

Instructor: Dr. Sartaj Sahni
Summer, 2002

Advanced Data Structures
(COP 5536 /AD 711R)
Exam 1

CLOSED BOOK
70 Minutes
Take one Week after Lecture 13

Name: _____

NOTE:

1. **For all problems, use only the algorithms discussed in class/text.**
2. All answers will be graded on correctness, efficiency, clarity, elegance and other normal criteria that determine quality.
3. The points assigned to each question are provided in parentheses.

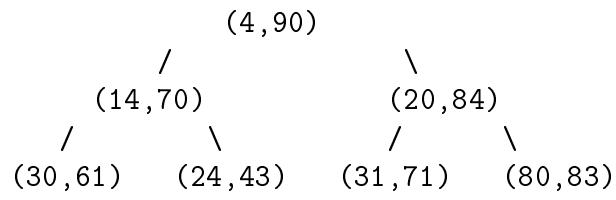
1. (12) Consider a data structure with the operations: $put(x)$, $find(x)$, and $remove(x)$. $Put(x)$ inserts an element x into the structure, $find(x)$ searches for x , and $remove(x)$ removes x from the structure. A $find(x)$ and a $remove(x)$ operation take $O(1)$ time each and a $put(x)$ operation takes $O(1)$ time except when the number of elements in the structure prior to the $put(x)$ operation equals half of the capacity n of the structure. In this case, $put(x)$ operation takes $O(n)$ time to double the capacity. Assume that the structure is initially empty and its initial capacity is 1.
 - (a) (8) Show that the amortized complexity of $put(x)$, $find(x)$, and $remove(x)$ is $O(1)$.
 - (b) (4) What is the actual complexity of a sequence of $put(x)$, $find(x)$, and $remove(x)$ operations based on the result of (a)?

2. (12) You are given $n=810$ records to be sorted on a computer with a memory capacity of $S=180$ records. Assume that the entire S -record capacity may be used for input/output buffers, i.e., you have extra memory for a k -way loser tree. The input is on disk and consists of m runs.

Assume that you use $2k$ buffers for input and 2 for output. Also assume that each time a disk access is made, the seek time is $t_s=8ms$ and the latency time is $t_l=2ms$. The transmission time is $t_t=0.1ms$ per record transmitted.

- (a) (8) What is the buffer size, b , and the total input time for phase two of external sorting, *merging*, if a k -way merge scheme is used? What is the better k with respect to the total input time for phase two? Consider only $k=2$ and 8.
- (b) (4) Assume that it takes $1ms$ to merge 10 records. Compute the total time for the phase two of external sorting, taken by the better scheme of part(b). I.e., compute the total time taken for input, merging, and output.

3. (8) For the interval heap,

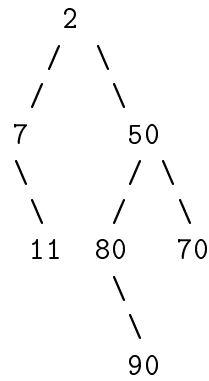
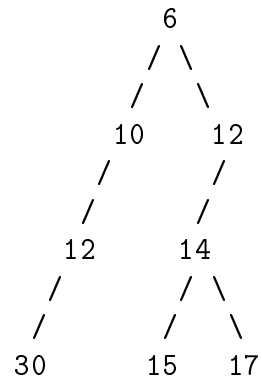


(a) (3) *Insert* 95 into the interval heap, showing each step.

(b) (5) Perform *RemoveMin* from the resulting interval heap of (a), showing each step.

4. (10) Consider a min leftist tree.

- (a) (4) *Convert* the min trees to *min leftist trees* and label each node x with its *shortest*(x) value (Note that one or both may already be min leftist trees).
- (b) (6) Draw the min leftist tree that results when the *meld* operation is performed on the two resulting min leftist trees. (*showing each step*)



5. (8) Show the *binomial heap* that results when the min element is deleted from the following binomial heap. (*showing each step*)
 (Note: For consistency in solution, if you have three binomial trees of the same size in the intermediate steps, please leave the binomial tree with the largest root, and combine the other binomial trees.)

