AVL TREES

COP 3502

Deletion from an AVL Tree

- First, do a normal Binary Search Tree Delete:
  - If the node is a leaf, remove it.
  - If it has 1 child, replace with its child
  - If it has 2 children, replace with the largest in its left subtree (inorder predecessor) and remove that node.

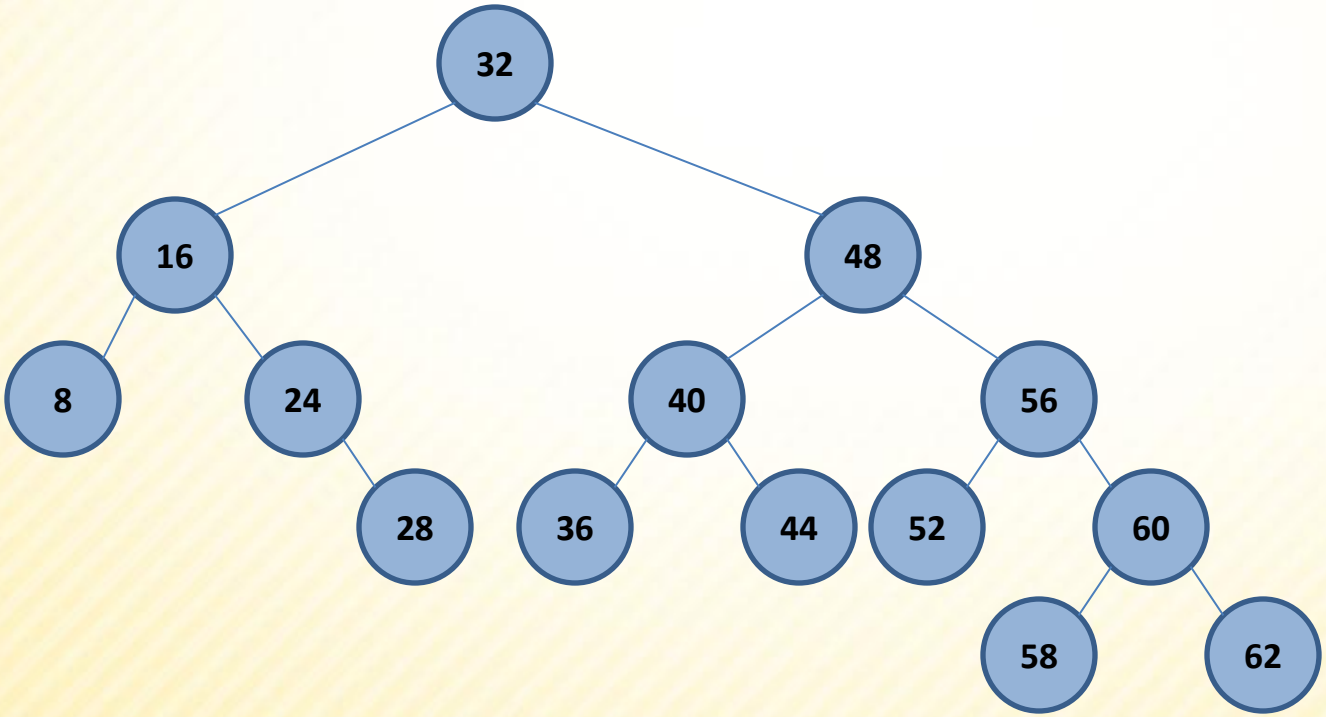
  - After deletion, retrace the path back up the tree, starting with the parent of the replacement, to the root, adjusting the balance factor as needed.

