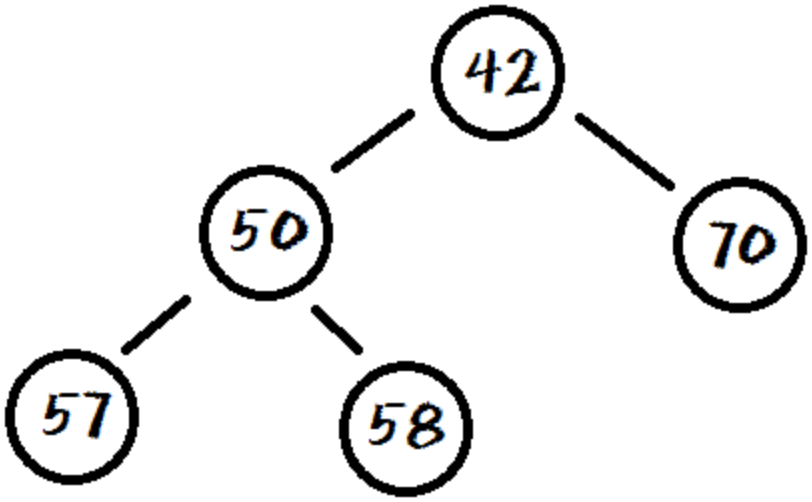
A+ Computer Science

HEAPS

What is a heap?

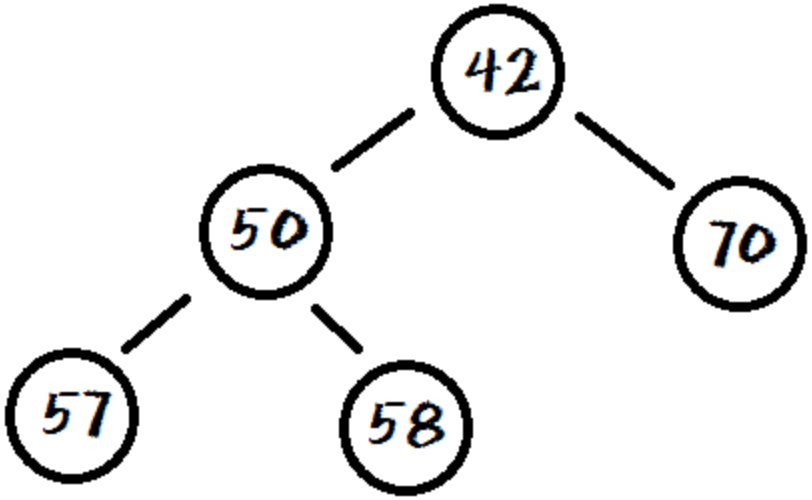
The heap is essentially an array-based binary tree with either the biggest or smallest element at the root.



What is a heap?

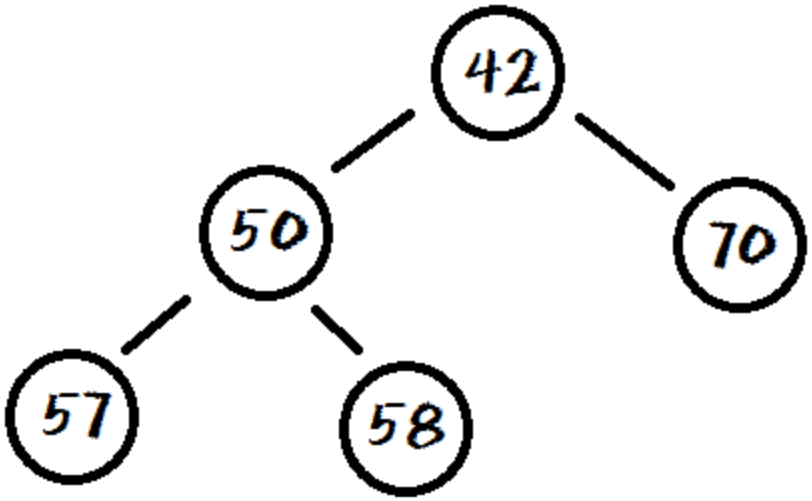
Every parent in a Heap will always be smaller or larger than both of its children.

This rule will hold true for every level of the heap.



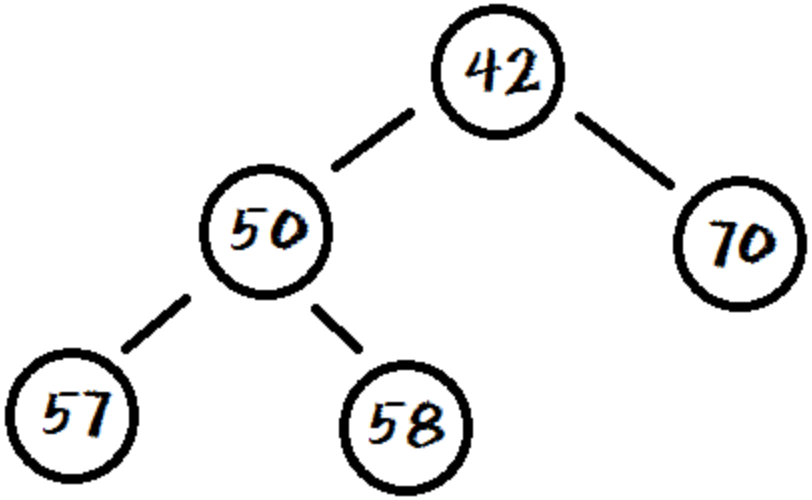
What is a complete tree?

