# CS 2420-003 ALGORITHMS AND DATA STRUCTURES

Fall Semester, 2018

# Assignment 6: Heaps

**Due Date:** 4:30 p.m., Monday, Nov. 5, 2018 (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 methods 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 java file "hw6_Q1.java" 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. After all operations in the input file are finished, the heap will be printed out by a method $printHeap()$, which has already been completed. 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 methods: $insert(x)$, $deleteMin()$, $buildHeap()$, $percolateDown(i)$. Everything else has been provided in the starter file.

   A file "solution_hw6_Q1_output.txt", which contains the correct output, is in the same folder.

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.

Figure 1: A heap

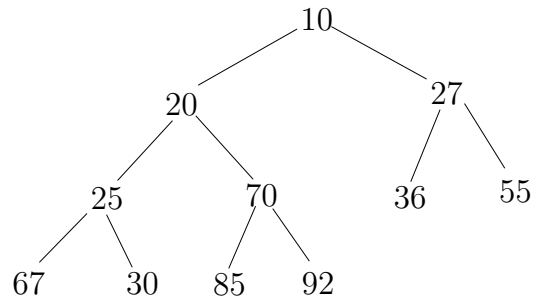10
20      27
25   70   36   55
67  30  85  92

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)**
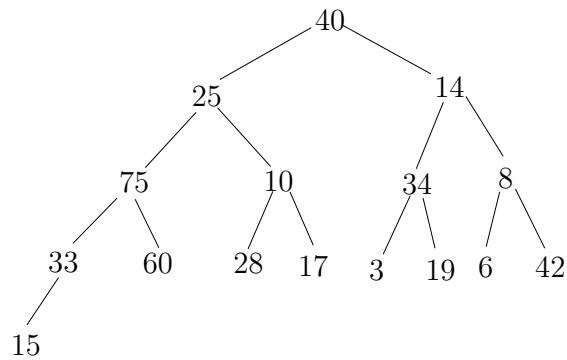
40
25      14
75   10   34   8
33  60  28  17  3  19  6  42
15

Figure 2:

**Total Points: 60**