ACM Programming Contest

- Do you want a free lunch and dinner on Saturday?
- Do you want a free t-shirt?
- Are you free on Saturday from 11:15am - 6:00pm
- Volunteer to help
  - http://bit.ly/contestNov12

- Queues and Stacks
- Priority queues
- Heaps

Queue vs. Stack

```
public static void main(String[] args) {

      Queue aQueue = new LinkedList();
      Stack aStack = new Stack();
      String[] wordsToAdd = {"compsci", "201", "is", "great"};

      for(String s: wordsToAdd){
         aQueue.add(s); //enqueue
         aStack.push(s);
      }

      while(!aQueue.isEmpty())
         System.out.print(aQueue.remove() + " "); //dequeue

      System.out.println();

      while(!aStack.isEmpty())
         System.out.print(aStack.pop() + " ");
   }
```

compsci 201 is great

great is 201 compsci

Priority Queue

- What about those people in first class?

Priority Queue

```
public static void main(String[] args) {

    //Queue aQueue = new LinkedList();
    PriorityQueue<String> aQueue = new PriorityQueue<String>();

    String[] wordsToAdd = {"compsci", "201", "is", "great"};

    for(String s: wordsToAdd){
       aQueue.add(s);
       aStack.push(s);
    }

    while(!aQueue.isEmpty())
       System.out.print(aQueue.remove() + " ");
}
```

1. compsci 201 is great

2. great is compsci 201

3. is great compsci 201

4. 201 compsci great is

- What is the output?

```
PriorityQueue<Integer> ex = new PriorityQueue<Integer>();
ex.add(2);
ex.add(13);
ex.add(9);
ex.add(75);
ex.add(4);
while(!ex.isEmpty()) {
    System.out.println(ex.remove());
}
```

- add in any order
- remove smallest first

Code practice

- Snarf the code
- The class BestPrice tracks all the prices of an item.
- Every time an item is found the price is added to an instance variable
- buyCheepest(n) returns the total price of the n cheapest items
  - and removes them because they have now been purchased.
- Hint: make a priority queue instance variable

Heaps

- A (common) implementation of a priority queue
- A tree-like structure
- Almost completely filled
  - all nodes filled expect last level
- Max-Heap - Descendants have values <= to its parent
- Min-Heap - Descendants have values >= to its parent

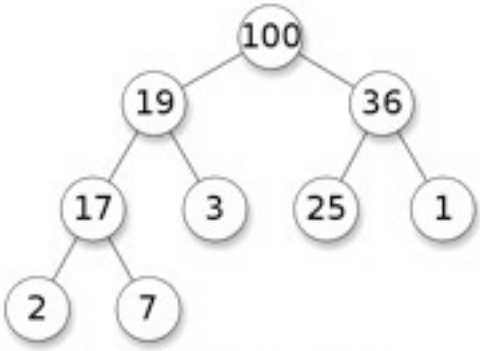
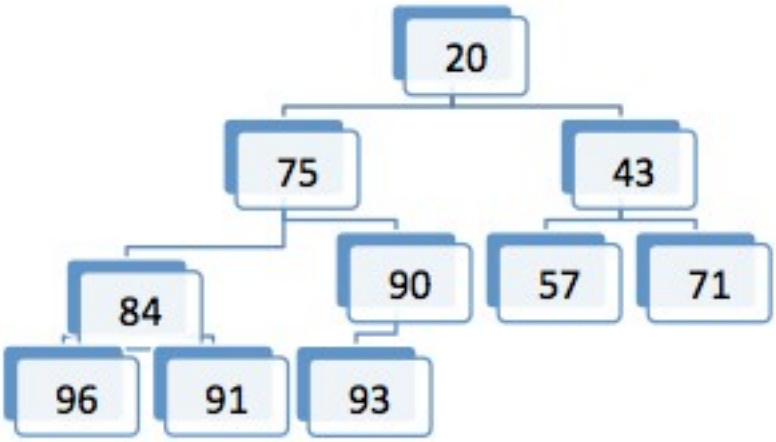


image form wikipedia

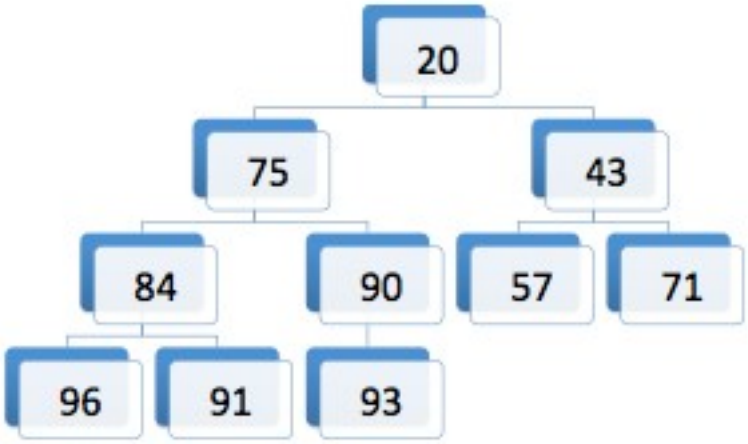
Min Heap

- The root is the minimum value!



