國立清華大學資訊工程學系

10810 CS 410000 計算機結構

Homework 2

Deadline: 2019.10.6 (23:59)

There are two parts in this homework.

PART I. (Load, Store, Add, Sub)

Please load the data 8(`$gp`) as `A`, 4(`$gp`) as `B`, and do the following calculations.

`C = B - A`, store `C` to 0(`$gp`).

`D = A + A`, store `D` to 12(`$gp`)

Hint

We will give a template called **arch_hw2_p1_template.asm**, just open it using Mars4_5.jar, write your code within the ####### block in the file (i.e., line 36~41), but **DO NOT** modify the code elsewhere. Please refer to the following figure.

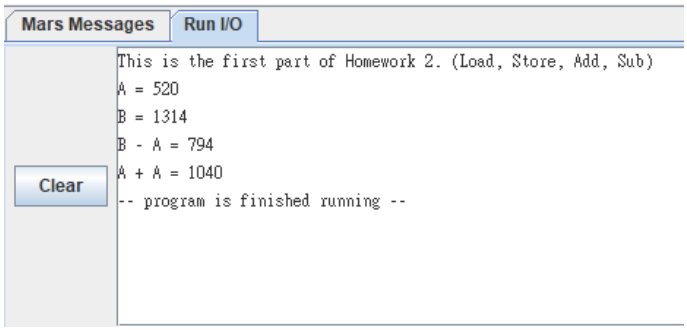
```
29  # The following block helps you practice with the R-type instructions,
30  # including ADD and SUB, and also LOAD and STORE.
31  # Here, please read data from 8($gp) and 4($gp),
32  # store 4($gp)-8($gp) to 0($gp), and
33  # store 8($gp)+8($gp) to 12($gp)
34  ##########################################################
35  # @@@ write the code here
36
37
38
39
40
41
42  ##########################################################
```

After you write your code, save it.

Next, press "F3" to assemble the code. (Make sure there is no error!)

Next, press "F5" to run.

The "Run I/O" screen should show the result like the following figure.



PART II. (Branch Loop, System call, Arithmetic Operations)

Please convert the following C-like code to MIPS assembly code. Write a new assembly file for this part.

Description: Enter a number and print the specific output. Most importantly, the program only terminated when user enters zero. (Note that all arithmetic operations are integer-type)

