

CSE 250 Recitation

November 10 - 11: Balanced Binary Trees



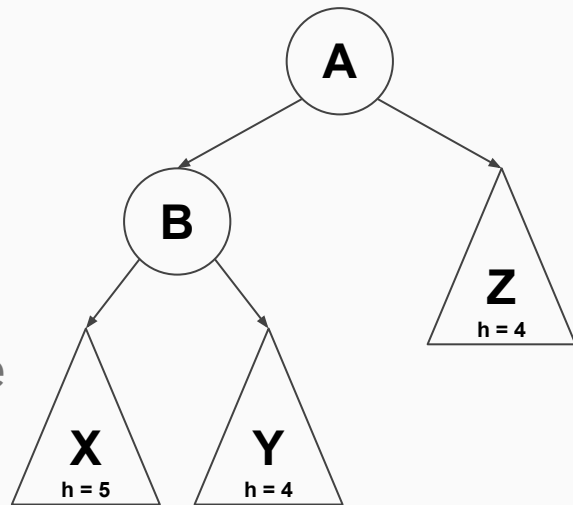
Warm Up

Discussion:

1. What is the height of B? A?
2. What is the balance factor of B? A?

Exercise:

1. Draw the tree after a right rotation around A
2. Answer questions 1 and 2 above for your new tree



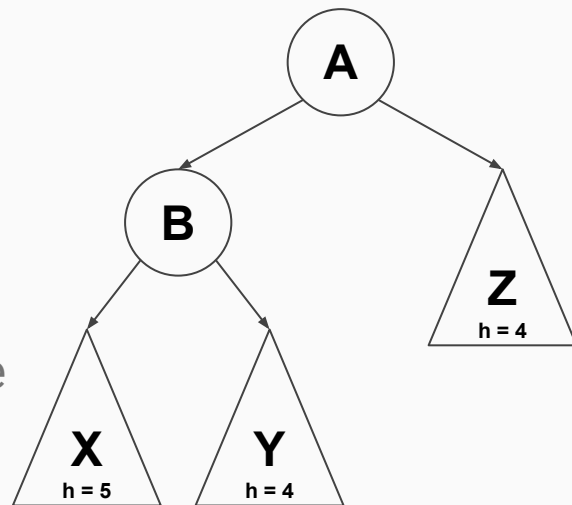
Warm Up

Discussion:

1. What is the height of B? **6** A? **7**
2. What is the balance factor of B? **-1** A? **-2**

Exercise:

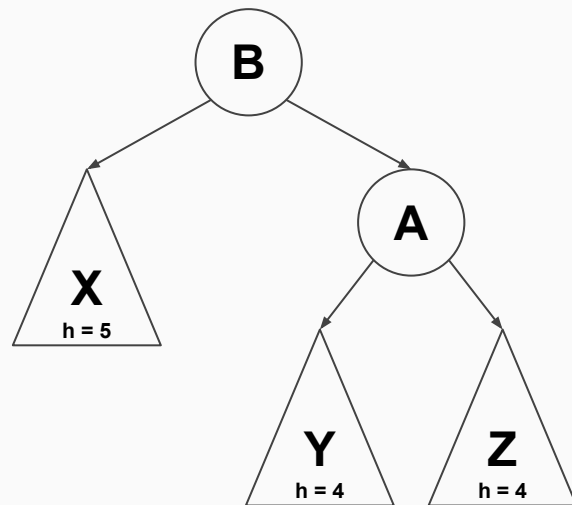
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Warm Up

Discussion:

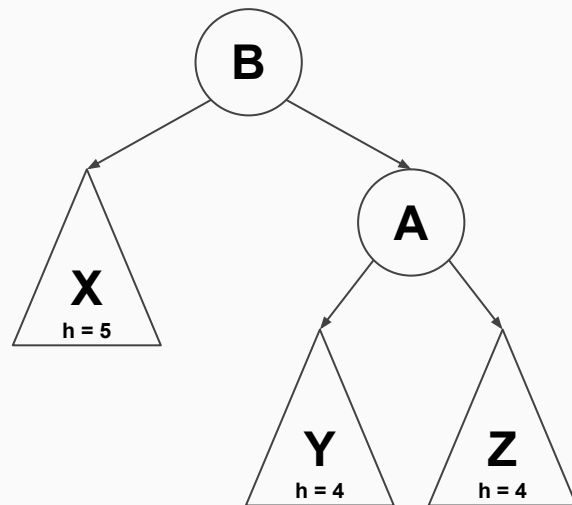
1. What is the height of B? A?
2. What is the balance factor of B? A?



