CSI 333 – Fall 2011

Programming Assignment V

Administrative Information

- **Individual project**.
- **Deadline:** 11 PM, Monday, Dec. 5, 2011.
  Submissions won't be accepted after this deadline.
- The assignment has two parts (Parts (a) and (b)).
  Both parts must be done in MAL.
- The source files for the two parts must be named `p5a.mal` and `p5b.mal` respectively.
- The two source files must be submitted **together** using the `turnin-csi333` command.
- README file will be available by 10 PM on Sunday, Nov. 20, 2011.

Administrative Information (continued)

Important Remarks:

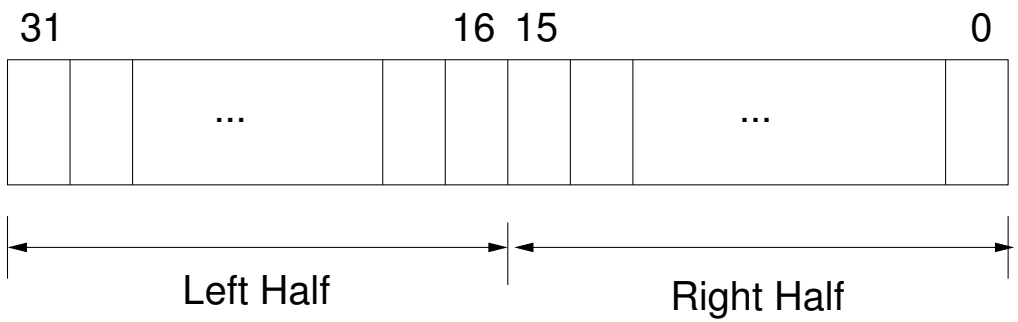
- There is no two-day grace period for this program.
- Programs for which the `spim` system reports syntax or runtime errors won't receive any credit.
- Your program must work correctly on `itsunix.albany.edu`.

- **Weightage:** 10%
- **Total Points:** 100
  - **Part (a)**: 40 points (34 points for correctness and 6 for documentation).
  - **Part (b)**: 60 points (52 points for correctness and 8 for documentation).

Description of Part (a)

Remarks:

- A **positive** integer is one that is *strictly* greater than zero.
- An integer x **evenly divides** an integer y if the remainder when y is divided by x is zero.
- In MIPS, each integer is stored using 32 bits.



Description of Part (a) (continued)

Goal: To read a positive (decimal) integer and compute the following values:

- The number of 1's in the *right half* of the binary representation of the integer.
- The number of 0's in the *left half* of the binary representation of the integer.
- The highest power of 2 that evenly divides the integer.
- The value of the largest digit in the decimal representation of the integer.

Description of Part (a) (continued)

Example: Consider the decimal integer 1536.

- The 32-bit binary representation for 1536 is:

  0000 0000 0000 0000 0000 0110 0000 0000

  (The 16 bits in the left half are all zero.)

- The number of 1's in the right half = 2.
- The number of 0's in the left half = 16.
- Since $1536 = 3 \times 2^9$, the largest power of 2 that evenly divides 1536 is 9. (This value 9 is also the number of 0's at the end of the binary representation of 1536.)
- The value of the largest digit in the decimal representation = 6.

Description of Part (a) (continued)

Program Outline:

1. Prompt the user for a positive integer.

2. Read the integer.

3. Compute the four quantities mentioned above
   and print the answers.

4. Stop.

Note: Each time your program for Part (a) is executed, it should handle **just one integer**.

Examples of Program Execution for Part (a)

```
unix2> /usr/local/bin/spim

   .
   .   <---  Initial lines printed by spim.
   .

(spim) read "p5a.mal"
(spim) run
Positive integer?  1536
No. of 1's in the right half =  2
No. of 0's in the left  half = 16
Largest power of 2           =  9
Largest decimal digit        =  6
(spim) quit
unix2>
```

Examples of Program Execution ... (continued)

```
unix2> /usr/local/bin/spim

   .
   .   <---  Initial lines printed by spim.
   .

(spim) read "p5a.mal"
(spim) run
Positive integer?  123
No. of 1's in the right half =  6
No. of 0's in the left  half = 16
Largest power of 2           =  0
Largest decimal digit        =  3
(spim) quit
unix2>
```

Additional Remarks for Part (a)

- You can assume that the user will type a positive integer. No error checks are needed.
- There is *no need* to convert the integer to binary; when the integer is read in (using `syscall`), it is already in binary form.
- Use bitwise operations to count the number of 1's (0's) in the right (left) half.
- To find the highest power of 2 that divides the integer, count the number of 0's at the end of the binary representation or use successive divisions by 2.
- To extract the decimal digits and compute the largest digit, use successive divisions by 10.

Description of Part (b)

Goal: To read a line of text and output the following information:

- The number of non-whitespace characters in the line.
- The number of words in the line.
- The maximum length of a word in the line.
- The minimum length of a word in the line.
- The word of maximum length in the line.
- The word of minimum length in the line.

Description of Part (b) (continued)

Remarks:

- A **whitespace** character refers to a space, a tab or the newline character.
- A **word** is any sequence of characters that does not contain a whitespace character.
- Assume that the line typed by user has at most 80 characters, including the `'\n'` character. (There is no need to check this condition.)
- If there are two or more words of maximum length in the line, then the program should print the word of maximum that appears *first* in the line.
- A similar comment applies to the word of minimum length.

Description of Part (b) (continued)

Example: Suppose the input line is:

```
This  example  contains  five words.
```

- No. of non-whitespace characters: 29
- No. of words: 5
- Maximum length of a word: 8
- Minimum length of a word: 4
- Word of maximum length: `contains`
- Word of minimum length: `This`

Note: In the above example, there are two words of minimum length (namely, `"This"` and `"five"`). The word that occurs first is `"This"`.

Description of Part (b) (continued)

Outline for Part (b):

```
1. Prompt the user for a line of text.

2. Read the line of text.

3. If the line has only whitespace characters
      Print a suitable message and stop.
   Else
      Compute the required quantities, print the
      answers and stop.
```

Notes:

- Each time your program for Part (b) is executed, it should handle **just one line** of input.
- Except for checking for a blank line, no error checks are needed.

Examples of Program Execution for Part (b)

```
unix2> /usr/local/bin/spim

   .
   .   <---  Initial lines printed by spim.
   .

(spim) read "p5b.mal"
(spim) run
Text? A   short   line.
No. of non-whitespace characters:  11
No. of words:  3
Maximum length of a word: 5
Minimum length of a word: 1
Word of maximum length: short
Word of minimum length: A
(spim) quit
unix2>
```

Examples of Program Execution ... (continued)

```
unix2> /usr/local/bin/spim

   .
   .   <---  Initial lines printed by spim.
   .

(spim) read "p5b.mal"
(spim) run
Text? This   example   contains  five    words.
No. of non-whitespace characters:  29
No. of words:  5
Maximum length of a word: 8
Minimum length of a word: 4
Word of maximum length: contains
Word of minimum length: This
(spim) quit
unix2>
```

Remarks and Suggestions for Part (b)

- For Part (b), your MAL program must have **at least one function in addition to** the main program.
- Study Lecture 15 (in particular, the material on arrays of character in MAL) before working on Part (b).
- You may find it useful to write a function that returns information (e.g. starting and ending indices) about the next word.

Program Grading and Other Notes

- Programs will be graded using a script written by the TAs.
- The script will compile your source program, generate the executable version and run the executable on new test data.
- The TAs will grade the version that you submit; once the submission is closed, you won't be allowed to make any changes to your program.
- You must follow the programming and documentation guidelines indicated in "Course Policies".