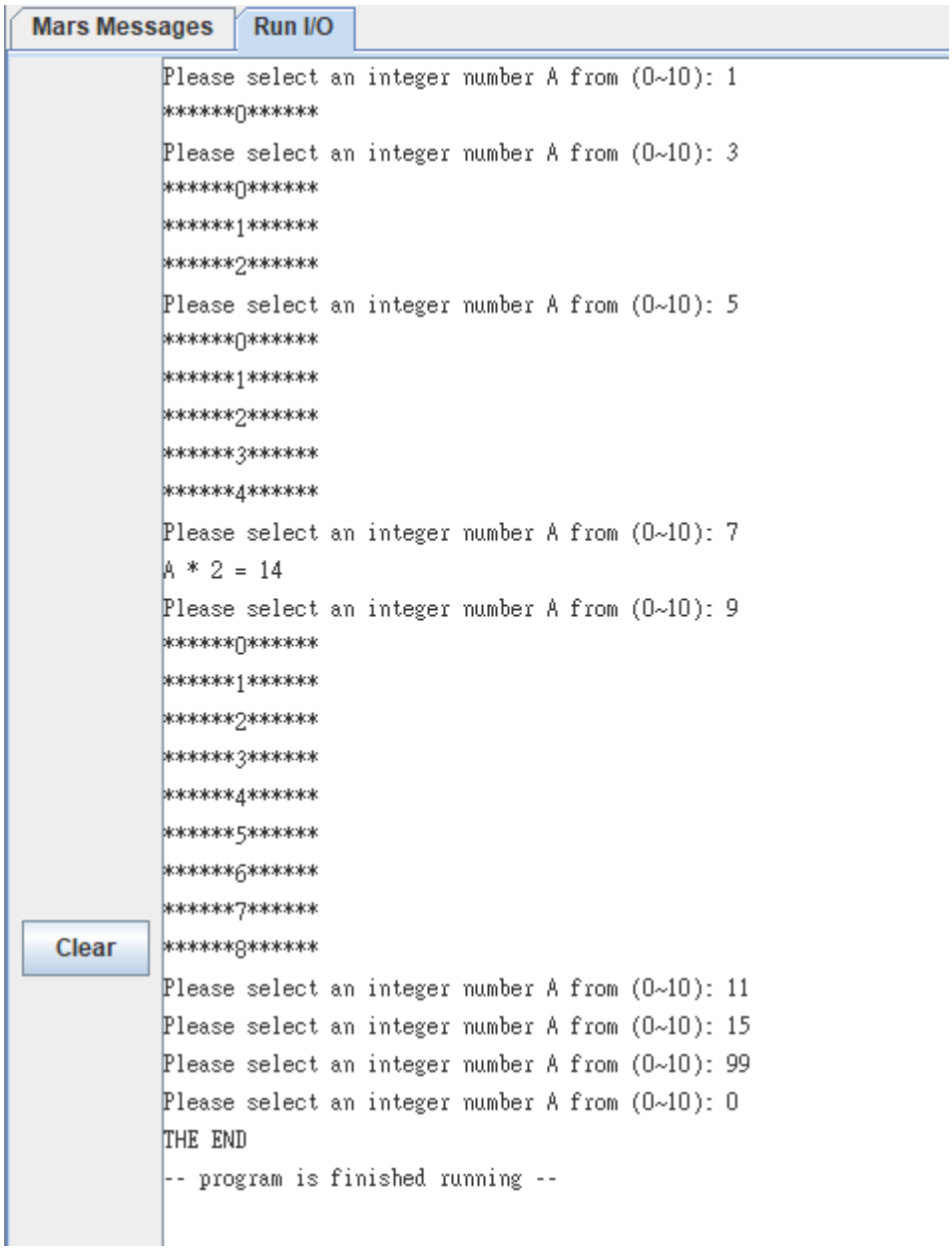
```c
#include<stdio.h>
int main()
{
    int t0, t1, i;
    while(1)
    {
        printf("Please select a number A from (0~10):");
        scanf("%d", &t0);

        if(t0 == 0)
        {
            printf("THE END");
            break;
        }

        else if (t0 < 0 || t0 > 10)
        {
            continue;
        }

        else
        {
            if(t0 == 7)
            {
                t1 = t0 * 2;
                printf("A * 2 = %d\n", t1);
                continue;
            }

            else
            {
                for(i = 0; i < t0; i++)
                printf("******%d*********\n",i);
                continue;
            }
        }
      return 0;
    }
}
```

Hint

a. You can refer to the template in Part I or Appendix to learn how to do `printf` and `scanf` in MIPS.

b. Two references for finding the functionality of MIPS instruction.
(English: http://alumni.cs.ucr.edu/~vladimir/cs161/mips.html)
(中文: https://blog.xuite.net/tzeng015/twblog/113272086-MIPS+%E6%8C%87%E4%BB%A4%E9%9B%86)

A simple test flow is like the following "Run I/O" screenshot.



Hint

a. We will give the C code called **arch_hw2_p2.c** for reference. We will also give a MIPS template called **arch_hw2_p2_template.asm**. We strongly recommend you do this part by yourself, or you can refer to the template if you need some help.

b. TA will use other numbers to test if your program is correct.

Submission (Two assembly programs)

Please name your assembly program with your student ID; for example, **arch_hw2_p1_102062801.asm** & **arch_hw2_p2_102062801.asm**, and upload these 2 files onto iLMS. (http://lms.nthu.edu.tw/course/35292)

