

Lab #1

ICE3003-43: Computer Architecture

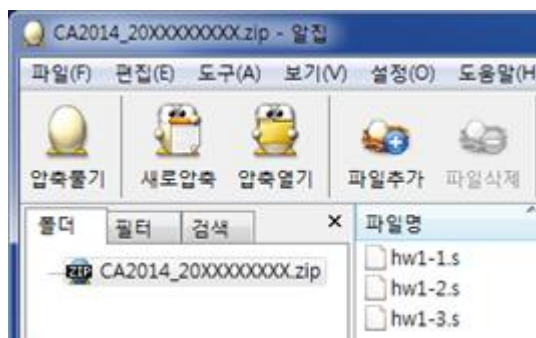
Parallel Architecture and Programming Lab

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Overview

- Download the attached template files,
and translate C code into MIPS assembly code.
- Save your code without changing the file names,
and compress them into a single zip.
- File name template: **CA2014_{your student ID}.zip**



- Upload the compressed file onto **iCampus**.
 - Due date : **4/8 (Tue) 4:30 PM** before class.
 - Penalty : 20% points off per one late day
based on the time stamp on iCampus.

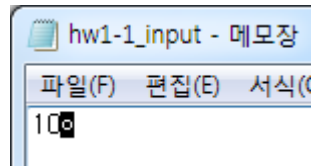
Lab #1-1 (Fibonacci)

Principle

$$a_n = a_{n-1} + a_{n-2}$$

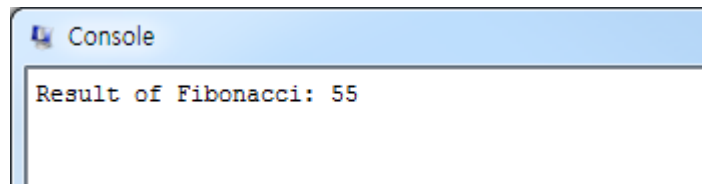
($a_0 = 0, a_1 = 1, n \geq 2$)

Input



10

Output



Example

0	1	1	2	3	5	8	13	21	34	55
a0	a1	a2	a3	a4	a5	a6	a7	a8	a9	a10

Lab #1-1 (Fibonacci)

C code

```
int fib (int input) {  
    if (input == 0)  
        return 0;  
    else if (input == 1)  
        return 1;  
    else  
        return fib (input-1) + fib (input-2);  
}
```

Fibonacci

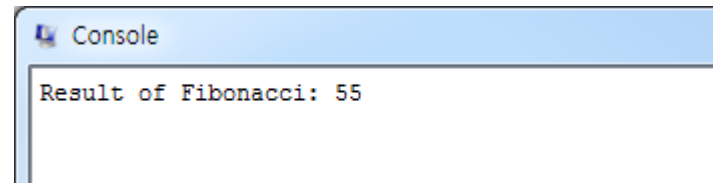
Print out the Nth fibonacci number.

You should complete the code for
"hw1-1.s".

Input

hw1-1_input.txt

Output



Lab #1-1 (Fibonacci)

hw1-1.c (reference code)

```
int fib (int input) {  
    if (input == 0)  
        return 0;  
    else if (input == 1)  
        return 1;  
    else  
        return fib (input-1) + fib (input-2);  
}
```

hw1-1.s (please fill in)

```
.data  
Input:  .ascii      "hw1-1_input.txt"  
output: .ascii      "Result of Fibonacci: "  
buffer:  
  
:  
  
fib:
```

```
#####  
# You are allowed to modify this part of the code only: START  
#####
```

FILL IN YOUR CODE HERE!!

```
#####  
# You are allowed to modify this part of the code only: END  
#####
```

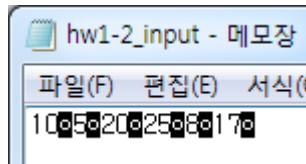
```
jr      $ra
```

Lab #1-2 (Maxheap)

