CS 225

#22: Heaps and Priority Queues

How might we build a queue where our 'front' is always the min element?

Priority Queue ADT:

insert

remove

isEmpty

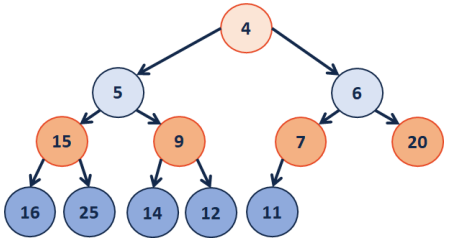
Implementation of PriorityQueue

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

Q1: What errors exist in this table? (Fix them!)

Q2: Which algorithm would we use?

Implementing a (min)Heap as an Array



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

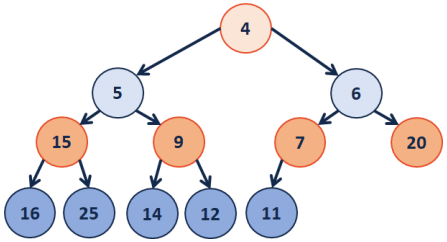
Operations:

leftChild(index) :=

rightChild(index) :=

parent(index) :=

Inserting into a Heap



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

...running time?

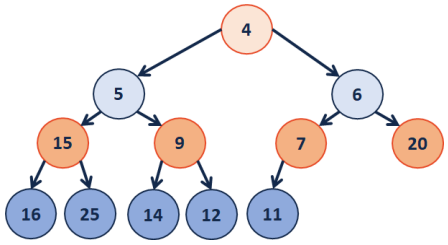
Heap.hpp (partial)

```
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 }
```

```
31 template <class T>
32 void Heap<T>::_heapifyUp( ____________________ ) {
33   if ( index > __________ ) {
34     if ( item_[index] < item_[ parent(index) ] ) {
35       std::swap( item_[index], item_[ parent(index) ]
36 );
37       _heapifyUp( ________________ );
38     }
39   }
40 }
```

What's wrong with this code?

Heap Operation: removeMin / heapifyDown:



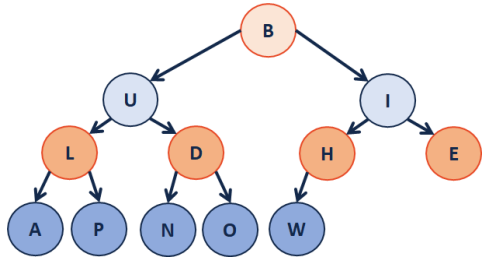
-	4	5	6	15	9	7	20	16	25	14	12	11			

Heap.hpp (partial)

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

Q: How do we construct a heap given data?



-	B	U	I	L	D	H	E	A	P	N	O	W			