目录

1. Two Sum

Easy

Given an array of integers, return **indices** of the two numbers such that they add up to a specific target.

You may assume that each input would have *exactly* one solution, and you may not use the *same* element twice.

Example:

Given nums = [2, 7, 11, 15], target = 9,

Because nums[**0**] + nums[**1**] = 2 + 7 = 9,

return [**0**, **1**].

```cpp
class Solution {
public:
    vector<int> twoSum(vector<int>& nums, int target) {


    }
};
```

```cpp
class Solution {
public:
    vector<int> twoSum(vector<int>& nums, int target) {
        unordered_map<int, int> my_map;
        for (int i = 0; i < nums.size(); i++){
            if (my_map.count(target-nums[i]) && i != my_map[target-nums[i]]) {
                return {i, my_map[target-nums[i]]};
            }
            my_map[nums[i]] = i;
        }
    }
};
```

2. Add Two Numbers

You are given two **non-empty** linked lists representing two non-negative integers. The digits are stored in **reverse order** and each of their nodes contain a single digit. Add the two numbers and return it as a linked list.

You may assume the two numbers do not contain any leading zero, except the number 0 itself.

Example:

Input: (2 -> 4 -> 3) + (5 -> 6 -> 4)

Output: 7 -> 0 -> 8

Explanation: 342 + 465 = 807.

```cpp
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     ListNode *next;
 *     ListNode(int x) : val(x), next(NULL) {}
 * };
 */

class Solution {
public:
    ListNode* addTwoNumbers(ListNode* l1, ListNode* l2) {

    }
};
```

```cpp
class Solution {
public:
    ListNode* addTwoNumbers(ListNode *l1, ListNode *l2) {
        ListNode *res = new ListNode(-1), *p = res;
        int c = 0;
        while (l1 || l2){
            int a = l1 ? l1->val : 0;
            int b = l2 ? l2->val : 0;
            p->next = new ListNode((c + a + b) % 10);
            c = (c + a + b) / 10;
            p = p->next;
            if (l1) l1 = l1->next;
            if (l2) l2 = l2->next;
        }
        if (c > 0)   p->next = new ListNode(c);
        return res->next;
    }
};
```

3. Longest Substring Without Repeating Characters(●'◡ '●)

Given a string, find the length of the **longest substring** without repeating characters.

Example 1:

Input: "abcabcbb"

Output: 3

Explanation: The answer is "abc", with the length of 3.

Example 2:

Input: "bbbbb"

Output: 1

Explanation: The answer is "b", with the length of 1.

Example 3:

Input: "pwwkew"

Output: 3

Explanation: The answer is "wke", with the length of 3.

Note that the answer must be a **substring**, "pwke" is a *subsequence* and not a substring.

```cpp
class Solution {
public:
    int lengthOfLongestSubstring(string s) {

    }
};
```

```cpp
class Solution {
public:
    int lengthOfLongestSubstring(string s) {
        if (s.empty()) return 0;
        int n = s.length(), left = -1, res = 1;
        vector<int> m(128,-1);
        for (int i = 0; i < n; i++) {
            left = max(left, m[s[i]]);
            m[s[i]] = i;
            res = max(res, i-left);
        }
        return res;
    }
};
```

4. Median of Two Sorted Arrays(●'◡'●)

There are two sorted arrays **nums1** and **nums2** of size m and n respectively.

Find the median of the two sorted arrays. The overall run time complexity should be O(log (m+n)).

You may assume **nums1** and **nums2** cannot be both empty.

Example 1:

nums1 = [1, 3]

nums2 = [2]

The median is 2.0

Example 2:

nums1 = [1, 2]

nums2 = [3, 4]

The median is (2 + 3)/2 = 2.5

```cpp
class Solution {
public:
    double findMedianSortedArrays(vector<int>& nums1, vector<int>& nums2) {

    }
};
```

```cpp
class Solution {
public:
    double findMedianSortedArrays(vector<int>& nums1, vector<int>& nums2) {
        int m = nums1.size(), n = nums2.size();
        double res = findKth(nums1, 0, nums2, 0, (m+n+1)/2);
        if ((m+n) % 2 != 0) return res;
        res += findKth(nums1, 0, nums2, 0, (m+n+2)/2);
        return res / 2.0;
    }

private:
    int findKth(vector<int>& nums1, int i, vector<int>& nums2, int j, int k) {
        if (i >= nums1.size()) return nums2[j + k - 1];
        if (j >= nums2.size()) return nums1[i + k - 1];
        if (k == 1) return min(nums1[i], nums2[j]);
        int midVal1 = (i+k/2-1 < nums1.size()) ? nums1[i+k/2-1] : INT_MAX;
        int midVal2 = (j+k/2-1 < nums2.size()) ? nums2[j+k/2-1] : INT_MAX;
        if (midVal1 < midVal2)  return findKth(nums1, i+k/2, nums2, j, k-k/2);
        else return findKth(nums1, i, nums2, j+k/2, k-k/2);
    }
};
```

5. Longest Palindromic Substring(●˘∀˘●)

Medium

Given a string **s**, find the longest palindromic substring in **s**. You may assume that the maximum length of **s** is 1000.

Example 1:

Input: "babad"

Output: "bab"

Note: "aba" is also a valid answer.

Example 2:

Input: "cbbd"

Output: "bb"

```cpp
class Solution {
public:
    string longestPalindrome(string s) {

    }
};
```

```cpp
class Solution {
public:
    string longestPalindrome(string s) {
        const int n = s.length();
        if(!n) return s;
        bool dp[n][n] = {false};
        int start = 0, len = 1;
        for(int i = 0; i < n; i++){
            dp[i][i] = true;
            if (i+1 < n && s[i] == s[i+1]) {
                dp[i][i+1] = true;
                len = 2;
                start = i;
            }
        }

        for (int k = 2; k < n; k++) {
            for (int i = 0; i < n-k; i++) {
                bool Flag = false;
                if (s[i] == s[k+i] && dp[i+1][i+k-1])
                    dp[i][i+k] = Flag = true;
                if (Flag) {
                    start = i; len = k+1;
                }
            }
        }
        return s.substr(start, len);
    }
};
```

```cpp
class Solution {
public:
    string longestPalindrome(string s) {
        string T = preProcess(s);
        const int n = T.length();
        int P[n];
        int C = 0, R = 0;
        for (int i = 1; i < n - 1; i++) {
            int i_mirror = 2 * C - i;
            P[i] = (R > i) ? min(R - i, P[i_mirror]) : 0;
            while (T[i + 1 + P[i]] == T[i - 1 - P[i]])  P[i]++;
            if (i + P[i] > R) {
                C = i;
                R = i + P[i];
            }
        }
        int max_len = 0, center_index = 0;
        for (int i = 1; i < n - 1; i++) {
            if (P[i] > max_len) {
                max_len = P[i];
                center_index = i;
            }
        }
        return s.substr((center_index - 1 - max_len) / 2, max_len);
    }
private:
    string preProcess(string &s) {
        int n = s.length();
        if (n == 0) return "^$";
        string ret = "^";
        for (int i = 0; i < n; i++) ret += "#" + s.substr(i, 1);
        return ret + "#$";
    }
};
```

6. ZigZag Conversion

Medium

The string `"PAYPALISHIRING"` is written in a zigzag pattern on a given number of rows like this:
(you may want to display this pattern in a fixed font for better legibility)

```
P   A   H   N
A P L S I I G
Y   I   R
```

And then read line by line: `"PAHNAPLSIIGYIR"`

Write the code that will take a string and make this conversion given a number of rows:

string convert(string s, int numRows);

Example 1:

Input: s = "PAYPALISHIRING", numRows = 3

Output: "PAHNAPLSIIGYIR"

Example 2:

Input: s = "PAYPALISHIRING", numRows = 4

Output: "PINALSIGYAHRPI"

Explanation:

```
P     I    N
A   L S   I G
Y A   H R
P     I
```

```cpp
class Solution {
public:
    string convert(string s, int numRows) {

    }
};
```

```cpp
class Solution {
public:
    string convert(string s, int numRows) {
        if (numRows == 1) return s;
        int n = s.length();
        string res;
        for (int i = 0; i < numRows; i++) {
            for (int j = i; j < n; j += 2*numRows-2) {
                res += s[j];
                if (i == 0 || i == numRows-1) continue;
                if (j+2*(numRows-i-1) < n)  res += s[j+2*(numRows-i-1)];
            }
        }
        return res;
    }
};
```

7. Reverse Integer

Given a 32-bit signed integer, reverse digits of an integer.

Example 1:

Input: 123

Output: 321

Example 2:

Input: -123

Output: -321

Example 3:

Input: 120

Output: 21

Note:

Assume we are dealing with an environment which could only store integers within the 32-bit signed integer range: $[-2^{31}, \ 2^{31} - 1]$. For the purpose of this problem, assume that your function returns 0 when the reversed integer overflows.

```cpp
class Solution {
public:
    int reverse(int x) {


    }
};
```

```cpp
class Solution {
public:
    int reverse(int x) {
        int rev = 0;
        while (x != 0) {
            int pop = x % 10;
            x /= 10;
            if (rev > INT_MAX/10 || (rev == INT_MAX/10 && pop > 7))  return 0;
            if (rev < INT_MIN/10 || (rev == INT_MIN/10 && pop < -8)) return 0;
            rev = rev * 10 + pop;
        }
        return rev;
    }
};
```

8. String to Integer (atoi)

Implement `atoi` which converts a string to an integer.

The function first discards as many whitespace characters as necessary until the first non-whitespace character is found. Then, starting from this character, takes an optional initial plus or minus sign followed by as many numerical digits as possible, and interprets them as a numerical value.

The string can contain additional characters after those that form the integral number, which are ignored and have no effect on the behavior of this function.

If the first sequence of non-whitespace characters in str is not a valid integral number, or if no such sequence exists because either str is empty or it contains only whitespace characters, no conversion is performed.

If no valid conversion could be performed, a zero value is returned.

Note:

- Only the space character `' '` is considered as whitespace character.
- Assume we are dealing with an environment which could only store integers within the 32-bit signed integer range: $[-2^{31}, \ 2^{31} - 1]$. If the numerical value is out of the range of representable values, INT_MAX $(2^{31} - 1)$ or INT_MIN (-2^{31}) is returned.

Example 1:

Input: "42"

Output: 42

Example 2:

Input: "   -42"

Output: -42

Explanation: The first non-whitespace character is '-', which is the minus sign.

Then take as many numerical digits as possible, which gets 42.

Example 3:

Input: "4193 with words"

Output: 4193

Explanation: Conversion stops at digit '3' as the next character is not a numerical digit.

Example 4:

Input: "words and 987"

Output: 0

Explanation: The first non-whitespace character is 'w', which is not a numerical

digit or a +/- sign. Therefore no valid conversion could be performed.

Example 5:

Input: "-91283472332"

Output: -2147483648

Explanation: The number "-91283472332" is out of the range of a 32-bit signed integer.

Therefore INT_MIN (-2^{31}) is returned.

```cpp
class Solution {
public:
    int myAtoi(string str) {


    }
};
```

```cpp
class Solution {
public:
    int myAtoi(string str) {
        long res = 0;
        int sign = 1, n = str.length(), i = str.find_first_not_of(' ');
        if (str[i] == '+' || str[i] == '-') sign = str[i++] == '+' ? 1 : -1;

        while (i < n && isdigit(str[i])) {
            res = res * 10 + str[i++]-'0';
            if (res * sign > INT_MAX) return INT_MAX;
            if (res * sign < INT_MIN) return INT_MIN;
        }
        return res * sign;
    }
};
```

9. Palindrome Number

Determine whether an integer is a palindrome. An integer is a palindrome when it reads the same backward as forward.

Example 1:

Input: 121

Output: true

Example 2:

Input: -121

Output: false

Explanation: From left to right, it reads -121. From right to left, it becomes 121-. Therefore it is not a palindrome.

Example 3:

Input: 10

Output: false

Explanation: Reads 01 from right to left. Therefore it is not a palindrome.

Follow up:

Could you solve it without converting the integer to a string?

```cpp
class Solution {
    public:
        bool isPalindrome(int x) {


    }
}
```

```cpp
class Solution {
public:
    bool isPalindrome(int x) {
        if (x < 0 || (x % 10 == 0 && x != 0))    return false;
        int y = 0, n = x;
        while (n) {
            if (y >= INT_MAX / 10) return false;
            y = y * 10 + n % 10;
            n /= 10;
        }
        return x == y;
    }
};
```

///

```cpp
class Solution {
  public:
    bool isPalindrome(int x) {
        // 特殊情况：
        // 如上所述，当 x < 0 时，x 不是回文数。
        // 同样地，如果数字的最后一位是 0，为了使该数字为回文，
        // 则其第一位数字也应该是 0
        // 只有 0 满足这一属性
        if (x < 0 || (x % 10 == 0 && x != 0))    return false;
        int revertedNumber = 0;
        while (x > revertedNumber) {
            revertedNumber = revertedNumber * 10 + x % 10;
            x /= 10;
        }
        // 当数字长度为奇数时，我们可以通过 revertedNumber/10 去除处于中位的数字。
        // 例如，当输入为 12321 时，在 while 循环的末尾我们可以得到 x = 12,
revertedNumber = 123,
        // 由于处于中位的数字不影响回文（它总是与自己相等），所以我们可以简单地将其去除。
        return x == revertedNumber || x == revertedNumber/10;
    }
};
```

10. Regular Expression Matching(●ˇ∀ˇ●)

Given an input string (`s`) and a pattern (`p`), implement regular expression matching with support for `'.'` and `'*'`.

'.' Matches any single character.

'*' Matches zero or more of the preceding element.

The matching should cover the **entire** input string (not partial).

Note:

- `s` could be empty and contains only lowercase letters `a-z`.
- `p` could be empty and contains only lowercase letters `a-z`, and characters like `.` or `*`.

Example 1:

Input:

s = "aa"

p = "a"

Output: false

Explanation: "a" does not match the entire string "aa".

Example 2:

Input:

s = "aa"

p = "a*"

Output: true

Explanation: '*' means zero or more of the precedeng element, 'a'. Therefore, by repeating 'a' once, it becomes "aa".

Example 3:

Input:

s = "ab"

p = ".*"

Output: true

Example 4:

Example 5:

```cpp
class Solution {
public:
    bool isMatch(string s, string p) {


    }
};
```

```cpp
class Solution {
public:
    bool isMatch(string s, string p) {
        if (p.empty()) return s.empty();
        if (p.length() > 1 && p[1] == '*') {
            return isMatch(s, p.substr(2))
                || (!s.empty() && (s[0] == p[0] || p[0] == '.')
                    && isMatch(s.substr(1), p));
        }
        else return !s.empty() && (s[0] == p[0] || p[0] == '.')
                && isMatch(s.substr(1), p.substr(1));
    }
};
```

//**dp**//
```cpp
class Solution {
public:
    bool isMatch(string s, string p) {
        //true if s[0..i) matches p[0..j) and false otherwise.
        if (p.empty()) return s.empty();
        int m = s.size(), n = p.size(), k = 0;
        vector<vector<bool>> dp(2, vector<bool>(n + 1, false));
        for (int i = 0; i <= m; i++) {
            for (int j = 0; j <= n; j++) {
                if (j == 0) dp[k][j] = i == 0;
                else if (p[j-1] == '*') {
                    dp[k][j] = dp[k][j-2]
                            || (i && dp[k^1][j]
                                && (s[i-1] == p[j-2] || p[j-2] == '.'));
                } else {
                    dp[k][j] = i && dp[k^1][j-1]
                            && (s[i-1] == p[j-1] || p[j-1] == '.');
                }
            }
            k ^= 1;
        }
        return dp[k^1][n];
    }
};
```

11. Container With Most Water

Given n non-negative integers a_1, a_2, ..., a_n, where each represents a point at coordinate (i, a_i). n vertical lines are drawn such that the two endpoints of line i is at (i, a_i) and $(i, 0)$. Find two lines, which together with x-axis forms a container, such that the container contains the most water.

Note: You may not slant the container and n is at least 2.
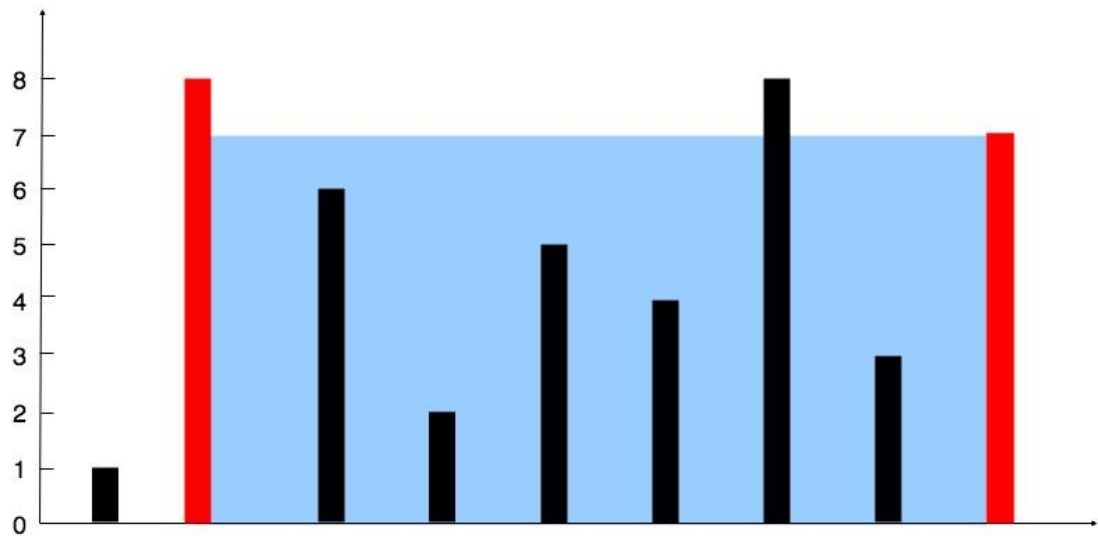
The above vertical lines are represented by array [1,8,6,2,5,4,8,3,7]. In this case, the max area of water (blue section) the container can contain is 49.

Example:

Input: [1,8,6,2,5,4,8,3,7]

Output: 49

```cpp
class Solution {
public:
    int maxArea(vector<int>& height) {


    }
};
```

```cpp
class Solution {
public:
    int maxArea(vector<int>& height) {
        int MAX = -1, L = 0, R = height.size()-1;
        while (L < R){
            MAX = max(MAX, (R-L) * min(height[L], height[R]));
            height[L] > height[R] ? R-- : L++;
        }
        return MAX;
    }
};
```

12. Integer to Roman

Roman numerals are represented by seven different symbols: `I`, `V`, `X`, `L`, `C`, `D` and `M`.

Symbol	Value
I	1
V	5
X	10
L	50
C	100
D	500
M	1000

For example, two is written as `II` in Roman numeral, just two one's added together. Twelve is written as, `XII`, which is simply `X` + `II`. The number twenty seven is written as `XXVII`, which is `XX` + `V` + `II`.