Warm Up

Discussion:

1. What is the height of B? **6** A? **5**
2. What is the balance factor of B? **0** A? **0**

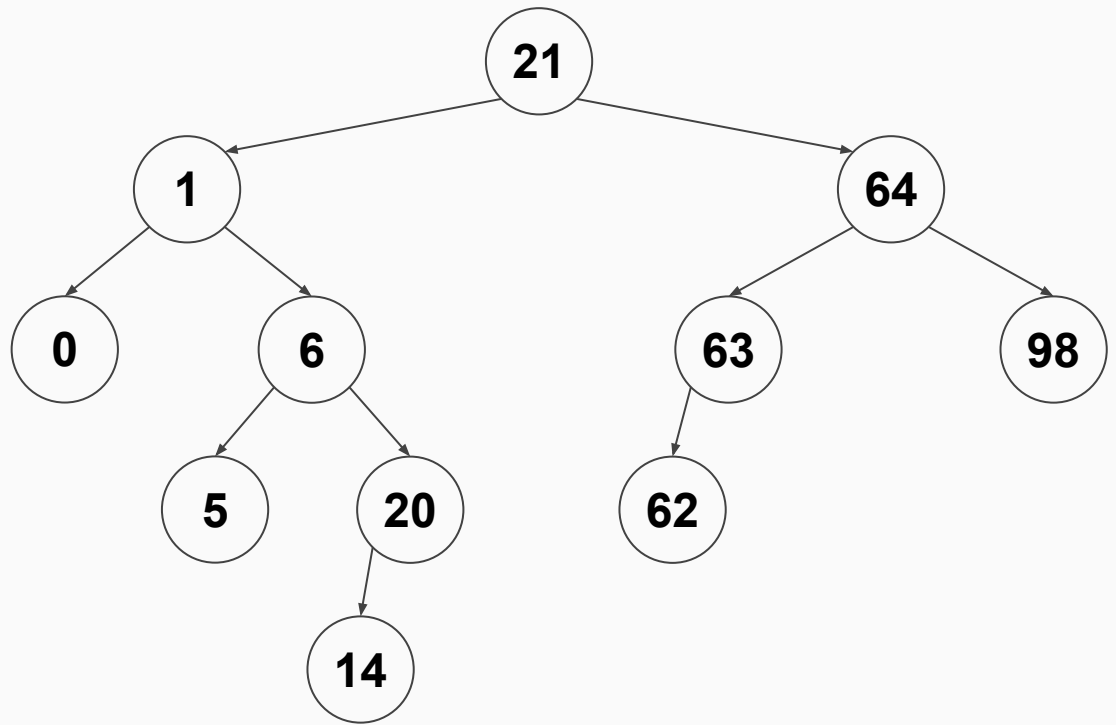


Exercise #2

Determine the balance factor of each node.

Does this tree satisfy AVL tree constraints?

If not, what rotation(s) would fix it?



