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# 301. Remove Invalid Parentheses

Hard

Remove the minimum number of invalid parentheses in order to make the input string valid. Return all possible results.

**Note:** The input string may contain letters other than the parentheses `(` and `)`.

**Example 1:**

**Input:** "()())()"

**Output:** ["()()()", "(())()"]

**Example 2:**

**Input:** "(a)())()"

**Output:** ["(a)()()", "(a())()"]

**Example 3:**

**Input:** ")("

**Output:** [""]

```
class Solution {
public:
    vector<string> removeInvalidParentheses(string s) {
        int num1 = 0, num2 = 0;
        for(char &c : s) {
            num1 += c == '(';
            if (num1 == 0) num2 += c == ')';
            else num1 -= c == ')';
        }
//num 指的是要删除的左右括号数
        vector<string> ret;
        dfs(s, 0, num1, num2, ret);
        return ret;
    }
```

```
private:
    bool isValid(string s) {
        int sum = 0;
        for(char &c : s) {
            if (c == '(') ++sum;
            else if (c == ')') --sum;
            if (sum < 0) return false;
        }
        return sum == 0;
    }

    void dfs(string &s, int cur, int num1, int num2,
             vector<string> &ret) {
        if (num1 == 0 && num2 == 0) {
            if (isValid(s))
                ret.push_back(s);
            return;
        }
        for (int i = cur; i < s.size(); ++i) {
            string tmp = s;
            if (num1 > 0 && tmp[i] == '(') {
                if (i == cur || tmp[i] != tmp[i - 1]) {
                    tmp.erase(i, 1);
                    dfs(tmp, i, num1 - 1, num2, ret);
                }
            }
            if (num2 > 0 && tmp[i] == ')') {
                if (i == cur || tmp[i] != tmp[i - 1]) {
                    tmp.erase(i, 1);
                    dfs(tmp, i, num1, num2 - 1, ret);
                }
            }
        }
    }
};
```

# 302. Smallest Rectangle Enclosing Black Pixels

An image is represented by a binary matrix with `0` as a white pixel and `1` as a black pixel. The black pixels are connected, i.e., there is only one black region. Pixels are connected horizontally and vertically. Given the location `(x, y)` of one of the black pixels, return the area of the smallest (axis-aligned) rectangle that encloses all black pixels.

**Example:**

```
Input:

[

  "0010",

  "0110",

  "0100"

]

and x = 0, y = 2


Output: 6
```

# 303. Range Sum Query - Immutable

Easy

Given an integer array *nums*, find the sum of the elements between indices *i* and *j* ($i \le j$), inclusive.

**Example:**

```
Given nums = [-2, 0, 3, -5, 2, -1]



sumRange(0, 2) -> 1

sumRange(2, 5) -> -1

sumRange(0, 5) -> -3
```

**Note:**

1. You may assume that the array does not change.
2. There are many calls to *sumRange* function.

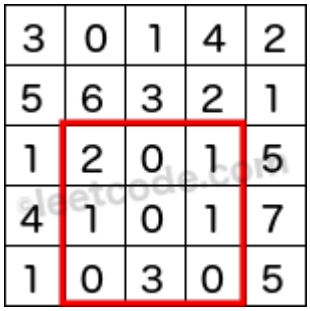
```
class NumArray {
public:
    NumArray(vector<int> nums) {

    }
};
```

```cpp
class NumArray {
public:
    NumArray(vector<int> nums) {
       partial_sum(nums.begin(), nums.end(), back_inserter(sum));
    }

    int sumRange(int i, int j) {
        return sum[j+1]-sum[i];
    }
private:
    vector<int> sum{0};
};
```

# 304. Range Sum Query 2D - Immutable

Medium

Given a 2D matrix *matrix*, find the sum of the elements inside the rectangle defined by its upper left corner (*row*1, *col*1) and lower right corner (*row*2, *col*2).




The above rectangle (with the red border) is defined by (row1, col1) = **(2, 1)** and (row2, col2) = **(4, 3)**, which contains sum = **8**.

**Example:**

```
Given matrix = [
  [3, 0, 1, 4, 2],
  [5, 6, 3, 2, 1],
  [1, 2, 0, 1, 5],
  [4, 1, 0, 1, 7],
  [1, 0, 3, 0, 5]
]

sumRegion(2, 1, 4, 3) -> 8
sumRegion(1, 1, 2, 2) -> 11
sumRegion(1, 2, 2, 4) -> 12
```

**Note:**

1. You may assume that the matrix does not change.
2. There are many calls to *sumRegion* function.
3. You may assume that *row*1 ≤ *row*2 and *col*1 ≤ *col*2.

```cpp
class NumMatrix {
public:
    NumMatrix(vector<vector<int>>& matrix) {
        if (matrix.size() == 0 || matrix[0].size() == 0) return;
        int n = matrix.size(), m = matrix[0].size();
        dp.resize(n+1, vector<int>(m+1, 0));
        for (int r = 0; r < n; r++) {
           for (int c = 0; c < m; c++) {
              dp[r + 1][c + 1] = dp[r + 1][c] + dp[r][c + 1]
                                 + matrix[r][c] - dp[r][c];
            }
        }
    }

    int sumRegion(int row1, int col1, int row2, int col2) {
        return dp[row2 + 1][col2 + 1] - dp[row1][col2 + 1]
               - dp[row2 + 1][col1] + dp[row1][col1];
    }
private:
    vector<vector<int>> dp;
};
```

# 305. Number of Islands II

A 2d grid map of `m` rows and `n` columns is initially filled with water. We may perform an *addLand* operation which turns the water at position (row, col) into a land. Given a list of positions to operate, **count the number of islands after each *addLand* operation**. An island is surrounded by water and is formed by connecting adjacent lands horizontally or vertically. You may assume all four edges of the grid are all surrounded by water.

**Example:**

```
Input: m = 3, n = 3, positions = [[0,0], [0,1], [1,2], [2,1]]

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

**Explanation:**

Initially, the 2d grid `grid` is filled with water. (Assume 0 represents water and 1 represents land).

```
0 0 0

0 0 0

0 0 0
```

Operation #1: addLand(0, 0) turns the water at grid[0][0] into a land.

```
1 0 0

0 0 0   Number of islands = 1

0 0 0
```

Operation #2: addLand(0, 1) turns the water at grid[0][1] into a land.

```
1 1 0

0 0 0   Number of islands = 1

0 0 0
```

Operation #3: addLand(1, 2) turns the water at grid[1][2] into a land.

```
1 1 0

0 0 1   Number of islands = 2

0 0 0
```

Operation #4: addLand(2, 1) turns the water at grid[2][1] into a land.

```
1 1 0
```

```
0 0 1   Number of islands = 3

0 1 0
```

**Follow up:**

Can you do it in time complexity O(k log mn), where k is the length of the `positions`?

```
class Solution {
public:
    vector<int> numIslands2(int m, int n, vector<vector<int>>& positions) {
        vector<vector<int>> dirs{{0, -1}, {-1, 0}, {0, 1}, {1, 0}};
        vector<int> fa(m*n, -1), res;
        // -1 water, other land标签
        int cnt = 0;

        for (auto &v : positions) {
            int id = n*v[0] + v[1];
            if (fa[id] == -1) {
                fa[id] = id;
                ++cnt;
            }
            for (auto dir : dirs) {
                int x = v[0]+dir[0], y = v[1]+dir[1], cur_id = n*x + y;
                if (x < 0 || x >= m || y < 0 || y >= n || fa[cur_id] == -1)
                     continue;
                int p = find(fa, cur_id), q = find(fa, id);
                if (p != q) {
                    fa[p] = q;
                    --cnt;
                }
            }
            res.push_back(cnt);
        }
        return res;
    }

private:
    int find(vector<int> &fa, int x) {
        return (x == fa[x]) ? x : (fa[x] = find(fa, fa[x]));
    }
};
```

# 306. Additive Number

Medium

Additive number is a string whose digits can form additive sequence.

A valid additive sequence should contain **at least** three numbers. Except for the first two numbers, each subsequent number in the sequence must be the sum of the preceding two.

Given a string containing only digits `'0'-'9'`, write a function to determine if it's an additive number.

**Note:** Numbers in the additive sequence **cannot** have leading zeros, so sequence `1, 2, 03` or `1, 02, 3` is invalid.

**Example 1:**

**Input:** "112358"

**Output:** true

**Explanation:** The digits can form an additive sequence: 1, 1, 2, 3, 5, 8.

1 + 1 = 2, 1 + 2 = 3, 2 + 3 = 5, 3 + 5 = 8

**Example 2:**

**Input:** "199100199"

**Output:** true

**Explanation:** The additive sequence is: 1, 99, 100, 199.

1 + 99 = 100, 99 + 100 = 199

**Follow up:**
How would you handle overflow for very large input integers?

