

# Programming Interview Notes

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## Contents

<b>1</b>	<b>DFS</b>	<b>2</b>
<b>2</b>	<b>BFS</b>	<b>2</b>
<b>3</b>	<b>Tree Traversal (DFS on Trees)</b>	<b>2</b>
3.1	Preorder Traversal . . . . .	2
3.2	Inorder Traversal . . . . .	3
<b>4</b>	<b>Sliding Window</b>	<b>3</b>
<b>5</b>	<b>Backtracking</b>	<b>4</b>
<b>6</b>	<b>Dynamic Programming</b>	<b>4</b>
<b>7</b>	<b>Greedy Algorithm</b>	<b>5</b>
<b>8</b>	<b>Miscellaneous</b>	<b>5</b>
8.1	Java For Each Loop on Map . . . . .	5
8.2	Implementing Java Comparator . . . . .	5
8.3	Linked List Dummy Head . . . . .	5
8.4	Modified Binary Search . . . . .	6
8.5	Trie . . . . .	6

# 1 DFS

---

```
stack.push(element);
while(!stack.isEmpty()) {
    T curr = stack.pop();
    for (e : adj(curr)) {
        if(!visited[e]) {
            visited[e] = true;    //Keep track of unvisited using array
            stack.push(e);
        }
    }
}
```

---

For graphs, need to figure out how to use visited array to match requirements

[323. Number of Connected Components in an Undirected Graph](#)    [200. Number of Islands](#)    [547. Friend Circles](#)

# 2 BFS

---

```
queue.add(element);
while(!queue.isEmpty()) {
    T curr = queue.poll();
    for (e : adj(curr)) {
        if(!visited[e]) {
            visited[e] = true;    //keep track of unvisited using array
            queue.add(e);
        }
    }
}
```

---

Key issue to recognize when to use DFS (look at deep as possible first) or BFS (process neighbors first because going deep first might be inefficient)

[102. Binary Tree Level Order Traversal](#)    [542. 01 Matrix](#)

# 3 Tree Traversal (DFS on Trees)

## 3.1 Preorder Traversal

root, Left, Right

---

```
public List<Integer> preorderTraversal(TreeNode root) {
    List<Integer> list = new ArrayList();
    if(root == null) return list;
    Stack<TreeNode> stack = new Stack();
    stack.push(root);

    while(!stack.isEmpty()) {
        TreeNode curr = stack.pop();
        list.add(curr.val);
        if(curr.right != null) stack.push(curr.right);
        if(curr.left != null) stack.push(curr.left);
    }
    return list;
}
```

---

[144. Binary Tree Preorder Traversal](#)

## 3.2 Inorder Traversal

Left, root, Right

Useful when you need to iterate through a tree inorder or retrieve the kth element

---

```
public List<Integer>> inorderTraversal(TreeNode root) {
    List<Integer> list = new ArrayList();
    if(root == null) return list;

    Stack<TreeNode> stack = new Stack(); //Use stack for DFS
    while(root != null && !stack.isEmpty()) {
        while(root != null) {           //Find left-most element
            stack.push(root);
            root = root.left;
        }
        root = stack.pop();
        list.add(root.val);
        root = root.right;              //Look at left-most element's right child
    }
}
```

---

[94. Binary Tree Inorder Traversal](#)   [98. Validate Binary Search Tree](#)   [230. Kth Smallest Element in a BST](#)

## 4 Sliding Window

Use two pointers and keep sliding the right pointer, examining the new character and updating the count table. Once a condition (usually duplicate) is found, start removing elements from the left pointer, shortening the window.

[76. Minimum Window Substring](#)

---

```
public String minWindow(String s, String t) {
    Map<Character, Integer> map = new HashMap();
    // populate hashmap with character frequencies
    for(char c : t.toCharArray()) {
        if(map.containsKey(c)) map.put(c, map.get(c) + 1);
        else map.put(c, 1);
    }
    int left = 0;
    int right = 0;
    int slen = s.length();
    int count = map.size(); // used to check how many characters still need to be processed
    int len = slen;         // length of answer string
    String ans = s;

    while(right < slen) {
        char rightChar = s.charAt(right);
        if(map.containsKey(rightChar)) {
            map.put(rightChar, map.get(rightChar) - 1);
            if(map.get(rightChar) == 0) count--;
        }
        right++;
        while(count == 0) {
            // normally is right - left + 1 but right++ happened above so indexing is correct
            if(right - left < len) {
                len = right - left;
                ans = s.substring(left, right);
            }
            char leftChar = s.charAt(left);
            if(map.containsKey(leftChar)) {
                map.put(leftChar, map.get(leftChar) + 1);
            }
            left++;
        }
    }
}
```

```

        if(map.get(leftChar) > 0) count++;
    }
    left++;
}
}
return ans;
}

```

---

[438. Find All Anagrams in a String](#)   
 [30. Substring with Concatenation of All Words](#)   
 [3. Longest Substring Without Repeating Characters](#)   
 [159. Longest Substring with At Most Two Distinct Characters](#)   
 [567. Permutation in String](#)