- Why would a priority queue be implemented with a heap?

Heaps as Arrays

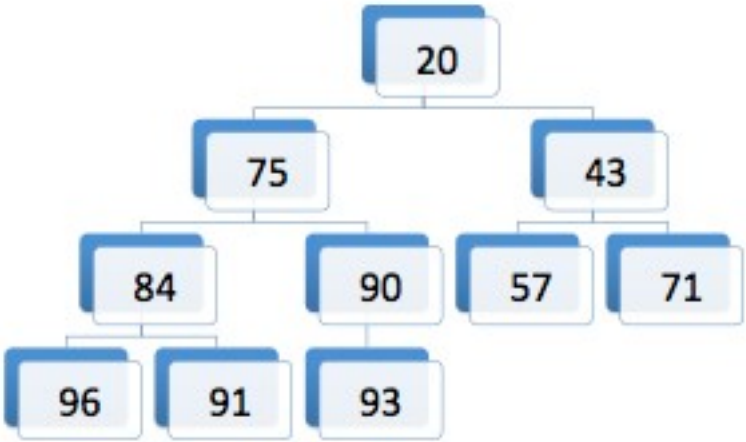


	20	75	43	84	90	57	71	96	91	93

Layer 1 Layer 2 Layer 3 Layer 4

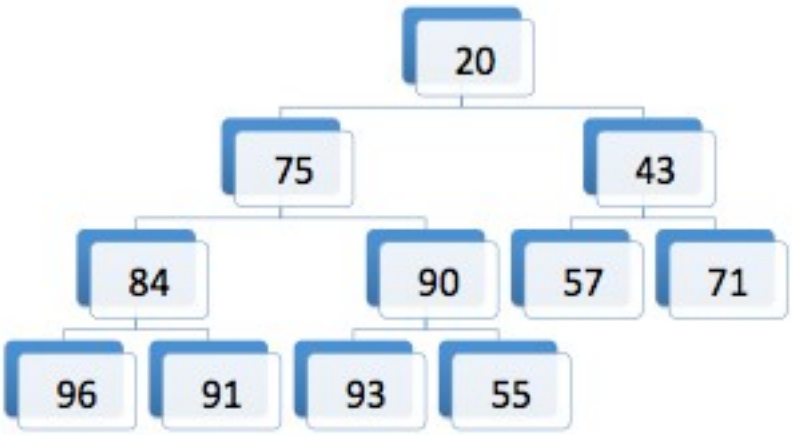
Add

- Add 55 to the heap
  - Add node in first open slot



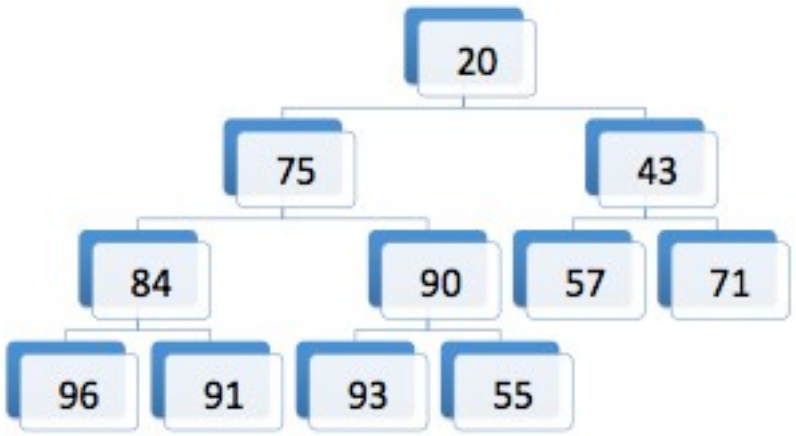
Heap insert

- Add 55 to the heap
  - Add node in first open slot



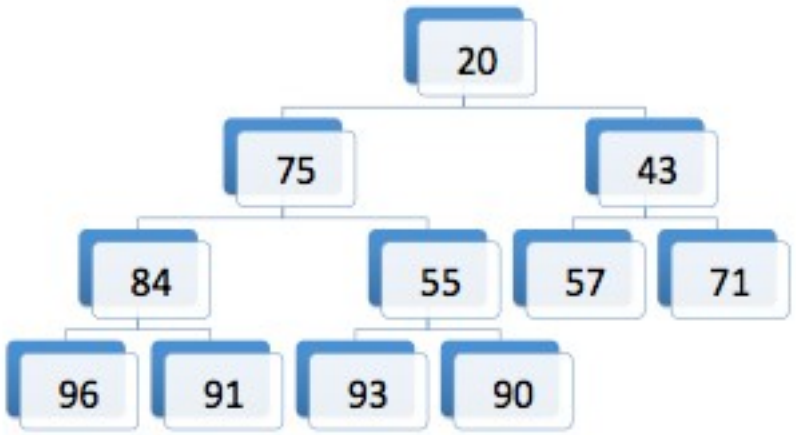
Heap insert

- Add 55 to the heap
  - If parent is larger, swap



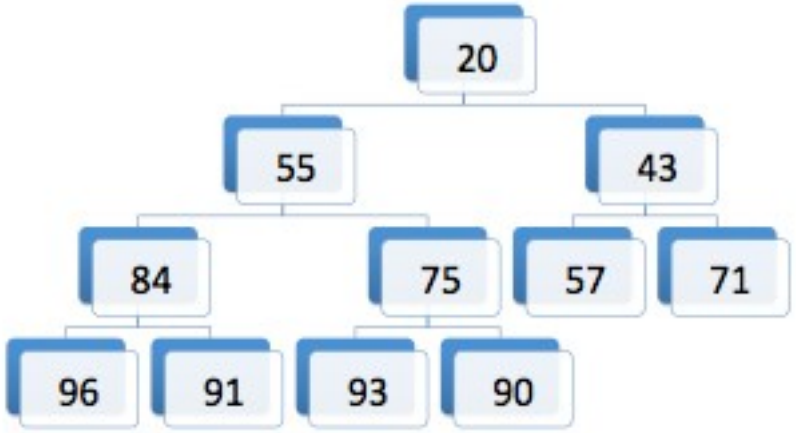
Heap insert

- Add 55 to the heap
  - If parent is larger, swap



Heap insert

- Add 55 to the heap
  - If parent is larger, swap



As an array

```
public void add(double d){
   mySize++;
   myMinHeap[mySize] = d;

   int index = mySize;
   int parentIndex = index/2;
   while((myMinHeap[parentIndex] > myMinHeap[index]) & parentIndex != 0){
      swap(index, parentIndex);
      index = parentIndex;
      parentIndex = index/2;
   }
}

private void swap(int i, int j){
   double temp = myMinHeap[i];
