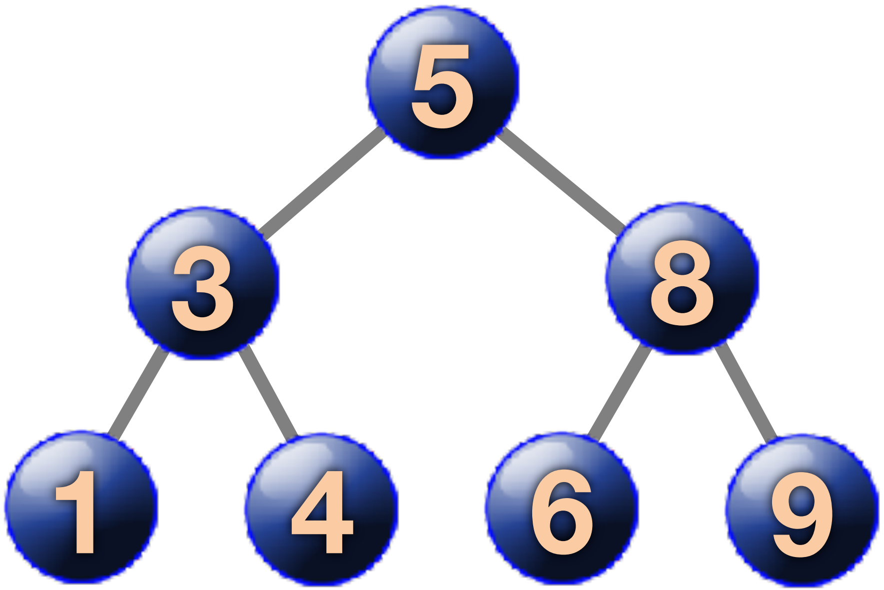
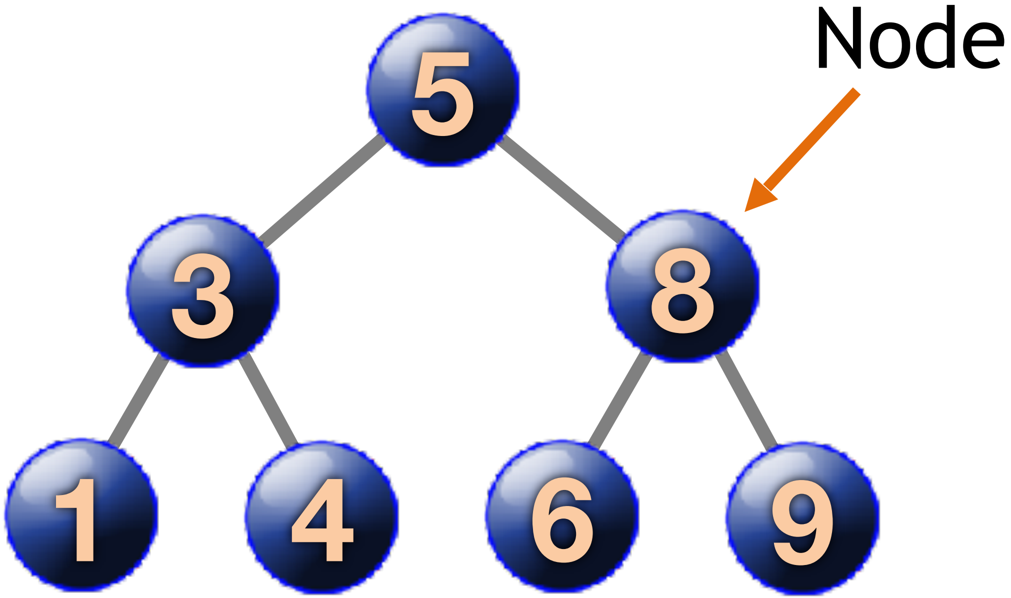
Binary Search Trees