Roman numerals are usually written largest to smallest from left to right. However, the numeral for four is not `IIII`. Instead, the number four is written as `IV`. Because the one is before the five we subtract it making four. The same principle applies to the number nine, which is written as `IX`. There are six instances where subtraction is used:

- `I` can be placed before `V` (5) and `X` (10) to make 4 and 9.
- `X` can be placed before `L` (50) and `C` (100) to make 40 and 90.
- `C` can be placed before `D` (500) and `M` (1000) to make 400 and 900.

Given an integer, convert it to a roman numeral. Input is guaranteed to be within the range from 1 to 3999.

Example 1:

Input: 3

Output: "III"

Example 2:

Input: 4

Output: "IV"

Example 3:

Input: 9

Output: "IX"

Example 4:

Input: 58

Output: "LVIII"

Explanation: L = 50, V = 5, III = 3.

Example 5:

Input: 1994

Output: "MCMXCIV"

Explanation: M = 1000, CM = 900, XC = 90 and IV = 4.

```cpp
class Solution {
public:
    string intToRoman(int num) {


    }
};
```

```cpp
class Solution {
public:
    string intToRoman(int num) {
        string res = "";
        vector<int> val{1000, 900, 500, 400, 100, 90, 50, 40, 10, 9, 5, 4, 1};
        vector<string> str{"M", "CM", "D", "CD", "C", "XC", "L", "XL", "X",
                           "IX", "V", "IV", "I"};
        for (int i = 0; i < val.size(); ++i) {
            while (num >= val[i]) {
                num -= val[i];
                res += str[i];
            }
        }
        return res;
    }
};
```

13. Roman to Integer

Easy

Roman numerals are represented by seven different symbols: `I`, `V`, `X`, `L`, `C`, `D` and `M`.

Symbol	Value
I	1
V	5
X	10
L	50
C	100
D	500
M	1000

For example, two is written as `II` in Roman numeral, just two one's added together. Twelve is written as, `XII`, which is simply `X + II`. The number twenty seven is written as `XXVII`, which is `XX + V + II`.

Roman numerals are usually written largest to smallest from left to right. However, the numeral for four is not `IIII`. Instead, the number four is written as `IV`. Because the one is before the five we subtract it making four. The same principle applies to the number nine, which is written as `IX`. There are six instances where subtraction is used:

- `I` can be placed before `V` (5) and `X` (10) to make 4 and 9.
- `X` can be placed before `L` (50) and `C` (100) to make 40 and 90.
- `C` can be placed before `D` (500) and `M` (1000) to make 400 and 900.

Given a roman numeral, convert it to an integer. Input is guaranteed to be within the range from 1 to 3999.

Example 1:

Input: "III"

Output: 3

Example 2:

Input: "IV"

Output: 4

Example 3:

Input: "IX"

Output: 9

Example 4:

Input: "LVIII"

Output: 58

Explanation: L = 50, V= 5, III = 3.

Example 5:

Input: "MCMXCIV"

Output: 1994

Explanation: M = 1000, CM = 900, XC = 90 and IV = 4.

```cpp
class Solution {
public:
    int romanToInt(string s) {

    }
};
```

```cpp
class Solution {
public:
    int romanToInt(string s) {
        if (s.empty()) return 0;
        map<char, int> My_map{ {'I',1},{'V',5},{'X', 10},{'L',50},
                               {'C',100},{'D',500},{'M', 1000} };
        int len = s.length(), res = My_map[s[len-1]];
        for(int i = 0; i < len-1; i++){
            if (My_map[s[i]] < My_map[s[i+1]]) res -= My_map[s[i]];
            else res += My_map[s[i]];
        }
        return res;
    }
};
```

14. Longest Common Prefix

Easy

Write a function to find the longest common prefix string amongst an array of strings.

If there is no common prefix, return an empty string `""`.

Example 1:

Input: ["flower","flow","flight"]

Output: "fl"

Example 2:

Input: ["dog","racecar","car"]

Output: ""

Explanation: There is no common prefix among the input strings.

Note:

All given inputs are in lowercase letters `a-z`.

```cpp
class Solution {
public:
    string longestCommonPrefix(vector<string>& strs) {


    }
};
```

```cpp
class Solution {
public:
    string longestCommonPrefix(vector<string>& strs) {
        string res = "";
        if (strs.empty()) return res;
        int len = strs[0].length();
        for (int i = 0; i < len; i++){
            char c = strs[0][i];
            for (auto &str : strs){
                if (str.length() < i || str[i] != c)  return res;
            }
            res += c;
        }
        return res;
    }
};
```

15. 3Sum

Given an array `nums` of *n* integers, are there elements *a*, *b*, *c* in `nums` such that $a + b + c = 0$? Find all unique triplets in the array which gives the sum of zero.

Note:

The solution set must not contain duplicate triplets.

Example:

Given array nums = [-1, 0, 1, 2, -1, -4],

A solution set is:

[

  [-1, 0, 1],

  [-1, -1, 2]

]


```cpp
class Solution {
public:
    vector<vector<int>> threeSum(vector<int>& nums) {

    }
};
```

```cpp
class Solution {
public:
    vector<vector<int>> threeSum(vector<int>& nums) {
        vector< vector<int> > ans;
        if (nums.size() < 3) return ans;
        sort(nums.begin(), nums.end());
        for (auto i = nums.begin(); i != nums.end()-2; i++){
            if (i > nums.begin() && *i == *(i-1)) continue;
            auto j = i + 1, k = nums.end() - 1;
            while (j < k){
                if(*i + *j + *k < 0) {
                    j++;
                    while (j < k && *j == *(j-1)) j++;
                } else if (*i + *j + *k > 0) {
                    k--;
                    while (j < k && *k == *(k+1)) k--;
                } else{
                    ans.push_back({*i,*j,*k});
                    j++; k--;
                    while (j < k && *j == *(j-1)) j++;
                    while (j < k && *k == *(k+1)) k--;
                }
            }
        }
        return ans;
    }
};
```

16. 3Sum Closest

Given an array `nums` of *n* integers and an integer `target`, find three integers in `nums` such that the sum is closest to `target`. Return the sum of the three integers. You may assume that each input would have exactly one solution.

Example:

Given array nums = [-1, 2, 1, -4], and target = 1.

The sum that is closest to the target is 2. (-1 + 2 + 1 = 2).

```cpp
class Solution {
public:
    int threeSumClosest(vector<int>& nums, int target) {


    }
};
```

```cpp
class Solution {
public:
    int threeSumClosest(vector<int>& nums, int target) {
        sort(nums.begin(), nums.end());
        int ans, minn = numeric_limits<int>::max();
        for (auto i = nums.begin(); i != nums.end() - 2; i++){
            auto j = i + 1, k = nums.end() - 1;
            while (j < k){
                int sum = *i + *j + *k;
                if (minn > abs(sum - target)) {
                    minn = abs(sum - target);
                    ans = sum;
                }
                if (sum < target)        j++;
                else if (sum > target)   k--;
                else return target;
            }
        }
        return ans;
    }
};
```

17. Letter Combinations of a Phone Number

Medium

Given a string containing digits from `2-9` inclusive, return all possible letter combinations that the number could represent.

A mapping of digit to letters (just like on the telephone buttons) is given below. Note that 1 does not map to any letters.

Example:

Input: "23"

Output: ["ad", "ae", "af", "bd", "be", "bf", "cd", "ce", "cf"].

Note:

Although the above answer is in lexicographical order, your answer could be in any order you want.

```
class Solution {
public:
    vector<string> letterCombinations(string digits) {


    }
};
```

```cpp
class Solution {
public:
    vector<string> letterCombinations(string digits) {
        vector<string> res;
        if (digits.empty()) return res;
        string s;
        dfs(s, 0, digits, res);
        return res;
    }
private:
    string a[8] = {"abc", "def", "ghi", "jkl",
                   "mno", "pqrs", "tuv", "wxyz"};

    void dfs(string s, int i, string &digits, vector<string> &res){
        if (i == digits.length()) res.push_back(s);
        else for(auto c : a[digits[i]-'2']){
            dfs(s+c, i+1, digits, res);
        }
    }
};
```

18. 4Sum

Given an array `nums` of *n* integers and an integer `target`, are there elements *a*, *b*, *c*, and *d* in `nums` such that $a + b + c + d = $ `target`? Find all unique quadruplets in the array which gives the sum of `target`.

Note:

The solution set must not contain duplicate quadruplets.

Example:

Given array nums = [1, 0, -1, 0, -2, 2], and target = 0.

A solution set is:

[

  [-1,   0, 0, 1],

  [-2, -1, 1, 2],

  [-2,   0, 0, 2]

]

```cpp
class Solution {
public:
    vector< vector<int> > fourSum(vector<int> &nums, int target) {

    }
};
```

```cpp
class Solution {
public:
    vector< vector<int> > fourSum(vector<int> &nums, int target) {
        vector<vector<int>> res;
        int n = nums.size();
        sort(nums.begin(), nums.end());
        for (int i = 0; i < n-3; ++i) {
            if (i > 0 && nums[i] == nums[i-1]) continue;
            for (int j = i+1; j < n-2; ++j) {
                if (j > i+1 && nums[j] == nums[j-1]) continue;
                int left = j+1, right = n-1;
                while (left < right) {
                    int sum = nums[i] + nums[j] + nums[left] + nums[right];
                    if (sum == target) {
                        res.push_back( {nums[i], nums[j],
                                        nums[left], nums[right]} );
                        while (left < right && nums[left] == nums[left+1])
                            ++left;
                        while (left < right && nums[right] == nums[right-1])
                            --right;
                        ++left; --right;
                    }
                    else if (sum < target) ++left;
                    else --right;
                }
            }
        }
        return res;
    }
};
```

```cpp
///////////////////////好 O（n^2）坏 O（n^4）/////////////////////////////
class Solution {
public:
    vector<vector<int>> fourSum(vector<int>& nums, int target) {
        vector<vector<int>> res;
        unordered_map<int, set<pair<int,int>>> My_map;
        int n = nums.size();
        if(n < 4) return res;
        sort(nums.begin(), nums.end());
        for (auto i = 0; i < n; i++){
            for (int j = i+1; j < n; j++)
                My_map[nums[i]+nums[j]].insert({i, j});    //坐标记录
        }
        for (auto &i : My_map) if (My_map.count(target-i.first)) {
            auto j = My_map.find(target-i.first);
            for(auto &x : i.second){
                for(auto &y : j->second){
                    if(x.second >= y.first) continue;    //四个坐标都不同
                    res.push_back({nums[x.first], nums[x.second],
                                   nums[y.first], nums[y.second]});
                }
            }
        }
        sort(res.begin(), res.end());
        res.erase(unique(res.begin(), res.end()), res.end() );
        return  res;
    }
};
```

19. Remove Nth Node From End of List

Medium

Given a linked list, remove the *n*-th node from the end of list and return its head.

Example:

Given linked list: **1->2->3->4->5**, and *n* = **2**.

After removing the second node from the end, the linked list becomes **1->2->3->5**.

Note:

Given *n* will always be valid.

Follow up:

Could you do this in one pass?

```cpp
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     ListNode *next;
 *     ListNode(int x) : val(x), next(NULL) {}
 * };
 */
class Solution {
public:
    ListNode* removeNthFromEnd(ListNode* head, int n) {

    }
};
```

```cpp
class Solution {
public:
    ListNode* removeNthFromEnd(ListNode* head, int n) {
        ListNode *dummy = new ListNode(-1);
        dummy->next = head;
        ListNode *pre = dummy, *p = pre;
        While (n--) p = p->next;
        While (p->next) {
          p = p->next;
          pre = pre->next;
        }
        pre->next = pre->next->next;
        return dummy->next;
    }
};
```

20. Valid Parentheses

Given a string containing just the characters `'('`, `')'`, `'{'`, `'}'`, `'['` and `']'`, determine if the input string is valid.

An input string is valid if:

1. Open brackets must be closed by the same type of brackets.
2. Open brackets must be closed in the correct order.

Note that an empty string is also considered valid.

Example 1:

Input: "()"

Output: true

Example 2:

Input: "()[]{}"

Output: true

Example 3:

Input: "(]"

Output: false

Example 4:

Input: "([)]"

Output: false

Example 5:

Input: "{[]}"

Output: true

```cpp
class Solution {
public:
    bool isValid(string s) {

    }
};
```

```cpp
class Solution {
public:
    bool isValid(string s) {
        stack<char> Stack;
        for(auto &c : s){
            if (c == '(' || c == '{' || c == '[') Stack.push(c);
            else if (!Stack.empty()
                    && (   (c == ')' && Stack.top() == '(')
                        || (c == ']' && Stack.top() == '[')
                        || (c == '}' && Stack.top() == '{'))) {
                Stack.pop();
            }
            else return false;
        }
        return Stack.empty();
    }
};
```

21. Merge Two Sorted Lists

Merge two sorted linked lists and return it as a new list. The new list should be made by splicing together the nodes of the first two lists.

Example:

Input: 1->2->4, 1->3->4

Output: 1->1->2->3->4->4

```cpp
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     ListNode *next;
 *     ListNode(int x) : val(x), next(NULL) {}
 * };
 */
class Solution {
public:
    ListNode* mergeTwoLists(ListNode* l1, ListNode* l2) {


    }
};
```

```cpp
class Solution {
public:
    ListNode* mergeTwoLists(ListNode* l1, ListNode* l2) {
        ListNode *dummy = new ListNode(-1), *p = dummy;
        while (l1 && l2){
            if (l1->val < l2->val){
                p->next = l1;
                l1 = l1->next;
            }
            else {
                p->next = l2;
                l2 = l2->next;
            }
            p = p->next;
        }
        if (l1) p->next = l1;
        if (l2) p->next = l2;
        return dummy->next;
    }
};
```

22. Generate Parentheses

Given *n* pairs of parentheses, write a function to generate all combinations of well-formed parentheses.

For example, given *n* = 3, a solution set is:

```
[

  "((()))",

  "(()())",

  "(())()",

  "()(())",

  "()()()"

]
```

```cpp
class Solution {
public:

    vector<string> generateParenthesis(int n) {


    }
};
```

```cpp
class Solution {
public:
    vector<string> res;
    vector<string> generateParenthesis(int n) {
        dfs(n, n, "");
        return res;
    }
    void dfs(int n, int m, string s){
        if (n < 0|| m < 0 || n > m) return;
        if (!n && !m){
            res.push_back(s);
            return;
        }
        dfs(n-1, m, s+'(');
        dfs(n, m-1, s+')');
    }
};
```

23. Merge k Sorted Lists(●ˇ∀ˇ●)

Hard

Merge *k* sorted linked lists and return it as one sorted list. Analyze and describe its complexity.

Example:

Input:

[

  1->4->5,

  1->3->4,

  2->6

]

Output: 1->1->2->3->4->4->5->6

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     ListNode *next;
 *     ListNode(int x) : val(x), next(NULL) {}
 * };
 */


class Solution {
public:
    ListNode* mergeKLists(vector<ListNode*>& lists) {


    }
};
```

```cpp
class Solution {
public:
    ListNode* mergeKLists(vector<ListNode*>& lists) {
        ListNode* dummy = new ListNode(-1), *p = dummy;
        auto cmp = [](const ListNode *lhs, const ListNode *rhs){
                    return lhs->val > rhs->val;};
        priority_queue<ListNode*, vector<ListNode*>, decltype(cmp)> pq(cmp);
        for(auto &i : lists) if (i) {
            pq.push(i);
        }
        while (!pq.empty()) {
            auto t = pq.top();
            pq.pop();
            p->next = t;
            p = t;
            t = t->next;
            if (t) pq.push(t);
        }
        return dummy->next;
    }
};
```

24. Swap Nodes in Pairs

Medium

Given a linked list, swap every two adjacent nodes and return its head.

Example:

Given 1->2->3->4, you should return the list as 2->1->4->3.

Note:

- Your algorithm should use only constant extra space.
- You may **not** modify the values in the list's nodes, only nodes itself may be changed.

```cpp
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     ListNode *next;
 *     ListNode(int x) : val(x), next(NULL) {}
 * };
 */
class Solution {
public:
    ListNode* swapPairs(ListNode* head) {


    }
};
```

```cpp
class Solution {
public:
    ListNode* swapPairs(ListNode* head) {
        ListNode *dummy = new ListNode(-1);
        dummy->next = head;
        ListNode *p = dummy, *q = p->next;
        While (q && q->next) {
            p->next = q->next;
            q->next = p->next->next;
            p->next->next = q;
            p = q;
            q = q->next;
        }
        return dummy->next;
    }
};
```

25. Reverse Nodes in k-Group

Hard

Given a linked list, reverse the nodes of a linked list k at a time and return its modified list.

k is a positive integer and is less than or equal to the length of the linked list. If the number of nodes is not a multiple of k then left-out nodes in the end should remain as it is.

Example:

Given this linked list: `1->2->3->4->5`

For k = 2, you should return: `2->1->4->3->5`

For k = 3, you should return: `3->2->1->4->5`

Note:

- Only constant extra memory is allowed.
- You may not alter the values in the list's nodes, only nodes itself may be changed.

```cpp
class Solution {
public:
    ListNode* reverseKGroup(ListNode* head, int k) {


    }
};
```

```cpp
class Solution {
public:
    ListNode* reverseKGroup(ListNode* head, int k) {
        if (head == nullptr || k < 2) return head;
        ListNode *head2 = head, *q;
        for (int i = 1; i < k; i++) {
            head2 = head2->next;
            if (head2 == nullptr) return head;
        }

        head2->next = reverseKGroup(head2->next, k);
        while (--k) {
            q = head->next;
            head->next = head2->next;
            head2->next = head;
            head = q;
        }
        return head2;
    }
};
```

26. Remove Duplicates from Sorted Array

Easy

Given a sorted array *nums*, remove the duplicates **in-place** such that each element appear only *once* and return the new length.

Do not allocate extra space for another array, you must do this by **modifying the input array in-place** with O(1) extra memory.

Example 1:

Given *nums* = **[1,1,2]**,

Your function should return length = **2**, with the first two elements of *nums* being **1** and **2** respectively.

It doesn't matter what you leave beyond the returned length.

Example 2:

Given *nums* = **[0,0,1,1,1,2,2,3,3,4]**,

Your function should return length = **5**, with the first five elements of *nums* being modified to **0**, **1**, **2**, **3**, and **4** respectively.

It doesn't matter what values are set beyond the returned length.

Clarification:

Confused why the returned value is an integer but your answer is an array?

Note that the input array is passed in by **reference**, which means modification to the input array will be known to the caller as well.

Internally you can think of this:

// **nums** is passed in by reference. (i.e., without making a copy)

int len = removeDuplicates(nums);

// any modification to **nums** in your function would be known by the caller.

// using the length returned by your function, it prints the first **len** elements.

for (int i = 0; i < len; i++) {

    print(nums[i]);

}

```cpp
class Solution {
public:
    int removeDuplicates(vector<int>& nums) {
        if (nums.empty()) return 0;
        int index = 1;
        for (int i = 1; i < nums.size(); i++) {
            if (nums[i] != nums[index-1])
                nums[index++] = nums[i];
        }
        return index;
    }
};
```

27. Remove Element

Easy

Given an array *nums* and a value *val*, remove all instances of that value **in-place** and return the new length.

Do not allocate extra space for another array, you must do this by **modifying the input array in-place** with O(1) extra memory.

The order of elements can be changed. It doesn't matter what you leave beyond the new length.

Example 1:

Given *nums* = **[3,2,2,3]**, *val* = **3**,

Your function should return length = **2**, with the first two elements of *nums* being **2**.

It doesn't matter what you leave beyond the returned length.

Example 2:

Given *nums* = **[0,1,2,2,3,0,4,2]**, *val* = **2**,

Your function should return length = **5**, with the first five elements of *nums* containing **0**, **1**, **3**, **0**, and **4**.

Note that the order of those five elements can be arbitrary.

It doesn't matter what values are set beyond the returned length.

Clarification:

Confused why the returned value is an integer but your answer is an array?

Note that the input array is passed in by **reference**, which means modification to the input array will be known to the caller as well.

Internally you can think of this:

// **nums** is passed in by reference. (i.e., without making a copy)

int len = removeElement(nums, val);

// any modification to **nums** in your function would be known by the caller.

// using the length returned by your function, it prints the first **len** elements.

for (int i = 0; i < len; i++) {

    print(nums[i]);

}

```cpp
class Solution {
public:
    int removeElement(vector<int>& nums, int val) {
        int index = 0;
        for (int i = 0; i < nums.size(); i++){
          if (nums[i] != val)
            nums[index++] = nums[i];
        }
        return index;
    }
};
```

28. Implement strStr()(●ˇ∀ˇ●)

Easy

Implement strStr().

Return the index of the first occurrence of needle in haystack, or **-1** if needle is not part of haystack.

Example 1:

Input: haystack = "hello", needle = "ll"

Output: 2

Example 2:

Input: haystack = "aaaaa", needle = "bba"

Output: -1

Clarification:

What should we return when needle is an empty string? This is a great question to ask during an interview.

For the purpose of this problem, we will return 0 when needle is an empty string. This is consistent to C's strstr() and Java's indexOf().

