CS 2 2 5

#27: Heaps
March 28, 2018 · *Wade Fagen-Ulmschneider*

Analysis of Dictionary-based Data Structures

	Hash Table		AVL	List
	SUHA	Worst Case		
Find	O(1) with load factor	O(n)	O(h) = O(lg n)	O(n)
Insert	O(1)	O(n)	O(h)	O(1)
Storage Space	O(n)		O(n)	O(n)

Data Structures in std library:

- std::map

- std::unordered_map

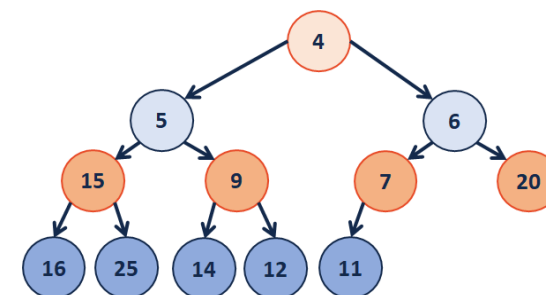## A Secret, Mystery Data Structure:

ADT:
insert

remove

isEmpty

Implementation of ___Prior Queue___

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

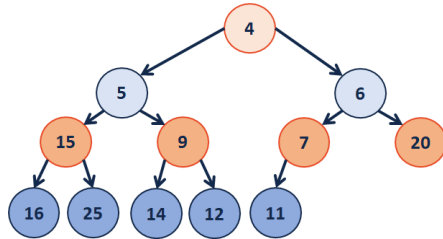**Q1:** What errors exist in this table? (Fix them!)

Q2: Which algorithm would we use?

A New Tree-like Structure:

1. Binary Tree
2. Parent is always smaller than all decedents
3. Complete Tree (always balanced trees)
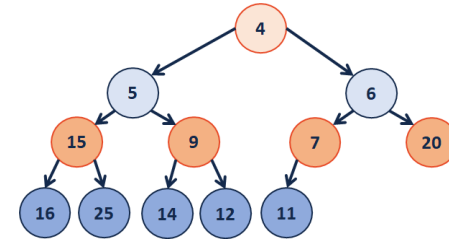4. Recursive structure

Implementing a (min)Heap as an Array

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

Insert:

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

index   0   1   2

leftChild(index):   2 * i + 1 => 2 * i

rightChild(index):   2 * (i + 1) => 2 * i + 1

parent(index):   floor of (i - 1) / 2 => floor of (i / 2)

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

-
-

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  }
```

```
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  }
```

CS 225 – Things To Be Doing:

1. Theory Exam 3 starts next week (Tuesday, April 3rd)
2. MP5 deadline is Monday, April 2nd
3. lab_hash released today; due Sunday, April 1st
4. Daily POTDs are ongoing!