CS 61BL Summer 2021

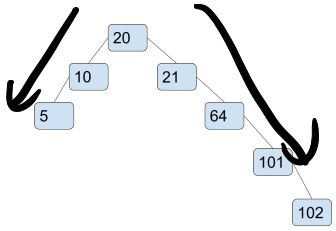
Balanced Search

Quiz 7: Wednesday July 21, 2021

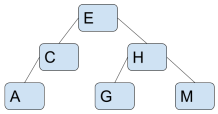
1 Binary Search Trees

Which of the following represent valid Binary Search Trees? Select the letter corresponding to **all valid BSTs**.

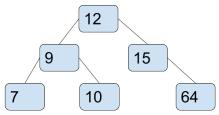
A



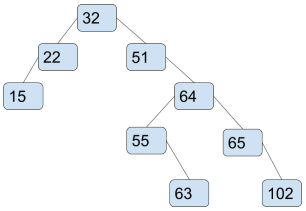
B



C

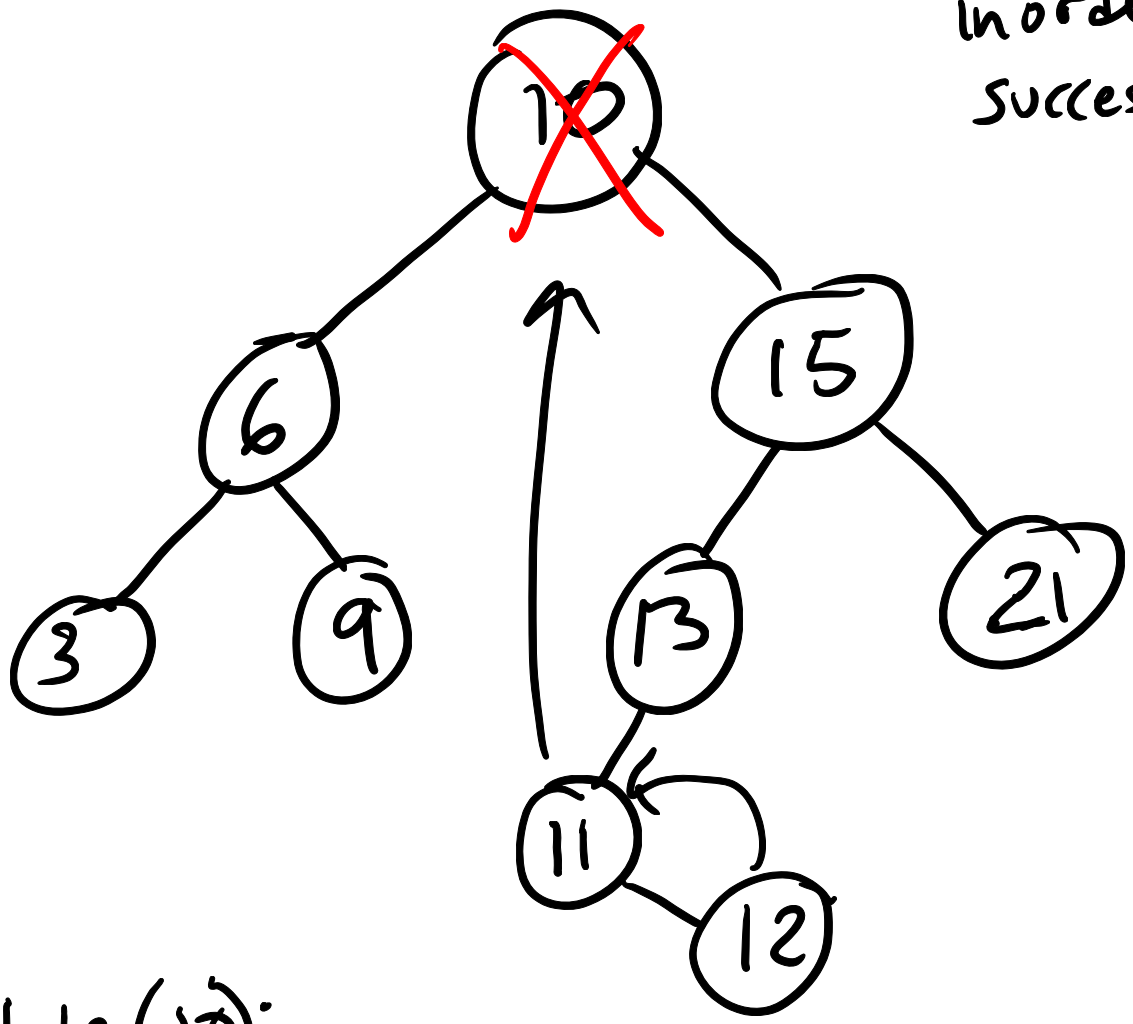


D



[ ] A [ ] B [ ] C [ ] D

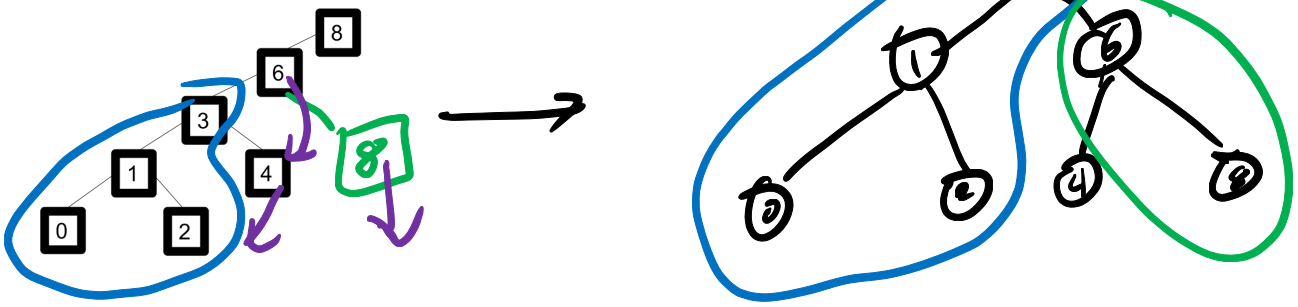
inorder succession



delete(10):
move 11, move 12 to 11 to 10

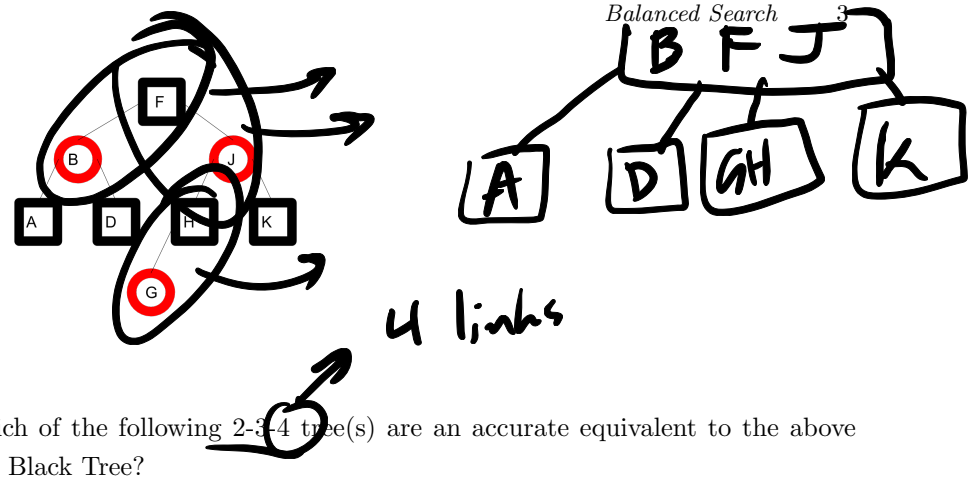
2 Balancing Trees

(a) We are given the following extremely unbalanced search tree.



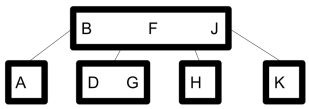
Select the minimum number of rotations in the correct order required to balance this tree. *Hint*: The resulting tree should have two layers of nodes below the root.

[ ] Rotate left on 8
[ ] Rotate right on 8
[ ] Rotate left on 6
[ ] Rotate right on 6
[ ] Rotate left on 4
[ ] Rotate right on 4
[ ] Rotate left on 3
[ ] Rotate right on 3
[ ] Rotate left on 2
[ ] Rotate right on 2
[ ] Rotate left on 1
[ ] Rotate right on 1
[ ] Rotate left on 0
[ ] Rotate right on 0

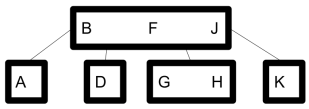


(b) Which of the following 2-3-4 tree(s) are an accurate equivalent to the above Red Black Tree?