   myMinHeap[i] = myMinHeap[j];
   myMinHeap[j] = temp;
}
```

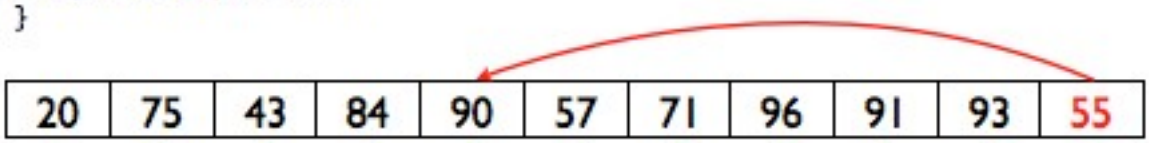
20	75	43	84	90	57	71	96	91	93	55
1	2	3	4	5	6	7	8	9	10	11

As an array

```
public void add(double d){
   mySize++;
   myMinHeap[mySize] = d;

   int index = mySize;
   int parentIndex = index/2;
   while((myMinHeap[parentIndex] > myMinHeap[index]) & parentIndex != 0){
      swap(index, parentIndex);
      index = parentIndex;
      parentIndex = index/2;
   }
}

private void swap(int i, int j){
   double temp = myMinHeap[i];
   myMinHeap[i] = myMinHeap[j];
   myMinHeap[j] = temp;
}
```

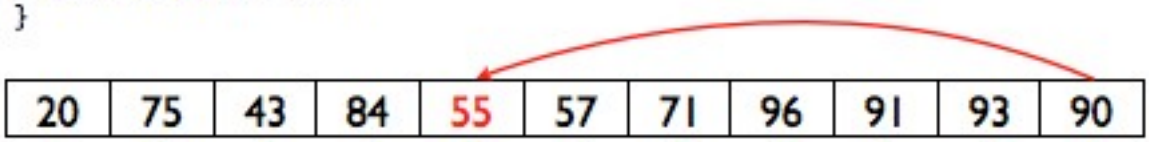


As an array

```
public void add(double d){
   mySize++;
   myMinHeap[mySize] = d;

   int index = mySize;
   int parentIndex = index/2;
   while((myMinHeap[parentIndex] > myMinHeap[index]) & parentIndex != 0){
      swap(index, parentIndex);
      index = parentIndex;
      parentIndex = index/2;
   }
}

private void swap(int i, int j){
   double temp = myMinHeap[i];
   myMinHeap[i] = myMinHeap[j];
   myMinHeap[j] = temp;
}
```