```
class Solution {
public:
    bool isAdditiveNumber(string num) {

    }
};
```

```cpp
class Solution {
public:
    bool isAdditiveNumber(string num) {
        int n = num.length();
        for (int i = 1; i <= n/2; i++) {
            for (int j = i+1; j < n; j++) {
                if (dfs(num.substr(0, i), num.substr(i, j-i),
                        j, num, 2))
                    return true;
            }
        }
        return false;
    }
private:
    bool dfs(string x, string y, int start, string &num, int cnt) {
        if (x[0] == '0' && x != "0") return false;
        if (y[0] == '0' && y != "0") return false;
        if (start == num.length() && cnt > 2) return true;
        string s = add(x, y);
        if (s != num.substr(start, s.length())) return false;
        return dfs(y, s, start+s.length(), num, cnt+1);
    }

    string add(string x, string y) {
        reverse(x.begin(), x.end());
        reverse(y.begin(), y.end());
        string ret;
        int c = 0, p = 0, q = 0, n = x.length(), m = y.length();
        while (p < n || q < m) {
            c += (p < n ? x[p++] -'0' : 0 )
                + (q < m ? y[q++] -'0' : 0 );
            ret += c % 10 + '0';
            c /= 10;
        }
        if (c) ret += '1';
        reverse(ret.begin(), ret.end());
        return ret;
    }
};
```

# 307. Range Sum Query - Mutable

Medium

Given an integer array *nums*, find the sum of the elements between indices *i* and *j* ($i \le j$), inclusive.

The *update(i, val)* function modifies *nums* by updating the element at index *i* to *val*.

**Example:**

```
Given nums = [1, 3, 5]



sumRange(0, 2) -> 9

update(1, 2)

sumRange(0, 2) -> 8
```

**Note:**

1. The array is only modifiable by the *update* function.
2. You may assume the number of calls to *update* and *sumRange* function is distributed evenly.

# 308. Range Sum Query 2D - Mutable

Given a 2D matrix *matrix*, find the sum of the elements inside the rectangle defined by its upper left corner (*row*1, *col*1) and lower right corner (*row*2, *col*2).



The above rectangle (with the red border) is defined by (row1, col1) = **(2, 1)** and (row2, col2) = **(4, 3)**, which contains sum = **8**.

**Example:**

```
Given matrix = [
  [3, 0, 1, 4, 2],
  [5, 6, 3, 2, 1],
  [1, 2, 0, 1, 5],
  [4, 1, 0, 1, 7],
  [1, 0, 3, 0, 5]
]

sumRegion(2, 1, 4, 3) -> 8
update(3, 2, 2)
sumRegion(2, 1, 4, 3) -> 10
```

**Note:**

1. The matrix is only modifiable by the *update* function.
2. You may assume the number of calls to *update* and *sumRegion* function is distributed evenly.
3. You may assume that *row*1 ≤ *row*2 and *col*1 ≤ *col*2.

# 309. Best Time to Buy and Sell Stock with Cooldown

Medium

Say you have an array for which the $i^{th}$ element is the price of a given stock on day $i$.

Design an algorithm to find the maximum profit. You may complete as many transactions as you like (ie, buy one and sell one share of the stock multiple times) with the following restrictions:

- You may not engage in multiple transactions at the same time (ie, you must sell the stock before you buy again).
- After you sell your stock, you cannot buy stock on next day. (ie, cooldown 1 day)

**Example:**

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

**Output:** 3

**Explanation:** transactions = [buy, sell, cooldown, buy, sell]

# 310. Minimum Height Trees★★

Medium

For an undirected graph with tree characteristics, we can choose any node as the root. The result graph is then a rooted tree. Among all possible rooted trees, those with minimum height are called minimum height trees (MHTs). Given such a graph, write a function to find all the MHTs and return a list of their root labels.

**Format**

The graph contains `n` nodes which are labeled from `0` to `n - 1`. You will be given the number `n` and a list of undirected `edges` (each edge is a pair of labels).

You can assume that no duplicate edges will appear in `edges`. Since all edges are undirected, `[0, 1]` is the same as `[1, 0]` and thus will not appear together in `edges`.

**Example 1 :**

**Input:** n = 4, edges = [[1, 0], [1, 2], [1, 3]]

```
        0
        |
        1
       / \
      2   3
```

**Output:** [1]

**Example 2 :**

**Input:** n = 6, edges = [[0, 3], [1, 3], [2, 3], [4, 3], [5, 4]]

```
    0   1   2
     \  |  /
       3
       |
       4
       |
       5
```

**Output:** [3, 4]

```cpp
class Solution {
public:
    vector<int> findMinHeightTrees(int n, vector<vector<int>>& edges) {
        vector<unordered_set<int>> adj(n);
        for (const auto &p : edges) {
           adj[p[0]].insert(p[1]);
           adj[p[1]].insert(p[0]);
        }
        vector<int> current;
        if (n == 1) {
           current.push_back(0);
           return current;
        }

        for (int i = 0; i < adj.size(); ++i) {
            if (adj[i].size() == 1) {
                 current.push_back(i);
            }
        }

        while (1) {
            vector<int> next;
            for (int node : current) {
                for (int neighbor : adj[node]) {
                    adj[neighbor].erase(node);
                    if (adj[neighbor].size() == 1)
                        next.push_back(neighbor);
                }
            }
            if (next.empty()) return current;
            current = next;
        }
    }
};
```

# 311. Sparse Matrix Multiplication

Given two sparse matrices **A** and **B**, return the result of **AB**.

You may assume that **A**'s column number is equal to **B**'s row number.

**Example:**

```
Input:


A = [
  [ 1, 0, 0],
  [-1, 0, 3]
]


B = [
  [ 7, 0, 0 ],
  [ 0, 0, 0 ],
  [ 0, 0, 1 ]
]


Output:


     |  1 0 0 |   | 7 0 0 |   |  7 0 0 |
AB = | -1 0 3 | x | 0 0 0 | = | -7 0 3 |
                  | 0 0 1 |
```

```cpp
class Solution {
public:
    vector<vector<int>> multiply(vector<vector<int>> &A, vector<vector<int>>
&B) {
        int n = A.size(), l = B.size(), m = B[0].size();
        vector<vector<int>> res(n, vector<int> (m, 0));
        vector<pair<int, int>> v[l];
        for (int i = 0; i < l; i++) {
            for (int j = 0; j < m; j++) if (B[i][j]) {
                v[i].push_back({j, B[i][j]});
            }
        }
        for (int i = 0; i < n; ++i) {
            for (int k = 0; k < l; ++k) if (A[i][k]) {
                for (auto &pii : v[k]) {
                    res[i][pii.first] += A[i][k] * pii.second;
                }
            }
        }
        return res;
    }
};
```

# 312. Burst Balloons★★

Hard

Given `n` balloons, indexed from `0` to `n-1`. Each balloon is painted with a number on it represented by array `nums`. You are asked to burst all the balloons. If the you burst balloon `i` you will get `nums[left] * nums[i] * nums[right]` coins. Here `left` and `right` are adjacent indices of `i`. After the burst, the `left` and `right` then becomes adjacent.

Find the maximum coins you can collect by bursting the balloons wisely.

**Note:**

- You may imagine `nums[-1] = nums[n] = 1`. They are not real therefore you can not burst them.
- $0 \leq$ `n` $\leq 500$, $0 \leq$ `nums[i]` $\leq 100$

**Example:**

**Input:** [3,1,5,8]

**Output:** 167

**Explanation:** nums = [3,1,5,8] --> [3,5,8] --> [3,8] --> [8] --> []

coins = 3*1*5 + 3*5*8 + 1*3*8 + 1*8*1 = 167

```cpp
class Solution {
public:
    int maxCoins(vector<int>& nums) {
        int N = nums.size();
        nums.insert(nums.begin(), 1);
        nums.insert(nums.end(), 1);
        vector<vector<int>> dp(N+2, vector<int>(N+2, 0));
        for (int i = N; i >= 1; --i) {
            for (int j = i; j <= N; ++j) {
                int bestCoins = 0;
                for (int k = i; k <= j; ++k) {
                    int coins = dp[i][k-1] + dp[k+1][j];
                    coins += nums[i-1] * nums[k] * nums[j+1];
                    bestCoins = max(bestCoins, coins);
                }
                dp[i][j] = bestCoins;
            }
        }
        return dp[1][N];
    }
};
```

# 313. Super Ugly Number

Medium

Write a program to find the `n`th super ugly number.

Super ugly numbers are positive numbers whose all prime factors are in the given prime list `primes` of size `k`.

**Example:**

**Input:** n = 12, primes = [2,7,13,19]

**Output:** 32

**Explanation:** [1,2,4,7,8,13,14,16,19,26,28,32] is the sequence of the first 12 super ugly numbers given primes = [2,7,13,19] of size 4.

**Note:**

- `1` is a super ugly number for any given `primes`.
- The given numbers in `primes` are in ascending order.
- $0 < k \leq 100$, $0 < n \leq 10^6$, $0 < primes[i] < 1000$.
- The nth super ugly number is guaranteed to fit in a 32-bit signed integer.

```
class Solution {
public:
    int nthSuperUglyNumber(int n, vector<int>& primes) {

    }
};
```

```cpp
class Solution {
public:
    int nthSuperUglyNumber(int n, vector<int>& primes) {
        int sz = primes.size();
        vector<int> k(sz, 0), res(1, 1);
        while (--n) {
            int min_v = INT_MAX;
            for (int i = 0; i < sz; i++) {
                min_v = min(min_v, primes[i]*res[k[i]]);
            }
            res.push_back(min_v);
            for (int i = 0; i < sz; i++) {
                if (primes[i]*res[k[i]] == min_v)
                    k[i]++;
            }
        }
        return res.back();
    }
};
```

```cpp
class Solution {
public:
    int nthSuperUglyNumber(int n, vector<int>& primes) {
        priority_queue<int, vector<int>, greater<int>> pq;
        unordered_set<int> My_set;
        pq.push(1);
        while (--n) {
            int t = pq.top();
            pq.pop();
            for (int i : primes) {
                if (INT_MAX / i < t) continue;
                i *= t;
                if (My_set.count(i)) continue;
                My_set.insert(i);
                pq.push(i);
            }
        }
        return pq.top();
    }
};
```

# 314. Binary Tree Vertical Order Traversal

Given a binary tree, return the *vertical order* traversal of its nodes' values. (ie, from top to bottom, column by column).

If two nodes are in the same row and column, the order should be from **left to right**.

**Examples 1:**

```
Input: [3,9,20,null,null,15,7]


   3
  /\
 /  \
 9  20
    /\
   /  \
  15   7


Output:


[
  [9],
  [3,15],
  [20],
  [7]
]
```

**Examples 2:**

```
Input: [3,9,8,4,0,1,7]
```

```
    3
   /\
  /  \
  9   8
 /\  /\
/  \/  \
4  01   7
```

**Output:**

```
[
  [4],
  [9],
  [3,0,1],
  [8],
  [7]
]
```

**Examples 3:**

**Input:** [3,9,8,4,0,1,7,null,null,null,2,5] (0's right child is 2 and 1's left child is 5)

```
    3
   /\
  /  \
  9   8
 /\  /\
/  \/  \
4  01   7
```

```
    /\
   /  \
   5   2
```

**Output:**

```
[
  [4],
  [9,5],
  [3,0,1],
  [8,2],
  [7]
]
```

```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<vector<int>> verticalOrder(TreeNode* root) {
        vector<vector<int>> res;
        if (!root) return res;
        map<int, vector<int>> m;
        queue<pair<TreeNode*, int>> q;
        q.emplace(root, 0);
        while(!q.empty()) {
            auto t = q.front();
            q.pop();
            m[t.second].push_back(t.first->val);
            if (t.first->left) q.emplace(t.first->left, t.second-1);
            if (t.first->right) q.emplace(t.first->right, t.second+1);
        }
        for (auto &i : m) res.push_back(i.second);
        return res;
    }
};
```

# 315. Count of Smaller Numbers After Self★★

Hard

You are given an integer array *nums* and you have to return a new *counts* array. The *counts* array has the property where `counts[i]` is the number of smaller elements to the right of `nums[i]`.

**Example:**

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

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

**Explanation:**

To the right of 5 there are **2** smaller elements (2 and 1).

To the right of 2 there is only **1** smaller element (1).

To the right of 6 there is **1** smaller element (1).

To the right of 1 there is **0** smaller element.

