Data Structure and Algorithm Analysis

2017-18 Mid-term Examination B

Part I. Please answer the questions (32%)

1. Write down a kind of structure that we can directly locate elements. _____.
2. What' s corresponding postfix expression of the infix expression (3 + 4*2) *3-6 / 3.

   _____.
3. What is number of the none-empty substrings of the string" windows10".

   45
   _____.
4. What is the basic difference between stack and queue? _____is FIFO, ____is FILO.
5. Suppose there is a stack, and when we push an element into the stack, it will print S, and when we pop an element out of the stack, it will print X. There are four integers, and the order of pushing into the stack is 1 2 3 4, if we want a pop order of these integers as 3 4 2 1, what is the corresponding sequence of pop and push operation? (the sequence should consist of "X" and "S") SSSXSXXX _____.
6. Suppose there is an empty stack, then there are six elements which will be pushed into the stack by the order $e_1, e_2, e_3, e_4, e_5, e_6$. If the pop order of these elements is $e_4, e_3, e_2, e_6, e_5, e_1$, in this case, what is the minimum capacity of the stack? _____.
7. Suppose that we use an array (the capacity of which is 6) to simulate a queue and when the index value of rear equals front, the queue is empty. Now the index values of rear and front are 4 and 2 respectively, in this case, after we add two elements into the queue, what's the index value of rear? _____. After that we remove one element out of the queue, what's the index value of front?

   _____.

Part II. Simple answer Question (28%)

1. A is a linear table $[a_1, a_2, a_3, \ldots\ldots a_n]$and use a sequential storage structure. In the case of equal probability, what is the average number of elements needed to move when adding an element to A? Please write a brief description of the calculation process.

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2. We know a pattern string P=" abababc" and a target string S=" abababababcaba".

(1) You are asked to give the next array of the pattern string P=" abababc".

(2) Please draw the matching process using KMP algorithm.

$$\text{next[j]} = \begin{cases} -1, & j = 0 \\ \max\{k: 0 < k < j \ \&\& \ P(0 \dots k-1) = P(j-k \dots j-1)\}, & \text{if } k \text{ exist} \\ 0, & \text{others} \end{cases}$$

3. Write down a class of doubly linked list and describe its process of adding and deleting an element.

4. Given a string, you are supposed to judge if it is symmetric. For example, given "abba", you should return 1; given "abbc", you should return 0.

Part III. Algorithm and programming (40%)

1. Given a nonnegative integer($1 \le n \le 10$), please calculate its factorial using recursion.

For example:

$$3! = 6, \quad 4! = 24, \quad 5! = 120$$

2. Suppose we have two singly linked lists. Maybe they have some common nodes. Please design an algorithm to find their first common node.

Assume the lengths of the two linked lists are m and n, if your algorithm's time complexity is O(m+n), you can get 10 marks at most; if O(mn), you can get 6 marks at most.

3. Using the defined double stack structure as following, please implement how to calculate the result of a postfix expression.

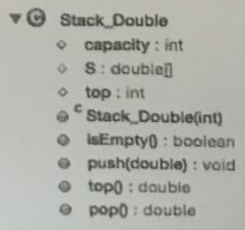

Fig.1

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4. Real estate developers plan to build m (2 <= m <= n) houses along a river. The houses can be located along a straight line at positions $x_1, \ldots, x_n$ ($2 \leq x_1 < x_2 \ldots < x_n \leq 10000$) near the river bank.

As we know, one of the factors that decide the house price is the distance of this house away from its neighbors: the further it is away from its neighbors, price could be higher. They ask you for help to find the largest minimum distance. Please design and implement an algorithm which time complexity is O(nlogn).

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一、Fill caps

1、 array

2、 342*+3*63/-

3、 45

4、 queue、stack

5、 SSSXSXXX

6、 4

7、 0，3

二、Simple answers

1、 n/2

2、 -1 0 0 1 2 3 4

3、 public class DoublyLinkedList<E>{

int size;

Node<E> first;

Node<E> last;

private static class Node<E> {

E item;

Node<E> next;

Node<E> prev;

}

public add(int index, E element){

```
if (!(index >= 0 && index <= size)) {
    throw new IndexOutOfBoundsException("Index: " + index + ", Size:
" + size);
}
if (index == size) {
   final Node<E> l = last;
   final Node<E> newNode = new Node<>(l, element, null);
```

```
                last = newNode;
                if (l == null)
                    first = newNode;
                else
                    l.next = newNode;
                size++;
            } else {
                 Node<E> succ = node(index);
                 final Node<E> pred = succ.prev;
                 final Node<E> newNode = new Node<>(pred, element, succ);
                 succ.prev = newNode;
                 if (pred == null)
                     first = newNode;
                 else
                     pred.next = newNode;
                 size++;
             }

            }
             public delete(int index){
              if (!(index >= 0 && index < size)) {
              throw new IndexOutOfBoundsException("Index: " + index + ", Size: " +
size);
         }
         Node<E> x = node(index);
        final E element = x.item;
        final Node<E> next = x.next;
        final Node<E> prev = x.prev;

        if (prev == null) {
            first = next;
        } else {
            prev.next = next;
```

```
            x.prev = null;
        }

        if (next == null) {
            last = prev;
        } else {
            next.prev = prev;
            x.next = null;
        }

        x.item = null;
        size--;
        return element;

         }
        }
```

4、
```
        for(int i=0; i<n/2; i++){
            if (s[i] != s[n-i]){
                return False;
            }
        }
        return True;
```

三、Algorithm

1、Factorial

```
int factorial(n){
    if(n==1){
        return 1;
    }
    return n* factorial(n-1);
}
```

2、Firstly, try to find out how long the two linked lists, for example, one linked list is n, the other is m, suppose n >=m;

Secondly, search the longer linked list, after finding (n-m) elements, should search the two linked list together, when the two pointer point to the same node, this node is the first common node.

3、Postfix notation is easier to calculator than other notation. With two simple operations, the stack push and the stack pop can handle any normal expression. The operations are as follows:

If the current character is a digital, then push to stack,

if it is an operator, will be the top of the stack of two elements for the corresponding pop-up operation, the result reentry to stack.

When all the character operated on above way, the stack should be contain only one element, that is the final result.

4、Binary search

The maximum value possible: mvp = (xn – x1)/(m - 1)

Binary search form 0 to mvp(begin = 0, end = mvp), each time check whether the distance can be satisfied.

```
current value = 0
if check return true
   if mid is bigger than current value
        update the current value
   adjust the range from mid+1 to end
else if check return false
     adjust the range from begin to mid-1
```