Deletion from an AVL Tree

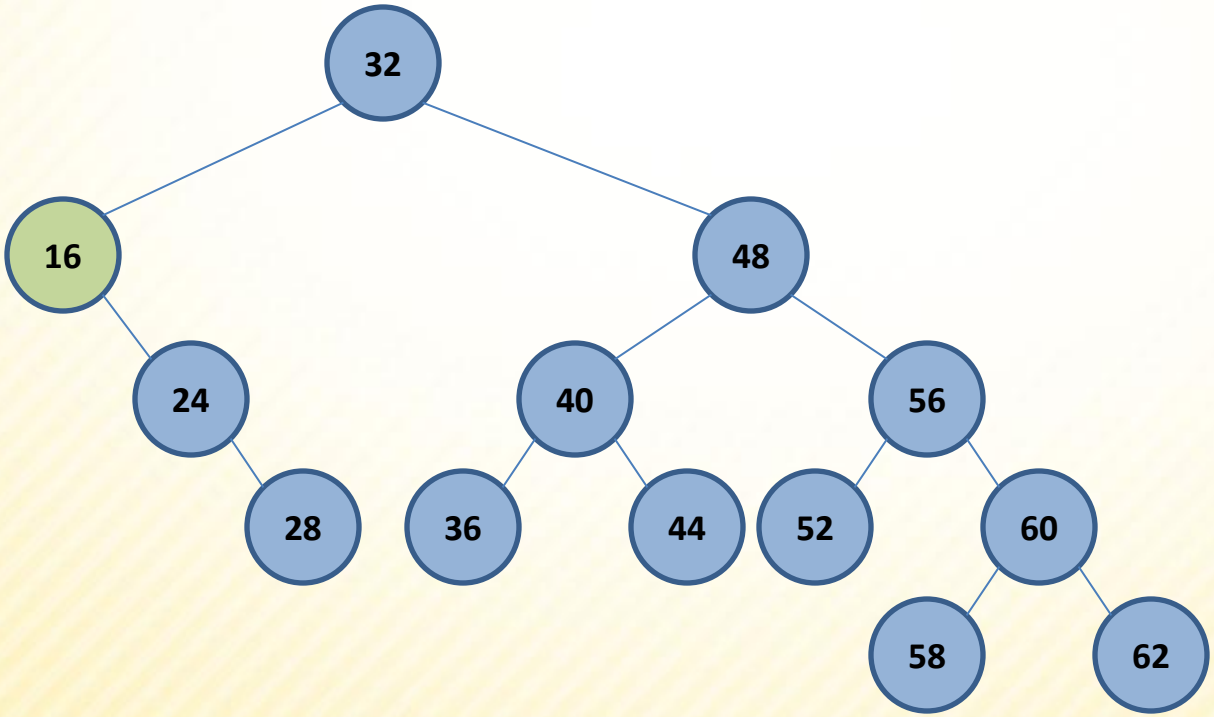
- In an insert there is at most one node that needs to be rebalanced.
  - But in a delete there may be multiple nodes to be rebalanced.
  - Technically only one rebalance that happens at a node, but once that happens it may affect the ancestral nodes.

Deletion Example

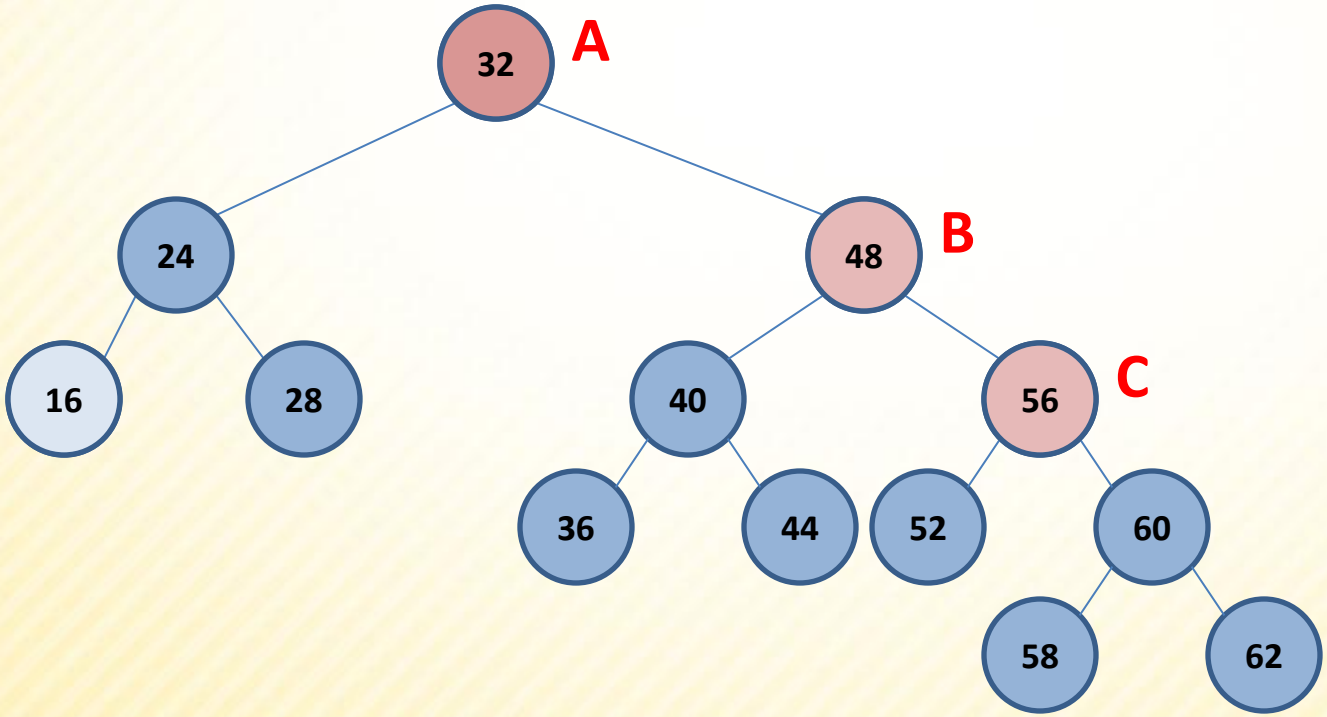
- Delete 8:



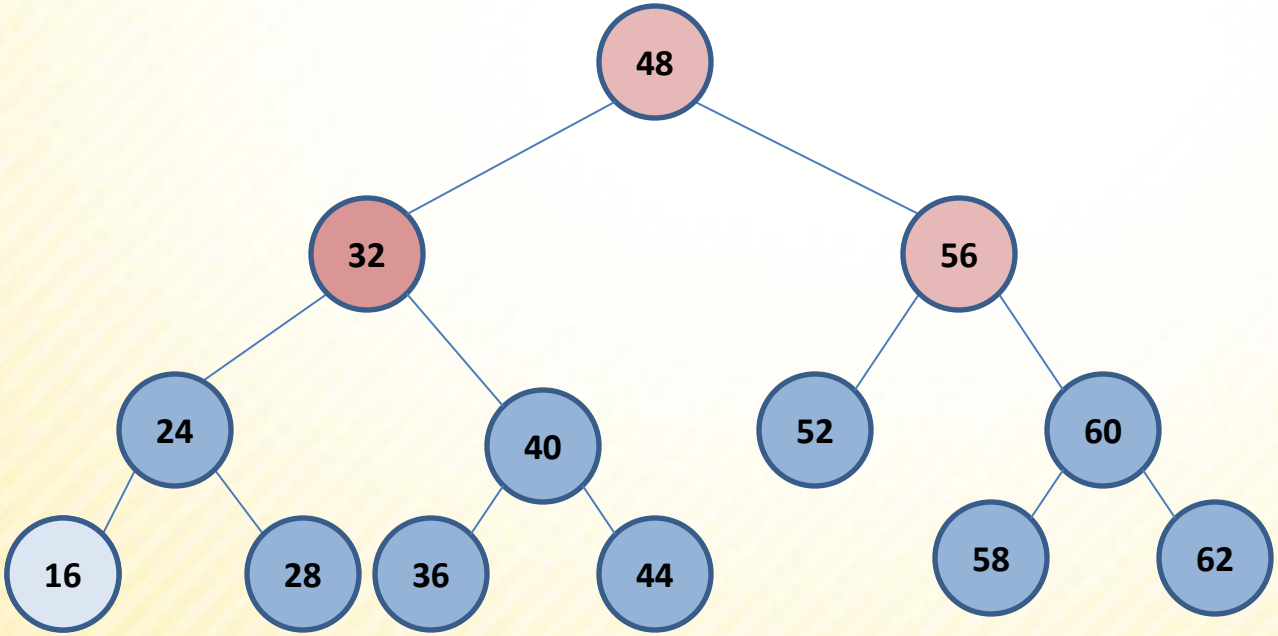
Deletion Example



Deletion Example

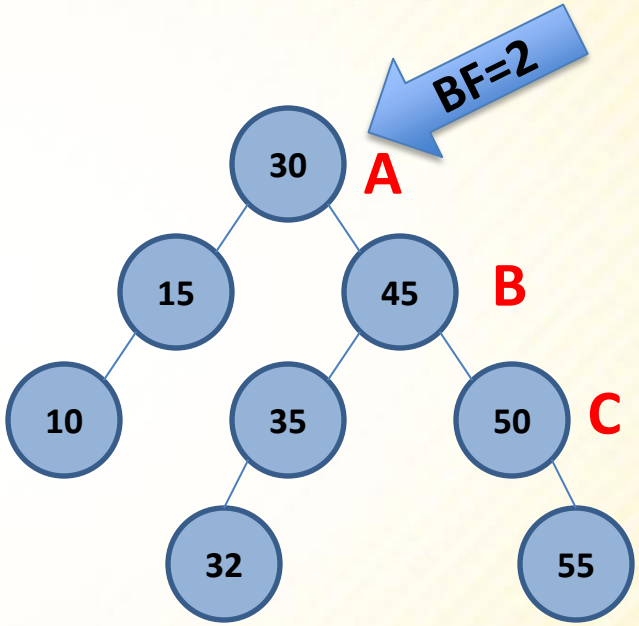


Deletion Example



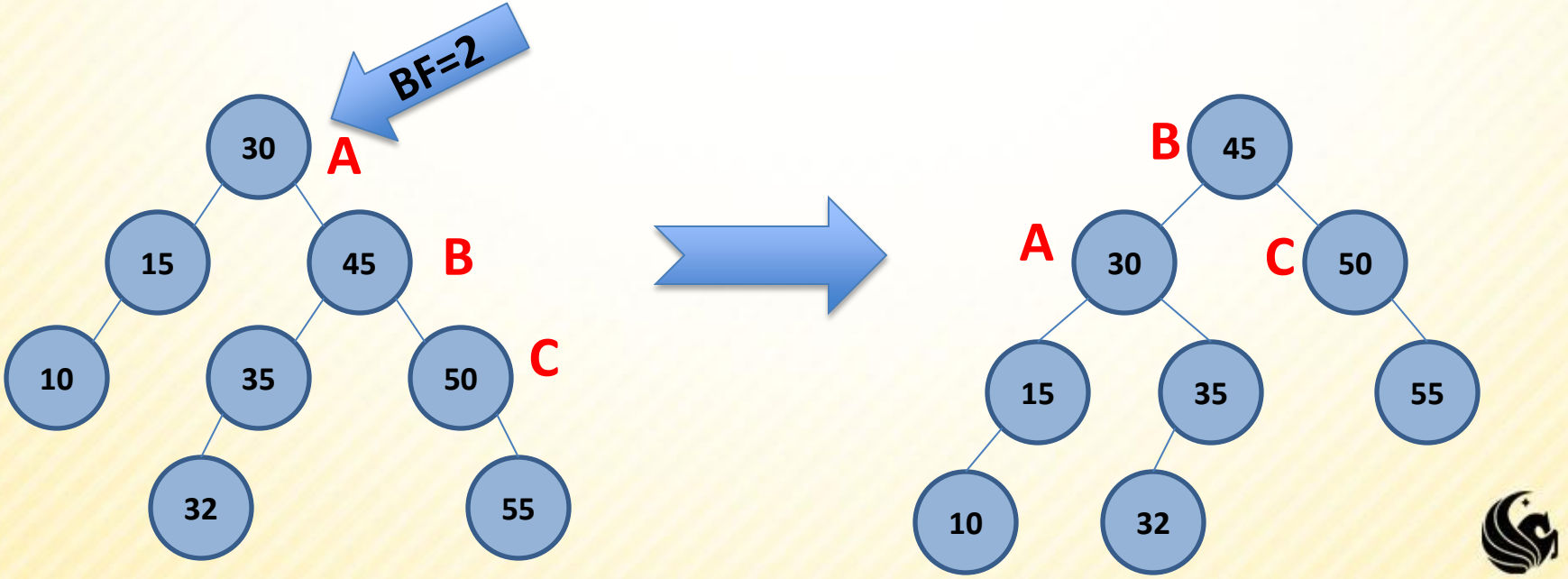
Choosing A,B,C for Delete Restructuring

- One thing that is more complicated about choosing the nodes A, B and C for the AVL Tree delete restructuring is that these nodes are NOT from the ancestral path followed from the origin of the delete.
  - Clearly, if a delete will cause an imbalance, it will be because the subtree that contains the deleted node has become too short.
  - Remember that the nodes A, B and C are always on the "longest" path to the bottom of the tree.
  - This means that when we find an imbalanced node after deleting, the node to the opposite side is guaranteed to be down the longer path.