In a complete tree, every level that can be filled is filled. Any levels that are not full have all nodes shifted as far left as possible.

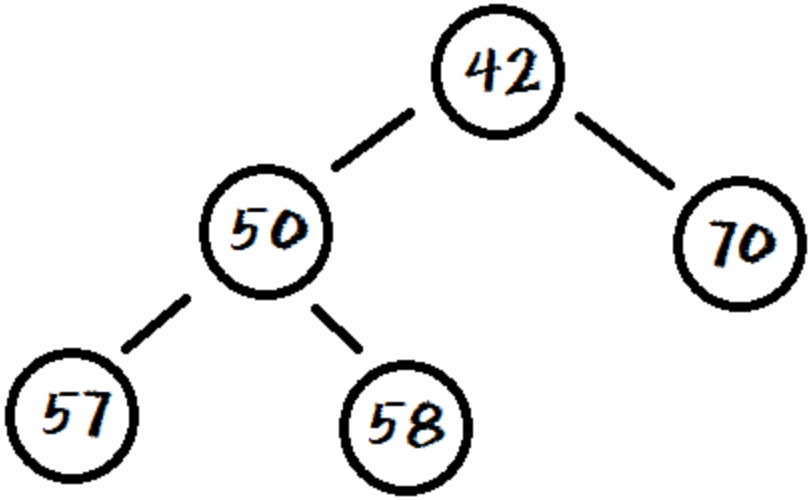


What is a heap?

A Heap is a complete tree.

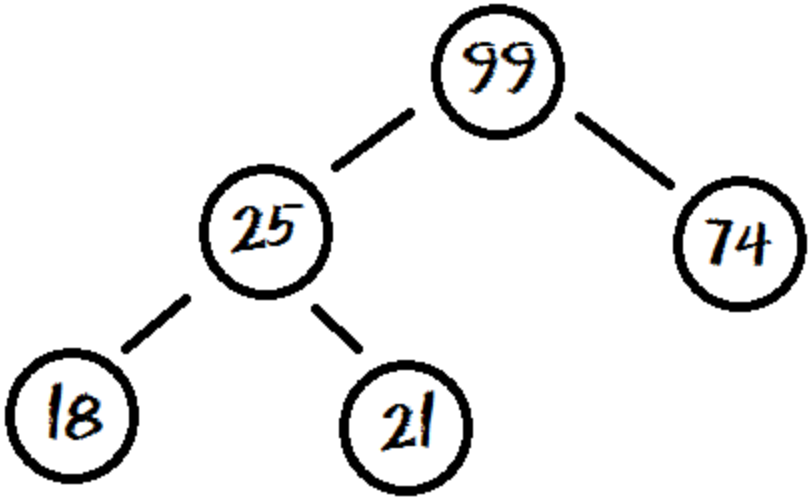


What is a min heap?



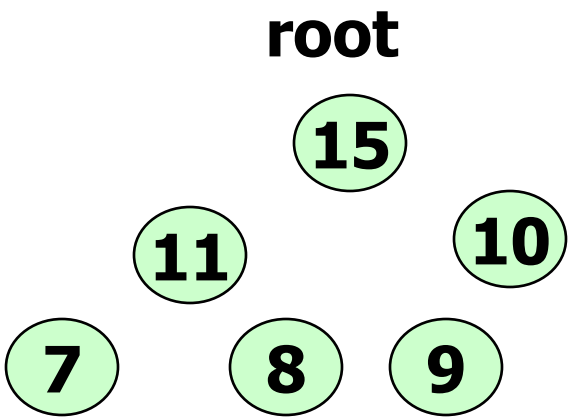
A min heap is a binary tree that has a root smaller than all of its children.

What is a max heap?



A max heap is a binary tree that has a root larger than all of its children.

What is a heap?



root

15	11	10	7	8	9

What is a heap?