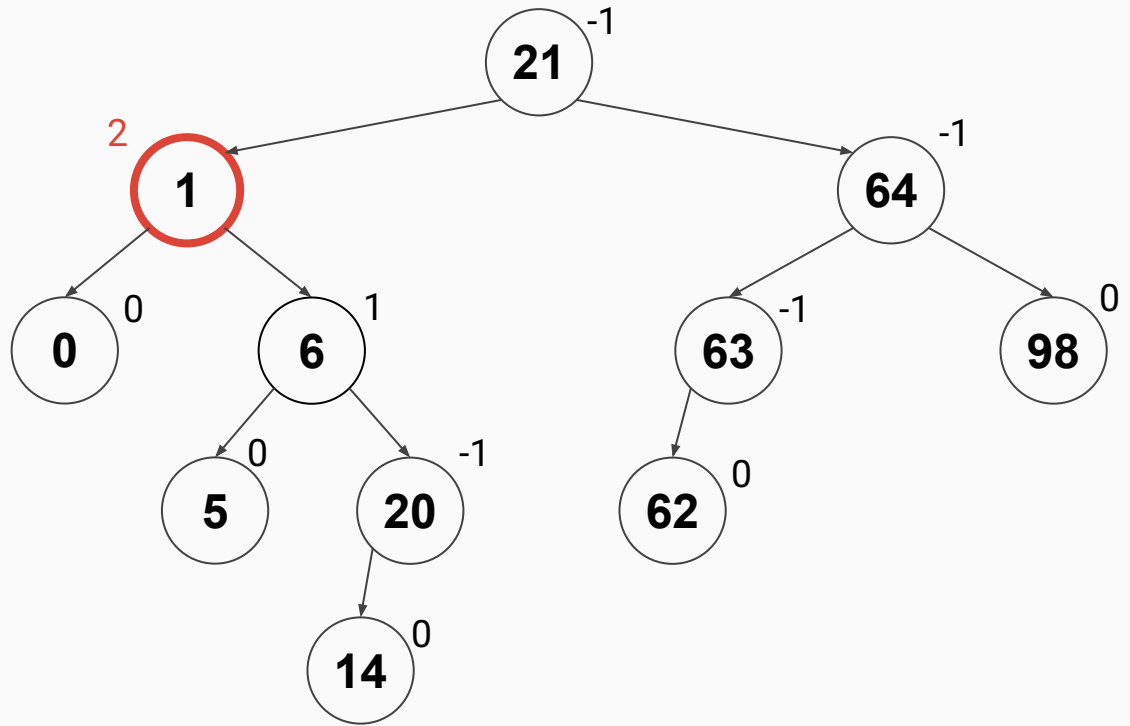
Exercise #2

Determine the balance factor of each node.

Does this tree satisfy AVL tree constraints?

No!

If not, what rotation(s) would fix it?



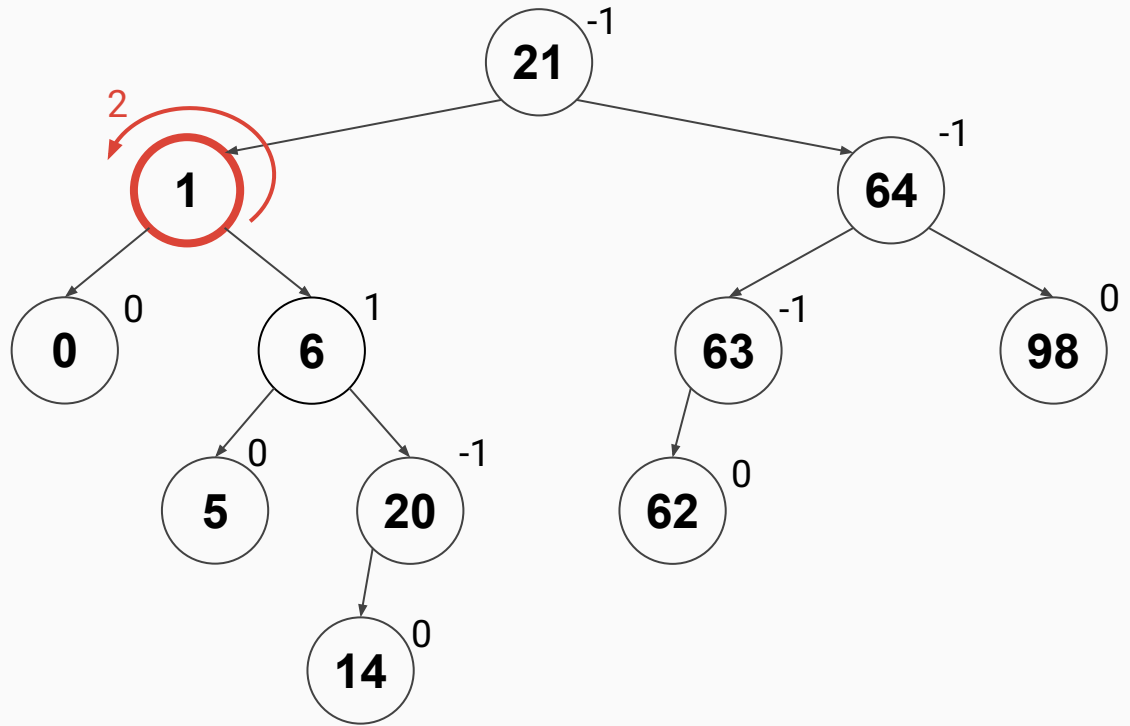
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Rotate left around 1...

