EECS 560: Exam # 2

Wednesday, April 8, 2020

The rules for this exam are as follows:

- From 9:50-10am, the exam can be **downloaded from http://people.eecs.ku.edu/~s906s230/eecs_560_spring_2020.html. However, you may not start on the exam until I indicate it is time to do so.** This exam will last for 50 minutes (i.e., from 10-10:50am). You will then have from 10:50-11am to take photos of your work and turn them into a **single PDF** which is named as follows: **LastName_FirstName_EECS560_Exam2.pdf.**
  E-mail the PDF of your exam to: ku.eecs560sp20.exam@gmail.com.
- Please write the following statement on a cover page which you turn in with your exam testifying to your academic integrity on the exam: "I neither gave nor received help of any kind on this exam." Sign and date this statement. **Exams which do not include this cover page will not be graded.**
- The exam is closed book, closed notes, and closed references.
- No collaboration of any kind is allowed on the exam.
- Use of a webcam is required during the exam to enable me to proctor the class.
- No electronic devices are allowed except for completing the following tasks: (1) allowing me to proctor your exam; (2) downloading the exam file; (3) writing solutions to the questions; (4) asking me questions (privately) in the chat window; (5) taking photos of your work and turning it into a single PDF, and (6) submitting the final PDF via e-mail. **Use of electronic devices for any other purpose is strictly forbidden.**
- The solutions to the exam must be handwritten (either on paper or on a tablet/ipad).
- Show **ALL** work for partial/full credit. This includes any definitions, mathematics, figures, etc.

1. _____ (15 points)
2. _____ (15 points)
3. _____ (15 points)
4. _____ (15 points)
5. _____ (15 points)

EC. _____ (8 points)

T. _____ (75 points)

Important Reminder: Create a cover page with the following academic integrity statement: "I never gave nor received help of any kind on this exam." Sign and date this statement. (Turn this in with your exam.)

1. (15 points) Reconstruct the binary search tree, T, from the following preorder traversal of T: G, C, A, F, H, M, I, J, O. When done, delete C, G, H from T. **Show all of your work.**

2. (15 points)

(a) (10 points) Suppose that you are given a set of six keys with $x_1 < x_2 < x_3 < x_4 < x_5 < x_6$ with probabilities $p_1 = 0.3, p_2 = 0.1, p_3 = 0.15, p_4 = 0.1, p_5 = 0.1, p_6 = 0.25$. The goal is to determine the set of optimal binary search trees for the above set of keys.

Here is the (partial) output from the associated dynamic programming algorithm:
$t_{1,1} = 1, t_{2,2} = 2, t_{3,3} = 3, t_{4,4} = 4, t_{5,5} = 5, t_{6,6} = 6$
$t_{1,2} = 1, t_{2,3} = 3, t_{3,4} = 3, t_{4,5} = 4$ or $5, t_{5,6} = 6$
$t_{1,3} = 1, t_{2,4} = 3, t_{3,5} = 4, t_{4,6} = 6$
$t_{1,4} = 1, t_{2,5} = 3, t_{3,6} = 4$ or 5 or 6
$t_{1,5} = 3, t_{2,6} = 4$ or 5
$t_{1,6} = 3$.

Show how to reconstruct an optimal BST T for the above set of keys based on the above output.

(b) (2 points) Compute the cost of T.

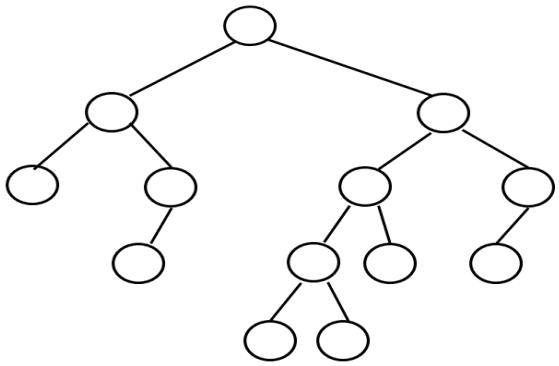
(c) (3 points) Are additional optimal BSTs possible? Why or why not? **Be specific.**

3. (15 points) Given a set of records S with 10 priorities $\{53, 2, 16, 21, 19, 32, 12, 20, 49, 35\}$, build a max 2-heap for S using the bottom-up approach. When done, deleteMax. **You must show all of your work in order to receive credit.**

4. (15 points) Given a set of records S with 10 priorities $\{62, 17, 19, 21, 13, 90, 18, 62, 73, 17\}$, build a maxmin heap for S using the top-down approach. When done, deleteMin, then deleteMax. **You must show all of your work in order to receive credit.**

5. (15 points)

(a) (8 points) Is the following a leftist tree? Why or why not? **Justify your answer.**



(b) (7 points) Why is it necessary to consider a concatenated queue (such as a leftist heap) for merging priority queues?

Hint: To answer this, compare the complexities associated with (1) the concatenate operation for leftist heaps, (2) the merging of two minmax heaps (by inserting objects in Q2 into Q1), and (3) the rebuilding of the minmax heap data structure (by using objects from both Q1 and Q2). For the latter two cases, suppose that the sizes of the priority queues Q1 and Q2 are n and m, where $n \geq m$ and $m = \Theta(n)$.

OPTIONAL: Extra-Credit Question

(8 points) Suppose you are a salesperson at ABC Applicances. For each applicance that is sold, you earn $5 if you helped the customer that purchased that item (independent of the item that is sold). Naturally, as a smart salesperson, you decide that you would like to help show appliances that do not require much review time prior to purchase. (For example, a customer would likely decide whether or not to purchase a toaster oven in less time than a dishwasher.)

You are tasked with determining the M customers that you would like to help in a stream of N customers that will be coming to the store, where N is huge, and M is large. The type of data that is available to you is the customer's name, the type of applicance they would like to purchase, and the expected amount of time to be spent with the salesperson previewing that item.

The store computer you will use to complete this task does not have enough memory in it to store N items. Explain how you would use a priority queue to complete this task. Be sure to specify the type of priority queue and the operation(s) to be performed on it. **You must explain your answer in detail in order to receive credit.**