```cpp
class Solution {
public:
    using pii = pair<int, int>;
    using vecIter = vector<pair<int, int>>::iterator;
    vector<int> countSmaller(vector<int>& nums) {
        int n = nums.size();
        vector<pii> v(n);
        vector<int> res(n, 0);
        for (int i = 0; i < n; i++)  v[i] = {nums[i], i};
        merge_sort(v.begin(), v.end(), res);
        return res;
}

private:
    void merge_sort(vecIter l, vecIter r, vector<int> &res) {
        if (l+1 < r) {
            auto mid = l + (r-l)/2;
            merge_sort(l, mid, res);
            merge_sort(mid, r, res);
            merge(l, r, res);
        }
    }

    void merge(vecIter l, vecIter r, vector<int> &res) {
        auto mid = l + (r-l)/2, p = l, q = mid;
        while (p < mid || q < r) {
            if (p < mid && q < r) {
                if (q->first >= p->first) q++;
                else {
                    res[p->second] += r-q;
                    p++;
                }
            }
            else if (p < mid)  p++;
            else q++;
        }
        inplace_merge(l, mid, r, greater<pii>());
    }
};
```

# 316. Remove Duplicate Letters★★

Hard

Given a string which contains only lowercase letters, remove duplicate letters so that every letter appear once and only once. You must make sure your result is the smallest in lexicographical order among all possible results.

**Example 1:**

**Input:** "bcabc"

**Output:** "abc"

**Example 2:**

**Input:** "cbacdcbc"

**Output:** "acdb"

```cpp
class Solution {
public:
    string removeDuplicateLetters(string s) {
        vector<int> dict(256, 0);
        vector<bool> visited(256, false);
        for(auto ch : s)  dict[ch]++;
        string result = "0";
        for(auto c : s) {
            dict[c]--;
            if (visited[c])  continue;
            while (c < result.back() && dict[result.back()] > 0) {
                visited[result.back()] = false;
                result.pop_back();
            }
            result += c;
            visited[c] = true;
        }
        return result.substr(1);
    }
};
```

# 317. Shortest Distance from All Buildings

You want to build a house on an *empty* land which reaches all buildings in the shortest amount of distance. You can only move up, down, left and right. You are given a 2D grid of values **0**, **1** or **2**, where:

- Each **0** marks an empty land which you can pass by freely.
- Each **1** marks a building which you cannot pass through.
- Each **2** marks an obstacle which you cannot pass through.

**Example:**

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



1 - 0 - 2 - 0 - 1

|   |   |   |   |

0 - 0 - 0 - 0 - 0

|   |   |   |   |

0 - 0 - 1 - 0 - 0


Output: 7


Explanation: Given three buildings at (0,0), (0,4), (2,2), and an obstacle
at (0,2),

             the point (1,2) is an ideal empty land to build a house, as the
total

             travel distance of 3+3+1=7 is minimal. So return 7.
```

**Note:**
There will be at least one building. If it is not possible to build such house according to the above rules, return -1.

# 318. Maximum Product of Word Lengths★★

Medium

Given a string array `words`, find the maximum value of `length(word[i]) * length(word[j])` where the two words do not share common letters. You may assume that each word will contain only lower case letters. If no such two words exist, return 0.

**Example 1:**

**Input:** ["abcw","baz","foo","bar","xtfn","abcdef"]

**Output:** 16

**Explanation:** The two words can be "abcw", "xtfn".

**Example 2:**

**Input:** ["a","ab","abc","d","cd","bcd","abcd"]

**Output:** 4

**Explanation:** The two words can be "ab", "cd".

**Example 3:**

**Input:** ["a","aa","aaa","aaaa"]

**Output:** 0

**Explanation:** No such pair of words.

```
class Solution {
public:
    int maxProduct(vector<string> &words) {

    }
};
```

```cpp
class Solution {
public:
    int maxProduct(vector<string> &words) {
        vector<int> mask(words.size());
        int res = 0;
        for (int i = 0; i < words.size(); ++i) {
            for (char c : words[i])
                mask[i] |= 1 << (c - 'a');
            for (int j = 0; j < i; ++j) if (!(mask[i] & mask[j])) {
                res = max(res, int(words[i].size()*words[j].size()));
            }
        }
        return res;
    }
};
```

```cpp
class Solution {
public:
    int maxProduct(vector<string>& words) {
        unordered_map<int, int> maxlen;
        for (string word : words) {
            int mask = 0;
            for (char c : word)  mask |= 1 << (c - 'a');
            maxlen[mask] = max(maxlen[mask], (int)word.size());
        }
        int res = 0;
        for (auto a : maxlen) {
            for (auto b : maxlen)
              if (!(a.first & b.first))
                  res = max(res, a.second * b.second);
        }
        return res
    }
};
```

# 319. Bulb Switcher

Medium

There are *n* bulbs that are initially off. You first turn on all the bulbs. Then, you turn off every second bulb. On the third round, you toggle every third bulb (turning on if it's off or turning off if it's on). For the *i*-th round, you toggle every *i* bulb. For the *n*-th round, you only toggle the last bulb. Find how many bulbs are on after *n* rounds.

**Example:**

**Input:** 3

**Output:** 1

**Explanation:**

At first, the three bulbs are **[off, off, off]**.

After first round, the three bulbs are **[on, on, on]**.

After second round, the three bulbs are **[on, off, on]**.

After third round, the three bulbs are **[on, off, off]**.

So you should return 1, because there is only one bulb is on.

```cpp
class Solution {
public:
    int bulbSwitch(int n) {
        // return sqrt(n); /*这是标答， 以下答案超时*/
        bitset<100000000> bit;
        for (int i = 1; i <= n; i++) {
            for (int j = i; j <= n; j += i) {
                bit.flip(j);
            }
        }
        return bit.count();
    }
};
/*
对于一个叫做 bit 的 bitset：
bit.size()       返回大小（位数）
bit.count()      返回 1 的个数
bit.any()        返回是否有 1
bit.none()       返回是否没有 1
bit.set()        全都变成 1
bit.set(p)       将第 p + 1 位变成 1（bitset 是从第 0 位开始的！）
bit.set(p, x)    将第 p + 1 位变成 x
bit.reset()      全都变成 0
bit.reset(p)     将第 p + 1 位变成 0
bit.flip()       全都取反
bit.flip(p)      将第 p + 1 位取反
bit.to_ulong()   返回它转换为 unsigned long 的结果，如果超出范围则报错
bit.to_ullong()  返回它转换为 unsigned long long 的结果，如果超出范围则报错
bit.to_string()  返回它转换为 string 的结果
*/
```

# 320. Generalized Abbreviation

Write a function to generate the generalized abbreviations of a word.

**Note:** The order of the output does not matter.

**Example:**

```
Input: "word"

Output:

["word", "1ord", "w1rd", "wo1d", "wor1", "2rd", "w2d", "wo2", "1o1d",
"1or1", "w1r1", "1o2", "2r1", "3d", "w3", "4"]
```

```
class Solution {
public:
    vector<string> generateAbbreviations(string word) {
        if (word.empty()) return {""};
        vector<string> pre{""};
        for(char &c : word) {
            vector<string> cur;
            for (auto &s : pre) {
                cur.push_back(s+c);
                if (isdigit(s.back())) {
                    int i = s.size()-1;
                    while(i >= 1 && isdigit(s[i-1])) i--;
                    cur.push_back(s.substr(0, i)
                             + to_string(stoi(s.substr(i))+1));
                }
                else cur.push_back(s+"1");
            }
            pre = cur;
        }
        return pre;
    }
};
```

```cpp
class Solution {
public:
    vector<string> generateAbbreviations(string word) {
        vector<string> res;
        for (int i = (1 << word.length()) - 1; i >= 0; --i)
            res.emplace_back(f(word, i));
        return res;
    }

   string f(const string &word, int x) {
        string s;
        int cnt = 0, n = word.length();
        for (int i = 0; i < n; ++i, x >>= 1) {
            if ((x & 1) == 0) {
                if (cnt != 0) {
                    s += to_string(cnt);
                    cnt = 0;
                }
                s += word[i];
            }
            else ++cnt;
        }
        if (cnt != 0) s += to_string(cnt);
        return s;
    }
};
```

# 321. Create Maximum Number★★

Hard

Given two arrays of length `m` and `n` with digits `0-9` representing two numbers. Create the maximum number of length `k <= m + n` from digits of the two. The relative order of the digits from the same array must be preserved. Return an array of the `k` digits.

