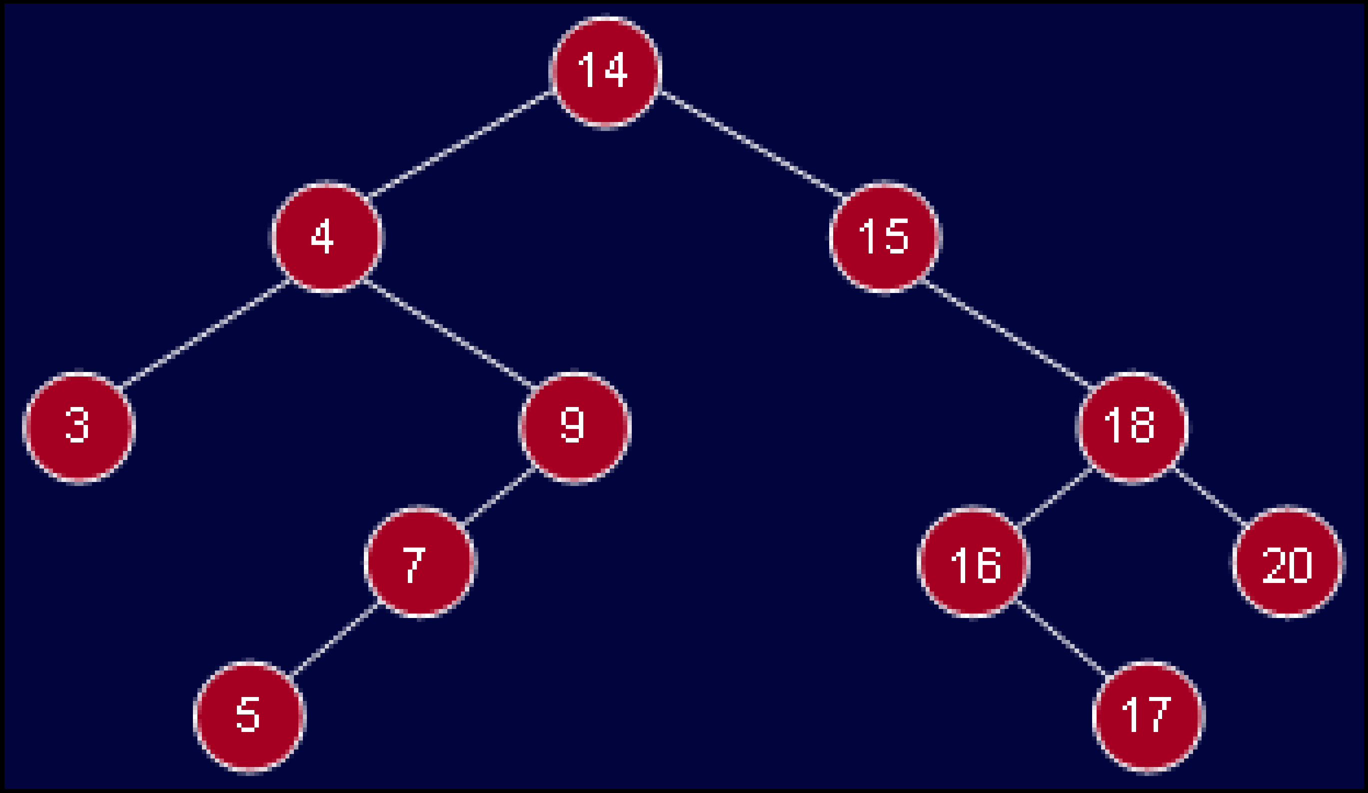
Lecture # 12
AVL Trees

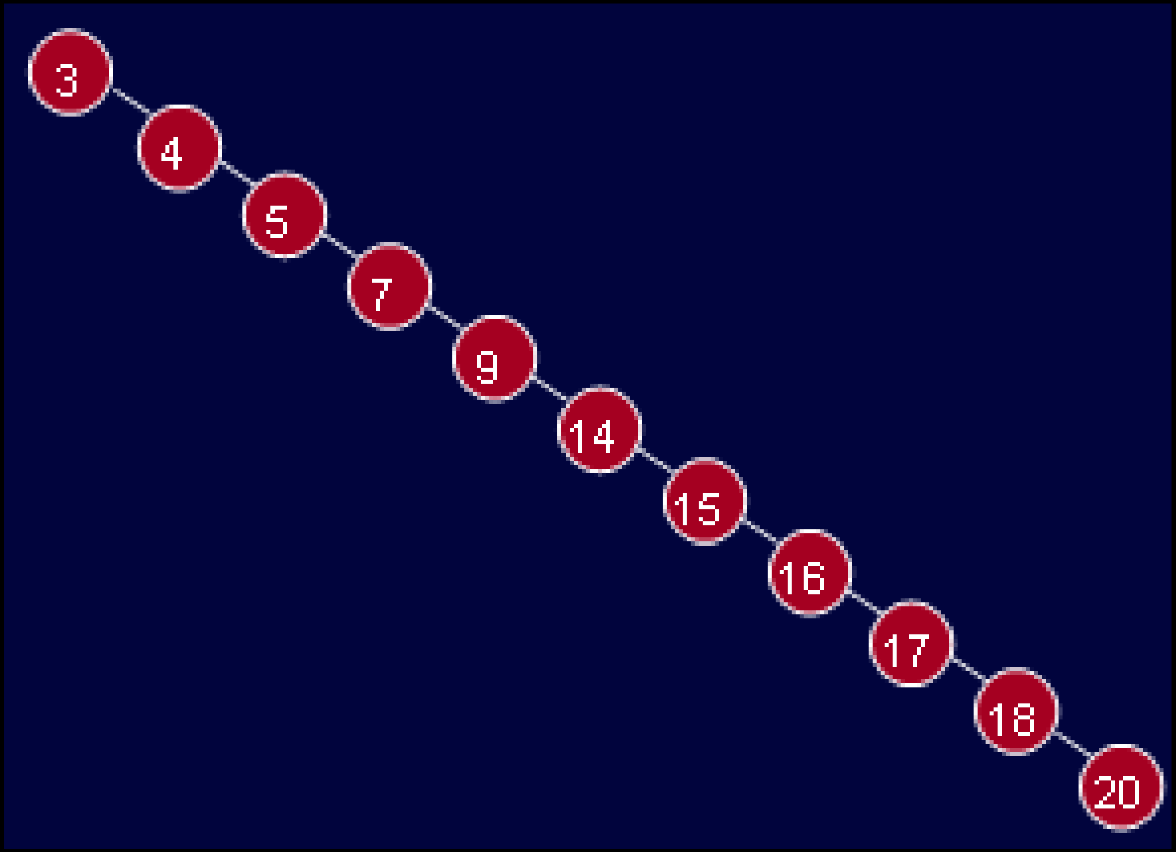
Binary Search Trees

- BST for 14, 15, 4, 9, 7, 18, 3, 5, 16, 20, 17



Binary Search Trees