Grading Criteria

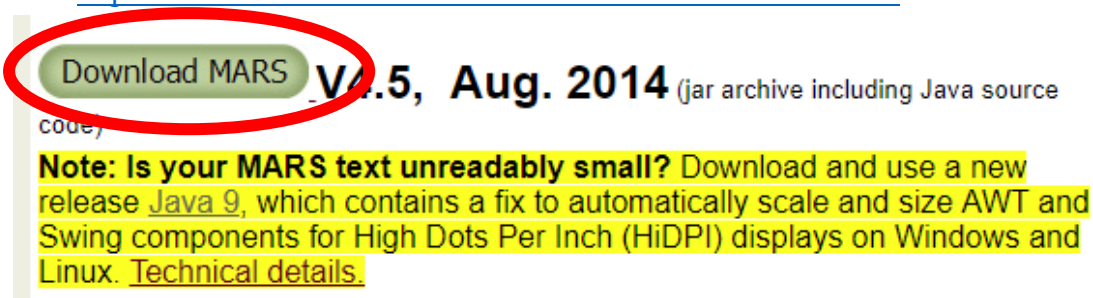
Correctness: 80%

Comments in your code: 10%

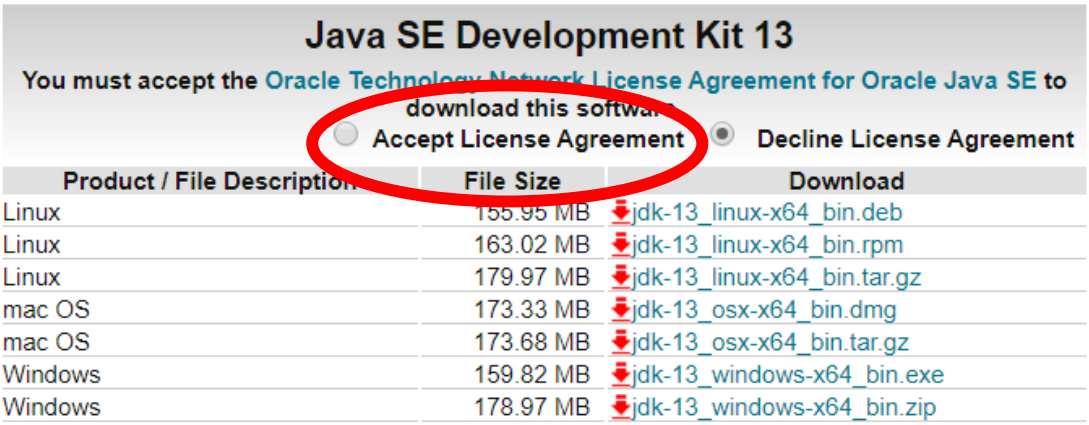
Output format: 10%

MARS (MIPS Assembler and Runtime Simulator)

1. MARS can assemble and simulate the execution of MIPS assembly language programs. Please refer to the following URL to download Mars4_5.jar:
   http://courses.missouristate.edu/kenvollmar/mars/download.htm

