Beijing-Dublin International College

SEMESTER I RESIT EXAMINATION - 2016/2017

School of Computer Science

COMP2002J Data Structures and Algorithms 1

HEAD OF SCHOOL: Pádraig Cunningham
MODULE COORDINATOR: Lina Xu*

Time Allowed: 120 minutes

Instructions for Candidates

All questions carry equal marks. The distribution of marks in the right margin shown as a percentage gives an approximate indication of the relative importance of each part of the question.

BJUT Student ID: ________________ **UCD Student ID:** ________________

I have read and clearly understand the Examination Rules of both Beijing University of Technology and University College Dublin. I am aware of the Punishment for Violating the Rules of Beijing University of Technology and/or University College Dublin. 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 accept the punishment thereof.

Honesty Pledge： ____ **(Signature)**

Instructions for Invigilators

Non-programmable calculators are permitted.
No rough-work paper is to be provided for candidates.

Obtained score
10

Question 1: Stack

a. Explain what is stack in your words. Write the interface for stack.

(8 Marks)

b. Create an empty stack based on your implementation and perform the following operations on the stack. (2 Marks)

push(8); pop(4); push(2); push(1);

Illustrate the process in diagrams.

Obtained score
20

Question 2: List

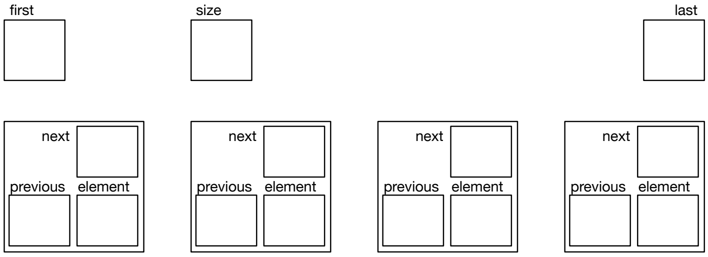
a. Write at least three functions in List. What is the complexity for them in terms of implementations in single linked list, array-based list and double linked list.

(5 Marks)

b. Draw a diagram similar to the one below. This diagram should show the state of a doubly linked list after the following operations have been completed. The references should be drawn as arrows and the values should be shown

(5 Marks)

addLast(B), addFirst(A), p = first(), addBefore(p, C), l = last(), addAfter(l,D), l = after(l), addAfter(p, E)



c. For SingleLinkedList data structure, write code in Java or pseudocode for before(Position p, Object d) method. It should return a Position. What is the complexity in big O notation? (10 Marks)

Obtained score
20

Question 3: Queue

a. List the operations should be provided in Queue, and the complexity of each operation in big O notation.

(6 Marks)

b. What is the main difference between link based implementation and array based implementation for queue? What is the advantage of circular array based implementation comparing non-circular array based implementation?
(4 Marks)

c. Write code for the removeLast() method in the link based double-ended queue. This method should return an Object and throw EmptyDequeException when the queue is empty. (10 Marks)

Obtained score
20

Question 4: Map

a. Giving the Map interface below, what is the complexity for those methods if implement is based on double linked list?

(5 Marks)

```
public interface Map {
        public int size();
        public boolean isEmpty();
        public Object get(int k);
        public Object put(int k, Object v);
        public Object remove(int k);
        public Iterator entries();
}
```

b. Separate chaining is used to solve entry collisions in array based Map abstract data structure implementation. Describe this strategy with your own words by using examples.

(5 Marks)

c. Hash code map and compression map are the two basic mappings that a hash function should provide. What are their tasks respectively? Give two examples for each them. (5 Marks)

d. In addition to separate chaining, open addressing is another strategy to deal with collisions in Mapping. One form of open addressing is called linear probing. Explain in your words what is linear probing. (5 Marks)

Obtained score
30

Question 5: Sorting and Complexity

a. 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!). (3 Marks)

b. Explain what is Dutch national flag problem and write down its complexity.
(6 Marks)

c. What are the complexities of the traditional sorting methods: selection sort, rank sort and insertion sort in big O notation? What are the complexities of the advanced sorting methods: quick sort and merge sort in big O notation? (5 Marks)

d. Apply the quicksort algorithm to the following array {10, 2, 34, 0, 3, 11, 25, 67}, considering the first number as the pivot. Draw a diagram showing the partitions and the values in the array after each recursion. Explain the recursive calls of the algorithm and the partitions specified for each call. (6 Marks)

e. Which no-comparison based sorting algorithms have you learned? Explain the algorithms in your own word. What are their complexities? Are they faster than the comparison sorting algorithms and why? (10 Marks)