**Note:** You should try to optimize your time and space complexity.

**Example 1:**

**Input:**

nums1 = [3, 4, 6, 5]

nums2 = [9, 1, 2, 5, 8, 3]

k = 5

**Output:**

[9, 8, 6, 5, 3]

**Example 2:**

**Input:**

nums1 = [6, 7]

nums2 = [6, 0, 4]

k = 5

**Output:**

[6, 7, 6, 0, 4]

**Example 3:**

**Input:**

nums1 = [3, 9]

nums2 = [8, 9]

k = 3

**Output:**

[9, 8, 9]

```
class Solution {
public:
    vector<int> maxNumber(vector<int>& nums1,vector<int>& nums2,int k){
        int n = nums1.size(), m = nums2.size();
        vector<int> res;
        for (int k1 = max(k-m, 0); k1 <= min(k, n); ++k1) {
            auto s1 = maxKsequence(nums1, k1);
            auto s2 = maxKsequence(nums2, k-k1);

            vector<int> temp;
            auto i1 = s1.begin(), end1 = s1.end();
            auto i2 = s2.begin(), end2 = s2.end();
            while (i1 != end1 || i2 != end2)
               temp.push_back(lexicographical_compare(i1, end1,
                                      i2, end2) ? *i2++ : *i1++);
            res = max(res, temp);
        }
        return res;
    }

    vector<int> maxKsequence(const vector<int> &nums, int k) {
        int drop = nums.size() - k;
        vector<int> stk;
        for (int i : nums) {
            while (drop && !stk.empty() && stk.back() < i) {
                stk.pop_back();
                drop--;
            }
            stk.push_back(i);
        }
        stk.resize(k);
        return stk;
    }
};
```

# 322. Coin Change★★

Medium

You are given coins of different denominations and a total amount of money *amount*. Write a function to compute the fewest number of coins that you need to make up that amount. If that amount of money cannot be made up by any combination of the coins, return `-1`.

**Example 1:**

**Input:** coins = [1, 2, 5], amount = 11

**Output:** 3

**Explanation:** 11 = 5 + 5 + 1

**Example 2:**

**Input:** coins = [2], amount = 3

**Output:** -1

**Note**:
You may assume that you have an infinite number of each kind of coin.

```
class Solution {
public:
    int coinChange(vector<int>& coins, int amount) {

    }
};
```

```cpp
class Solution {
public:
    int coinChange(vector<int>& coins, int amount) {
        int Max = amount + 1;
        vector<int> dp(amount+1, Max);
        dp[0] = 0;
        for(int i = 0; i < coins.size(); i++) {
            for(int j = coins[i]; j <= amount; j++)
                dp[j] = min(dp[j], dp[j-coins[i]] + 1);
        }
        return dp[amount] == Max ? -1 : dp[amount];
    }
};
```

# 323. Number of Connected Components in an Undirected Graph

Given `n` nodes labeled from `0` to `n - 1` and a list of undirected edges (each edge is a pair of nodes), write a function to find the number of connected components in an undirected graph.

**Example 1:**

```
Input: n = 5 and edges = [[0, 1], [1, 2], [3, 4]]


    0          3
    |          |
    1 --- 2    4


Output: 2
```

**Example 2:**

```
Input: n = 5 and edges = [[0, 1], [1, 2], [2, 3], [3, 4]]


    0           4
    |           |
    1 --- 2 --- 3


Output:  1
```

**Note:**
You can assume that no duplicate edges will appear in `edges`. Since all edges are undirected, `[0, 1]` is the same as `[1, 0]` and thus will not appear together in `edges`.

```cpp
class Solution {
public:
    int countComponents(int n, vector<vector<int>>& edges) {
        vector<vector<int>> g(n);
        vector<bool> v(n, false);
        for (auto &i : edges) {
            g[i[0]].push_back(i[1]);
            g[i[1]].push_back(i[0]);
        }
        for (int i = 0; i < n; i++) if (!v[i]) {
            dfs(i, g, v);
            res++;
        }
        return res;
    }
private:
    int res = 0;
    void dfs(int i, vector<vector<int>> &g, vector<bool> &v) {
        v[i] = true;
        for (auto &j : g[i]) if (!v[j]) {
            dfs(j, g, v);
        }
    }
};
```

# 324. Wiggle Sort II★★

Medium

Given an unsorted array `nums`, reorder it such that `nums[0] < nums[1] > nums[2] < nums[3]...`.

**Example 1:**

**Input:** nums = [1, 5, 1, 1, 6, 4]

**Output:** One possible answer is [1, 4, 1, 5, 1, 6].

**Example 2:**

**Input:** nums = [1, 3, 2, 2, 3, 1]

**Output:** One possible answer is [2, 3, 1, 3, 1, 2].

**Note:**
You may assume all input has valid answer.

**Follow Up:**
Can you do it in O(n) time and/or in-place with O(1) extra space?

O(n) time and in-place with O(1) extra space 待补充

```
class Solution {
public:
    void wiggleSort(vector<int>& nums) {
        int n = nums.size(), mid = (n + 1) / 2 - 1;
        nth_element(nums.begin(), nums.begin() + mid, nums.end());
        threeWayPartition(nums, nums[mid]);
        vector<int> res(nums);
        int end0 = (n + 1) / 2 - 1, end1 = n-1;
        for (int i = 0; i < n; ++i) {
            nums[i] = i % 2 == 0 ? res[end0--] : res[end1--];
        }
    }

    void threeWayPartition(vector<int> &nums, int val) {
        int i = 0, j = 0, k = nums.size()-1;
        while (j <= k){
            if (nums[j] < val)
                swap(nums[i++], nums[j++]);
            else if (nums[j] > val)
                swap(nums[j], nums[k--]);
            else ++j;
        }
    }
};
```

# 325. Maximum Size Subarray Sum Equals k

Given an array *nums* and a target value *k*, find the maximum length of a subarray that sums to *k*. If there isn't one, return 0 instead.

**Note:**
The sum of the entire *nums* array is guaranteed to fit within the 32-bit signed integer range.

**Example 1:**

```
Input: nums = [1, -1, 5, -2, 3], k = 3

Output: 4

Explanation: The subarray [1, -1, 5, -2] sums to 3 and is the longest.
```

**Example 2:**

```
Input: nums = [-2, -1, 2, 1], k = 1

Output: 2

Explanation: The subarray [-1, 2] sums to 1 and is the longest.
```

**Follow Up:**
Can you do it in O(*n*) time?

```
class Solution {
public:
    int maxSubArrayLen(vector<int> &nums, int k) {

    }
};
```

```cpp
class Solution {
public:
    int maxSubArrayLen(vector<int> &nums, int k) {
        int sum = 0, res = 0, n = nums.size();
        unordered_map<int, int> m;
        for (int i = 0; i < n; ++i) {
            sum += nums[i];
            if (sum == k) res = i + 1;
            else if (m.count(sum - k)) res = max(res, i-m[sum-k]);
            if (!m.count(sum)) m[sum] = i;
        }
        return res;
    }
};
```

# 326. Power of Three

Easy

Given an integer, write a function to determine if it is a power of three.

**Example 1:**

**Input:** 27

**Output:** true

**Example 2:**

**Input:** 0

**Output:** false

**Example 3:**

**Input:** 9

**Output:** true

**Example 4:**

**Input:** 45

**Output:** false

**Follow up:**
Could you do it without using any loop / recursion?

```
class Solution {
public:
    bool isPowerOfThree(int n) {
        if(n <= 0) return false;
        return pow(3, (int)(log10(n) / log10(3)+0.5) ) == n;
       // return n > 0 && (1162261467 % n == 0);
    }
};
```

# 327. Count of Range Sum★★

Hard

Given an integer array `nums`, return the number of range sums that lie in `[lower, upper]` inclusive.
Range sum `S(i, j)` is defined as the sum of the elements in `nums` between indices `i` and `j` (`i` ≤ `j`), inclusive.

**Note:**
A naive algorithm of $O(n^2)$ is trivial. You MUST do better than that.

**Example:**

**Input:** *nums* = [-2,5,-1], *lower* = -2, *upper* = 2,

**Output:** 3

**Explanation:** The three ranges are : [0,0], [2,2], [0,2] and their respective sums are: -2, -1, 2.

```cpp
class Solution {
public:
    using vecIter = vector<long long>::iterator;
    int countRangeSum(vector<int>& nums, int lower, int upper) {
        int n = nums.size();
        vector<long long> sum(n+1, 0);
        for (int i = 1; i <= n; i++) sum[i] = sum[i-1] + nums[i-1];
        merge_sort(sum.begin(), sum.end(), lower, upper);
        return res;
    }
private:
    int res = 0;

    void merge_sort(vecIter l, vecIter r, int lower, int upper) {
        if (l + 1 < r) {
            auto mid = l + distance(l, r) / 2;
            merge_sort(l, mid, lower, upper);
            merge_sort(mid, r, lower, upper);
            merge(l, r, lower, upper);
        }
    }

    void merge(vecIter l, vecIter r, int lower, int upper) {
        auto mid = l + distance(l, r) / 2;
        auto p = l, Low = mid, Up = mid;
        while (p < mid) {
            while (Low < r && *Low - *p < lower) ++Low;
            while (Up < r && *Up - *p <= upper) ++Up;
            res += Up-Low;
            p++;
        }
        inplace_merge(l, mid, r);
    }
};
```

# 328. Odd Even Linked List

Medium

Given a singly linked list, group all odd nodes together followed by the even nodes. Please note here we are talking about the node number and not the value in the nodes.

You should try to do it in place. The program should run in O(1) space complexity and O(nodes) time complexity.

**Example 1:**

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

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

**Example 2:**

**Input:** 2->1->3->5->6->4->7->NULL

**Output:** 2->3->6->7->1->5->4->NULL

**Note:**

- The relative order inside both the even and odd groups should remain as it was in the input.
- The first node is considered odd, the second node even and so on ...

