

lecture 23

priority queue ADT, heap

Priority Queue ADT

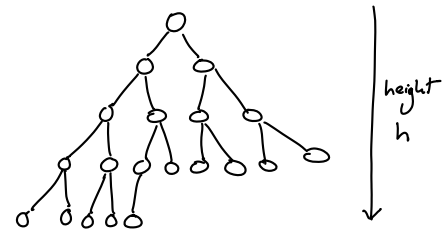
- like a queue but it allows a more general definition of which element to remove
- a set of comparable objects and operations
 - add()
 - removeMin()

Priority Queue

How to implement add(), removeMin() ?

- sorted list
 - linked list
 - array
- binary search tree
- heap (today)

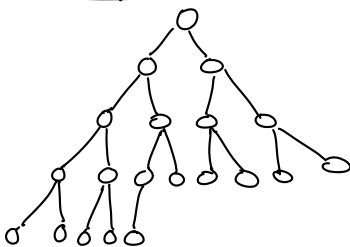
Complete Binary Tree



binary tree of height h such that:

- every level l less than h is full
- all nodes at level h are as far to the left as possible

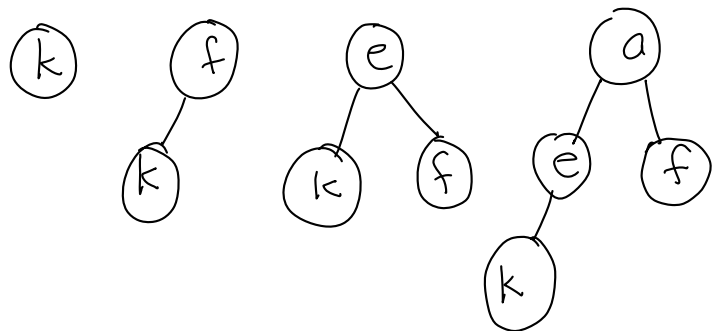
Heap (min Heap)



- a complete binary tree
 - nodes are comparable
 - each node is less than its children
- i.e. $\begin{cases} \text{node.key} < \text{node.left.key} \\ \text{node.key} < \text{node.right.key} \end{cases}$

add (called "offer")

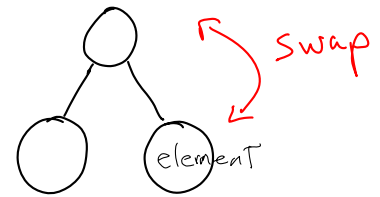
k, f, e, a



add (element)

insert element at next available leaf position

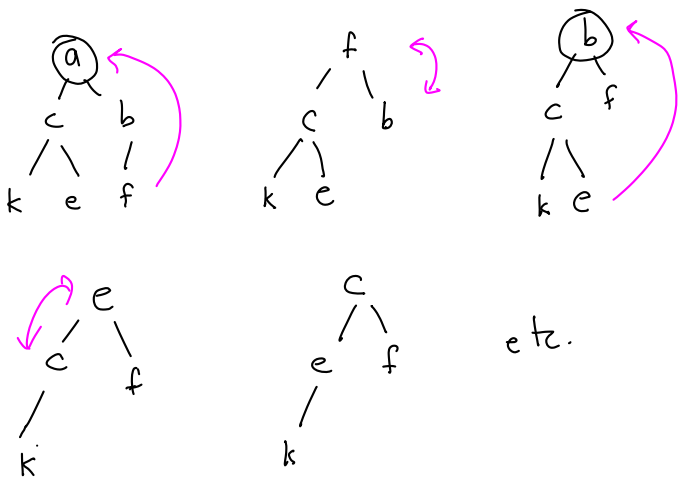
```
while (element < parent) {  
  swap element with its parent  
}
```



```
while (element < parent) {  
  swap element with its parent  
}
```

Can this destroy the heap property?
NO.

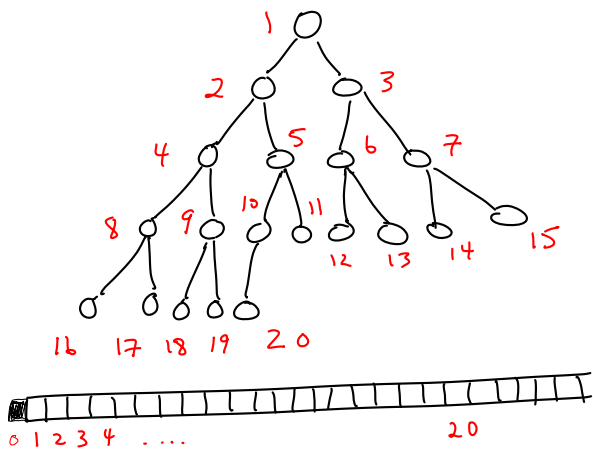
remove Min()



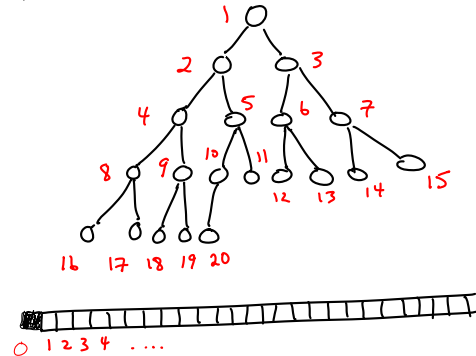
remove Min()

- remove last leaf and put element in root
- while element > one of its children {
 swap element with smaller of its children }

Heap (array implementation)



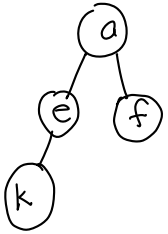
Parent-child index relations



parent = child / 2
left child = 2 * parent
right child = 2 * parent + 1

// Suppose $a[1..i-1]$ defines a heap

```
add(element) {  
  i = a.size + 1 // a.size == i-1  
  a[i] = element  
  upheap(i) // see next slide  
}
```



e.g. $\text{add}(5, 'b')$

```
upheap(i) {  
  if (i > 1 and  $a[i] < a[i/2]$ ) {  
    swap(i, i/2)  
    // swap elements at these indices  
    upheap(i/2)  
  }  
}
```

Given an array $a[]$ with n elements, convert the array into a heap.

```
for i = 2 to n {  
  upheap(i)  
}
```

Announcements

- A3 to be posted this weekend (more challenging, worth 12%)
- A2 Q2 average $\sim 37/50$
See solutions
- big O tutorial Tuesday
(Only people who got less than 30/50 on A2Q2)
SEND ME EMAIL
- Quiz 2 next Friday.