```cpp
class Solution {
public:
    int removeElement(vector<int>& nums, int val) {

    }
};
```

```cpp
class Solution {
public:
    int strStr(string haystack, string needle) {
        if (needle.empty()) return 0;
        for (int i = 0; i < haystack.length(); i++) {
            bool ok = true;
            if (haystack.length() - i < needle.length()) break;
            int ii = i;
            for (int j = 0; j < needle.length(); j++){
                if (haystack[ii++] != needle[j]) {
                    ok = false; break;
                }
            }
            if (ok) return i;
        }
        return -1;
    }
};
```

```cpp
class Solution {
public:
    int strStr(string haystack, string needle) {
        int m = haystack.size(), n = needle.size();
        if (!n)  return 0;
        vector<int> f = get_fail(needle);
        for (int i = 0, j = 0; i < m;) {
            if (haystack[i] == needle[j]) {
                i++, j++;
            }
            if (j == n)  return i-j;
            else if (i < m && haystack[i] != needle[j]) {
                j ? j = f[j - 1] : i++;
            }
        }
        return -1;
    }
private:
    vector<int> get_fail(string str) {
        int n = str.size();
        vector<int> f(n, 0);
        for (int i = 1, len = 0; i < n;) {
            if (str[i] == str[len])  f[i++] = ++len;
            else if (len) len = f[len - 1];
            else  f[i++] = 0;
        }
        return f;
    }
};
```

29. Divide Two Integers(●ˇ∀ˇ●)

Medium

Given two integers `dividend` and `divisor`, divide two integers without using multiplication, division and mod operator.

Return the quotient after dividing `dividend` by `divisor`.

The integer division should truncate toward zero.

Example 1:

Input: dividend = 10, divisor = 3

Output: 3

Example 2:

Input: dividend = 7, divisor = -3

Output: -2

Note:

- Both dividend and divisor will be 32-bit signed integers.
- The divisor will never be 0.
- Assume we are dealing with an environment which could only store integers within the 32-bit signed integer range: $[-2^{31}, \ 2^{31} - 1]$. For the purpose of this problem, assume that your function returns $2^{31} - 1$ when the division result overflows.

```cpp
class Solution {
public:
    int divide(int dividend, int divisor) {


    }
};
```

```cpp
class Solution {
public:
    int divide(int dividend, int divisor) {
        if (divisor == 0 || (dividend == INT_MIN && divisor == -1))
            return INT_MAX;
        int sign = (dividend > 0) ^ (divisor > 0) ? -1 : 1;
        long long Dividend = labs(dividend);
        long long Divisor = labs(divisor);
        int res = 0;
        while (Dividend >= Divisor) {
            long long mul = 1, temp = Divisor;
            while (Dividend > (temp << 1)) {
                mul <<= 1;
                temp <<= 1;
            }
            res += mul;
            Dividend -= temp;
        }
        return sign*res;
    }
};
```

30. Substring with Concatenation of All Words(●˘∀ ˘●)

You are given a string, **s**, and a list of words, **words**, that are all of the same length. Find all starting indices of substring(s) in **s** that is a concatenation of each word in **words** exactly once and without any intervening characters.

Example 1:

Input:

  s = "barfoothefoobarman",

  words = ["foo","bar"]

Output: [0,9]

Explanation: Substrings starting at index 0 and 9 are "barfoor" and "foobar" respectively.

The output order does not matter, returning [9,0] is fine too.

Example 2:

Input:

  s = "wordgoodgoodgoodbestword",

  words = ["word","good","best","word"]

Output: []

```cpp
class Solution {
public:
    vector<int> findSubstring(string s, vector<string>& words) {


    }
};
```

```cpp
class Solution {
public:
    vector<int> findSubstring(string s, vector<string>& words) {
        vector<int> res;
        if (words.empty() || s.empty()) return res;
        unordered_map<string, int> M0, M1;
        const int N = words[0].length(), M = s.length(), K = words.size();
        for (auto &i : words) M0[i]++;
        for (int i = 0; i < N; i++) {
            int cnt = 0, left = i;
            M1.clear();
            for (int j = i; j+N <= M; j += N){
                string a = s.substr(j, N);
                if (M0.count(a)) {
                    if (++M1[a] <= M0[a]){
                        if (++cnt == K){
                            res.push_back(left);
                            cnt--; M1[s.substr(left, N)]--; left += N;
                        }
                    } else{
                        While (s.substr(left, N) != a) {
                            cnt--; M1[s.substr(left, N)]--; left += N;
                        }
                        left += N; M1[a]--;
                    }
                } else{
                    M1.clear();
                    left = j+N;
                    cnt = 0;
                }
            }
        }
        return res;
    }
};
```

31. Next Permutation

Implement **next permutation**, which rearranges numbers into the lexicographically next greater permutation of numbers.

If such arrangement is not possible, it must rearrange it as the lowest possible order (ie, sorted in ascending order).

The replacement must be **in-place** and use only constant extra memory.

Here are some examples. Inputs are in the left-hand column and its corresponding outputs are in the right-hand column.

$1, 2, 3 \rightarrow 1, 3, 2$
$3, 2, 1 \rightarrow 1, 2, 3$
$1, 1, 5 \rightarrow 1, 5, 1$

```cpp
class Solution {
public:
    void nextPermutation(vector<int>& nums) {

    }
};
```

```cpp
class Solution {
public:
    void nextPermutation(vector<int>& nums) {
        permutation(nums, 0, nums.size());
    }
private:
    bool permutation(vector<int> &nums, int begin, int end) {
        int p = end - 2;
        while (p > -1 && nums[p] >= nums[p+1]) p--;
        if (p == -1) {
            reverse(nums.begin(),nums.end());
            return false;
        }
        int c = end-1;
        while (nums[p] >= nums[c]) c--;
        swap(nums[p],nums[c]);
        reverse(nums.begin()+p+1, nums.end());
        return true;
    }
};
```

32. Longest Valid Parentheses(●ˇ∀ˇ●)

Given a string containing just the characters `'('` and `')'`, find the length of the longest valid (well-formed) parentheses substring.

Example 1:

Input: "(()"

Output: 2

Explanation: The longest valid parentheses substring is "()"

Example 2:

Input: ")()())"

Output: 4

Explanation: The longest valid parentheses substring is "()()"

```cpp
class Solution {
public:
    int longestValidParentheses(string s) {

    }
};
```

```cpp
/////////////////////stack///////////////////////////////////////
class Solution {
public:
    int longestValidParentheses(string s) {
        int res = 0, left = -1, n = s.length();
        stack<int> S;
        for (int i = 0; i < n; i++){
            if (s[i] == '(') S.push(i);
            else if (S.empty()) left = i;
            else {
                S.pop();
                if (S.empty())  res = max(res, i-left);
                else res = max(res, i-S.top());
            }
        }
        return res;
    }
};
```

```cpp
/////////////////////////dp/////////////////////////////////
class Solution {
public:
    int longestValidParentheses(string s) {
        if (s.length() <= 1) return 0;
        int res = 0;
        vector<int> dp(s.size(), 0);
        //dp[i] 表示以 s[i]结尾最长匹配括号的长度
        for (int i = 1; i < s.length(); i++){
            if (s[i] == '(') continue;
            if (s[i-1] == '(') {
                dp[i] = (i-2) >= 0 ? dp[i-2]+2 : 2;
                res = max(dp[i], res);
            } else if (i-dp[i-1]-1 >= 0 && s[i-dp[i-1]-1] == '(') {
                dp[i] = dp[i-1] + 2+ ((i-dp[i-1]-2>=0) ? dp[i-dp[i-1]-2] : 0);
                res = max(dp[i], res);
            }
        }
        return res;
    }
};
```

33. Search in Rotated Sorted Array

Medium

Suppose an array sorted in ascending order is rotated at some pivot unknown to you beforehand.

(i.e., `[0,1,2,4,5,6,7]` might become `[4,5,6,7,0,1,2]`).

You are given a target value to search. If found in the array return its index, otherwise return `-1`.

You may assume no duplicate exists in the array.

Your algorithm's runtime complexity must be in the order of $O(\log n)$.

Example 1:

Input: nums = [4,5,6,7,0,1,2], target = 0

Output: 4

Example 2:

Input: nums = [4,5,6,7,0,1,2], target = 3

Output: -1

```cpp
class Solution {
public:
    int search(vector<int>& nums, int target) {

    }
};
```

```cpp
class Solution {
public:
    int search(vector<int>& nums, int target) {
        int left = 0, right = nums.size() - 1;
        while (left <= right) {
            int mid = left + (right - left) / 2;
            if (nums[mid] == target) return mid;
            else if (nums[mid] < nums[right]) {
                if(nums[mid] < target && nums[right] >= target) left = mid + 1;
                else right = mid - 1;
            } else {
                if(nums[left] <= target && nums[mid] > target) right = mid - 1;
                else left = mid + 1;
            }
        }
        return -1;
    }
};
```

34. Find First and Last Position of Element in Sorted Array (●ˇ∀ ˇ●)

Given an array of integers `nums` sorted in ascending order, find the starting and ending position of a given `target` value.

Your algorithm's runtime complexity must be in the order of $O(\log n)$.

If the target is not found in the array, return `[-1, -1]`.

Example 1:

Input: nums = [5,7,7,8,8,10], target = 8

Output: [3,4]

Example 2:

Input: nums = [5,7,7,8,8,10], target = 6

Output: [-1,-1]

```cpp
class Solution {
public:
    vector<int> searchRange(vector<int>& nums, int target) {

    }
};
```

```cpp
class Solution {
public:
    vector<int> searchRange(vector<int>& nums, int target) {
        /*
        if (nums.empty()) return {-1, -1};
        auto p = equal_range(nums.begin(), nums.end(), target);
        if (p.first == nums.end() || *(p.first) != target) return {-1, -1};
        else return {p.first-nums.begin(), p.second-nums.begin()-1};
        */
        vector<int> res{-1, -1};
        if (nums.empty()) return res;
        int left = 0, right = nums.size();
        while (left < right) {
            int mid = left + (right - left) / 2;
            if (nums[mid] < target) left = mid + 1;
            else right = mid;
        }
        if (left == nums.size() || nums[left] != target) return res;
        res[0] = left;
        right = nums.size();
        while (left < right) {
            int mid = left + (right-left) / 2;
            if (nums[mid] <= target) left = mid+1;
            else right = mid;
        }
        res[1] = left-1; //or right-1;
        return res;
    }
};
```

35. Search Insert Position

Easy

Given a sorted array and a target value, return the index if the target is found. If not, return the index where it would be if it were inserted in order.

You may assume no duplicates in the array.

Example 1:

Input: [1,3,5,6], 5

Output: 2

Example 2:

Input: [1,3,5,6], 2

Output: 1

Example 3:

Input: [1,3,5,6], 7

Output: 4

Example 4:

Input: [1,3,5,6], 0

Output: 0

```cpp
class Solution {
public:
    int searchInsert(vector<int>& nums, int target) {

    }
};
```

```cpp
class Solution {
public:
    int searchInsert(vector<int>& nums, int target) {
        if (nums.back() < target) return nums.size();
        int left = 0, right = nums.size();
        while (left < right) {
            int mid = left + (right - left) / 2;
            if (nums[mid] < target) left = mid + 1;
            else right = mid;
        }
        return left;
    }
};
```

36. Valid Sudoku

Determine if a 9x9 Sudoku board is valid. Only the filled cells need to be validated **according to the following rules**:

1. Each row must contain the digits `1-9` without repetition.
2. Each column must contain the digits `1-9` without repetition.
3. Each of the 9 `3x3` sub-boxes of the grid must contain the digits `1-9` without repetition.

A partially filled sudoku which is valid.

The Sudoku board could be partially filled, where empty cells are filled with the character `'.'`.

Example 1:

Input:

```
[
    ["5","3",".",".","7",".",".",".","."],
    ["6",".",".","1","9","5",".",".","."],
    [".","9","8",".",".",".",".","6","."],
    ["8",".",".",".","6",".",".",".","3"],
    ["4",".",".","8",".","3",".",".","1"],
    ["7",".",".",".","2",".",".",".","6"],
    [".","6",".",".",".",".","2","8","."],
    [".",".",".","4","1","9",".",".","5"],
```

[".",".",".",".","8",".",".","7","9"]

]

Output: true

Example 2:

Input:

[

["8","3",".",".","7",".",".",".","."],

["6",".",".","1","9","5",".",".","."],

[".","9","8",".",".",".",".","6","."],

["8",".",".",".","6",".",".",".","3"],

["4",".",".","8",".","3",".",".","1"],

["7",".",".",".","2",".",".",".","6"],

[".","6",".",".",".",".","2","8","."],

[".",".",".","4","1","9",".",".","5"],

[".",".",".",".","8",".",".","7","9"]

]

Output: false

Explanation: Same as Example 1, except with the **5** in the top left corner being

    modified to **8**. Since there are two 8's in the top left 3x3 sub-box, it is invalid.

Note:

- A Sudoku board (partially filled) could be valid but is not necessarily solvable.
- Only the filled cells need to be validated according to the mentioned rules.
- The given board contain only digits `1-9` and the character `'.'`.
- The given board size is always `9x9`.

```cpp
class Solution {
public:
    bool isValidSudoku(vector<vector<char>>& board) {


    }
};
```

```cpp
class Solution {
public:
    bool isValidSudoku(vector<vector<char>>& board) {
        bool used[9];
        for (int i = 0; i < 9; i++){
            fill(used, used+9, false);
            for (int j = 0; j < 9; j++) {
                if (!check(board[i][j], used))
                    return false;
            }
            fill (used, used+9, false);
            for (int j = 0; j < 9; j++) {
                if (!check(board[j][i], used))
                    return false;
            }
        }

        for (int i = 0; i < 3; i++){
            for (int j = 0; j < 3; j++) {
                fill(used, used+9, false);
                for (int a = 3*i; a < 3*i+3; a++) {
                    for (int b = 3*j; b < 3*j+3; b++)
                        if (!check(board[a][b],used))
                            return false;
                }
            }
        }
        return true;
    }

private:
    bool check(char a, bool used[]){
        if (a == '.') return true;
        if (used[a-'1']) return false;
        used[a-'1'] = true;
        return true;
    }
};
```

37. Sudoku Solver

Write a program to solve a Sudoku puzzle by filling the empty cells.

A sudoku solution must satisfy **all of the following rules**:

1. Each of the digits `1-9` must occur exactly once in each row.
2. Each of the digits `1-9` must occur exactly once in each column.
3. Each of the the digits `1-9` must occur exactly once in each of the 9 `3x3` sub-boxes of the grid.

Empty cells are indicated by the character `'.'`.

A sudoku puzzle...

...and its solution numbers marked in red.

Note:

- The given board contain only digits `1-9` and the character `'.'`.
- You may assume that the given Sudoku puzzle will have a single unique solution.
- The given board size is always `9x9`.

```cpp
class Solution {
public:
    void solveSudoku(vector<vector<char>> &board) {
        solveSudoku(board, 0, 0);
    }

private:
    bool check(vector<vector<char>> &board, int i, int j, char val) {
        int row = i-i%3, column = j-j%3;
        for (int x = 0; x < 9; x++) {
            if (board[x][j] == val || board[i][x] == val)
                return false;
        }
        for (int x = 0; x < 3; x++) {
            for (int y = 0; y < 3; y++) {
                if (board[row+x][column+y] == val)
                    return false;
            }
        }
        return true;
    }

    bool solveSudoku(vector<vector<char>> &board, int i, int j){
        if (i == 9) return true;
        else if (j == 9) return solveSudoku(board, i+1, 0);
        if (board[i][j] != '.') return solveSudoku(board, i, j+1);
        else for (char c = '1'; c <= '9'; c++){
            if (check(board, i, j, c)) {
                board[i][j] = c;
                if (solveSudoku(board, i, j+1)) return true;
                board[i][j] = '.';
            }
        }
        return false;
    }
};
```

38. Count and Say

The count-and-say sequence is the sequence of integers with the first five terms as following:

1.   1

2.   11

3.   21

4.   1211

5.   111221

1 is read off as "one 1" or 11.

11 is read off as "two 1s" or 21.

21 is read off as "one 2, then one 1" or 1211.

Given an integer *n* where $1 \le n \le 30$, generate the nth term of the count-and-say sequence.

Note: Each term of the sequence of integers will be represented as a string.

Example 1:

Input: 1

Output: "1"

Example 2:

Input: 4

Output: "1211"

```cpp
class Solution {
public:
    string countAndSay(int n) {


    }
};
```

```cpp
class Solution {
public:
    string countAndSay(int n) {
        string s = "1";
        while (--n) {
            string t;
            char c = s[0];
            int cnt = 1;
            for (int i = 1; i < s.length(); i++){
                if (s[i] == c) cnt++;
                else {
                    t += to_string(cnt)+c;
                    cnt = 1;
                    c = s[i];
                }
            }
            s = t + to_string(cnt)+c;
        }
        return s;
    }
};
```

39. Combination Sum

Medium

Given a **set** of candidate numbers (candidates) **(without duplicates)** and a target number (target), find all unique combinations in candidates where the candidate numbers sums to target.

The **same** repeated number may be chosen from candidates unlimited number of times.

Note:

- All numbers (including target) will be positive integers.
- The solution set must not contain duplicate combinations.

Example 1:

Input: candidates = [2,3,6,7], target = 7,

A solution set is:

[

  [7],

  [2,2,3]

]

Example 2:

Input: candidates = [2,3,5], target = 8,

A solution set is:

[

  [2,2,2,2],

  [2,3,3],

  [3,5]

]

```cpp
class Solution {
public:
    vector<vector<int>> combinationSum(vector<int>& candidates, int target) {


    }
};
```

```cpp
class Solution {
public:
    vector<vector<int>> res;
    vector<vector<int>> combinationSum(vector<int> &candidates, int target) {
        vector<int> t;
        sort(candidates.begin(), candidates.end());
        dfs(candidates, 0, target, t);
        return res;
    }
private:
    void dfs(vector<int> &v, int cur, int target, vector<int> &t) {
        if (target == 0) res.push_back(t);
        else for(auto i = cur; i < v.size() && target-v[i] >= 0; i++) {
            t.push_back(v[i]);
            dfs(v, i, target-v[i], t);
            t.pop_back();
        }
    }
};
```

40. Combination Sum II(●ˇ∀ˇ●)

Given a collection of candidate numbers (`candidates`) and a target number (`target`), find all unique combinations in `candidates` where the candidate numbers sums to `target`.

Each number in `candidates` may only be used **once** in the combination.

Note:

- All numbers (including `target`) will be positive integers.
- The solution set must not contain duplicate combinations.

Example 1:

Input: candidates = [10,1,2,7,6,1,5], target = 8,

A solution set is:

[

  [1, 7],

  [1, 2, 5],

  [2, 6],

  [1, 1, 6]

]

Example 2:

Input: candidates = [2,5,2,1,2], target = 5,

A solution set is:

[

  [1,2,2],

  [5]

]

```cpp
class Solution {
public:
    vector<vector<int>> combinationSum2(vector<int>& candidates, int target) {

    }
};
```

```cpp
class Solution {
public:
    vector<vector<int>> res;
    vector<vector<int>>combinationSum2(vector<int> &candidates, int target) {
        vector<int> t;
        sort(candidates.begin(), candidates.end());
        dfs(candidates, 0, target, t);
        return res;
    }

private:
    void dfs(vector<int> &v, int cur, int target, vector<int> &t) {
        if (target == 0) res.push_back(t);
        else for(auto i = cur; i < v.size() && target-v[i] >= 0; i++) {
            if (i != cur && v[i] == v[i-1]) continue;        //不同之处 1
            t.push_back(v[i]);
            dfs(v, i+1, target-v[i], t);                     //不同之处 2
            t.pop_back();
        }
    }
};
```

41. First Missing Positive(●˘∀ ˘●)

Given an unsorted integer array, find the smallest missing positive integer.

Example 1:

Input: [1,2,0]

Output: 3

Example 2:

Input: [3,4,-1,1]

Output: 2

Example 3:

Input: [7,8,9,11,12]

Output: 1

Note:

Your algorithm should run in $O(n)$ time and uses constant extra space.

