Data Structures TD1 : Queues and Stacks

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1 Introduction

1. **Josèphe's problem** :

```
Require: n, X
Q ← Q_0
for i ∈ [1, n] do
    add(i, Q)
end for
s ← random(1, n)
current ← get(Q)
while current != s do
    remove(Q)
    add(current, Q)
    current ← get(Q)
end while
while !isEmpty(Q) do
    for i ∈ [1, X − 1] do
        current ← get(Q)
        remove(Q)
        add(current, Q)
    end for
    remove(Q)
end while
return current
```

Apply the algorithm for 10 participants and a step of 4, starting with participant 4:

(a) write down the different states of the queue;

(b) give the remaining participant.

2. **Polish writing** :

```
Require: exp
 1: S ← S_0
 2: for char ∈ exp do
 3:     add(char, S)
 4: end for
 5: S' ← S_0
 6: while !isEmpty(S) do
 7:     current ← get(S)
 8:     if current is an operator then
 9:         op ← current
10:         remove(S)
11:         first ← get(S')
12:         remove(S')
13:         secnd ← get(S')
14:         remove(S')
15:         current ← first op secnd
16:         add(current, S')
17:     else
18:         remove(S)
19:         add(current, S')
20:     end if
21: end while
22: return get(S')
```

Apply the algorithm and give the result of the operation for:

(a) + * 5 3 6

(b) * + * 9 3 2 4

2 Queues

1. **Length of a queue**
   (a) Write an algorithm that will return the length of a given queue Q.
   (b) What does the previous given queue Q looks like after the execution of your algorithm ? If it is not the same queue as before, modify your algorithm so that the queue remains the same at the end.

2. **Even integers**
   Given a queue Q, write an algorithm that will return a queue Q' containing only the even elements of Q in the same order as they were in Q.
   Example : if Q is |4,9,2,74,6,5,8,50,3|, then Q' will be |4,2,74,6,8,50|
   Note: you can use the test isEven(n) to know if an integer is even.

3 Stacks

1. **Even integers**
   Given a stack S, write an algorithm that will return a stack S' containing only the even elements of S in the same order as they were in S.
   Example : if S is ⊢4,9,2,74,6,5,8,50,3 ⊢, then S' will be ⊢4,2,74,6,8,50 ⊢

2. **Palindromes:**
   A palindrome is a word that can be read forward as well as backward and remains the same in both directions. (*For example, Hannah and radar are palindromes*). Write an algorithm, using stacks, that checks if a given word is a palindrome.
   Note: in order to initialise a stack with the given word (in other terms, to "write" the given word in a stack), we can use the same steps as in the Polish writing algorithm to initialise S with the given expression.

4 Optional Exercise: Back to the Palindromes - Due October 16th

Write an algorithm, using stacks and queues, that checks if a given word is a palindrome. This algorithm should require at most 2 structures (*i.e. 2 stacks, 2 queues, or 1 of each*). Describe your algorithm and its idea (in 2 lines for instance).