

Engineering IT Town Hall

Come to the Engineering Tech Services Town Hall and let your voice be heard! The College wants your feedback on:

- **EWS Labs**
- **Remote Access**
- **Software or Hardware Resources**
- **Online Resources (such as Compass 2g)**

When and Where?
TUESDAY, MARCH 12

5:30 PM

100 MSEB

Pizza served to all attendees!

RSVP:



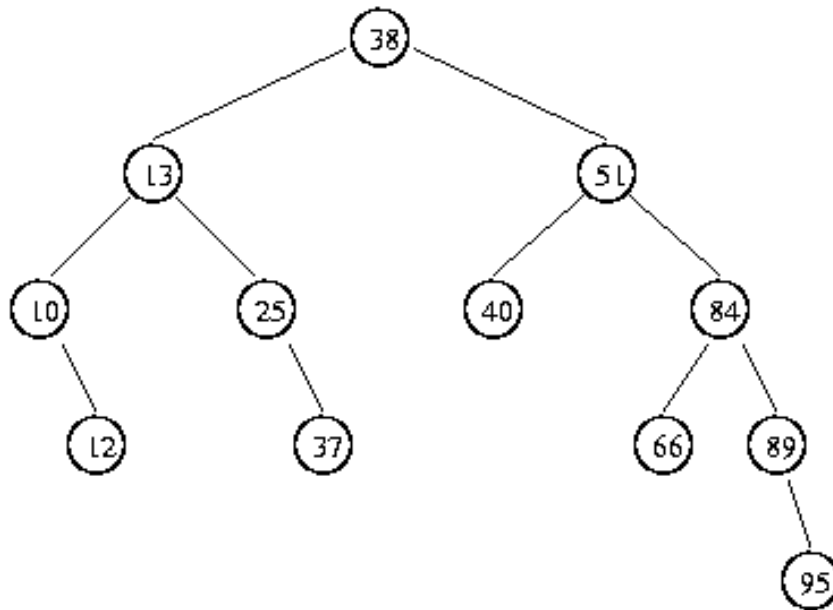
Or:

tinyurl.com/UIUC-IT

Announcements

MP5 available, due 3/29, 11:59p. EC due 3/15, 11:59p.

Code Challenge #2: winners!



Running times:

insert

remove

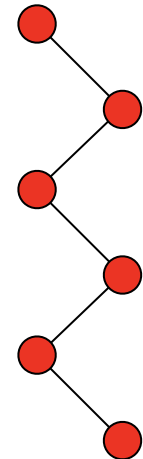
find

traverse

Binary Search Tree - miscellaneous characteristics and analysis

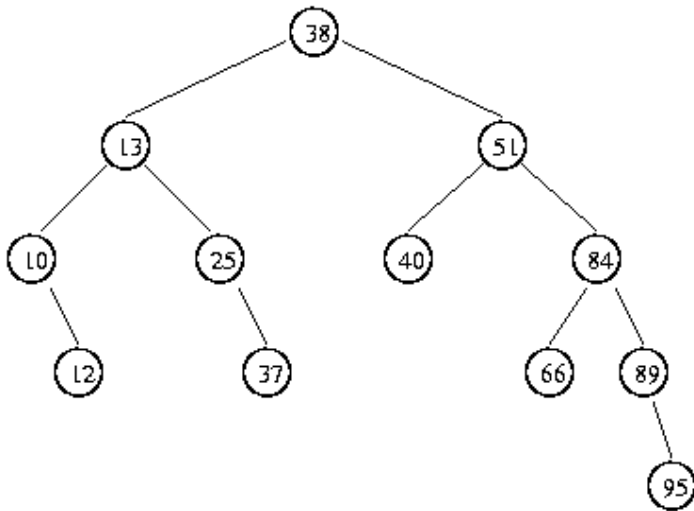
```
BST<int> myT;  
myT.insert(2);  
myT.insert(7);  
myT.insert(15);  
myT.insert(22);  
myT.insert(28);  
...
```

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 a relationship between h and n .