```cpp
class Solution {
public:
    int firstMissingPositive(vector<int>& nums) {


    }
};
```

```cpp
class Solution {
public:
    int firstMissingPositive(vector<int>& nums) {
        int n = nums.size();
        for (int i = 0; i < n; i++) {
            while (nums[i] > 0 && nums[i] <= n
                    && nums[nums[i] - 1] != nums[i]) {
                swap(nums[i], nums[nums[i] - 1]);
            }
        }
        for (int i = 0; i < n; i++) {
            if (nums[i] != i + 1)
                return i + 1;
        }
        return n + 1;
    }
};
```

42. Trapping Rain Water(●ˇ∀ˇ●)

Hard

Given *n* non-negative integers representing an elevation map where the width of each bar is 1, compute how much water it is able to trap after raining.

The above elevation map is represented by array [0,1,0,2,1,0,1,3,2,1,2,1]. In this case, 6 units of rain water (blue section) are being trapped. **Thanks Marcos** for contributing this image!

Example:

Input: [0,1,0,2,1,0,1,3,2,1,2,1]

Output: 6

```cpp
class Solution {
public:
    int trap(vector<int>& height) {

    }
};
```

```cpp
class Solution {
public:
    int trap(vector<int>& height) {
        int res = 0, n = height.size();
        vector<int> L_MAX(n, 0);
        for (int i = 0; i < n; i++){
            if (!i) L_MAX[i] = height[i];
            else  L_MAX[i] = max(height[i], L_MAX[i-1]);
        }
        int R_MAX = height[n-1];
        for (int i = n-2; i >= 0; i--){
            if (R_MAX < height[i]) R_MAX = height[i];
            else res += min(R_MAX-height[i], L_MAX[i]-height[i]);
        }
        return res;
    }
};
```

```cpp
class Solution {
public:
    int trap(vector<int>& height) {
        int res = 0, l = 0, r = height.size()-1;
        while (l < r) {
            int MIN = min(height[l], height[r]);
            if (MIN == height[l]) {
                ++l;
                while (l < r && height[l] < MIN) res += MIN-height[l++];
            } else {
                --r;
                while (l < r && height[r] < MIN) res += MIN-height[r--];
            }
        }
        return res;
    }
};
```

43. Multiply Strings

Given two non-negative integers `num1` and `num2` represented as strings, return the product of `num1` and `num2`, also represented as a string.

Example 1:

Input: num1 = "2", num2 = "3"

Output: "6"

Example 2:

Input: num1 = "123", num2 = "456"

Output: "56088"

Note:

1. The length of both `num1` and `num2` is < 110.
2. Both `num1` and `num2` contain only digits `0-9`.
3. Both `num1` and `num2` do not contain any leading zero, except the number 0 itself.
4. You **must not use any built-in BigInteger library** or **convert the inputs to integer** directly.

```cpp
class Solution {
public:
    string multiply(string num1, string num2) {


    }
};
```

```cpp
class Solution {
public:
    string multiply(string num1, string num2) {
        if (num1 == "0" || num2 == "0") return "0";
        int n = num1.size(), m = num2.size();
        vector<int> sum(n+m);
        for (int i = 0; i < n; i++) {
            for (int j = 0; j < m; j++) {
                sum[n+m-i-j-2] += (num1[i]-'0')*(num2[j]-'0');
            }
        }
        int carry = 0;
        string res;
        for (int i = 0; i < n+m-1; i++) {
            carry += sum[i];
            res += carry%10+'0';
            carry /= 10;
        }
        if (carry) res += carry+'0';
        reverse(res.begin(), res.end());
        return res;
    }
};
```

44. Wildcard Matching(●ˇ∀ˇ●)

Given an input string (s) and a pattern (p), implement wildcard pattern matching with support for `'?'` and `'*'`.

'?' Matches any single character.

'*' Matches any sequence of characters (including the empty sequence).

The matching should cover the **entire** input string (not partial).

Note:

- s could be empty and contains only lowercase letters `a-z`.
- p could be empty and contains only lowercase letters `a-z`, and characters like `?` or `*`.

Example 1:

Input:

s = "aa"

p = "a"

Output: false

Explanation: "a" does not match the entire string "aa".

Example 2:

Input:

s = "aa"

p = "*"

Output: true

Explanation: '*' matches any sequence.

Example 3:

Input:

s = "cb"

p = "?a"

Output: false

Explanation: '?' matches 'c', but the second letter is 'a', which does not match 'b'.

Example 4:

Input:

s = "adceb"

p = "*a*b"

Output: true

Explanation: The first '*' matches the empty sequence, while the second '*' matches the substring "dce".

Example 5:

Input:

s = "acdcb"

p = "a*c?b"

Output: false

```cpp
class Solution {
public:
    bool isMatch(string s, string p) {

    }
}
```

```cpp
class Solution {
public:
    bool isMatch(string s, string p) {
        int  slen = s.size(), plen = p.size(), i, j, iStar = -1, jStar = -1;
        for(i = 0, j = 0 ; i < slen; ++i, ++j) {
            if (p[j] == '*') {
                //meet a new '*', update traceback i/j info
                iStar = i;
                jStar = j;
                --i;
            }
            else if (p[j] != s[i] && p[j] != '?') {
                // mismatch happens
                if (iStar < 0) return false;
                // met a '*' before, then do traceback
                i = iStar++;
                j = jStar;
            }
        }
        while (p[j] == '*') ++j;
        return j == plen;
    }
}
```

45. Jump Game II

Given an array of non-negative integers, you are initially positioned at the first index of the array.

Each element in the array represents your maximum jump length at that position.

Your goal is to reach the last index in the minimum number of jumps.

Example:

Input: [2,3,1,1,4]

Output: 2

Explanation: The minimum number of jumps to reach the last index is 2.

   Jump 1 step from index 0 to 1, then 3 steps to the last index.

Note:

You can assume that you can always reach the last index.

```cpp
class Solution {
public:
    int jump(vector<int>& nums) {


    }
};
```

```cpp
class Solution {
public:
    int jump(vector<int>& nums) {
        if (nums.size() <= 1) return 0;
        int res = 1, n = nums.size(), i = 0;
        while (i < n) {
            int farest = i+nums[i], temp = farest;
            if (farest >= n-1) return res;
            else for (int k = i+1; k <= farest; k++) {
                if (k+nums[k] > temp) temp = k + nums[i = k];
            }
            res++;
        }
        return res;
    }
};
```

46. Permutations(+_+)?

Given a collection of **distinct** integers, return all possible permutations.

Example:

Input: [1,2,3]

Output:

[

  [1,2,3],

  [1,3,2],

  [2,1,3],

  [2,3,1],

  [3,1,2],

  [3,2,1]

]

```cpp
class Solution {
public:
    vector<vector<int>> permute(vector<int>& nums) {

    }
};
```

```cpp
class Solution {
public:
    vector<vector<int>> permute(vector<int>& nums) {
        sort(nums.begin(), nums.end());
        vector<vector<int>> res;
        do{
            res.push_back(nums);
        }while (Next_Permutation(nums));
        return res;
    }

    bool Next_Permutation(vector<int> &nums) {
        int n = nums.size(), i, j;
        for (i = n-2, j = n-1; i >= 0; i--) {
            if (nums[i] < nums[i+1]) {
                while (nums[j] < nums[i]) j--;
                swap(nums[i], nums[j]);
                int l = i+1, r = n-1;
                while (l < r)  swap(nums[l++], nums[r--]);
                return true;
            }
        }
        return false;
    }
};
```

```cpp
//////////////////////////////////DFS//////////////////////////////////
class Solution {
public:
    vector<vector<int>> permute(vector<int> &num) {
        visited.resize(num.size(), false);
        permuteDFS(num, 0);
        return res;
    }

private:
    vector<vector<int>> res;
    vector<int> out;
    vector<bool> visited;

    void permuteDFS(vector<int> &num, int level) {
        if (level == num.size()) res.push_back(out);
        else for (int i = 0; i < num.size(); ++i) {
            if (!visited[i]) {
                visited[i] = true;
                out.push_back(num[i]);
                permuteDFS(num, level + 1);
                out.pop_back();
                visited[i] = false;
            }
        }
    }
};
```

```cpp
/////////////////////////////注意nums为值传递/////////////////////////////
class Solution {
public:
    vector<vector<int>> permute(vector<int>& nums) {
        vector<vector<int>> res;
        permute(nums, 0, res);
        return res;
    }
private:
    void permute(vector<int> nums, int i, vector<vector<int>> &res) {
        if (i == nums.size())  res.push_back(nums);
        else for (int j = i; j < nums.size(); j++) {
            swap(nums[i], nums[j]);
            permute(nums, i + 1, res);
        }
    }
};
```

47. Permutations II(+_+)?

Medium

Given a collection of numbers that might contain duplicates, return all possible unique permutations.

Example:

Input: [1,1,2]

Output:

[

  [1,1,2],

  [1,2,1],

  [2,1,1]

```cpp
class Solution {
public:
    vector<vector<int>> permuteUnique(vector<int>& nums) {

    }
};
```

```cpp
class Solution {
public:
    vector<vector<int>> permuteUnique(vector<int>& nums) {
        sort(nums.begin(), nums.end());
        vector<vector<int>> res;
        do{
            res.push_back(nums);
        } while (Next_Permutation(nums));
        return res;
    }


    bool Next_Permutation(vector<int> &nums) {
        int n = nums.size(), i, j;
        for (i = n-2, j = n-1; i >= 0; i--) {
            if (nums[i] < nums[i+1]) {
                while (nums[j] <= nums[i]) j--;
                swap(nums[i], nums[j]);
                int l = i+1, r = n-1;
                while (l < r)  swap(nums[l++], nums[r--]);
                return true;
            }
        }
        return false;
    }
};
```

```
/////////////////////////////DFS/////////////////////////////
class Solution {
public:
    vector<vector<int> > permuteUnique(vector<int> &num) {
        sort(num.begin(), num.end());                //不同之处1
        visited.resize(num.size(), false);
        permuteUniqueDFS(num, 0);
        return res;
    }

private:
    vector<vector<int>> res;
    vector<int> out;
    vector<bool> visited;

    void permuteUniqueDFS(vector<int> &num, int level) {
        if (level == num.size()) res.push_back(out);
        else for (int i = 0; i < num.size(); ++i) {
            if (!visited[i]) {
                if (i > 0 && num[i] == num[i - 1] && !visited[i - 1]) continue;
                                                    //不同之处2
                visited[i] = true;
                out.push_back(num[i]);
                permuteUniqueDFS(num, level + 1);
                out.pop_back();
                visited[i] = false;
            }
        }
    }
};
```

```cpp
/////////////////////////////注意nums为值传递/////////////////////////////
class Solution {
public:
    vector<vector<int>> permuteUnique(vector<int> &nums) {
        sort(nums.begin(), nums.end());              //不同之处1
        vector<vector<int>> res;
        permute(nums, 0, res);
        return res;
    }
    void permute(vector<int> nums, int i, vector<vector<int>> &res) {
        if (i == nums.size()) res.push_back(nums);
        else for (int k = i; k < nums.size(); k++) {
            if (i != k && nums[i] == nums[k]) continue;   //不同之处2
            swap(nums[i], nums[k]);
            permute(nums, i+1, res);
        }
    }
};
```

48. Rotate Image

You are given an *n* x *n* 2D matrix representing an image.

Rotate the image by 90 degrees (clockwise).

Note:

You have to rotate the image **in-place**, which means you have to modify the input 2D matrix directly. **DO NOT** allocate another 2D matrix and do the rotation.

Example 1:

Given **input matrix** =

[

   [1,2,3],

   [4,5,6],

   [7,8,9]

],

rotate the input matrix **in-place** such that it becomes:

[

   [7,4,1],

   [8,5,2],

   [9,6,3]

]

Example 2:

Given **input matrix** =

[

   [5, 1, 9,11],

   [2, 4, 8,10],

   [13, 3, 6, 7],

[15,14,12,16]

],

rotate the input matrix **in-place** such that it becomes:

[

    [15,13, 2, 5],

    [14, 3, 4, 1],

    [12, 6, 8, 9],

    [16, 7,10,11]

]


```cpp
class Solution {
public:
    void rotate(vector<vector<int>>& matrix) {

    }
};
```

```cpp
class Solution {
public:
    void rotate(vector<vector<int>>& matrix) {
        int n = matrix.size();
        int i = 0, j = n-1;
        while (i < j){
            for (int k = 0; k < n; k++)  swap(matrix[k][i], matrix[k][j]);
            i++; j--;
        }
        for (int i = 0; i < n; i++) {
            for (int j = 0; j + i < n-1; j++)
                swap(matrix[i][j],matrix[n-1-j][n-1-i]);
        }
    }
};
```

49. Group Anagrams

Given an array of strings, group anagrams together.

Example:

Input: ["eat", "tea", "tan", "ate", "nat", "bat"],

Output:

[

  ["ate","eat","tea"],

  ["nat","tan"],

  ["bat"]

]

Note:

- All inputs will be in lowercase.
- The order of your output does not matter.

```cpp
class Solution {
public:
    vector<vector<string>> groupAnagrams(vector<string>& strs) {

};
```

```cpp
class Solution {
public:
    vector<vector<string>> groupAnagrams(vector<string>& strs) {
        unordered_map<string, vector<string>> m;
        for (string s : strs) {
            string t = s;
            sort(t.begin(), t.end());
            m[t].push_back(s);
        }
        vector<vector<string>> res;
        for (auto &p : m) {
            res.push_back(p.second);
        }
        return res;
    }
};
```

50. Pow(x, n)(●˘∀˘●)

Implement pow(x, n), which calculates x raised to the power n (x^n).

Example 1:

Input: 2.00000, 10

Output: 1024.00000

Example 2:

Input: 2.10000, 3

Output: 9.26100

Example 3:

Input: 2.00000, -2

Output: 0.25000

Explanation: $2^{-2} = 1/2^2 = 1/4 = 0.25$

Note:

- $-100.0 < x < 100.0$
- n is a 32-bit signed integer, within the range $[-2^{31}, 2^{31} - 1]$

```cpp
class Solution {
public:
    double myPow(double x, int n) {


    }
};
```

```cpp
class Solution {
public:
    double myPow(double x, int n) {
        if (x == 1 || n == 0) return 1;
        if (n < 0)  x = 1/x;
        double res = 1;
        unsigned long long m = abs(n);
        while (m) {
            if (m&1) res *= x;
            x *= x;
            m >>= 1;
        }
        return res ;
    }
};
```

51. N-Queens

The *n*-queens puzzle is the problem of placing *n* queens on an *n*×*n* chessboard such that no two queens attack each other.

One solution to the eight queens puzzle
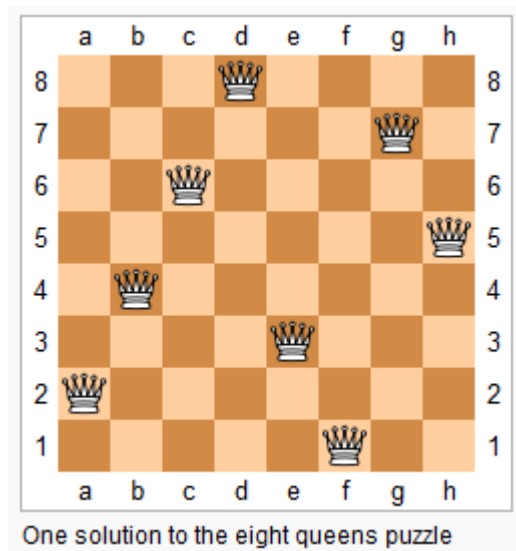
Given an integer *n*, return all distinct solutions to the *n*-queens puzzle.

Each solution contains a distinct board configuration of the *n*-queens' placement, where `'Q'` and `'.'` both indicate a queen and an empty space respectively.

Example:

Input: 4

Output: [

 [".Q..", // Solution 1

  "...Q",

  "Q...",

  "..Q."],

 ["..Q.", // Solution 2

  "Q...",

  "...Q",

  ".Q.."]

]

Explanation: There exist two distinct solutions to the 4-queens puzzle as shown above.

