CS 225

#29: Heaps!

November 3, 2017

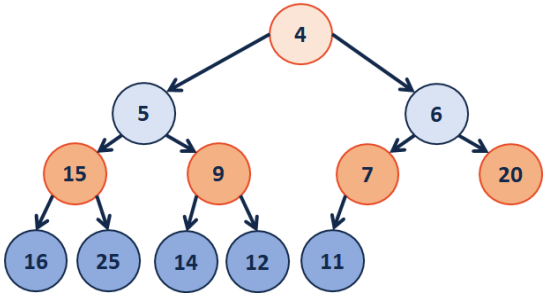
Priority Queue Implementations

insert	removeMin	Implementation
O(n)	O(n)	Unsorted Array
O(1)	O(n)	Unsorted List
O(lg(n))	O(1)	Sorted Array
O(lg(n))	O(1)	Sorted List

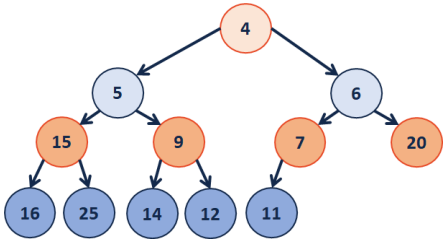
...what errors exist in this table?

Which algorithm would we use?

A New Tree Structure:



Implementing a (min)Heap as an Array



4	5	6	15	9	7	20	16	25	14	12	11			

leftChild(index):

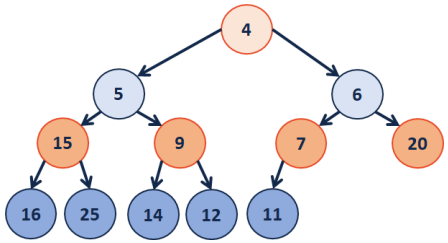
rightChild(index):

parent(index):

A complete binary tree T is a min-heap if:

-
-

Insert:



-	4	5	6	15	9	7	20	16	25	14	12	11			

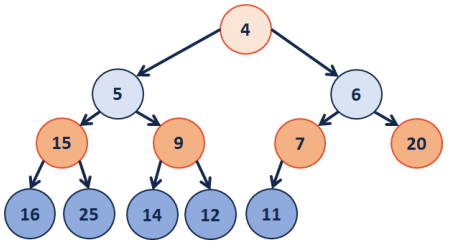
Heap.cpp (partial)

```
1  template <class T>
2  void Heap<T>::_insert(const T & key) {
3    // Check to ensure there's space to insert an element
4    // ...if not, grow the array
5    if ( size_ == capacity_ ) { _growArray(); }
6
7    // Insert the new element at the end of the array
8    item_[++size] = key;
9
10   // Restore the heap property
11   _heapifyUp(size);
12 }
```

Heap.cpp (partial)

```
1  template <class T>
2  void Heap<T>::_heapifyUp( ____________________ ) {
3    if ( index > _____________ ) {
4      if ( item_[index] < item_[ parent(index) ] ) {
5         std::swap( item_[index], item_[ parent(index) ] );
6         _heapifyUp( ____________________ );
7      }
8    }
9  }
```

removeMin:



-	4	5	6	15	9	7	20	16	25	14	12	11			

Heap.cpp (partial)

```
1  template <class T>
2  void Heap<T>::_removeMin() {
3    // Swap with the last value
4    T minValue = item_[1];
5    item_[1] = item_[size_];
6    size--;
7
8    // Restore the heap property
9    heapifyDown();
10
11   // Return the minimum value
12   return minValue;
13 }
```

```
1  template <class T>
2  void Heap<T>::_heapifyDown(int index) {
3    if ( !_isLeaf(index) ) {
4      T minChildIndex = _minChild(index);
5      if ( item_[index] ___ item_[minChildIndex] ) {
6         std::swap( item_[index], item_[minChildIndex] );
7         _heapifyDown( ____________________ );
8      }
9    }
10 }
```

CS 225 – Things To Be Doing:

1. Register for CS 225's Final Exam!
2. Exam #8 (programming, MP4-like and AVL) onging
3. MP5 due Monday, Nov. 6
4. lab_heaps due Sunday, Nov. 5
5. Daily POTDs