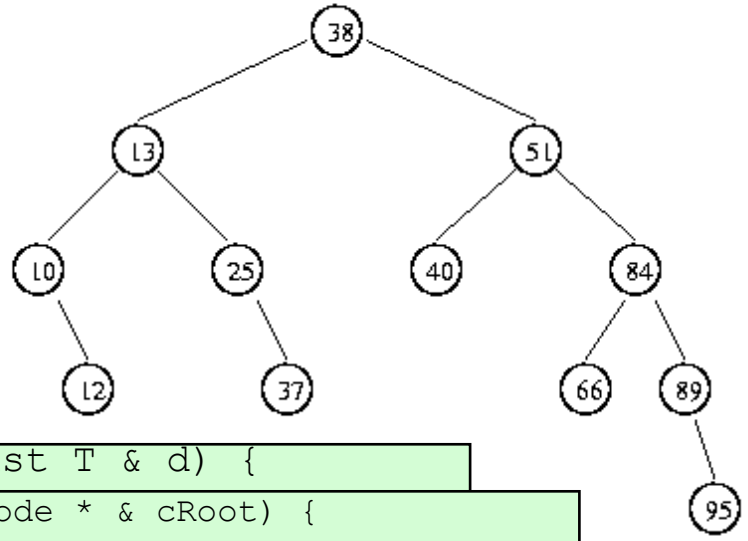
Announcements

MP5 available, due 11/1, 11:59p. EC due 10/25, 11:59p.

http://www.qmatica.com/DataStructures/Trees/AVL/AVLTree.html

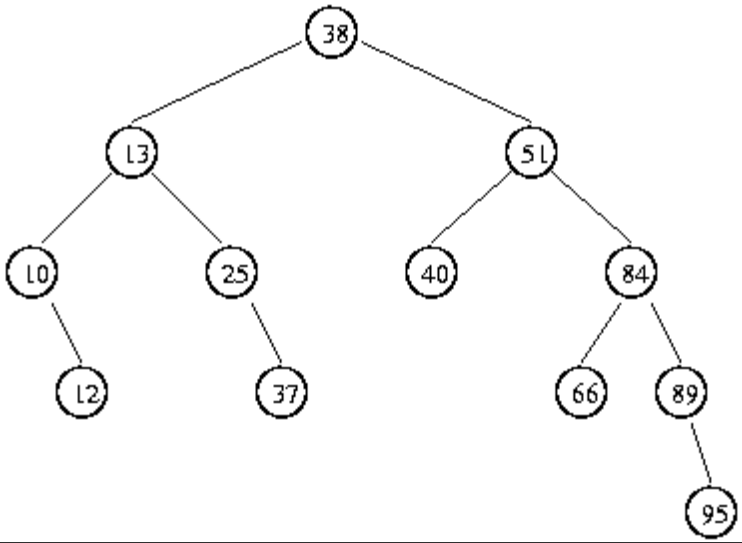



```
void Dict<K,V>::remove(treeNode * & cRoot, const T & d) {
   if (cRoot !=
      if (cRoot
        doRem
      else if (
        remov
      else
        remov
  }
```

```
void Dictionary<K>::doRemoval(treeNode * & cRoot) {
   if ((c
      noC
   else i
      two
   else
      one
}
```

```
void Dict<K,V>::twoChildRemove(treeNode * & cRoot) {
    treeNode *  iop = rightMostChild(cRoot->left);
    cRoot->key = iop->key;
    doRemoval(iop);
}
```

Binary Search Tree - Remove

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void Dictionary<K>::doRemoval(treeNode * & cRoot) {
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   else i
      two
   else
      one
}
```

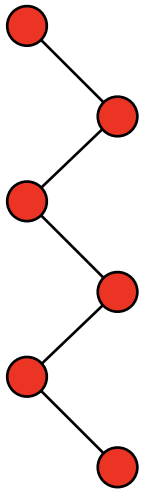
```
void Dict<K,V>::twoChildRemove(treeNode * & cRoot) {
   treeNode *  iop = rightMostChild(cRoot->left);
   cRoot->key = iop->key;
   doRemoval(iop);
}
```