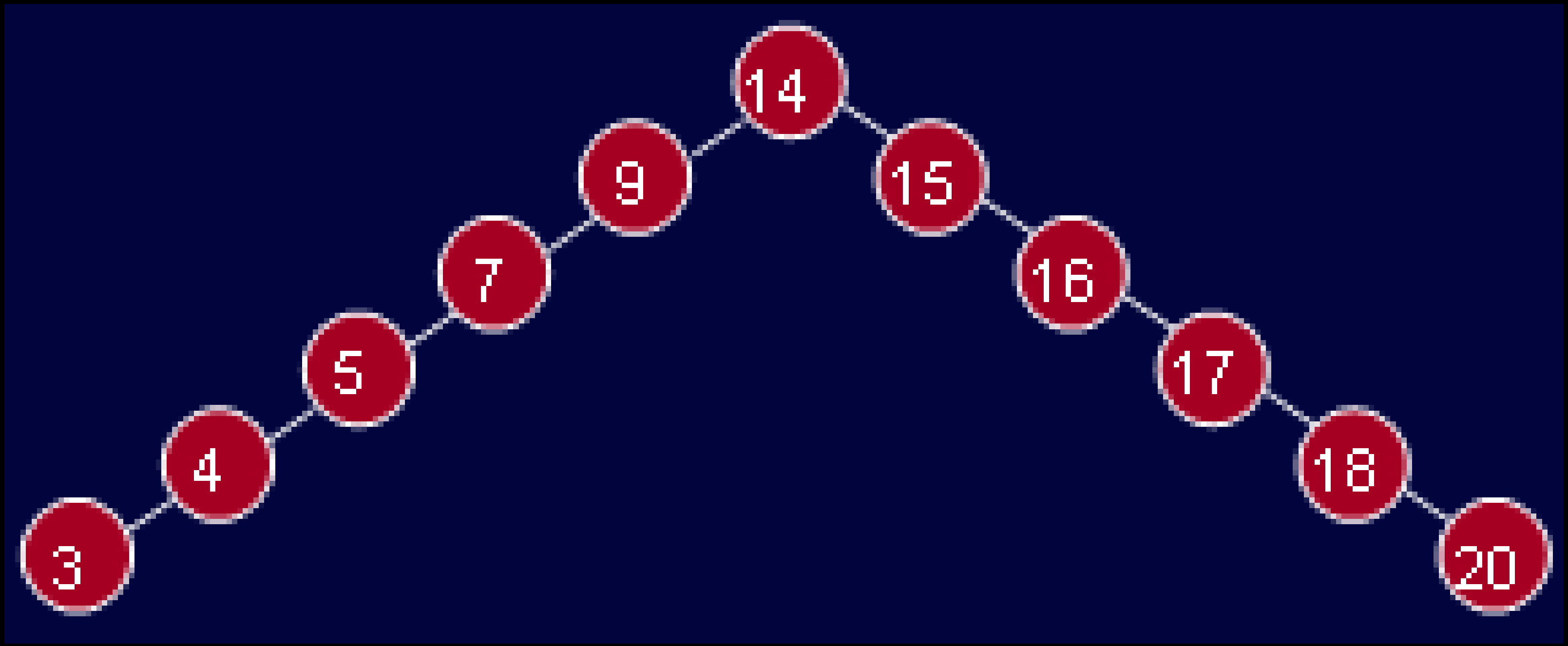
- <u>BST for</u> 3 4 5 7 9 14 15 16 17 18 20



Balanced BST

- We should keep the tree *balanced*.
- One idea would be to have the left and right subtrees have the same height