```cpp
class Solution {
public:
    vector<vector<string>> solveNQueens(int n) {

    }
};
```

```cpp
class Solution {
public:
    vector<vector<string>> res;
    vector<vector<string>> solveNQueens(int n) {
        col.resize(n, false);
        main_diag.resize(2*n-1, false);
        anti_diag.resize(2*n-1, false);
        vector<string> v;
        dfs(0, n, v);
        return res;
    }

private:
    vector<bool> col;
    vector<bool> main_diag;
    vector<bool> anti_diag;

    void dfs(int x, int n, vector<string> &v) {
        if (x == n) res.push_back(v);
        else for (int y = 0; y < n; y++) {
            if (!col[y] && !main_diag[x+y] && !anti_diag[x-y+n-1]){
                col[y] = main_diag[x+y] = anti_diag[x-y+n-1] = true;
                v.push_back( string(y,'.') + 'Q' + string(n-y-1,'.') );
                dfs(x+1, n, v);
                v.pop_back();
                col[y] = main_diag[x+y] = anti_diag[x-y+n-1] = false;
            }
        }
    }
};
```

52. N-Queens II

The *n*-queens puzzle is the problem of placing *n* queens on an *n*×*n* chessboard such that no two queens attack each other.

One solution to the eight queens puzzle
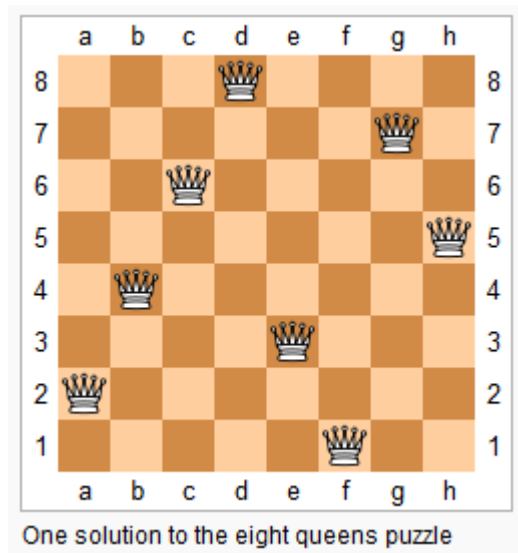
Given an integer *n*, return the number of distinct solutions to the *n*-queens puzzle.

Example:

Input: 4

Output: 2

Explanation: There are two distinct solutions to the 4-queens puzzle as shown below.

[

 [".Q..",   // Solution 1

  "...Q",

  "Q...",

  "..Q."],

 ["..Q.",   // Solution 2

  "Q...",

  "...Q",

```
  ".Q.."]

]
```

```cpp
class Solution {
public:
    int totalNQueens(int n) {

    }
};
```

```cpp
class Solution {
public:
    int totalNQueens(int n) {
        col.resize(n, false);
        main_diag.resize(2*n-1, false);
        anti_diag.resize(2*n-1, false);
        return dfs(0, n);
    }

private:
    vector<bool> col;
    vector<bool> main_diag;
    vector<bool> anti_diag;

    int dfs(int x, int n) {
        if (x == n) return 1;
        int res = 0;
        for (int y = 0; y < n; y++) {
            if (!col[y] && !main_diag[x+y] && !anti_diag[x-y+n-1]){
                col[y] = main_diag[x+y] = anti_diag[x-y+n-1] = true;
                res += dfs(x+1, n);
                col[y] = main_diag[x+y] = anti_diag[x-y+n-1] = false;
            }
        }
        return res;
    }
};
```

53. Maximum Subarray(●ˇ∀ˇ●)

Given an integer array `nums`, find the contiguous subarray (containing at least one number) which has the largest sum and return its sum.

Example:

Input: [-2,1,-3,4,-1,2,1,-5,4],

Output: 6

Explanation: [4,-1,2,1] has the largest sum = 6.

Follow up:

If you have figured out the O(*n*) solution, try coding another solution using the divide and conquer approach, which is more subtle.

```cpp
class Solution {
public:
    int maxSubArray(vector<int>& nums) {
        int sum = nums[0], cur = 0;
        for (auto &i : nums) {
            cur += i;
            sum = max(sum, cur);
            if (cur <= 0)  cur = 0;
        }
        return sum;
    }
};
```

```cpp
///////////////////divide and conquer approach///////////////////////////
class Solution {
public:
    int maxSubArray(vector<int>& nums) {
        return maxSubArray(nums, 0, nums.size()-1);
    }

private:
    int maxSubArray(vector<int>& nums, int left, int right) {
        if (right < left) return INT_MIN;
        else if (right == left) return nums[left];
        int mid = left+(right-left)/2;
        int ret = max(maxSubArray(nums, left, mid),
                      maxSubArray(nums, mid+1, right));
        int sum = nums[mid], temp = 0;
        for (int i = mid+1, t = 0; i <= right; i++) {
            temp = max(t += nums[i], temp);
        }
        sum += temp;
        temp = 0;
        for (int i = mid-1, t = 0; i >= left; i--) {
            temp = max(t += nums[i], temp);
        }
        return max(ret, sum += temp);
    }
};
```

54. Spiral Matrix

Medium

Given a matrix of *m* x *n* elements (*m* rows, *n* columns), return all elements of the matrix in spiral order.

Example 1:

Input:

```
[
 [ 1, 2, 3 ],
 [ 4, 5, 6 ],
 [ 7, 8, 9 ]
]
```

Output: [1,2,3,6,9,8,7,4,5]

Example 2:

Input:

```
[
  [1, 2, 3, 4],
  [5, 6, 7, 8],
  [9,10,11,12]
]
```

Output: [1,2,3,4,8,12,11,10,9,5,6,7]

```cpp
class Solution {
public:
    vector<int> spiralOrder(vector<vector<int>>& matrix) {


    }
};
```

```cpp
class Solution {
public:
    vector<int> spiralOrder(vector<vector<int>>& matrix) {
        vector <int> res;
        if (matrix.empty()) return res;
        int rowSize = matrix.size(), colSize = matrix[0].size();
        int lb = 0, rb = colSize-1, ub = 0, db = rowSize-1;
        // left bound, right bound, up bound, down bound;
        int direction = 0, col = 0, row = 0;
        while (lb <= rb && ub <= db) {
            res.push_back(matrix[row][col]);
            switch (direction){
                case 0:  //  right
                    if (col >= rb) {direction = 1; row++; ub++;}
                    else col++;
                    break;
                case 1: // down
                    if (row >= db) {direction = 2; col--; rb--;}
                    else row++;
                    break;
                case 2: // left
                    if (col <= lb) {direction = 3; row--; db--;}
                    else col--;
                    break;
                case 3:  // up
                    if (row <= ub) {direction = 0; col++; lb++;}
                    else row--;
            }
        }
        return res;
    }
};
```

55. Jump Game

Given an array of non-negative integers, you are initially positioned at the first index of the array.

Each element in the array represents your maximum jump length at that position.

Determine if you are able to reach the last index.

Example 1:

Input: [2,3,1,1,4]

Output: true

Explanation: Jump 1 step from index 0 to 1, then 3 steps to the last index.

Example 2:

Input: [3,2,1,0,4]

Output: false

Explanation: You will always arrive at index 3 no matter what. Its maximum

jump length is 0, which makes it impossible to reach the last index.

```cpp
class Solution {
public:
    bool canJump(vector<int>& nums) {


    }
};
```

```cpp
class Solution {
public:
    bool canJump(vector<int>& nums) {
        if (nums.size() <= 1) return true;
        int n = nums.size(), temp = n-1;
        for (int i = n-1; i >= 0; --i) {
            int j = i + nums[i];
            if (j >= temp) temp = i;
        }
        return temp == 0;
    }
};
```

56. Merge Intervals(●ˇ∀ˇ●)

Given a collection of intervals, merge all overlapping intervals.

Example 1:

Input: [[1,3],[2,6],[8,10],[15,18]]

Output: [[1,6],[8,10],[15,18]]

Explanation: Since intervals [1,3] and [2,6] overlaps, merge them into [1,6].

Example 2:

Input: [[1,4],[4,5]]

Output: [[1,5]]

Explanation: Intervals [1,4] and [4,5] are considered overlapping.

```cpp
class Solution {
public:
    vector<vector<int>> merge(vector<vector<int>>& intervals) {

    }
};
```

```cpp
class Solution {
public:
    vector<vector<int>> merge(vector<vector<int>>& intervals) {
        vector<vector<int>> res;
        if (intervals.empty()) return res;
        auto cmp = [](const vector<int> &a, const vector<int> &b){
            return a[0] < b[0];
        };
        sort(intervals.begin(), intervals.end(), cmp);
        res.push_back(intervals[0]);
        for (auto &v : intervals) {
            if (res.back()[1] < v[0]) res.push_back(v);
            else res.back()[1] = max(res.back()[1], v[1]);
        }
        return res;
    }
};
```

57. Insert Interval(●ˇ∀ˇ●)

Hard

Given a set of *non-overlapping* intervals, insert a new interval into the intervals (merge if necessary).

You may assume that the intervals were initially sorted according to their start times.

Example 1:

Input: intervals = [[1,3],[6,9]], newInterval = [2,5]

Output: [[1,5],[6,9]]

Example 2:

Input: intervals = [[1,2],[3,5],[6,7],[8,10],[12,16]], newInterval = [4,8]

Output: [[1,2],[3,10],[12,16]]

Explanation: Because the new interval [4,8] overlaps with [3,5],[6,7],[8,10].

```cpp
class Solution {
public:
    vector<vector<int>> insert(vector<vector<int>>& ins, vector<int>& newIn){
        auto it = ins.begin();
        while (it != ins.end()) {
            if ((*it)[1] < newIn[0]) it++;
            else if ((*it)[0] > newIn[1]) {
                ins.insert(it, newIn);
                return ins;
            } else {
                newIn[0] = min(newIn[0], (*it)[0]);
                newIn[1] = max(newIn[1], (*it)[1]);
                it = ins.erase(it);
            }
        }
        ins.insert(ins.end(), newIn);
        return ins;
    }
};
```

```cpp
class Solution {
public:
    vector<vector<int>> insert(vector<vector<int>>& ins, vector<int>& newIn){
        auto cmp = [] (const vector<int> &lhs, const vector<int> &rhs) {
            return lhs[1] < rhs[0];
        };
        auto range = equal_range(ins.begin(), ins.end(), newIn, cmp);
        auto p = range.first, q = range.second;
        if (p == q)  ins.insert(p, newIn);
        else {
            q--;
            (*q)[0] = min(newIn[0], (*p)[0]);
            (*q)[1] = max(newIn[1], (*q)[1]);
            ins.erase(p, q);
        }
        return ins;
    }
};
```

58. Length of Last Word

Easy

Given a string *s* consists of upper/lower-case alphabets and empty space characters `' '`, return the length of last word in the string.

If the last word does not exist, return 0.

Note: A word is defined as a character sequence consists of non-space characters only.

Example:

Input: "Hello World"

Output: 5

```cpp
class Solution {
public:
    int lengthOfLastWord(string s) {


    }
};
```

```cpp
class Solution {
public:
    int lengthOfLastWord(string s) {
        stringstream ss(s);
        string res;
        while (ss >> res);
        return res.length();
    }
};
```

```cpp
class Solution {
public:
    int lengthOfLastWord(string s) {
        int i = s.find_last_not_of(' ');
        int res = 0;
        while (i >= 0 && s[i--] != ' ') res++;
        return res;
    }
};
```

59. Spiral Matrix II

Given a positive integer n, generate a square matrix filled with elements from 1 to n^2 in spiral order.

Example:

Input: 3

Output:

[

 [1, 2, 3],

 [8, 9, 4],

 [7, 6, 5]

]

```cpp
class Solution {
public:
    vector<vector<int>> generateMatrix(int n) {


    }
};
```

```cpp
class Solution {
public:
    vector<vector<int>> generateMatrix(int n) {
        vector<vector<int>> res(n, vector<int>(n, 0));
        int x = 0, y = 0, cnt = 0;
        res[x][y] = ++cnt;
        while (cnt < n*n) {
            while (y+1 < n  && !res[x][y+1]) res[x][++y] = ++cnt;
            while (x+1 < n  && !res[x+1][y]) res[++x][y] = ++cnt;
            while (y-1 >= 0 && !res[x][y-1]) res[x][--y] = ++cnt;
            while (x-1 >= 0 && !res[x-1][y]) res[--x][y] = ++cnt;
        }
        return res;
    }
};
```

60. Permutation Sequence(●ˇ∀ˇ●)

The set `[1,2,3,...,n]` contains a total of *n*! unique permutations.

By listing and labeling all of the permutations in order, we get the following sequence for *n* = 3:

1. `"123"`
2. `1]"132"`
3. `"213"`
4. `"231"`
5. `"312"`
6. `"321"`

Given *n* and *k*, return the *k*th permutation sequence.

Note:

- Given *n* will be between 1 and 9 inclusive.
- Given *k* will be between 1 and *n*! inclusive.

Example 1:

Input: n = 3, k = 3

Output: "213"

Example 2:

Input: n = 4, k = 9

Output: "2314"

```
class Solution {
public:
    string getPermutation(int n, int k) {

    }
};
```

```cpp
class Solution {
public:
    string getPermutation(int n, int k) {
        string s(n, '0');
        for (int i = 0; i < n; ++i) s[i] += i + 1;
        return kth_permutation(s, k);
    }

private:
    int factorial(int n) {
        int result = 1;
        for (int i = 1; i < n+1; ++i)  result *= i;
        return result;
    }

    string kth_permutation(string &s, int k) {
        int n = s.size();
        string res;
        int base = factorial(n - 1);
        --k; // 康托编码从 0 开始
        for (int i = n - 1;; i--) {
            auto a = next(s.begin(), k / base);
            res.push_back(*a);
            s.erase(a);
            if (!i) break;
            k %= base;
            base /= i;
        }
        return res;
    }
};
```

61. Rotate List

Given a linked list, rotate the list to the right by *k* places, where *k* is non-negative.

Example 1:

Input: 1->2->3->4->5->NULL, k = 2

Output: 4->5->1->2->3->NULL

Explanation:

rotate 1 steps to the right: 5->1->2->3->4->NULL

rotate 2 steps to the right: 4->5->1->2->3->NULL

Example 2:

Input: 0->1->2->NULL, k = 4

Output: 2->0->1->NULL

Explanation:

rotate 1 steps to the right: 2->0->1->NULL

rotate 2 steps to the right: 1->2->0->NULL

rotate 3 steps to the right: 0->1->2->NULL

rotate 4 steps to the right: 2->0->1->NULL

```cpp
class Solution {
public:
    ListNode* rotateRight(ListNode* head, int k) {

    }
};
```

```cpp
class Solution {
public:
    ListNode* rotateRight(ListNode* head, int k) {
        if (head == nullptr) return head;
        int len = 1;
        ListNode *last = head, *p = head;
        While (last->next) {
            last = last->next;
            len++;
        }
        k = len-k%len;
        while (--k) p = p->next;
        last->next = head;
        head = p->next;
        p->next = nullptr;
        return head;
    }
};
```

62. Unique Paths

Medium

A robot is located at the top-left corner of a *m* x *n* grid (marked 'Start' in the diagram below).

The robot can only move either down or right at any point in time. The robot is trying to reach the bottom-right corner of the grid (marked 'Finish' in the diagram below).

How many possible unique paths are there?

Above is a 7 x 3 grid. How many possible unique paths are there?

Note: *m* and *n* will be at most 100.

Example 1:

Input: m = 3, n = 2

Output: 3

Explanation:

From the top-left corner, there are a total of 3 ways to reach the bottom-right corner:

1. Right -> Right -> Down

2. Right -> Down -> Right

3. Down -> Right -> Right

Example 2:

Input: m = 7, n = 3

Output: 28

```cpp
class Solution {
public:
    int uniquePaths(int m, int n) {
        if (n > m)  swap(m, n);
        long long res = 1;
        int i = 1;
        while(i < n) res = res*(m++)/i++;
        return res;
    }
};
```

```cpp
class Solution {
public:
    int uniquePaths(int m, int n) {
        vector<int> f(n, 1);
        while (--m) {
            for (int j = n-1; j >= 0; j--) {
                if (j != n-1) f[j] += f[j+1];
            }
        }
        return f[0];
    }
};
```

63. Unique Paths II

Medium

A robot is located at the top-left corner of a *m* x *n* grid (marked 'Start' in the diagram below). The robot can only move either down or right at any point in time. The robot is trying to reach the bottom-right corner of the grid (marked 'Finish' in the diagram below).

Now consider if some obstacles are added to the grids. How many unique paths would there be?

An obstacle and empty space is marked as 1 and 0 respectively in the grid.

Note: *m* and *n* will be at most 100.

Example 1:

Input:

[

  [0,0,0],

  [0,1,0],

  [0,0,0]

]

Output: 2

Explanation:

There is one obstacle in the middle of the 3x3 grid above.

There are two ways to reach the bottom-right corner:

1. Right -> Right -> Down -> Down

2. Down -> Down -> Right -> Right

```cpp
class Solution {
public:
    int uniquePathsWithObstacles(vector<vector<int>>& obstacleGrid) {
        int m = obstacleGrid.size(), n = obstacleGrid[0].size();
        if (obstacleGrid[0][0] || obstacleGrid[m-1][n-1]) return 0;
        vector<long long> f(n, 0);
        f[n-1] = 1;
        for (int i = m-1; i >= 0; i--){
            for (int j = n-1; j >= 0; j--) {
                if (i == m-1 && j == n-1) continue;
                else if (obstacleGrid[i][j]) f[j] = 0;
                else if (j != n-1) f[j] += f[j+1];
            }
        }
        return f[0];
    }
};
```

64. Minimum Path Sum

Medium

Given a *m* x *n* grid filled with non-negative numbers, find a path from top left to bottom right which *minimizes* the sum of all numbers along its path.

Note: You can only move either down or right at any point in time.

Example:

Input:

[

  [1,3,1],

   [1,5,1],

   [4,2,1]

]

Output: 7

Explanation: Because the path 1→3→1→1→1 minimizes the sum.

