CSE 247 Data Structures (3 + 1) Fall 2020

Assignment 2

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Instructions to Students:

- The assignment would be due on Friday 4th Dec before 11:00 PM– No late submissions
- For all the questions you are required to write Java code
- You are required to work individually on the assignment
- Plagiarism means zero you can take help from me, TAs, online resources

Topic: Asymptotic Analysis

Question 1:

Suppose you are given an n-element array A containing distinct integers that are listed in increasing order. Given a number k, describe a recursive algorithm to find two integers in A that sum to k, if such a pair exists. What is the running time of your algorithm?

Question 2:

Suppose that each row of an $n \times n$ array A consists of 1's and 0's such that, in any row of A all the 1's come before any 0's in that row. Assuming A is already in memory, describe a method running in $O(n)$ time (not $O(n^2)$ time) for finding the row of A that contains the most 1's.

Topic: Trees

Question 3: Lowest Common Ancestor

Let T be a tree with n nodes. Define the ***lowest common ancestor*** (LCA) between two nodes v and w as the lowest node in T that has both v and w as descendants (where we allow a node to be a descendent of itself). Given two nodes v and w, describe an efficient algorithm for finding the LCA of v and w. What is the running time of your algorithm?

Question 4: Roman Node

Let T be a binary tree with n nodes. Define a ***Roman node*** to be a node v in T, such that the number of descendants in v's left sub tree differ from the number of descendants in v's right sub tree by at most 5. Describe a linear-time method for finding each node v of T, such that v is not a Roman node, but all of v's descendants are Roman nodes.

Question 5: Binary Expression Tree

Write a program that takes as input a fully parenthesized, arithmetic expression and converts it to a binary expression tree. Your program should display the tree in some way and also print the value associated with the root. To answer this question you must explore what Binary expression tree is.

Topic: Heap

Question 6: Key value less than equal to k

Given a heap T and a key k, give an algorithm to compute all the entries in T with key less than or equal to k. For example, given the heap and query k= 7, the algorithm should report the entries with keys 2, 4, 5, 6, and 7 (but not necessarily in this order). Your algorithm should run in time proportional to the number of entries returned.

Question 7: Combining Heaps

Suppose two binary trees, T_1 and T_2, hold entries satisfying the heap-order property. Describe a method for combining T_1 and T_2 into a tree T whose internal nodes hold the union of the entries in T_1 andT_2 and also satisfy the heap-order property. Your algorithm should run in time $O(h_1 + h_2)$ where h_1 and h_2 are the respective heights of T_1 and T_2.

Topic: Priority Queues

Question 8: CPU Job Scheduling

One of the main applications of priority queues is in operating systems for ***scheduling jobs*** on a CPU. In this project you are to build a program that schedules simulated CPU jobs. Your program should run in a loop, each iteration of which corresponds to a ***time slice*** for the CPU. Each job is assigned a priority, which is an integer between -20 (highest priority) and 19 (lowest priority), inclusive. From among all jobs waiting to be processed in a time slice, the CPU must work on a job with highest priority. In this simulation, each job will also come with a ***length*** value, which is an integer between 1 and 100, inclusive, indicating the number of time slices that are needed to process this job. For simplicity, you may assume jobs cannot be interrupted—once it is scheduled on the CPU, a job runs for a number of time slices equal to its length.

Your simulator must output the name of the job running on the CPU in each time slice and must process a sequence of commands, one per time slice, each of which is of the form "add job *name* with length n and priority *p*" or "no new job this slice".

Topic: Applications of Binary Search Tree

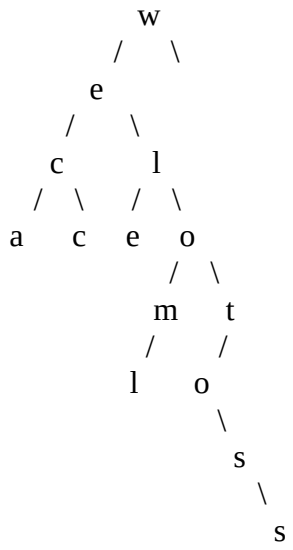
Question 9:

Implement a binary tree where each node contains a character for a given text. Use rules of binary search tree

a. Every element in n's left subtree is less than or equal to the element in node n.
b. Every element in n's right subtree is greater than the element in node n.

Example: For the following text you have to create a binary search tree and traverse it according to inorder traversal. Also show graphical view of tree.

welcometoclass



Inorder Traversal : acceellmoosstw

Question 10: Huffman Coding

You can find Huffman.ppt uploaded in the lectures section of LMS. Your task is to understand the method and implement it.

---------- Good Luck ----------