Course Name: Computer Architecture Lab

Course Number and Section: **14:332:333:02**

Experiment: Lab 2 – Control Flow (loops and branches), Inputs & Outputs, and Making Decisions

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Purpose

This laboratory exercise taught me how to use flow control in MIPS as well as input and output data to the user. Branching and loops were used extensively and are important for more complex problems. User input and output were extremely important in providing an interface to interact with the program. By providing instructions to the user and by getting the user inputs, the interaction between the user and the program is clear and successful. String manipulation is another part of this lab that requires getting the character from the string and knowing how to increment to the next element like with an array. Throughout all this, decision making based on the values (such as ending when the char is the end of the string, branching when a number is less than another number, etc), determined the branching and what actions to take to complete the program.

Approach

For reading and printing, “syscall” is used. For syscall to know what to do, $v0 must be loaded with a code. When reading values, the value the user inputs is put into $v0 and to put it into a register, one must use “move $t0, $v0” so the value is stored in $t0. The codes below specify what syscall will do:

$v0 code	What it does	Arguments needed
1	Print int	Value in $a0
2	Print float	Value in $f12
3	Print double	Value in $f12
4	Print string	Value in $a0
5	Read int	-
6	Read float	-
7	Read double	-
8	Read string	Addr. to store $a0 No. of char $a1
9	Memory allocation	Bytes storage $a0

10	Exit program	
11	Print character	Integer in $a0
12	Read character	

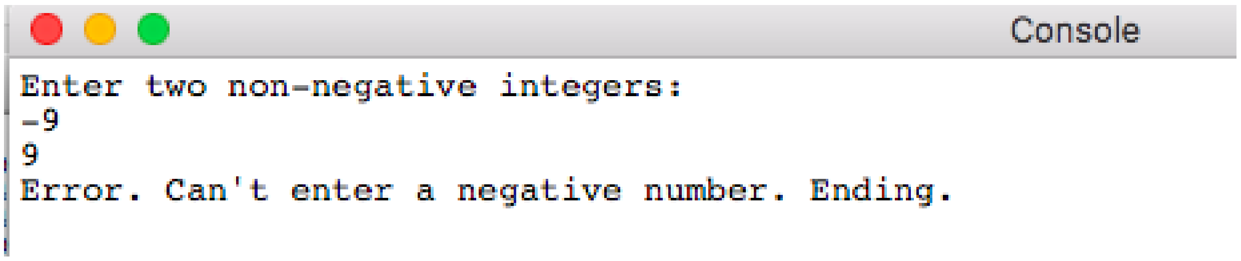
Other concepts used are branching, such as beq, beqz, bne, etc, which branch off into other sections. To return to the loops, using “j loop” with loop as the loop name returned it to the top of that loop. Loops were used extensively to continuously get user data, to iterate through all characters of a string, and to sort arrays, just to name a few.

Loops, array and string element retrieval, and conditionals were a huge part of these assignments as well as eliminating user inputs for being negative, being too large, or for not being made of just letters.

<u>Results (and screenshots of program results)</u>

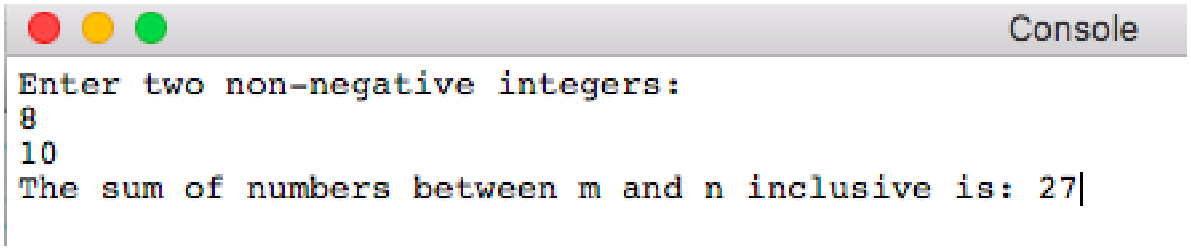
<u>Assignment 1</u> – code attached

Below: the program rejects any negative number



```
Enter two non-negative integers:
-9
9
Error. Can't enter a negative number. Ending.
```