Balanced BST



Balanced BST

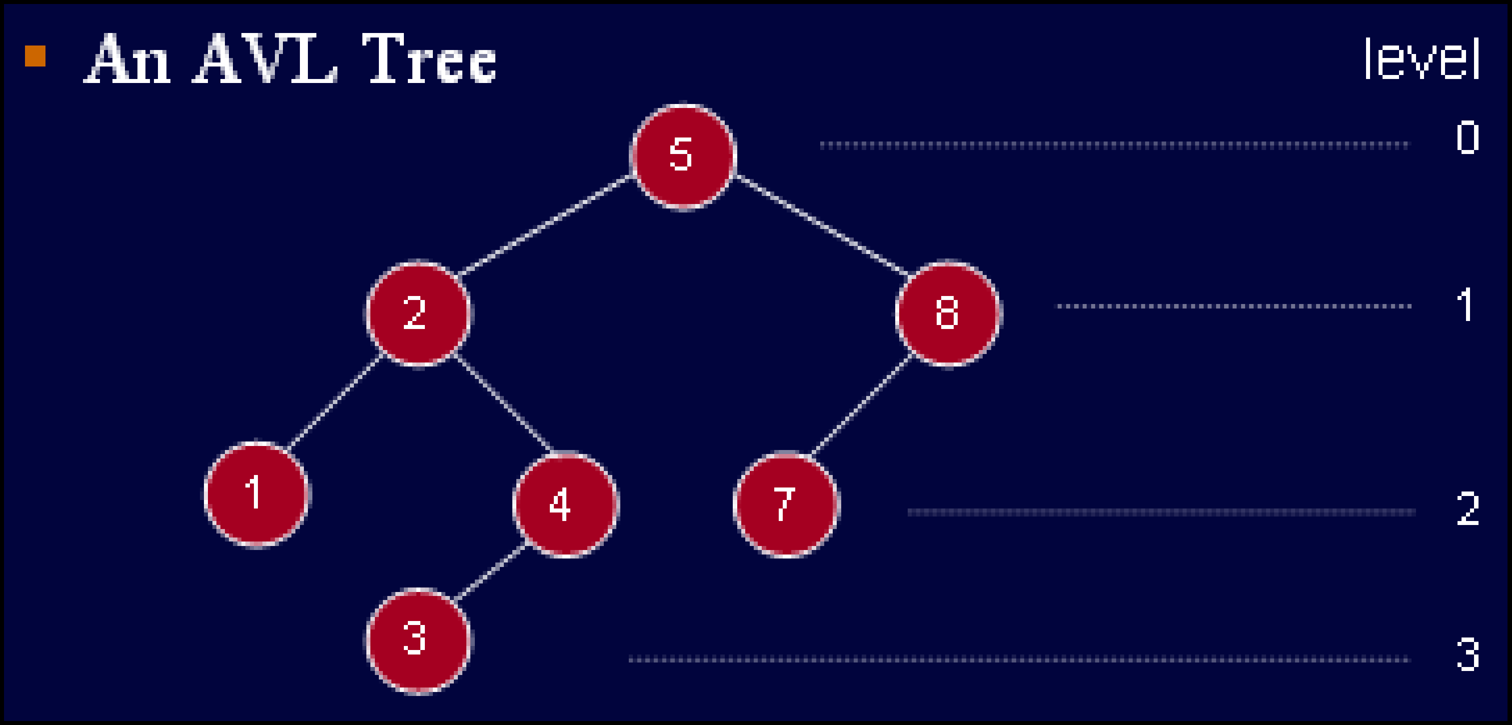
- We could insist that every node must have left and right subtrees of same height.
- But this requires that the tree be a complete binary tree
- To do this, there must have ($2^{d+1} - 1$) data items, where *d* is the depth of the tree.
- This is too rigid a condition.