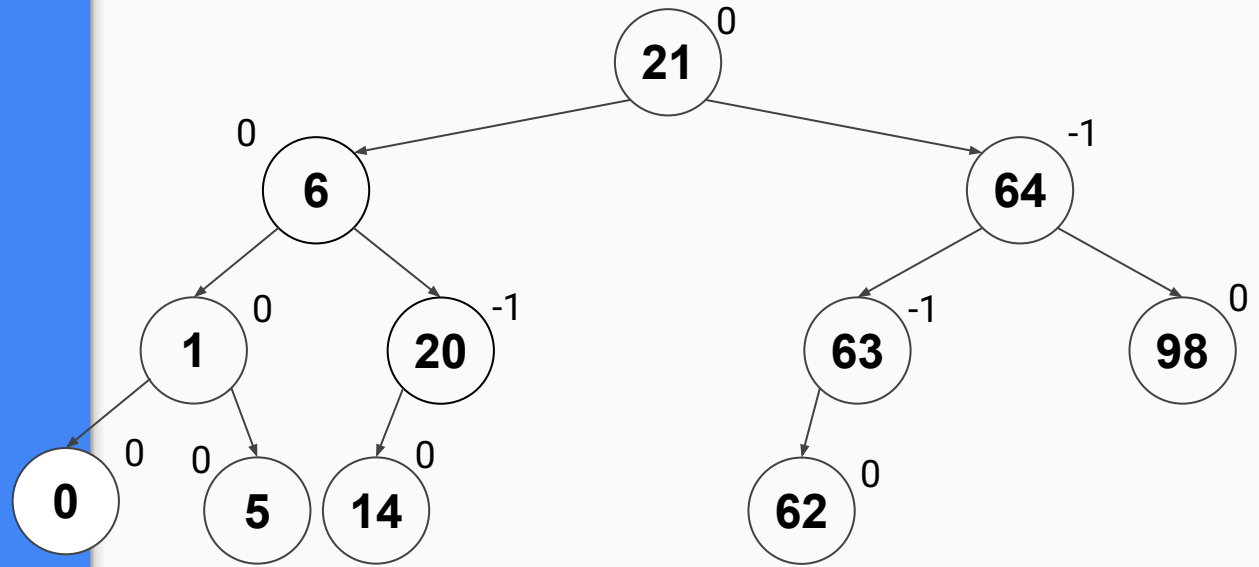
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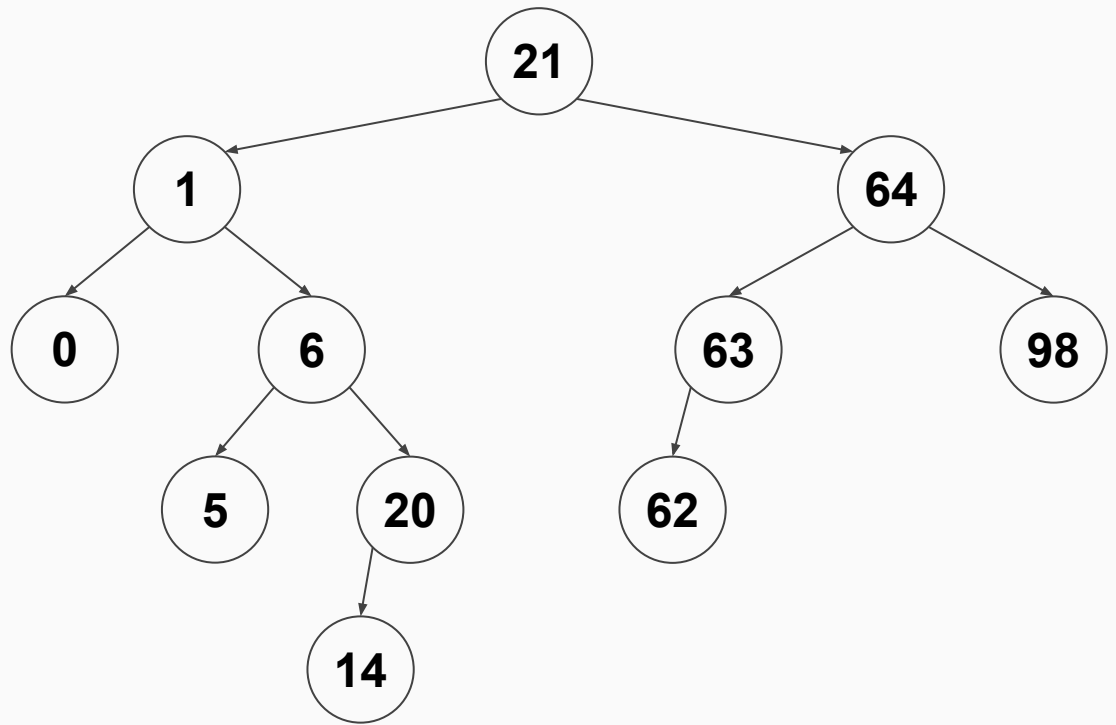


Discussion

Back to this tree!

It doesn't meet AVL constraints...but could it be Red-Black?

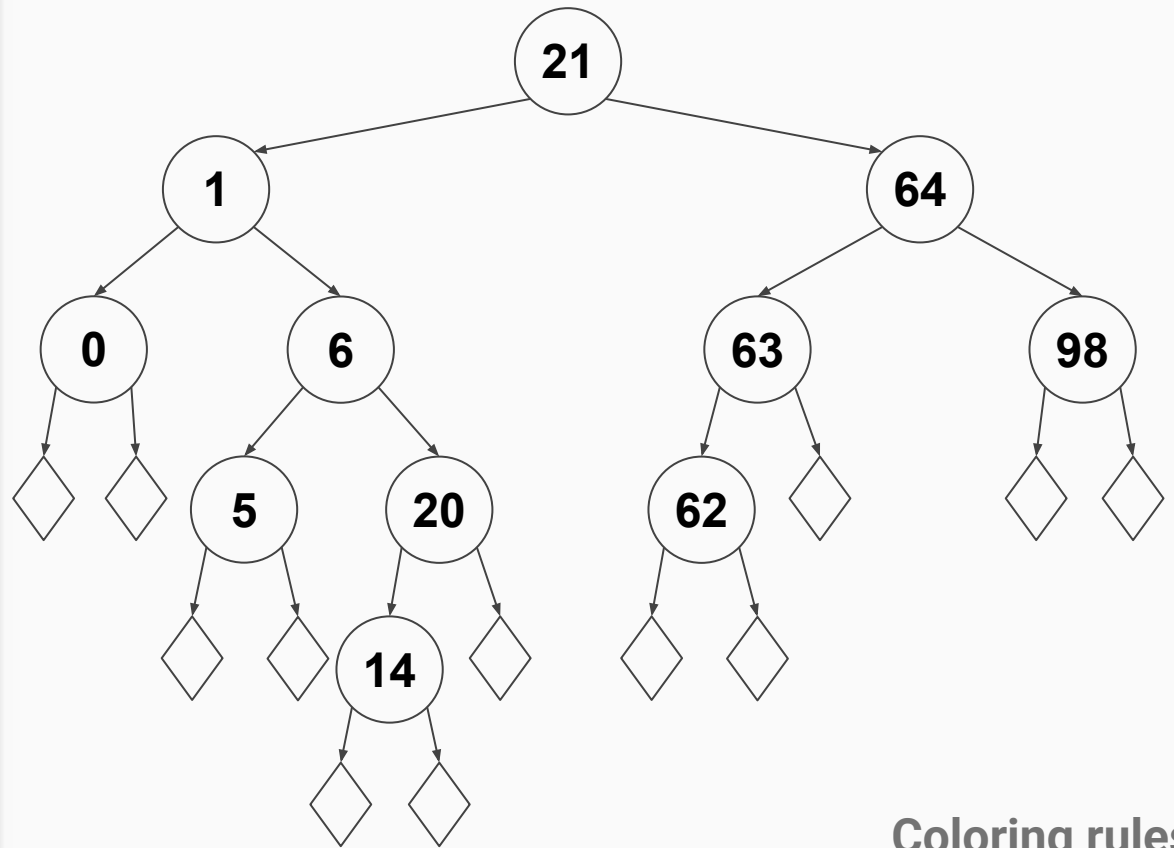
What do we need to check to figure that out?



Exercise #3

Check if depth of the deepest empty node is at most 2x the shallowest for EVERY subtree.

Equivalently, see if the tree can be colored.



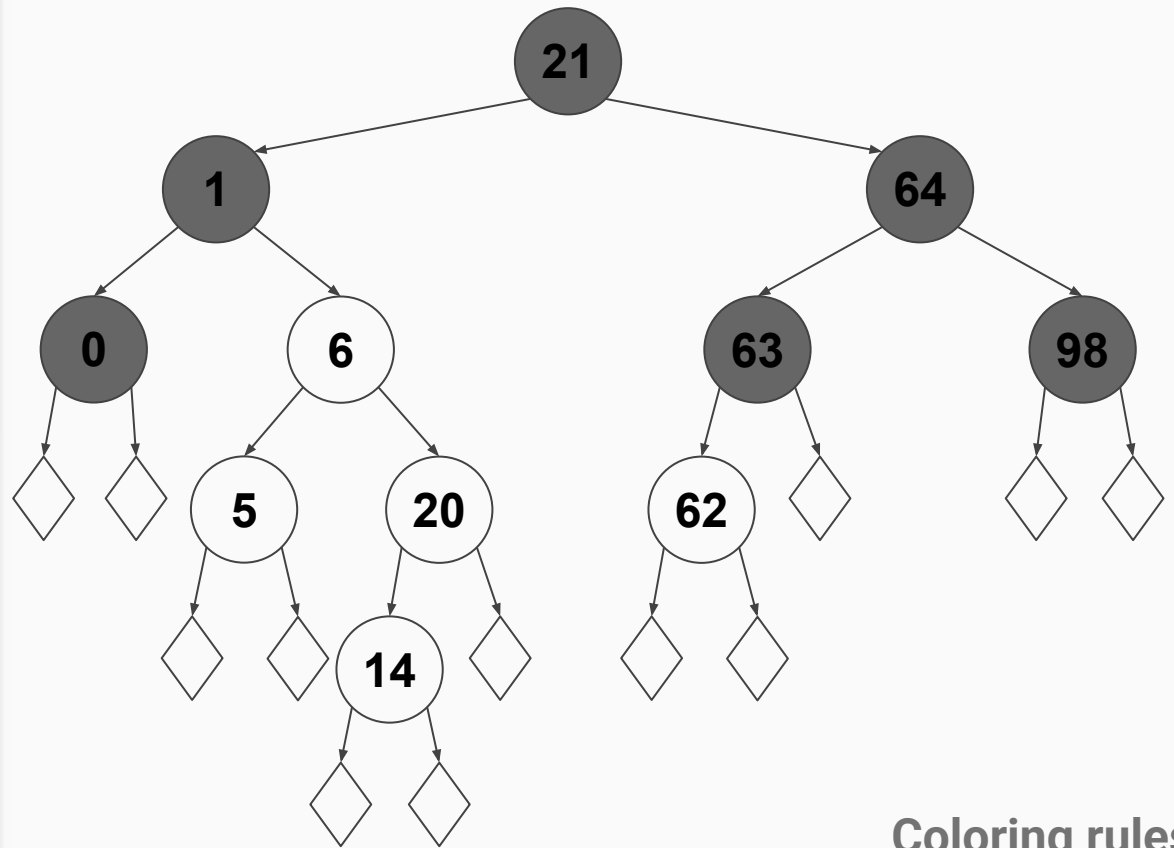
**ALWAYS DRAW YOUR
EMPTY TREE NODES!**

Coloring rules:
Equal # of black nodes from
empty node to root
No red-red connections

Exercise #3

Check if depth of the deepest empty node is at most 2x the shallowest for EVERY subtree. **IT IS!**

Equivalently, see if the tree can be colored.



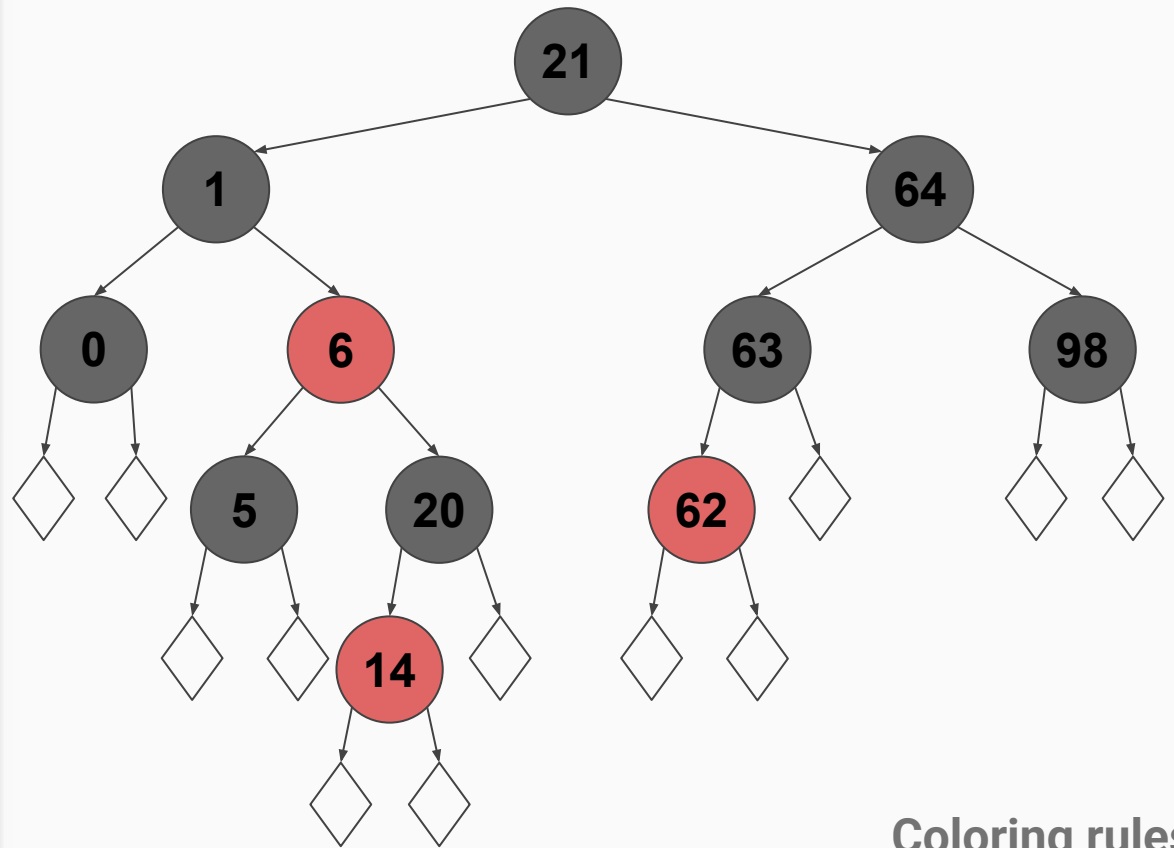
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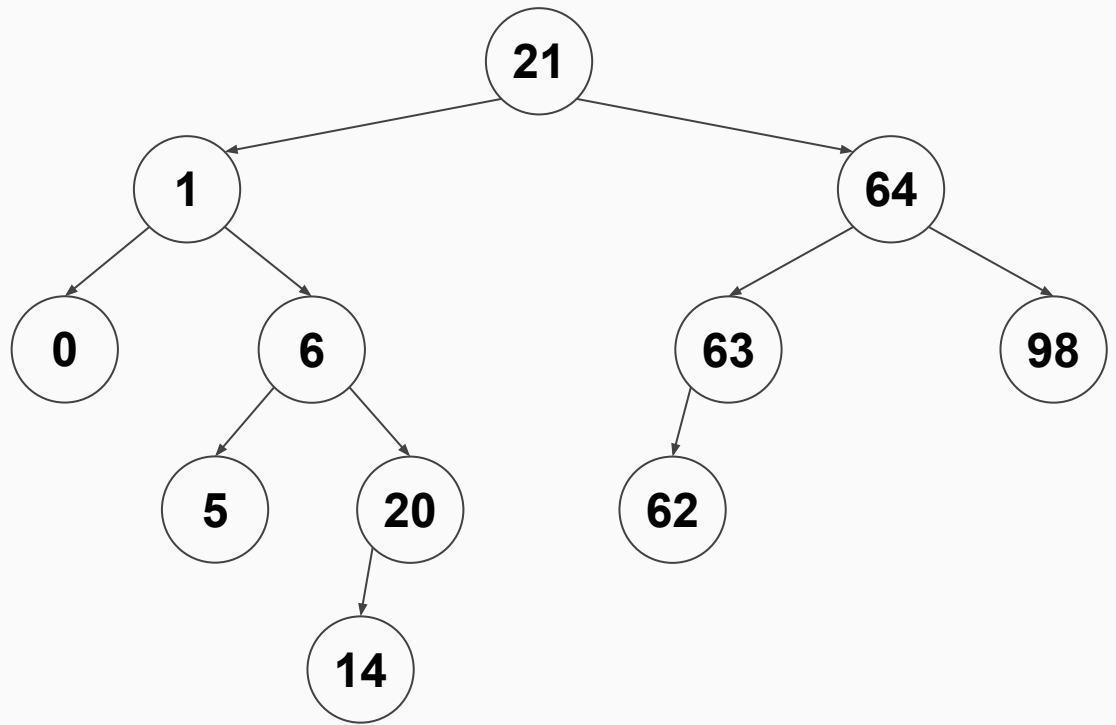


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Discussion

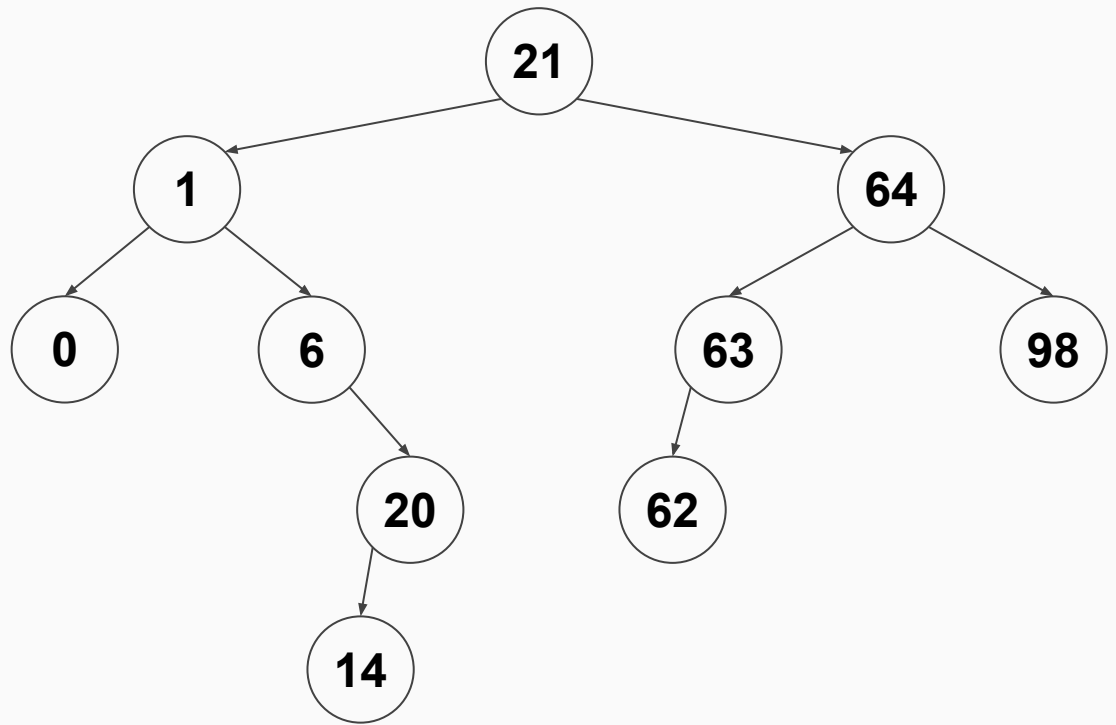
What if we remove the 5?