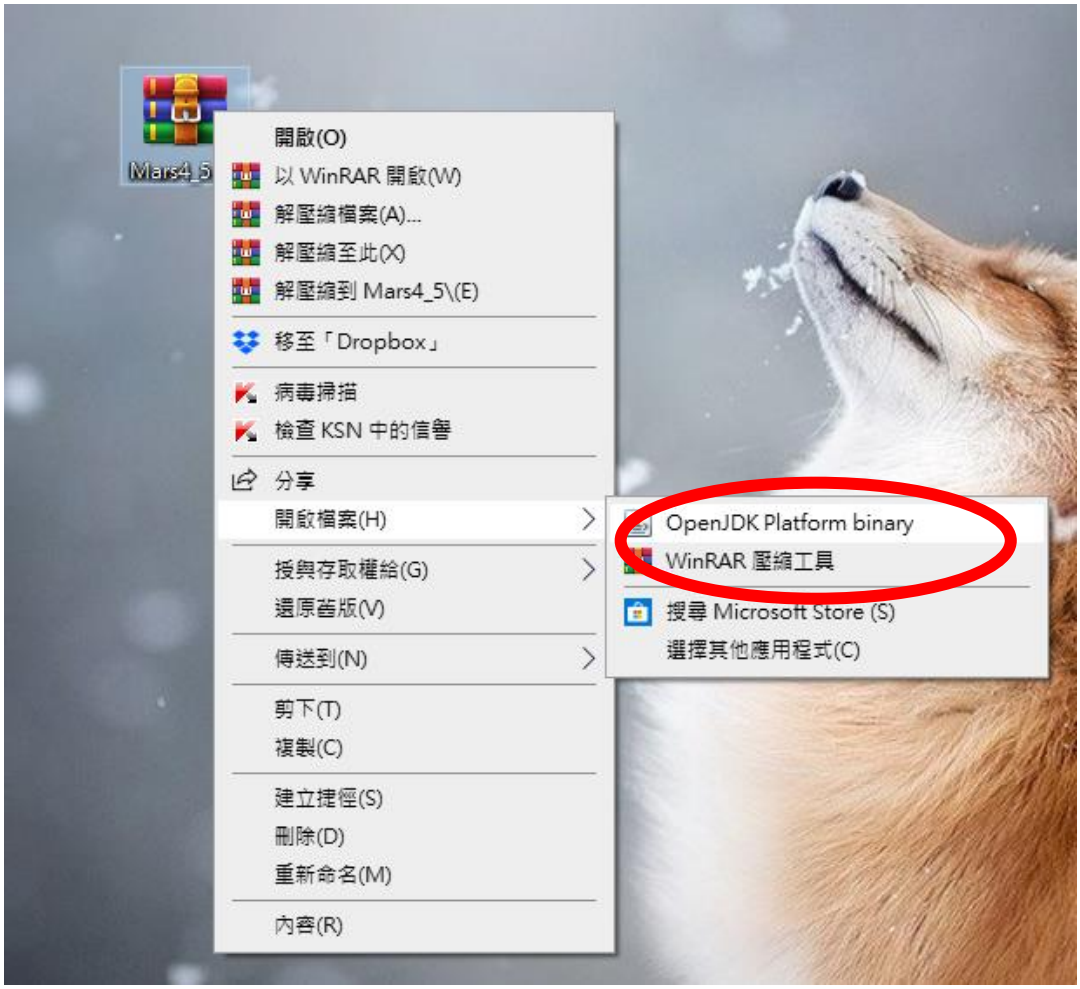


2. MARS is developed with Java language, and it requires JRE (Java Runtime Environment) installed on your computer. Please refer to the following URL to download JRE 10:
   http://www.oracle.com/technetwork/java/javase/downloads/jre10-downloads-4417026.html

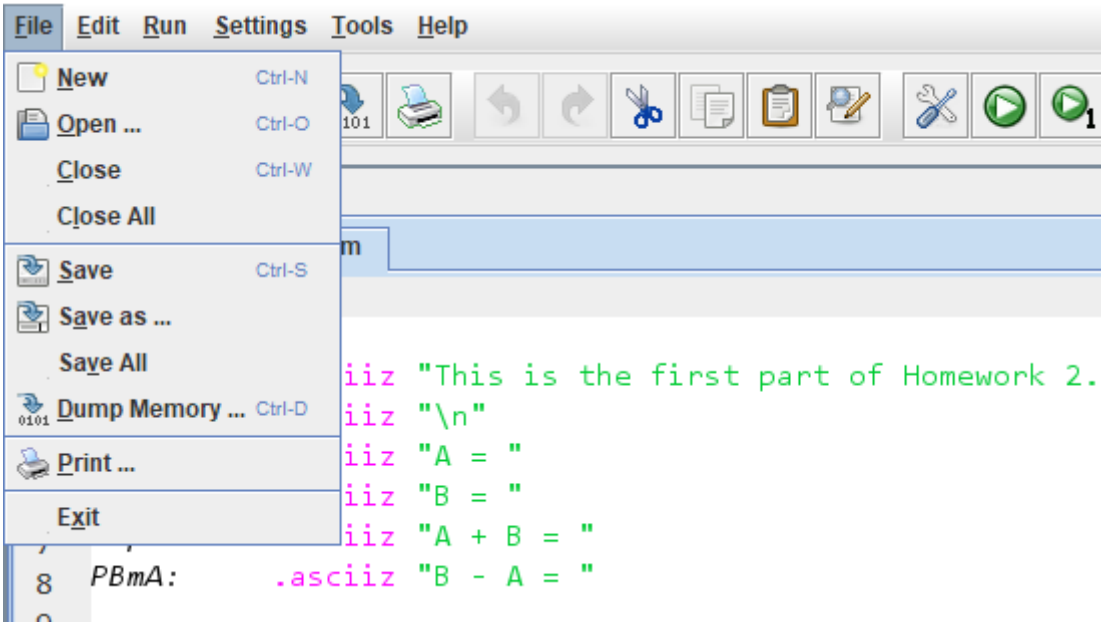


Product / File Description	File Size	Download
Linux	155.95 MB	jdk-13_linux-x64_bin.deb
Linux	163.02 MB	jdk-13_linux-x64_bin.rpm
Linux	179.97 MB	jdk-13_linux-x64_bin.tar.gz
mac OS	173.33 MB	jdk-13_osx-x64_bin.dmg
mac OS	173.68 MB	jdk-13_osx-x64_bin.tar.gz
Windows	159.82 MB	jdk-13_windows-x64_bin.exe
Windows	178.97 MB	jdk-13_windows-x64_bin.zip