AVL Trees

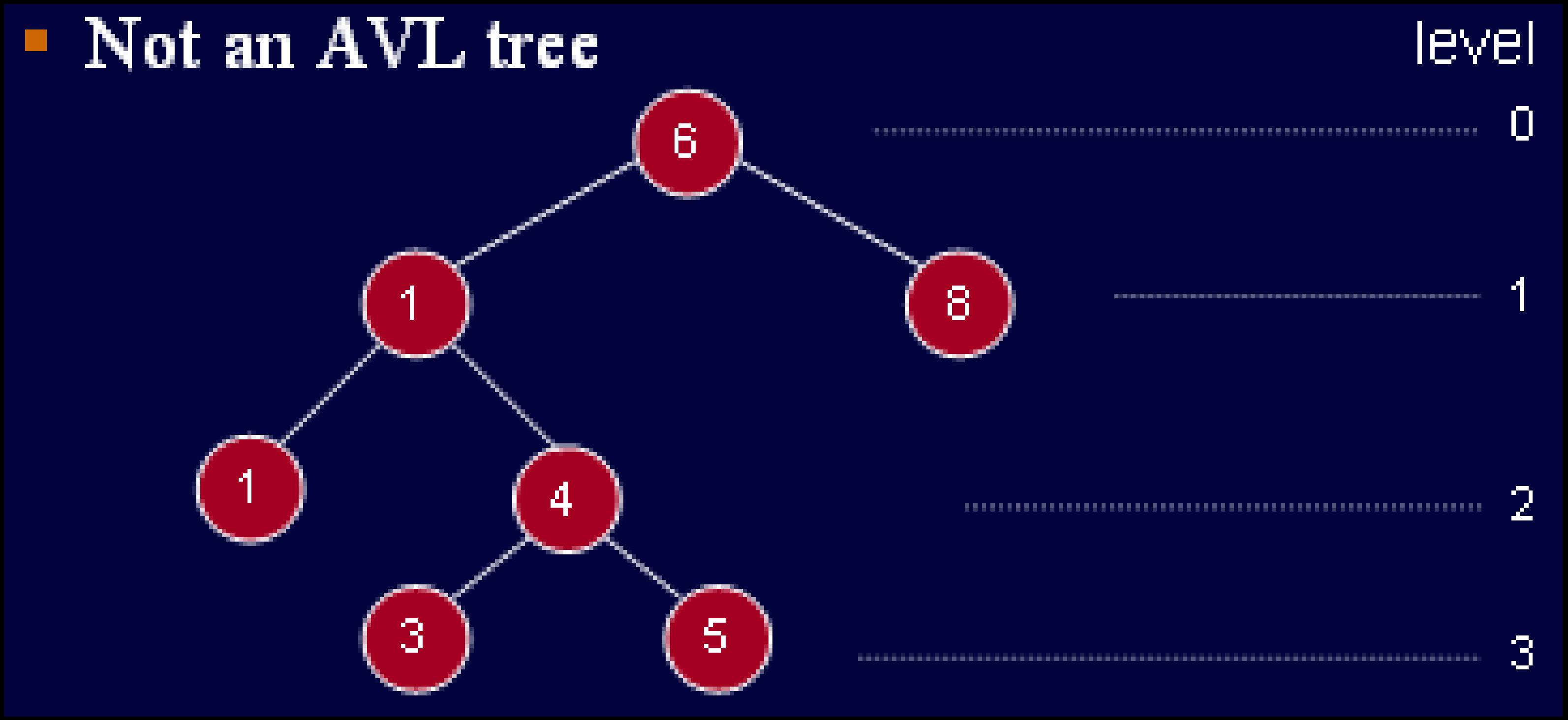
AVL Trees

- AVL (Adelson-Velskii and Landis) tree.
  - An AVL tree is identical to a BST except
  - height of the left and right subtrees can differ by at most 1.
  - height of an empty tree is defined to be (–1).

