1 Introduction and Objective

The purpose of this tutorial is to do one last review of the basic concepts taught in CS1020 which are the essential foundation to CS2010. Please try out all the questions in the tutorial, and if you encounter difficulties in answering them, don’t hesitate to clear up all doubts and questions you might have, with the tutor (front-line) or lecturer (if the tutor gives up).

At the start of this first tutorial session of CS2010, the tutor (Jonathan, Nathan, Beier, or Zeng Zhong) will introduce himself and similarly you will have to briefly introduce yourself. Tutor reserves 3% of your course grade for tutorial participation point.

- 0% if you only attend \( \leq 5 \) out of 10+1 tutorial sessions (we have Deepavali public holiday on Tuesday of Week 13),

- 1% if you are very silent throughout all > 5 tutorial sessions that you attend,

- 3% for top three most active students in each tutorial group, and

- 2% for the rest.

We will start this tutorial by reviewing some of CS1020 topics and then jumps into the first topic of CS2010: Priority Queue (PQ).
2 Tutorial 01 Questions

Sorting

Q1. Which sorting algorithm is the best to sort the following sequence (stored in an array): \{50, 9, 8, 7, 6, 5, 4, 3, 2, 1\} in ascending order? Explain your answer!

1. Insertion Sort  
   (http://visualgo.net/sorting.html?mode=Insertion&create=50,9,8,7,6,5,4,3,2,1)
2. Quick Sort  
   (http://visualgo.net/sorting.html?mode=Quick&create=50,9,8,7,6,5,4,3,2,1)  
   Note: Quick Sort as initially taught in CS1020: pivot is always the first element)
3. Bubble Sort  
   (http://visualgo.net/sorting.html?mode=Bubble&create=50,9,8,7,6,5,4,3,2,1)
4. Selection Sort  
   (http://visualgo.net/sorting.html?mode=Selection&create=50,9,8,7,6,5,4,3,2,1)
5. Merge Sort  
   (http://visualgo.net/sorting.html?mode=Merge&create=50,9,8,7,6,5,4,3,2,1)

Order of Growth

Q2.a). What is the bound of the following function? \(F(n) = n + \frac{1}{2}n + \frac{1}{3}n + \frac{1}{4}n + \ldots + 1\)

1. \(O(2^n)\)
2. \(O(n^2)\)
3. \(O(n \log n)\)
4. \(O(n)\)
5. \(O(\log^2 n)\)
6. \(O(\log n)\)

Q2.b). What about \(G(n) = n + \frac{1}{2}n + \frac{1}{4}n + \frac{1}{8}n + \ldots + 1\)

Hash Table

Q3. Which of the following is the best hash function?

1. Index = (currentTimeMillis() * (Key.charAt(0) - 'A')) % N;
2. Index = (Key.charAt(0) - 'A') % N;
3. Index = Key.hashCode() % N;
where

- Key is a Java string
- `currentTimeMillis()` is a function in `Java.lang.System` that returns the current time in milliseconds
- $N$ is the hash table size, usually a prime number

Finding $k$-th Smallest Element (Selection Algorithm)

Q4. In the first lecture you have been briefly exposed to the concept of quicksort’s partitioning algorithm combined with binary search-like algorithm on an unsorted array to find the $k$-th smallest element in the array. In this tutorial, we will spend some time discussing the details. Before attending this tutorial, please investigate this algorithm from the Internet: http://en.wikipedia.org/wiki/Quickselect.

Basic Operations of Binary Heap

Q5. We will end this tutorial 01 with a review of the first topic of CS2010. All 5 basic operations of Binary Heap can be reviewed in http://visualgo.net/heap.html. During the tutorial session, the tutor will randomize the binary heap structure, ask student to Insert random integers, perform ExtractMax operations (or the first few steps of heapsort), and/or the $O(n \log n)$ or the $O(n)$ build heap operation from a random array.