Because a heap will always be a complete tree, it makes sense to use an array to store the values.

root

15	11	10	7	8	9

What is a heap?

root

15	11	10	7	8	9

left = i*2+1 right=i*2+2

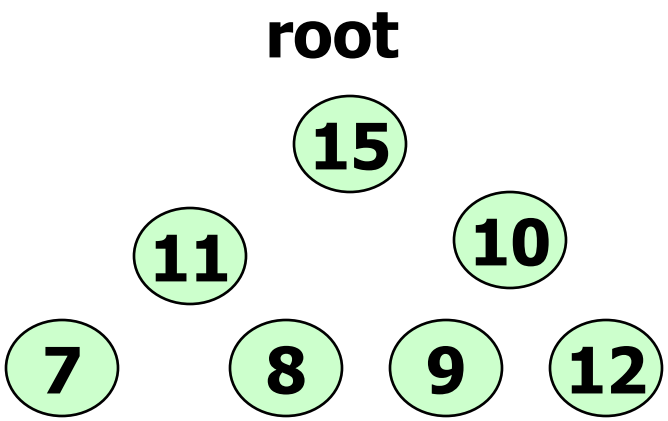
left child of root = [0 *2 + 1]
right child of root = [0 *2 + 2]

Adding to a heap

The easiest way to add a new item to a heap implemented with an array is to add the new value at the end of the array and then move the new item up the tree as far as it needs to go.

add will use swapUp to restructure the tree so that it remains a heap.

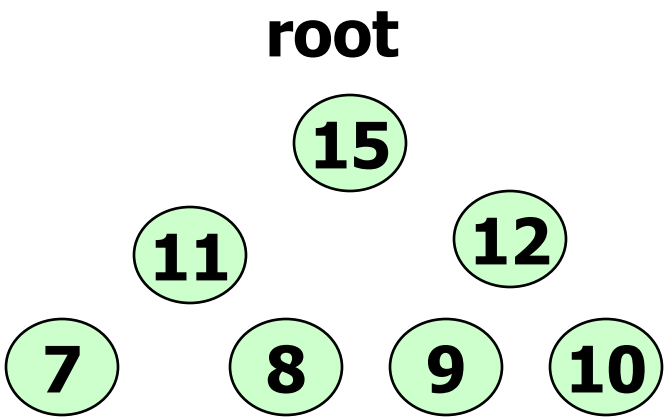
Adding to a heap



root

15	11	10	7	8	9	12

Adding to a heap



root

15	11	12	7	8	9	10

Adding to a heap

```
int bot = length-1
while( bot>0 )
{
   int parent = (bot-1)/2
   if list[parent] < list[bot]
      swap list[parent] and list[bot]
      bot = parent
  else
      stop
}
```

Adding to a heap

swapUp starts access at the bottom of tree

swapUp checks to see that the bottom index has not gone past the root of tree. The root is at index position 0.

Next, locate bottom's parent = (bot–1) / 2.

Check if bottom is larger than its parent
If it is → swap bottom and parent

Finally, set bottom to parent and start the process over.

This method can be written iteratively or recursively.

Removing from a heap

When you remove from a Heap, you are taking off the largest value or value with the highest priority.

You just take the top value off and save it.

Next, you move the last item in the tree to the root and move the new root down the tree as far as it can go.

remove will use swapDown to restructure the tree so it remains a heap.

Removing from a heap

```
int root=0;
while(root<list.size())

  define max and left and right indexes

  if left child exists
     if right child exists
          find max
     else
          max is left
   else   stop

   if max > root
          swap
          root = max
   else  stop
```

Removing from a heap

swapDown starts access at the root

swapDown first generates the index values of the root's children. **root * 2 + 1** **root * 2 + 2**

Make sure root is less than bottom
Find the largest child
Determine if largest child is larger than root
If it is → swap largest child and root

Root is set to the index of the largest child and the process starts over again.

This method can be written iteratively or recursively.

Work on Programs!

Crank

Some Code!

What is a Priority Queue?

A PriorityQueue is a queue structure that organizes the data inside by the natural ordering or by some specified criteria.

The Java PriorityQueue is a min heap as it removes the smallest items first.

The Java PriorityQueue stores Comparables.

PriorityQueue

frequently used methods

Name	Use
add(x)	adds item x to the pQueue
remove()	removes and returns min priority item
peek()	returns the min item with no remove
size()	returns the # of items in the pQueue
isEmpty()	checks to see if the pQueue is empty

What is a Priority Queue?

```
PriorityQueue<Integer> pQueue;
pQueue = new PriorityQueue<Integer>();

pQueue.add(11);
pQueue.add(10);
pQueue.add(7);
out.println(pQueue);
```

OUTPUT

[7, 11, 10]

What is a Priority Queue?

```
PriorityQueue<Integer> pQueue;
pQueue = new PriorityQueue<Integer>();

pQueue.add(11);
pQueue.add(10);
pQueue.add(7);
out.println(pQueue);
out.println(pQueue.remove());
out.println(pQueue);
```

OUTPUT

```
[7, 11, 10]
7
[10, 11]
```

pqadd.java
pqremove.java

What is a Priority Queue?

```
PriorityQueue<Integer> pQueue;
pQueue = new PriorityQueue<Integer>();

pQueue.add(11);
pQueue.add(10);
pQueue.add(7);

while(!pQueue.isEmpty())
{
  out.println(pQueue.remove());
}
```

OUTPUT

```
7
10
11
```

pqueueisempty.java

Work on Programs!

Crank

Some Code!

A+ Computer Science

HEAPS