PA7 released today
PA6 hard deadline → tonight 10pm
PA4 Late/Resubmit → Tuesday
Friday → holiday → No class
Exam 2 → Friday of Week 8 → 11/18
↳ counting steps, runtime, sorting, hash tables

→ largest value comes out first

Max Heap

Assume the key and value are identical for this example

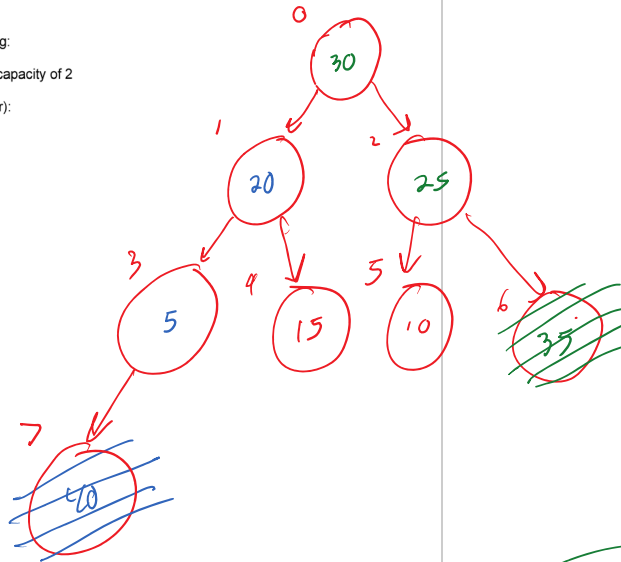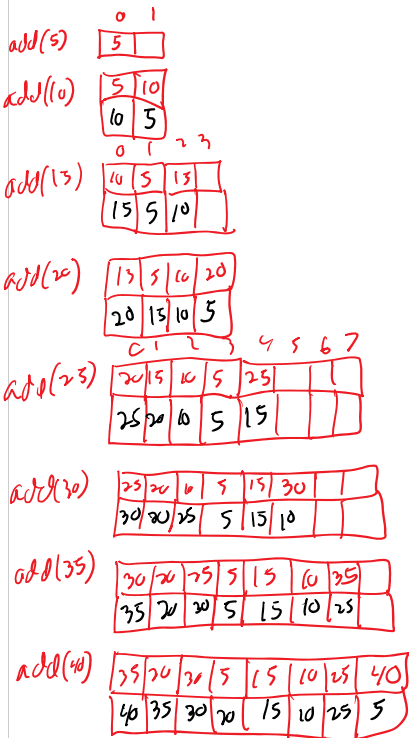Draw the picture of the tree and the array for the following:

ArrayList<Integer> heap = new ArrayList<>(2);   //initial capacity of 2

Add the following elements to the max heap (in this order):
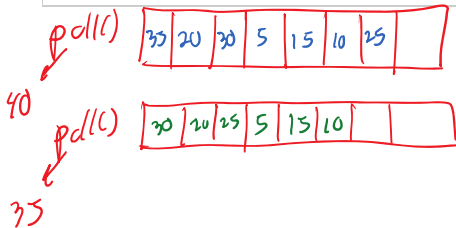
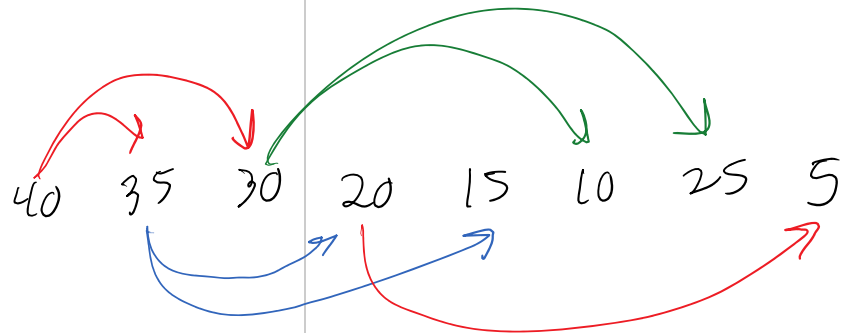5, 10, 15, 20, 25, 30, 35, 40

Call poll() twice

What elements were returned?

height
$\log_2(N)$

add(5)
5	

add(10)
5	10
10	5

add(15)
10	5	15
15	5	10

add(20)
15	5	10	20
20	15	10	5

add(25)
20	15	10	5	25			
25	20	10	5	15			

add(30)
25	20	10	5	15	30		
30	20	25	5	15	10		

add(35)
30	20	25	5	15	10	35	
35	20	30	5	15	10	25	

add(40)
35	20	30	5	15	10	25	40
40	35	30	20	15	10	25	5

40   35   30   20   15   10   25   5

poll()
35	20	30	5	15	10	25	

40

poll()
30	20	25	5	15	10		

35

```
void bubbleDown(int index) {
    if(index >= this.entries.size()) { return; }
    int leftIndex = left(index);
    if(leftIndex >= this.entries.size()) { return; }
    int largerChildIndex = leftIndex;
    int rightIndex = right(index);
    if(existsAndGreater(rightIndex, leftIndex)) {
        largerChildIndex = rightIndex;
    }
    if(existsAndGreater(largerChildIndex, index)) {
        swap(index, largerChildIndex);
        bubbleDown(largerChildIndex);
    }
}

void bubbleUp(int index) {
    if(index <= 0) { return; }
    Entry<K,V> e = this.entries.get(index);
    Entry<K,V> parent = this.entries.get(parent(index));
    int comp = this.comparator.compare(e.key, parent.key);
    if(comp > 0) {
        swap(index, parent(index));
        bubbleUp(parent(index));
    }
    else {
        return;
    }
}
```

What is the run-time for a Max Heap

add()

Worst Case $\Theta\left(\log_2(N)\right)$

What conditions make up the worst case for add()?

max heap → sorted

Best Case: $\Theta(1)$

What conditions make up the best case for add()?

added key already
in heap order

max heap → reverse sorted list
min heap → sorted

poll()

Worst Case $\Theta\left(\log_2(N)\right)$

What conditions make up the worst case for poll()?

smallest # is at the end of the array

Best Case: $\Theta(1)$

What conditions make up the best case for poll()?

duplicate #s