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

    }
};
```

```cpp
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     ListNode *next;
 *     ListNode(int x) : val(x), next(NULL) {}
 * };
 */
class Solution {
public:
    ListNode* oddEvenList(ListNode* head) {
        ListNode *even = new ListNode(-1), *odd = new ListNode(-1);
        ListNode *q = even, *p = odd, *t = head;
        while (t) {
            p->next = t;
            p = t;
            t = t->next;
            q->next = t;
            q = t;
            if(t) t = t->next;
        }
        p->next = even->next;
        return odd->next;
    }
};
```

# 329. Longest Increasing Path in a Matrix

Hard

Given an integer matrix, find the length of the longest increasing path.

From each cell, you can either move to four directions: left, right, up or down. You may NOT move diagonally or move outside of the boundary (i.e. wrap-around is not allowed).

**Example 1:**

**Input:** nums =

[

  [9,9,4],

  [6,6,8],

  [2,1,1]

]

**Output:** 4

**Explanation:** The longest increasing path is [1, 2, 6, 9].

**Example 2:**

**Input:** nums =

[

  [3,4,5],

  [3,2,6],

  [2,2,1]

]

**Output:** 4

**Explanation:** The longest increasing path is [3, 4, 5, 6]. Moving diagonally is not allowed.

```cpp
class Solution {
public:
    int longestIncreasingPath(vector<vector<int>>& matrix) {
        if (matrix.empty()) return 0;
        int n = matrix.size(), m = matrix[0].size();

        vector<vector<int>> dp(n, vector<int>(m, 0));
        int ret = 0;
        for (int i = 0; i < n; ++i) {
            for (int j = 0; j < m; ++j) {
                ret = max(ret, dfs(i, j, n, m, matrix, dp));
            }
        }
        return ret;
    }
private:
    const vector<pair<int, int>> dirs = {{-1,0},{1,0},{0 1}, {0,-1}};
    int dfs(int x, int y, int n, int m, vector<vector<int>>& matrix,
             vector<vector<int>> &dp) {
        if (dp[x][y]) return dp[x][y];
        for (auto [dx, dy] : dirs) {
            int xx = x + dx, yy = y + dy;
            if (xx < 0 || xx >= n || yy < 0 || yy >= m) continue;
            if (matrix[xx][yy] <= matrix[x][y]) continue;
            dp[x][y] = max(dp[x][y], dfs(xx, yy, n, m, matrix, dp));
        }
        return ++dp[x][y];
    }
};
```

# 330. Patching Array★★

Hard

Given a sorted positive integer array *nums* and an integer *n*, add/patch elements to the array such that any number in range `[1, n]` inclusive can be formed by the sum of some elements in the array. Return the minimum number of patches required.

**Example 1:**

**Input:** *nums* = [1,3], *n* = 6

**Output:** 1

**Explanation:**

Combinations of *nums* are [1], [3], [1,3], which form possible sums of: 1, 3, 4.

Now if we add/patch 2 to *nums*, the combinations are: [1], [2], [3], [1,3], [2,3], [1,2,3].

Possible sums are 1, 2, 3, 4, 5, 6, which now covers the range [1, 6].

So we only need 1 patch.

**Example 2:**

**Input:** *nums* = [1,5,10], *n* = 20

**Output:** 2

**Explanation:** The two patches can be [2, 4].

**Example 3:**

**Input:** *nums* = [1,2,2], *n* = 5

**Output:** 0

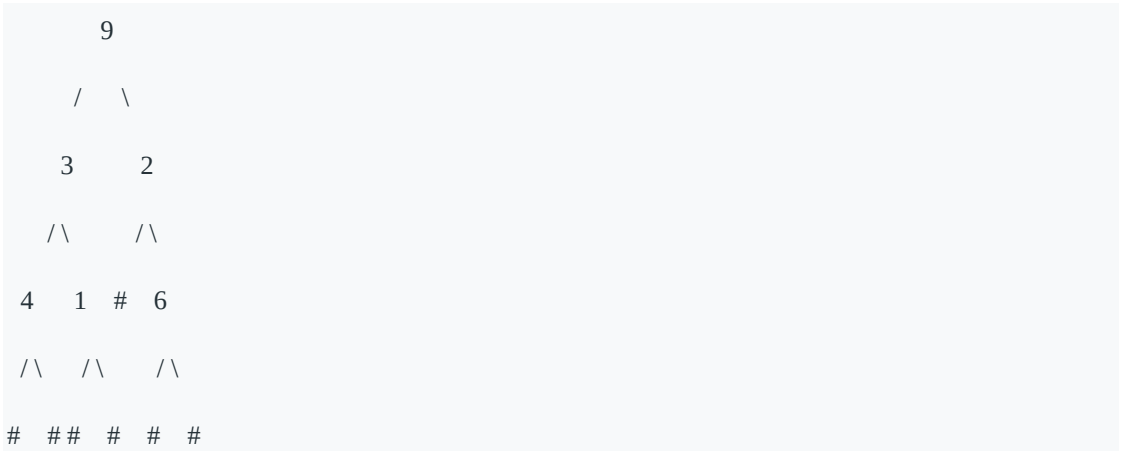
```
class Solution {
public:
    int minPatches(vector<int>& nums, int n) {

    }
};
```

```cpp
class Solution {
public:
    int minPatches(vector<int>& nums, int n) {
        int cnt = 0, i = 0;
        long long maxNum = 1;
        while (maxNum <= n) {
            if (i < nums.size() && nums[i] <= maxNum)
                maxNum += nums[i++];
            else {
                maxNum *= 2;
                cnt++;
            }
        }
        return cnt;
    }
};
```

# 331. Verify Preorder Serialization of a Binary Tree

Medium

One way to serialize a binary tree is to use pre-order traversal. When we encounter a non-null node, we record the node's value. If it is a null node, we record using a sentinel value such as `#`.




For example, the above binary tree can be serialized to the string `"9,3,4,#,#,1,#,#,2,#,6,#,#"`, where `#` represents a null node.

Given a string of comma separated values, verify whether it is a correct preorder traversal serialization of a binary tree. Find an algorithm without reconstructing the tree.

Each comma separated value in the string must be either an integer or a character `'#'` representing `null` pointer.

You may assume that the input format is always valid, for example it could never contain two consecutive commas such as `"1,,3"`.

**Example 1:**

**Input:** "9,3,4,#,#,1,#,#,2,#,6,#,#"

**Output:** true

**Example 2:**

**Input:** "1,#"

**Output:** false

**Example 3:**

**Input:** "9,#,#,1"

**Output:** false

```cpp
class Solution {
public:
    bool isValidSerialization(string preorder) {
        stack<bool> stk;
        stringstream ss(preorder+',');
        char c;
        while (ss >> c) {
            bool Isdigit = isdigit(c);
            while(c != ',') ss >> c;
            if (!insert(stk, Isdigit)) return false;
        }
        return stk.size() == 1 && stk.top() == false;
    }

private:
    bool insert(stack<bool> &stk, bool Isdigit) {
        if (Isdigit) stk.push(true);
        else if (!stk.empty() && stk.top() == false) {
            stk.pop();
            if (stk.empty() || stk.top() != true) return false;
            stk.pop();
            return insert(stk, Isdigit);
        }
        else stk.push(false);
        return true;
    }
};
```

# 332. Reconstruct Itinerary(●ˇ∀ˇ●)

Medium

Given a list of airline tickets represented by pairs of departure and arrival airports `[from, to]`, reconstruct the itinerary in order. All of the tickets belong to a man who departs from `JFK`. Thus, the itinerary must begin with `JFK`.

**Note:**

1. If there are multiple valid itineraries, you should return the itinerary that has the smallest lexical order when read as a single string. For example, the itinerary `["JFK", "LGA"]` has a smaller lexical order than `["JFK", "LGB"]`.
2. All airports are represented by three capital letters (IATA code).
3. You may assume all tickets form at least one valid itinerary.

**Example 1:**

**Input:** [["MUC", "LHR"], ["JFK", "MUC"], ["SFO", "SJC"], ["LHR", "SFO"]]

**Output:** ["JFK", "MUC", "LHR", "SFO", "SJC"]

**Example 2:**

**Input:** [["JFK","SFO"],["JFK","ATL"],["SFO","ATL"],["ATL","JFK"],["ATL","SFO"]]

**Output:** ["JFK","ATL","JFK","SFO","ATL","SFO"]

**Explanation:** Another possible reconstruction is ["JFK","SFO","ATL","JFK","ATL","SFO"].

But it is larger in lexical order.

```cpp
class Solution {
public:
    // fleury's algorithm or Hierholzer algorithm
    vector<string> findItinerary(vector<vector<string>> &tickets) {
        for (auto e : tickets)
            graph[e[0]].push(e[1]);
        dfs("JFK");
        reverse(res.begin(), res.end());
        return res;
    }

private:
    unordered_map<string, priority_queue<string, vector<string>,
greater<string>>> graph;
    vector<string> res;

    void dfs(string from) {
        auto &edges = graph[from];
        while (!edges.empty()) {
            string to = edges.top();
            edges.pop();
            dfs(to);
        }
        res.push_back(from);
    }
};
```

# 333. Largest BST Subtree

Given a binary tree, find the largest subtree which is a Binary Search Tree (BST), where largest means subtree with largest number of nodes in it.

**Note:**
A subtree must include all of its descendants.

**Example:**

```
Input: [10,5,15,1,8,null,7]


   10
   / \
  5  15
 / \   \
1   8   7


Output: 3

Explanation: The Largest BST Subtree in this case is the highlighted one.
             The return value is the subtree's size, which is 3.
```

**Follow up:**
Can you figure out ways to solve it with O(n) time complexity?

```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:
    int largestBSTSubtree(TreeNode* root) {
        int sum = 0, Min = INT_MAX, Max = INT_MIN;
        dfs(root, Min, Max, sum);
        return res;
    }

private:
    int res = 0;
    bool dfs(TreeNode *root, int &Min, int &Max, int &sum) {
        if (root == nullptr) {
            Min = INT_MAX, Max = INT_MIN, sum = 0;
            return true;
        }
        int l_sum = 0, r_sum = 0;
        int l_min = INT_MAX, r_min  = INT_MAX;
        int l_max = INT_MIN, r_max  = INT_MIN;
        bool l_tree = dfs(root->left, l_min, l_max, l_sum);
        bool r_tree = dfs(root->right, r_min, r_max, r_sum);
        Min = min(Min, min(root->val, l_min));
        Max = max(Max, max(root->val, r_max));
       if (l_tree && r_tree && l_max < root->val && r_min > root->val){
            res = max(res, sum = l_sum + r_sum+1);
            return true;
        }
        return false;
    }
};
```

# 334. Increasing Triplet Subsequence

Medium

Given an unsorted array return whether an increasing subsequence of length 3 exists or not in the array.

Formally the function should:

Return true if there exists *i, j, k*
such that *arr[i] < arr[j] < arr[k]* given $0 \leq i < j < k \leq n-1$ else return false.

**Note:** Your algorithm should run in O(*n*) time complexity and O(*1*) space complexity.

**Example 1:**

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

**Output:** true

**Example 2:**

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

**Output:** false

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

    }
};
```

```cpp
class Solution {
public:
    bool increasingTriplet(vector<int>& nums) {
        int i = INT_MAX, j = INT_MAX;
        for (auto &a : nums) {
            if (a <= i) i = a;
            else if (a <= j) j = a;
            else return true;
        }
        return false;
    }
};
```

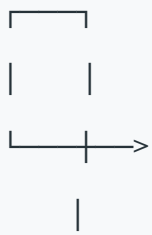
# 335. Self Crossing★★

Hard

You are given an array *x* of `n` positive numbers. You start at point `(0,0)` and moves `x[0]` metres to the north, then `x[1]` metres to the west, `x[2]` metres to the south, `x[3]` metres to the east and so on. In other words, after each move your direction changes counter-clockwise.

Write a one-pass algorithm with `O(1)` extra space to determine, if your path crosses itself, or not.

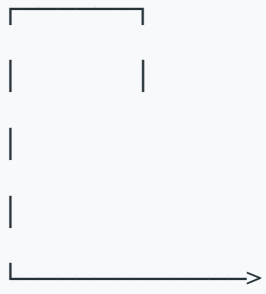
**Example 1:**



**Input:** [2,1,1,2]

**Output:** true

**Example 2:**



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

**Output:** false

**Example 3:**

**Input:** [1,1,1,1]

**Output:** true

```cpp
class Solution {
public:
    bool isSelfCrossing(vector<int>& x) {
        x.insert(x.begin(), 4, 0);
        int i = 4, n = x.size();

        while (i < n && x[i] > x[i-2]) ++i; //逐渐变大

        if (i == n) return false;

        if (x[i] >= x[i-2] - x[i-4]) x[i-1] -= x[i-3];

        ++i;  // [3, 3, 3, 2, 1, 1] 没有的话相等时会出错
        while (i < n && x[i] < x[i-2]) ++i; //逐渐变小

        return i != n;
    }
};
```

# 336. Palindrome Pairs★★

Hard

Given a list of **unique** words, find all pairs of ***distinct*** indices `(i, j)` in the given list, so that the concatenation of the two words, i.e. `words[i] + words[j]` is a palindrome.

**Example 1:**

**Input:** ["abcd","dcba","lls","s","sssll"]

**Output:** [[0,1],[1,0],[3,2],[2,4]]

**Explanation:** The palindromes are ["dcbaabcd","abcddcba","slls","llssssll"]

**Example 2:**

**Input:** ["bat","tab","cat"]

**Output:** [[0,1],[1,0]]

**Explanation:** The palindromes are ["battab","tabbat"]

```cpp
class Solution {
public:
    vector<vector<int>> palindromePairs(vector<string>& words) {
        vector<vector<int>> res;
        unordered_map<string, int> dict;
        int i, j, n = words.size();
        for(i = 0; i < n; i++) {
            string t = words[i];
            reverse(t.begin(), t.end());
            dict[t] = i;
        }

        for(i = 0; i < n; i++) {
            for(j = 0; j < words[i].size(); j++) {
                string left = words[i].substr(0, j);
                string right = words[i].substr(j);
                if(dict.count(left) && dict[left] != i && isPalindrome(right)){
                    res.push_back({i, dict[left]});
                    if (left.empty()) res.push_back({dict[left], i});
                }
                if (dict.count(right) && dict[right] != i
                    && isPalindrome(left)) {
                    res.push_back({dict[right], i});
                }
            }
        }
        return res;
    }

private:
    bool isPalindrome(string s) {
        int start, end, n = s.size();
        for(start = 0, end = n - 1; start < end; start++, end--) {
            if(s[start] != s[end])
                return false;
        }
        return true;
    }
};
```

# 337. House Robber III★★

Medium

The thief has found himself a new place for his thievery again. There is only one entrance to this area, called the "root." Besides the root, each house has one and only one parent house. After a tour, the smart thief realized that "all houses in this place forms a binary tree". It will automatically contact the police if two directly-linked houses were broken into on the same night.

Determine the maximum amount of money the thief can rob tonight without alerting the police.

**Example 1:**

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

**Output:** 7

**Explanation:** Maximum amount of money the thief can rob = 3 + 3 + 1 = **7**.

**Example 2:**

**Input:** [3,4,5,1,3,null,1]

**Output:** 9

**Explanation:** Maximum amount of money the thief can rob = 4 + 5 = **9**.

```cpp
class Solution {
public:
    using pii =  pair<int,int>;

    int rob(TreeNode* root) {
        pii res = dfs(root);
        return max(res.first, res.second);
    }
private:
    map<TreeNode*, pii> mp;

    pii dfs(TreeNode* p) {
        if (!p) return {0, 0};
        if (mp.count(p)) return mp[p];
        pii ret(0, p->val);
        if (p->left) {
            auto t = dfs(p->left);
            ret.first += max(t.first, t.second);
            ret.second += t.first;
        }
        if (p->right) {
            auto t = dfs(p->right);
            ret.first += max(t.first, t.second);
            ret.second += t.first;
        }
        return mp[p] = ret;
    }
};
```

# 338. Counting Bits★★

Medium

Given a non negative integer number **num**. For every numbers **i** in the range **0 ≤ i ≤ num** calculate the number of 1's in their binary representation and return them as an array.

**Example 1:**

**Input:** 2

**Output:** [0,1,1]

**Example 2:**

**Input:** 5

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

**Follow up:**

- It is very easy to come up with a solution with run time **O(n*sizeof(integer))**. But can you do it in linear time **O(n)** /possibly in a single pass?
- Space complexity should be **O(n)**.
- Can you do it like a boss? Do it without using any builtin function like **__builtin_popcount** in c++ or in any other language.

```
class Solution {
public:
    vector<int> countBits(int num) {

    }
};
```

```cpp
class Solution {
public:
    vector<int> countBits(int num) {
        vector<int> res(num + 1, 0);
        for (int i = 1; i <= num; ++i) {
            res[i] = res[i >> 1] + (i & 1);
        }
        return res;
    }
};
```

# 339. Nested List Weight Sum

Given a nested list of integers, return the sum of all integers in the list weighted by their depth.

Each element is either an integer, or a list -- whose elements may also be integers or other lists.

**Example 1:**

```
Input: [[1,1],2,[1,1]]

Output: 10

Explanation: Four 1's at depth 2, one 2 at depth 1.
```

**Example 2:**

```
Input: [1,[4,[6]]]

Output: 27

Explanation: One 1 at depth 1, one 4 at depth 2, and one 6 at depth 3; 1 +
4*2 + 6*3 = 27.
```

```
/**
 * // This is the interface that allows for creating nested lists.
 * // You should not implement it, or speculate about its implementation
 * class NestedInteger {
 *   public:
 *     // Constructor initializes an empty nested list.
 *     NestedInteger();
 *
 *     // Constructor initializes a single integer.
 *     NestedInteger(int value);
 *
 *     // Return true if this NestedInteger holds a single integer, rather
than a nested list.
 *     bool isInteger() const;
 *
 *     // Return the single integer that this NestedInteger holds, if it
holds a single integer
 *     // The result is undefined if this NestedInteger holds a nested list
 *     int getInteger() const;
 *
 *     // Set this NestedInteger to hold a single integer.
 *     void setInteger(int value);
 *
 *     // Set this NestedInteger to hold a nested list and adds a nested
integer to it.
 *     void add(const NestedInteger &ni);
 *
 *     // Return the nested list that this NestedInteger holds, if it holds a
nested list
 *     // The result is undefined if this NestedInteger holds a single
integer
 *     const vector<NestedInteger> &getList() const;
 * };
 */

class Solution {
public:
    int depthSum(vector<NestedInteger>& nestedList) {

    }
};
```

```cpp
class Solution {
public:
    int depthSum(vector<NestedInteger>& nestedList) {
        return dfs(1, nestedList);
    }

private:
    int dfs(int depth, vector<NestedInteger>& nestedList) {
        int ret = 0;
        for (auto &nest : nestedList) {
            if (nest.isInteger()) ret += depth*nest.getInteger();
            else ret += dfs(depth+1, nest.getList());
        }
        return ret;
    }
};
```

# 340. Longest Substring with At Most K Distinct Characters

Given a string, find the length of the longest substring T that contains at most *k* distinct characters.

**Example 1:**

```
Input: s = "eceba", k = 2

Output: 3

Explanation: T is "ece" which its length is 3.
```

**Example 2:**

```
Input: s = "aa", k = 1

Output: 2

Explanation: T is "aa" which its length is 2.
```

```
class Solution {
public:
    int lengthOfLongestSubstringKDistinct(string s, int k) {

    }
};
```

```cpp
class Solution {
public:
    int lengthOfLongestSubstringKDistinct(string s, int k) {
        int res = 0, left = 0, n = s.size();
        unordered_map<char, int> m;
        for (int i = 0; i < n; ++i) {
            ++m[s[i]];
            while (m.size() > k) {
                if (--m[s[left]] == 0) m.erase(s[left]);
                ++left;
            }
            res = max(res, i - left + 1);
        }
        return res;
    }
};
```

# 341. Flatten Nested List Iterator

Medium

Given a nested list of integers, implement an iterator to flatten it.

Each element is either an integer, or a list -- whose elements may also be integers or other lists.

**Example 1:**

**Input:** [[1,1],2,[1,1]]

**Output:** [1,1,2,1,1]

**Explanation:** By calling *next* repeatedly until *hasNext* returns false,

the order of elements returned by *next* should be: [1,1,2,1,1].

**Example 2:**

**Input:** [1,[4,[6]]]

**Output:** [1,4,6]

**Explanation:** By calling *next* repeatedly until *hasNext* returns false,

the order of elements returned by *next* should be: [1,4,6].

```
/**
 * // This is the interface that allows for creating nested lists.
 * // You should not implement it, or speculate about its implementation
 * class NestedInteger {
 *   public:
 *     // Return true if this NestedInteger holds a single integer, rather
than a nested list.
 *     bool isInteger() const;
 *
 *     // Return the single integer that this NestedInteger holds, if it
holds a single integer
 *     // The result is undefined if this NestedInteger holds a nested list
 *     int getInteger() const;
 *
 *     // Return the nested list that this NestedInteger holds, if it holds a
nested list
 *     // The result is undefined if this NestedInteger holds a single
integer
 *     const vector<NestedInteger> &getList() const;
 * };
 */
```

```
class NestedIterator {
public:
    NestedIterator(vector<NestedInteger> &nestedList) {
        int n = nestedList.size();
        for(int i = n-1; i >= 0; --i) {
            stk.push(nestedList[i]);
        }
    }

    int next() {
        int result = stk.top().getInteger();
        stk.pop();
        return result;
    }


    bool hasNext() {
        while (!stk.empty()) {
            auto cur = stk.top();
            if (cur.isInteger()) return true;
            stk.pop();
            auto &adjs = cur.getList();
            int n = adjs.size();
            for (int i = n-1; i >= 0; --i) stk.push(adjs[i]);
        }
        return false;
    }
private:
    stack<NestedInteger> stk;
};
```

# 342. Power of Four

Easy

Given an integer (signed 32 bits), write a function to check whether it is a power of 4.

**Example 1:**

**Input:** 16

**Output:** true

**Example 2:**

**Input:** 5

**Output:** false

**Follow up**: Could you solve it without loops/recursion?

```
class Solution {
public:
    bool isPowerOfFour(int num) {
        return num > 0 && (num & (num - 1)) == 0 && (num - 1) % 3 == 0;
        //return (num > 0) && ((num & (num - 1)) == 0) && ((num & 0x55555555)
== num);
    }
};
```

# 343. Integer Break

Medium

Given a positive integer *n*, break it into the sum of **at least** two positive integers and maximize the product of those integers. Return the maximum product you can get.

**Example 1:**

**Input:** 2

**Output:** 1

**Explanation:** 2 = 1 + 1, 1 × 1 = 1.

**Example 2:**

**Input:** 10

**Output:** 36

**Explanation:** 10 = 3 + 3 + 4, 3 × 3 × 4 = 36.

**Note**: You may assume that *n* is not less than 2 and not larger than 58.

```cpp
class Solution {
public:
    int integerBreak(int n) {
        if (n <= 3) return n - 1;
        int a = n / 3, b = n % 3;
        if (b == 0) return pow(3, a);
        else if (b == 1) return pow(3, a - 1) * 4;
        else return pow(3, a) * 2;
    }
};
```

```cpp
class Solution {
public:
    int integerBreak(int n) {
        if (n <= 3) return n-1;
        vector<int> dp(n+1, 0);
        dp[1] = 1, dp[2] = 2, dp[3] = 3;
        for (int i = 4; i <= n; ++i) {
            for (int j = 2; j < i; ++j) {
                dp[i] = max(dp[i], j * dp[i-j]);
            }
        }
        return dp[n];
    }
};
```

# 344. Reverse String

Easy

Write a function that reverses a string. The input string is given as an array of characters `char[]`.

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

You may assume all the characters consist of printable ascii characters.

**Example 1:**

**Input:** ["h","e","l","l","o"]

**Output:** ["o","l","l","e","h"]

**Example 2:**

**Input:** ["H","a","n","n","a","h"]

**Output:** ["h","a","n","n","a","H"]

```
class Solution {
public:
    void reverseString(vector<char>& s) {
        int i = 0, j = s.size()-1;
        while (i < j) {
            swap(s[i++], s[j--]);
        }
    }
};
```

# 345. Reverse Vowels of a String

Easy

Write a function that takes a string as input and reverse only the vowels of a string.

**Example 1:**

**Input:** "hello"

**Output:** "holle"

**Example 2:**

**Input:** "leetcode"

**Output:** "leotcede"

**Note:**
The vowels does not include the letter "y".

```
class Solution {
public:
    string reverseVowels(string s) {
        int i = 0, j = s.size()-1;
        while (i < j) {
            i = s.find_first_of("aeiouAEIOU", i);
            j = s.find_last_of("aeiouAEIOU", j);
            if (i < j)  swap(s[i++], s[j--]);
        }
        return s;
    }
};
```

# 346. Moving Average from Data Stream

Given a stream of integers and a window size, calculate the moving average of all integers in the sliding window.

**Example:**

```
MovingAverage m = new MovingAverage(3);

m.next(1) = 1

m.next(10) = (1 + 10) / 2

m.next(3) = (1 + 10 + 3) / 3

m.next(5) = (10 + 3 + 5) / 3
```

```
class MovingAverage {
public:
    /** Initialize your data structure here. */
    MovingAverage(int size) {
        this->size = size;
    }

    double next(int val) {
        q.push(val);
        if (q.size() > size) {
            sum -= q.front();
            q.pop();
        }
        return (sum += val)/q.size();
    }

private:
    int size;
    double sum = 0;
    queue<int> q;
};
```

# 347. Top K Frequent Elements★★

Medium

Given a non-empty array of integers, return the ***k*** most frequent elements.

**Example 1:**

**Input:** nums = [1,1,1,2,2,3], k = 2

**Output:** [1,2]

**Example 2:**

**Input:** nums = [1], k = 1

**Output:** [1]

**Note:**

- You may assume *k* is always valid, $1 \leq k \leq$ number of unique elements.
- Your algorithm's time complexity **must be** better than O(*n* log *n*), where *n* is the array's size.

```
class Solution {
public:
    vector<int> topKFrequent(vector<int>& nums, int k) {

    }
};
```

```cpp
class Solution {
public:
    vector<int> topKFrequent(vector<int> &nums, int k) {
        unordered_map<int, int> counts;
        for(auto i : nums) ++counts[i];
        vector<vector<int>> buckets(nums.size() + 1);
        for(auto &k : counts) buckets[k.second].push_back(k.first);
        vector<int> res;
        for(int t = buckets.size()-1; t >= 0; t--) {
            for(auto i : buckets[t]) {
                res.push_back(i);
                if (res.size() == k) return res;
            }
        }
        return res;
    }
};
```

# 348. Design Tic-Tac-Toe

Design a Tic-tac-toe game that is played between two players on a *n* x *n* grid.

You may assume the following rules:

1. A move is guaranteed to be valid and is placed on an empty block.
2. Once a winning condition is reached, no more moves is allowed.
3. A player who succeeds in placing *n* of their marks in a horizontal, vertical, or diagonal row wins the game.

**Example:**

```
Given n = 3, assume that player 1 is "X" and player 2 is "O" in the board.


TicTacToe toe = new TicTacToe(3);


toe.move(0, 0, 1); -> Returns 0 (no one wins)

|X| | |

| | | |    // Player 1 makes a move at (0, 0).

| | | |


toe.move(0, 2, 2); -> Returns 0 (no one wins)

|X| |O|

| | | |    // Player 2 makes a move at (0, 2).

| | | |


toe.move(2, 2, 1); -> Returns 0 (no one wins)

|X| |O|

| | | |    // Player 1 makes a move at (2, 2).

| | |X|
```

```
toe.move(1, 1, 2); -> Returns 0 (no one wins)
|X| |O|
| |O| |    // Player 2 makes a move at (1, 1).
| | |X|


toe.move(2, 0, 1); -> Returns 0 (no one wins)
|X| |O|
| |O| |    // Player 1 makes a move at (2, 0).
|X| |X|


toe.move(1, 0, 2); -> Returns 0 (no one wins)
|X| |O|
|O|O| |    // Player 2 makes a move at (1, 0).
|X| |X|


toe.move(2, 1, 1); -> Returns 1 (player 1 wins)
|X| |O|
|O|O| |    // Player 1 makes a move at (2, 1).
|X|X|X|
```

**Follow up:**
Could you do better than O($n^2$) per `move()` operation?

```cpp
class TicTacToe {
public:
    /** Initialize your data structure here. */
    TicTacToe(int n) {
        this->n = n;
        R.resize(n, 0);
        C.resize(n, 0);
    }

    int move(int row, int col, int player) {
        int add = (player == 2) ? -1 : 1;
        if (judge(row, add, R) || judge(col, add, C)) return player;
        else if (row == col && judge_diag(0, add)) return player;
        else if (row + col == n-1 && judge_diag(1, add)) return player;
        else return 0;
    }

private:
    int n;
    vector<int> R, C, diag{0, 0};

    bool judge(int row, int add, vector<int> &R) {
        if (abs(R[row] += add) == n)  return true;
        else return false;
    }

    bool judge_diag(int type, int add) {
        if (abs(diag[type] += add) == n) return true;
        else return false;
    }
};
```

# 349. Intersection of Two Arrays

Easy

Given two arrays, write a function to compute their intersection.

**Example 1:**

**Input:** nums1 = [1,2,2,1], nums2 = [2,2]

**Output:** [2]

**Example 2:**

**Input:** nums1 = [4,9,5], nums2 = [9,4,9,8,4]

**Output:** [9,4]

**Note:**

- Each element in the result must be unique.
- The result can be in any order.