Principle

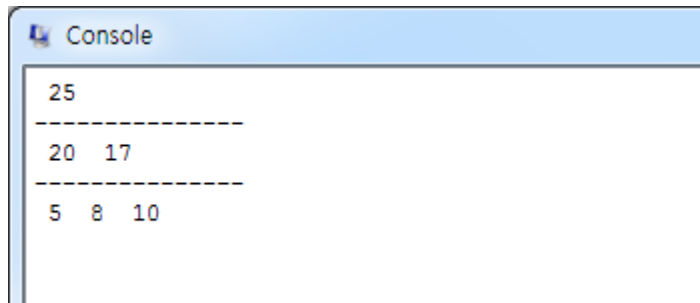
of Parent = # of Child / 2

Input

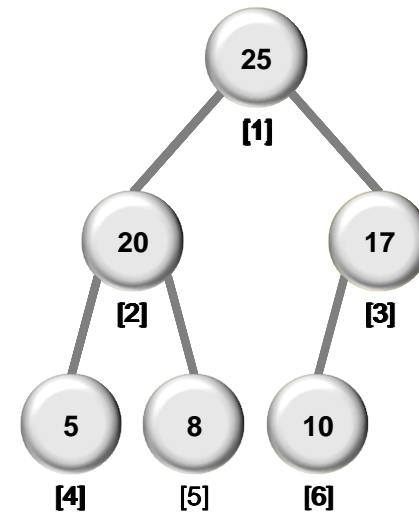


10 → 5 → 20 → 25 → 8 → 17

Output



Example



	[0]	[1]	[2]	[3]	[4]	[5]	[6]	...
heap	-	25	20	17	5	8	10	

Lab #1-2 (Maxheap)

C code

```
int insert_heap (int curr, int input) {
    int i;
    i = curr;
    heap[curr] = input;
    while ((i != 1) && (heap[i] > heap[i/2])) {
        swap (&heap[i], &heap[i/2]);
        i = i/2;
    }
}

void swap (int *a, int *b) {
    int t = *a;
    *a = *b;
    *b = t;
}
```

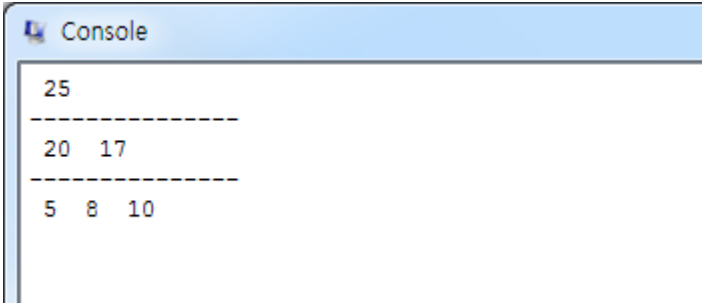
Maxheap

Insert the numbers in the input file into heap in an order of Maxheap algorithm. You should complete the code for “hw1-2.s”.

Input

hw1-2_input.txt

Output



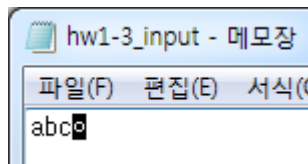
```
Console
-----
25
-----
20 17
-----
5 8 10
```

Lab #1-3 (Anagram)

