极客大学算法训练营
第六课
树、二叉树、二叉搜索树

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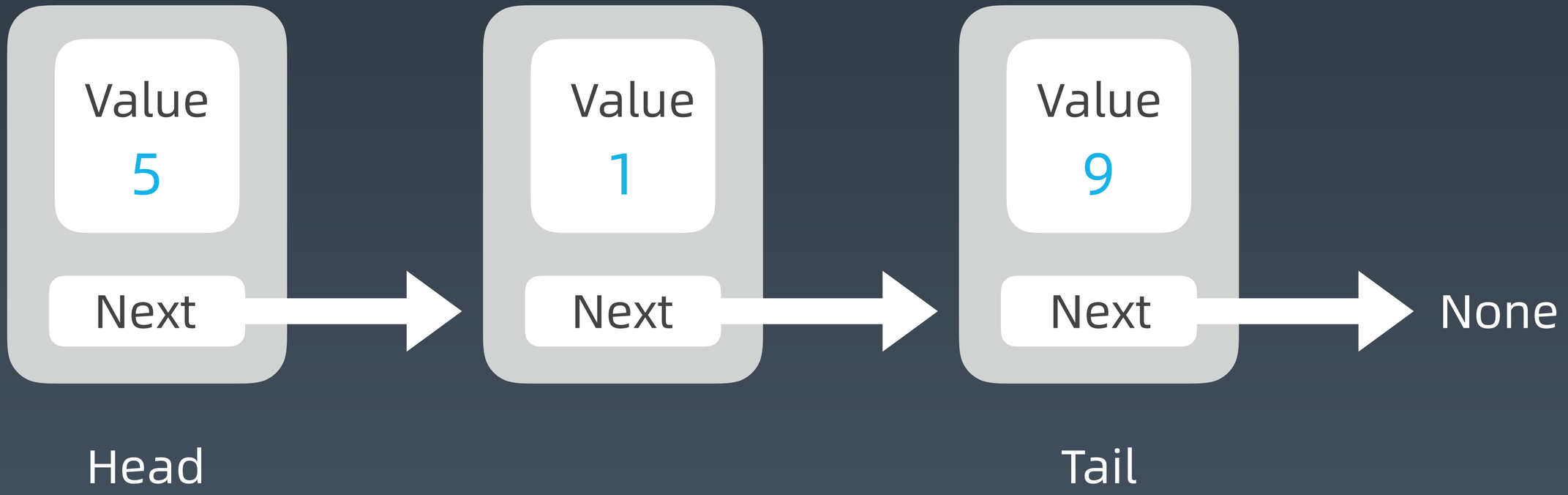
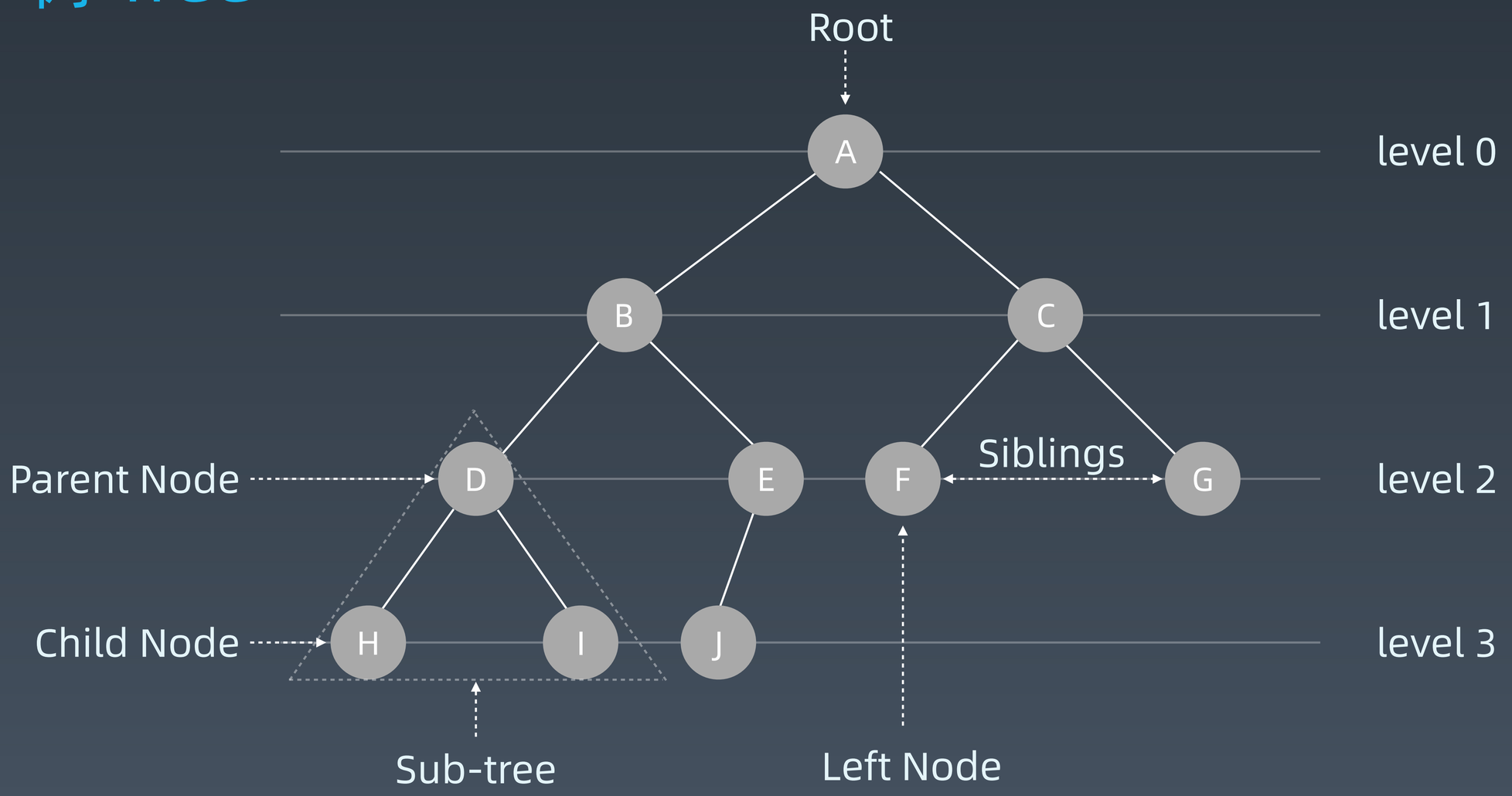
前序知识回顾：链表等一维结构

单链表 Linked List



树 Tree


Root
A
B
C
D
E
F
G
H
I
J
level 0
level 1
level 2
level 3
Parent Node
Child Node
Siblings
Sub-tree
Left Node

二叉树 Binary Tree

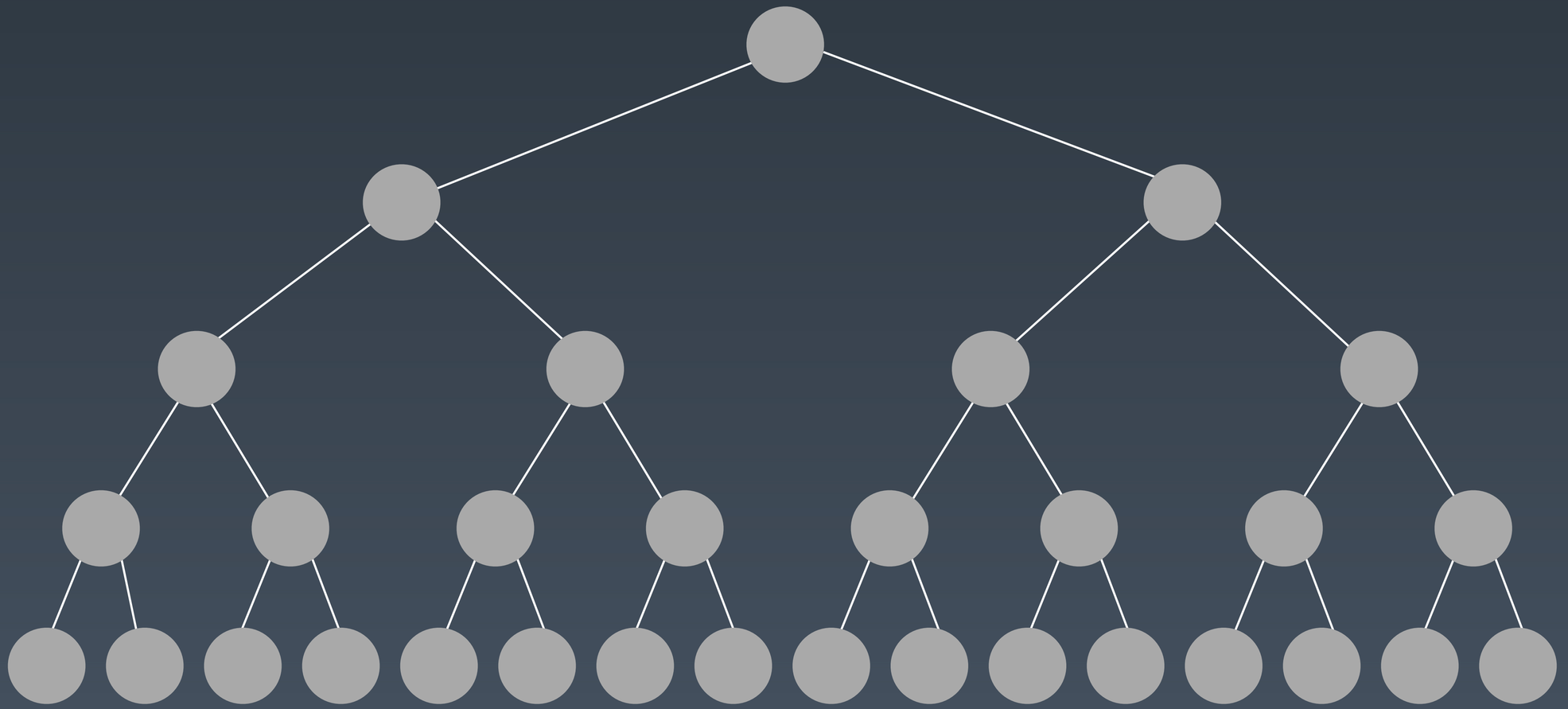
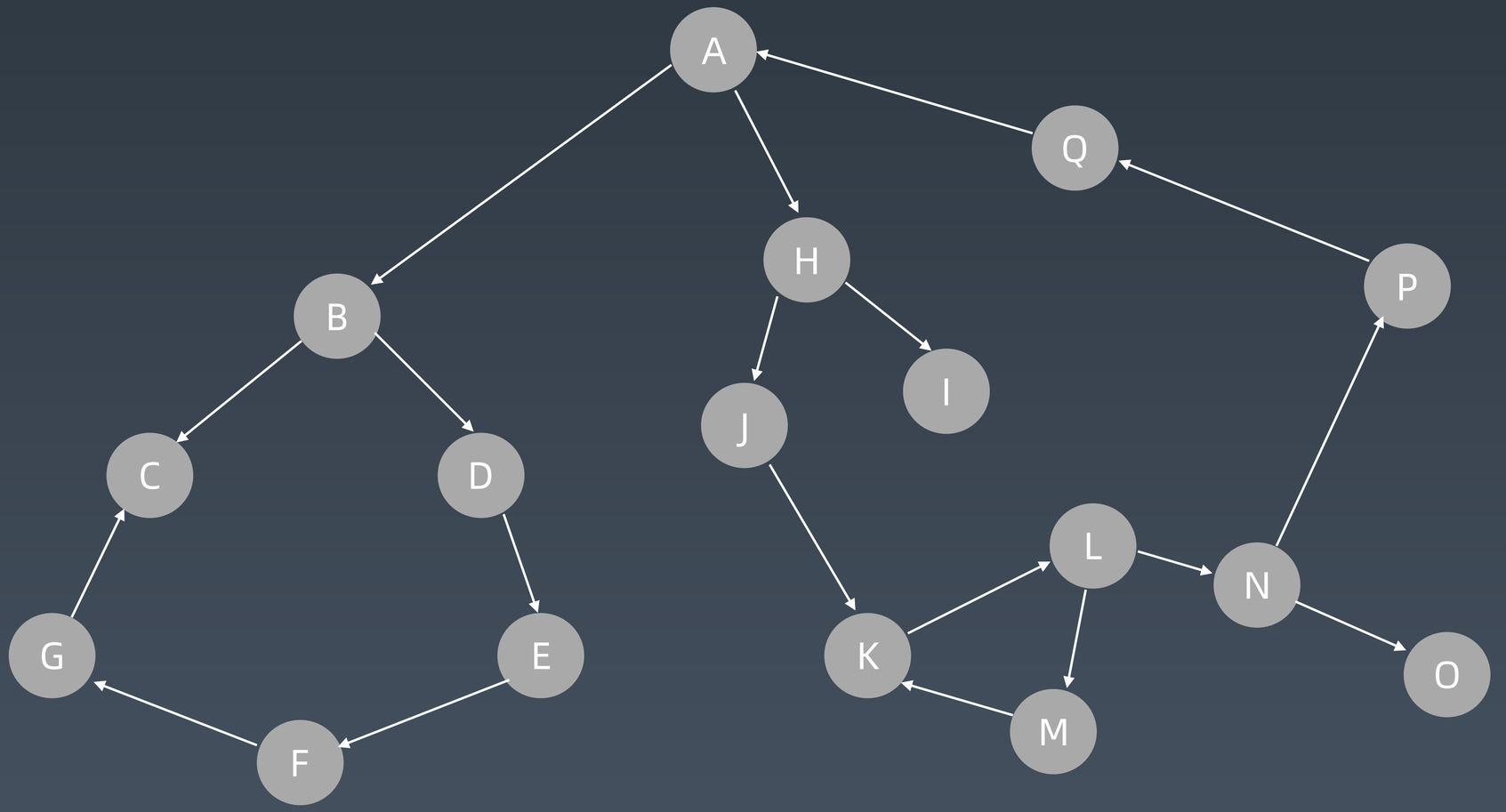


