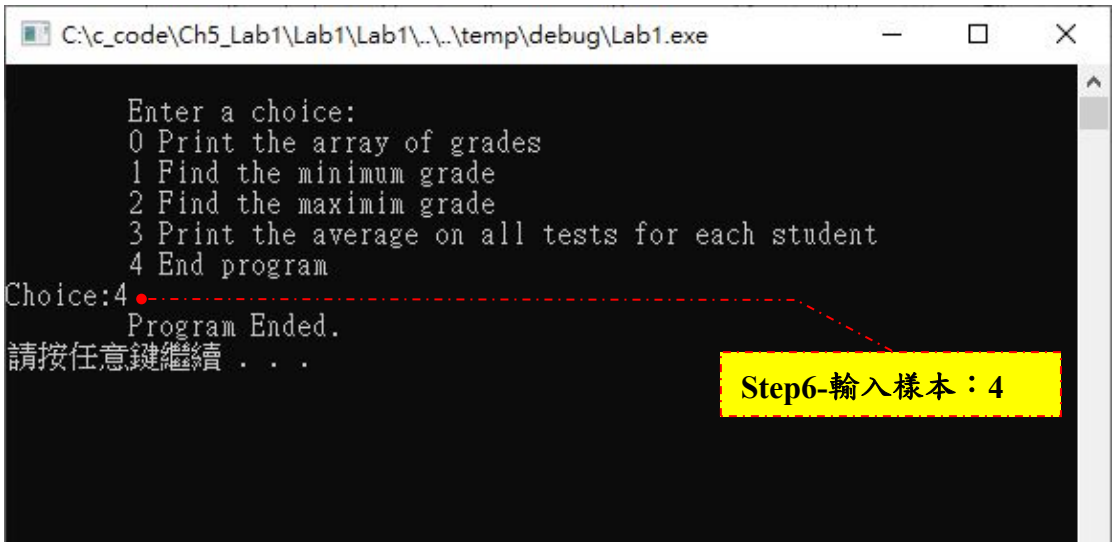

Step1-點選開始偵測，進行偵測
Lab1 - Microsoft Visual Studio
檔案(F) 編輯(E) 檢視(V) 專案(P) 建置(B) 偵錯(D) 小組(M) 工具(T) 測試(S) 分析(N) 視窗(W) 說明(H)
Debug x86 本機 Windows 偵錯工具 自動
方案總管
搜尋方案總管 (Ctrl+;)
方案 'Lab1' (1 專案)
Lab1
參考
外部相依性
include
source
main.c
main.c
Lab1
(全域範圍)
#include <stdio.h>
#include <stdlib.h>
#define STUDENTS 3
#define EXAMS 4
void minimum(int grades[][EXAMS], int pupils, int tests);
void maximum(int grades[][EXAMS], int pupils, int tests);
void average(int grades[][EXAMS], int pupils, int tests);
void printArray(int grades[][EXAMS], int pupils, int tests);
void printMenu();
int main() {
//initial std grades
int studentGrades[STUDENTS][EXAMS] = { {77,68,86,73},
{96,87,89,78},
{70,90,86,81} };
void(*processGrages[4])(int[STUDENTS][EXAMS], int, int)
= { printArray,minimum,maximum,average };
int choice = 0;


C:\c_code\Ch5_Lab1\Lab1\Lab1\..\..\temp\debug\Lab1.exe
Enter a choice:
0 Print the array of grades
1 Find the minimum grade
2 Find the maximim grade
3 Print the average on all tests for each student
4 End program
Choice:0
Step2-輸入樣本：0
[0] [1] [2] [3]
studentGrades[0]77 68 86 73
studentGrades[1]96 87 89 78
studentGrades[2]70 90 86 81
Enter a choice:
0 Print the array of grades
1 Find the minimum grade
2 Find the maximim grade
3 Print the average on all tests for each student
4 End program
Choice:


C:\c_code\Ch5_Lab1\Lab1\Lab1\..\..\temp\debug\Lab1.exe
Enter a choice:
0 Print the array of grades
1 Find the minimum grade
2 Find the maximim grade
3 Print the average on all tests for each student
4 End program
Choice:1
The lowest grade is 68
Enter a choice:
0 Print the array of grades
1 Find the minimum grade
2 Find the maximim grade
3 Print the average on all tests for each student
4 End program
Choice:
Step3-輸入樣本：1


C:\c_code\Ch5_Lab1\Lab1\Lab1\..\..\temp\debug\Lab1.exe
Enter a choice:
0 Print the array of grades
1 Find the minimum grade
2 Find the maximim grade
3 Print the average on all tests for each student
4 End program
Choice:2
The highest grade is 96
Enter a choice:
0 Print the array of grades
1 Find the minimum grade
2 Find the maximim grade
3 Print the average on all tests for each student
4 End program
Choice:
Step4-輸入樣本：2


C:\c_code\Ch5_Lab1\Lab1\Lab1\..\..\temp\debug\Lab1.exe
Enter a choice:
0 Print the array of grades
1 Find the minimum grade
2 Find the maximim grade
3 Print the average on all tests for each student
4 End program
Choice:3
The average grade for student 1 is 76.0
The average grade for student 2 is 87.5
The average grade for student 3 is 81.8
Enter a choice:
0 Print the array of grades
1 Find the minimum grade
2 Find the maximim grade
3 Print the average on all tests for each student
4 End program
Choice:
Step5-輸入樣本：3


C:\c_code\Ch5_Lab1\Lab1\Lab1\..\..\temp\debug\Lab1.exe
Enter a choice:
0 Print the array of grades
1 Find the minimum grade
2 Find the maximim grade
3 Print the average on all tests for each student
4 End program
Choice:4
Program Ended.
請按任意鍵繼續 . . .
Step6-輸入樣本：4