

C Programming I

2020 Fall

Homework 05

Instructor: Po-Wen Chi

Due: 2020.12.22 PM 11:59

Policies:

- Zero tolerance for late submission.
- You need to prepare a README file about how to make and run your program. Moreover, you need to provide your name and your student ID in the README file.
- For the writing assignment, I only accept pdf. MS. doc/docx format is not acceptable. Moreover, please use Chinese instead of English.
- Do not forget your Makefile. For your convenience, each assignment needs only one Makefile.
- The executable programs should be hw0501, hw0502

1 Sorting (20 pts)

Given an integer array, please sort this array. Wait ... that is too simple. Let's make it more interesting. The sorting policy is as follows:

1. All odd numbers should be before even numbers.
2. All odd numbers are in ascending order.
3. All even numbers are in descending order.

For your simplicity, the TA will prepare a header file called **test.h** and you need to include it in your source code. **test.h** will be like the following code:

```
1 int32_t array[10] = { 0,1,2,3,4,5,6,7,8,9 };
2 int32_t array_size = 10;
```

```

1 $ ./hw0501
2 Before:
3 0 1 2 3 4 5 6 7 8 9
4 After:
5 1 3 5 7 9 8 6 4 2 0

```

You need to implement the function in another C code and prepare a header file.

2 Determinant (20 pts)

In linear algebra, the determinant is a scalar value that can be computed from the elements of a square matrix and encodes certain properties of the linear transformation described by the matrix. If you do not know how to get the determinant, I will show you here.

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc.$$

$$\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix} = a \begin{vmatrix} e & f \\ h & i \end{vmatrix} - b \begin{vmatrix} d & f \\ g & i \end{vmatrix} + c \begin{vmatrix} d & e \\ g & h \end{vmatrix}.$$

$$\begin{vmatrix} a & b & c & d \\ e & f & g & h \\ i & j & k & l \\ m & n & o & p \end{vmatrix} = a \begin{vmatrix} f & g & h \\ j & k & l \\ n & o & p \end{vmatrix} - b \begin{vmatrix} e & g & h \\ i & k & l \\ m & o & p \end{vmatrix} + c \begin{vmatrix} e & f & h \\ i & j & l \\ m & n & p \end{vmatrix} - d \begin{vmatrix} e & f & g \\ i & j & k \\ m & n & o \end{vmatrix}.$$

Now please develop a program to calculate a determinant of a 4×4 matrix. For your simplicity, the TA will prepare a header file called **test2.h** and you need to include it in your source code. **test2.h** will be like the following code:

```

1 int32_t matrix[4][4] = { {1,0,0,0},
2                           {0,1,0,0},
3                           {0,0,1,0},
4                           {0,0,0,1} };

```

So you can use the array variable name **matrix** directly. BTW, the above answer should be 1. For your convenience, the answer and all values are 32-bits integers.

```

1 $ ./hw0502
2 The matrix is
3 1 0 0 0
4 0 1 0 0
5 0 0 1 0
6 0 0 0 1
7 The determinant is 1.

```

You need to implement the function in another C code and prepare a header file.

3 Polynomial Calculator (20 pts)

In mathematics, a polynomial is an expression consisting of variables and coefficients. A polynomial involves the operations of addition, subtraction, multiplication. So this time, I want you to develop a polynomial calculator. For your simplicity, this problem guarantees that all polynomials in this problem has only one variable, which we call it x .

```
1 $ ./hw0503
2 Please enter p1 degree: 2
3 Please enter p1 coefficients: 2 3 4
4 Please enter p2 degree: 2
5 Please enter p2 coefficients: 1 1 1
6 p1: 2x^2 + 3x + 4
7 p2: x^2 + x + 1
8 p1 + p2: 3x^2 + 4x + 5
9 p1 - p2: x^2 + 2x + 3
10 p1 * p2: 2x^4 + 5x^3 + 9x^2 + 7x + 4
```

For your convenience, I guarantee that the coefficient number will be equal to the degree plus one. All coefficients are 32-bits integers.

You need to implement the function in another C code and prepare a header file.

4 Linear regression (20 pts)

In statistics, linear regression is a linear approach to modeling the relationship between a scalar response (or dependent variable) and one or more explanatory variables (or independent variables). The case of one explanatory variable is called simple linear regression. If you do not know what linear regression is, please check it on the wikipedia.

In this homework, I want you to implement **Simple linear regression**. That is, I want you to find a linear function (a non-vertical straight line) that, as accurately as possible, predicts the dependent variable values as a function of the independent variables. The accuracy of each predicted value is measured by its squared residual (vertical distance between the point of the data set and the fitted line), and the goal is to make the sum of these squared deviations as small as possible. Figure 1 is an example.

```
1 $ ./hw0504
2 Please enter the point number: 4
3 Please enter Point 1: 80 11
4 Please enter Point 2: 90 12
5 Please enter Point 3: 110 8
6 Please enter Point 4: 120 9
7 Regression Equation: y = -0.08 x + 18
```

For your reference, you can see the following link.

https://en.wikipedia.org/wiki/Simple_linear_regression

Please use **double** and the precision is not the concern.

