Complex AVL Tree Deletion Example

- Original AVL tree:

```
    30
   /   \
  20   55
 /     |
10      60
    /   |
   25    45
  /     /|
15    40 65
  /     |
 35
```

- External nodes have height 0; internal nodes have height labelled in red to their left
- Original AVL tree is indeed balanced
- Say we had the above tree, and want to delete key 20
- To delete key 20:
  - Move key 25 up to where key 20 is
  - Delete the node that used to contain 25
Next Step

• Now the tree is unbalanced at the node containing 25
  – Left subtree has height 2
  – Right subtree (just one external node) has height 0

• Must restructure
  – Label nodes z, y, x from unbalanced node down to grandchild causing the problem
  – Relabel those nodes a, b, c going through those nodes in inorder traversal
  – The four other trees are just external nodes
  – As always, move b up to where unbalanced node was
Next Step

- Now the tree is unbalanced at the root (the node containing 30)
  - Left subtree has height 2
  - Right subtree has height 4
- Must restructure again
  - Label nodes z, y, x from unbalanced node down to grandchild causing the problem
  - Relabel those nodes a, b, c going through those nodes in inorder traversal
  - The four other trees are T1, T2, T3, T4 as shown
  - As always, move b up to where unbalanced node was
Last Step

- Balanced