

Department of Computer Science and Engineering  
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Data Structures and Algorithms Lab  
Assignment 2

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**Problem 1**

Implement a stack class that supports PUSH, POP, ISEMPTY, TOP using an array. The stack should be implemented in such a way that it can take any number of elements and the PUSH operation is performed in amortized  $O(1)$  time.

Using the above implemented stack class, implement a queue using a two stacks. Your queue should support ENQUEUE, DEQUEUE, ISEMPTY and FRONT commands. In your report, please analyze the number of stack commands required to perform the corresponding queue command.

**Problem 2**

Infix and postfix notations are two different ways of writing arithmetic expressions. Please see the URL below for more details on the two notations.

<http://www.cs.man.ac.uk/~pjj/cs2121/fix.html>

Write a program to evaluate infix expressions using stacks. Your program should read the expression as input and evaluate it in a single pass.

(**Hint:** You have to use the infix to postfix conversion algorithm and postfix evaluation algorithm using two stacks - one stack for the operands and one stack for the operators. The infix to postfix conversion algorithm is explained in the following URL:

<http://csis.pace.edu/~wolf/CS122/infix-postfix.htm>

The postfix evaluation algorithm is explained in the following URL:

[http://scriptasylum.com/tutorials/infix\\_postfix/algorithms/postfix-evaluation/](http://scriptasylum.com/tutorials/infix_postfix/algorithms/postfix-evaluation/))

The infix expression can contain

1. Integers
2. Function  $f(a, b, c)$  (defined below) where  $a, b$  and  $c$  are non-negative integers.
3. '+' and '\*' operators
4. '(' and ')' parentheses.

As usual,  $*$  operator has higher precedence than  $+$  operator. Both  $*$  and  $+$  are left associative.

Function  $f(a, b, c)$  where  $a, b, c$  are non-negative integers and  $a \leq b \leq c$  is defined as follows:

$$f(a, b, c) = 3 \text{ if } c \leq a + 1.$$

Otherwise

$$f(a, b, c) = u + f(a, \left\lceil \frac{a+b}{2} \right\rceil, b) + f(b, \left\lfloor \frac{b+c}{2} \right\rfloor, c)$$

where

$$u = \begin{cases} 3 & \text{if } a \text{ is even and } c \text{ is even} \\ -7 & \text{if } a \text{ is odd and } c \text{ is even} \\ 4 & \text{if } a \text{ is odd and } c \text{ is odd} \\ -5 & \text{if } a \text{ is even and } c \text{ is odd} \end{cases}$$

Implement  $f$  as a separate function that takes as input  $a, b$  and  $c$ . Your implementation should not make any recursive calls and it should use a stack to evaluate  $f(a, b, c)$ . (Hence, your final program will have three stacks in total - two for the infix expression evaluation and one for evaluating  $f$ )

Following is a sample input for the program:

$$2 + 3 * (5 + f(2, 5, 9) + (-7 + 25 + f(12, 15, 20) * 2)) * 10 + -100$$

While scanning the input, when an  $f$  function is encountered, evaluate  $f$  and use its value as operand in the infix expression evaluation procedure.