Below: Showing the added result (8+9+10 = 27)

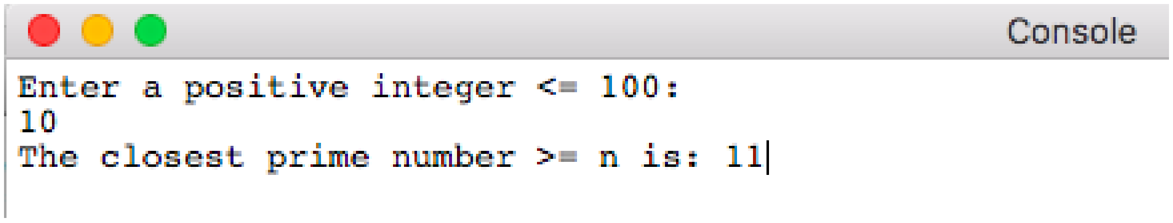


```
Enter two non-negative integers:
8
10
The sum of numbers between m and n inclusive is: 27
```

I tested the program for other values as well and the sum of the numbers between m and n inclusive is correct.

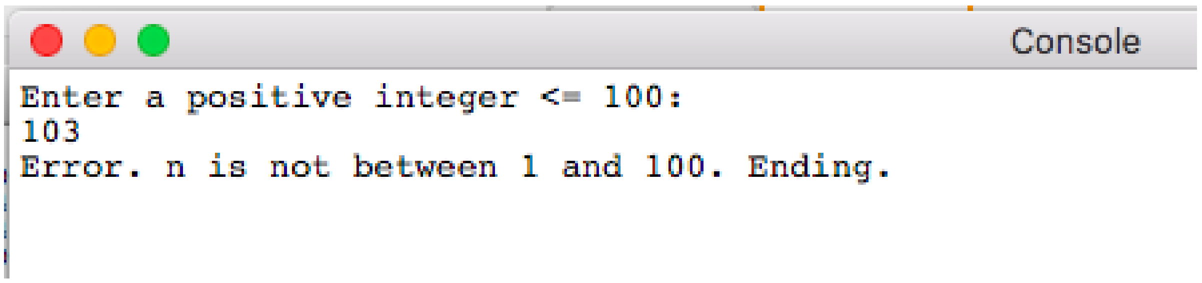
Assignment 2 – code attached

Below: example of program finding closest prime number



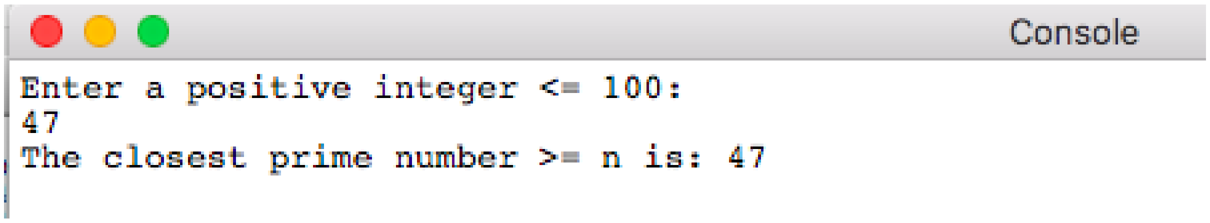
```
Enter a positive integer <= 100:
10
The closest prime number >= n is: 11
```

Below: example of program rejecting number above 100 (rejects below 1 as well)



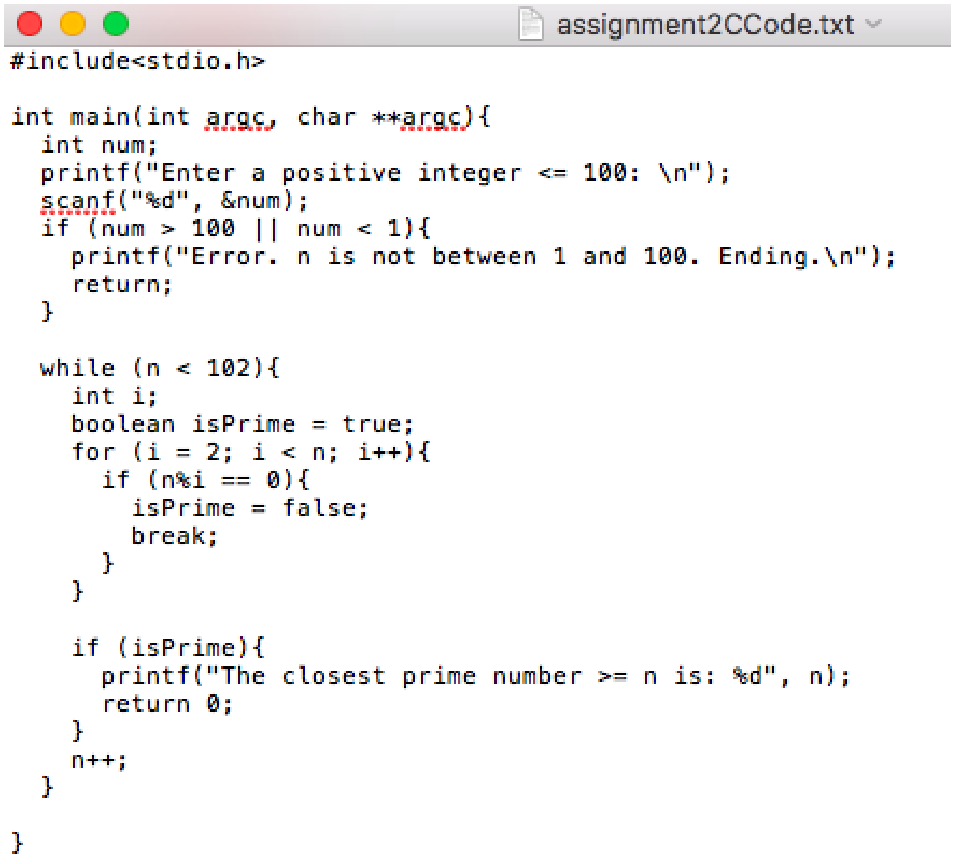
```
Enter a positive integer <= 100:
103
Error. n is not between 1 and 100. Ending.
```

Below: example of program knowing number entered is prime



```
Enter a positive integer <= 100:
47
The closest prime number >= n is: 47
```

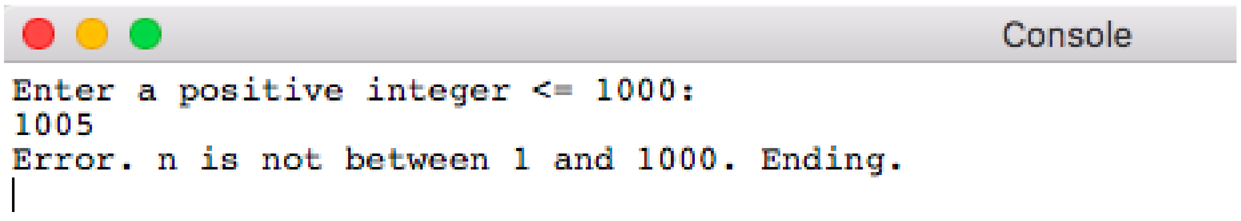
Assignment 2 C code/pseudocode:



```
#include<stdio.h>

int main(int argc, char **argc){
  int num;
  printf("Enter a positive integer <= 100: \n");
  scanf("%d", &num);
  if (num > 100 || num < 1){
    printf("Error. n is not between 1 and 100. Ending.\n");
    return;
  }

  while (n < 102){
    int i;
    boolean isPrime = true;
    for (i = 2; i < n; i++){
      if (n%i == 0){
        isPrime = false;
        break;
      }
    }

    if (isPrime){
      printf("The closest prime number >= n is: %d", n);
      return 0;
    }
    n++;
  }

}
```

