Semester One of Academic Year (2014---2015) of BJUT

Data Structures and Algorithms I Exam Paper A

Exam Instructions：Answer 4 of 5 Questions

Honesty Pledge：

I have read and clearly understand the Examination Rules of Beijing University of Technology and am aware of the Punishment for Violating the Rules of Beijing University of Technology. I hereby promise to abide by the relevant rules and regulations by not giving or receiving any help during the exam. If caught violating the rules, I would accept the punishment thereof.

Pledger：_____ **Class No：_____**

BJUT Student ID：_____ **UCD Student ID_____**

Notes：

The exam paper has 5 parts on 5 pages, with a full score of 100 points. You are required to use the given answer book only.

Part 1: The Stack

1. What is a Stack? What methods does the Stack Abstract Data Type usually have?

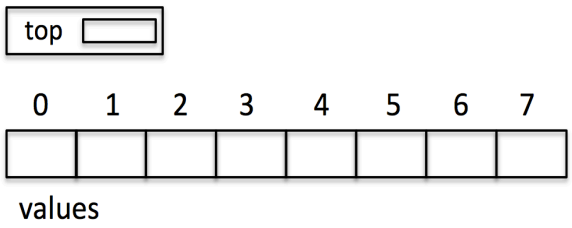
(5 Marks)

2. What is would the output of the following operations if they were performed on an empty stack. Assume that every time we use pop the element is printed.
   push(45), push(67), pop(), push(24), push(87), pop(), pop(), push(93), push(14), pop(), push(75), push(62), pop(), pop(), push(45), pop(), pop().

(6 Marks)

3. Copy the drawing below (in your answer book) and show the contents of the variables top and values from an array-based implementation of the stack after the following operations.

   push(13), pop(), push(7), push(45), push(56), push(33), pop(), push(75).



(5 Marks)

4. Write the code for the method push in the array based implementation of the Stack. This method should place the new element on top of the stack.

(9 Marks)

Part 2: Complexity

1. What is the complexity of each of the following pieces of code in big O notation? For each question explain your answer

(15 Marks)

a.
```
public int answer(int k) {
    for (int i = 0; i < k; ++i) {
       return k;
    }
}
```

b.
```
for (int j = 0; j < n; ++j) {
    int a = j*2;
    for (int i = 0; i < j; ++i) {
       b = b + a * c; }
       for (int k = 0; k < n; ++k) {
          c = b + c;
       }
}
```

```
c. public void sunny (int n, int sum) {
     for (int i = 0; i < n * 1000; ++i)
        for (int j = 0; j < i; ++j)
           for (int k = n; k > 0; k--)
              sum++;
   }
```

2. Order the following big O values from most efficient to least efficient:
   O(n log n), O(1), O(n^2), O(n) O(log n), O (n^3), O(n!)

(5 Marks)

3. The Queue ADT has two methods **enqueue** (to put something in) and **dequeue** (to take something out):
   Which data of the following data structures would be the most efficient for implementing the Queue, a singly linked list or a doubly linked list?
   Explain your answer by talking about the complexity of the methods that would be used in enqueue and dequeue .

(5 Marks)

Part 3: Doubly Linked List

1. What is the difference between a Singly Linked list and a Doubly-Linked List? Which of these data structures is better? Why?

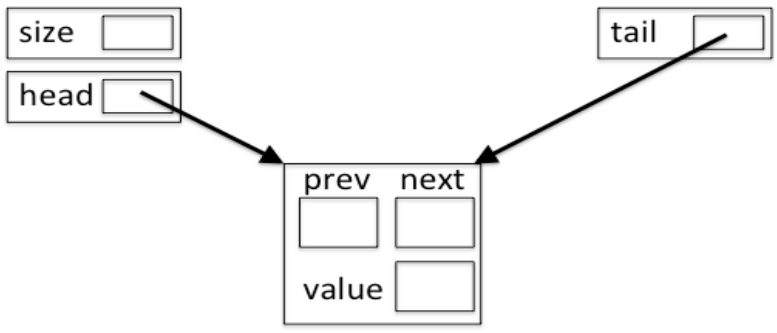
(5 Marks)

2. Describe in English the steps involved in searching a linked list to check if it contains an element X. What is the complexity of this operation in big O notation?

(5 Marks)

3. Copy the diagram below and complete it to show the contents of the linked list after the following operations.
   addFirst("Welcome"), addLast("the"), n = first(), addAfter(n, "to"), l = last(), addAfter(l, "you"), n = next(n), addAfter(n, "place").

(7 Marks)



4. Write the method addFirst for the DoublyLinkedList class. This method should take one parameter, the Object to be inserted.
   You can assume the top of the list is stored in the variable **head**, the bottom in the variable **tail** and the number of elements in the variable **size**.
   Remember to consider special cases.

(10 Marks)

Part 4: Vector

1. What is a Vector? Name the core operations of a Vector.

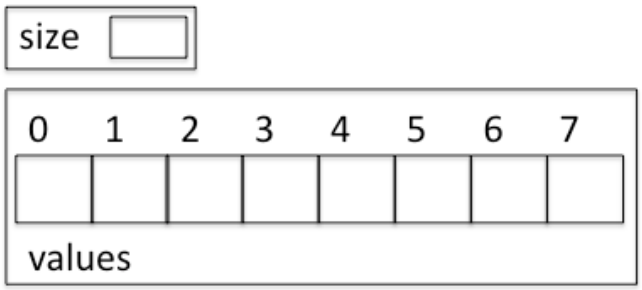
(8 Marks)

2. What is the complexity of the method insertAtRank? Explain why this is.

(6 Marks)

3. Copy the picture below and complete it to show the result of the following operations.
   insertAtRank(0,34), insertAtRank(1,12), insertAtRank(1,14),
   insertAtRank(0,155), insertAtRank(4,12), removeAtRank(1)

(6 Marks)



4. Write the code for the method replaceAtRank, this should be written for the array-based implementation of the Vector.

(5 Marks)

Part 5: Maps

1. What is a Map? Name the core operations of a Map (you do not need to include the Iterators).

(5 Marks)

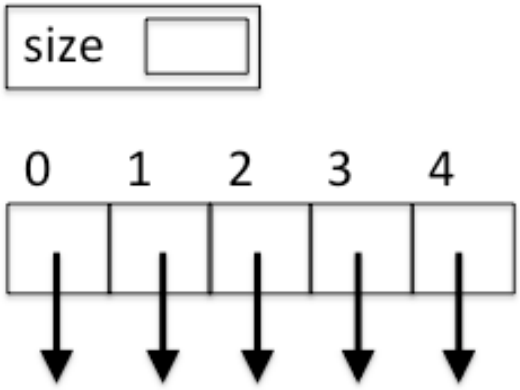
2. What are the two collision handling strategies we studied. How do they both work?

(10 Marks)

3. Copy the picture below and complete it to show the result of the following

operations when performed on a HashMap with Linear Chaining. The array size in the HashMap is 5 and the hashCode method returns the key % 5.
put(12,34), put(21,19), put(12,67), put(11,15), put(93,34), put(68,5), remove(93)

(6 Marks)



4. Write the code for the method replaceAtRank, this should be written for the array-based implementation of the Vector.

(5 Marks)