Principle

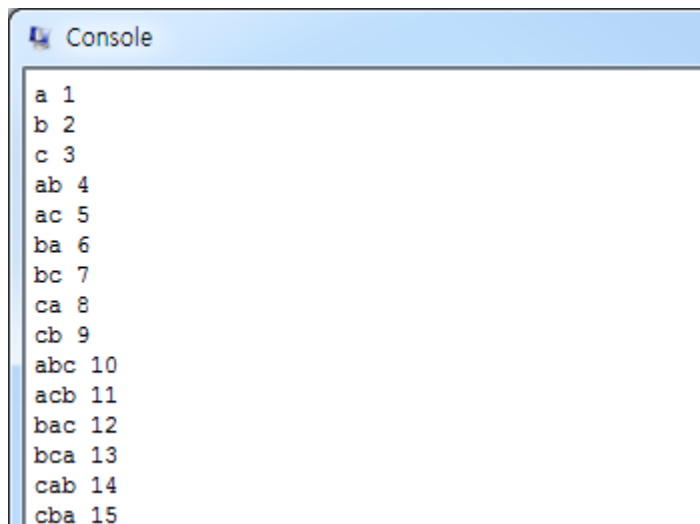
$$N = nP_1 + nP_2 + \dots + nP_n$$

Input

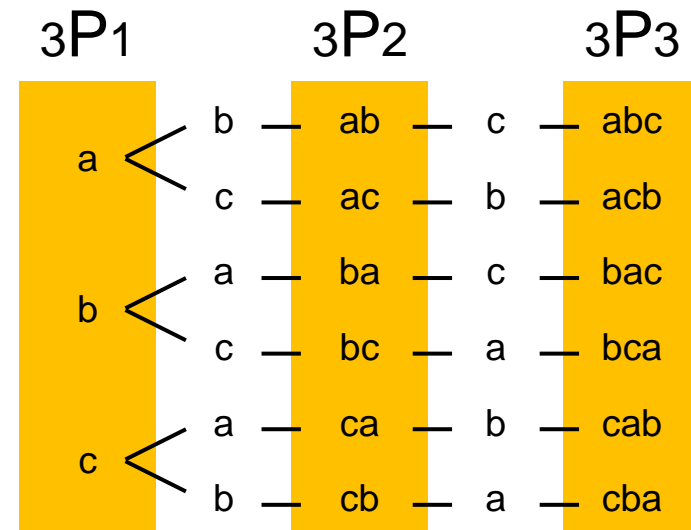


abc

Output



Example



$$\therefore N = 3P_1 + 3P_2 + 3P_3$$

Lab #1-3 (Anagram)

C code

```
void execute_anagram (int size) {
    int i;
    for (i = 1; i <= size; i++)
        permutation (size, i);
}

void permutation (int n, int r) {
    int i, j;
    if (r==0)
        print();
    else {
        for (i = 0; i < n; i++) {
            for (j = 0; j < cnt; j++) {
                if (i == array_index[j])
                    break;
            }
            if (j == cnt) {
                array_index[cnt] = i;
                print_array[cnt] = original_array[i];
                cnt++;
                permutation (n, r-1);
                cnt--;
            }
        }
    }
}
```

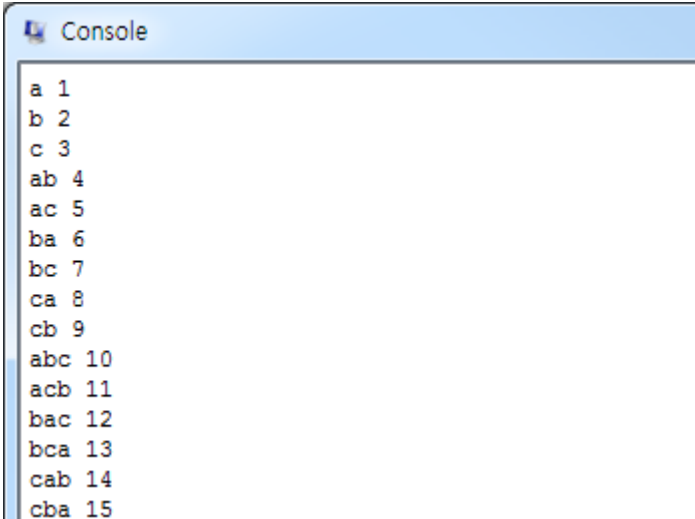
Anagram

Read the characters in the input file and make an anagram. And then, print out result. You should complete the code for “hw1-3.s”.

Input

hw1-3_input.txt

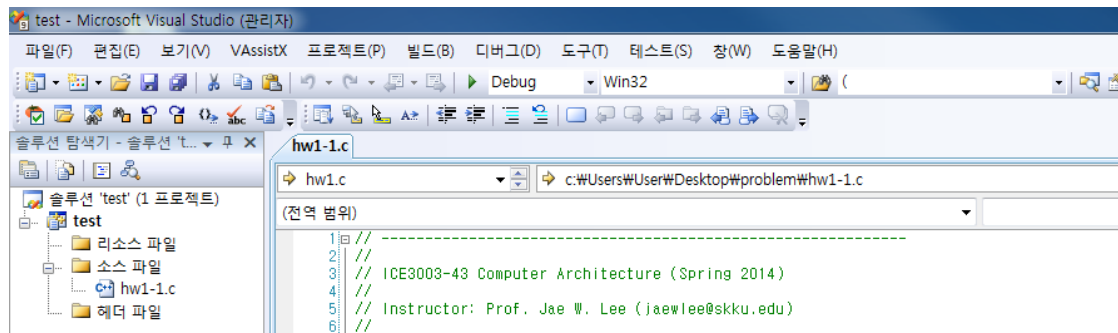
Output



```
Console
a 1
b 2
c 3
ab 4
ac 5
ba 6
bc 7
ca 8
cb 9
abc 10
acb 11
bac 12
bca 13
cab 14
cba 15
```