$$h \geq f(n)$$

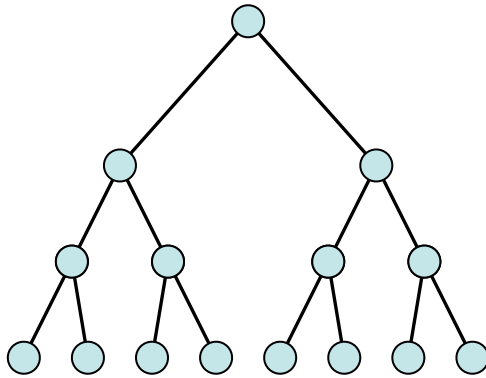
$$h \leq g(n)$$

Reminder:

height(T) is:

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

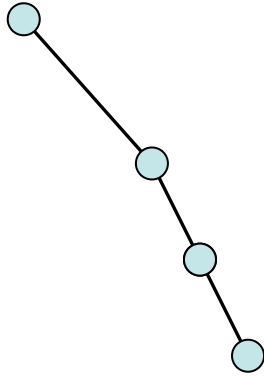
Binary Tree (theory moment #1)



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.

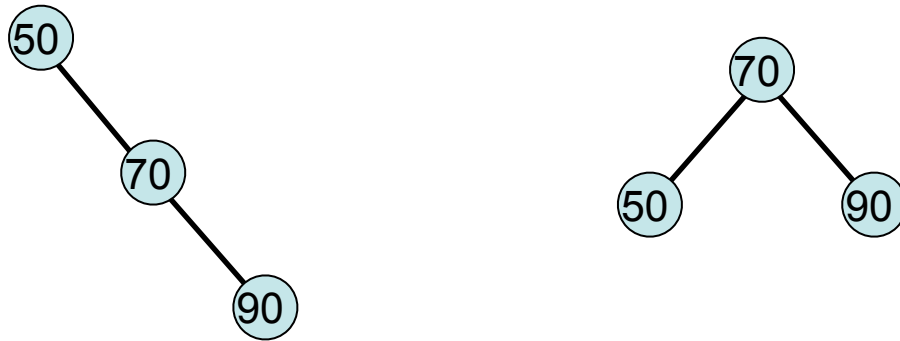
ex. 1 3 2 4 5 7 6 vs. 4 2 3 6 7 1 5

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?



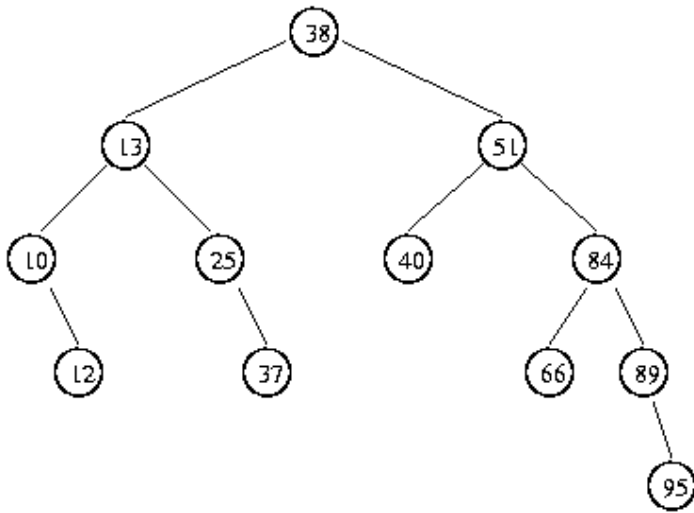
The “height balance” of a tree T is:

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

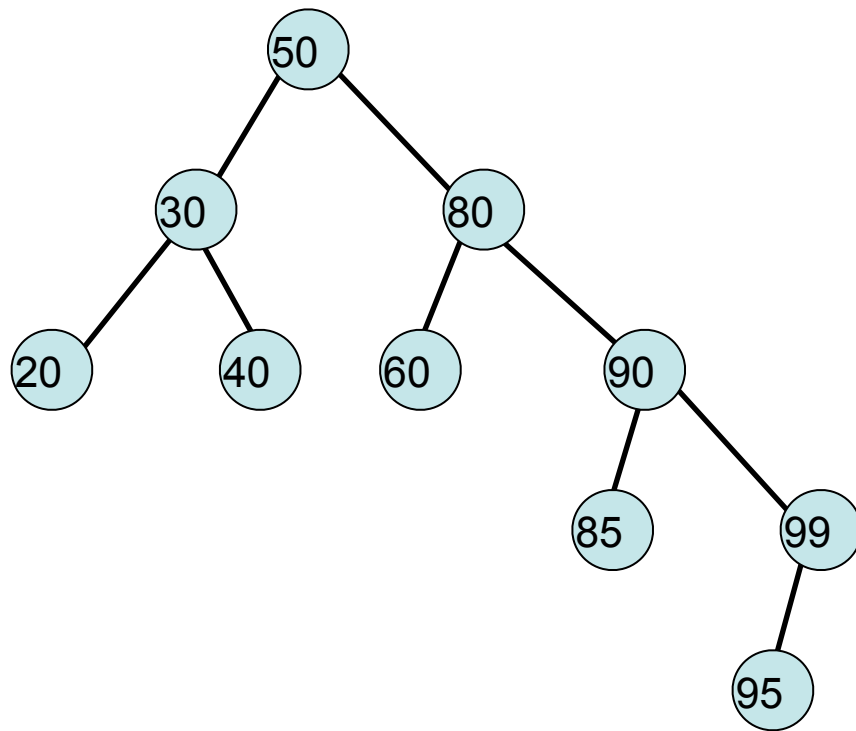
A tree T is “height balanced” if:

-
-

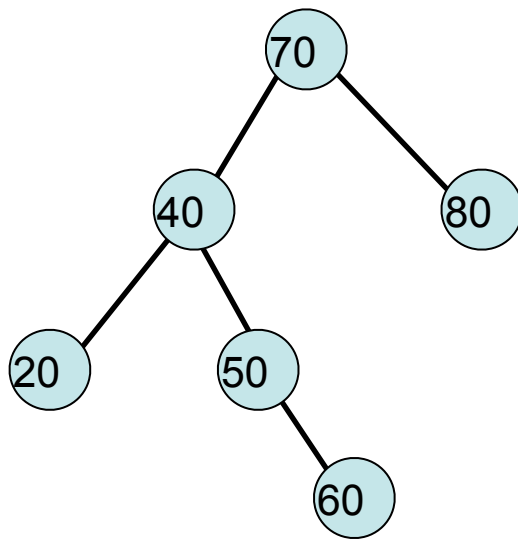
Binary Search Tree - is this tree “height balanced”?



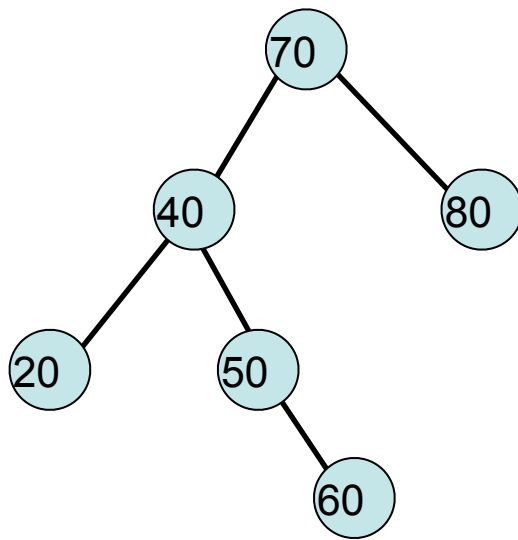
operations on BST - rotations



balanced trees - rotations



balanced trees - rotations



balanced trees - rotations summary:

- there are 4 kinds: left, right, left-right, right-left (symmetric!)
- local operations (subtrees not affected)
- constant time operations
- BST characteristic maintained

GOAL: use rotations to maintain balance of BSTs.

height balanced trees - we have a special name:

Three issues to consider as we move toward implementation:

Rotating

Maintaining height

Detecting imbalance