CS 2420-001 ALGORITHMS AND DATA STRUCTURES

Spring Semester, 2016

Assignment 6: Heaps

Due Date: 9:30 a.m., Friday, Mar. 25, 2016 (at the beginning of CS 2420 class)

Note: This assignment has one programming question (the first one) and two written questions.

1. Suppose we have a heap stored in an array H with index beginning from 1, as discussed in class. You are asked to write procedures to support the following operations. **(40 points)**

   (a) $insert(x)$: insert a new key x into H (assuming that x is not already in H).

   (b) $deleteMin()$: remove the smallest key from H and return it.

   (c) $buildHeap()$: build the heap.

   (d) $percolateDown(i)$: as discussed in class, in both $deleteMin()$ and $buildHeap()$ functions, you will need to call the procedure $percolateDown(i)$.

   On Canvas, go to the following directory: homework/hw6/question1. There are a starter cpp file "hw6_Q1.cpp" and an input file "hw6_Q1_input.txt".

   The program first defines an array A and uses the elements of A to build a heap H by passing A to the class constructor; the class constructor will call the procedure $buildHeap()$ to build the heap H. Then, the program reads the input file. Each line of the input file is either "insert x" or "deleteMin". The program reads the input file line by line and perform the operations accordingly. After each deleteMin operation, the smallest key just removed by the operation will be printed out (to both an output file and the concole). After all operations in the input file are finished, the heap will be printed out. Finally, the program calls a procedure $heapSort()$ to sort all keys in the heap in descending order and print them out. I already finished the $heapSort()$ function, in the same way as discussed in class.

   Your task is to complete the above four functions: $insert(x)$, $deleteMin()$, $buildHeap()$, $percolateDown(i)$. Everything else has been provided in the starter file.

   To help you check whether your program runs correctly, a file "solution_hw6_Q1_output.txt", which contains the correct output, is in the same directory. For your convenience, all above files are included in a zip file.

2. Consider the heap in Fig. 1. Answer the following two questions. **(10 points)**

   (a) Suppose we insert a new key 18 into the heap. Draw the new heap after the insertion.

   (b) Suppose we do a deleteMin operation on the original heap (without the insertion in (a)). Draw the new heap after the operation.

10

20   27
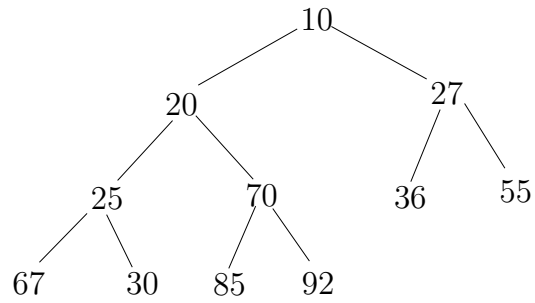
25   70   36   55

67   30   85   92

Figure 1: A heap

3. Suppose we use the linear-time algorithm discussed in class to build a heap from the following array of numbers: 40 25 14 75 10 34 8 33 60 28 17 3 19 6 42 15. Figure 2 shows a complete binary tree formed by these numbers. Draw the heap constructed by the linear-time heap construction algorithm.   **(10 points)**
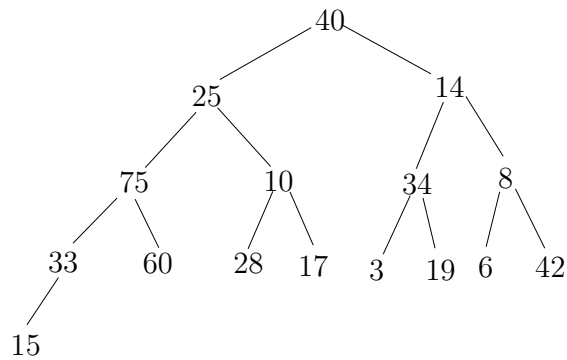
40

25   14

75   10   34   8

33   60   28   17   3   19 6   42

15

Figure 2:

Total Points: 60