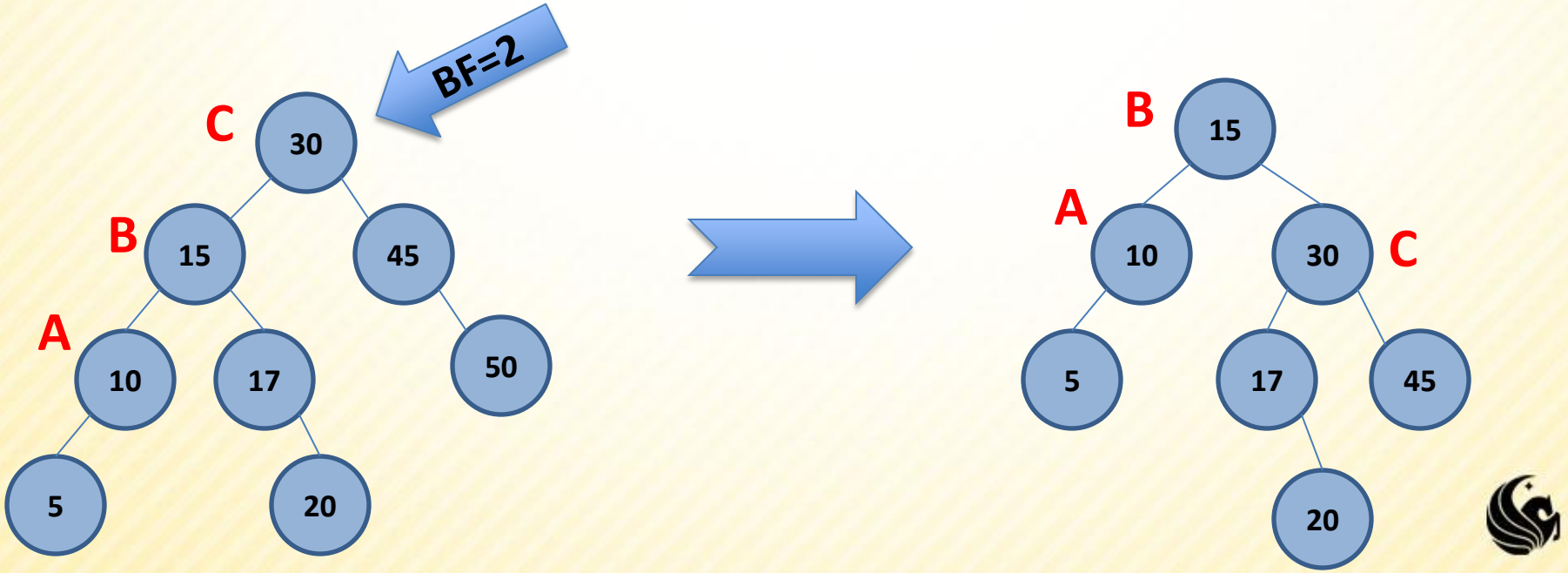
Choosing A,B,C for Delete Restructuring

- After labeling the first two nodes of A,B,C and there is still a choice between the right and left:
  - If one side is longer than the other, choose that side.
  - If the two sides are equal, go to the same side as the parent is to the grandparent.



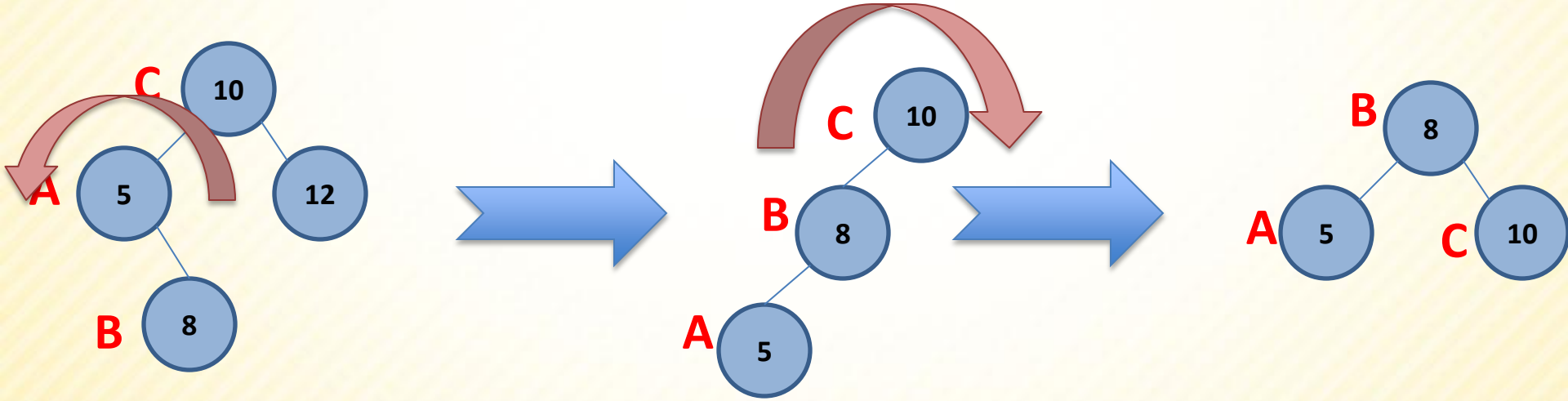
Choosing A,B,C for Delete Restructuring

- The following situation is similar if we delete 50 from the following tree:



AVL Tree Delete Examples

- The most simple example is when a node from a tree with four nodes gets deleted.
- Consider deleting 12 from the following tree:



AVL Tree Delete Examples

- Delete 30 from the following tree: