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?

<table>
<thead>
<tr>
<th>operation</th>
<th>BST Avg. Case</th>
<th>BST Worst Case</th>
<th>Sorted Array</th>
<th>Sorted List</th>
</tr>
</thead>
<tbody>
<tr>
<td>find</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>insert</td>
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<tr>
<td>delete</td>
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<tr>
<td>traverse</td>
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</tbody>
</table>

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. 

Height Balance on BST

What tree makes you happier?
Example: Defining a Rotation

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

![Tree Diagram]

2. Perform a left rotation to balance this tree:

![Rotation Diagram]

Implementing a left rotation:

Example 2: A Complex Rotation

![Tree Diagram]

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:

<table>
<thead>
<tr>
<th>CS 225 – Things To Be Doing:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Theory Exam 2 starts next Tuesday (topic list is online)</td>
</tr>
<tr>
<td>2. MP3 due Monday, Feb. 26; MP4 released on Tuesday</td>
</tr>
<tr>
<td>3. lab_trees is due Sunday, Feb. 25</td>
</tr>
<tr>
<td>4. Daily POTDs</td>
</tr>
</tbody>
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