

CS101- Algorithms and Programming I

Lab 05

Lab Objectives: `for` and `do-while` loops

- For all labs in CS 101, your solutions must conform to these [CS101 style guidelines](#) (rules!)
 - Create a Lab05 workspace (i.e. the folder `H:\private\cs101\lab05`). This assignment has parts a, b, c, and d, each of which should be placed in a separate project within the same Lab05 workspace. Note: only one project is active at a time. To work (Build/Run) a different project, right click on the project's name and select "Set as active project".
 - You can only use `for` and `do-while` statements for repetition purposes in this lab assignment. You cannot use `while` statements. You are not allowed to use arrays or any data structures to store user input.
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- a. Bran has a string of lower and upper characters in range `ascii ['a'..'z' 'A'..'Z']`. He wants to reduce the string to its shortest length by doing a series of operations. In each operation he selects a pair of adjacent letters that match, and he deletes them. For instance, the string "aab" is shortened to "b" in one operation, so is "Aab". (It should be case-insensitive, meaning 'A' and 'a' should mean the same thing.) Another example is that "aaabba" is reduced to empty-string in three operations.

Create a new project Lab05a and help Bran to delete as many characters as possible using this method and print the resulting string. If the final string is empty, print "Empty String". After that you also have to print the reverse of the final string if it is not empty. You will input the string from the user. See the sample runs below.

Sample Runs:

```
> run Lab05a
Please enter a string: aa
---> Empty String
The final string is empty.
> run Lab05a
Please enter a string: aaabccddd
---> abd
Reverse: dba
> run Lab05a
Please enter a string: baab
---> Empty String
The final string is empty.
> run Lab05a
Please enter a string: baxab
---> baxab
Reverse: baxab
> run Lab05a
Please enter a string: aabAbCcBaAf
---> bAf
Reverse: fAb
```

- b. Remember the Fibonacci series question you solved in Lab01. Of course you do :D It was a cool question. We were able to find the n th Fibonacci number in constant time. Now, you are expected to use *for* loop to solve this question. Create a new project Lab05b. Write a program that takes an integer, n , and calculate and print the sequence up to n th Fibonacci number (inclusive). Note that Fibonacci numbers are defined by the sequence

$$F_0 = 0$$

$$F_1 = 1$$

$$F_n = F_{n-1} + F_{n-2}, n > 1$$

You should validate the user input as shown in the sample runs. Try to find $F(47)$ and $F(48)$. Have you noticed anything unusual? Why do you think this happens?

Sample runs:

```
> run Lab05b
Please enter a value for n: 
Invalid value has been entered.
Please enter a value for n: 
Invalid value has been entered.
Please enter a value for n: 
Fib(0) = 0
Fib(1) = 1
Fib(2) = 1
Fib(3) = 2
Fib(4) = 3
Fib(5) = 5
Fib(6) = 8
Fib(7) = 13
Fib(8) = 21
Fib(9) = 34
Fib(10) = 55
Fib(11) = 89
Fib(12) = 144
Fib(13) = 233
Fib(14) = 377
Fib(15) = 610
```

- c. Create a new project Lab05c. Design and implement a program that uses *for* loops to print the following rectangular pattern with a user specified width, height and wall thickness. Check the values entered by the user and, (a) simply output an error message (& stop) if any of the values are invalid (i.e not positive), and (b) display the rectangle but print a warning message if it does not have a hole in the middle!

Once this is working, modify your program so that, after outputting the pattern, it will ask the user if they wish to create another pattern and, if the user responds 'Y' or 'y', does so --any other response causing the program to print the message "goodbye" and stop.

Sample Run:

```
> run Lab05c
Enter a width, height & thickness: 5 6 0
Error: all values must be positive!
Enter Y or y to continue : y
Enter a width, height & thickness: 10 8 3
*****
*****
*****
***      ***
***      ***
*****
*****
*****
Enter Y or y to continue : Y
Enter a width, height & thickness: 5 6 2
*****
*****
** **
** **
*****
*****
Enter Y or y to continue : y
Enter a width, height & thickness: 4 4 3
****
****
****
****

Oops... no hole!
Enter Y or y to continue : n
goodbye
```

- d. Create a new project Lab05d. Write a menu driven program, that asks the user to provide their selection. If any response given other than the “Strings”, “Math”, and “Exit” (case-insensitive), the program should ignore that response and should continue to ask a valid selection.