图 Graph



Linked List 是特殊化的 Tree

Tree 是特殊化的 Graph

示例代码

Python

```python
class TreeNode:
  def __init__(self, val):
    self.val = val
    self.left, self.right = None, None
```

Java

```java
public class TreeNode {
  public int val;
  public TreeNode left, right;
  public TreeNode(int val) {
    this.val = val;
    this.left = null;
    this.right = null;
  }
}
```

C++

```cpp
struct TreeNode {
  int val;
  TreeNode *left;
  TreeNode *right;
  TreeNode(int x) : val(x), left(NULL), right(NULL) {}
}
```

二叉树遍历 Pre-order/In-order/Post-order

1.前序（Pre-order）：根-左-右

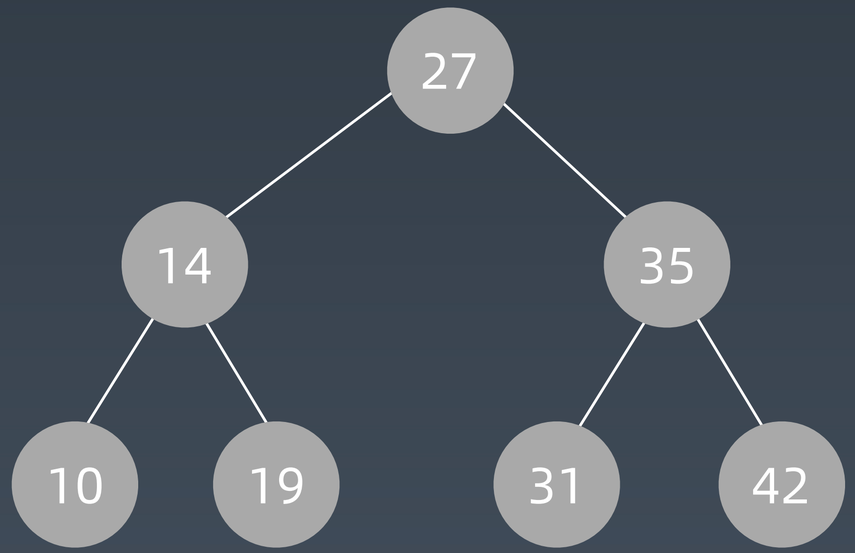
2.中序（In-order）：左-根-右

3.后序（Post-order）：左-右-根

示例代码

```
def preorder(self, root):

  if root:
    self.traverse_path.append(root.val)
    self.preorder(root.left)
    self.preorder(root.right)

def inorder(self, root):

  if root:
    self.inorder(root.left)
    self.traverse_path.append(root.val)
    self.inorder(root.right)

def postorder(self, root):

  if root:
    self.postorder(root.left)
    self.postorder(root.right)
    self.traverse_path.append(root.val)
```