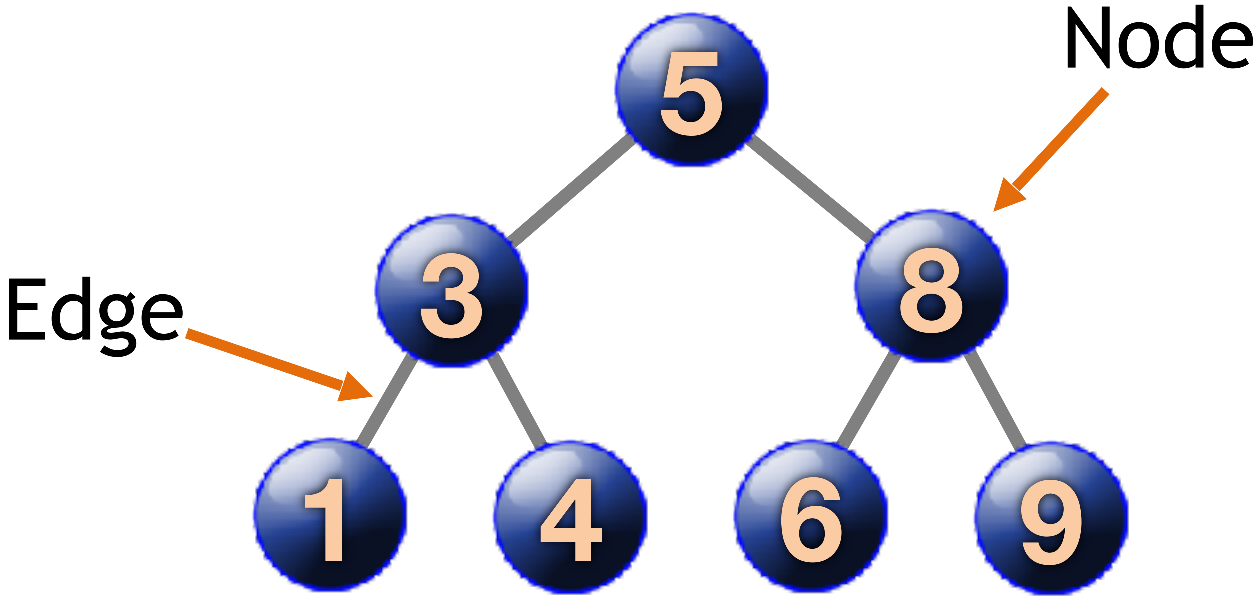
Tree



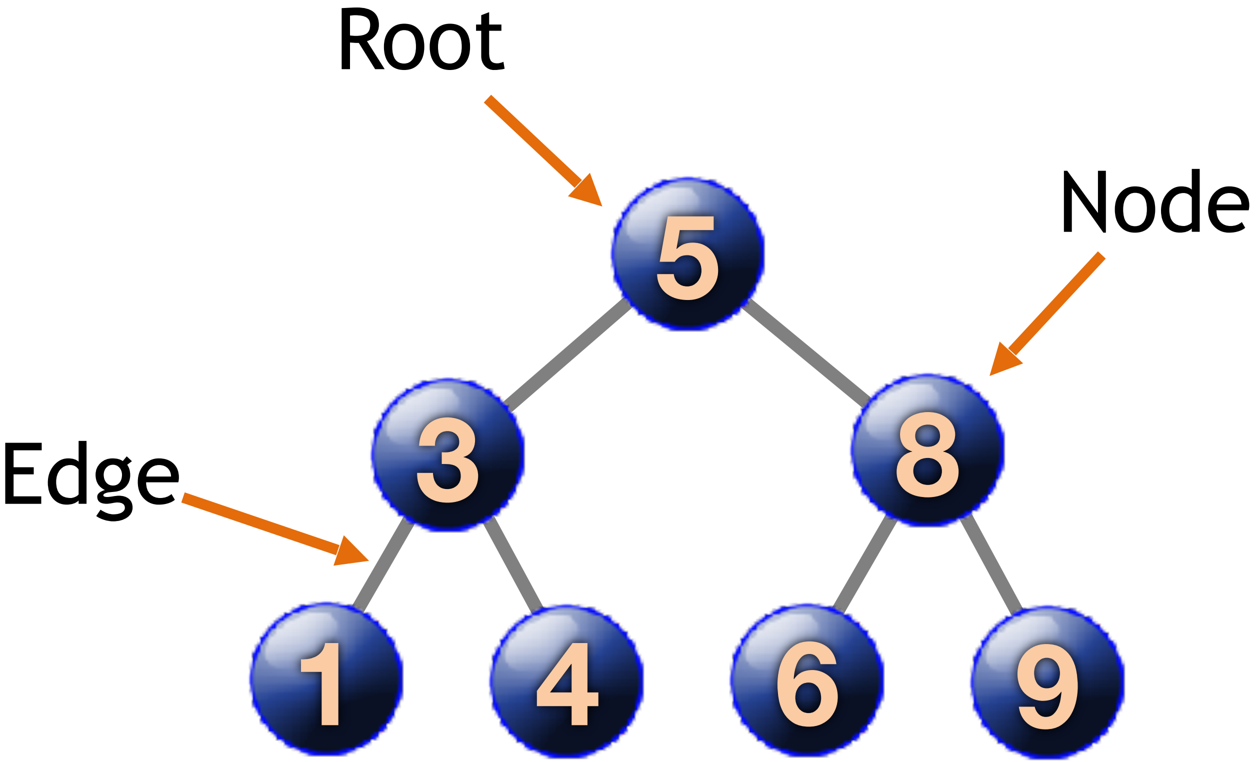
Tree

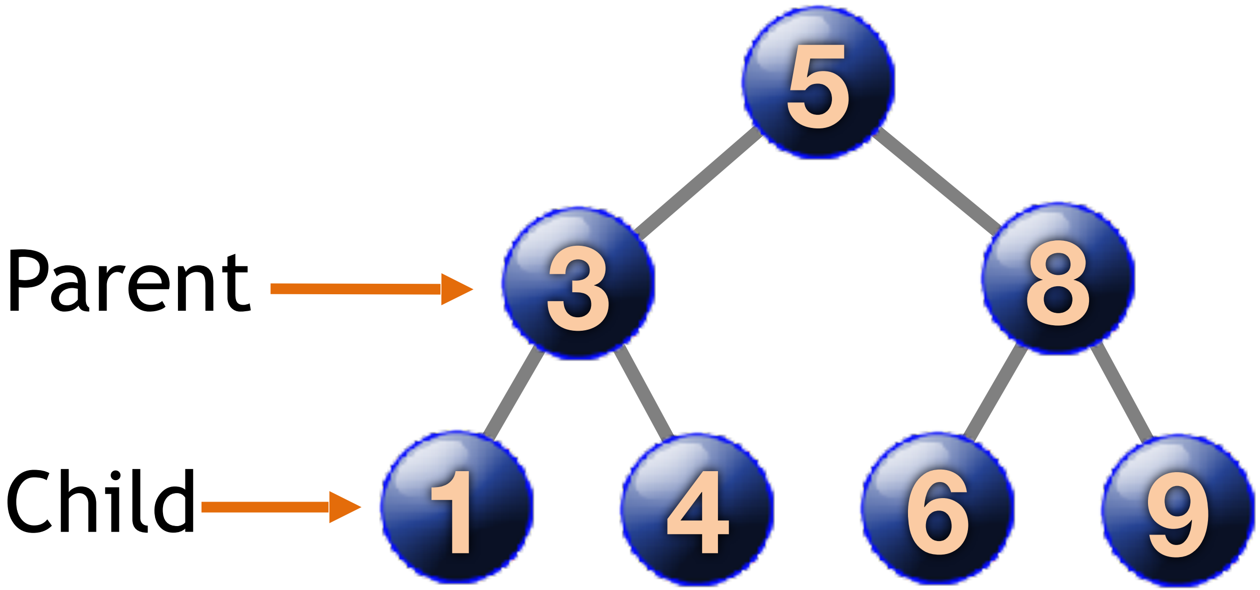


Tree

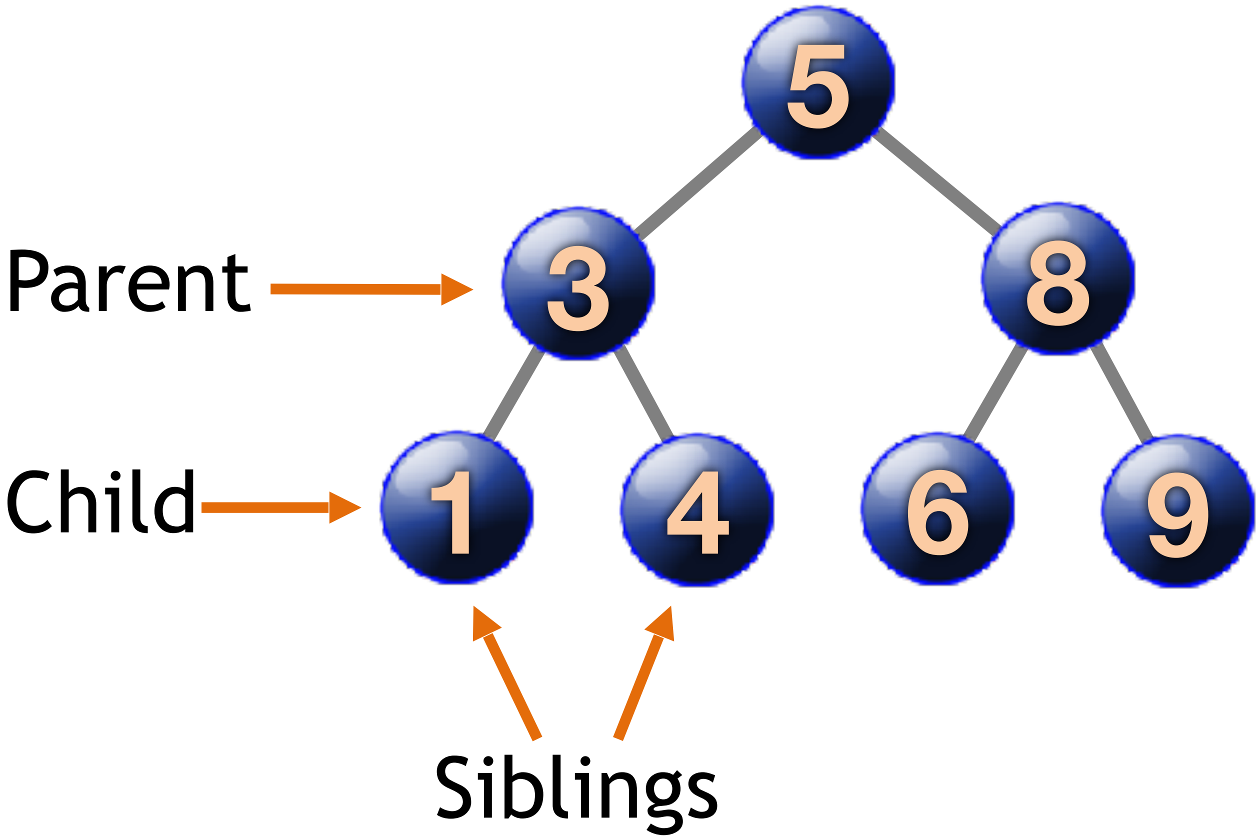


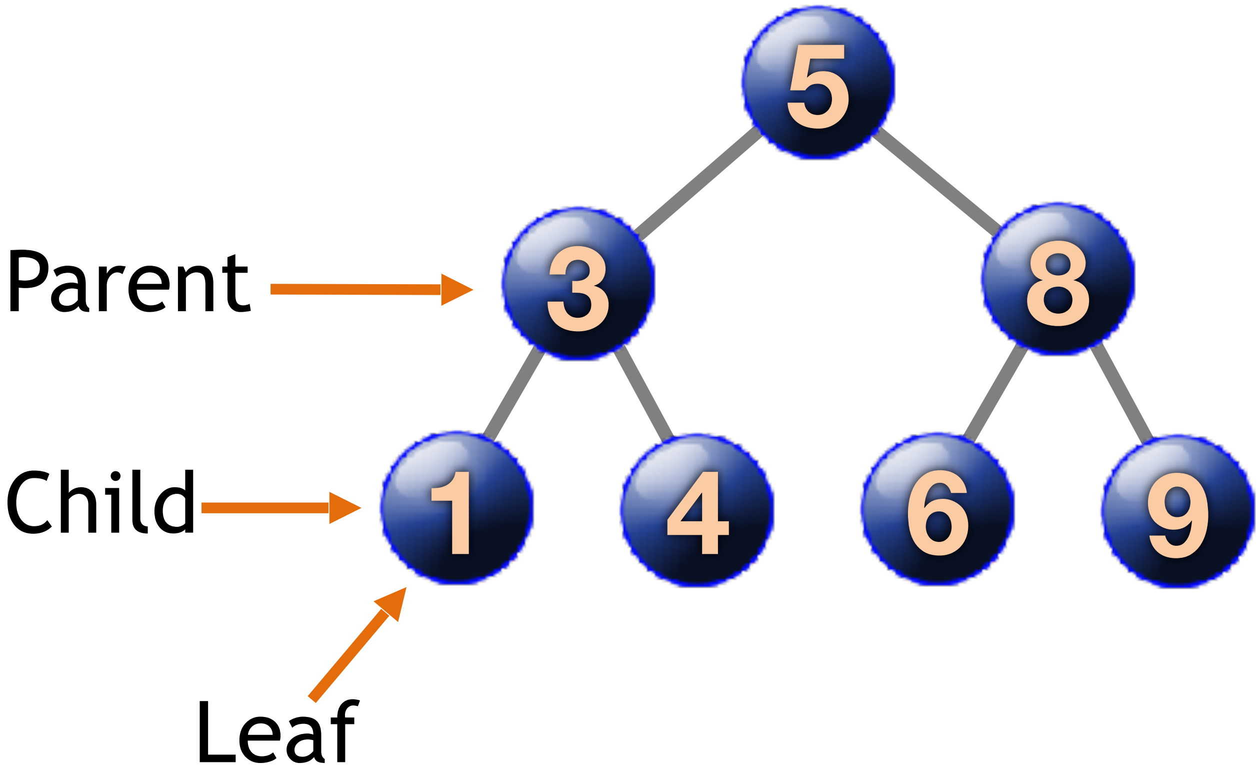
Tree



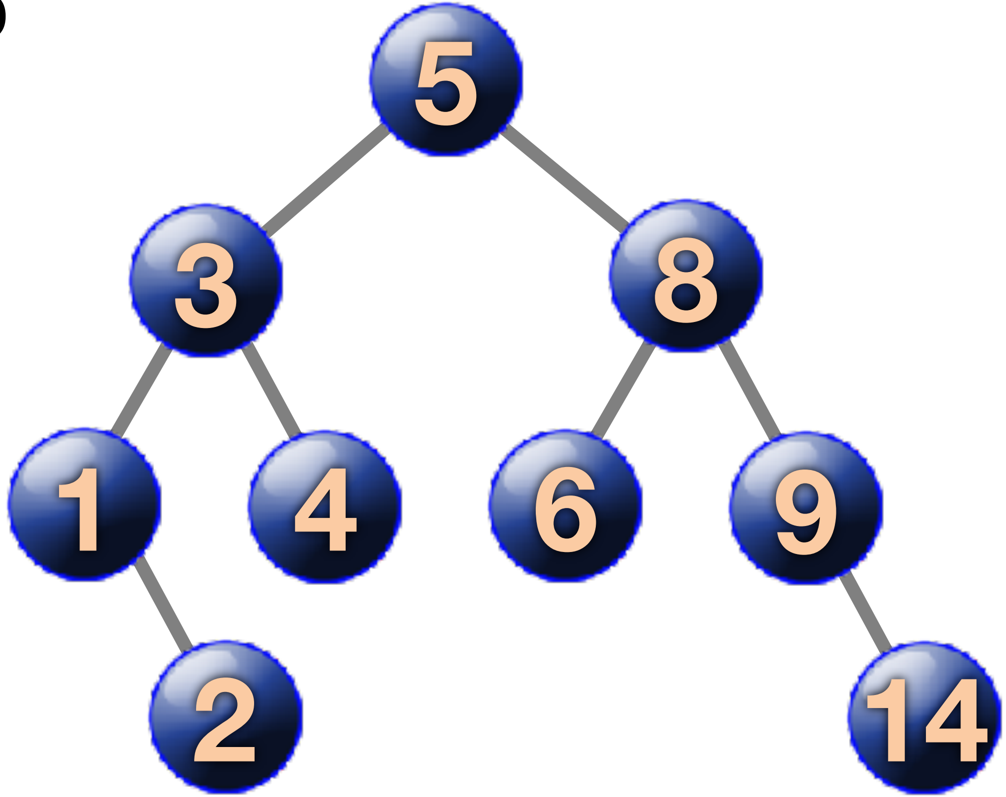


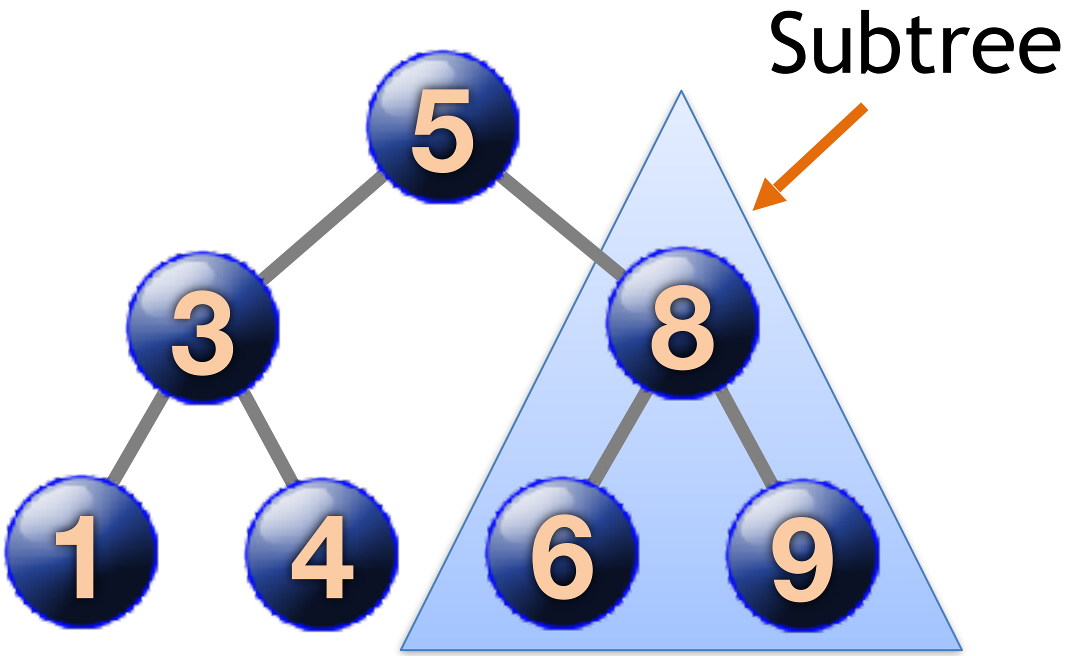
Parent
Child
5
3
8
1
4
6
9

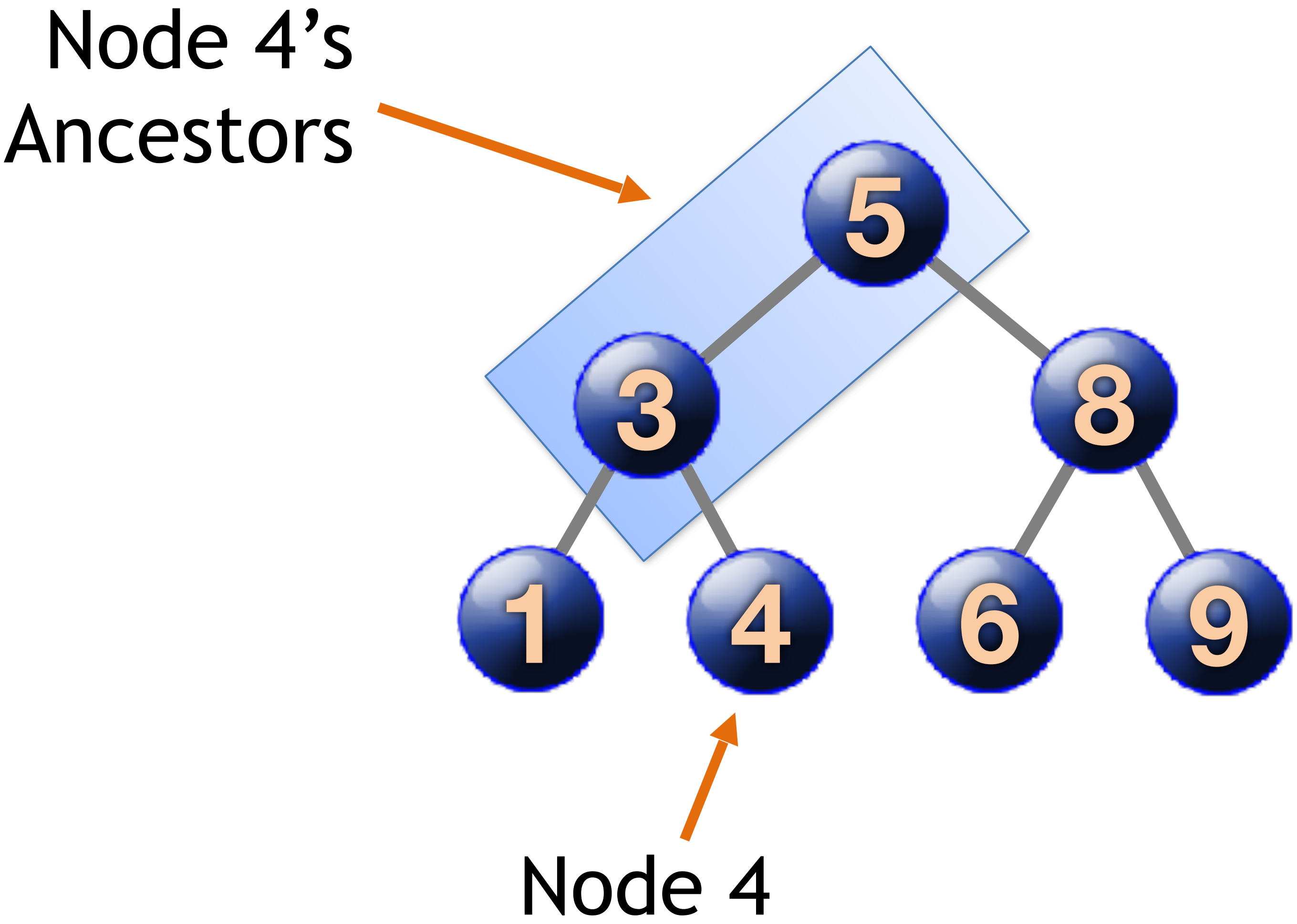

Parent
Child
5
3
8
1
4
6
9
Siblings


Parent
Child
Leaf
5
3
8
1
4
6
9

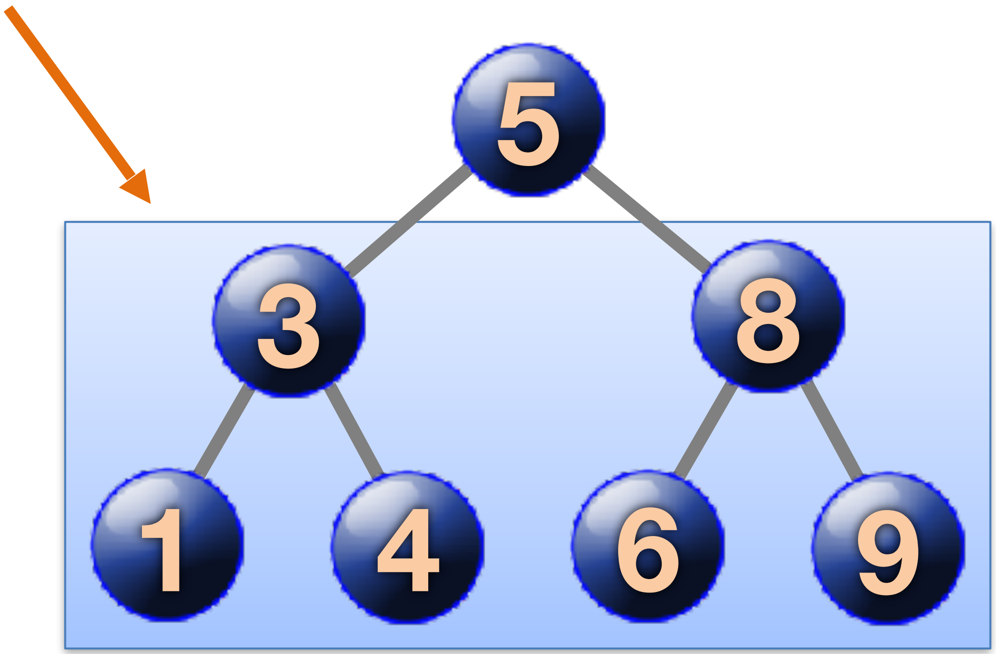
Binary Tree - each node can have up to 2 child nodes.




Subtree
5
3
8
1
4
6
9

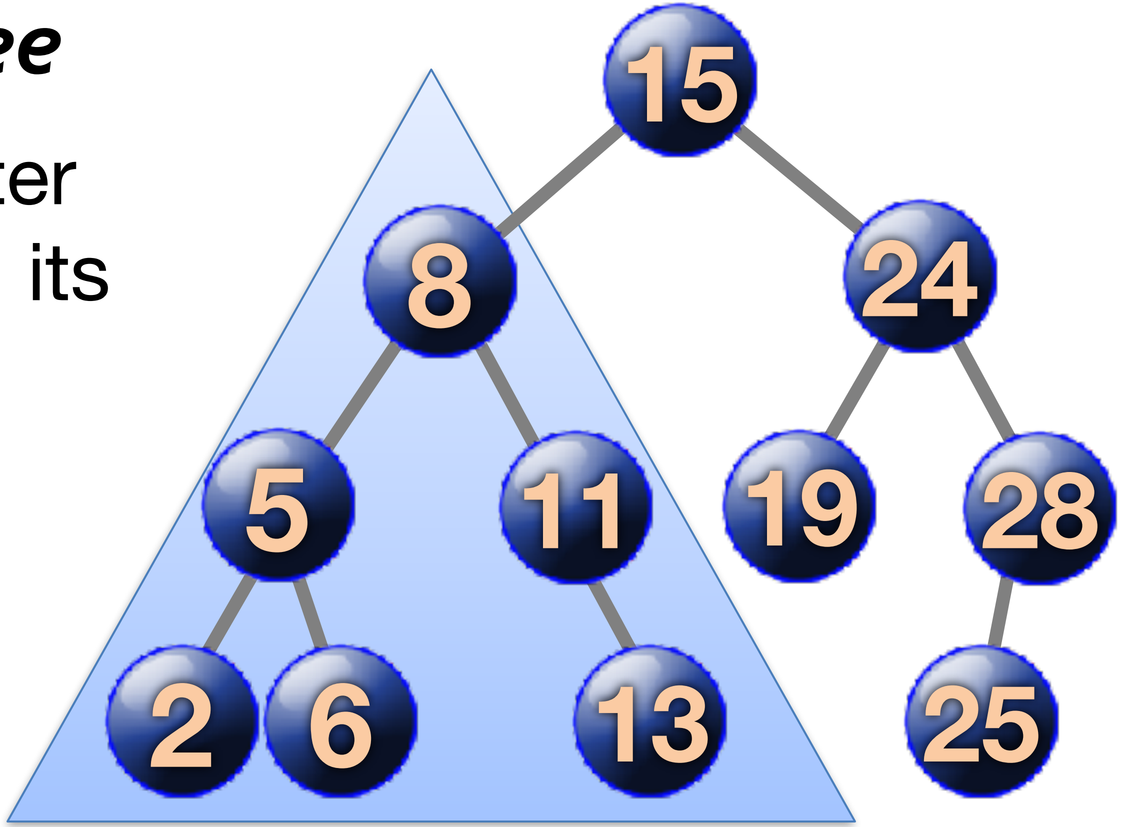

Node 4's
Ancestors
5
3
8
1
4
6
9
Node 4

Node 5's Descendants



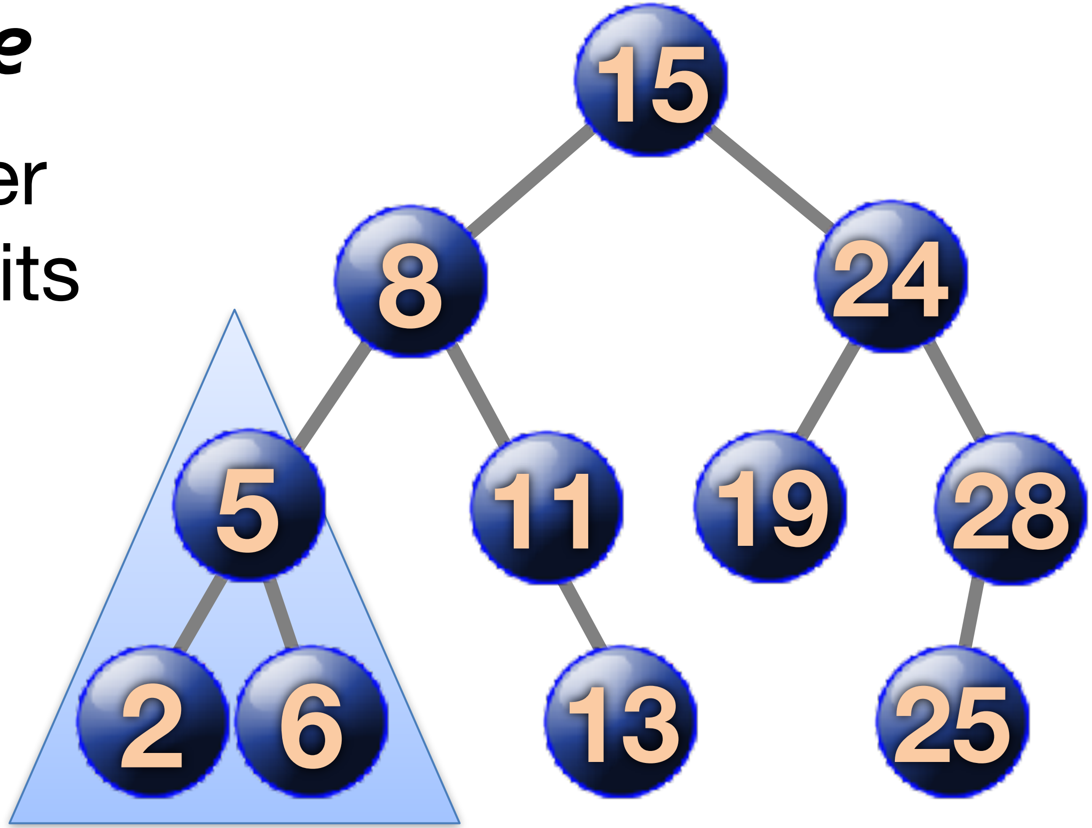
Binary Search Tree

- each node is greater than every node in its left subtree



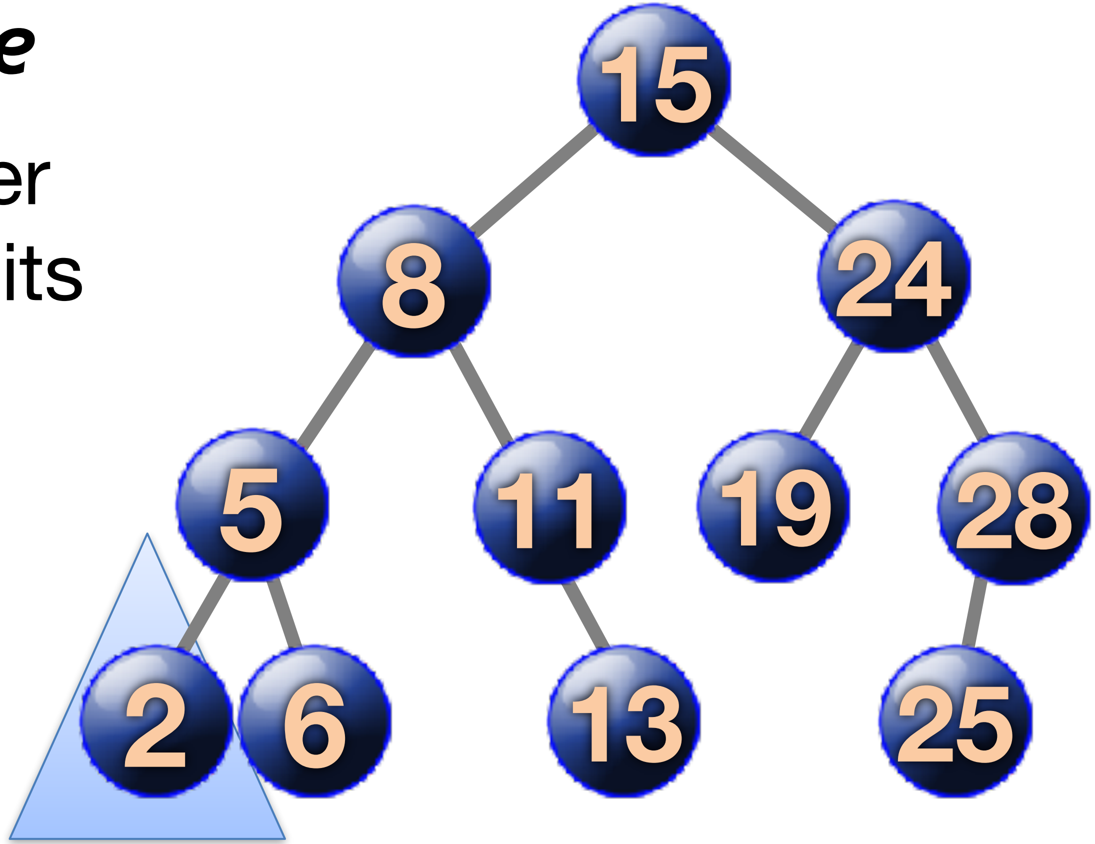
Binary Search Tree

- each node is greater than every node in its left subtree



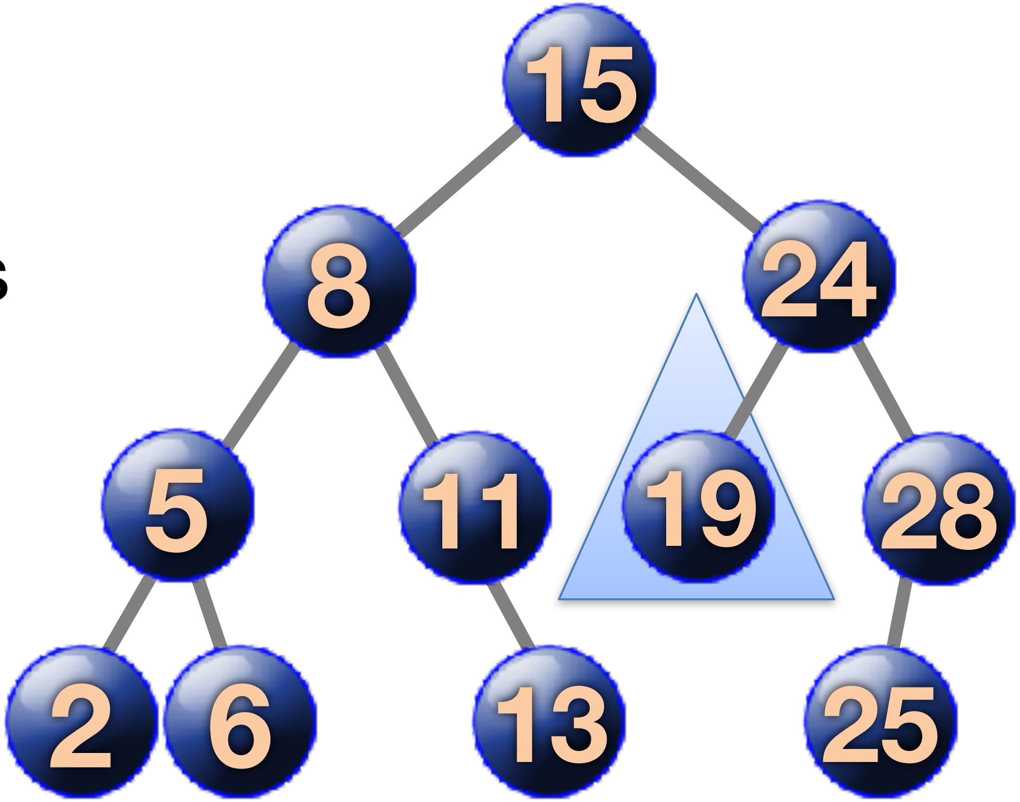
Binary Search Tree

- each node is greater than every node in its left subtree



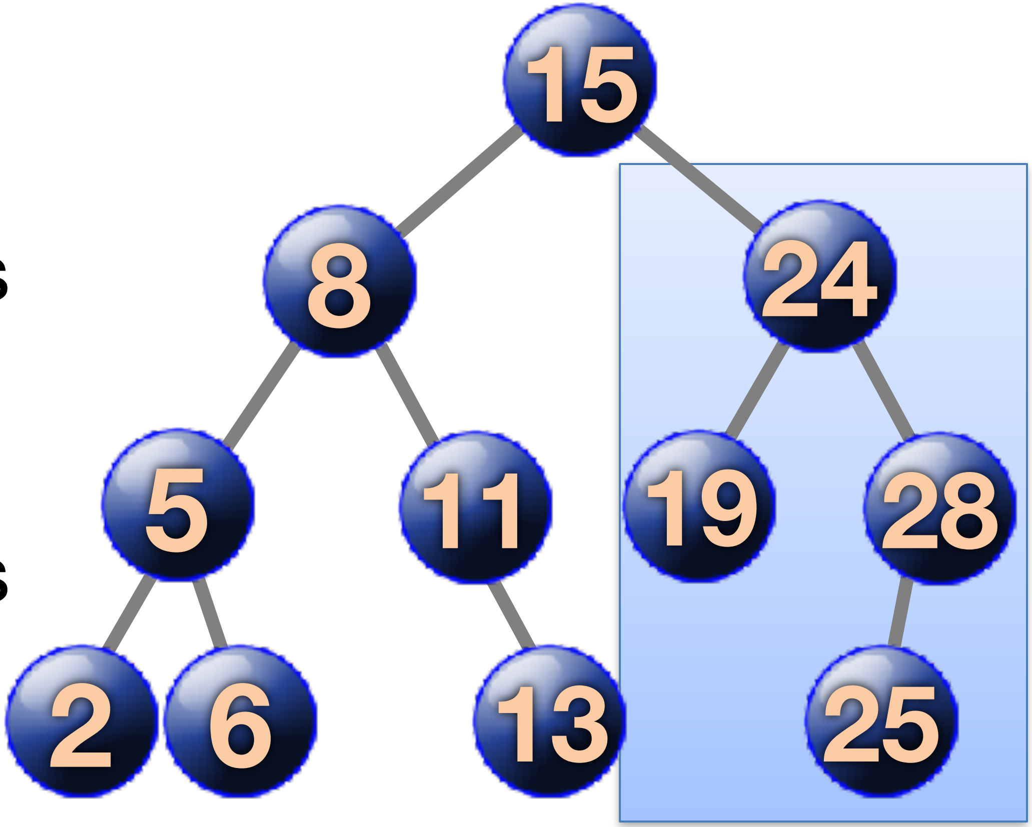
Binary Search Tree

- each node is greater than every node in its left subtree



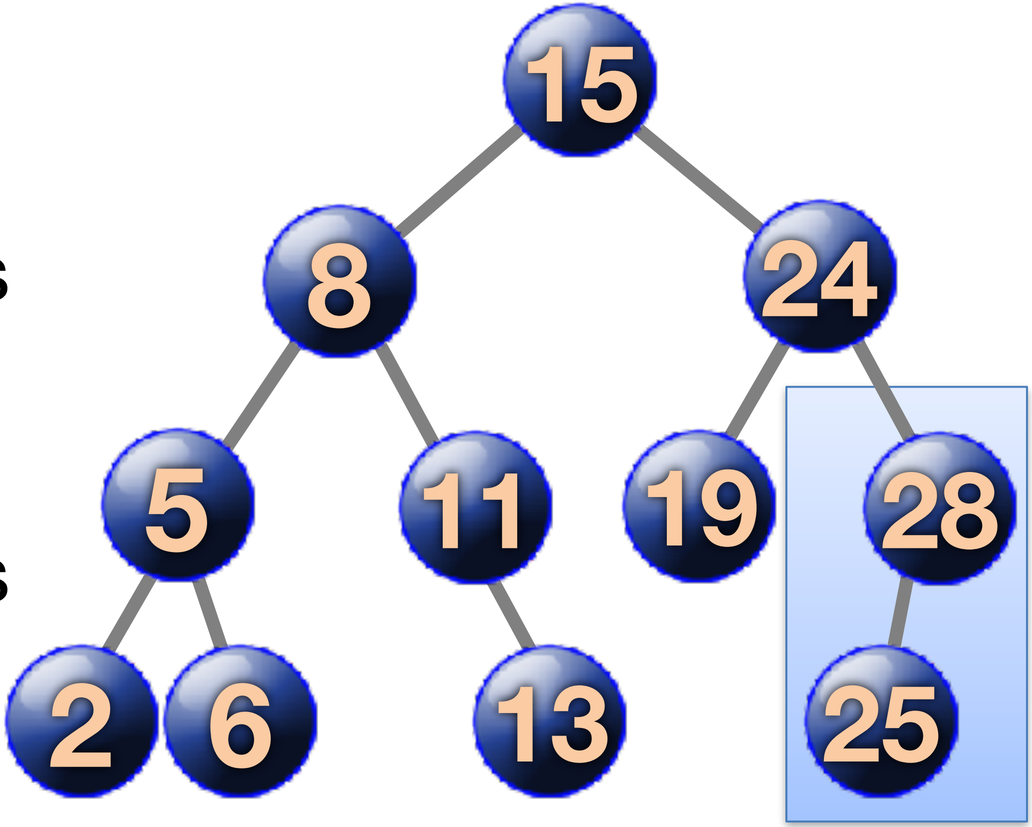
Binary Search Tree

- each node is greater than every node in its left subtree
- each node is less than every node in its right subtree



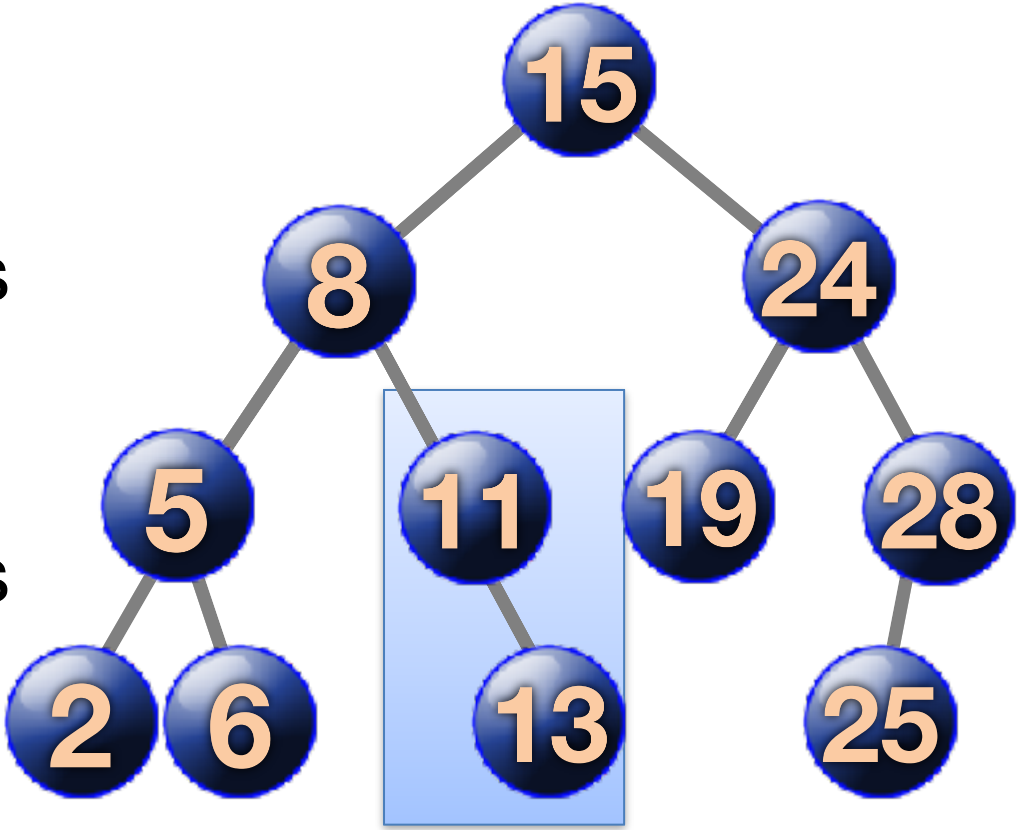
Binary Search Tree

- each node is greater than every node in its left subtree
- each node is less than every node in its right subtree



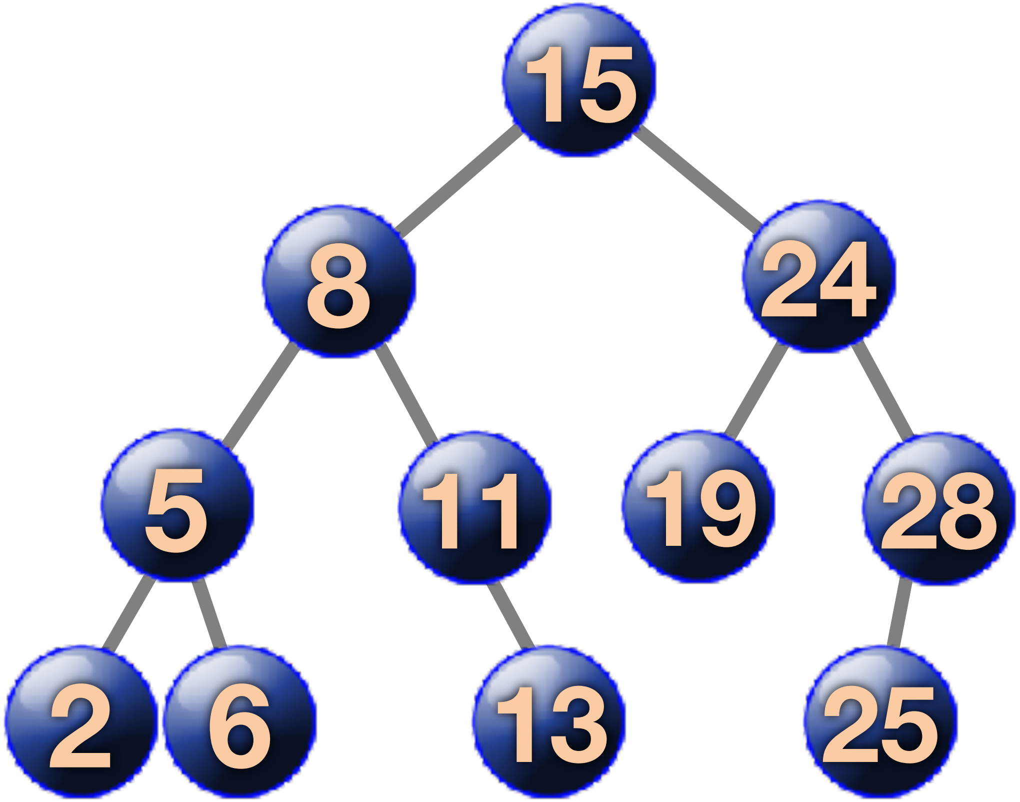
Binary Search Tree

- each node is greater than every node in its left subtree
- each node is less than every node in its right subtree



