Data Structures, Spring 2022

Assignment 03

Problem Description

In this problem, you have to implement variants of heaps. This assignment has four steps.

Step 1: Paper work, a warm-up exercise. Practice inserting into and removing from heaps.

Step 2: Implement a heap that is able to toggle between a min-heap and a max-heap.

Step 3: Implement a minimum 3-heap in which each node in this heap can have up to 3 children.

Step 4: Using the heaps for sorting. Discuss their performances.

Please do not try to solve this problem by calling other programs in your source code. If (and only if) you patiently, wholeheartedly code the homework out, you will gain a better coding skill and a deeper understanding of the data structure!

Input

Data array: 10, 12, 1, 14, 6, 5, 8, 15, 3, 9, 7, 4, 11, 13, and 2.

Output

List of data store in heap.

Tasks

(a) (15%) **Warm-up.** Show the result of inserting 10, 12, 1, 14, 6, 5, 8, 15, 3, 9, 7, 4, 11, 13, and 2, one at a time, into an initially empty heap:

i. Min-heap.

ii. Max-heap.

iii. Minimum 3-heap.

(b) (15%) **Warm-up.** Show the result of performing three remove operations (i.e. three deleteRoot operations) on the heap from (a).

i. Min-heap.

ii. Max-heap

iii. Minimum 3-heap.

(c) (45%) **Implementation.** Implement the three variants of heaps abovementioned. Test your code using the given data in (a). Does the program work as you expected in (a) and (b).

(d) (25%) **Discussion**.

i. (5%) On inserts, do you expect binary-heap or 3-heap to perform better? Explain why.

ii. (5%) On remove, do you expect binary-heap or 3-heap to perform better? Explain why.

iii. (15%) Using binary-heap and 3-heap for sorting data array, perform them on different size of arrays and time them. Which heap performs better for sorting? Does the result meet your expectation? If not, why do you think this may be the case?