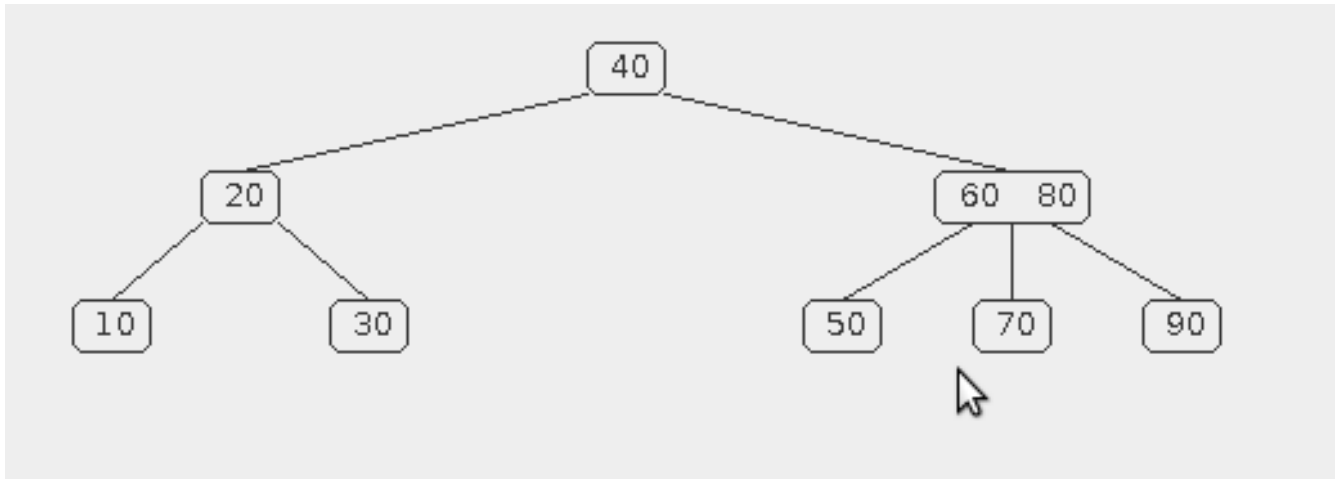


Supplementary Exercises: 2-4 Deletion

Exercise #1:

Delete **30** from the following 2-4 tree.



Solution:

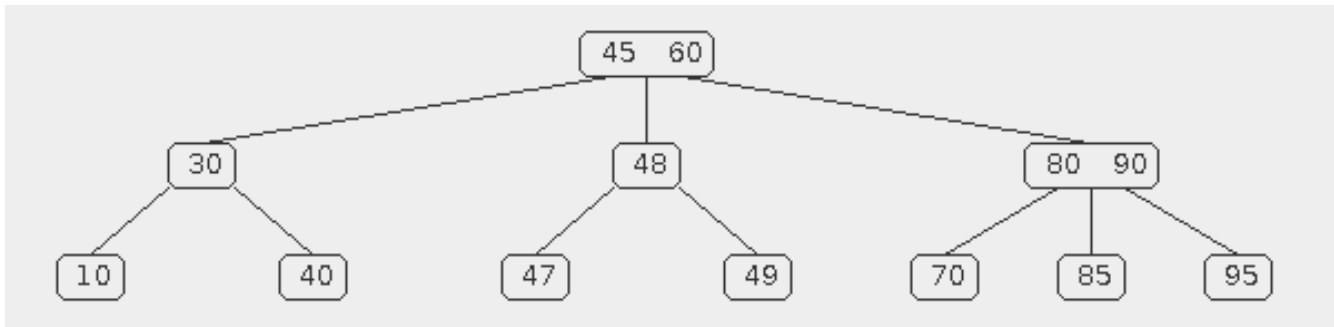
1. Fuse 10 and empty 30 node.
2. Move 20 down into that fused node.
3. The empty 20 node borrows from its sibling.
4. 40 comes down, 60 moves up, and a child has to switch allegiances.