```cpp
class Solution {
public:
    int minPathSum(vector<vector<int>>& grid) {


    }
};
```

```cpp
class Solution {
public:
    int minPathSum(vector<vector<int>>& grid) {
        int res = 0;
        if (grid.empty()) return res;
        int n = grid.size(), m = grid[0].size();
        vector<int> f = grid[0];
        for (int i = 0; i < n; ++i) {
            for (int j = 0; j < m; ++j) {
                if (i == 0) f[j] += (j == 0 ? 0: f[j-1]);
                else if (j == 0) f[j] += grid[i][j];
                else f[j] = min(f[j], f[j-1]) + grid[i][j];
            }
        }
        return f[m-1];
    }
};
```

65. Valid Number

Validate if a given string can be interpreted as a decimal number.

Some examples:
```
"0" => true
" 0.1 " => true
"abc" => false
"1 a" => false
"2e10" => true
" -90e3   " => true
" 1e" => false
"e3" => false
" 6e-1" => true
" 99e2.5 " => false
"53.5e93" => true
" --6 " => false
"-+3" => false
"95a54e53" => false
```

Note: It is intended for the problem statement to be ambiguous. You should gather all requirements up front before implementing one. However, here is a list of characters that can be in a valid decimal number:

- Numbers 0-9
- Exponent - "e"
- Positive/negative sign - "+"/"-"
- Decimal point - "."

Of course, the context of these characters also matters in the input.

Update (2015-02-10):
The signature of the C++ function had been updated. If you still see your function signature accepts a const char * argument, please click the reload button to reset your code definition.
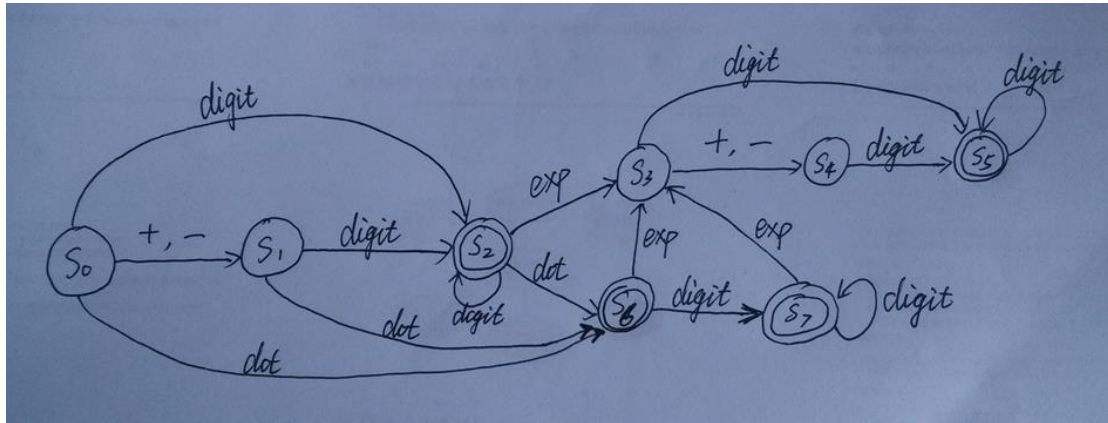
```cpp
class Solution {
public:
    bool isNumber(string str) {
        int state = 0, flag = 0;
        while (str[0]==' ')  str.erase(0,1);
        while (str.back() == ' ') str.erase(str.length()-1);
        for (auto &c : str){
            if (isdigit(c)) {
                flag = 1;
                if (state <= 2) state = 2;
                else state = (state <= 5) ? 5 : 7;
            }
            else if('+' == c || '-' == c){
                if (state == 0 || state == 3) state++;
                else return false;
            }
            else if('.' == c){
                if (state <= 2) state = 6;
                else return false;
            }
            else if('e' == c){
                if(flag && (state == 2 || state == 6 || state == 7)) state = 3;
                else return false;
            }
            else return false;
        }
        return state == 2 || state == 5 || (flag && state == 6) || state == 7;
    }
};
```

66. Plus One

Given a **non-empty** array of digits representing a non-negative integer, plus one to the integer.

The digits are stored such that the most significant digit is at the head of the list, and each element in the array contain a single digit.

You may assume the integer does not contain any leading zero, except the number 0 itself.

Example 1:

Input: [1,2,3]

Output: [1,2,4]

Explanation: The array represents the integer 123.

Example 2:

Input: [4,3,2,1]

Output: [4,3,2,2]

Explanation: The array represents the integer 4321.

```cpp
class Solution {
public:
    vector<int> plusOne(vector<int>& digits) {


    }
};
```

```cpp
class Solution {
public:
    vector<int> plusOne(vector<int>& digits) {
        int c = 1;
        for(auto i = digits.rbegin(); i != digits.rend(); i++){
            c += *i;
            *i = c % 10;
            c /= 10;
        }
        if (c) digits.insert(digits.begin(), c);
        return digits;
    }
};
```

67. Add Binary

Easy

Given two binary strings, return their sum (also a binary string).

The input strings are both **non-empty** and contains only characters 1 or 0.

Example 1:

Input: a = "11", b = "1"

Output: "100"

Example 2:

Input: a = "1010", b = "1011"

Output: "10101"

```cpp
class Solution {
public:
    string addBinary(string a, string b) {

    }
};
```

```cpp
class Solution {
public:
    string addBinary(string a, string b) {
        int c = 0;
        string res;
        reverse(a.begin(), a.end());
        reverse(b.begin(), b.end());
        auto p = a.begin(), q = b.begin();
        while (p != a.end() || q != b.end()) {
            if (p != a.end()) {
                c += *p-'0';
                p++;
            }
            if (q != b.end()) {
                c += *q-'0';
                q++;
            }
            res += c%2+'0';
            c /= 2;
        }
        if (c) res += '1';
        reverse(res.begin(), res.end());
        return res;
    }
};
```

68. Text Justification

Given an array of words and a width *maxWidth*, format the text such that each line has exactly *maxWidth* characters and is fully (left and right) justified.

You should pack your words in a greedy approach; that is, pack as many words as you can in each line. Pad extra spaces ' ' when necessary so that each line has exactly *maxWidth* characters.

Extra spaces between words should be distributed as evenly as possible. If the number of spaces on a line do not divide evenly between words, the empty slots on the left will be assigned more spaces than the slots on the right.

For the last line of text, it should be left justified and no **extra** space is inserted between words.

Note:

* A word is defined as a character sequence consisting of non-space characters only.
* Each word's length is guaranteed to be greater than 0 and not exceed *maxWidth*.
* The input array `words` contains at least one word.

Example 1:

Input:

words = ["This", "is", "an", "example", "of", "text", "justification."]

maxWidth = 16

Output:

[

  "This   is   an",

  "example   of text",

  "justification. "

]

Example 2:

Input:

words = ["What","must","be","acknowledgment","shall","be"]

maxWidth = 16

Output:

[

  "What   must   be",

  "acknowledgment   ",

  "shall be   "

]

Explanation: Note that the last line is "shall be   " instead of "shall   be",

            because the last line must be left-justified instead of fully-justified.

                Note that the second line is also left-justified becase it contains only one word.

Example 3:

Input:

words = ["Science","is","what","we","understand","well","enough","to","explain",

        "to","a","computer.","Art","is","everything","else","we","do"]

maxWidth = 20

Output:

[

  "Science is   what we",

   "understand   well",

  "enough to explain to",

  "a   computer. Art is",

  "everything else we",

  "do   "

]

```cpp
class Solution {
public:
    vector<string> fullJustify(vector<string>& words, int maxWidth) {
    }
};
```

```cpp
class Solution {
public:
    vector<string> fullJustify(vector<string>& words, int maxWidth) {
        vector<string> res, t;
        int n = words.size(), i = 0, width = 0;
        while (i < n) {
            if (width + words[i].length() <= maxWidth-t.size()) {
                width += words[i].length();
                t.push_back(words[i++]);
                continue;
            }
            string s = t[0];
            int space_num = maxWidth-width;
            if (t.size() == 1)   s += string(space_num, ' ');
            else {
                int aver = space_num / (t.size()-1);
                int k = space_num - (t.size()-1)*aver;
                for (int j = 1; j < t.size(); ++j) {
                    s += string((j <= k ? aver+1: aver), ' ') + t[j];
                }
            }
            res.push_back(s);
            t.clear();
            width = 0;
        }
        string s = t[0];
        for (int j = 1; j < t.size(); j++) s += ' ' + t[j];
        s += string(maxWidth-s.length(), ' ');
        res.push_back(s);
        return res;
    }
};
```

69. Sqrt(x)(●ˇ∀ˇ●)

Implement `int sqrt(int x)`.

Compute and return the square root of *x*, where *x* is guaranteed to be a non-negative integer.

Since the return type is an integer, the decimal digits are truncated and only the integer part of the result is returned.

Example 1:

Input: 4

Output: 2

Example 2:

Input: 8

Output: 2

Explanation: The square root of 8 is 2.82842..., and since

the decimal part is truncated, 2 is returned.

```cpp
class Solution {
public:
    int mySqrt(int x) {
        int low = 0,  high = x;
        if (x < 2) return x;
        while (low < high) {
            int mid = low + (high-low)/2;
            if (x/mid >= mid) low = mid+1;
            else high = mid;
        }
        return low-1;
    }
};
```

70. Climbing Stairs(●ˇ∀ ˇ●)

Easy

You are climbing a stair case. It takes *n* steps to reach to the top.

Each time you can either climb 1 or 2 steps. In how many distinct ways can you climb to the top?

Note: Given *n* will be a positive integer.

Example 1:

Input: 2

Output: 2

Explanation: There are two ways to climb to the top.

1. 1 step + 1 step

2. 2 steps

Example 2:

Input: 3

Output: 3

Explanation: There are three ways to climb to the top.

1. 1 step + 1 step + 1 step

2. 1 step + 2 steps

3. 2 steps + 1 step

```cpp
class Solution {
public:
    int climbStairs(int n) {

    }
};
```

```cpp
class Solution {
public:
    struct Matrix{
        int a[2][2] = {0};
        void init() {
            for (int i = 0; i < 2; i++)
                a[i][i] = 1;
        }
    };

    Matrix MUL(Matrix A, Matrix B){
        Matrix C;
        for (int i = 0; i < 2; i++) {
            for (int j = 0; j < 2; j++) {
                for (int k = 0; k < 2; k++) {
                    C.a[i][j] += A.a[i][k]*B.a[k][j];
                }
            }
        }
        return C;
    }


    int climbStairs(int n) {
        if (n == 1) return 1;
        if (n == 2) return 2;
        Matrix res, x;
        x.a[0][0] = x.a[0][1] = x.a[1][0] = 1;
        x.a[1][1] = 0;
        res.init();
        while (n) {
            if (n&1) res = MUL(res, x);
            x = MUL(x, x);
            n >>= 1;
        }
        return res.a[0][1]+res.a[1][1];
    }
};
```

71. Simplify Path

Given an **absolute path** for a file (Unix-style), simplify it. Or in other words, convert it to the **canonical path**.

In a UNIX-style file system, a period `.` refers to the current directory. Furthermore, a double period `..` moves the directory up a level. For more information, see: Absolute path vs relative path in Linux/Unix

Note that the returned canonical path must always begin with a slash `/`, and there must be only a single slash `/` between two directory names. The last directory name (if it exists) **must not** end with a trailing `/`. Also, the canonical path must be the **shortest** string representing the absolute path.

Example 1:

Input: "/home/"

Output: "/home"

Explanation: Note that there is no trailing slash after the last directory name.

Example 2:

Input: "/../"

Output: "/"

Explanation: Going one level up from the root directory is a no-op, as the root level is the highest level you can go.

Example 3:

Input: "/home//foo/"

Output: "/home/foo"

Explanation: In the canonical path, multiple consecutive slashes are replaced by a single one.

Example 4:

Input: "/a/./b/../../c/"

Output: "/c"

Example 5:

Input: "/a/../../b/../c//.//"

Output: "/c"

Example 6:

Input: "/a//b////c/d//.//..//.."

Output: "/a/b/c"

```cpp
class Solution {
public:
    string simplifyPath(string path) {

    }
};
```

```cpp
class Solution {
public:
    string simplifyPath(string path) {
        string res, tmp;
        vector<string> stk;
        stringstream ss(path);
        while (getline(ss, tmp,'/')) {
        //getline(istream &is, string &str, char delim);  delim终止符
            if (tmp == "" || tmp == ".") continue;
            else if (tmp == ".." && !stk.empty()) stk.pop_back();
            else if (tmp != "..") stk.push_back(tmp);
        }
        for (auto &str : stk) res += '/' + str;
        return res.empty() ? "/" : res;
    }
};
```

72. Edit Distance(●ˇ∀ˇ●)

Given two words *word1* and *word2*, find the minimum number of operations required to convert *word1* to *word2*.

You have the following 3 operations permitted on a word:

1. Insert a character
2. Delete a character
3. Replace a character

Example 1:

Input: word1 = "horse", word2 = "ros"

Output: 3

Explanation:

horse -> rorse (replace 'h' with 'r')

rorse -> rose (remove 'r')

rose -> ros (remove 'e')

Example 2:

Input: word1 = "intention", word2 = "execution"

Output: 5

Explanation:

intention -> inention (remove 't')

inention -> enention (replace 'i' with 'e')

enention -> exention (replace 'n' with 'x')

exention -> exection (replace 'n' with 'c')

exection -> execution (insert 'u')

```cpp
class Solution {
public:
    int minDistance(string word1, string word2) {
        int m = word1.size(), n = word2.size();
        vector<vector<int>> dp(2, vector<int>(n+1));
        int k = 0;
        for (int i = 0; i <= m; i++) {
            for (int j = 0; j <= n; j++) {
                if (i == 0) dp[k][j] = j;
                else if (j == 0) dp[k][j] = i;
                else if (word1[i-1] == word2[j-1]) dp[k][j] = dp[k^1][j-1];
                else  dp[k][j] = 1 + min(dp[k^1][j-1],
                                    min(dp[k][j-1], dp[k^1][j]));
            }
            k ^= 1;
        }
        return dp[k^1][n];
    }
};
```

73. Set Matrix Zeroes(●˘∀˘●)

Given a *m* x *n* matrix, if an element is 0, set its entire row and column to 0. Do it **in-place**.

Example 1:

Input:

[

  [1,1,1],

  [1,0,1],

  [1,1,1]

]

Output:

[

  [1,0,1],

  [0,0,0],

  [1,0,1]

]

Example 2:

Input:

[

  [0,1,2,0],

  [3,4,5,2],

  [1,3,1,5]

]

Output:

[

  [0,0,0,0],

  [0,4,5,0],

[0,3,1,0]

]

Follow up:

- A straight forward solution using O(*mn*) space is probably a bad idea.
- A simple improvement uses O(*m* + *n*) space, but still not the best solution.
- Could you devise a constant space solution?

```cpp
class Solution {
public:
    void setZeroes(vector<vector<int>>& matrix) {

    }
};
```

```cpp
class Solution {
public:
    void setZeroes(vector<vector<int>>& matrix) {
        if (matrix.empty()) return;
        bool Row_Zero = false, Col_Zero = false;
        int N = matrix.size(), M = matrix[0].size();
        for (int i = 0; i < N; i++) {
            for (int j = 0; j < M; j++) {
                if (!i && !matrix[i][j]) Row_Zero = true;
                if (!j && !matrix[i][j]) Col_Zero = true;
                if (!matrix[i][j])  matrix[i][0] = matrix[0][j] = 0;
            }
        }

        for (int i = 1; i < N; i++) {
            for (int j = 1; j < M; j++) {
                if (!matrix[i][0] || !matrix[0][j])
                    matrix[i][j] = 0;
            }
        }

        if (Row_Zero){
            for (int j = 0; j < M; j++) matrix[0][j] = 0;
        }
        if (Col_Zero){
            for (int i = 0; i < N; i++) matrix[i][0] = 0;
        }
    }
};
```

74. Search a 2D Matrix

Write an efficient algorithm that searches for a value in an *m* x *n* matrix. This matrix has the following properties:

- Integers in each row are sorted from left to right.
- The first integer of each row is greater than the last integer of the previous row.

Example 1:

Input:

matrix = [

  [1,   3,   5,   7],

  [10, 11, 16, 20],

  [23, 30, 34, 50]

]

target = 3

Output: true

Example 2:

Input:

matrix = [

  [1,   3,   5,   7],

  [10, 11, 16, 20],

  [23, 30, 34, 50]

]

target = 13

Output: false

```cpp
class Solution {
public:
    bool searchMatrix(vector<vector<int>>& matrix, int target) {
        if (matrix.empty()) return false;
        int n = matrix.size(), m  = matrix[0].size();
        int l = 0, r = m*n;
        while (l < r) {
            int mid = l + (r-l)/2;
            int v = matrix[mid/m][mid%m];
            if (v == target) return true;
            else if (v < target) l = mid+1;
            else  r = mid;
        }
        return false;
    }
};
```

75. Sort Colors(❤ ω ❤)

Given an array with *n* objects colored red, white or blue, sort them **in-place** so that objects of the same color are adjacent, with the colors in the order red, white and blue.

Here, we will use the integers 0, 1, and 2 to represent the color red, white, and blue respectively.

Note: You are not suppose to use the library's sort function for this problem.

Example:

Input: [2,0,2,1,1,0]

Output: [0,0,1,1,2,2]

Follow up:

* A rather straight forward solution is a two-pass algorithm using counting sort.
  First, iterate the array counting number of 0's, 1's, and 2's, then overwrite array with total number of 0's, then 1's and followed by 2's.
* Could you come up with a one-pass algorithm using only constant space?

```cpp
class Solution {
public:
    void sortColors(vector<int>& nums) {

    }
};
```

```cpp
class Solution {
public:
    void sortColors(vector<int>& nums) {
        int red = 0, blue = nums.size()-1, i = 0;
        while (i <= blue) {
            if (nums[i] == 0)  swap(nums[i++], nums[red++]);
            else if (nums[i] == 2)  swap(nums[i], nums[blue--]);
            else  i++;
        }
    }
};
```

76. Minimum Window Substring(●˘∀˘●)

Given a string S and a string T, find the minimum window in S which will contain all the characters in T in complexity O(n).

Example:

Input: S = "ADOBECODEBANC", **T** = "ABC"

Output: "BANC"

Note:

- If there is no such window in S that covers all characters in T, return the empty string `" "`.
- If there is such window, you are guaranteed that there will always be only one unique minimum window in S.

```cpp
class Solution {
public:
    string minWindow(string s, string t) {

    }
};
```

```cpp
class Solution {
public:
    string minWindow(string s, string t) {
        string res;
        vector<int> tab(256, 0), window(256,0);
        for(char &c: t) ++tab[c];

        int st = 0, cur = 0;
        int minlen = INT_MAX, nums = 0;

        while (1) {
            while (cur < s.length() && nums < t.length()){
                int idx = s[cur++];
                if (tab[idx] > 0 && window[idx]++ < tab[idx])  ++nums;
            }
            if (nums < t.length()) break;
            if (minlen > cur - st) {
                res = s.substr(st, cur-st);
                minlen = res.length();
            }
            int idx = s[st++];
            if (tab[idx] > 0 && --window[idx] < tab[idx]) --nums;
        }
        return res;
    }
};
```

77. Combinations

Given two integers *n* and *k*, return all possible combinations of *k* numbers out of 1 ... *n*.

Example:

Input: n = 4, k = 2

Output:

[

  [2,4],

  [3,4],

  [2,3],

  [1,2],

  [1,3],

  [1,4],

]

```cpp
class Solution {
public:
    vector<vector<int>> res;


    }
};
```

```cpp
class Solution {
public:
    vector<vector<int>> res;
    vector<vector<int>> combine(int n, int k) {
        vector<int> v;
        dfs(0, k, 1, n, v);
        return res;
    }
private:
    void dfs(int cur, int k, int start, int n, vector<int> &v) {
        if (cur == k) {
            res.push_back(v);
            return;
        }
        for (int i = start; i <= n; i++) {
            v.push_back(i);
            dfs(cur+1, k, i+1, n, v);
            v.pop_back();
        }
    }
};
```

78. Subsets

Given a set of **distinct** integers, *nums*, return all possible subsets (the power set).

Note: The solution set must not contain duplicate subsets.

Example:

Input: nums = [1,2,3]

Output:

```
[
  [3],
  [1],
  [2],
  [1,2,3],
  [1,3],
  [2,3],
  [1,2],
  []
]
```

```cpp
class Solution {
public:
    vector<vector<int>> subsets(vector<int>& nums) {


    }
};
```

```cpp
class Solution {
public:
    vector<vector<int>> res;
    vector<vector<int>> subsets(vector<int>& nums) {
        vector<int> v;
        dfs(0, nums, v);
        return res;
    }
private:
    void dfs(int cur, vector<int> &nums, vector<int> &v) {
        if (cur == nums.size()) {
            res.push_back(v);
            return;
        }
        v.push_back(nums[cur]);
        dfs(cur+1, nums, v);
        v.pop_back();
        dfs(cur+1, nums, v);
    }
};
```

```cpp
class Solution {
public:
    vector<vector<int>> res;
    vector<vector<int>> subsets(vector<int>& nums) {
        vector<int> v;
        dfs(0, nums, v);
        return res;
    }

private:
    void dfs(int start, vector<int> &nums, vector<int> &v) {
        res.push_back(v);
        for (int i = start; i < nums.size(); i++) {
            v.push_back(nums[i]);
            dfs(i+1, nums, v);
            v.pop_back();
        }
    }
};
```

```cpp
class Solution {
public:
    vector<vector<int>> subsets(vector<int>& nums) {
        int n = nums.size();
        vector<vector<int>> res;
        for (int i = 0; i < (1<<n) ; i++) {
            vector<int> v;
            for (int j = 0; j < n; j++) {
                if (i & (1<<j)) v.push_back(nums[j]);
            }
            res.push_back(v);
        }
        return res;
    }
};
```

```cpp
class Solution {
public:
    vector<vector<int>> subsets(vector<int>& nums) {
        int n = nums.size();
        vector<vector<int>> res{{}};
        for(auto &x : nums){
            res.reserve(res.size()*2);
            auto half = res.begin()+res.size();  // auto half = res.end();
            copy(res.begin(), res.end(), back_inserter(res));
            for_each(res.begin(), half, [&x](decltype(res[0]) &v){
                v.push_back(x);
            });
            /*int sz = res.size();
            for(int i = 0; i < sz; i++) {
                res.push_back(res[i]);
                res.back().push_back(x);
            }*/
        }
        return res;
    }
};
```

79. Word Search

Given a 2D board and a word, find if the word exists in the grid.

The word can be constructed from letters of sequentially adjacent cell, where "adjacent" cells are those horizontally or vertically neighboring. The same letter cell may not be used more than once.

Example:

```
board =

[

  ['A','B','C','E'],

  ['S','F','C','S'],

  ['A','D','E','E']

]


Given word = "ABCCED", return true.