二叉搜索树 Binary Search Tree



二叉搜索树 Binary Search Tree

二叉搜索树，也称二叉搜索树、有序二叉树（Ordered Binary Tree）、排序二叉树（Sorted Binary Tree），是指一棵空树或者具有下列性质的二叉树：

1. 左子树上所有结点的值均小于它的根结点的值；
2. 右子树上所有结点的值均大于它的根结点的值；
3. 以此类推：左、右子树也分别为二叉查找树。（这就是 重复性！）

中序遍历：升序排列

二叉搜索树常见操作

1. 查询
2. 插入新结点（创建）
3. 删除

Demo: https://visualgo.net/zh/bst

复杂度分析

Common Data Structure Operations

Data Structure	Time Complexity								Space Complexity
	Average				Worst				Worst
	Access	Search	Insertion	Deletion	Access	Search	Insertion	Deletion	
Array	Θ(1)	Θ(n)	Θ(n)	Θ(n)	O(1)	O(n)	O(n)	O(n)	O(n)
Stack	Θ(n)	Θ(n)	Θ(1)	Θ(1)	O(n)	O(n)	O(1)	O(1)	O(n)
Queue	Θ(n)	Θ(n)	Θ(1)	Θ(1)	O(n)	O(n)	O(1)	O(1)	O(n)
Singly-Linked List	Θ(n)	Θ(n)	Θ(1)	Θ(1)	O(n)	O(n)	O(1)	O(1)	O(n)
Doubly-Linked List	Θ(n)	Θ(n)	Θ(1)	Θ(1)	O(n)	O(n)	O(1)	O(1)	O(n)
Skip List	Θ(log(n))	Θ(log(n))	Θ(log(n))	Θ(log(n))	O(n)	O(n)	O(n)	O(n)	O(n log(n))
Hash Table	N/A	Θ(1)	Θ(1)	Θ(1)	N/A	O(n)	O(n)	O(n)	O(n)
Binary Search Tree	Θ(log(n))	Θ(log(n))	Θ(log(n))	Θ(log(n))	O(n)	O(n)	O(n)	O(n)	O(n)
Cartesian Tree	N/A	Θ(log(n))	Θ(log(n))	Θ(log(n))	N/A	O(n)	O(n)	O(n)	O(n)
B-Tree	Θ(log(n))	Θ(log(n))	Θ(log(n))	Θ(log(n))	O(log(n))	O(log(n))	O(log(n))	O(log(n))	O(n)
Red-Black Tree	Θ(log(n))	Θ(log(n))	Θ(log(n))	Θ(log(n))	O(log(n))	O(log(n))	O(log(n))	O(log(n))	O(n)
Splay Tree	N/A	Θ(log(n))	Θ(log(n))	Θ(log(n))	N/A	O(log(n))	O(log(n))	O(log(n))	O(n)
AVL Tree	Θ(log(n))	Θ(log(n))	Θ(log(n))	Θ(log(n))	O(log(n))	O(log(n))	O(log(n))	O(log(n))	O(n)
KD Tree	Θ(log(n))	Θ(log(n))	Θ(log(n))	Θ(log(n))	O(n)	O(n)	O(n)	O(n)	O(n)

图片来源：http://www.bigocheatsheet.com/

树的面试题解法一般都是递归

为什么？

示例代码

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```java
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    this.val = val;
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  }
}
```

C++

```cpp
struct TreeNode {
  int val;
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示例代码

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    self.preorder(root.left)
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def inorder(self, root):
  if root:
    self.inorder(root.left)
    self.traverse_path.append(root.val)
    self.inorder(root.right)


def postorder(self, root):
  if root:
    self.postorder(root.left)
    self.postorder(root.right)
    self.traverse_path.append(root.val)
```

树的遍历 DEMO

实战题目

1. https://leetcode-cn.com/problems/binary-tree-inorder-traversal/
2. https://leetcode-cn.com/problems/binary-tree-preorder-traversal/
3. https://leetcode-cn.com/problems/n-ary-tree-postorder-traversal/
4. https://leetcode-cn.com/problems/n-ary-tree-preorder-traversal/
5. https://leetcode-cn.com/problems/n-ary-tree-level-order-traversal/

THANKS!