If the selection is “strings”, it should input two Strings from the user and check whether the given two Strings are *semazen-strings*. Assume that you have two Strings s1 and s2. If one can be generated by rotating the other one on the right side, they are called *semazen-strings*. *Note that you may not use indexOf() or lastIndexOf() in this question. You are expected use for loop for iteration purposes.* For example if s1 = "BilkentMETU" and s2 = "TUBilkentME" then your program should print “They are semazen-strings”, if not show the common characters in both Strings. It should be case-insensitive, meaning ‘A’ and ‘a’ should mean the same thing. There should be no duplicates, even if ‘a’ is found more than once, it should be displayed only once.

If the selection is “math”, we will use one of the very famous equations you used in high school. Do you remember the sum of infinite geometric series if the common ratio is r and $-1 < r < 1$? See the formula below.

$$S = \sum_{i=0}^{\infty} a_i r^i = \frac{a_1}{1 - r}$$

[note: if $|r| \geq 1$, the infinite series does not have a sum]

According to the formula, when $a = 1$ and $r = 1/2$

$$\begin{aligned} S &= 1 + 1/2 + 1/4 + 1/8 + 1/16 + \dots \\ &= 2 \end{aligned}$$

You will prove this is the case. You will take ‘a’ being the first term, and ‘r’ being the common ratio from the user. As you can understand r should be a real value between -1 and 1 (exclusive), and a precision, a small positive real value less than 1. Open the summation formula above and try to compute approximate value using the inputs. Your program stops calculation whenever the increment is less than given precision value. Try different common ratios. Do compute it using the formula in a paper and compare with the result of your program.

If the selection is “exit”, the program should say Goodbye and exit. See the sample runs below.

Sample runs:

```
> run Lab05d
**** Make your selection ****
Strings
Math
Exit
Your selection: 
** Semazen-Strings **
Enter a string: 
Enter another string: 
They are semazen-strings.

**** Make your selection ****
Strings
Math
Exit
Your selection: 
** Semazen-Strings **
Enter a string: 
Enter another string: 
Common characters: m e c n u i l y a

**** Make your selection ****
Strings
Math
Exit
Your selection: 
Goodbye!

> run Lab05d
**** Make your selection ****
Strings
Math
Exit
Your selection: 
** Infinite Geometric Sum Calculation **
Enter an r: 
Enter an a: 
Enter precision: 
Current result is: 1.0
Current result is: 0.5
Current result is: 0.75
Current result is: 0.625
Current result is: 0.6875
Current result is: 0.65625
Current result is: 0.671875
Current result is: 0.6640625
Current result is: 0.66796875
Current result is: 0.666015625
Current result is: 0.6669921875
Result is: 0.6669921875
**** Make your selection ****
Strings
Math
Exit
Your selection: 
```

The rest of the second sample run above is as follows:

```
Your selection: 
** Infinite Geometric Sum Calculation **
Enter an r: 
Enter an a: 
Enter precision: 
Current result is: 1.0
Current result is: 1.5
Current result is: 1.75
Current result is: 1.875
Current result is: 1.9375
Current result is: 1.96875
Current result is: 1.984375
Current result is: 1.9921875
Current result is: 1.99609375
Current result is: 1.998046875
Current result is: 1.9990234375
Current result is: 1.99951171875
Current result is: 1.999755859375
Current result is: 1.9998779296875
Current result is: 1.99993896484375
Current result is: 1.999969482421875
Current result is: 1.9999847412109375
Current result is: 1.9999923706054688
Current result is: 1.9999961853027344
Current result is: 1.9999980926513672
Current result is: 1.9999990463256836
Result is: 1.9999990463256836
**** Make your selection ****
Strings
Math
Exit
Your selection: 
Goodbye!
```