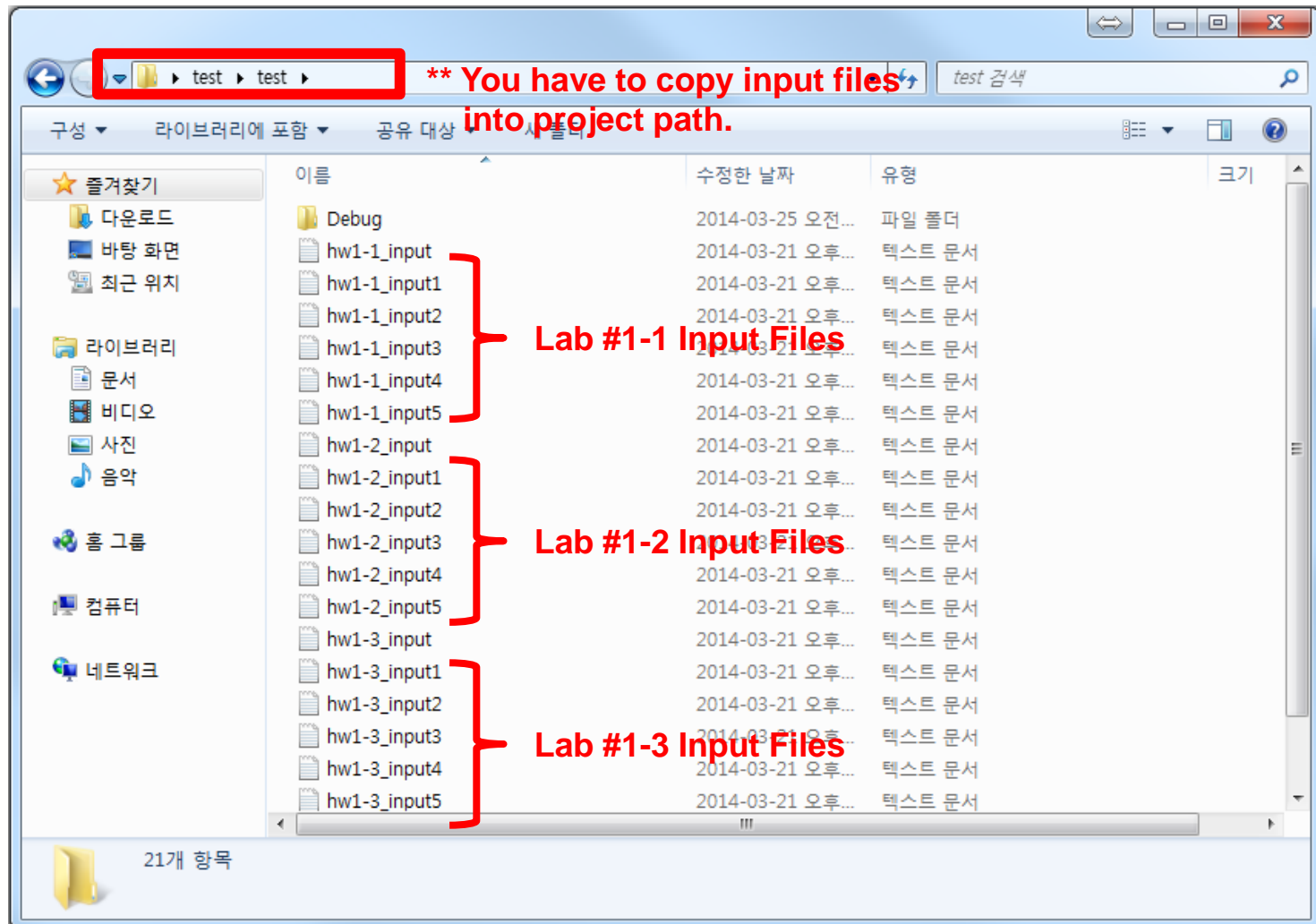
Execution Tips (Windows)

- Run Visual Studio
- Make a new project and add the C code.



