# CS 61B Spring 2018

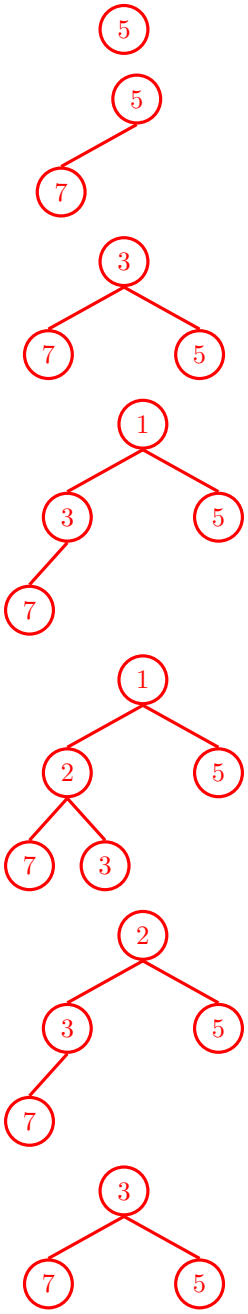
# Heaps, Traversals & Trees

Discussion 10: March 20, 2018

## 1 Heaps of Fun

1.1 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 each of the operations below:

```
1 Heap h = new Heap();
2 h.insert(5);
3 h.insert(7);
4 h.insert(3);
5 h.insert(1);
6 h.insert(2);
7 h.removeMin();
8 h.removeMin();
```

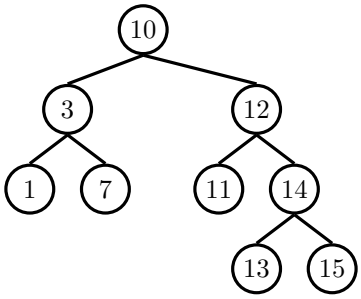


1.2 Your friend Sahil Finn-Garng challenges you to quickly implement an integer max-heap data structure. "Hah! I'll just use my min-heap implementation as a template to write MaxHeap.java," you think to yourself. Unfortunately, two Destroyer Penguins manage to delete your `MinHeap.java` file. You notice that you still have `MinHeap.class`. Can you still complete the challenge before time runs out?

*Hint*: You can still use methods from `MinHeap`.

Yes. For every insert operation, negate the number and add it to the min-heap. For a `removeMax` operation call `removeMin` on the min-heap and negate the number returned. Any number negated twice is itself (with one exception in Java, $2^{-31}$), and since we store the negation of numbers, the order is now reversed (what used to be the max is now the min).

# 2 Tree Traversals




2.1 Write the pre-order, in-order, post-order, and level-order traversals of the above binary search tree.

Pre-order: 10 3 1 7 12 11 14 13 15

In-order: 1 3 7 10 11 12 13 14 15

Post-order: 1 7 3 11 13 15 14 12 10

Level-order (BFS): 10 3 12 1 7 11 14 13 15

# 3 Quadtrees

3.1 Draw the quadtree built by inserting the following nodes with the given coordinates.

```
insert A (2, 3);
insert B (-1, 1);
insert C (3, 2);
insert D (0, 0);
insert E (4, 4);
insert F (-3, 2);
```