National Taiwan Normal University
CSIE Computer Programming I

Instructor: Po-Wen Chi
Due Date: 2023.11.28 PM 11:59

Assignment 4

Policies:

- Zero tolerance for late submission.
- Please pack all your submissions in one zip file. **RAR is not allowed!!**
- For convenience, your executable programs must be named following the rule hwXXYY, where the red part is the homework number and the blue part is the problem number. For example, hw0102 is the executable program for homework #1 problem 2.
- I only accept **PDF** or **TEXT**. MS Word is not allowed.
- Do not forget your Makefile. For convenience, each assignment needs only one Makefile.
- Please provide a README file. The README file should have at least the following information:
  - Your student ID and your name.
  - How to build your code.
  - How to execute your built programs.
  - Anything that you want to notify our TAs.
- **DO NOT BE A COPYCAT!!** You will get ZERO if you are caught.

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

You need to implement the following functions with a header file called **mysort.h**. Our TAs will prepare hw0401.c which includes mysort.h and uses these functions. **Do not forget to make hw0401.c to hw0401 in your Makefile.**

```
// Sort array according to the given policies.
void mysort( int32_t array[], int32_t size );

// Print array elements in order.
void myprint( int32_t array[], int32_t size );
```

4.2 Differential of a Function (20 pts)

Given a function $y = f(x)$, I want you to calculate $\frac{dy}{dx} = f'(x)$. Wait ... that is too simple. I want you to develop a program that can be input two polynomial equations $f(x)$ and $g(x)$, and print the results of $\frac{d}{dx}f(x)g(x)$ and $\frac{d}{dx}\frac{f(x)}{g(x)}$. For your simplicity, I will give you formula as follows and I promise all coefficients are int32_t.

$$\frac{d}{dx}f(x)g(x) = f(x)g'(x) + f'(x)g(x),$$

$$\frac{d}{dx}\frac{f(x)}{g(x)} = \frac{g(x)f'(x) - f(x)g'(x)}{g^2(x)}$$

```
$ ./hw0402
Please enter f(x) degree: 2
Please enter f(x) coefficients: 1 0 1
Please enter g(x) degree: 2
Please enter g(x) coefficients: 1 0 0
f(x): x^2 + 1
g(x): x^2
(f(x)g(x))': 4x^3+2x
 f(x)    -2
(----)': ---
 g(x)    x^3
```

Notes:

- All functions should be printed in order, from high to low.
- For your convenience, the numerator function and the denominator function should be left-aligned and the middle line length should be the same length with the longest length of the numerator function and the denominator function.
- You need to do x reduction.Coefficient reduction is also required.

- The first coefficient cannot be zero.
- For any error inputs, print an error message and terminate your program.

4.3 GSAT (20 pts)

The General Scholastic Ability Test (學科能力測驗) is the Taiwanese university entrance exam. This time, I want you to develop a program to calculate five standards with given students scores.

Our TAs will prepare a header file called **gsat.h** for you which is as follows:

```
#include <stdint.h>

#define STUDENT_NUMBER (100) // Of course, the number may not be 100.
#define CHINESE (0)
#define ENGLISH (1)
#define MATH_A  (2)
#define MATH_B  (3)
#define SOCIAL  (4)
#define SCIENCE (5)

int32_t score[][6] = { { 15, 15, 15, 0, 15, 15 },
                       ...
                       { 15, 15, 0, 15, 15, 15 } };
```

You need to include **gsat.h** and your program should be executed as follows:

```
$ ./hw0403
        CHINESE | ENGLISH | MATH_A  | MATH_B  | SOCIAL  | SCIENCE
TOP 12%    13        14        11        12        12        13
TOP 25%    12        12         9        10        11        11
TOP 50%    11        10         7         7         9         9
TOP 75%     9         6         5         4         8         6
TOP 88%     7         4         4         3         6         5
```

For your simplicity, you do not need to consider the array overflow case.

https://zh.wikipedia.org/zh-tw/%E5%A4%A7%E5%AD%B8%E5%AD%B8%E7%A7%91%E8%83%BD%E5%8A%9B%E6%B8%AC%E9%A9%97#%E6%A8%99%E6%BA%96

4.4 Xiangqi (20 pts)

Do you know how to play Xiangqi（象棋）? Xiangqi , commonly known as Chinese chess or elephant chess, is a strategy board game for two players.

It is the most popular board game in China. If you do not know its rule, please reference the wikipeida. Now I want you to develop a program that given a situation, how many moves can the red side to checkmate the black general.

Let's start from the piece definitions and function definitions. Fig. 4.1 is an example.

```
#include <stdint.h>

#define EMPTY         (0)
#define RED_GENERAL   (1)
#define RED_ADVISOR   (2)
#define RED_ELEPHANT  (3)
#define RED_HORSE     (4)
#define RED_CHARIOT   (5)
#define RED_CANNON    (6)
#define RED_SOLDIER    (7)
#define BLACK_GENERAL   (11)
#define BLACK_ADVISOR   (12)
#define BLACK_ELEPHANT  (13)
#define BLACK_HORSE     (14)
#define BLACK_CHARIOT   (15)
#define BLACK_CANNON    (16)
#define BLACK_SOLDIER    (17)

// Return -1 if the board is invalid;
// otherwise, print all red side possible move to checkmate the
    black general and return the possible move number.
// Note the print should follow the piece order.
int32_t checkmate( int32_t board[10][9] );
```

Let's see an example. Given a board as shown in Fig. 4.2, your function should print the messages. I know some moves are very stupid but I just want you to list all possible checkmate moves. If there is no possible move, just return 0 and print nothing.

```
1) Move Horse from (4,7) to (6,6)
2) Move Chariot from (8,7) to (8,4)
3) Move Soldier from (7,6) to (7,5)
```

You should also prepare a header file called mychess.h. Our TAs will prepare hw0404.c which includes mychess.h and uses your function. **Do not forget to make hw0404.c to hw0404 in your Makefile.**

4.5 Japanese Mahjong (20 pts)

Have you play Japanese Mahjong? If not, don't worry, here's wikipedia Rule introduction. As we all know, TA not a bad guy like prof.Chi, you don't need to implement whole game. We want you make a Japanese

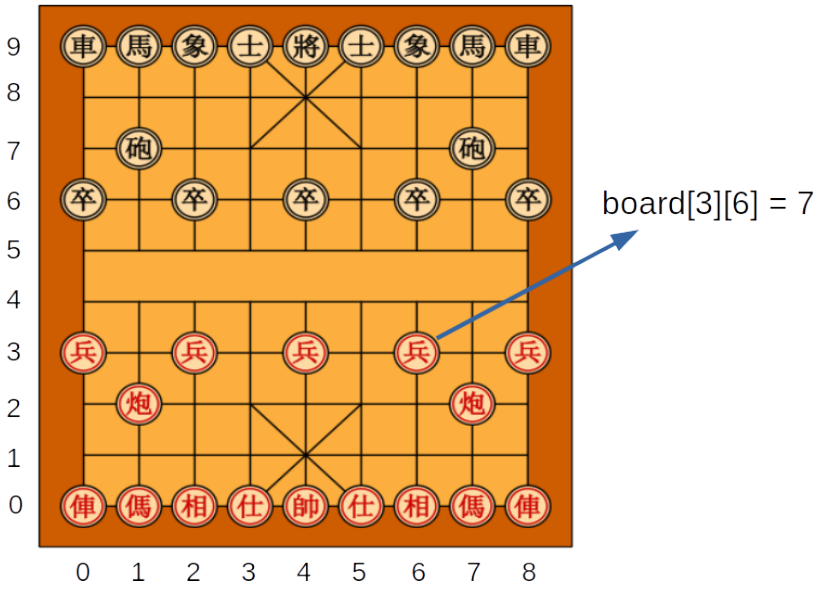


FIGURE 4.1: 2-D array for the game board.

FIGURE 4.2: An example.

Mahjong Scoring calculator.

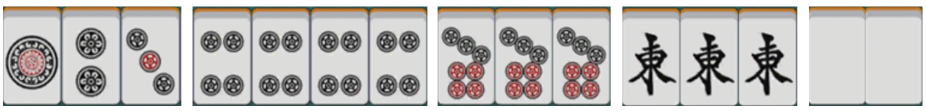
For input, I will use 1-34 to present the tile.

- 1 ∼ 9: 1 Pin(餅) ∼ 9 Pin(餅)
- 10 ∼ 18: 1 So(索) ∼ 9 So(索)
- 19 ∼ 27: 1 Wan(萬) ∼ 9 Wan(萬)
- 28 ∼ 31: East(東) South(南) West(西) North(北)
- 32 ∼ 34: White(白) Green(發) Red(中)

For input, I will input the tiles meld(面子) by meld(面子) and stop with 0, then I will tell you the meld(面子) is open or close(the tile in one meld(面子) which would not be order), and promise the scoring combination will fixed, you don't need to shuffle the tiles and find higher combination. For Special case, such as Seven-pair(七對子) and Thirteen orphans(國士無雙), I will input as one meld(面子).
Then, I will give your pair(對子), winning tile(和張), Self-drawn win(自摸), Player' s wind(自風), Prevailing wind(場風).
For output, you need to show each Yaku(役) or Yakumen(役滿), and calculate the sum of Han(番) or Yakumen(役滿). Your need to show the Yaku(役) by decreasing according to Han(番). However, in this homework, you don't need to consider Dora(寶牌), Ancient(古役), local(當地特殊牌型) Yaku(役) and any Yaku(役) which not depend on hand-tiles. All legal Yaku(役) please see **Yaku.pdf**
If there's multiple same Han(番) of Yaku(役), You need to show them by lexicographical order.
If the sum of Han larger than 13 Han(番), you still need to show total Han(番), and need to show "(Kazoe-yakuman)" after show total.
If there no any Yaku(役), you need to show
"The Score is... No Yaku Total: 0 Han".
If there's any unreasonable case, you need to stop all input event and show "The Score is... Unreasonable case Total: 0 Han".
Unreasonable case example:

- The tile number out of 1 ∼ 34
- The number of same tile larger than 4.
- Any Unreasonable case.

Yaku(役) reference:link



```
$ ./hw0
Please input meld: 1 2 3 0
Is open/closed group(1: open 0: closed): 0
Please input meld: 4 4 4 4 0
Is open/closed group(1: open 0: closed): 1
Please input meld: 7 7 7 0
Is open/closed group(1: open 0: closed): 0
Please input meld: 28 28 28 0
Is open/closed group(1: open 0: closed): 1
Please input pair: 32 32
Please input winning tile: 28
Is Self-drawn win?(1: YES 0: NO): 1
Player's wind(0:E 1:S 2:W 3:N): 0
Prevailing wind(0:E 1:S 2:W 3:N): 0

The Score is...
    Half-flush (2 Han)
    Honer: Player's wind (1 Han)
    Honer: Prevailing wind (1 Han)
Total: 4 Han
```

```
$ ./hw0
Please input meld: 32 32 32 0
Is open group(1: YES 0: NO): 0
Please input meld: 33 33 33 0
Is open group(1: YES 0: NO): 0
Please input meld: 28 28 28 0
Is open group(1: YES 0: NO): 0
Please input meld: 9 9 9 0
Is open group(1: YES 0: NO): 1
Please input pair: 34 34
Please input winning tile: 34
Is Self-drawn win?(1: YES 0: NO): 0
Player's wind(0:E 1:S 2:W 3:N): 0
Prevailing wind(0:E 1:S 2:W 3:N): 0

The Score is...
    All terminals and honors (2 Han)
    All triplets (2 Han)
    Half-flush (2 Han)
    Little three dragons (2 Han)
    Three concealed triplets (2 Han)
    Honer: Green (1 Han)
    Honer: Player's wind (1 Han)
    Honer: Prevailing wind (1 Han)
```

```

Total: 14 Han (Kazoe-yakuman)
```

```
Please input meld: 1 9 32 10 18 19 27 29 30 31 33 34 28 32
Please input winning tile: 32
Is Self-drawn win?(1: YES 0: NO): 0
Player's wind(0:E 1:S 2:W 3:N): 0
Prevailing wind(0:E 1:S 2:W 3:N): 0

The Score is...
    Thirteen orphans 13 wait (2 Yakuman)
Total: 2 Yakuman
```

4.6 Bonus: What Happens? (5 pts)

Please read the following code.

```
#include <stdio.h>
#include <stdint.h>

int main()
{
    int32_t array[100000000] = {0};
    return 0;
}
```

After building this code and executing it, I get the following error.

```
$ ./a.out

Segmentation Fault (core dump)
```

Would you please help me to find the reason?