You need to implement the function in another C code and prepare a header file.

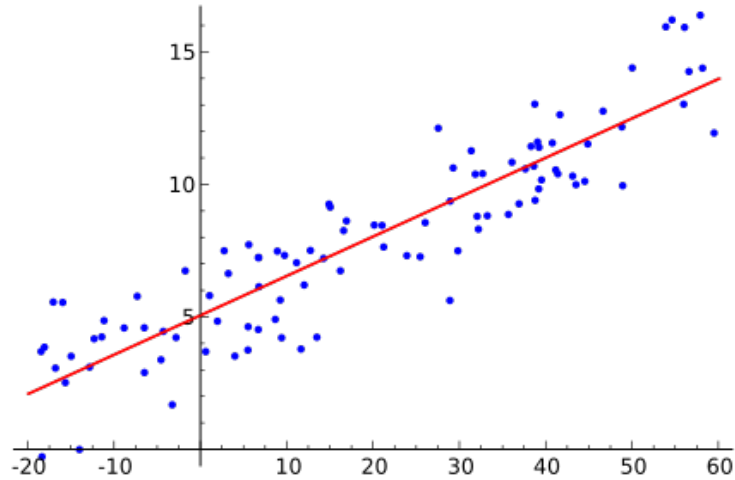


Figure 1: Linear Regression

5 Minesweeper (20 pts)

Have you ever played the game like figure 2?

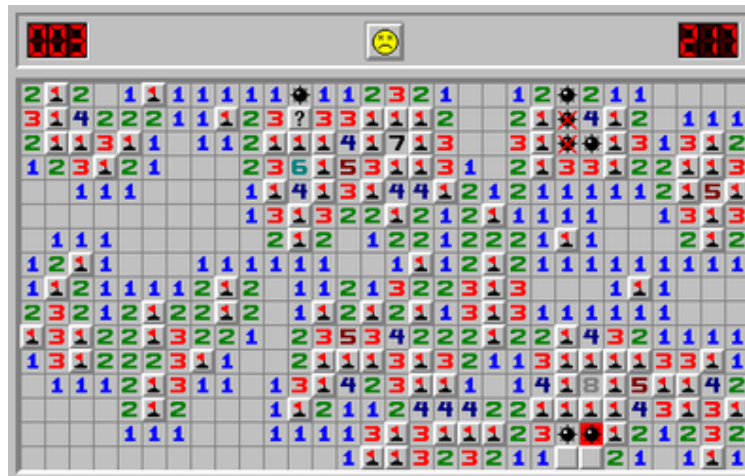


Figure 2: A typical minesweeper game with its commonly used style.

Minesweeper is a single-player puzzle game. The objective of the game is to clear a rectangular board containing hidden mines without detonating any of them, with help from clues about the number of neighboring mines in each field. Please develop a Minesweeper game.

```

1 $ ./hw0505
2 Please enter the width      (10-16): 10
3 Please enter the height    (10-16): 10
4 Please enter the mine number (30-90): 10
5   00 01 02 03 04 05 06 07 08 09
6 -----
7 00 | * * * * * * * * * *
```

```

8 01| * * * * * * * * * *
9 02| * * * * * * * * * *
10 03| * * * * * * * * * *
11 04| * * * * * * * * * *
12 05| * * * * * * * * * *
13 06| * * * * * * * * * *
14 07| * * * * * * * * * *
15 08| * * * * * * * * * *
16 09| * * * * * * * * * *
17
18 Your Option (1:Open, 2: Flag): 1
19 Position (row,column): 0 1
20
21    00 01 02 03 04 05 06 07 08 09
22 -----
23 00|      1 * * * * * * *
24 01| 1 1 1 * * * * * * *
25 02| * * * * * * * * * *
26 03| * * * * * * * * * *
27 04| * * * * * * * * * *
28 05| * * * * * * * * * *
29 06| * * * * * * * * * *
30 07| * * * * * * * * * *
31 08| * * * * * * * * * *
32 09| * * * * * * * * * *
33
34 Your Option (1:Open, 2: Flag): 2
35 Position (row,column): 0 3
36
37    00 01 02 03 04 05 06 07 08 09
38 -----
39 00|      1 F * * * * * *
40 01| 1 1 1 * * * * * * *
41 02| * * * * * * * * * *
42 03| * * * * * * * * * *
43 04| * * * * * * * * * *
44 05| * * * * * * * * * *
45 06| * * * * * * * * * *
46 07| * * * * * * * * * *
47 08| * * * * * * * * * *
48 09| * * * * * * * * * *
49
50 Your Option (1:Open, 2: Flag):

```

The game ends if the player successfully flags all mines or the player opens a mine. When receiving an invalid position, you should give an error message and make the player re-input.

You need to implement the function in another C code and prepare a header file.

6 Bonus: Code Explanation (10 pts)

Please explain the following code:

```

1 int p(int i, int N) {

```

```
2     return (i < N && printf("%d\n", i) && !p(i + 1, N))
3         || printf("%d\n", i);
4 }
```

Undoubtedly, please use Chinese. Do not tell me that I run this code and I find the output rule. Please explain the code itself.