

# CS F342

## Computer Architecture

Semester 1 – 2020 - 21

### Lab Sheet 6

**Goals for the Lab:** We build up on prior labs and explore basics of functions and recursion.

**Background:**

- Calling a subroutine is between a *caller*, who makes the subroutine call, and the *callee*, which is the subroutine itself.
- The caller passes arguments to the callee by placing the values into the argument registers **\$a0-\$a3**.
- The caller calls **jal** followed by the label of the subroutine. This saves the return address in **\$ra**. The return address is PC + 4, where PC is the address of the jal instruction. If the callee uses a frame pointer, then it usually sets it to the stack pointer. The old frame pointer must be saved on the stack before this happens.
- The callee usually starts by pushing any registers it needs to save on the stack. If the callee calls a helper subroutine, then it must push \$ra on the stack. It may need to push temporary (**\$t0-\$t7**) or saved registers (**\$s0-\$s7**) as well.
- Once the subroutine is complete, the return value is placed in **\$v0-\$v1**. The callee then calls **jr \$ra** to return back to the caller.

**Exercise 1 – With Sample Code:** Study the code given below.

```
.data
    line: .asciiz "\n"
    print_str: .asciiz "value of $s0: "
.text

main:

    li $a0,10
    la $a1, print_str
    la $a2, line
    jal increase_the_value #function to increase the value of $s0 by 10 and print

    jal print_value #function to print value stored in $a0

    li $v0,10
    syscall

# cont .. to next page
```

increase\_the\_value:

addi \$sp,\$sp,-8 *#4 bytes for each value*

sw \$a0,\$sp *#call by value*

sw \$ra,4(\$sp) *#since we are having nested procedure, which will overwrite the current value of \$ra*

addi \$a0,\$a0,10

jal print\_value *#print\_value is a nested procedure*

lw \$a0,\$sp *#restore the value of \$a0, main function should get old value of \$a0*

lw \$ra,4(\$sp) *#restore the value of \$ra*

addi \$sp,\$sp,8

jr \$ra

print\_value:

addi \$sp,\$sp,-4 *#Since \$a0 will be used to print the string, its original value would be lost*

sw \$a0,\$sp *#saving the original value of \$a0(as received by this procedure)*

*#since we are not calling any other procedure in this procedure value of \$ra wouldnt change, hence no need to store it in stack*

move \$a0,\$a1

li \$v0,4

syscall

lw \$a0,\$sp

li \$v0,1

syscall

move \$a0,\$a2

li \$v0,4

syscall

lw \$a0,\$sp

addi \$sp,\$sp,4

jr \$ra

**Exercise 2:** Write a function to count the number of vowels in a given string and also return the string after removing the vowels and print that string in main function. Call the function twice with two different strings.

Input : String (without space)

Output : Single integer

**Exercise 3:** Write a program that asks if the user wants a triangle or a square. It then asks the user for the size of the object (the number of lines it takes to draw the object). The program then writes a triangle or a square of stars "\*" to the console.

```

*****
*****
*****
*****
*****
*****

```

or

```

*
**
***
****
*****
*****

```

Write a subroutine for each figure. In them, use a subroutine **print\_star\_line** that writes a line of a given number of stars. (that number is passed as an argument to **print\_star\_line** function).

### Take home assignment:

Print the pyramid as:

```

      *
     **
    ***
   ****
  *****
 *****
*****

```

**Exercise 4:** Find Factorial of a given integer recursively. Take care of the base case.

**Exercise 5:** Disassemble the following hex instructions.

- 02002009
- 03e00008
- 0c100013