Given word = "SEE", return true.

Given word = "ABCB", return false.
```

```cpp
class Solution {
public:
    bool exist(vector<vector<char>>& board, string word) {


    }
};
```

```cpp
class Solution {
public:
    bool exist(vector<vector<char>>& board, string word) {
        n = board.size();
        m = board[0].size();
        visited.resize(n, vector<bool>(m, false));
        for (int i = 0; i < n; i++) {
            for (int j = 0; j < m; j++) {
                if (dfs(i, j, 0, word, board))
                    return true;
            }
        }
        return false;
    }


private:
    int n, m;
    vector<vector<bool>> visited;
    bool dfs(int i, int j, int cnt, string &s, vector<vector<char>>& board) {
        if(cnt == s.length()) return true;
        if (i < 0 || j < 0 || i >= n || j >= m) return false;
        else if (visited[i][j] || board[i][j] != s[cnt++]) return false;
        visited[i][j] = true;
        bool ret =   dfs(i-1, j, cnt, s, board)
                  || dfs(i+1, j, cnt, s, board)
                  || dfs(i, j-1, cnt, s, board)
                  || dfs(i, j+1, cnt, s, board);
        visited[i][j] = false;
        return ret;
    }
};
```

80. Remove Duplicates from Sorted Array II

Given a sorted array *nums*, remove the duplicates **in-place** such that duplicates appeared at most *twice* and return the new length.

Do not allocate extra space for another array, you must do this by **modifying the input array in-place** with O(1) extra memory.

Example 1:

Given *nums* = **[1,1,1,2,2,3]**,

Your function should return length = **5**, with the first five elements of *nums* being **1, 1, 2, 2** and **3** respectively.

It doesn't matter what you leave beyond the returned length.

Example 2:

Given *nums* = **[0,0,1,1,1,1,2,3,3]**,

Your function should return length = **7**, with the first seven elements of *nums* being modified to **0, 0, 1, 1, 2, 3** and **3** respectively.

It doesn't matter what values are set beyond the returned length.

Clarification:

Confused why the returned value is an integer but your answer is an array?

Note that the input array is passed in by **reference**, which means modification to the input array will be known to the caller as well.

Internally you can think of this:

```cpp
class Solution {
public:
    int removeDuplicates(vector<int>& nums) {


    }
};
```

```cpp
class Solution {
public:
    int removeDuplicates(vector<int>& nums) {
        if (nums.size() <= 2) return nums.size();
        int index = 2, n = nums.size();
        for (int i = 2; i < n; i++){
            if (nums[index-2] != nums[i]) {
                nums[index++] = nums[i];
            }
        }
        return index;
    }
};
```

81. Search in Rotated Sorted Array II(●ˇ∀ ˇ●)

Suppose an array sorted in ascending order is rotated at some pivot unknown to you beforehand.

(i.e., `[0,0,1,2,2,5,6]` might become `[2,5,6,0,0,1,2]`).

You are given a target value to search. If found in the array return `true`, otherwise return `false`.

Example 1:

Input: nums = [2,5,6,0,0,1,2], target = 0

Output: true

Example 2:

Input: nums = [2,5,6,0,0,1,2], target = 3

Output: false

Follow up:

- This is a follow up problem to <u>Search in Rotated Sorted Array</u>, where `nums` may contain duplicates.
- Would this affect the run-time complexity? How and why?

```cpp
class Solution {
public:
    bool search(vector<int>& nums, int target) {


    }
};
```

```cpp
class Solution {
public:
    bool search(vector<int>& nums, int target) {
        int l = 0, r = nums.size()-1;
        while (l <= r) {
            int mid = l + (r-l)/2;
            if (nums[mid] == target)  return true;
            if (nums[mid] < nums[r]) {
                if (nums[mid] < target && target <= nums[r])  l = mid + 1;
                else  r = mid - 1;
            } else if (nums[mid] > nums[r]) {
                if (nums[l] <= target && target < nums[mid])  r = mid - 1;
                else  l = mid+1;
            } else r--;
        }
        return false;
    }
};
```

```cpp
class Solution {
public:
    bool search(vector<int>& nums, int target) {
        int l = 0, r = nums.size()-1;
        while (l <= r) {
            int mid = l + (r-l)/2;
```

82. Remove Duplicates from Sorted List II

Given a sorted linked list, delete all nodes that have duplicate numbers, leaving only *distinct* numbers from the original list.

Example 1:

Input: 1->2->3->3->4->4->5

Output: 1->2->5

Example 2:

Input: 1->1->1->2->3

Output: 2->3

```cpp
class Solution {
public:
    ListNode* deleteDuplicates(ListNode* head) {

    }
};
```

```cpp
class Solution {
public:
    ListNode* deleteDuplicates(ListNode* head) {
        ListNode *dummy = new ListNode(-1);
        dummy->next = head;
        head = dummy;
        ListNode *p = dummy, *q = dummy->next;

        while (q) {
            bool duplicated = false;
            while (q->next && p->next->val == q->next->val) {
                duplicated = true;
                q = q->next;
            }
            if (!duplicated) {head->next = q; head = q;}
            p = q;
            q = q->next;
        }
        head->next = nullptr;
        return dummy->next;
    }
};
```

```cpp
/////////////////////递归/////////////////////////////////////////////

class Solution {
public:
    ListNode* deleteDuplicates(ListNode* head) {
        if (head == nullptr || head->next == nullptr) return head;
        ListNode *p = head->next;
        if (head->val == p->val) {
            while (p && head->val == p->val) {
                ListNode *t = p;
                p = p->next;
                delete(t);
            }
            delete(head);
            return deleteDuplicates(p);
        } else {
            head->next = deleteDuplicates(p);
            return head;
        }
    }
};
```

83. Remove Duplicates from Sorted List

Easy

Given a sorted linked list, delete all duplicates such that each element appear only *once*.

Example 1:

Input: 1->1->2

Output: 1->2

Example 2:

Input: 1->1->2->3->3

Output: 1->2->3

```cpp
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     ListNode *next;
 *     ListNode(int x) : val(x), next(NULL) {}
 * };
 */
class Solution {
public:
    ListNode* deleteDuplicates(ListNode* head) {


    }
};
```

```cpp
class Solution {
public:
    ListNode* deleteDuplicates(ListNode* head) {
        if (!head) return head;
        ListNode *p = head, *q = p->next;
        while (q) {
            if (q->val != p->val) {
                p->next = q;
                p = q;
            }
            q = q->next;
        }
        p->next = nullptr;
        return head;
    }
};
```
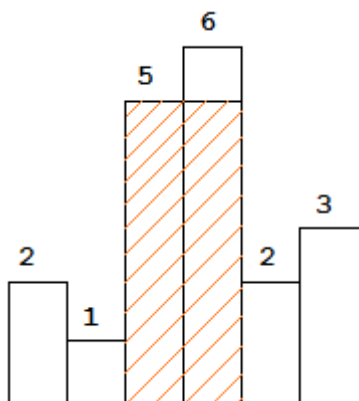
84. Largest Rectangle in Histogram

Given *n* non-negative integers representing the histogram's bar height where the width of each bar is 1, find the area of largest rectangle in the histogram.
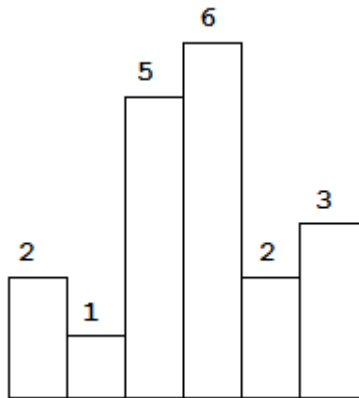
Above is a histogram where width of each bar is 1, given height = `[2,1,5,6,2,3]`.

The largest rectangle is shown in the shaded area, which has area = `10` unit.

Example:

Input: [2,1,5,6,2,3]

Output: 10

```cpp
class Solution {
public:
    int largestRectangleArea(vector<int>& heights) {

    }
};
```

```cpp
class Solution {
public:
    int largestRectangleArea(vector<int>& heights) {
        stack<int> stk;
        heights.push_back(0);
        int res = 0, n = heights.size();
        for (int i = 0; i < n; i++) {
            while (!stk.empty() && heights[i] <= heights[stk.top()]) {
                int h = heights[stk.top()];
                stk.pop();
                res = max(res,
                        h*(stk.empty() ? i : i-stk.top()-1));
            }
            stk.push(i);
        }
        return res;
    }
};
```

85. Maximal Rectangle(●ˇ∀ˇ●)

Hard

Given a 2D binary matrix filled with 0's and 1's, find the largest rectangle containing only 1's and return its area.

Example:

Input:

[

  ["1","0","1","0","0"],

  ["1","0","**1**","**1**","**1**"],

  ["1","1","**1**","**1**","**1**"],

  ["1","0","0","1","0"]

]

Output: 6

```cpp
class Solution {
public:
    int maximalRectangle(vector<vector<char>>& matrix) {


    }
};
```

```cpp
class Solution {
public:
    int maximalRectangle(vector<vector<char>>& matrix) {
        if (matrix.empty()) return 0;
        int res = 0, n = matrix[0].size(), m = matrix.size();
        vector<int> v(n+1,0);
        for (auto &u : matrix) {
            for (int j = 0; j < n; j++) {
                if (u[j] == '1') v[j]++;
                else v[j] = 0;
            }
            res = max(res, largestRectangleArea(v));
        }
        return res;
    }

private:
    int largestRectangleArea(vector<int>& heights) {
        stack<int> stk;
        int res = 0, n = heights.size();
        for (int i = 0; i < n; i++) {
            while (!stk.empty() && heights[i] <= heights[stk.top()]) {
                int h = heights[stk.top()];
                stk.pop();
                res = max(res,
                        h*(stk.empty() ? i : i-stk.top()-1));
            }
            stk.push(i);
        }
        return res;
    }
};
```

86. Partition List

Medium

Given a linked list and a value x, partition it such that all nodes less than x come before nodes greater than or equal to x.

You should preserve the original relative order of the nodes in each of the two partitions.

Example:

Input: head = 1->4->3->2->5->2, x = 3

Output: 1->2->2->4->3->5

```cpp
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     ListNode *next;
 *     ListNode(int x) : val(x), next(NULL) {}
 * };
 */
class Solution {
public:
    ListNode* partition(ListNode* head, int x) {

    }
};
```

```cpp
class Solution {
public:
    ListNode* partition(ListNode* head, int x) {
        ListNode *L_dummy = new ListNode(-1), *R_dummy = new ListNode(-1);
        ListNode *l = L_dummy, *r = R_dummy, *p = head;
        while (p) {
            if (p->val < x) {
                l->next = p;
                l = p;
            } else {
                r->next = p;
                r = p;
            }
            p = p->next;
        }
        l->next = R_dummy->next;
        r->next = NULL;
        return L_dummy->next;
    }
};
```
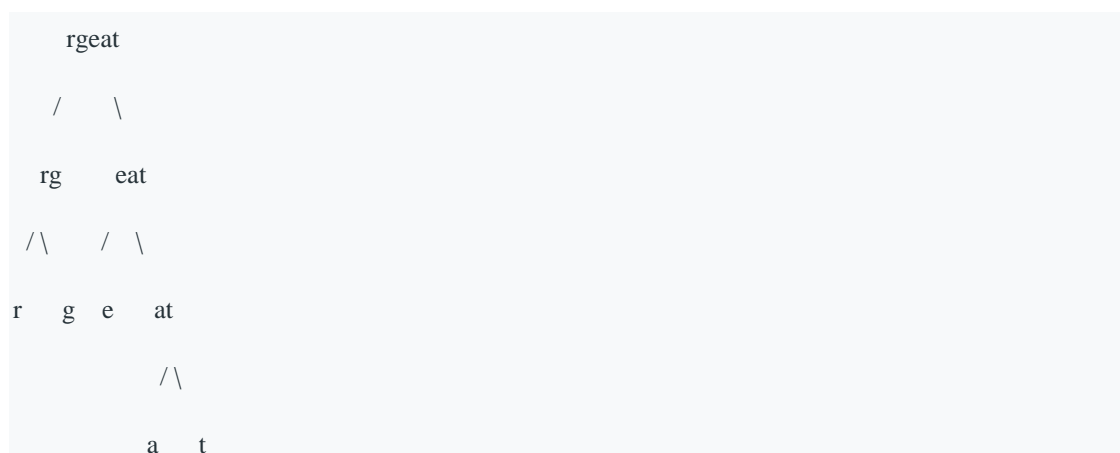
87. Scramble String

Given a string *s1*, we may represent it as a binary tree by partitioning it to two non-empty substrings recursively.

Below is one possible representation of *s1* = `"great"`:

```
    great
   /    \
  gr     eat
 /\     /  \
g  r   e    at
            /\
           a  t
```
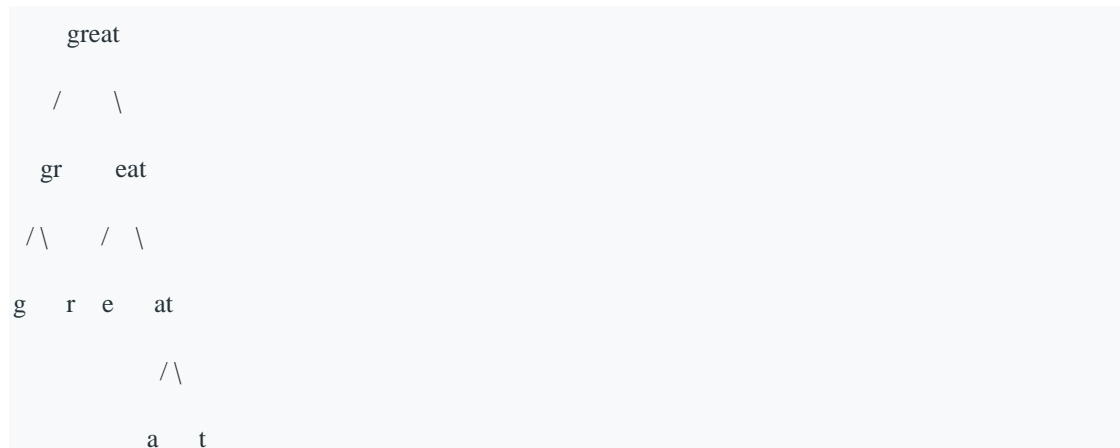
To scramble the string, we may choose any non-leaf node and swap its two children.

For example, if we choose the node `"gr"` and swap its two children, it produces a scrambled string `"rgeat"`.

```
    rgeat
   /    \
  rg     eat
 /\     /  \
r  g   e    at
            /\
           a  t
```

We say that `"rgeat"` is a scrambled string of `"great"`.

Similarly, if we continue to swap the children of nodes `"eat"` and `"at"`, it produces a scrambled string `"rgtae"`.

