

### Binary Search Tree (BST) Finale

Q: How does our data determine the height?

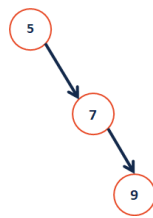
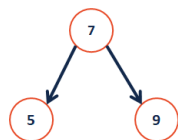
1 3 2 4 5 7 6      vs.      4 2 3 6 7 1 5

Q: How many different ways are there to insert data into a BST?

Q: What is the average height of every arrangement?

operation	BST Avg. Case	BST Worst Case	Sorted Array	Sorted List
find				
insert				
delete				
traverse				

**Height Balance on BST**  
What tree makes you happier?

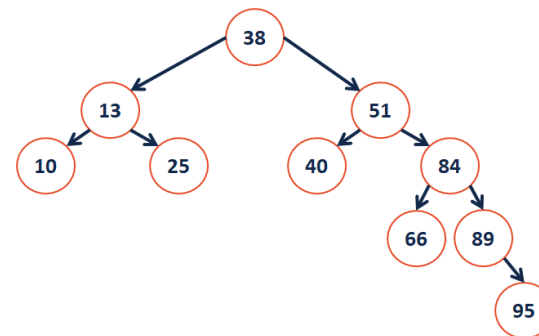


Let us describe the **balance (b)** of a BST to be:

- If **b** is negative:
- If **b** is positive:

We define a BST tree T to be **height balanced** if:

A node is considered to be **out of balance** if it's not height balanced. What is the lowest node that is out of balance?



### Brining a tree back into balance

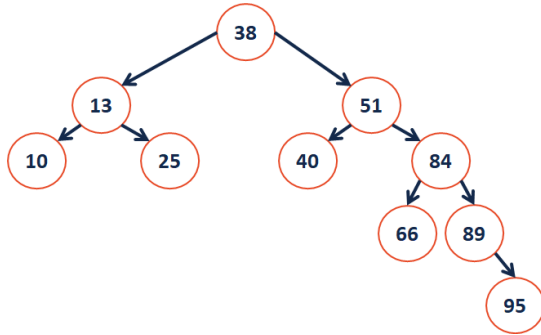
Goal: Create a strategy to bring a BST back into balance after an operation has caused the tree to be out of balance.

A **Tree Rotation** is an operation that maintains two properties:

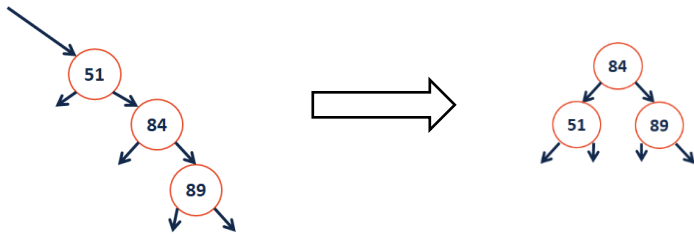
- 1.
- 2.

## Example: Defining a Rotation

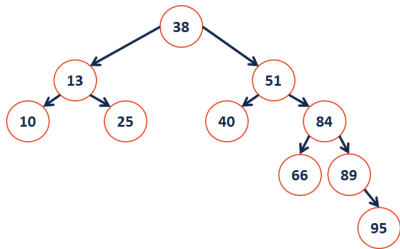
1. Where is the deepest point of imbalance in the following tree?



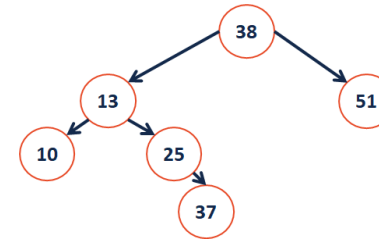
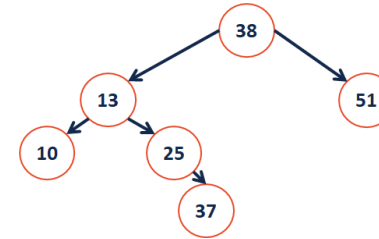
2. Perform a left rotation to balance this tree:



## Implementing a left rotation:



## Example 2: A Complex Rotation



## BST Rotation Summary:

1. Four kinds of rotations (L, R, LR, and RL)
2. All rotations are local
3. All rotations run in constant time,  $O(1)$
4. BST property is maintained!

## Overall Goal:

...and we call these trees:

### CS 225 – Things To Be Doing:

1. Theory Exam 2 starts next Tuesday (topic list is online)
2. MP3 due Monday, Feb. 26; MP4 released on Tuesday
3. lab\_trees is due Sunday, Feb. 25
4. Daily POTDs