AVL Trees



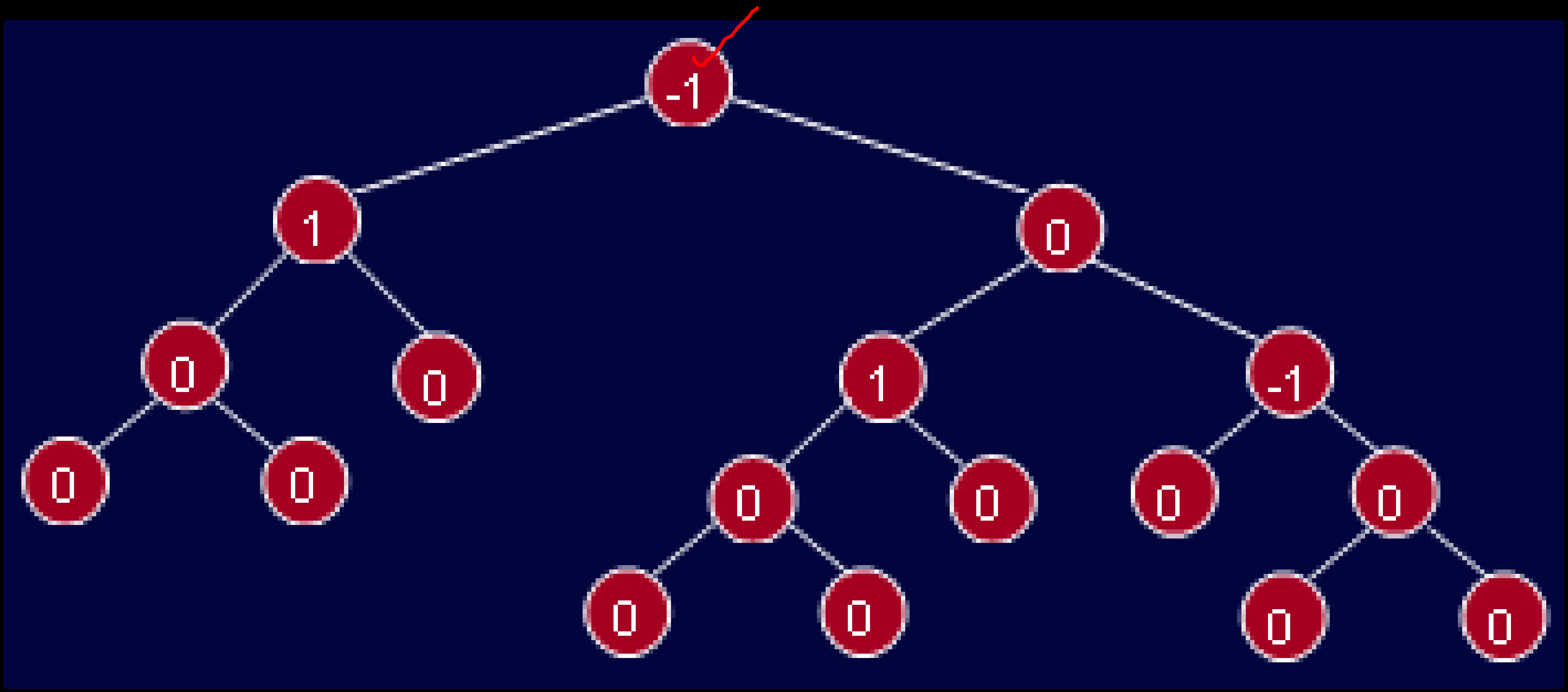
AVL Trees



Balanced Binary Tree

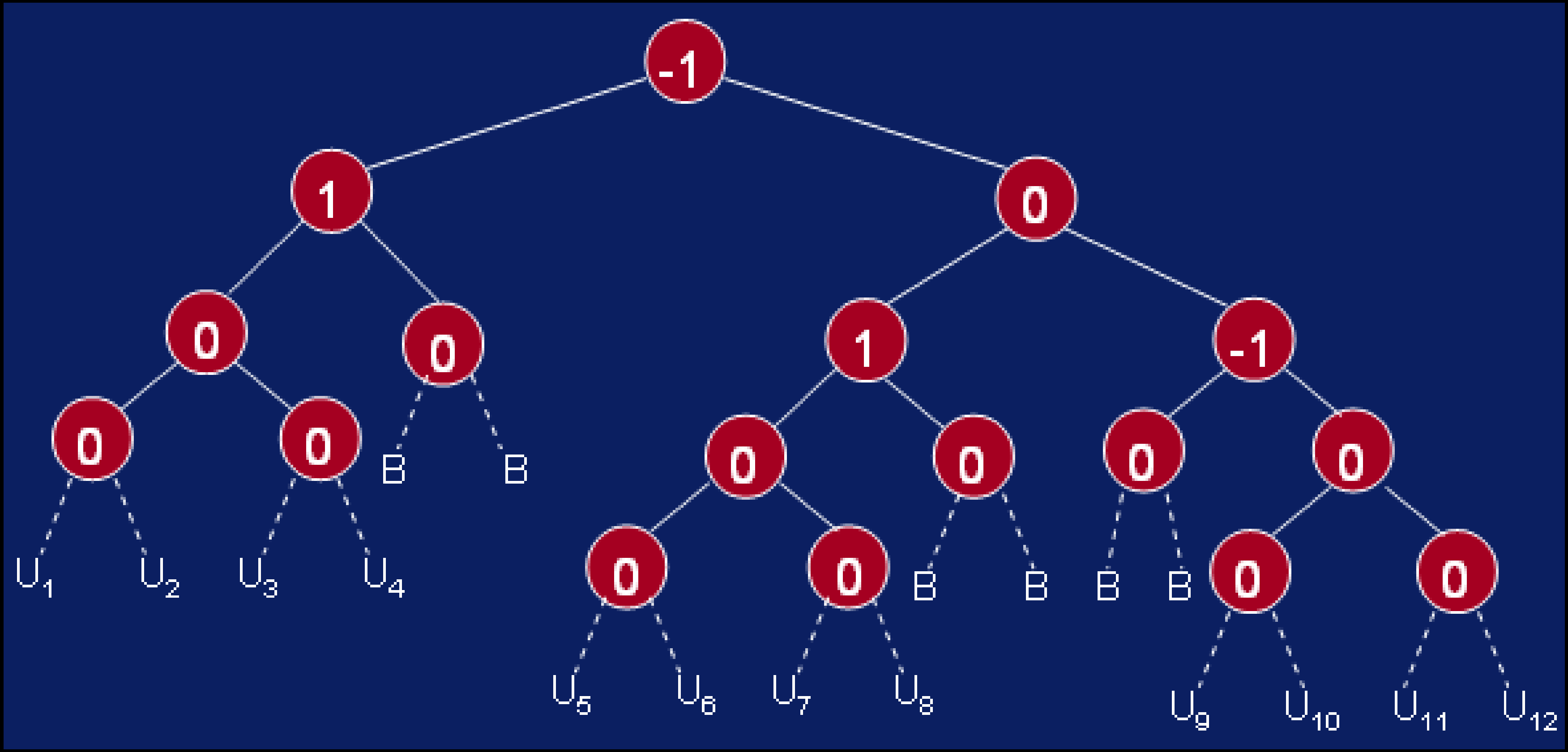
- The *height* of a binary tree is the maximum level of its leaves (also called the depth).
- The balance of a node in a binary tree is defined as the height of its left subtree minus height of its right subtree.
- Here, for example, is a balanced tree. Each node has an indicated balance of 1, 0, or –1.

