

# CSCE-629 Analysis of Algorithms

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## Assignment # 1 (Due February 12, 2019)

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. Solve the following recurrence relations:
  - a)  $T(1) = O(1)$ , and  $T(n) = 2T(n/2) + O(n^2)$ ;
  - b)  $T(1) = O(1)$ , and  $T(n) = 2T(n-2) + O(n)$ .
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  $O(k)$ .