- Compile (Ctrl + F7)
 - Build (F7)
 - Run (Ctrl + F5)
- } (Ctrl + Alt + B)

Execution Tips (Windows)



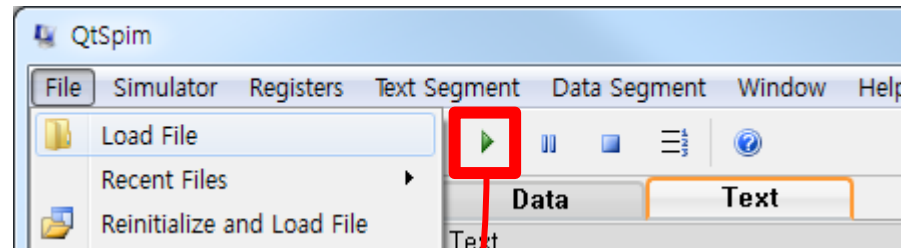
**** We will test your codes with the released input files only.**

Execution Tips (Windows)

- **Download & Install & Run QtSpim**

<http://sourceforge.net/projects/spimsimulator/files/>

- **Load assembly file**



- **Run assembly file**



Execution Tips (Windows)

The screenshot shows a Windows File Explorer window with the address bar set to `C:\Program Files\QtSpim`. A red box highlights this path, and a red text annotation says: **** You have to copy input files into "QtSpim install path"**. The left sidebar shows the navigation pane with '컴퓨터' (Computer) selected. The main pane displays a list of files and folders. Red brackets group the files into three categories: Lab #1-1 Input Files, Lab #1-2 Input Files, and Lab #1-3 Input Files. At the bottom, a status bar indicates '18개 항목을 선택했습니다.' (Selected 18 items) and '자세한 내용 표시...' (Show details...). A red text annotation at the bottom right says: **** We will test your codes with the released input files only.**

이름	수정한 날짜	유형	크기
hw1-1_input	2014-03-19 오전...	텍스트 문서	1KB
hw1-1_input1	2014-03-19 오전...	텍스트 문서	1KB
hw1-1_input2	2014-03-19 오후...	텍스트 문서	1KB
hw1-1_input3	2014-03-19 오후...	텍스트 문서	1KB
hw1-1_input4	2014-03-19 오후...	텍스트 문서	1KB
hw1-1_input5	2014-03-19 오후...	텍스트 문서	1KB
hw1-2_input	2014-03-19 오후...	텍스트 문서	1KB
hw1-2_input1	2014-03-19 오후...	텍스트 문서	1KB
hw1-2_input2	2014-03-19 오후...	텍스트 문서	1KB
hw1-2_input3	2014-03-19 오후...	텍스트 문서	1KB
hw1-2_input4	2014-03-19 오후...	텍스트 문서	1KB
hw1-2_input5	2014-03-19 오후...	텍스트 문서	1KB
hw1-3_input	2014-03-19 오후...	텍스트 문서	1KB
hw1-3_input1	2014-03-19 오후...	텍스트 문서	1KB
hw1-3_input2	2014-03-19 오후...	텍스트 문서	1KB
hw1-3_input3	2014-03-19 오후...	텍스트 문서	1KB
hw1-3_input4	2014-03-19 오후...	텍스트 문서	1KB
hw1-3_input5	2014-03-19 오후...	텍스트 문서	1KB
icudt51.dll	2013-04-23 오전...	응용 프로그램 확장	21,794KB
icuin51.dll	2013-04-23 오전...	응용 프로그램 확장	1,759KB

18개 항목을 선택했습니다.
자세한 내용 표시... **** We will test your codes with the released input files only.**

Execution Tips (Windows)

- If you want to test with the other input files, you have to modify the code.

hw1-1.c

hw1-1.s

- Modify the input file name in code.

hw1-1.c

```
// file open  
fp = fopen("hw1-1_input.txt", "r");
```

hw1-1.s

```
.data  
input      : .asciiz "hw1-1_input.txt"  
output     : .asciiz "result of fibonacci: "
```

- And then, you should re-compile and re-run the files.

Execution Tips (Ubuntu)

- **Go to the Lab #1 download path**

ex) \$ cd ~/Desktop/problem

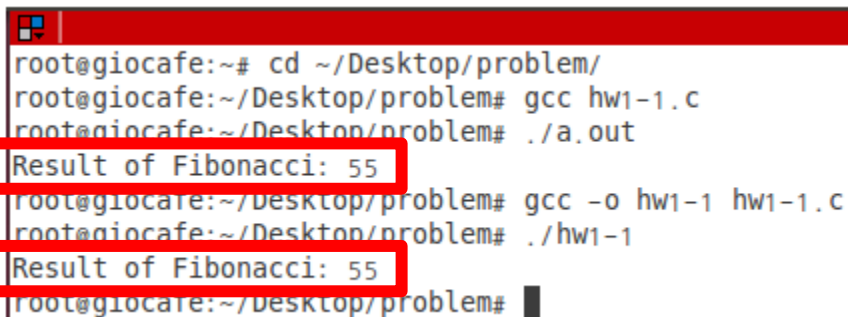
- **Compile & Run**

ex1) \$ gcc hw1-1.c

\$./a.out

ex2) \$ gcc -o "name" hw1-1.c

\$./ "name"



```
root@giocafe:~# cd ~/Desktop/problem/
root@giocafe:~/Desktop/problem# gcc hw1-1.c
root@giocafe:~/Desktop/problem# ./a.out
Result of Fibonacci: 55
root@giocafe:~/Desktop/problem# gcc -o hw1-1 hw1-1.c
root@giocafe:~/Desktop/problem# ./hw1-1
Result of Fibonacci: 55
root@giocafe:~/Desktop/problem#
```

The screenshot shows a terminal window with a red title bar. It displays the steps to compile and run a C program. The first part shows the user navigating to the directory and running the program with ./a.out, which outputs "Result of Fibonacci: 55". The second part shows the user compiling the program with a specific name (hw1-1) and then running it with ./hw1-1, which also outputs "Result of Fibonacci: 55". The output lines are highlighted with red boxes in the original image.

Execution Tips (Ubuntu)

- Install spim.

\$ sudo apt-get install spim

- Go to the Lab#1 path and run spim like this.

\$ spim -f hw1-1.s



A terminal window screenshot showing the installation and execution of spim. The terminal has a red title bar. The user is at the prompt `root@giocafe:~/Desktop/problem`. The first command is `sudo apt-get install spim`, which is highlighted with a red box. The output shows that spim is already installed. The second command is `spim -f hw1-1.s`, also highlighted with a red box. The output shows the spim version and copyright information. The final output is `Result of Fibonacci: 55`, which is highlighted with a red box. The prompt is `root@giocafe:~/Desktop/problem#`.

```
root@giocafe:~/Desktop/problem$ sudo apt-get install spim
패키지 목록을 읽는 중입니다... 완료
의존성 트리를 만드는 중입니다
상태 정보를 읽는 중입니다... 완료
spim 패키지는 이미 최신 버전입니다.
다음 패키지가 자동으로 설치되었지만 더 이상 필요하지 않습니다:
gir1.2-ubuntuoneui-3.0 libubuntuoneui-3.0-1 thunderbird-globalmenu
이들을 지우려면 'apt-get autoremove'를 사용하십시오.
0개 업그레이드, 0개 새로 설치, 0개 제거 및 23개 업그레이드 안 함.
root@giocafe:~/Desktop/problem$ spim -f hw1-1.s
SPIM Version 8.0 of January 8, 2010
Copyright 1990-2010, James R. Larus. All Rights Reserved.
See the file README for a full copyright notice.
Loaded: /usr/lib/spim/exceptions.s
Result of Fibonacci: 55
root@giocafe:~/Desktop/problem#
```


Execution Tips (Ubuntu)

```
root@giocafe:~/Desktop/problem# ls -al
합계 112
drwx----- 2 giocafe giocafe 4096 3월 25 00:28 .
drwxr-xr-x 6 giocafe giocafe 4096 3월 25 00:22 ..
-rw-r--r-- 1 giocafe giocafe 1083 3월 25 00:16 hw1-1.c
-rw-r--r-- 1 giocafe giocafe 3458 3월 22 09:31 hw1-1.s
-rw-r--r-- 1 giocafe giocafe 3 3월 21 23:18 hw1-1_input.txt
-rw-r--r-- 1 giocafe giocafe 3 3월 21 23:18 hw1-1_input1.txt
-rw-r--r-- 1 giocafe giocafe 2 3월 21 23:18 hw1-1_input2.txt
-rw-r--r-- 1 giocafe giocafe 3 3월 21 23:18 hw1-1_input3.txt
-rw-r--r-- 1 giocafe giocafe 2 3월 21 23:18 hw1-1_input4.txt
-rw-r--r-- 1 giocafe giocafe 3 3월 21 23:18 hw1-1_input5.txt
-rw-r--r-- 1 giocafe giocafe 1703 3월 22 09:19 hw1-2.c
-rw-r--r-- 1 giocafe giocafe 4233 3월 22 09:31 hw1-2.s
-rw-r--r-- 1 giocafe giocafe 16 3월 21 23:18 hw1-2_input.txt
-rw-r--r-- 1 giocafe giocafe 16 3월 21 23:18 hw1-2_input1.txt
-rw-r--r-- 1 giocafe giocafe 14 3월 21 23:18 hw1-2_input2.txt
-rw-r--r-- 1 giocafe giocafe 14 3월 21 23:18 hw1-2_input3.txt
-rw-r--r-- 1 giocafe giocafe 22 3월 21 23:18 hw1-2_input4.txt
-rw-r--r-- 1 giocafe giocafe 21 3월 21 23:18 hw1-2_input5.txt
-rw-r--r-- 1 giocafe giocafe 2202 3월 22 09:26 hw1-3.c
-rw-r--r-- 1 giocafe giocafe 5979 3월 22 09:31 hw1-3.s
-rw-r--r-- 1 giocafe giocafe 4 3월 21 23:18 hw1-3_input.txt
-rw-r--r-- 1 giocafe giocafe 4 3월 21 23:18 hw1-3_input1.txt
-rw-r--r-- 1 giocafe giocafe 5 3월 21 23:18 hw1-3_input2.txt
-rw-r--r-- 1 giocafe giocafe 5 3월 21 23:18 hw1-3_input3.txt
-rw-r--r-- 1 giocafe giocafe 5 3월 21 23:18 hw1-3_input4.txt
-rw-r--r-- 1 giocafe giocafe 3 3월 21 23:18 hw1-3_input5.txt
root@giocafe:~/Desktop/problem#
```

**** MIPS code file & related input files exist in the same path**

Lab #1-1 Input Files

Lab #1-2 Input Files

Lab #1-3 Input Files

Execution Tips (Ubuntu)

- If you want to test with the other input files, you have to modify the code.

```
$ vi hw1-1.c
```

```
$ vi hw1-1.s
```

- Press 'i' or 'a' and modify the input file name in fopen fuction.

```
hw1-1.c      28
              29 // file open
              30 fp = fopen("hw1-1_input.txt", "r");
              31

hw1-1.s      27 .data
              28 input      : .asciiz "hw1-1_input.txt"
              29 output     : .asciiz "Result of Fibonacci: "
```

- Press ESC, and “:wq”.

And then, you should re-compile and re-run the files.

Grading Guidelines

- **Working Correctly**

- Your MIPS code outputs the same result as the reference C code.
- We don't care about performance or algorithms you use.

**** You are allowed to modify only those part labeled**

with **“## FILL IN YOUR CODE HERE!! ##”** in your MIPS code.

**** You are allowed to modify the name of the input files**

to try different inputs for verifying or debugging.

ex) hw1-1_input1, ..., hw1-1_input5, ..., hw1-3_input1, ..., hw1-3_input5

**** But, you NEVER modify the contents of the input files**

even though some characters in file are broken. Never mind.

- **Comments**

- Insert appropriate comments to help TAs understand your code.
- Please exercise your common sense. TAs are reasonable guys.

Grading Guidelines

Code	Score (pts)	Description (pts)
Fibonacci	30	Working correctly: 25 Comments: 5
Maxheap	30	Working correctly: 25 Comments: 5
Anagram	40	Working correctly: 35 Comments: 5

Tutorials & Questions

- **QtSpim & SPIM tutorial will be given by TAs this Friday.**
 - When : **3/28 (Fri) 3 PM**
 - Where : **400118 (This room)**
 - It will be videotaped, and your attendance is totally optional.
- **If you have a question, consult the TAs during the office hours or by emails.**
 - Office hours : 3~4 PM (Tue, Fri)
 - Chung-ha Sung : sch8906@gmail.com
 - Yunkeuk Kim : giocafe87@gmail.com

Thank you