Balanced Binary Tree



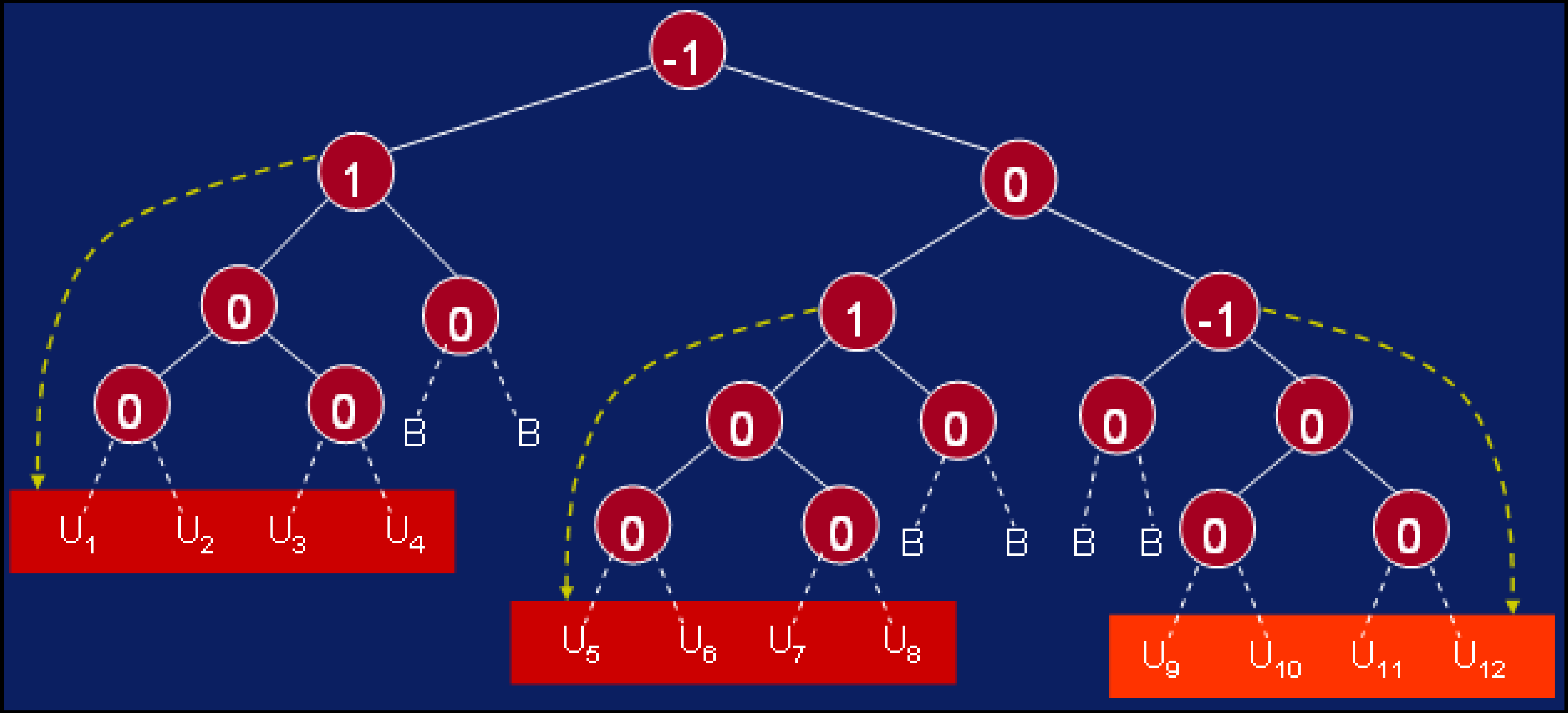
Balanced Binary Tree

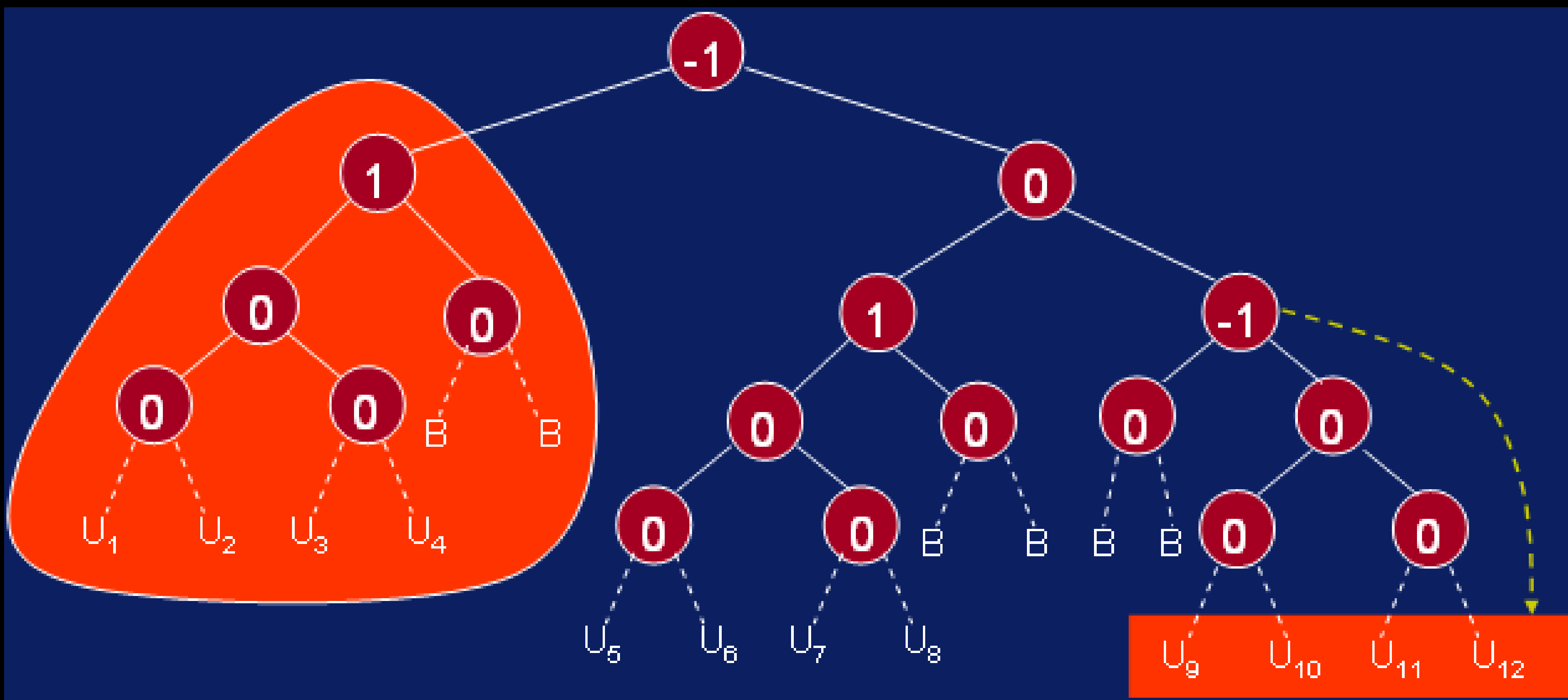
- Insertions and effect on balance



Balanced Binary Tree