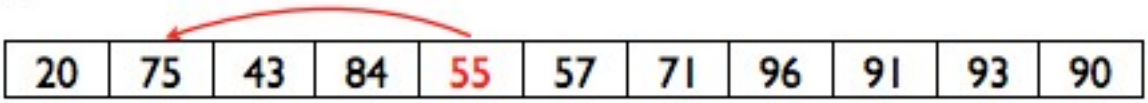


As an array

```
public void add(double d){
   mySize++;
   myMinHeap[mySize] = d;

   int index = mySize;
   int parentIndex = index/2;
   while((myMinHeap[parentIndex] > myMinHeap[index]) & parentIndex != 0){
      swap(index, parentIndex);
      index = parentIndex;
      parentIndex = index/2;
   }
}

private void swap(int i, int j){
   double temp = myMinHeap[i];
   myMinHeap[i] = myMinHeap[j];
   myMinHeap[j] = temp;
}
```



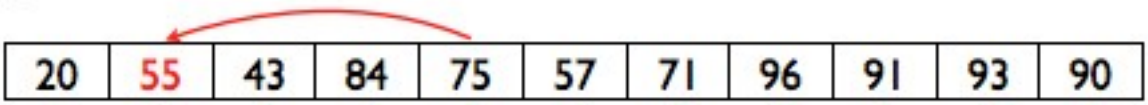
20	75	43	84	55	57	71	96	91	93	90
1	2	3	4	5	6	7	8	9	10	11

As an array

```
public void add(double d){
   mySize++;
   myMinHeap[mySize] = d;

   int index = mySize;
   int parentIndex = index/2;
   while((myMinHeap[parentIndex] > myMinHeap[index]) & parentIndex != 0){
      swap(index, parentIndex);
      index = parentIndex;
      parentIndex = index/2;
   }
}

private void swap(int i, int j){
   double temp = myMinHeap[i];
   myMinHeap[i] = myMinHeap[j];
   myMinHeap[j] = temp;
}
```



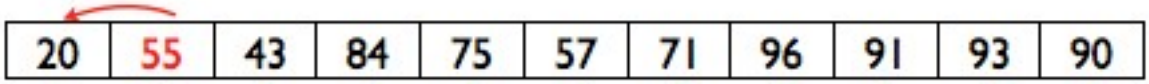
20	55	43	84	75	57	71	96	91	93	90
1	2	3	4	5	6	7	8	9	10	11

As an array

```
public void add(double d){
   mySize++;
   myMinHeap[mySize] = d;

   int index = mySize;
   int parentIndex = index/2;
   while((myMinHeap[parentIndex] > myMinHeap[index]) & parentIndex != 0){
      swap(index, parentIndex);
      index = parentIndex;
      parentIndex = index/2;
   }
}

private void swap(int i, int j){
   double temp = myMinHeap[i];
   myMinHeap[i] = myMinHeap[j];
   myMinHeap[j] = temp;
}
```



20	55	43	84	75	57	71	96	91	93	90
1	2	3	4	5	6	7	8	9	10	11

Remove

- Remove the root
- Move last value into root
- If a child is smaller than root
  - promote the smallest child

20	55	43	84	75	57	71	96	91	93	90

- What would the array look like if I called remove()?
- And then remove()?

Remove

- Remove the root
- Move last value into root
- If a child is smaller than root
  - promote the smallest child

20	55	43	84	75	57	71	96	91	93	90
43	55	57	84	75	90	71	96	91	93	
55	75	57	84	93	90	71	96	91		

Practice

- Imagine a binary tree where each node gives a score. Your goal is to get a high score by selecting nodes. But you're only allowed to select a node if you've already selected its parent. (so to get the 9 in the lower left, you must also select 2,0, and 6 first)
- One algorithm is to always select the node that has the highest value of your current possible nodes. First you would select 2. Then you would select 5 (best of [0,5]). Then you would select 3 [best of [0,3,2].
- Write the function greedyTreeScore that computes your overall score using this approach, given a tree and the number of nodes you are allowed to select.
- If you finish early write a function that computes the best possible score given a tree and a number of nodes you are allowed to select.