Assignment 3 – code attached

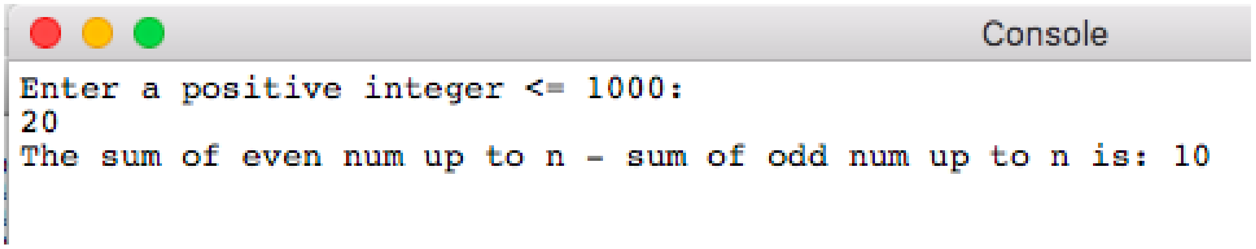
Below: program ending if not in the range



```
Enter a positive integer <= 1000:
1005
Error. n is not between 1 and 1000. Ending.
```

Below: Program running with n = 20

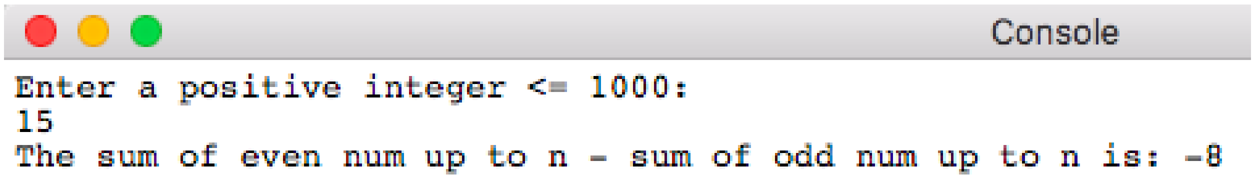
Check: (2+4+6+8+10+12+14+16+18+20)-(1+3+5+7+9+11+13+15+17+19) = 10



```
Enter a positive integer <= 1000:
20
The sum of even num up to n - sum of odd num up to n is: 10
```

Below: Program running with n = 15

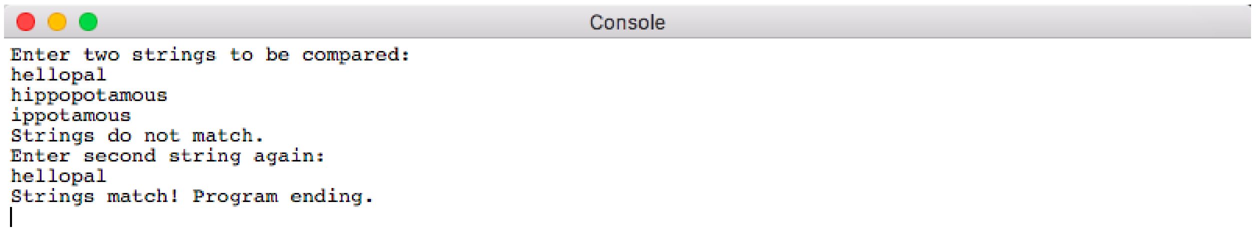
Check: (2+4+6+8+10+12+14)-(1+3+5+7+9+11+13+15) = -8



```
Enter a positive integer <= 1000:
15
The sum of even num up to n - sum of odd num up to n is: -8
```