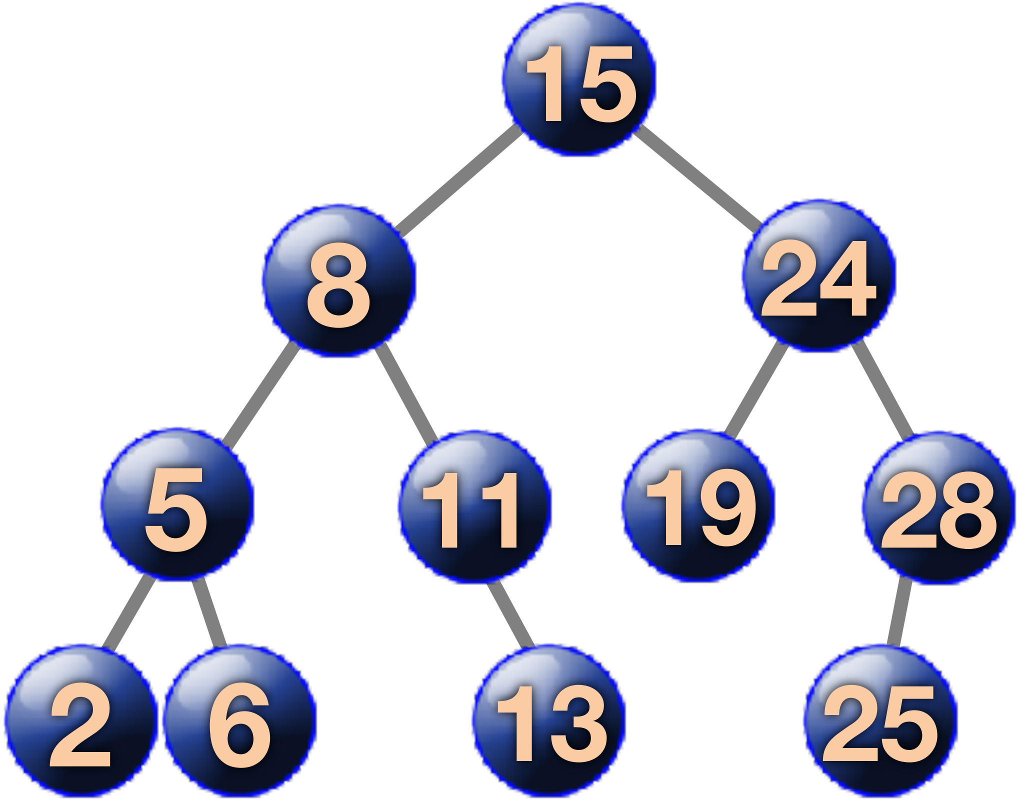
BST Operations

- Insert
- Find
- Delete
- Get_size
- Traversals



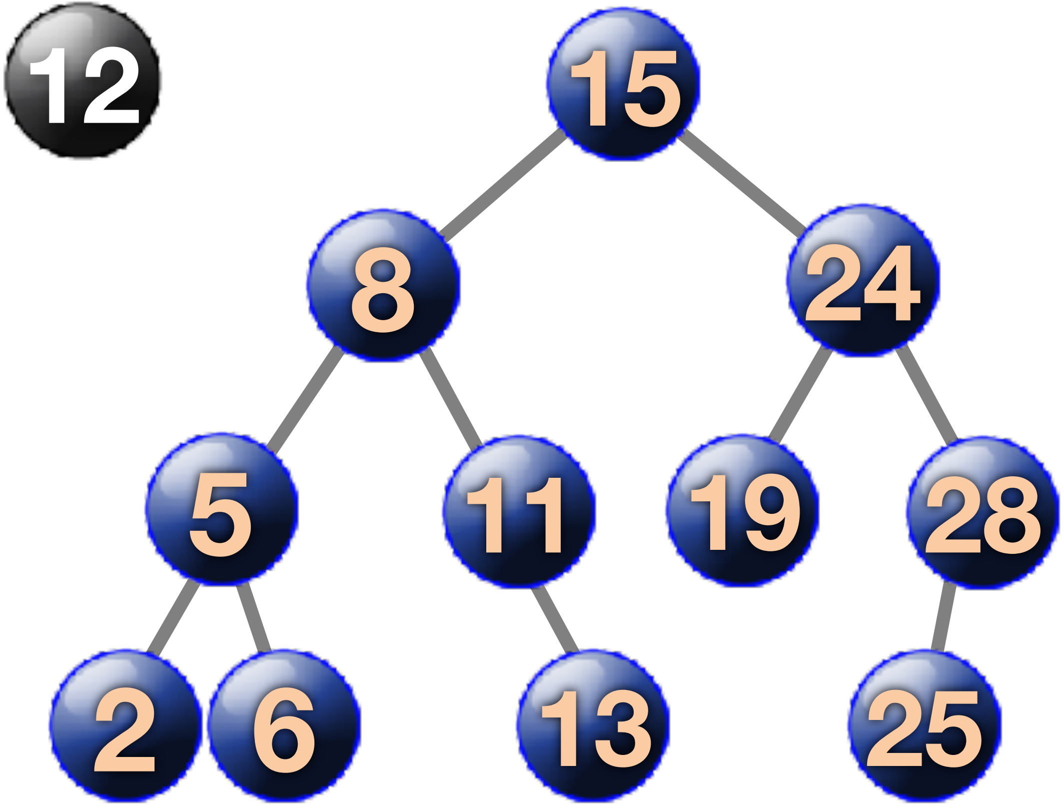
BST Insert

- Start at root
- Always insert as a leaf



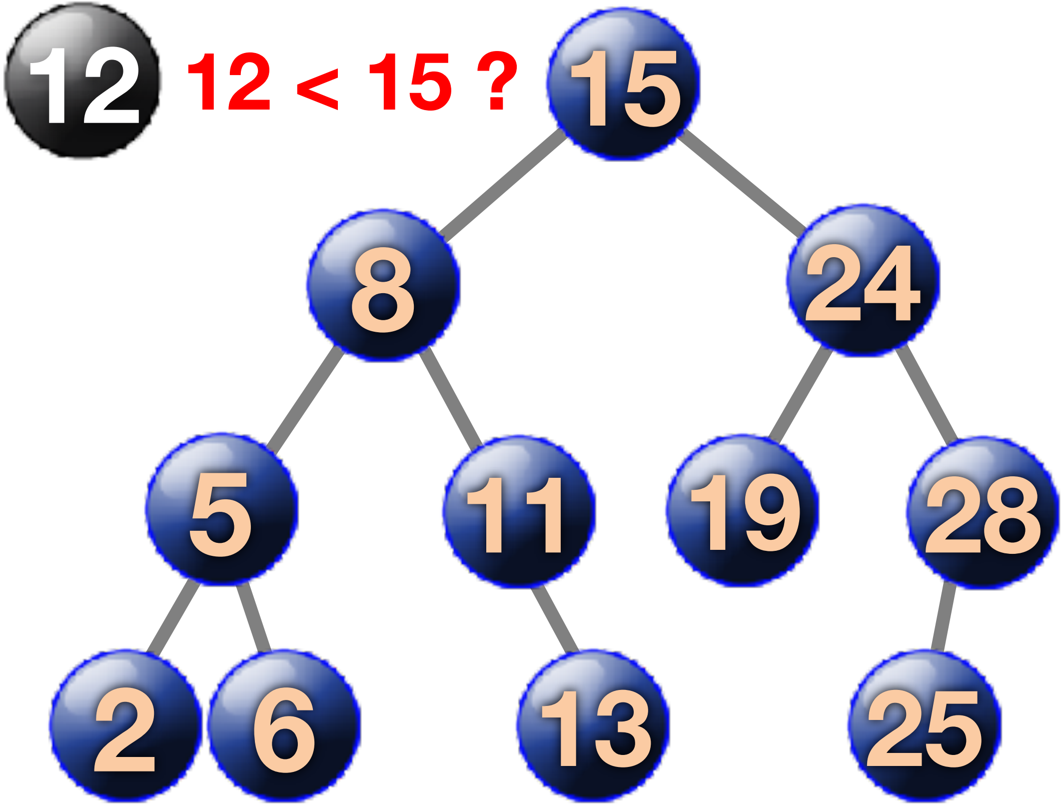
BST Insert

- Start at root
- Always insert as a leaf



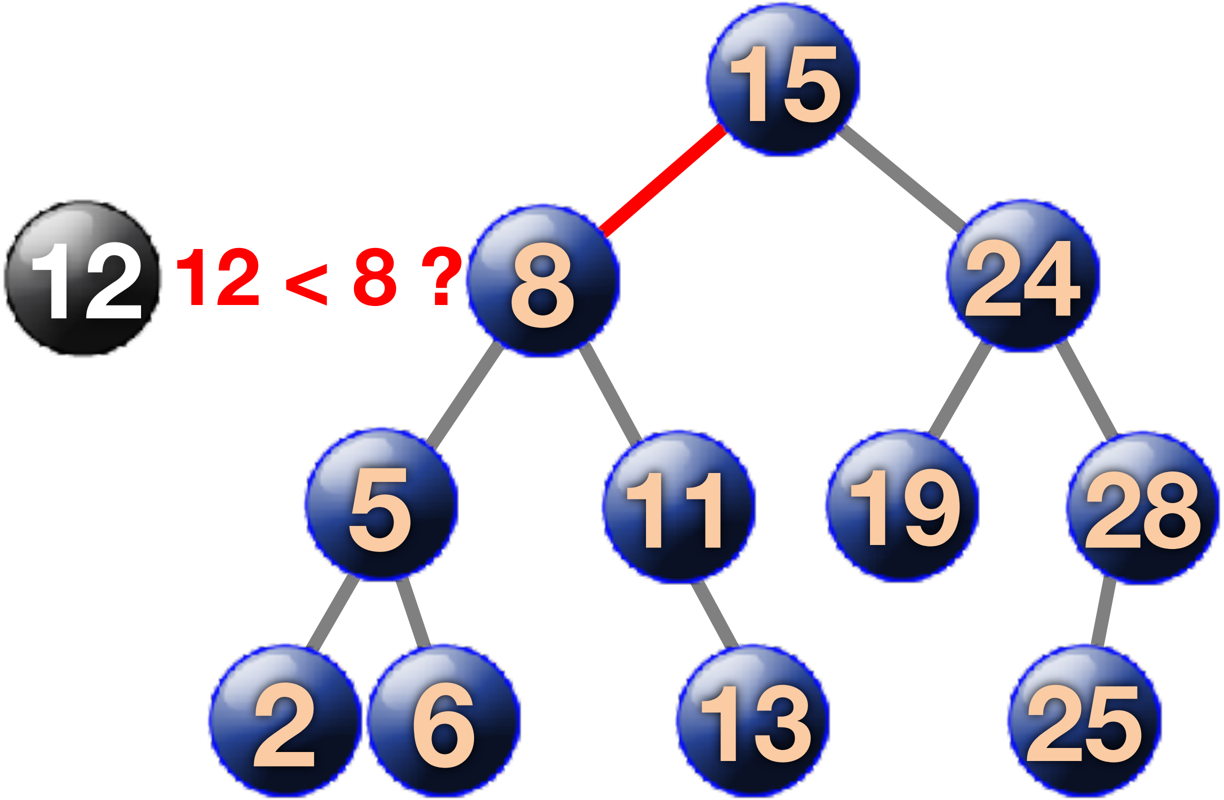
BST Insert

- Start at root
- Always insert as a leaf



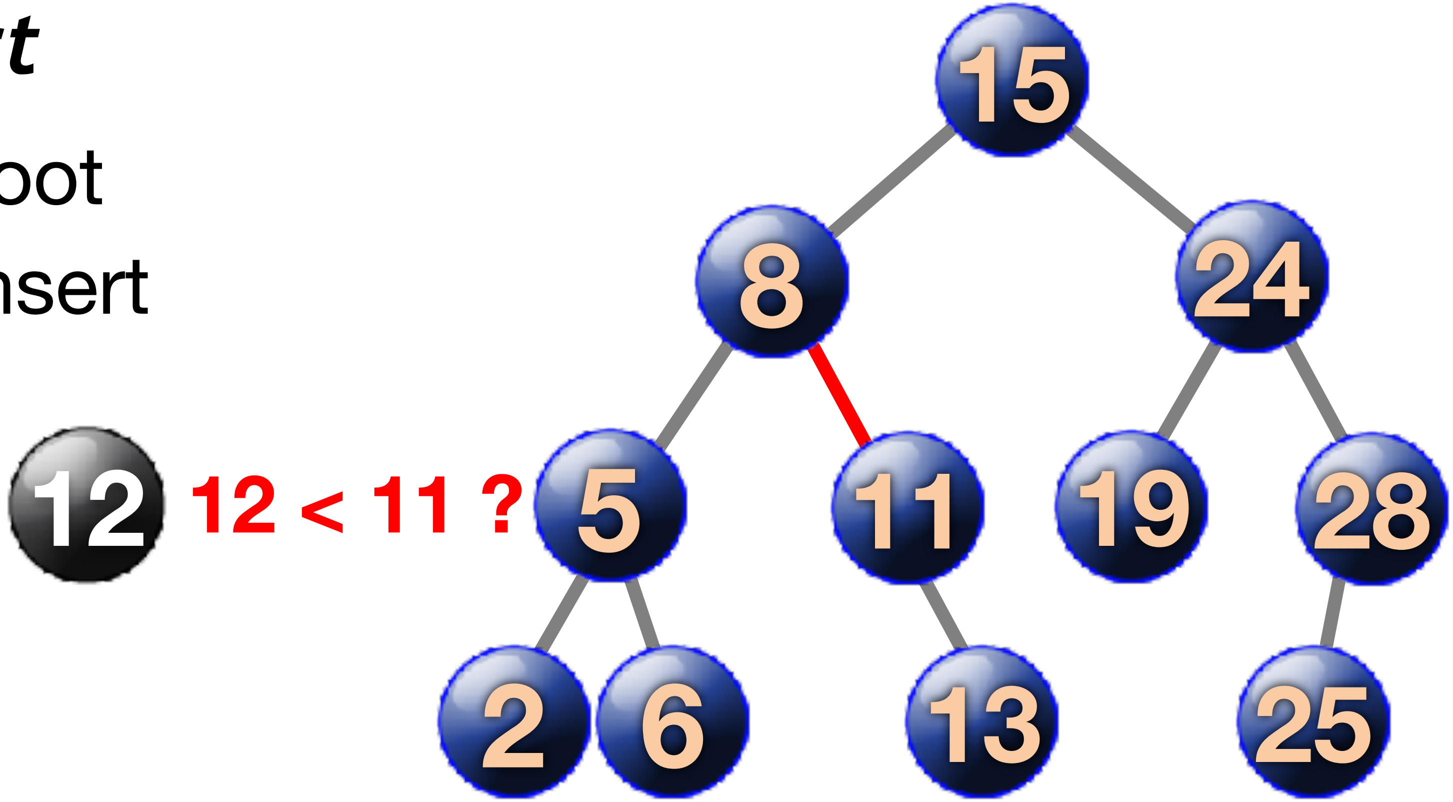
BST Insert

- Start at root
- Always insert as a leaf



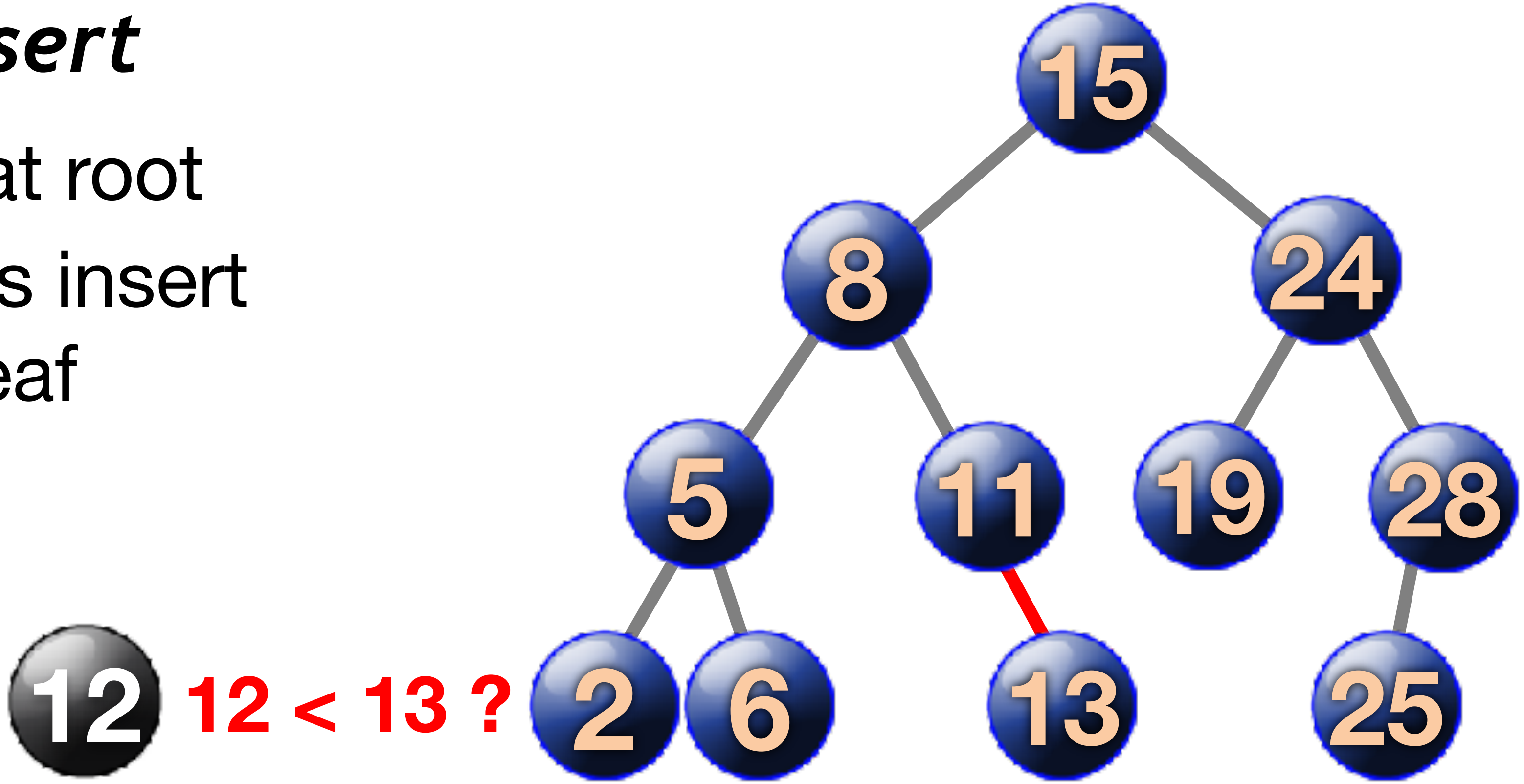
BST Insert

- Start at root
- Always insert as a leaf



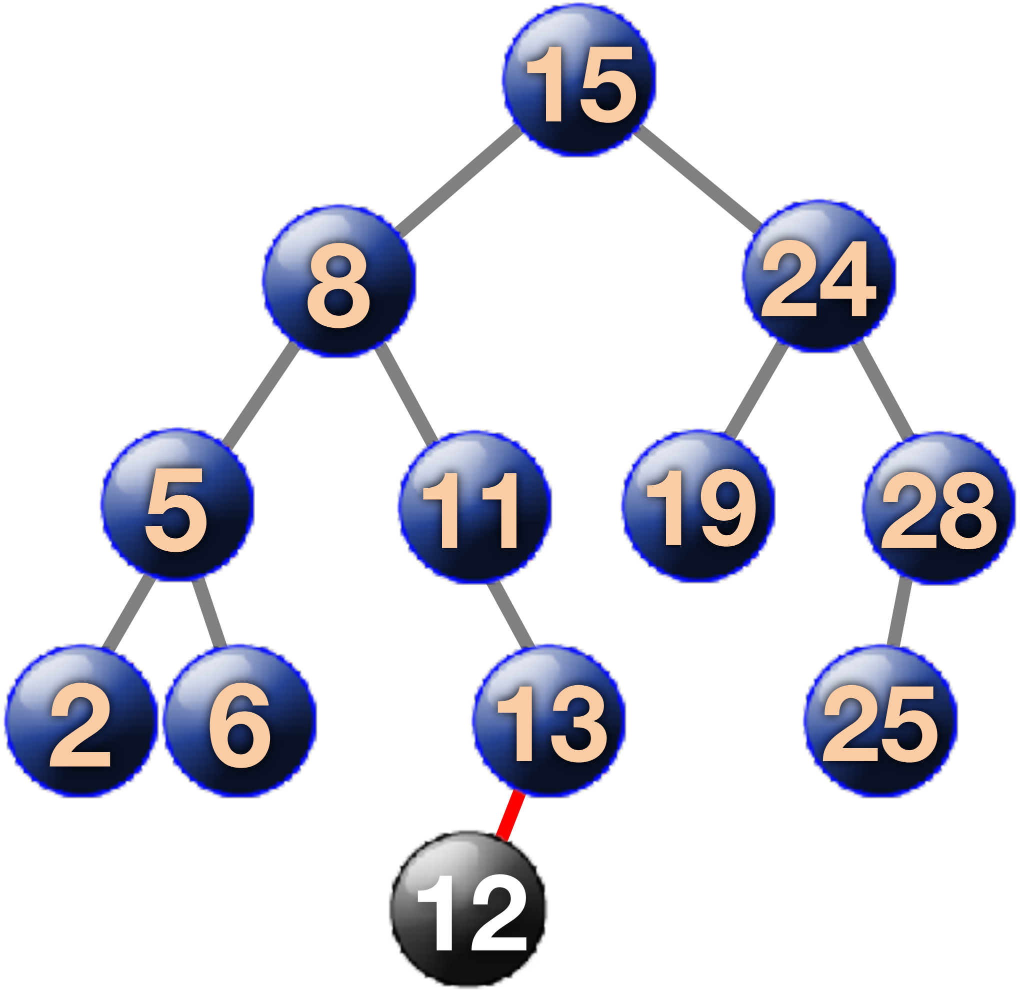
