

## COMP3600/COMP6466 in 2009 – Tutorial Three

### Question 1.

Insert the keys 5, 2, 8, 9, 1, 6, 3 into a max-heap once a time, then remove the key in the root repeatedly until the heap is empty. What is the time complexity of sorting in this fashion?

### Question 2.

In the open addressing schema of Hash table, three probing techniques have been introduced, they are **linear probing**, **quadratic probing**, and **double hashing**. Point out how many different probing sequences for each of the schemes. Compare the advantages and disadvantages among the techniques.

### Question 3.

Design a hash function for the open addressing schema such that there are no primary and secondary clustering problems by using it for hashing. In addition, the number of probing sequences derived from it is no less than  $O(m^3)$ .

### Question 4.

Almost all analysis of binary search trees assumes that the keys are distinct. Suppose the definition of the binary search tree ordering is changed to:

For each node, if the key is  $K$ , then:

- the key in the left child (if any) is  $\leq K$
- the key in the right child (if any) is  $> K$

Redesign the insertion algorithm so that all insertions create a new node, even if the key is already present. Explain how to search in such a tree.

**Question 5.**

- (i) What is the difference between the binary search tree and the red-black tree?
- (ii) What is the left/right rotation? what's its purpose when applied in the red-black trees.

**Question 6.**

Apply the directed tree implementation of the disjoint sets data structure, using both heuristics, to find the components of the graph with 8 vertices and edges provided in this order: 1-3, 2-5, 2-8, 3-5, 4-6

**Question 7.**

Given an undirected graph with  $n$  vertices and  $m$  edges, show how DFS can be used to find a cycle (or prove there isn't one) in  $O(n)$  time. Recall: DFS in general takes more time than that.