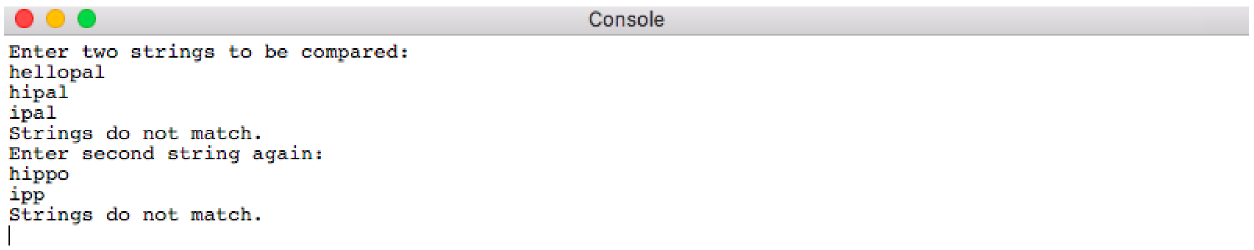
Assignment 4 – code attached

Below: not matching at first, then matches on second time



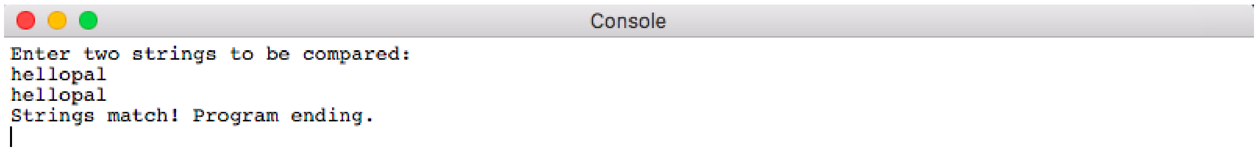
```
Enter two strings to be compared:
hellopal
hippopotamous
ippotamous
Strings do not match.
Enter second string again:
hellopal
Strings match! Program ending.
```

Below: not matching twice and program ending



```
Enter two strings to be compared:
hellopal
hipal
ipal
Strings do not match.
Enter second string again:
hippo
ipp
Strings do not match.
```

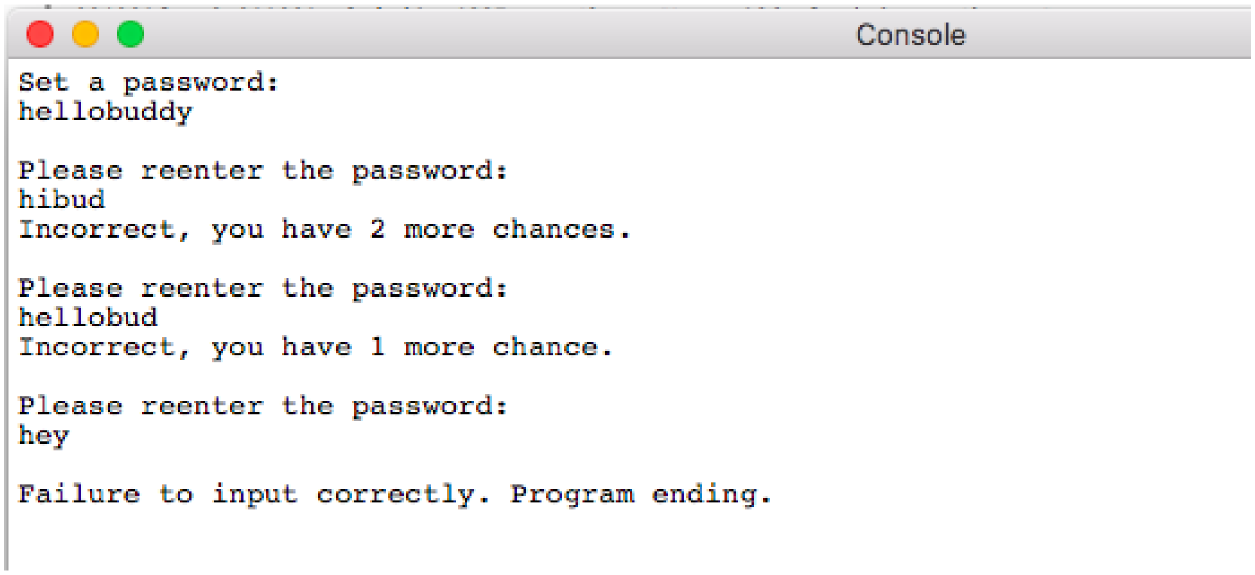
Below: two strings matching immediately



```
Enter two strings to be compared:
hellopal
hellopal
Strings match! Program ending.
```