## 5 Backtracking

1. Iterate through all possible configurations of search space (permutations or subsets)
2. Generate each configuration once by defining a generation order
3. At each step, try to extend a partial solution by adding an element. Test if it's a solution
  - if yes then process it
  - if no then recurse down and check if it is a partial solution
4. Pruning: cut off search if we know it is not part of the solution (e.g. cost > curr min)

---

```

public List<List<Integer>> subsets(int[] nums) {
    List<List<Integer>> list = new ArrayList(); //solution array
    backtrack(list, new ArrayList(), 0, nums);
    return list;
}

public void backtrack(List<List<Integer>> list, List<Integer> sublist, int k, int[] nums) {
    if (isSolution(sublist)) {
        process(sublist); //if sublist is a valid solution, process it
    }
    for (int i = k; i < nums.length; i++) {
        sublist.add(nums[i]); //extend partial solution
        backtrack(list, sublist, i + 1, nums); //recurse down
        sublist.remove(sublist.size() - 1); //remove extension
    }
}

```

---

[78. Subsets](#)   
 [90. Subsets II](#)   
 [39. Combination Sum](#)   
 [40. Combination Sum II](#)   
 [51. N-Queens](#)

## 6 Dynamic Programming

Solves by combining optimal solutions to subproblems that overlap. Divide and conquer only work for disjoint sets otherwise there's a lot of repetitive recursive calls. However, dynamic programming uses additional memory to save subproblem solutions so there is a time-memory tradeoff.

1. Characterize structure of optimal solution
2. Recursively define value of optimal solution
3. Compute value of optimal solution (usually bottom-up approach)
4. Construct optimal solution from computed info

Two approaches to dynamic programming:

- Top-down with memoization: write the procedure recursively but saves result of each subproblem in an array. The procedure will first check to see if the array has the solution to the subproblem; if not then the value is computed normally.

- Bottom-up: intuition is to sort by subproblem size and solve them in size order (smallest first). When solving a particular subproblem, we have already saved the solutions to the smaller subproblems.

Look for an optimal substructure: optimal solution requires optimal solution to subproblems

- Solution consists of making a choice
- Assume given choice leads to optimal solution
- determine which subproblems occur
- show solutions to subproblems used within optimal solution must also be optimal

Dynamic Programming makes choice at each step based on solutions to sub problems so we do bottom-up approach, using best subproblems to solve later problems or top-down with memoization. In both cases, we always end up solving the smaller subproblems then solving bigger ones.

## 7 Greedy Algorithm

**Greedy Choice Property:** Idea is to make locally optimal choices in hopes that it will lead to a globally optimal solution.

- Determine optimal substructure
- Develop recursive solution
- Show if we make greedy choice, only one subproblem remains
- Prove it's safe to make greedy choice
- Develop recursive algorithm for greedy choice
- Convert recursive greedy to iterative

We want to make greedy choice then solve the subproblems that remain. This is usually a top-down approach where one greedy choice is made after another, reducing the size of the problem

## 8 Miscellaneous

### 8.1 Java For Each Loop on Map

---

```
for(Map.Entry<Key, Value> e : map.entrySet()) {
    e.getKey();
    e.getValue();
}
```

---

### 8.2 Implementing Java Comparator

---

```
Set<String> set = new TreeSet(new Comparator<String>() {
    @Override
    public int compare(String s1, String s2) {
        return s1.compareTo(s2);
    }
});
```

---

### 8.3 Linked List Dummy Head

Using dummy head node avoids having to prepopulating the head with a value prior to iterating through the linked list. At the end just return dummy.next. [21. Merge Two Sorted Lists](#)

---

```

public ListNode mergeTwoLists(ListNode l1, ListNode l2) {
    ListNode dummy = new ListNode(0);
    ListNode curr = dummy;
    while(l1 != null && l2 != null) {
        if(l1.val < l2.val) {
            curr.next = new ListNode(l1.val);
            l1 = l1.next;
        } else {
            curr.next = new ListNode(l2.val);
            l2 = l2.next;
        }
        curr = curr.next;
    }
    if(l1 != null) {
        curr.next = l1;
    }
    if(l2 != null) {
        curr.next = l2;
    }
    return dummy.next;
}

```

---

## 8.4 Modified Binary Search

Returns the target index by finding the left neighbor's index then returning  $\text{mid} + 1$ .

---

```

//find target by finding the element to the left of target then do index + 1.
public int modifiedBS(int[], int l, int r, int target) {
    int left = l;
    int right = r;
    while(left <= right) {
        int mid = (left + right) / 2;
        if(nums[mid + 1] == target) {
            return mid + 1;
        }
        if(nums[mid] > target) {
            right = mid - 1;
        } else {
            left = mid + 1;
        }
    }
}

```

---

34. Find First and Last Position of Element in Sorted Array    33. Search in Rotated Sorted Array

## 8.5 Trie