CSCE 629-601 Analysis of Algorithms

Fall 2022

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Assignment # 1

(Due September 16, 2022)

1. Answer the following questions, and give a brief explanation for each of your answers.
   a) True or False: Quicksort takes time $O(n \log n)$;
   b) True or False: Quicksort takes time $O(n^2)$;
   c) True or False: Mergesort takes time $O(n \log n)$;
   b) True or False: Mergesort takes time $O(n^2)$;

2. (*Lower bound* for searching algorithms) Prove: any comparison-based searching algorithm on a set of n elements takes time $\Omega(\log n)$ in the worst case. (Hint: you may want to read Section 8.1 of the textbook for related terminologies and techniques.)

3. Consider the following operation on a set S:

   Neighbors(S, x): find the two elements y_1 and y_2 in the set S, where y_1 is the largest element in S that is strictly smaller than x, while y_2 is the smallest element in S that is strictly larger than x.

   Develop an $O(\log n)$-time algorithm for this operation, assuming that the set S is stored in a 2-3 tree. *Hint*: the element x can be either in or not in the set S.

4. Consider the following problem: given a 2-3 tree T of n leaves, and an integer k such that $\log n \leq k \leq n$, find the k smallest elements in the tree T. Develop an $O(k)$-time algorithm for the problem. Give a detailed analysis to explain why your algorithm runs in time $O(k)$.