```
treeNode * & Dict<K,V>::rightMostChild(treeNode * & cRoot) {
   if (cRoot->right == NULL) return cRoot;
   else return rightMostChild(cRoot->right);
}
```

Binary Search Tree - miscellaneous characteristics and analysis

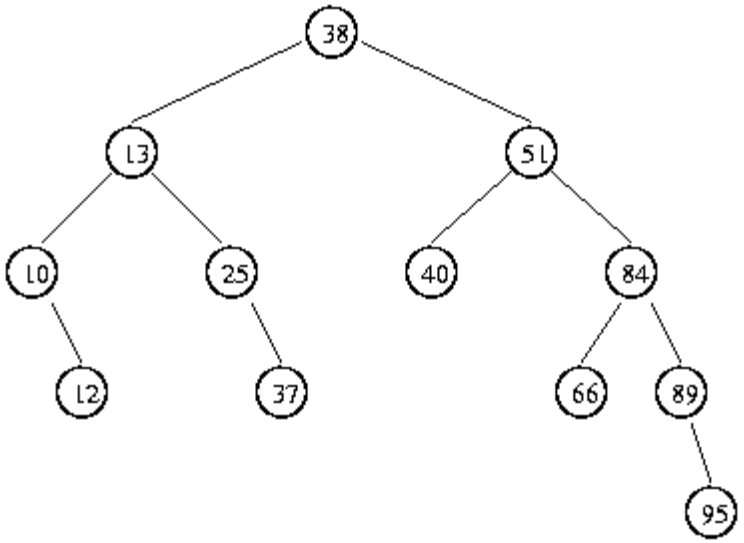
```
BST<int> myT;
myT.insert(2);
myT.insert(7);
myT.insert(15);
myT.insert(22);
myT.insert(28);
…
```

Give a sequence of inserts that result in a tree that looks like:



How many “bad” n-item trees are there?

Binary Tree -



The *algorithms* on BST depend on the height (h) of the tree.

The *analysis* should be in terms of the amt of data (n) the tree contains.

So we need relationships between h and n.

$$h \geq f(n)$$

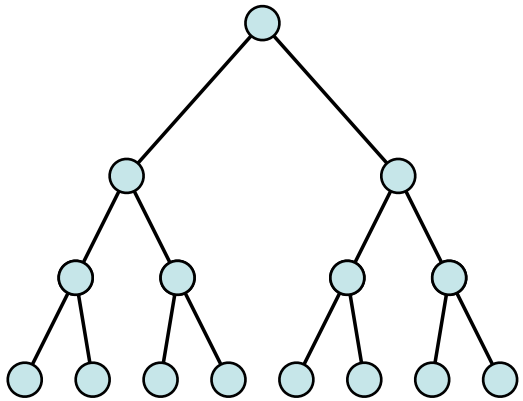
$$h \leq g(n)$$

Reminder:

height(T) is:

- _____ if T is empty
- 1 + max{height(T_L), height(T_R)}, otherwise

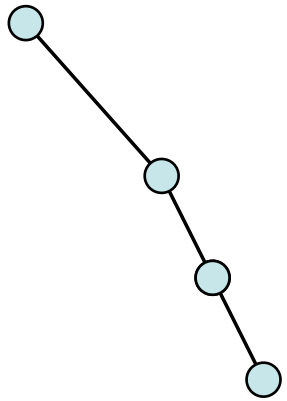
Binary Tree (theory moment #1)



what is maximum number of nodes in a tree of height h?

what is the least possible height (h) for a tree of n nodes?

Binary Tree (theory moment #2)



what is minimum number of nodes (n) in a tree of height h?

what is the greatest possible height (h) for a tree of n nodes?

thus: lower bd on ht _____, upper bd on ht _____, good news or bad?

Binary Search Tree -

The height of a BST depends on the order in which the data is inserted into it.

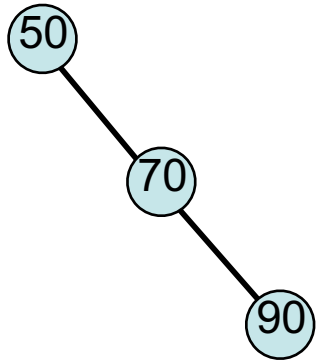
ex. 1 3 2 4 5 7 6 vs. 4 2 3 6 7 1 5

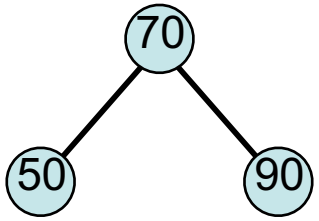
How many different ways are there to insert n keys into a tree?

Avg height, over all arrangements of n keys is _____.

operation	avg case	worst case	sorted array	sorted list
find				
insert				
delete				
traverse				

something new… which tree makes you happiest?





The “height balance” of a tree T is:

$$b = height(T_L) - height(T_R)$$

A tree T is “height balanced” if:

-
-