```
    rgtae
   /    \
  rg     tae
```
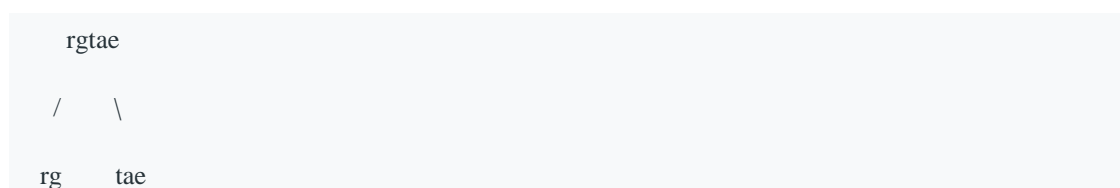
```
 /\     /  \

r   g   ta  e

      /\

     t   a
```

We say that `"rgtae"` is a scrambled string of `"great"`.

Given two strings *s1* and *s2* of the same length, determine if *s2* is a scrambled string of *s1*.

Example 1:

Input: s1 = "great", s2 = "rgeat"

Output: true

Example 2:

Input: s1 = "abcde", s2 = "caebd"

Output: false

```cpp
class Solution{
public:
    bool isScramble(string s1, string s2) {
        if (s1.length() != s2.length()) return false;
        int len = s1.length();
        vector<vector<vector<bool>>> dp
        dp.resize(len, vector<vector<bool>>(len,vector<bool>(len+1, false)));
        for (size_t i = 0; i < len; ++i) {
            for (size_t j = 0; j < len; ++j) {
                dp[i][j][1] = (s1[i] == s2[j]);
            }
        }

        for (int subLen = 2; subLen <= len; ++subLen) {
            int len0 = len - subLen;
            for (int i = 0; i <= len0; ++i) {
                for (int j = 0; j <= len0; ++j) {
                    for (int k = 0; k < subLen-1 && !dp[i][j][subLen]; ++k){
                        int len1 = k + 1, len2 = subLen - len1;
                        dp[i][j][subLen] =      (dp[i][j][len1]
                                                && dp[i + len1][j + len1][len2])
                                            || (dp[i][j + len2][len1]
                                                && dp[i + len1][j][len2]);
                    }
                }
            }
        }
        return dp[0][0][len];
    }
};
```

```cpp
class Solution {
public:
    bool isScramble(string s1, string s2) {
        if (s1 == s2) return true;

        int len = s1.length();
        int cnt[26] = {0};
        for(int i = 0; i < len; i++) {
            cnt[s1[i]-'a']++;
            cnt[s2[i]-'a']--;
        }

        for (int i : cnt) {
            if (i != 0)
                return false;
        }

        for(int i = 1; i < len; i++) {
            if (isScramble(s1.substr(0,i), s2.substr(0,i))
                && isScramble(s1.substr(i), s2.substr(i)))
                return true;
            if (isScramble(s1.substr(0,i), s2.substr(len-i))
                && isScramble(s1.substr(i), s2.substr(0,len-i)))
                return true;
        }
        return false;
    }
};
```

88. Merge Sorted Array

Given two sorted integer arrays *nums1* and *nums2*, merge *nums2* into *nums1* as one sorted array.

Note:

- The number of elements initialized in *nums1* and *nums2* are *m* and *n* respectively.
- You may assume that *nums1* has enough space (size that is greater or equal to *m* + *n*) to hold additional elements from *nums2*.

Example:

Input:

nums1 = [1,2,3,0,0,0], m = 3

nums2 = [2,5,6],   n = 3

Output: [1,2,2,3,5,6]

```cpp
class Solution {
public:
    void merge(vector<int>& nums1, int m, vector<int>& nums2, int n) {


    }
};
```

```cpp
class Solution {
public:
    void merge(vector<int>& nums1, int m, vector<int>& nums2, int n) {
        int t = m+n-1, p = m-1, q = n-1;
        while (p >= 0 || q >= 0) {
            if (p >= 0 && q >= 0) {
                if (nums1[p] > nums2[q]) nums1[t--] = nums1[p--];
                else nums1[t--] = nums2[q--];
            }
            else if (q >= 0) {
                while (q >= 0) nums1[t--] = nums2[q--];
            }
            else break;
        }
    }
};
```

89. Gray Code(●ˇ∀ˇ●)

The gray code is a binary numeral system where two successive values differ in only one bit.

Given a non-negative integer *n* representing the total number of bits in the code, print the sequence of gray code. A gray code sequence must begin with 0.

Example 1:

Input: 2

Output: [0,1,3,2]

Explanation:

00 - 0

01 - 1

11 - 3

10 - 2

For a given *n*, a gray code sequence may not be uniquely defined.

For example, [0,2,3,1] is also a valid gray code sequence.

00 - 0

10 - 2

11 - 3

01 - 1

Example 2:

Input: 0

Output: [0]

Explanation: We define the gray code sequence to begin with 0.

A gray code sequence of *n* has size = 2^n, which for *n* = 0 the size is $2^0 = 1$.

Therefore, for *n* = 0 the gray code sequence is [0].

```cpp
class Solution {
public:
    vector<int> grayCode(int n) {
        vector<int> res{0};
        if (n == 0) return res;
        for (int i = 0; i < n; i++) {
            int bit = 1<<i;
            for(int j = res.size()-1; j >= 0; j--)
                res.push_back(res[j] | bit);
        }
        return res;
    }
};
```

90. Subsets II(●ˇ∀ˇ●)

Given a collection of integers that might contain duplicates, *nums*, return all possible subsets (the power set).

Note: The solution set must not contain duplicate subsets.

Example:

Input: [1,2,2]

Output:

```
[
  [2],
  [1],
  [1,2,2],
  [2,2],
  [1,2],
  []
]
```

```cpp
class Solution {
public:
    vector<vector<int>> subsetsWithDup(vector<int>& nums) {

    }
};
```

```cpp
class Solution {
public:
    vector<vector<int>> res;
    vector<vector<int>> subsetsWithDup(vector<int>& nums) {
        sort(nums.begin(), nums.end());                //不同之处1
        vector<int> v;
        dfs(0, nums, v);
        return res;
    }

private:
    void dfs(int start, vector<int> &nums, vector<int> &v) {
        res.push_back(v);
        for (int i = start; i < nums.size(); i++) {
            if (i != start && nums[i] == nums[i-1]) continue;//不同之处2
            v.push_back(nums[i]);
            dfs(i+1, nums, v);
            v.pop_back();
        }
    }
};
```

```cpp
class Solution {
public:
    vector<vector<int>> res;
    vector<vector<int>> subsetsWithDup(vector<int>& nums) {
        unordered_map<int, int> My_map;
        for (auto &i : nums) My_map[i]++;
        vector<pair<int, int>> Nums;
        for (auto &i : My_map) Nums.push_back({i.first, i.second});
        vector<int> v;
        dfs(0, Nums, v);
        return res;
    }
private:
    void dfs(int cur, vector<pair<int, int>> &Nums, vector<int> &v) {
        if (cur == Nums.size()) {
            res.push_back(v);
            return;
        }
        int x = Nums[cur].first, n = Nums[cur].second;
        for(int i = 0; i <= n; i++) {
            for (int j = 0; j < i; j++) v.push_back(x);
            dfs(cur+1, Nums, v);
            for (int j = 0; j < i; j++) v.pop_back();
        }
    }
};
```

91. Decode Ways

A message containing letters from `A-Z` is being encoded to numbers using the following mapping:

'A' -> 1

'B' -> 2

...

'Z' -> 26

Given a **non-empty** string containing only digits, determine the total number of ways to decode it.

Example 1:

Input: "12"

Output: 2

Explanation: It could be decoded as "AB" (1 2) or "L" (12).

Example 2:

Input: "226"

Output: 3

Explanation: It could be decoded as "BZ" (2 26), "VF" (22 6), or "BBF" (2 2 6).

```cpp
class Solution {
public:
    int numDecodings(string s) {

    }
};
```

```cpp
class Solution {
public:
    int numDecodings(string s) {
        int f_0 = 0, f_1 = 1, n = s.size();
        for (int i = 0; i < n; i++) {
            int f_2 = s[i] == '0' ? 0 : f_1;
            if (!i && (s[i-1]=='1' || s[i-1]=='2' && s[i]<'7')) f_2 += f_0;
            f_0 = f_1;
            f_1 = f_2;
        }
        return f_1;
    }
};
```

92. Reverse Linked List II

Reverse a linked list from position *m* to *n*. Do it in one-pass.

Note: $1 \le m \le n \le$ length of list.

Example:

Input: 1->2->3->4->5->NULL, *m* = 2, *n* = 4

Output: 1->4->3->2->5->NULL

```cpp
class Solution {
public:
    ListNode* reverseBetween(ListNode* head, int m, int n) {


    }
};
```

```cpp
class Solution {
public:
    ListNode* reverseBetween(ListNode* head, int m, int n) {
        ListNode *dummy = new ListNode(-1), *post, *cur, *last;
        dummy->next = head;
        head = dummy;
        for (int i = 0; i < m-1; i++) head = head->next;
        last = cur = head->next;
        for (int i = m; i <= n; i++) {
            post = cur->next;
            cur->next = head->next;
            head->next = cur;
            cur = post;
        }
        last->next = cur;
        return dummy->next;
    }
};
```

93. Restore IP Addresses

Given a string containing only digits, restore it by returning all possible valid IP address combinations.

Example:

Input: "25525511135"

Output: ["255.255.11.135", "255.255.111.35"]

```cpp
class Solution {
public:
    vector<string> restoreIpAddresses(string s) {


    }
};
```

```cpp
class Solution {
public:
    vector<string> restoreIpAddresses(string s) {
        vector<string> res;
        string t;
        dfs(0, s , t, 4, res);
        return res;
    }
private:
    void dfs(int cur, string &s, string t, int cnt, vector<string> &res) {
        if (cnt == 1) {
            string a = s.substr(cur);
            if (a.length() > 3 || (a[0] == '0' && a != "0")) return;
            if (stoi(a) < 256)   res.push_back(t + a);
        }
        else for(int k = 1; k <= 3 && cur+k < s.length(); k++) {
            string a = s.substr(cur, k);
            if (k != 3 || stoi(a) < 256)  dfs(cur+k, s, t+a+'.', cnt-1, res);
            if (a[0] == '0') break;
        }
    }
};
```

94. Binary Tree Inorder Traversal(●ˇ∀ˇ●)

Medium

Given a binary tree, return the *inorder* traversal of its nodes' values.

Example:

Input: [1,null,2,3]

```
   1

    \

      2

     /

   3
```

Output: [1,3,2]

Follow up: Recursive solution is trivial, could you do it iteratively?

```cpp
class Solution {
public:
    vector<int> inorderTraversal(TreeNode* root) {


    }
};
```

```cpp
class Solution {
public:
    vector<int> inorderTraversal(TreeNode* root) {
        vector<int> res;
        stack<TreeNode*> stk;
        TreeNode *p = root;
        while (!stk.empty() || p) {
            while (p) {
                stk.push(p);
                p = p->left;
            }
            p = stk.top();
            stk.pop();
            res.push_back(p->val);
            p = p->right;
        }
        return res;
    }
};
```

95. Unique Binary Search Trees II(●ˇ∀ ˇ●)

Medium

Given an integer *n*, generate all structurally unique **BST's** (binary search trees) that store values 1 ... *n*.

Example:

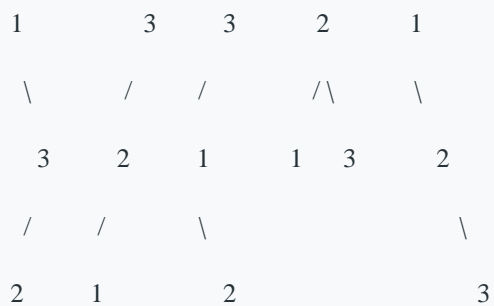**Input:** 3

Output:

[

  [1,null,3,2],

  [3,2,null,1],

  [3,1,null,null,2],

  [2,1,3],

  [1,null,2,null,3]

]

Explanation:

The above output corresponds to the 5 unique BST's shown below:

```
   1         3     3      2      1
    \       /     /      / \      \
     3     2     1      1   3      2
    /     /       \                 \
   2     1         2                 3
```

```cpp
/**
 * Definition for a binary tree node.
 * struct TreeNode {
 *     int val;
 *     TreeNode *left;
 *     TreeNode *right;
 *     TreeNode(int x) : val(x), left(NULL), right(NULL) {}
 * };
 */


class Solution {
public:
    vector<TreeNode*> generateTrees(int n) {
        if (n == 0) return vector<TreeNode*> ();
        dp.resize(n+1, vector<vector<TreeNode*>> (n+1));
        return generateTrees(1, n);
    }

private:
    vector<vector<vector<TreeNode*>>>dp;

    vector<TreeNode*> generateTrees(int start, int end) {
        vector<TreeNode*> subTree;
        if (start > end)  {
            subTree.push_back(nullptr);
            return subTree;
        }
        else if (!dp[start][end].empty()) return dp[start][end];
        else for (int k = start; k <= end; ++k) {
            vector<TreeNode*> leftsubTree = generateTrees(start, k-1);
            vector<TreeNode*> rightsubTree = generateTrees(k+1, end);
            for (auto &i : leftsubTree) {
                for (auto &j : rightsubTree) {
                    TreeNode *t = new TreeNode(k);
                    t->left = i;
                    t->right = j;
                    subTree.push_back(t);
                }
            }
        }
        return dp[start][end] = subTree;
    }
};
```

96. Unique Binary Search Trees

Given *n*, how many structurally unique **BST's** (binary search trees) that store values 1 ... *n*?
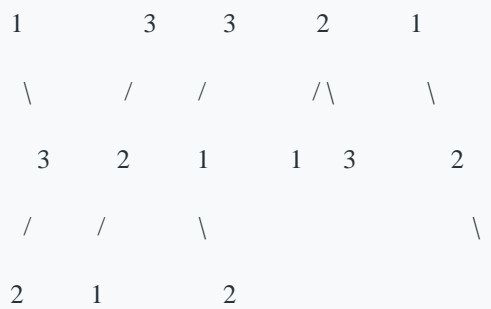
Example:

Input: 3

Output: 5

Explanation:

Given *n* = 3, there are a total of 5 unique BST's:

```
   1         3     3      2      1

    \       /     /      /\       \

     3     2     1      1  3       2

    /     /       \                 \

   2     1         2                 3
```

```cpp
class Solution {
public:
    int numTrees(int n) {

    }
};
```

```cpp
class Solution {
public:
    int numTrees(int n) {
        vector<int> f(n+1, 0);
        f[0] = f[1] = 1;
        for (int i = 2; i <= n; i++) {
            for (int k = 0; k <= i; k++) {
                f[i] += f[k]*f[i-1-k];
            }
        }
        return f[n];
    }
};
```

97. Interleaving String

Given *s1*, *s2*, *s3*, find whether *s3* is formed by the interleaving of *s1* and *s2*.

Example 1:

Input: s1 = "aabcc", s2 = "dbbca", *s3* = "aadbbcbcac"

Output: true

Example 2:

Input: s1 = "aabcc", s2 = "dbbca", *s3* = "aadbbbaccc"

Output: false

```cpp
class Solution {
public:
    bool isInterleave(string s1, string s2, string s3) {
        int n = s1.length(), m = s2.length(), l = s3.length();
        if (n+m != l) return false;
        else if (n < m) return isInterleave(s2, s1, s3);
        vector<vector<bool>> f(n+1, vector<bool>(m+1, false));
        f[0][0] = true;
        for (int k = 1; k <= l; k++) {
            for (int j = max(0, k-n); j <= min(m, k); j++) {
                int i = k-j;
                f[i][j] = (i >= 1 && s1[i-1] == s3[i+j-1] && f[i-1][j])
                        || (j >= 1 && s2[j-1] == s3[i+j-1] && f[i][j-1]);
            }
        }
        return f[n][m];
    }
};
```

```cpp
class Solution {
public:
    bool isInterleave(string s1, string s2, string s3) {
        int n = s1.length(), m = s2.length(), l = s3.length();
        if (n+m != l) return false;
        else if (n < m) return isInterleave(s2, s1, s3);
        vector<bool> f(m+1, false);
        f[0] = true;
        for (int k = 1; k <= l; k++) {
            for (int j = min(m, k); j >= max(0, k-n); j--) {
                int i = k-j;
                f[j] =  (j >= 1 && s2[j-1] == s3[i+j-1] && f[j-1])
                        || (i >= 1 && s1[i-1] == s3[i+j-1] && f[j]);

            }
        }
        return f[m];
    }
};
```

98. Validate Binary Search Tree

Medium

Given a binary tree, determine if it is a valid binary search tree (BST).

Assume a BST is defined as follows:

- The left subtree of a node contains only nodes with keys **less than** the node's key.
- The right subtree of a node contains only nodes with keys **greater than** the node's key.
- Both the left and right subtrees must also be binary search trees.

Example 1:

Input:

```
    2

   / \

  1   3
```

Output: true

Example 2:

```
    5

   / \

  1   4

     / \

    3   6
```

Output: false

Explanation: The input is: [5,1,4,null,null,3,6]. The root node's value

is 5 but its right child's value is 4.

```cpp
class Solution {
public:
    bool isValidBST(TreeNode* root) {

    }
};
```

```cpp
class Solution {
public:
    bool isValidBST(TreeNode* root) {
        return isValidBST(root, LONG_MIN, LONG_MAX);
    }

private:
    bool isValidBST(TreeNode* root, long long Min, long long Max) {
        if (root == nullptr) return true;
        return  root->val < Max && root->val > Min
                && isValidBST(root->left, Min, root->val)
                && isValidBST(root->right, root->val, Max);
    }
};
```

```cpp
class Solution {
public:
    bool isValidBST(TreeNode* root) {
        return isValidBST(root, nullptr, nullptr);
    }

private:
    bool isValidBST(TreeNode *root, TreeNode *Min, TreeNode *Max) {
        if (!root) return true;
        else if (Min && root->val <= Min->val || Max && root->val >= Max->val)
            return false;
        else return  isValidBST(root->left, Min, root)
                    && isValidBST(root->right, root, Max);
    }
};
```

99. Recover Binary Search Tree(●ˇ∀ˇ●)

Two elements of a binary search tree (BST) are swapped by mistake.

Recover the tree without changing its structure.

Example 1:

Input: [1,3,null,null,2]

```
   1

  /

 3

  \

   2
```

Output: [3,1,null,null,2]

```
   3

  /

 1

  \

   2
```

Example 2:

Input: [3,1,4,null,null,2]

```
   3

  / \

 1   4

    /

   2
```

Output: [2,1,4,null,null,3]

```
  2

 / \

1   4

  /

 3
```

Follow up:

- A solution using O(n) space is pretty straight forward.
- Could you devise a constant space solution?

```cpp
/**
 * Definition for a binary tree node.
 * struct TreeNode {
 *     int val;
 *     TreeNode *left;
 *     TreeNode *right;
 *     TreeNode(int x) : val(x), left(NULL), right(NULL) {}
 * };
 */
class Solution {
public:
    void recoverTree(TreeNode* root) {

    }
};
```

```cpp
/**
 * Definition for a binary tree node.
 * struct TreeNode {
 *     int val;
 *     TreeNode *left;
 *     TreeNode *right;
 *     TreeNode(int x) : val(x), left(NULL), right(NULL) {}
 * };
 */
class Solution {
public:
    void recoverTree(TreeNode* root) {
        inorder(root);
        swap(p->val, q->val);
    }


private:
    TreeNode *p = nullptr, *q = nullptr, *prev = nullptr;
    void inorder(TreeNode *root) {
        stack<TreeNode*> stk;
        while (!stk.empty() || root) {
            while (root) {
                stk.push(root);
                root = root->left;
            }
            root = stk.top();
            stk.pop();
            if (prev && root->val < prev->val) {
                if (!p)  p = prev;
                q = root;
            }
            prev = root;
            root = root->right;
        }
    }
};
```

100. Same Tree

Easy

Given two binary trees, write a function to check if they are the same or not.

Two binary trees are considered the same if they are structurally identical and the nodes have the same value.

Example 1:

Input: 1   1

          / \   / \

         2   3   2   3

        [1,2,3],   [1,2,3]

Output: true

Example 2:

Input: 1   1

          /   \

         2   2

        [1,2],   [1,null,2]

Output: false

Example 3:

Input: 1   1

          / \   / \

         2   1   1   2

        [1,2,1],   [1,1,2]

Output: false

```cpp
class Solution {
public:
    bool isSameTree(TreeNode* p, TreeNode* q) {


    }
};
```

```cpp
class Solution {
public:
    bool isSameTree(TreeNode* p, TreeNode* q) {
        if (p == nullptr || q == nullptr) return p == q;
        stack<TreeNode*> s;
        s.push(p); s.push(q);
        while (!s.empty()) {
            TreeNode *p = s.top();  s.pop();
            TreeNode *q = s.top();  s.pop();
            if (p->val != q->val) return false;
            if (p->left || q->left) {
                if (!(q->left && q->left)) return false;
                s.push(p->left);
                s.push(q->left);
            }
            if (p->right || q->right) {
                if (!(p->right && q->right)) return false;
                s.push(p->right);
                s.push(q->right);
            }
        }
        return true;
    }
};
```

```cpp
class Solution {
public:
    bool isSameTree(TreeNode *p, TreeNode *q) {
        if (p == nullptr || q == nullptr) return p == q;
        return  p->val == q->val && isSameTree(p->left, q->left)
                && isSameTree(p->right, q->right);
    }
};
```