Discussion

What if we remove the 5?

Could this still be Red-Black?

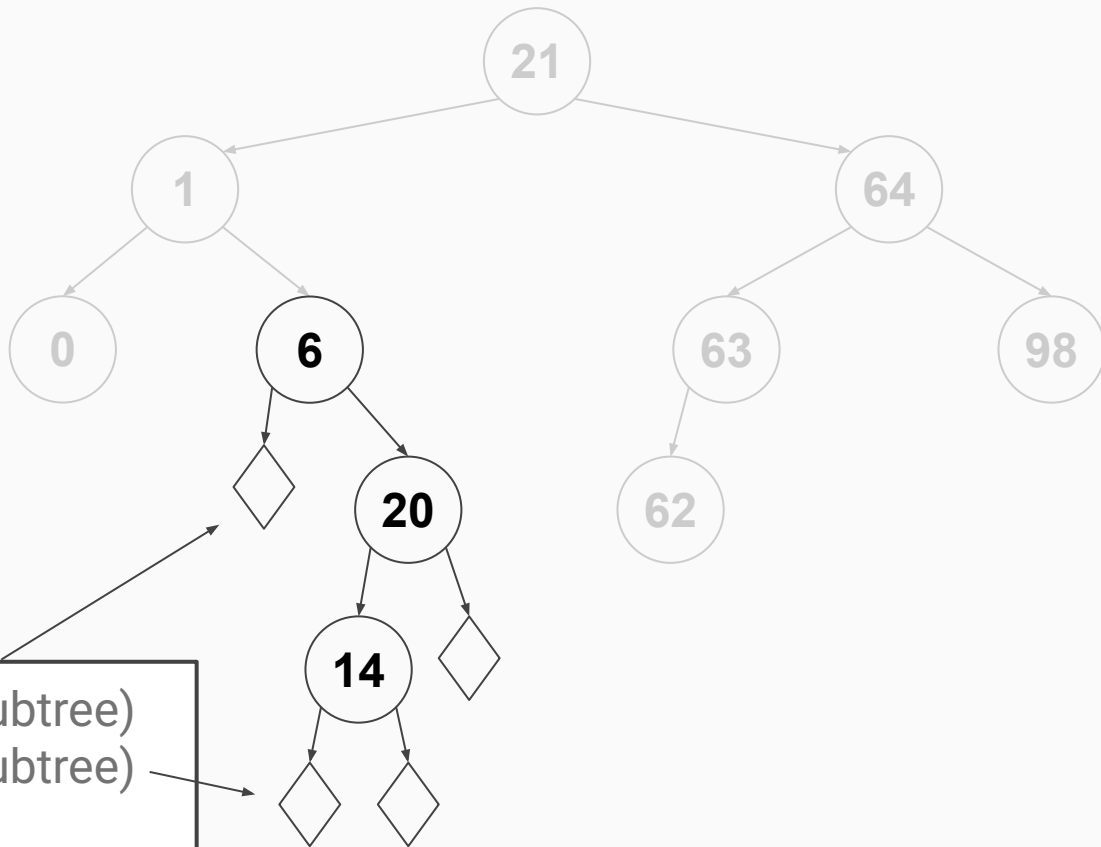


Discussion

What if we remove the 5?

Could this still be Red-Black? **NO!**

Depth 1 (in this subtree)
Depth 3 (in this subtree)
 $3 \not\leq 1 \cdot 2$



Remember: All subtrees must also be Red-Black trees as well!