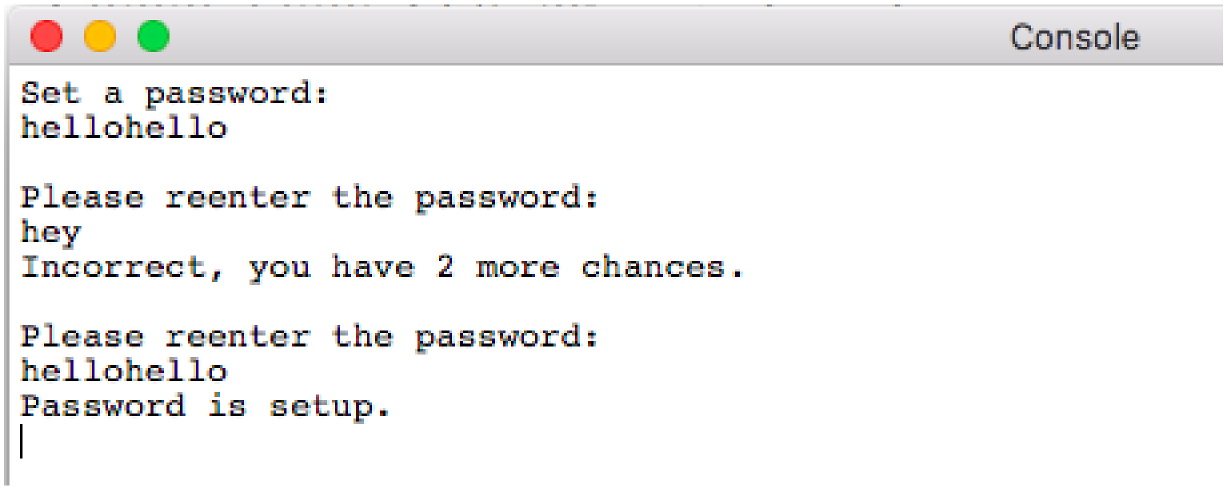
Assignment 5 – code attached

Below: First password entry fit criteria, and three failed reentries



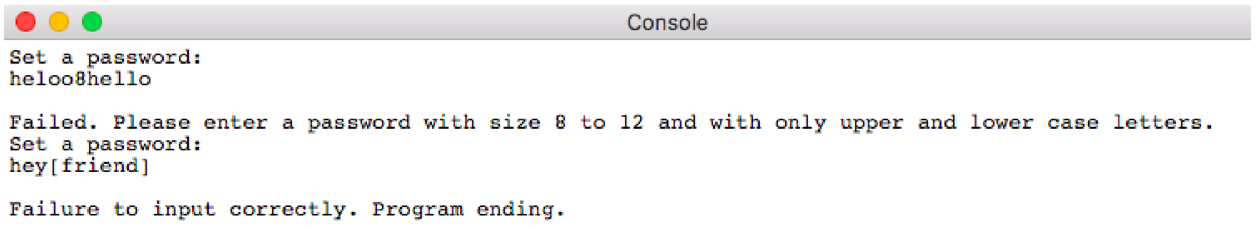
```
Set a password:
hellobuddy

Please reenter the password:
hibud
Incorrect, you have 2 more chances.

Please reenter the password:
hellobud
Incorrect, you have 1 more chance.

Please reenter the password:
hey

Failure to input correctly. Program ending.
```

Below: Good first password setting, then one incorrect reentry before correctly entered