BST Insert

- Start at root
- Always insert as a leaf



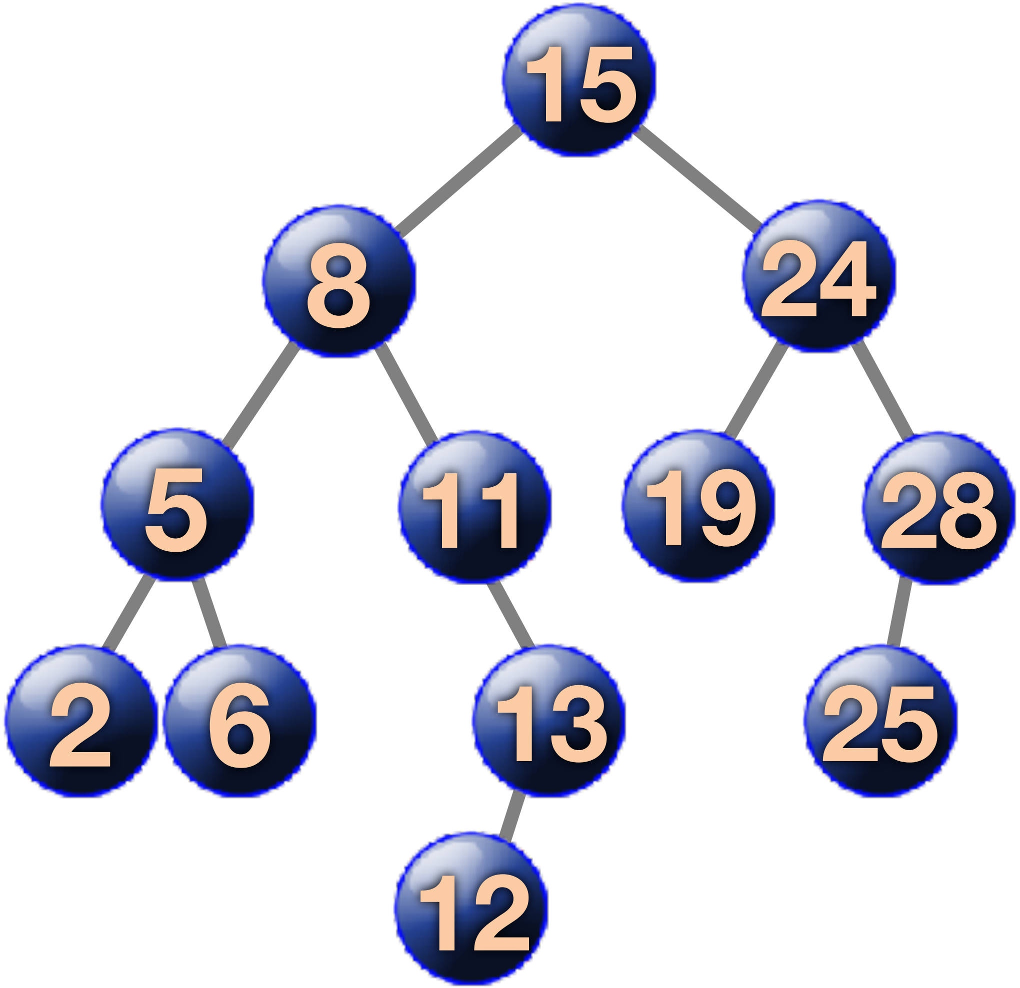
BST Insert

- Start at root
- Always insert as a leaf



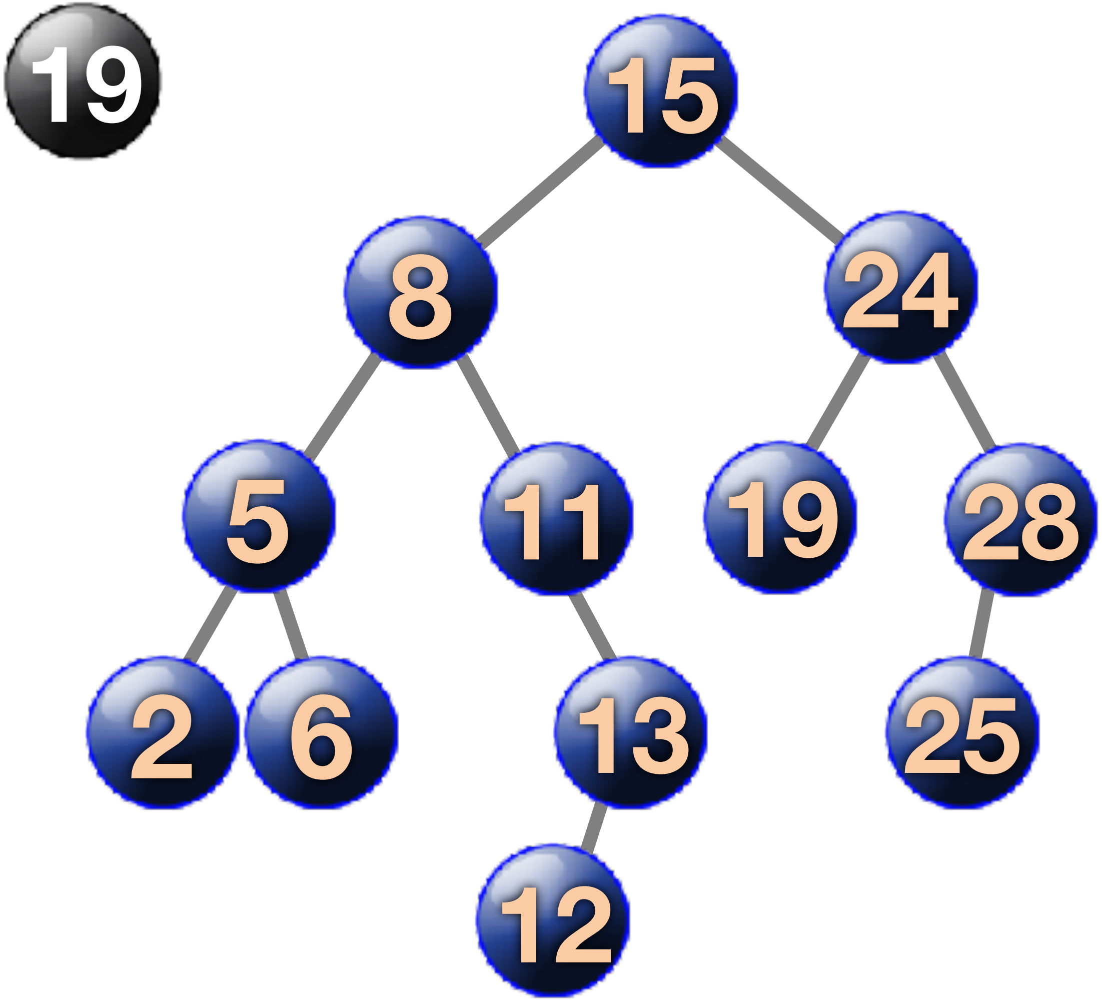
BST Find

- Start at root



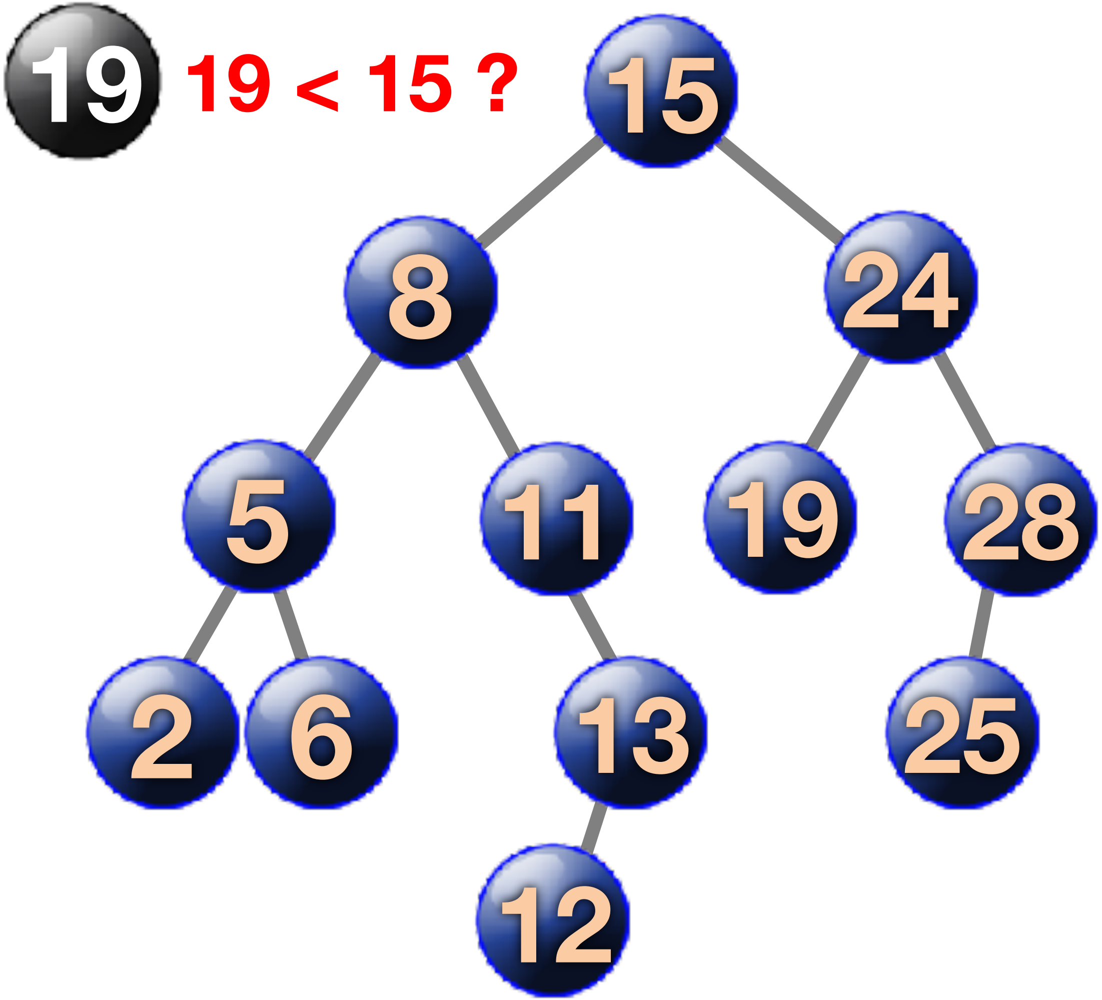
BST Find

- Start at root



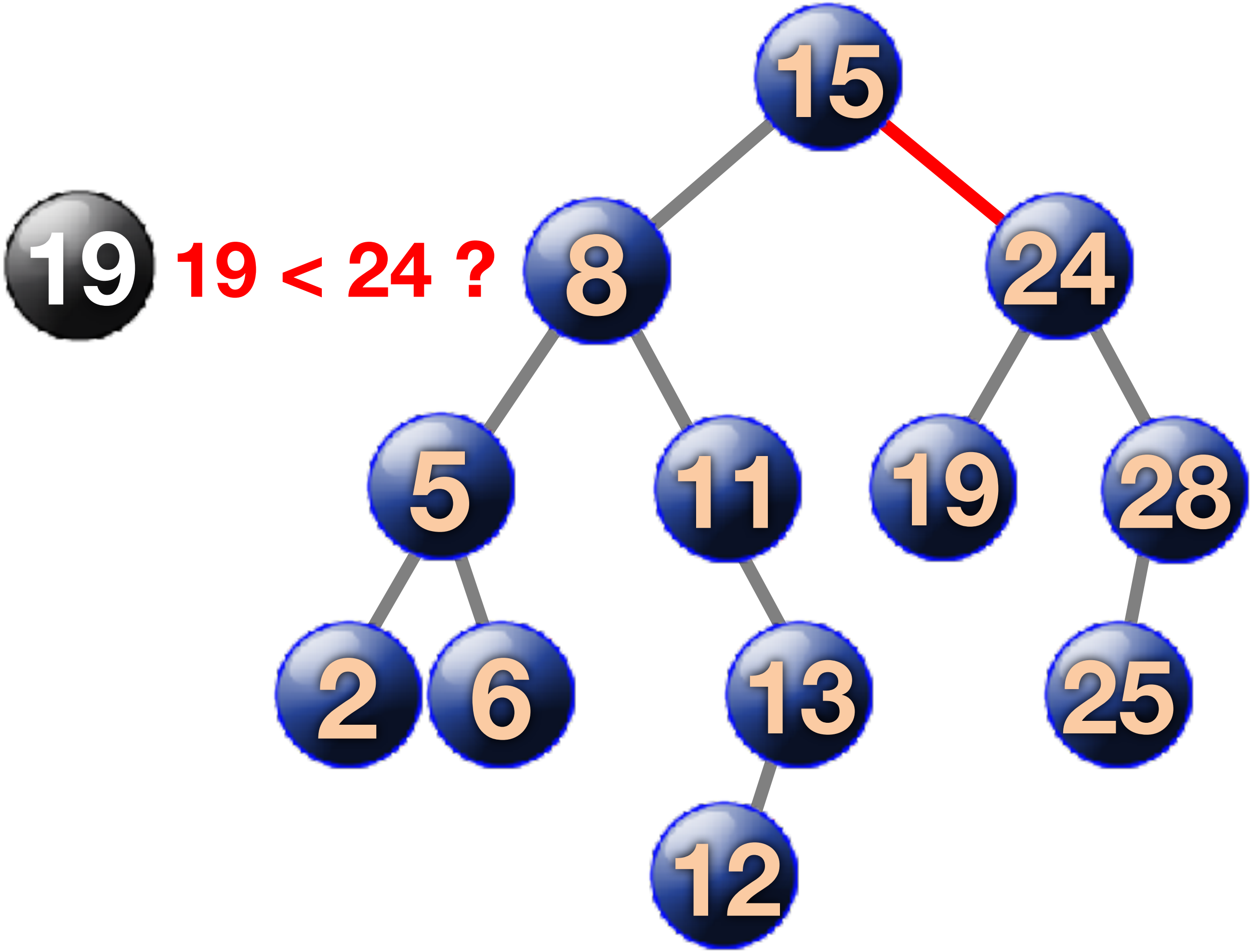
BST Find

- Start at root



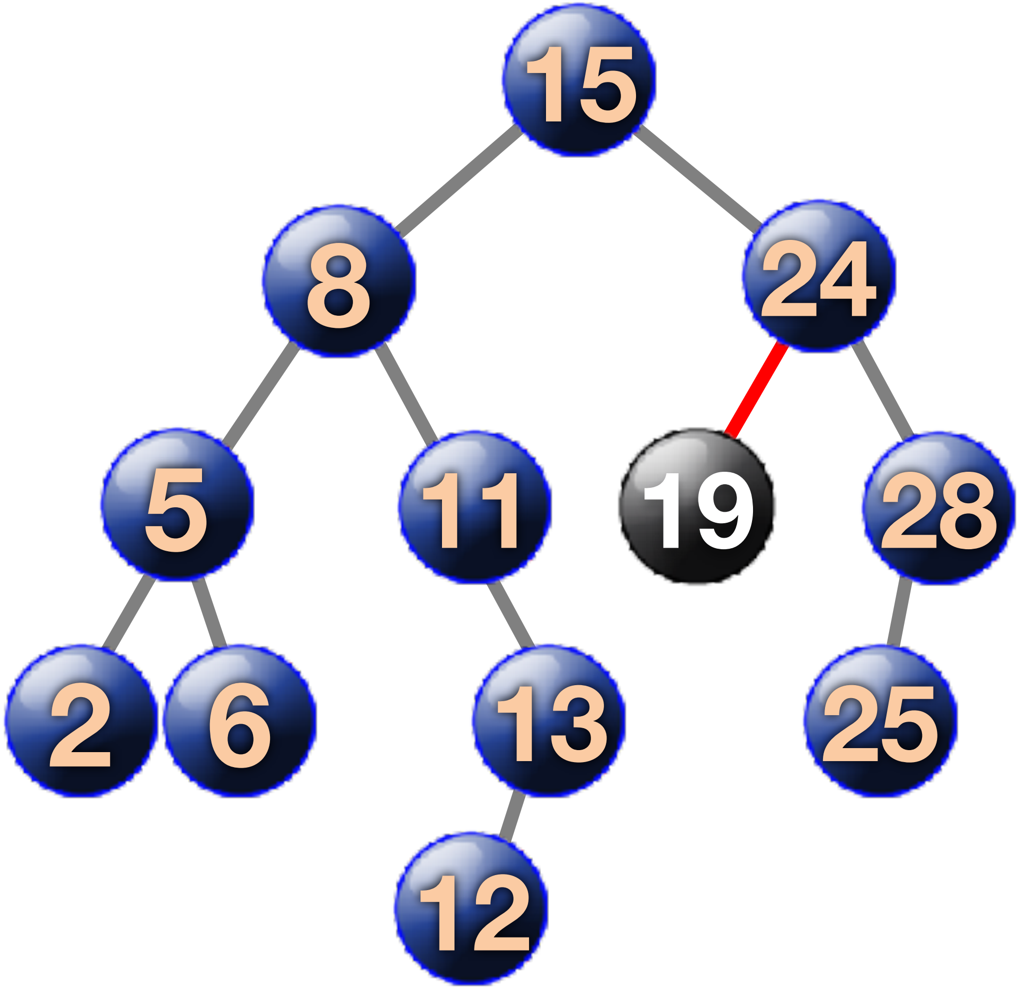
BST Find

- Start at root



BST Find

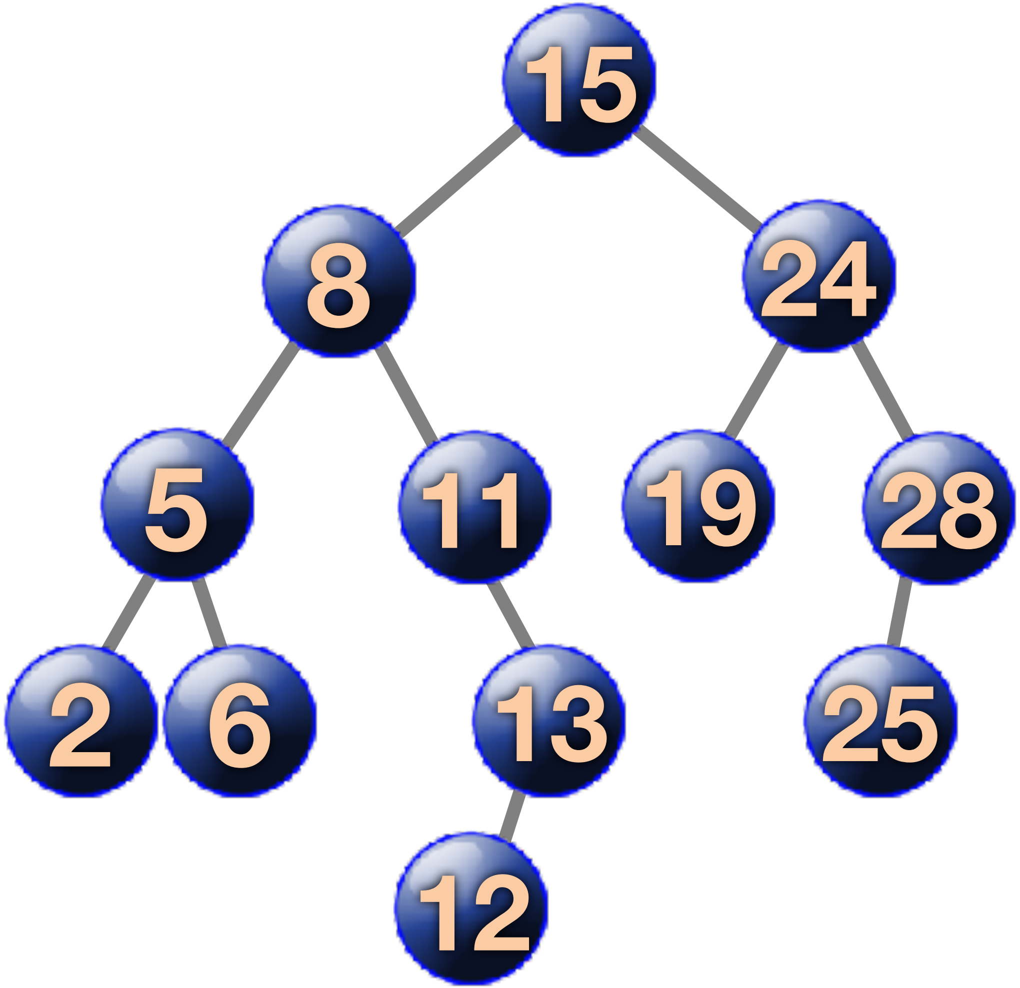
- Start at root
- Return the data if found, or False if not found



BST Delete

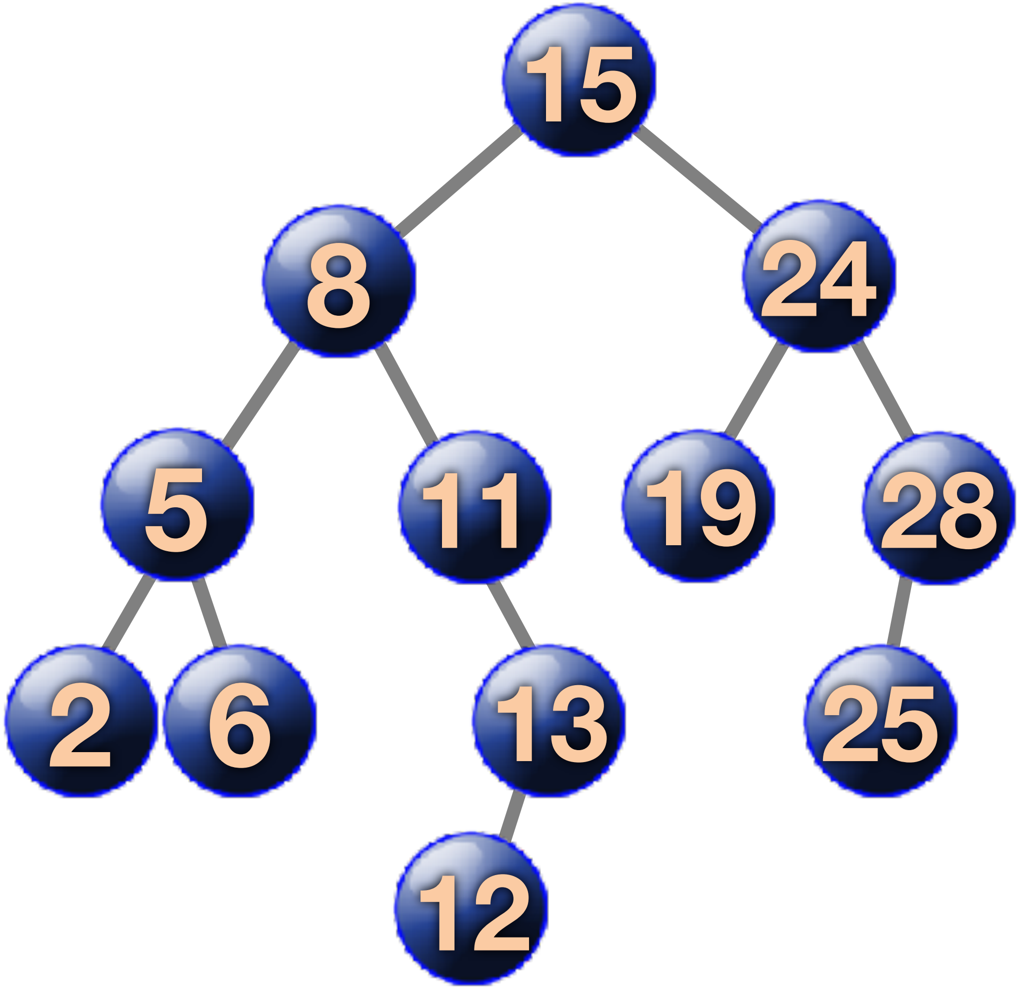
3 possible cases:

- leaf node
- 1 child
- 2 children



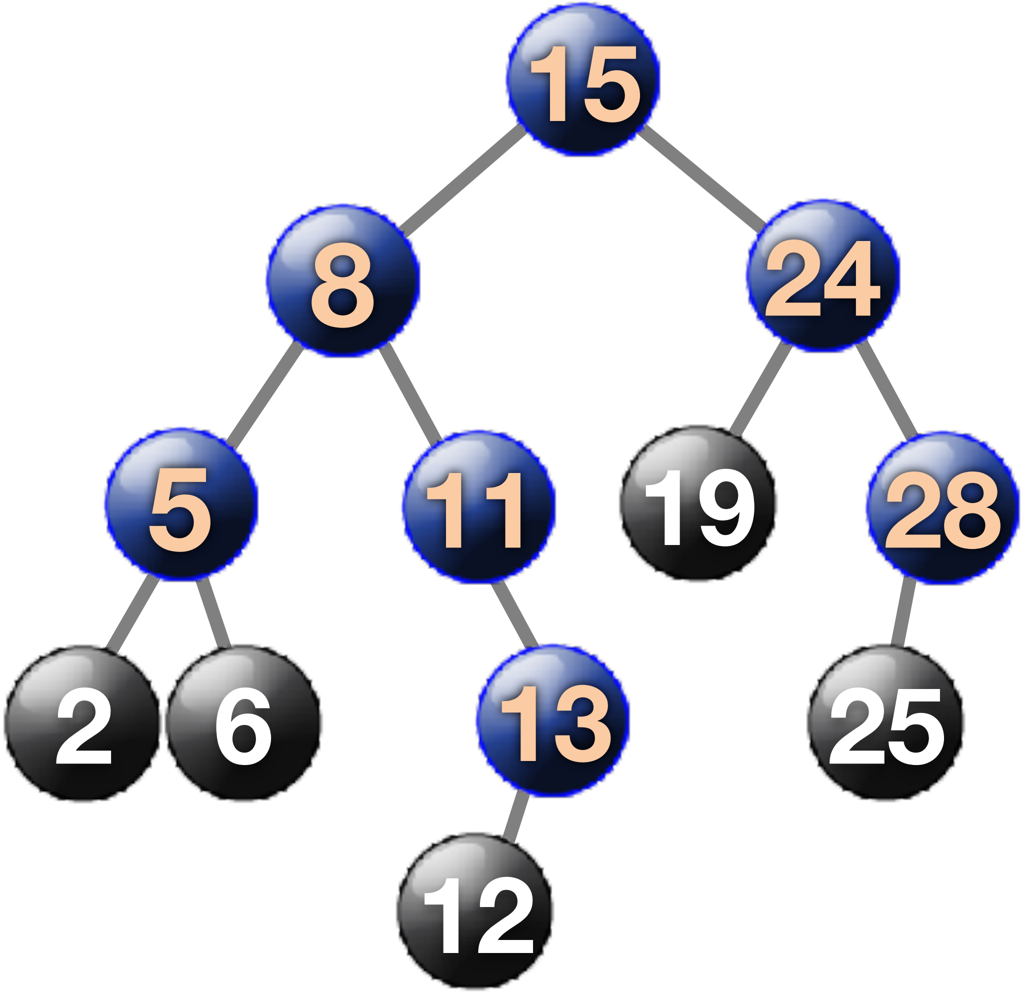
BST Delete

- leaf node



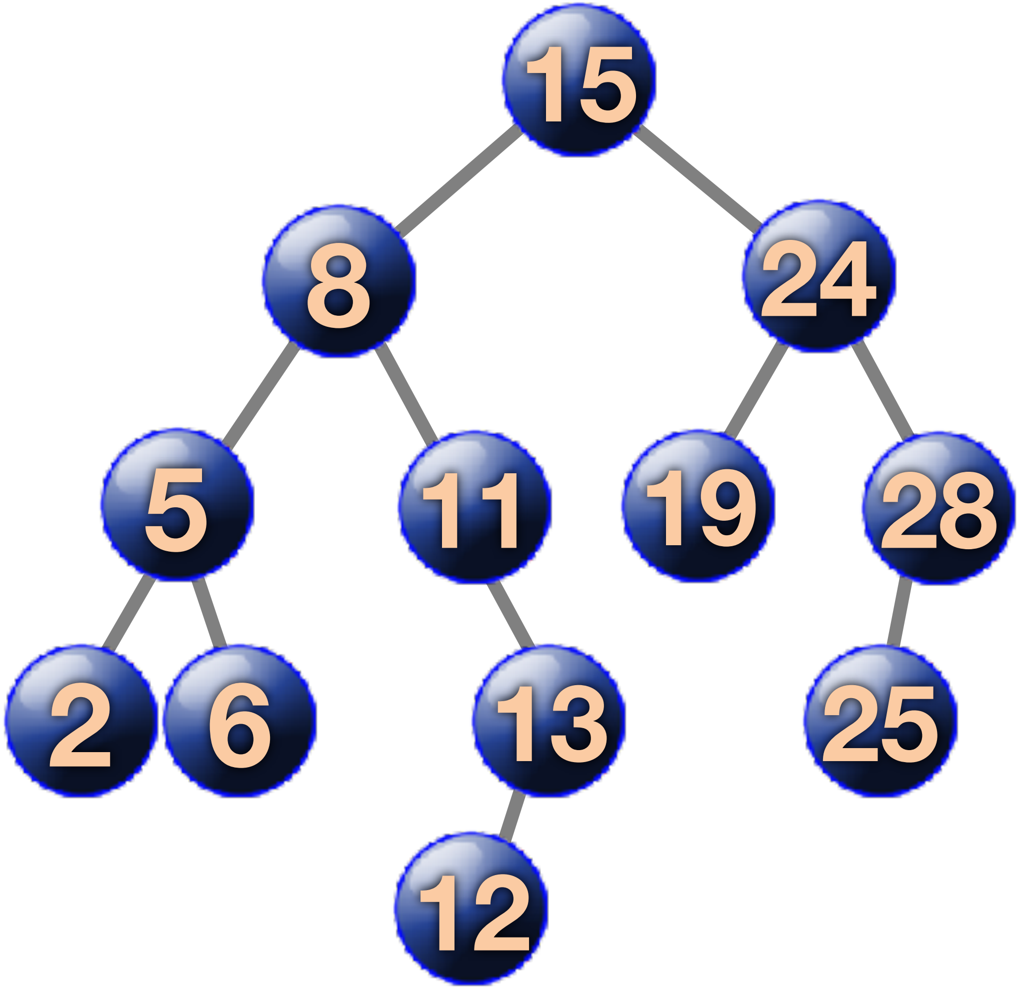
BST Delete

- leaf node
  - just delete the leaf node



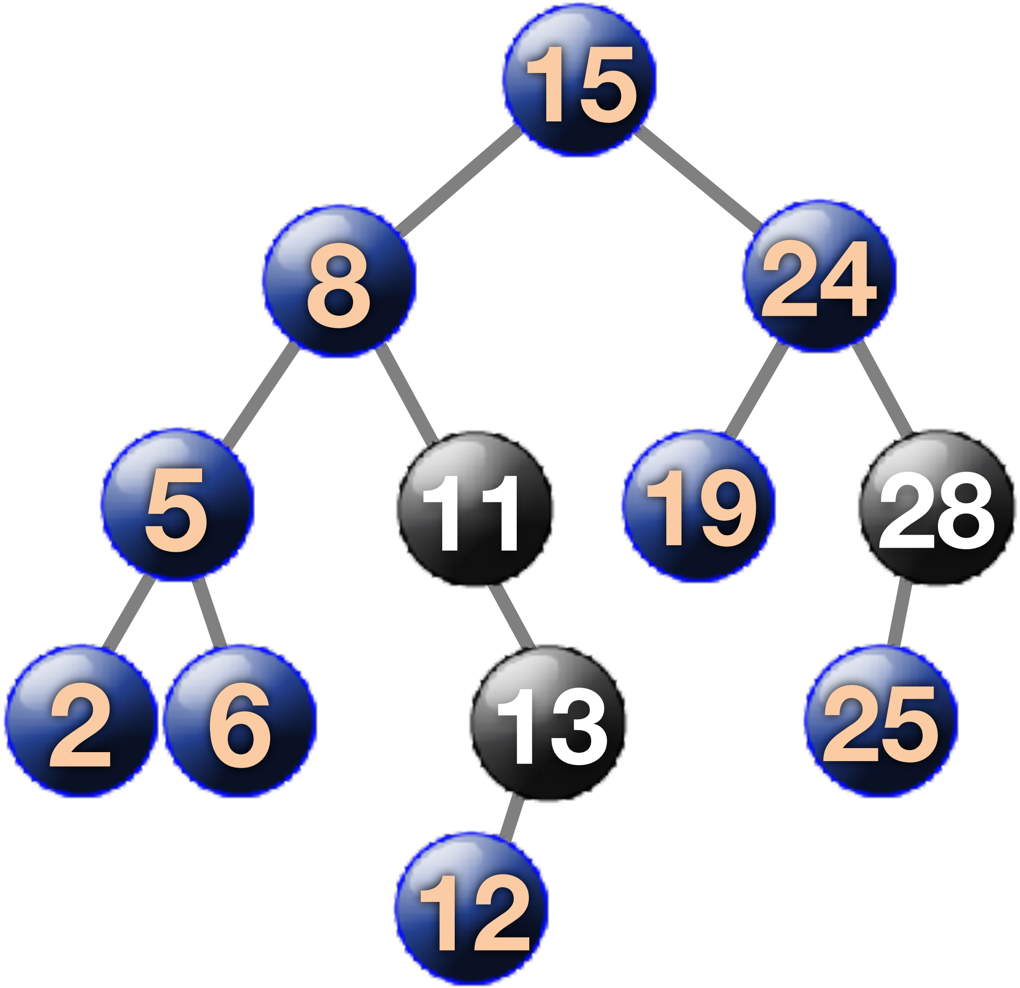
BST Delete

- 1 child



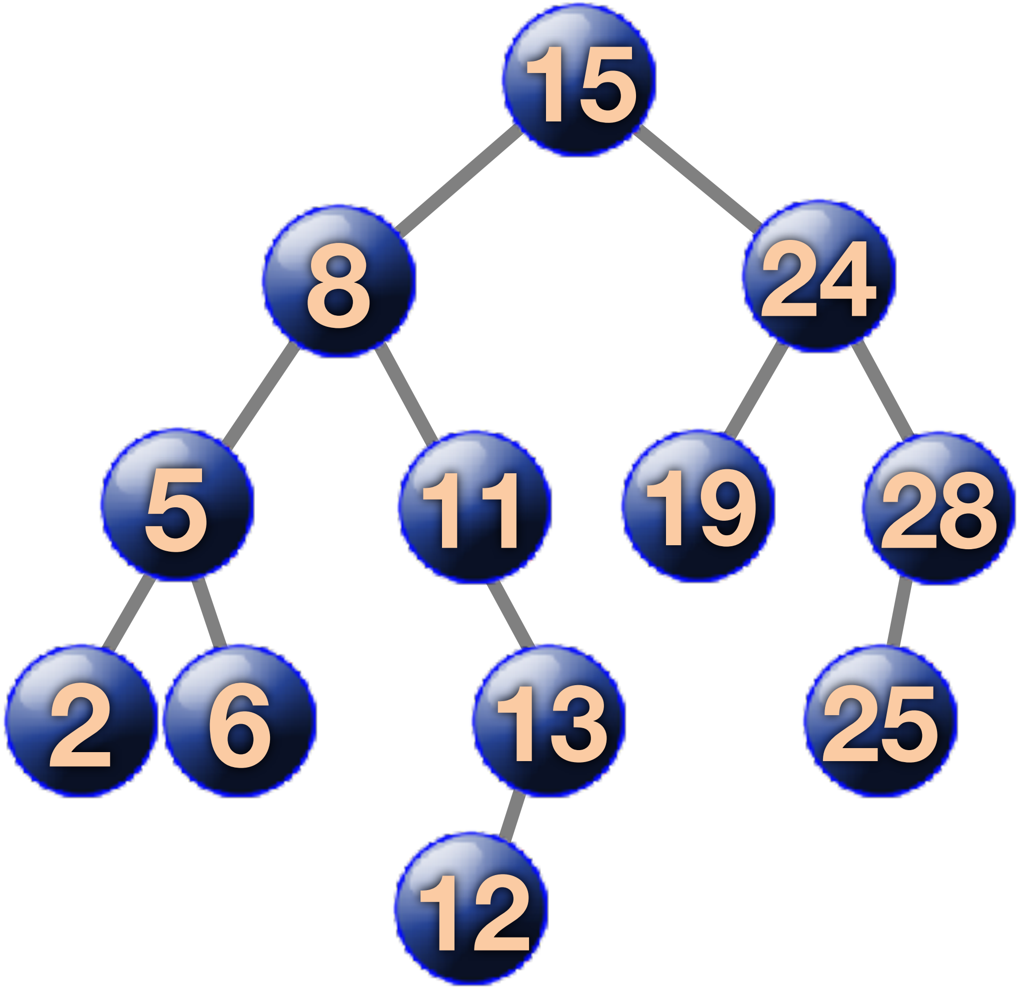
BST Delete

- 1 child
  - promote the child to the target node's position



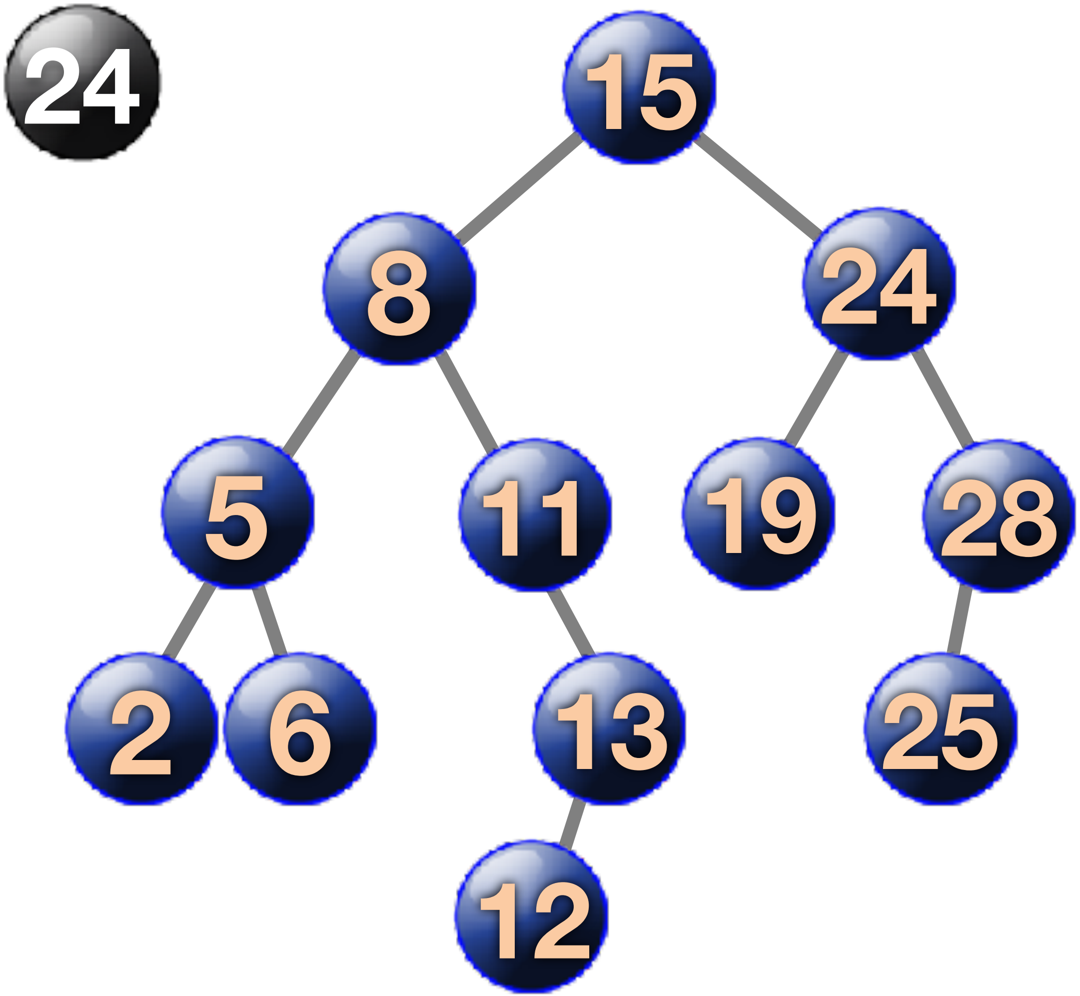
BST Delete

- 2 children



BST Delete

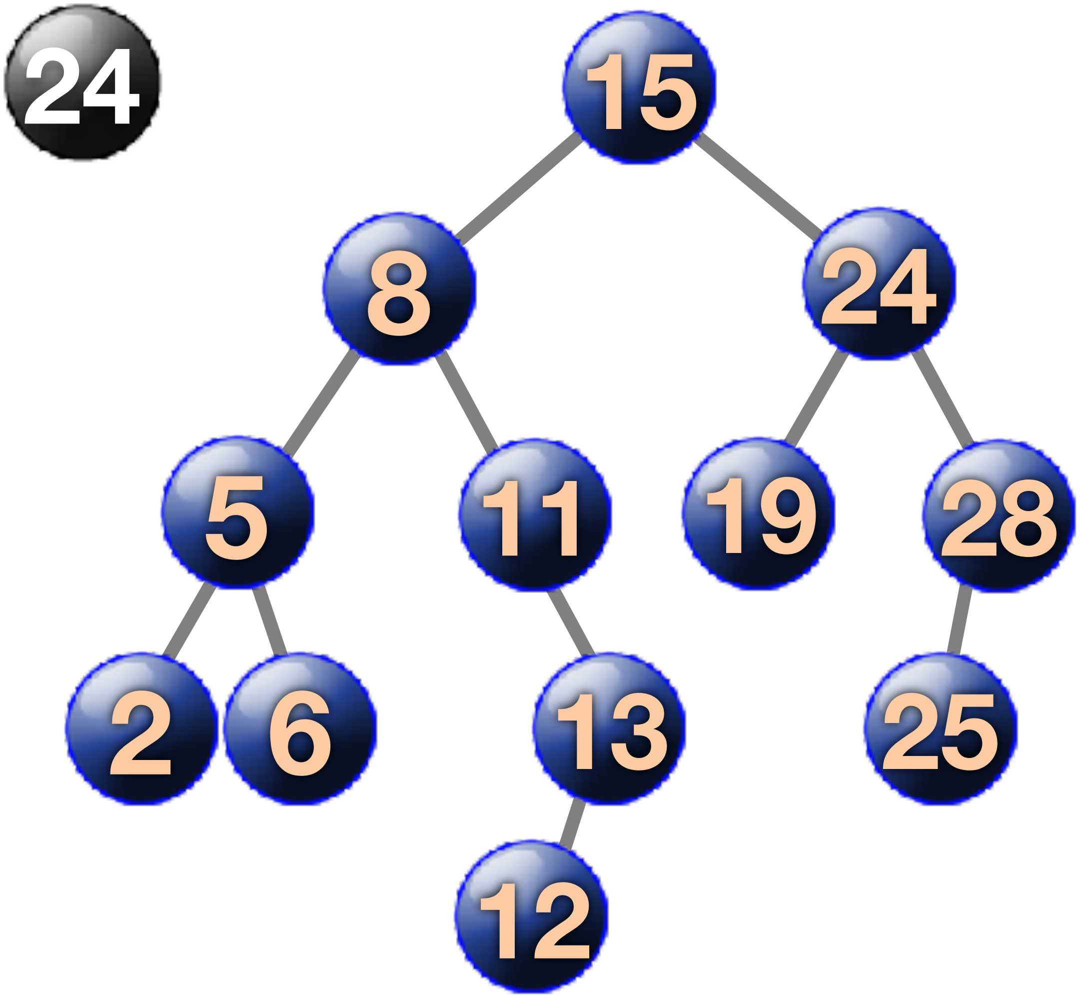
- 2 children



BST Delete

- 2 children

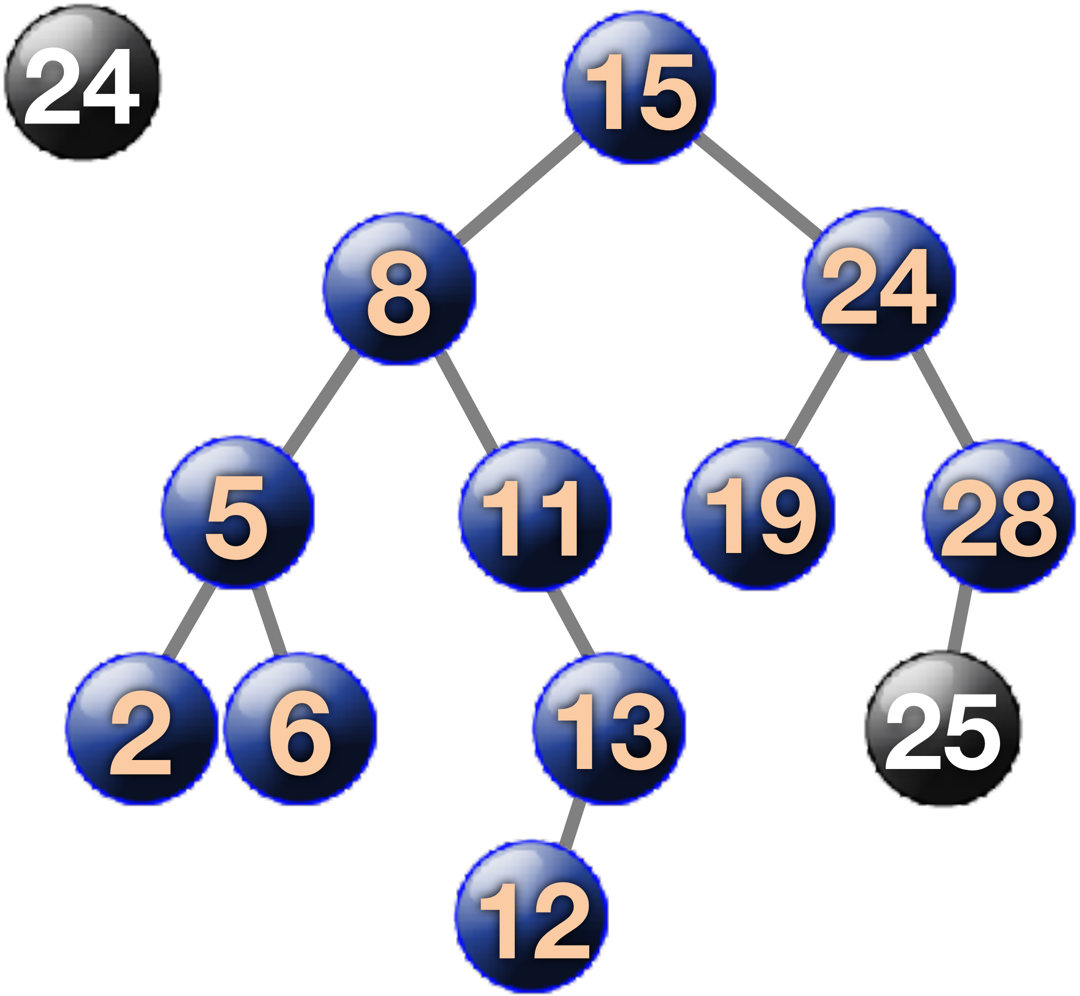
Find the next higher node



BST Delete

- 2 children

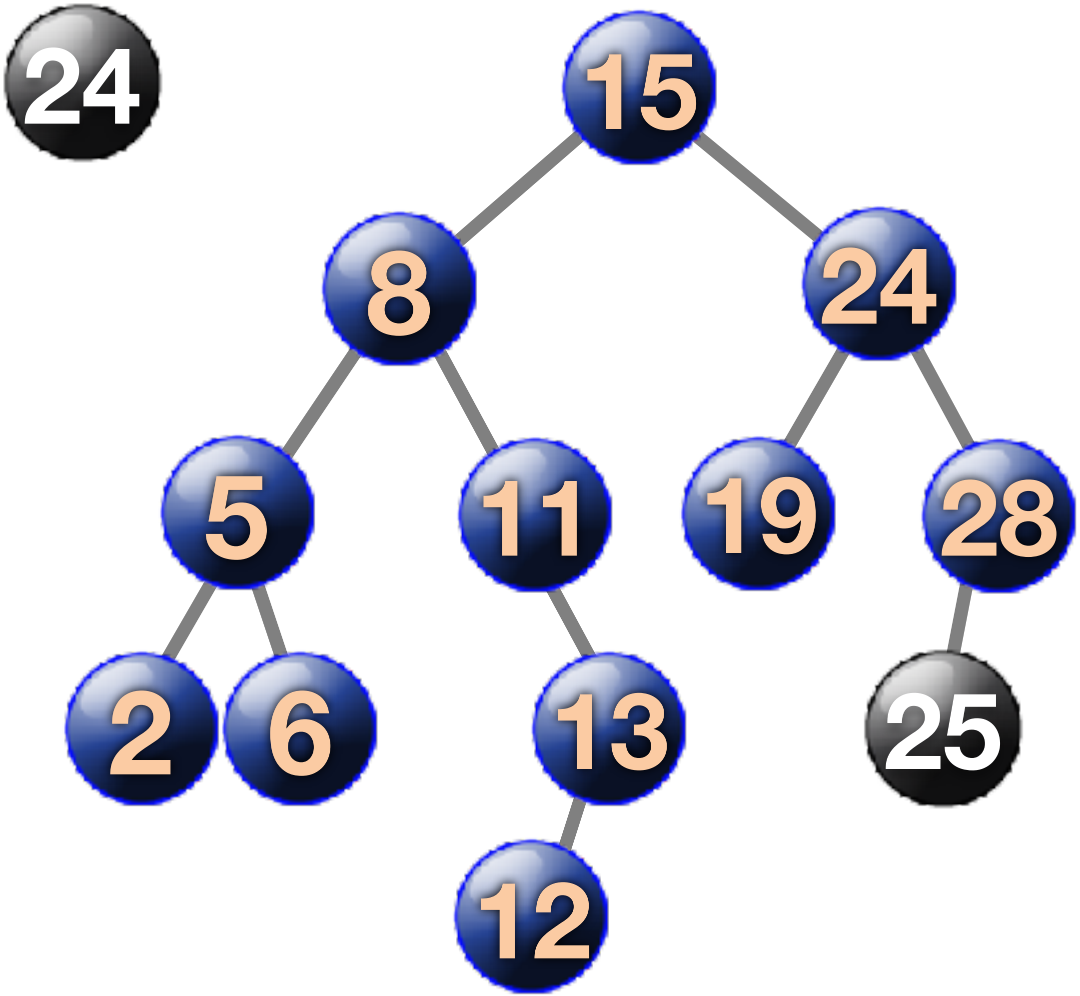
Find the next higher node



BST Delete

- 2 children

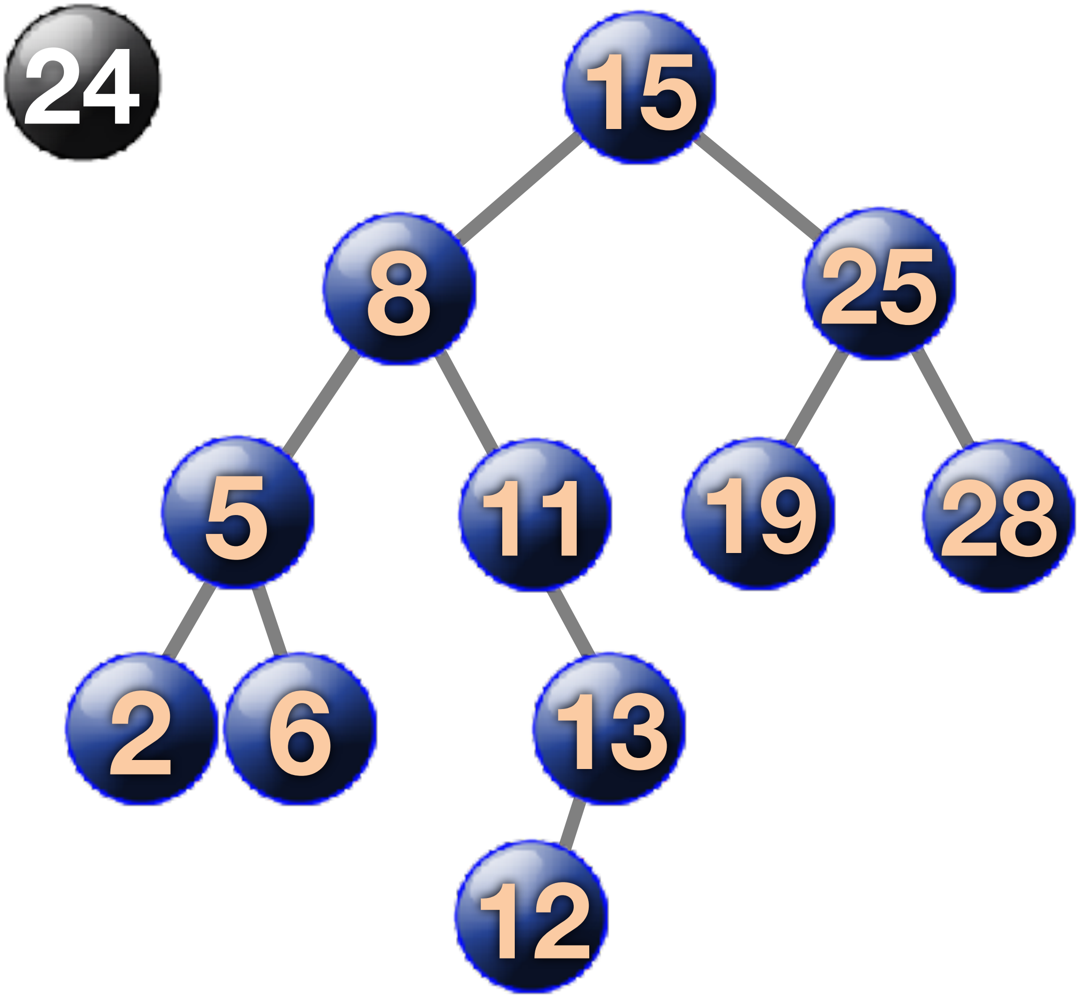
Find the next higher node, change 24 to 25, then delete node 25



