# Lab 5, Spring 2019

Using Stacks and Recursive Functions

### Important:

* Please comment your function and separate, with blank lines, stack management code (prologue/epilogue)

code from body code.

In this lab, you will first write a few (non-recursive) functions that use the stack. In the second part, you will have to write recursive functions. **Functions must comply with MIPS calling conventions**, such as:

1. Pass parameters via the $a\* registers.
2. Put the return value in $v\* registers.
3. Save registers on the stack as necessary (i.e., if your function uses any $s\* registers, it should save and

restore $s\* registers using a prologue/epilogue).

1. Save $ra on the stack, if the function is a non-leaf function.

# Using Stacks

In this part, we will write a string manipulation function. Recall that strings are ASCII-encoded bytes that are terminated with a NULL character (0x0). You are required to write a program that randomly replaces 5 characters with ‘@’. The input string is at least 10 characters long and atmost 63 characters long (excluding the NULL character). Additionally, it will not contain any ‘@’ when it is entered by the user. You can declare a buffer as follows to store the input string from the user:

.data

input\_str: .space 64

Once you receive the string, you will have to find it’s length, *N* . To randomly replace a character of this string with ‘@’, you will have to generate a random number *x* in the range 0 to (*N -* 1). **Hint: You can generate a random number using a syscall. Check the help menu in MARS.** This random numberwill be used as the index for the next character to be replaced. The procedure of generating a random number and replacing a character with ‘@’ should be done 5 times. *Note:* If the generated random number points to a character that is already ‘@’, then you need to regenerate a random number unless it points to a character that is not ‘@’. Make sure there are five random ‘@’s in your output. For the same input string, the output string can be different each time you run the program because of the randomness. The output format is shown in the sample output:

Enter your string?

University of Pittsburgh *←* input from user (no need to print)

Here is your output:

Un@versity@of Pi@ts@u@gh

Because of the random indexes, another output of the same program could be:

Here is your output:

Unive@@ity of Pi@tsb@r@h

University of Pittsburgh

Enter your string:

For submission, name your solution file as **lab5part1\_username.asm**. **Please do not forget the ‘.asm’ extension and do not use any upper-case letter in the filename.**

# Recursive Functions (Fibonacci Sequence)

The Fibonacci sequence is a special sequence of numbers discovered by mathematician Leonardo Fibonacci. In the Fibonacci sequence, each number is the sum of the two previous numbers. Its function can be defined as following:

Fibonacci(n) = Fibonacci(n − 1) + Fibonacci(n − 2), if (n > 2)

Fibonacci(n) = 1, if (n <= 2)

Example:

|  |  |
| --- | --- |
| Fibonacci(1) | 1 |
| Fibonacci(2) | 1 |
| Fibonacci(3) | 2 |
| Fibonacci(4) | 3 |
| Fibonacci(5) | 5 |
| Fibonacci(6) | 8 |

The Fibonacci sequence function can expressed recursively, as shown in the following pseudo-code:

int Fibonacci(int n) { if (n <= 2) {

return 1; //The base case stops the recursion

}

else {

return Fibonacci(n-1)+Fibonacci(n-2); }

}

In this part, we will translate the Fibonacci function into MIPS assembly. You are required to write a program to achieve calculating the sum of two values which belong to Fibonacci sequence. There are two input numbers from the user in this program, and these two numbers are the index of the Fibonacci sequence. You should calculate the Fibonacci value for each index and the sum of the two Fibonacci values.

### Your code must call itself recursively (TAs will explicitly check for ‘jal’ instructions inside the func- tion). If you do not recursively call your function, you will receive no credit!

Enter the first index:

5

Enter the second index:

6

The sum of two Fibonacci values is:

13

For submission, name your solution file **as lab5part2\_username.asm. Please do not forget to put the ‘.asm’ extension**

**and do not use any upper-case letter in the filename.**