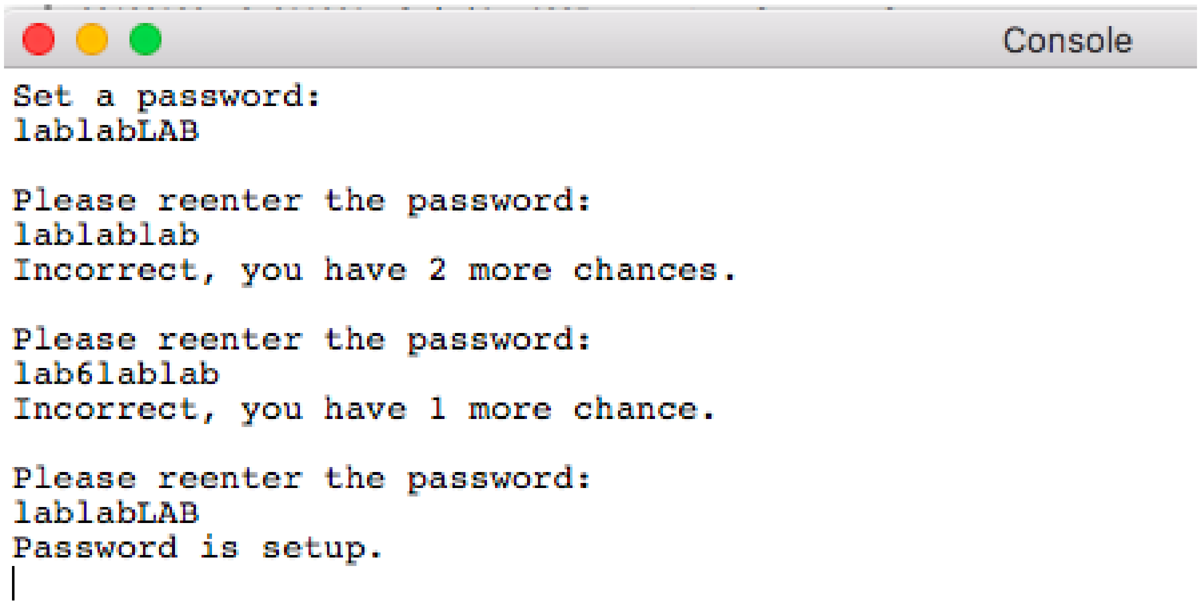
```
Set a password:
hellohello

Please reenter the password:
hey
Incorrect, you have 2 more chances.

Please reenter the password:
hellohello
Password is setup.
```

Below: failure twice to enter in good password because of non-letter entry, program ended



```
Set a password:
heloo8hello

Failed. Please enter a password with size 8 to 12 and with only upper and lower case letters.
Set a password:
hey[friend]

Failure to input correctly. Program ending.
```

Below: Good password and two failed reentries before correct entry

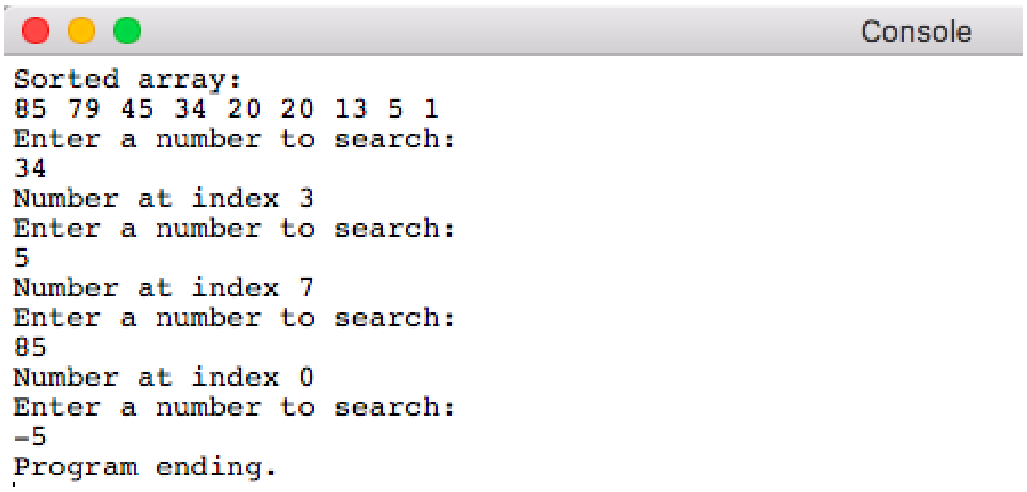


```
Set a password:
lablabLAB

Please reenter the password:
lablablab
Incorrect, you have 2 more chances.

Please reenter the password:
lab6lablab
Incorrect, you have 1 more chance.

Please reenter the password:
lablabLAB
Password is setup.
```