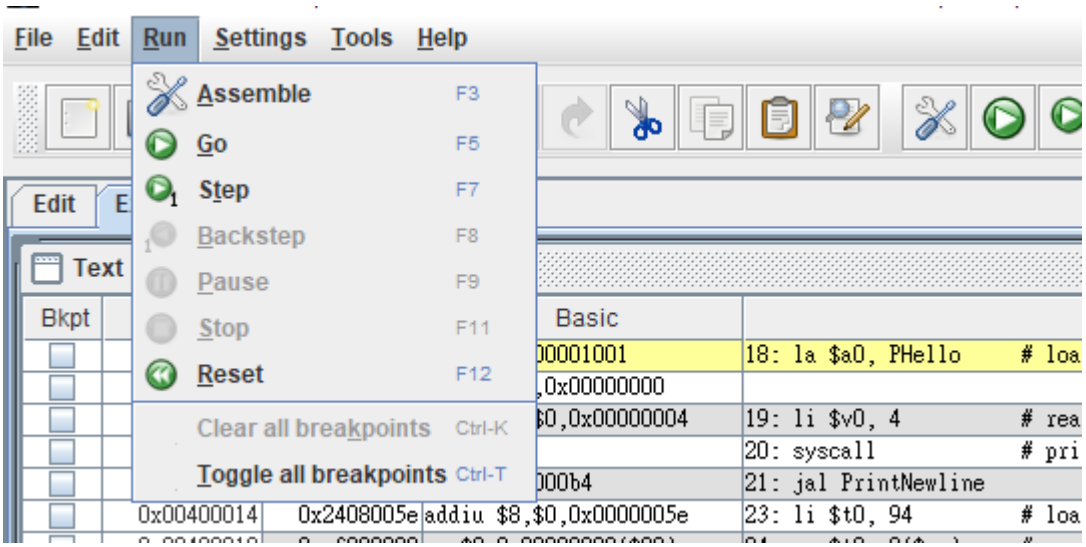
3. After you download the MARS, it is a ".jar" file. Please **DO NOT** decompress it. You can open the MARS by following method.


Mars4_5
開啟(O)
以 WinRAR 開啟(W)
解壓縮檔案(A)...
解壓縮至此(X)
解壓縮到 Mars4_5\(E)
移至「Dropbox」
病毒掃描
檢查 KSN 中的信譽
分享
開啟檔案(H)
授與存取權給(G)
還原舊版(V)
傳送到(N)
剪下(T)
複製(C)
建立捷徑(S)
刪除(D)
重新命名(M)
內容(R)
OpenJDK Platform binary
WinRAR 壓縮工具
搜尋 Microsoft Store (S)
選擇其他應用程式(C)

4. Usage of MARS:



(a) New, Open, Save and Close



(b) Assemble and then Go (Run)

P. S. Save your file, Assemble and Go

Appendix

(Source: http://students.cs.tamu.edu/tanzir/csce350/reference/syscalls.html)

MIPS system calls

(from SPIM S20: A MIPS R2000 Simulator, James J. Larus, University of Wisconsin-Madison)

SPIM provides a small set of operating-system-like services through the MIPS system call (syscall) instruction. To request a service, a program loads the system call code (see Table below) into register $v0 and the arguments into registers $a0, ..., $a3 (or $f12 for floating point values). System calls that return values put their result in register $v0 (or $f0 for floating point results).

Service	System Call Code	Arguments	Result
print integer	1	$a0 = value	(none)
print float	2	$f12 = float value	(none)
print double	3	$f12 = double value	(none)
print string	4	$a0 = address of string	(none)
read integer	5	(none)	$v0 = value read
read float	6	(none)	$f0 = value read
read double	7	(none)	$f0 = value read
read string	8	$a0 = address where string to be stored $a1 = number of characters to read + 1	(none)
memory allocation	9	$a0 = number of bytes of storage desired	$v0 = address of block
exit (end of program)	10	(none)	(none)
print character	11	$a0 = integer	(none)
read character	12	(none)	char in $v0

For example, to print "`the answer = 5`", use the commands:

```
.data
str: .asciiz "the answer = "
.text
    li $v0, 4       # $system call code for print_str
    la $a0, str     # $address of string to print
    syscall         # print the string

    li $v0, 1       # $system call code for print_int
    li $a0, 5       # $integer to print
    syscall         # print it
```

- **print int** passes an integer and prints it on the console.
- **print float** prints a single floating point number.
- **print double** prints a double precision number.
- **print string** passes a pointer to a null-terminated string
- **read int**, **read float**, and **read double** read an entire line of input up to and including a newline.
- **read string** has the same semantics as the Unix library routine fgets. It reads up to n - 1 characters into a buffer and terminates the string with a null byte. If there are fewer characters on the current line, it reads through the newline and again null-terminates the string.
- **sbrk** returns a pointer to a block of memory containing *n* additional bytes.
- **exit** stops a program from running.