Lab 14 WS

Tuesday, July 23, 2019 11:43 AM

CS 61BL Summer 2019 — Lab 14 — July 23, 2019

Name: SID:

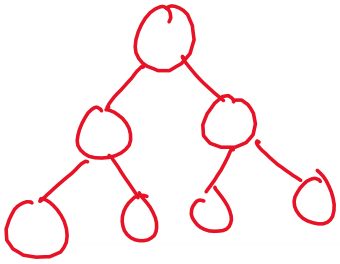
Please complete this worksheet during your lab, and turn it in to your TA by the end of your section. You are encouraged to work with your neighbors collaboratively.

Section Number: (01) (02) (03) (04) (05) (06) (07) (08) (09) (10) (11) (12)

1 PQ Implementations

Consider implementing a priority queue with each of the following data structures and determine the worst case runtimes in $\Theta()$ notation for inserting an item into the PQ (`insert`) and removing the element with highest priority (`poll`). Assume that the PQ contains N elements, each item is associated with a priority value, we prioritize items with the smallest priority value first, and all items are unique.

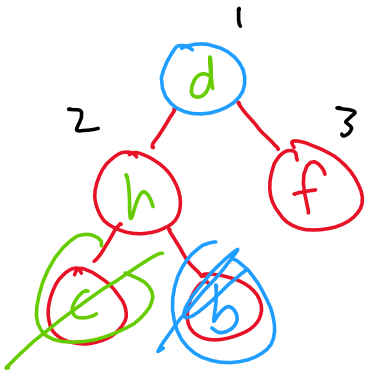
Data structure	`insert()`	`poll()`
Unordered linked list	$\Theta(1)$	$\Theta(N)$
Ordered linked list	$\Theta(N)$	$\Theta(1)$
Balanced binary search tree	$\Theta(\log N)$	$\Theta(\log N)$

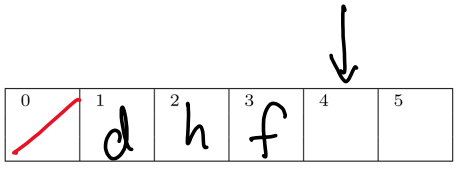


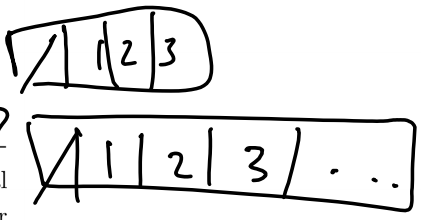
2 Min Heap Operations

Assume that we have a binary min-heap (smallest value on top) data structure called `Heap` that stores integers, and has properly implemented `insert` and `removeMin` methods. Draw the heap and its corresponding array representation after all of the operations below have occurred:

```
1 Heap<Character> h = new Heap<>();
2 h.insert('f');
3 h.insert('h');
4 h.insert('d');
5 h.insert('b');
6 h.insert('c');
7 h.removeMin();
8 h.removeMin();
```







3 Runtimes

Consider an array-based min-heap with N elements. What is the worst case asymptotic run time of each of the following operations if we ignore resizing of the internal array? What is the worst case asymptotic run time if we account for resizing our internal array? Fill in the table below accordingly using $\Theta()$ notation. Assume all elements in the min-heap are unique.

Operation	Ignore Resize	Resize
`insert`	$\Theta(\log N)$	$\Theta(N)$
`removeMin`	$\Theta(\log N)$	$\Theta(\log N)$
`findMin`	$\Theta(1)$	$\Theta(1)$ (N/A)

$\Theta(N) + \Theta(\log N)$ if we do resize down, $\Theta(N)$

4 Brainteasers

4.1 Consider binary trees that are both max heaps and binary search trees simultaneously. Assuming all elements are unique, how many nodes can such a tree have? Fill in the box(es) of all that apply.

- ☒ 1 node
- ☒ 2 nodes
- ☐ 3 nodes
- ☐ 4 nodes
- ☐ 5 nodes
- ☐ Any number of nodes
- ☐ No trees exist

4.2 You are tasked to implement a max-heap data structure of integers using only a min-heap of integers. Could you complete the task? If so, fill in the circle next to "Yes" and describe your approach and how you would implement the max-heap's methods (`insert`, `removeMax`, and `findMax`). If not, fill in the circle next to "No" explain why it's impossible.

- ○ Yes
- ○ No