Assignment 6 – code attached

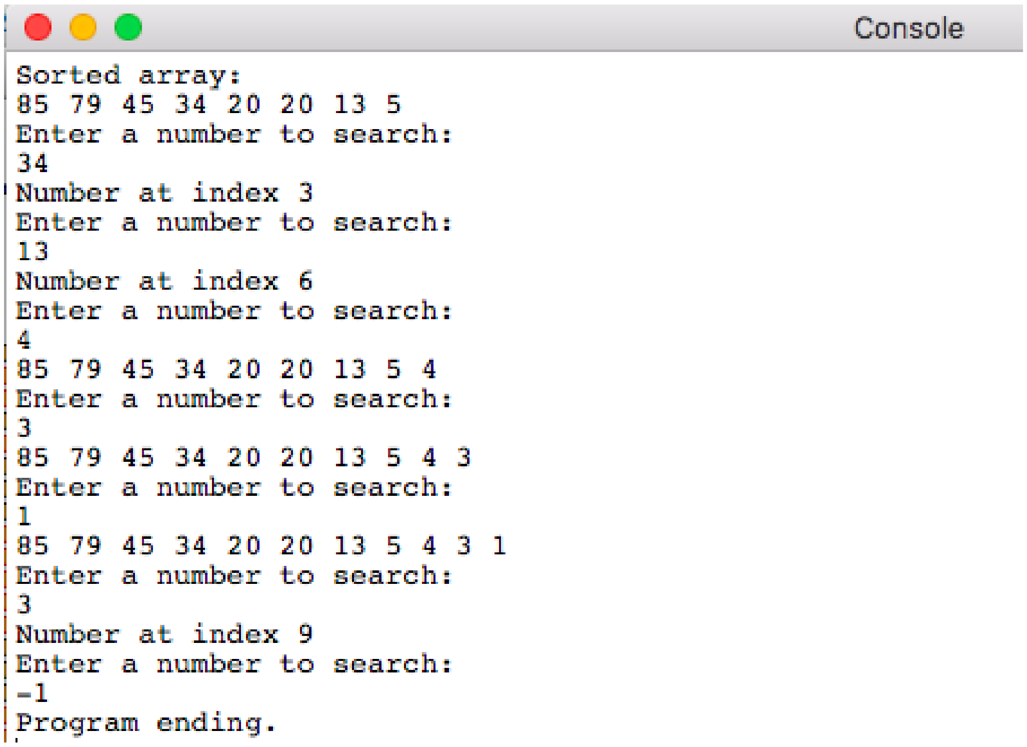
Original array → array: .word 45, 85, 34, 79, 13, 20, 20, 5, 0xF

Below: sorted array displayed and searching for numbers present working, ending at negative number entry



```
Sorted array:
85 79 45 34 20 20 13 5 1
Enter a number to search:
34
Number at index 3
Enter a number to search:
5
Number at index 7
Enter a number to search:
85
Number at index 0
Enter a number to search:
-5
Program ending.
```

Below: Searching and inserting numbers



```
Sorted array:
85 79 45 34 20 20 13 5
Enter a number to search:
34
Number at index 3
Enter a number to search:
13
Number at index 6
Enter a number to search:
4
85 79 45 34 20 20 13 5 4
Enter a number to search:
3
85 79 45 34 20 20 13 5 4 3
Enter a number to search:
1
85 79 45 34 20 20 13 5 4 3 1
Enter a number to search:
3
Number at index 9
Enter a number to search:
-1
Program ending.
```

Conclusion

Assignment 1 required user input for the bounds of the sum and the use of loops to sum up all the numbers in between the bounds. Then, the result was outputted using syscall and $v0 as well. In Assignment 2, conditionals were used to make sure the number was within the specified range of 1-100 inclusive, and then the closest prime was found by looping from that number until 102 (because 101 is the nearest prime number to 100) and dividing the numbers by all numbers before to check if it was prime. Assignment 3 required using “jal” to go to loops and return using “jr $ra” because of the use of multiple loops, one for adding all even numbers and one for all odd numbers. Assignment 4 taught how to get specific characters from a string and how to traverse the string. Assignment 5 continued with string manipulation, but included criteria to check for other than mismatches characters. It required checking the char ascii ranges to make sure the characters in the password string were only letters. Then, the password has to be matched and three overall chances were given to let the user enter it again. Finally, Assignment 6 taught how to sort an array using two for loops and swapping with the sw command, how to search through an array, and how to insert into an array. Overall, I learned string manipulation, array searching and adding, and prime checking. I also interacted with the user by taking in user inputs and by outputting commands and status updates.