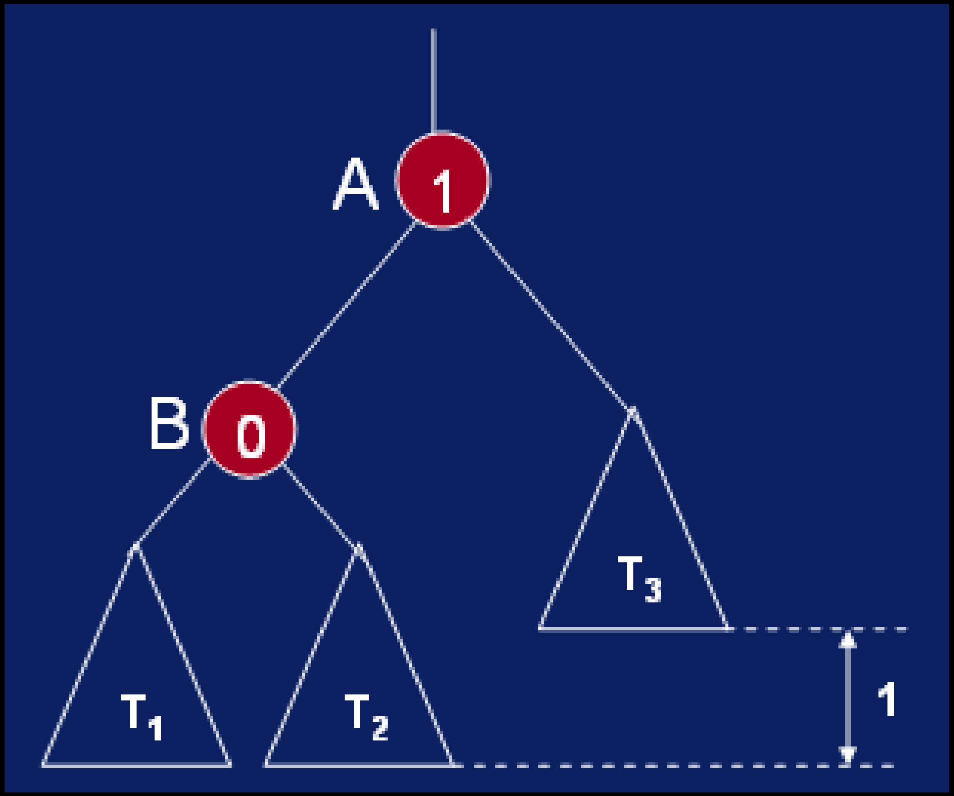
- Insertions and effect on balance



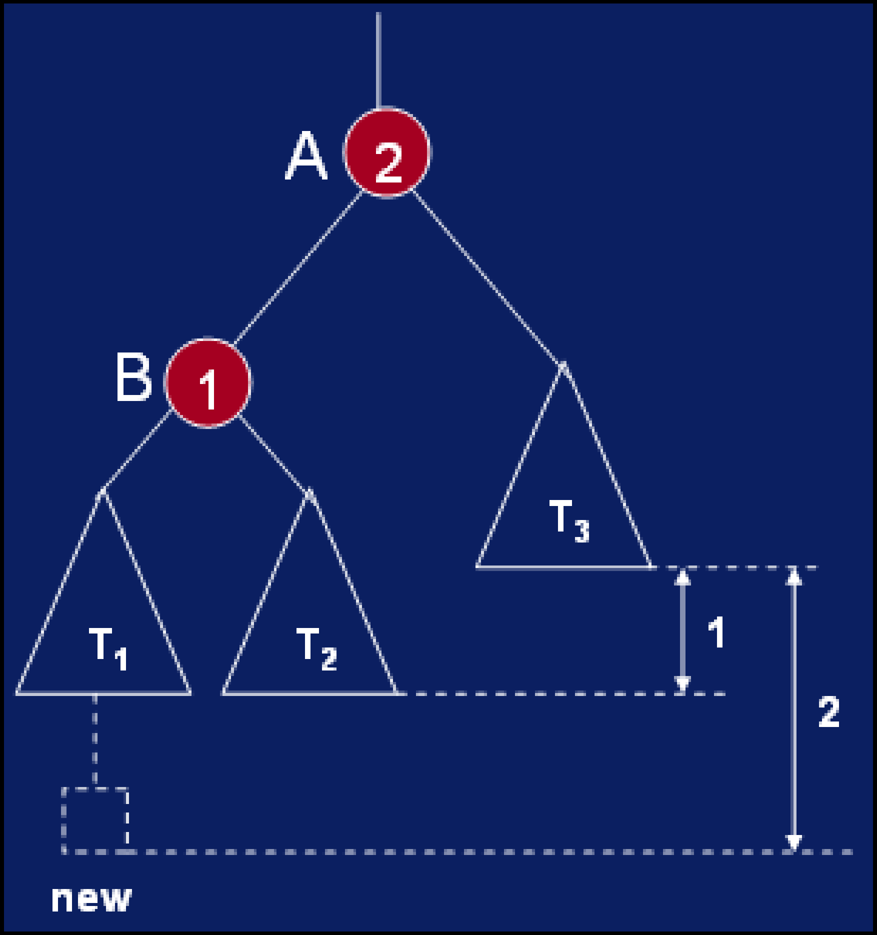


-1
1
0
0
0
-1
0
0
0
0
0
0
B
B
0
0
B
B
B
B
0
0
U1
U2
U3