Final 2-4 Tree:



Exercise #2:

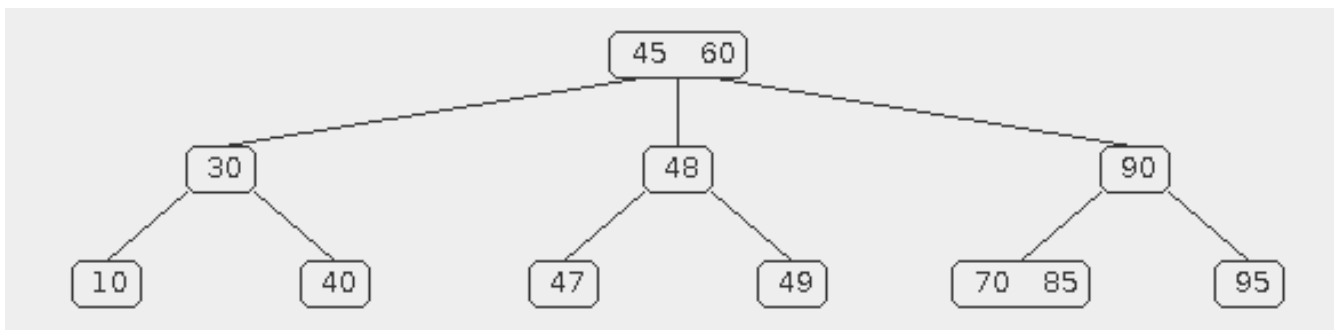
Delete **80** from the following 2-4 tree:



Solution:

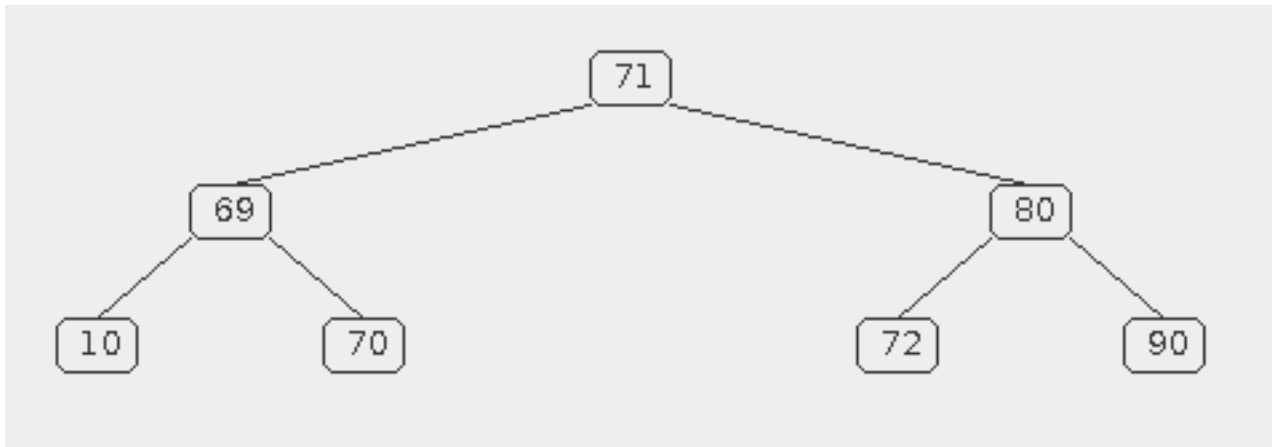
1. 70 moves up (max of 80's left subtree).
2. We now proceed as we would have if we had been deleting the original 70:
 - a. The node that once contained 70 is empty, and we cannot perform a transfer because it has no siblings with multiple values. We eliminate node by fusing it with 85.
 - b. The parent (70) moves down to take the empty position left by deleted value.

Final 2-4 Tree:



Exercise #3:

Delete **10** from the following 2-4 tree:



Solution:

1. Fuse 70 with empty 10 node.
2. Move 69 down into that fused node.
3. Fuse the now-empty node where 69 used to be located with the node where 80 is located.
4. Fuse 71 and 80.

Final 2-4 Tree:

