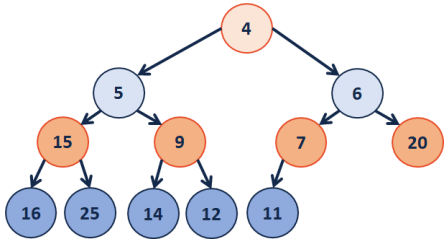
CS 225

#30: Heap Operations

November 6, 2017 · *Wade Fagen-Ulmschneider*

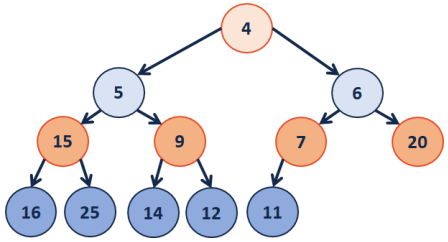
Heap Operation: insert / heapifyUp:



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

Running Time?

Heap Operation: removeMin / heapifyDown:



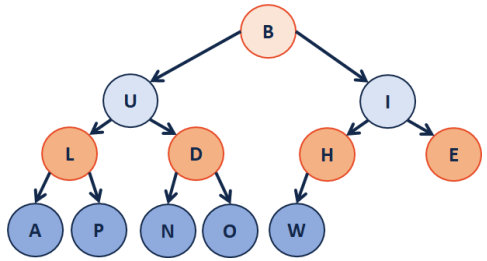
-	4	5	6	15	9	7	20	16	25	14	12	11			

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 }
```

Q: How do we construct a heap given data?



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

An O(n) approach to buildHeap:

Heap.cpp (partial)

```
1  template <class T>
2  void Heap<T>::buildHeap() {
3    for (unsigned i = parent(size); i > 0; i--) {
4      heapifyDown(i);
5    }
6  }
```

Theorem: The running time of buildHeap on array of size n is:

_____.

Strategy:

- We know that constant work is done based on the distance a node is away from the root (eg: it's height).
- Therefore, the running time is proportional to the sum of the heights of the heights of all the nodes.
- We will work towards creating a proof around the sum of the heights of all the nodes.

Define S(h):

Let **S(h)** denote the sum of the heights of all nodes in a complete tree of height **h**.

S(0) =

S(1) =

S(h) =

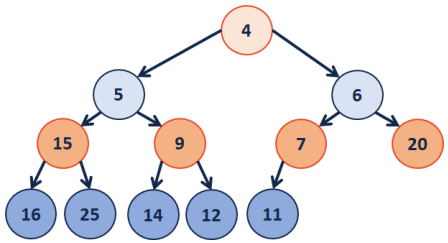
Proof of S(h) by Induction:

Base Case(s):

General Case:

Finally, finding the running time:

Heap Sort



Algorithm:

1.

2.

3.

Running time?

Why do we care about another sort?

CS 225 – Things To Be Doing:
1. Register for CS 225's Final Exam!
2. Exam #9 starts today
3. MP5 due tonight (grace period until tomorrow)
4. New lab on Wednesday
5. Daily POTDs