BST Delete

- 2 children

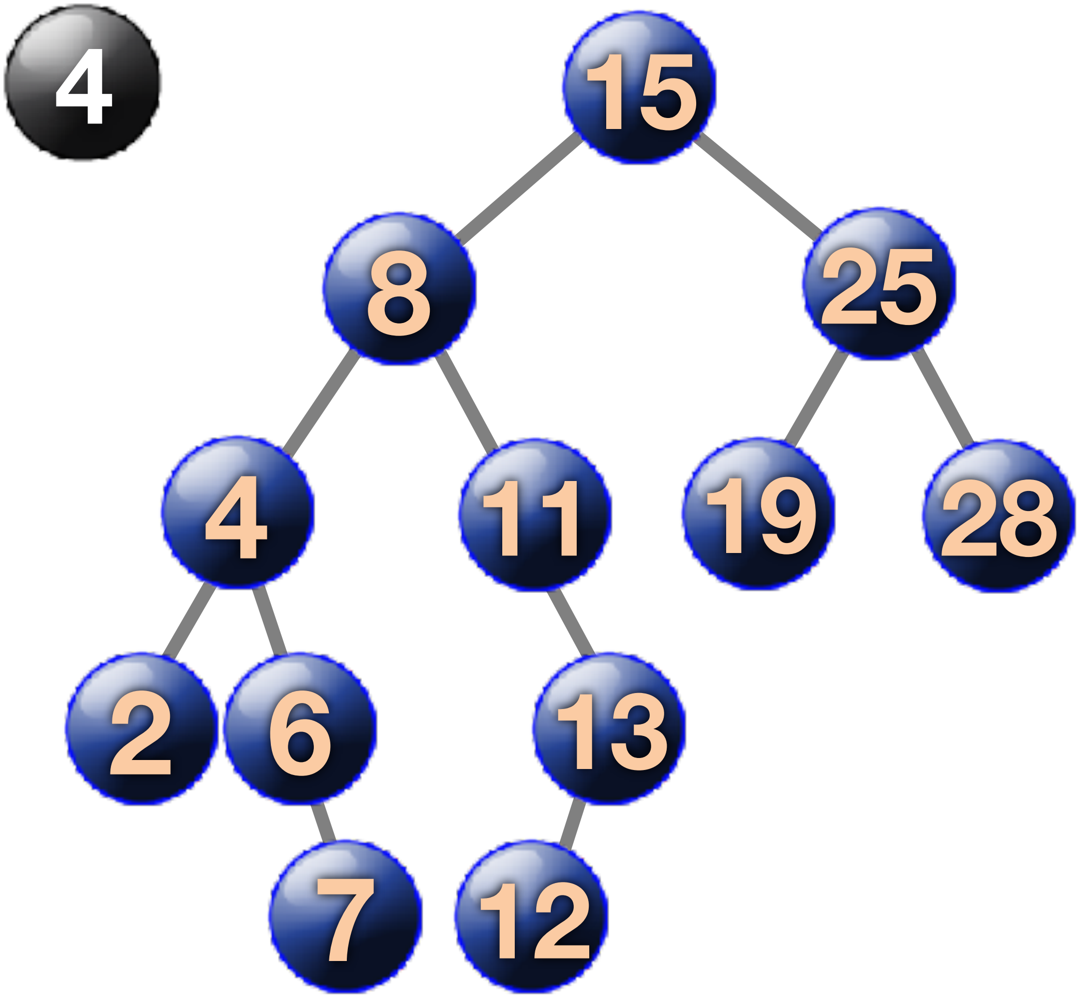
Find the next higher node, change 24 to 25, then delete node 25



BST Delete

- 2 children

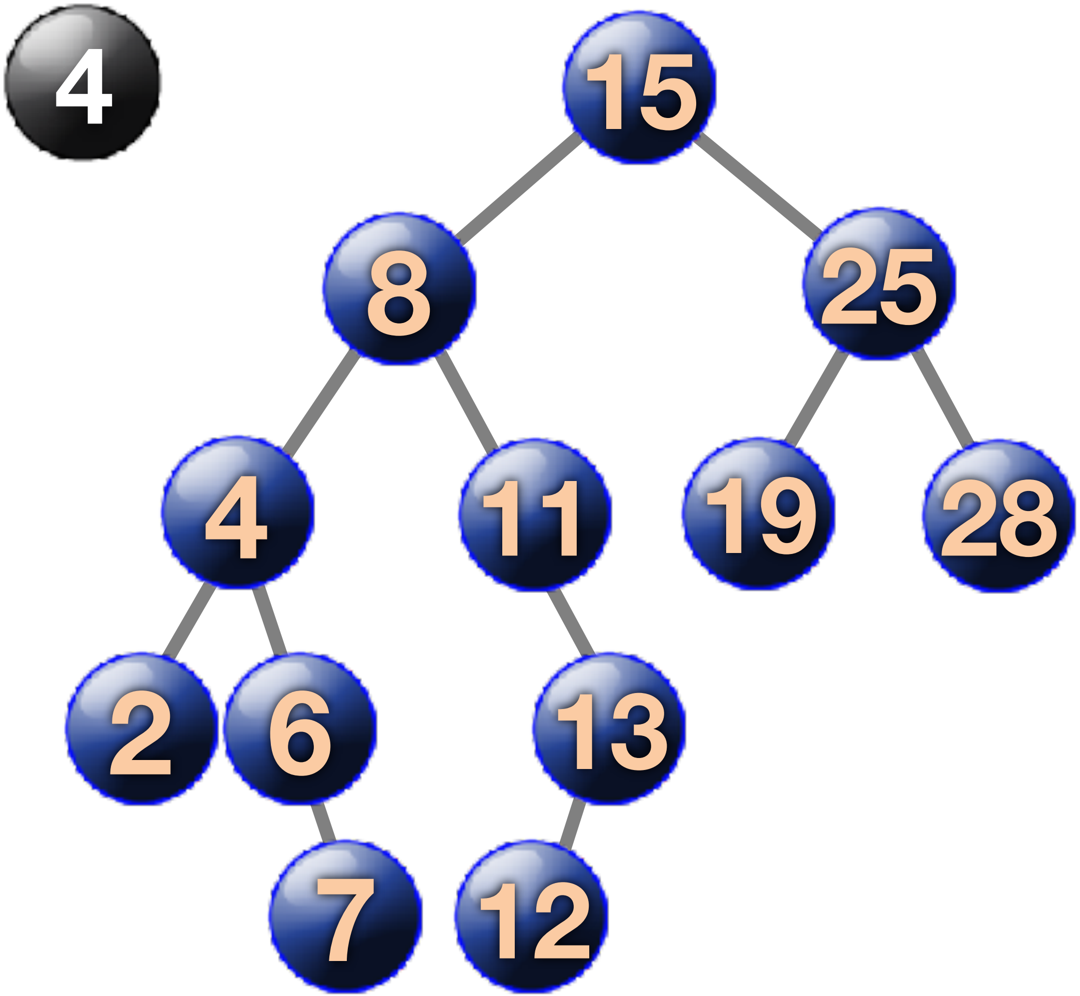
Find the next higher node,



BST Delete

- 2 children

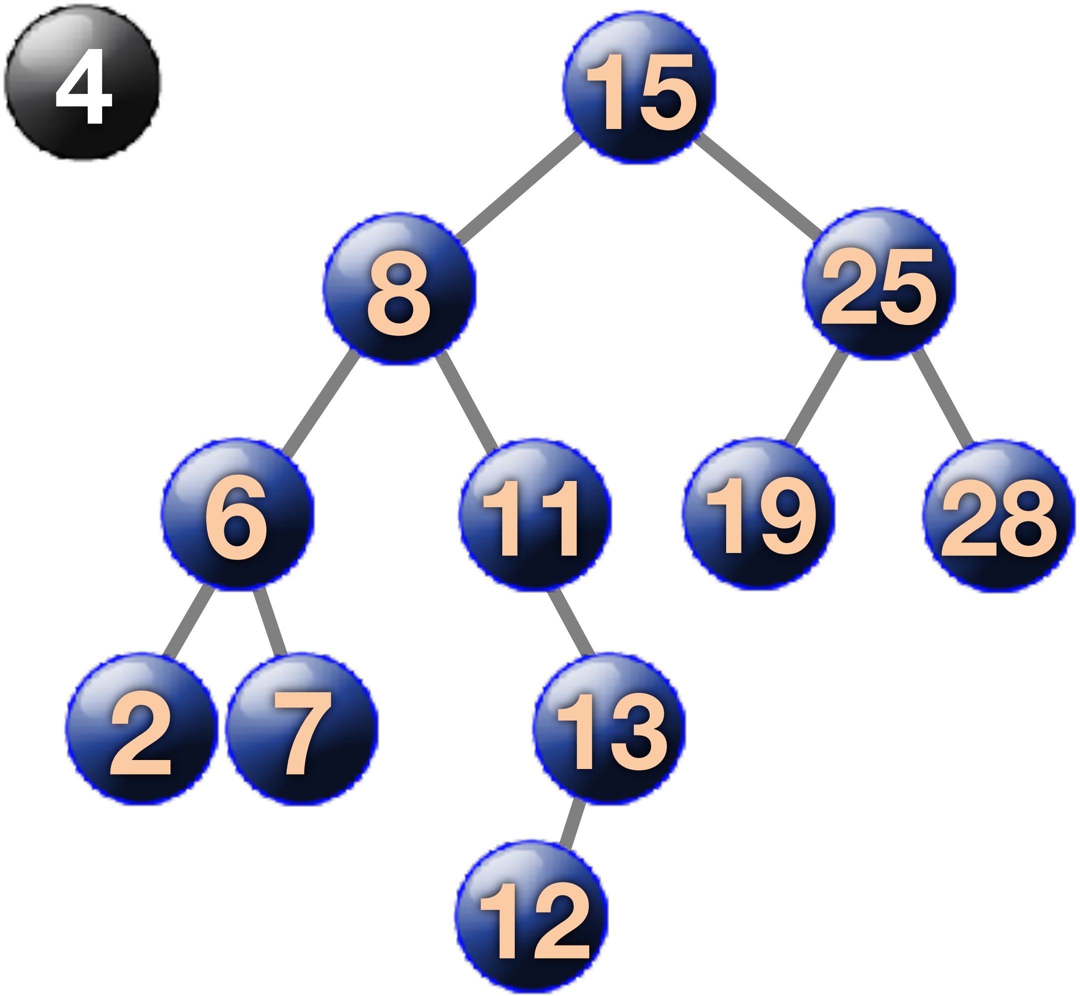
Find the next higher node, change 4 to 6, then delete node 6



BST Delete

- 2 children

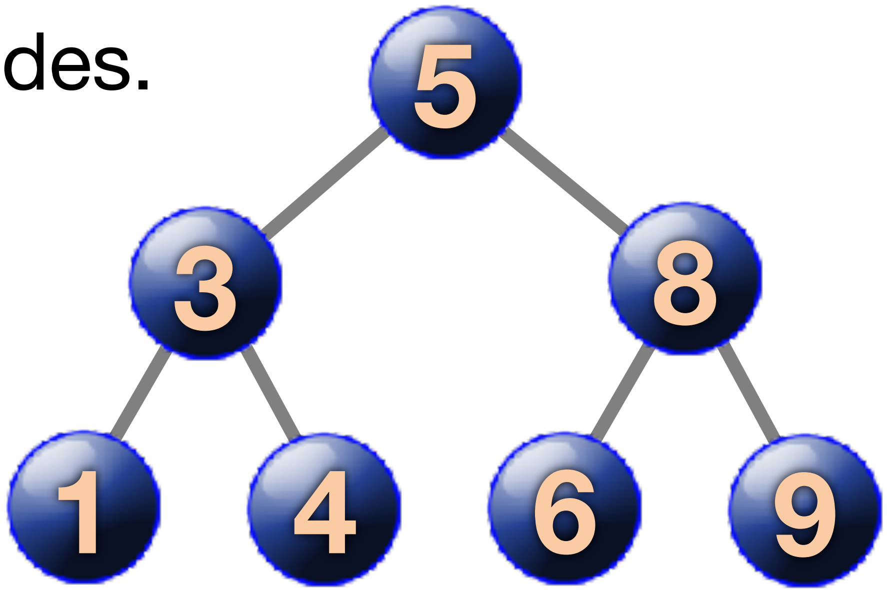
Find the next higher node, change 4 to 6, then delete node 6



Get_size

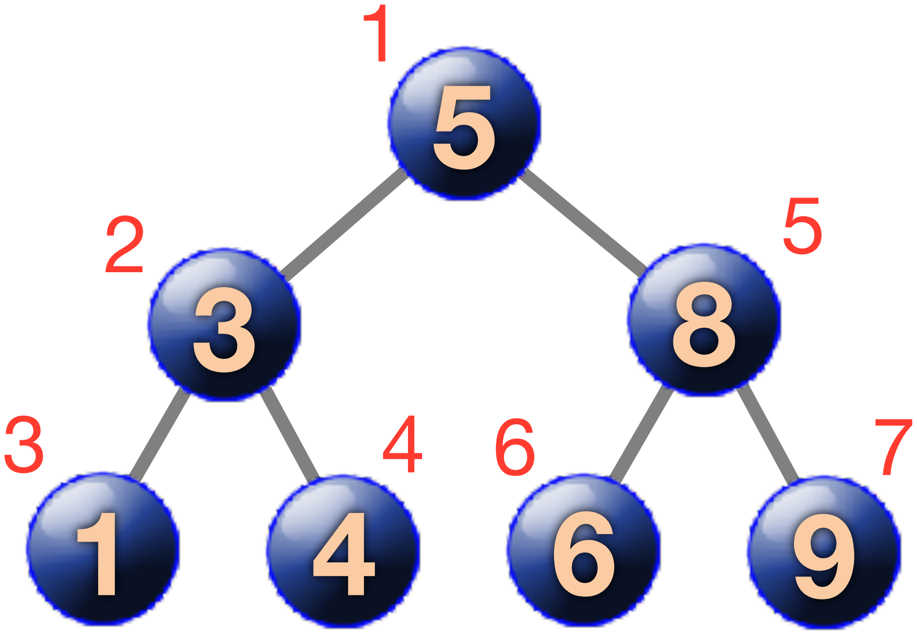
Returns number of nodes.
Works recursively

size = 1
    + size(left subtree)
    + size(right subtree)



Preorder Traversal

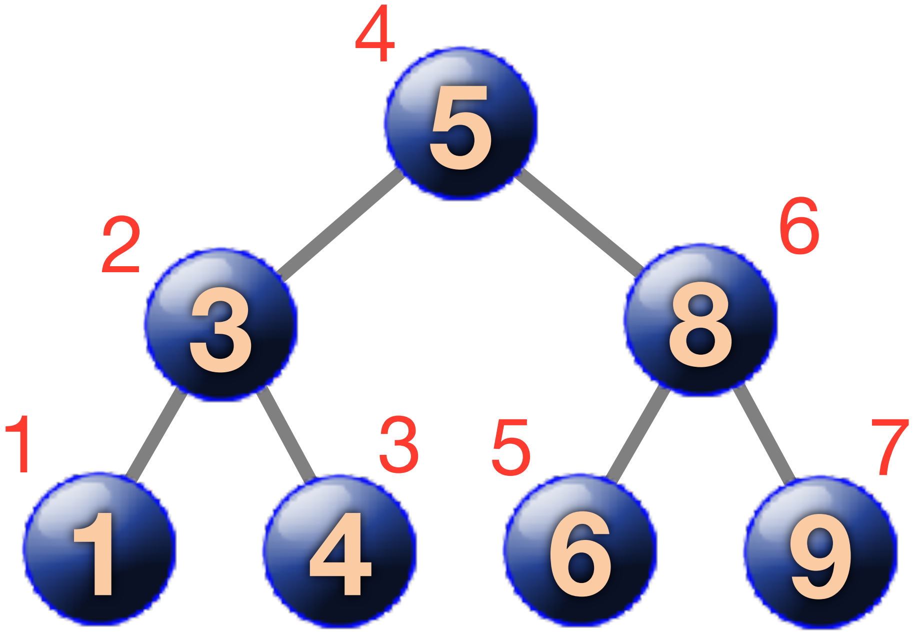
Visit root before visiting the root's subtrees.



Inorder Traversal

Visit root between visiting the root's subtrees.

Gives values in sorted order.



Advantages of Binary Search Trees?

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Because trees use recursion for most operations, they are fairly easy to implement.

Advantages of Binary Search Trees?

SPEED

Advantages of Binary Search Trees?

SPEED

Insert, Delete, Find in

O(h) = O(log n)

Advantages of Binary Search Trees?

SPEED

In a balanced BST
with 10,000,000 nodes
Find takes 30 comparisons!

Advantages of Binary Search Trees?

SPEED

Why are trees so fast?

Because each comparison *cuts in half* the number of nodes to search.