U4
U5
U6
U7
U8
U9
U10
U11
U12

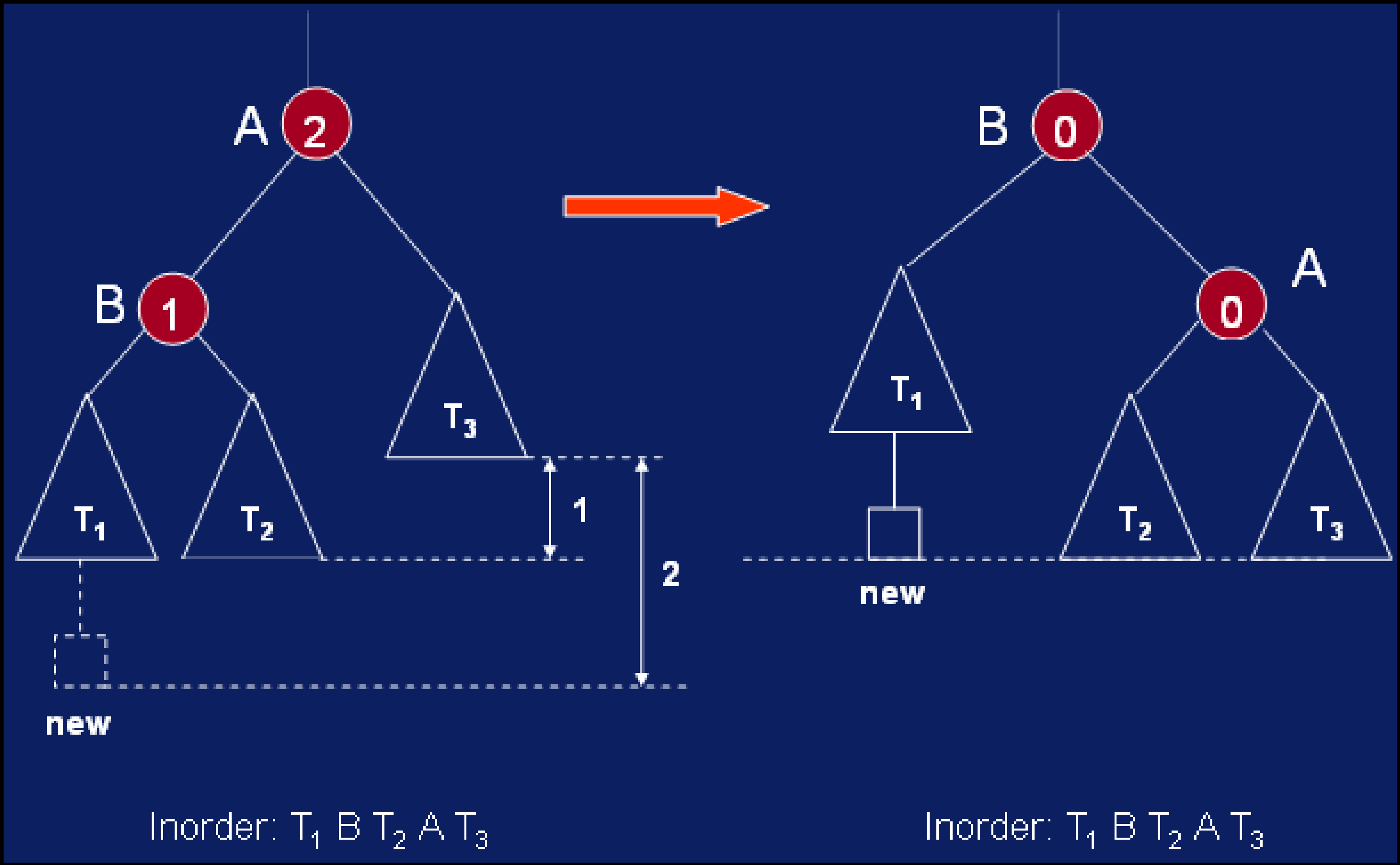
Inserting New Node in AVL Tree



Inserting New Node in AVL Tree



Inserting New Node in AVL Tree



Thanks …