Department of Electrical and Computer Engineering
North South University
CSE 373 : Design and Analysis of Algorithms
Section 3
Midterm Examination
Summer 2020

Total Marks: 35

Start time: 4:30 PM

End Time: 5:30 PM

Instruction: Write ALL answers in handwriting. Take snapshots of your answers and then compile all pages in one pdf document. **You are also required to write your name and ID in each of the pages**. Upload your document via Google Classroom.

1. Write down the recurrence relation to capture the time complexity of a mergesort algorithm. Solve the recurrence relation using recursion tree method. — 10 marks

2 This question is about the max-heap data structure

a) Consider that a set of keys are added in an array *A* such that it maintains the heap-order property. Infact, *A* is a max-heap. Write down an algorithm **isInternalNode(A, i, n)** that returns a *true* if the ith element in the array *A* is an internal node. If that is not the case, it should return a *false*. The heap-size is *n*. *All nodes except that of leaf nodes are referred to as internal nodes*. What is the time complexity of your algorithm. — 4 + 1 = 5 marks

b) Figure 1 shows a tree-based and the corresponding array-based representation of keys stored in a max-heap data structure. You need to write down an algorithm, **ithMax(A, i, n)**, that will return the ith largest element in a max-heap. Here, *A* is the array and *n* is the heap-size. In the example, given in figure 1, if *i* were 2, it would return 30 since 30 is the 2nd largest number in the Array A. What should be the worst case time complexity for your algorithm. Your objective must be to come with a time and space efficient algorithm. — 4 + 1 = 5 marks

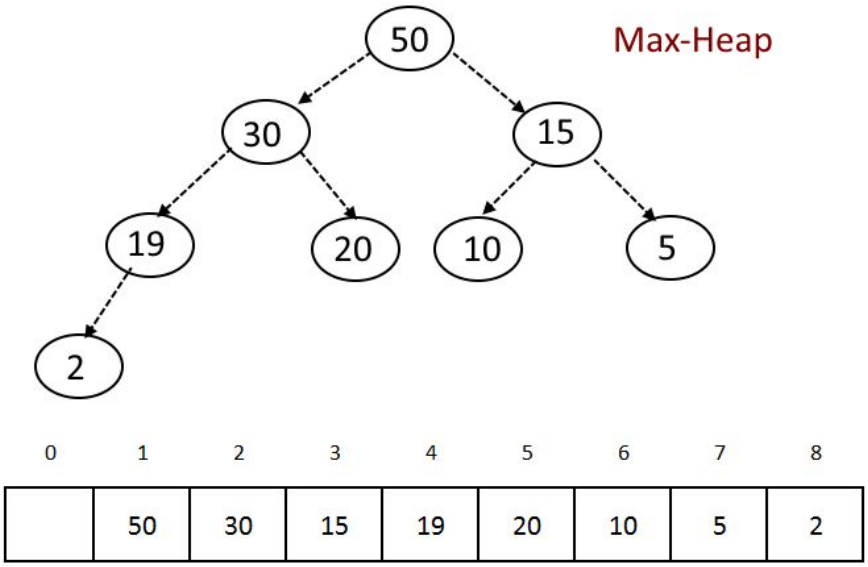

Figure 1: The array and tree-based representation of a max-heap

3. Write down an insertion sort algorithm that would sort an unsorted array in **non-increasing order**. Insertion sort is referred to as a stable sort algorithm. Explain briefly what does stable sort mean? 5 marks

4. Explain the advantage of randomized quicksort algorithm over naive quicksort algorithm. 3 marks

5. Imagine data (items) is stored in a complete binary tree of height 30. What is the maximum number of items stored in this data structure? Show your workings. **You should not use any calculator**. 7 marks