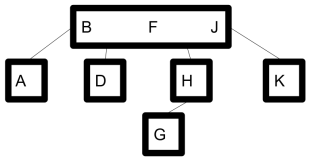
A



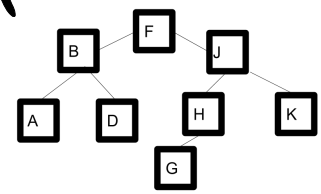
B



C



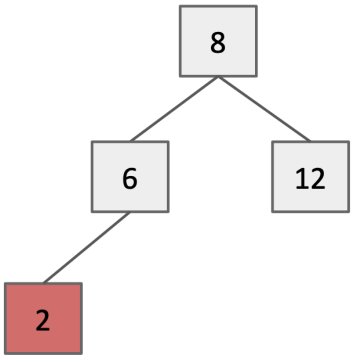
D



[ ] A
[ ] B
[ ] C
[ ] D

3 LLRB Insertions

Suppose that we have the LLRB below. Note that `2` is the only red node.



Each subpart below is *dependent* of the previous parts. Recall a fixup is one of the following.

- `rotateRight`
- `rotateLeft`
- `colorFlip`
- change the color of the root node to black

a) Insert 4 into the LLRB. List the needed fixups in the correct order.

[ ] `rotateLeft(2)`
[ ] `rotateRight(2)`
[ ] `rotateLeft(4)`
[ ] `rotateRight(2)`
[ ] `rotateLeft(6)`
[ ] `rotateRight(6)`
[ ] `rotateLeft(4)`
[ ] `rotateRight(4)`
[ ] `colorFlip(2)`
[ ] `colorFlip(4)`
[ ] `colorFlip(6)`
[ ] change the root color to black

b) Next, let's insert 7. List the needed fixups in the correct order. Note that 4 has already been inserted

[ ] `rotateLeft(7)`
[ ] `rotateRight(7)`
[ ] `rotateLeft(6)`
[ ] `rotateRight(6)`
[ ] `rotateLeft(8)`
[ ] `rotateRight(8)`
[ ] `colorFlip(6)`
[ ] `colorFlip(7)`
[ ] `colorFlip(8)`
[ ] change the root color to black

c) Finally, what integer, when inserted, would increase the height of the corresponding 2-3 tree? If multiple integers would work, put any. Note that 4 and 7 have been inserted. You may not insert a duplicate.

`integer = __________`