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

    }
};
```

```cpp
class Solution {
public:
    vector<int> intersection(vector<int>& nums1, vector<int>& nums2) {
        sort(nums1.begin(), nums1.end());
        sort(nums2.begin(), nums2.end());
        int n1 = nums1.size(), n2 = nums2.size();
        int i1 = 0, i2 = 0;
        vector<int> res;
        while (i1 < n1 && i2 < n2){
            if (nums1[i1] == nums2[i2]) {
                res.push_back(nums1[i1]);
                i1++; i2++;
                while (i1 < n1 && nums1[i1] == nums1[i1-1]) i1++;
                while (i2 < n2 && nums2[i2] == nums2[i2-1]) i2++;
            }
            else if(nums1[i1] > nums2[i2])  {
                i2++;
                while (i2 < n2 && nums2[i2] == nums2[i2-1]) i2++;
            }
            else {
                i1++;
                while (i1 < n1 && nums1[i1] == nums1[i1-1]) i1++;
            }
        }
        return res;
    }
};
```

```cpp
class Solution {
public:
    vector<int> intersection(vector<int>& nums1, vector<int>& nums2) {
        vector<int> res;
        unordered_map<int, bool> m;
        for (auto i : nums1)  m[i] = true;
        for (auto i : nums2) if (m[i]){
            res.push_back(i);
            m[i] = false;
        }
        return res;
    }
};
```

# 350. Intersection of Two Arrays II

Easy

Given two arrays, write a function to compute their intersection.

**Example 1:**

**Input:** nums1 = [1,2,2,1], nums2 = [2,2]

**Output:** [2,2]

**Example 2:**

**Input:** nums1 = [4,9,5], nums2 = [9,4,9,8,4]

**Output:** [4,9]

**Note:**

- Each element in the result should appear as many times as it shows in both arrays.
- The result can be in any order.

**Follow up:**

- What if the given array is already sorted? How would you optimize your algorithm?
- What if *nums1*'s size is small compared to *nums2*'s size? Which algorithm is better?
- What if elements of *nums2* are stored on disk, and the memory is limited such that you cannot load all elements into the memory at once?

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

    }
};
```

```cpp
class Solution {
public:
    vector<int> intersect(vector<int>& nums1, vector<int>& nums2) {
        sort(nums1.begin(), nums1.end());
        sort(nums2.begin(), nums2.end());
        int n1 = nums1.size(), n2 = nums2.size();
        int i1 = 0, i2 = 0;
        vector<int> res;
        while (i1 < n1 && i2 < n2){
            if (nums1[i1] == nums2[i2]) {
                res.push_back(nums1[i1]);
                i1++;
                i2++;
            }
            else if(nums1[i1] > nums2[i2]) i2++;
            else i1++;
        }
        return res;
    }
};
```

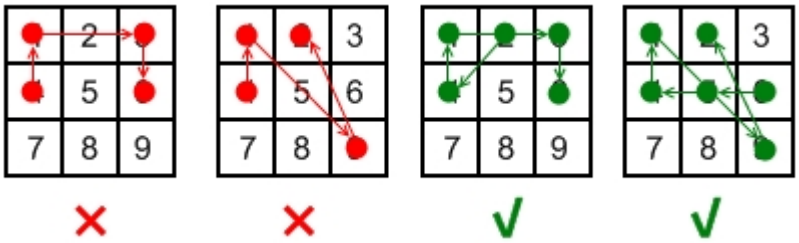
```cpp
class Solution {
public:
    vector<int> intersect(vector<int>& nums1, vector<int>& nums2) {
        vector<int> res;
        unordered_map<int, int> m;
        for (auto i : nums1)  m[i]++;
        for (auto i : nums2) if (m[i] > 0){
            res.push_back(i);
            m[i]--;
        }
        return res;
    }
};
```

# 351. Android Unlock Patterns

Given an Android **3x3** key lock screen and two integers **m** and **n**, where 1 ≤ m ≤ n ≤ 9, count the total number of unlock patterns of the Android lock screen, which consist of minimum of **m** keys and maximum **n** keys.

**Rules for a valid pattern:**

1. Each pattern must connect at least **m** keys and at most **n** keys.
2. All the keys must be distinct.
3. If the line connecting two consecutive keys in the pattern passes through any other keys, the other keys must have previously selected in the pattern. No jumps through non selected key is allowed.
4. The order of keys used matters.




**Explanation:**

```
| 1 | 2 | 3 |

| 4 | 5 | 6 |

| 7 | 8 | 9 |
```

**Invalid move:** `4 - 1 - 3 - 6`
Line 1 - 3 passes through key 2 which had not been selected in the pattern.

**Invalid move:** `4 - 1 - 9 - 2`
Line 1 - 9 passes through key 5 which had not been selected in the pattern.

**Valid move:** `2 - 4 - 1 - 3 - 6`
Line 1 - 3 is valid because it passes through key 2, which had been selected in the pattern

**Valid move:** `6 - 5 - 4 - 1 - 9 - 2`
Line 1 - 9 is valid because it passes through key 5, which had been selected in the pattern.

**Example:**

**Input:** `m = 1, n = 1`

**Output:** `9`

```cpp
class Solution {
public:
    int numberOfPatterns(int m, int n) {
        vector<bool> visited(10, false);
        vector<vector<int>> jumps(10, vector<int>(10, 0));
        jumps[1][3] = jumps[3][1] = 2;
        jumps[4][6] = jumps[6][4] = 5;
        jumps[7][9] = jumps[9][7] = 8;
        jumps[1][7] = jumps[7][1] = 4;
        jumps[2][8] = jumps[8][2] = 5;
        jumps[3][9] = jumps[9][3] = 6;
        jumps[1][9] = jumps[9][1] = jumps[3][7] = jumps[7][3] = 5;
        res += helper(1, 1, m, n, jumps, visited) * 4;
        res += helper(2, 1, m, n, jumps, visited) * 4;
        res += helper(5, 1, m, n, jumps, visited);
        return res;
    }
private:
    int res = 0;

    int helper(int num, int len, int m, int n,vector<vector<int>>&jumps
, vector<bool> &visited) {
        int ret = 0;
        if (len++ >= m) ++ret;
        if (len > n) return ret;
        visited[num] = true;
        for (int next = 1; next <= 9; ++next) {
            int jump = jumps[num][next];
            if (!visited[next] && (jump == 0 || visited[jump])) {
                ret += helper(next, len, m, n, jumps, visited);
            }
        }
        visited[num] = false;
        return ret;
    }
};
```

# 352. Data Stream as Disjoint Intervals

Hard

Given a data stream input of non-negative integers $a_1$, $a_2$, ..., $a_n$, ..., summarize the numbers seen so far as a list of disjoint intervals.

For example, suppose the integers from the data stream are 1, 3, 7, 2, 6, ..., then the summary will be:

```
[1, 1]

[1, 1], [3, 3]

[1, 1], [3, 3], [7, 7]

[1, 3], [7, 7]

[1, 3], [6, 7]
```

**Follow up:**

What if there are lots of merges and the number of disjoint intervals are small compared to the data stream's size?

```
class SummaryRanges {
public:
    /** Initialize your data structure here. */
    void addNum(int val) {
        if (hash_set.count(val)) return;
        hash_set.insert(val);
        auto it = st.lower_bound({val, val});
        int start = val, end = val;
        if (it != st.begin() && (*prev(it))[1] + 1 == val) --it;
        while (it != st.end() && val+1 >= (*it)[0]
                                  && val-1 <= (*it)[1]) {
            start = min(start, (*it)[0]);
            end = max(end, (*it)[1]);
            it = st.erase(it);
        }
        st.insert(vector<int> {start, end});
    }

    vector<vector<int>> getIntervals() {
        return vector<vector<int>> (st.begin(), st.end());
    }
private:
    unordered_set<int> hash_set;
    set<vector<int>> st;
};
```

# 353. Design Snake Game

Design a Snake game that is played on a device with screen size = *width* x *height*. Play the game online if you are not familiar with the game.

The snake is initially positioned at the top left corner (0,0) with length = 1 unit.

You are given a list of food's positions in row-column order. When a snake eats the food, its length and the game's score both increase by 1.

Each food appears one by one on the screen. For example, the second food will not appear until the first food was eaten by the snake.

When a food does appear on the screen, it is guaranteed that it will not appear on a block occupied by the snake.

**Example:**

```
Given width = 3, height = 2, and food = [[1,2],[0,1]].

Snake snake = new Snake(width, height, food);

Initially the snake appears at position (0,0) and the food at (1,2).

|S| | |

| | |F|

snake.move("R"); -> Returns 0

| |S| |

| | |F|

snake.move("D"); -> Returns 0

| | | |

| |S|F|

snake.move("R"); -> Returns 1 (Snake eats the first food and right after
that, the second food appears at (0,1) )

| |F| |

| |S|S|

snake.move("U"); -> Returns 1
```

| |F|S|

| | |S|

snake.move("L"); -> Returns 2 (Snake eats the second food)

| |S|S|

| | |S|

snake.move("U"); -> Returns -1 (Game over because snake collides with border)

```cpp
class SnakeGame {
public:
    SnakeGame(int width, int height, vector<vector<int>> &food) {
        g.resize(n = height, vector<int> (m = width, -1));
        this->food = food;
    }

    int move(string direction) {
        g[x][y] = mp[direction];
        x += dir[mp[direction]].first, y += dir[mp[direction]].second;
        if (x < 0 || x >= n || y < 0 || y >= m) return -1;
        if (k < food.size() && x == food[k][0] && y == food[k][1]) {
            k++;
            score++;
        } else{
            int new_xx = xx + dir[g[xx][yy]].first,
                new_yy = yy + dir[g[xx][yy]].second;
            g[xx][yy] = -1;
            xx = new_xx, yy = new_yy;
        }
        return g[x][y] == -1 ? score : -1;
    }

private:
    map<string, int> mp{{"U", 0}, {"D", 1}, {"L", 2}, {"R", 3}};
    vector<pair<int, int>> dir{{-1, 0}, {1, 0}, {0, -1}, {0, 1}};
    int n, m, score = 0, k = 0;
    int x = 0, y = 0, xx = 0, yy = 0;
    vector<vector<int>> food, g;
};
```

# 354. Russian Doll Envelopes★★

Hard

You have a number of envelopes with widths and heights given as a pair of integers `(w, h)`. One envelope can fit into another if and only if both the width and height of one envelope is greater than the width and height of the other envelope.

What is the maximum number of envelopes can you Russian doll? (put one inside other)

**Note:**

Rotation is not allowed.

**Example:**

**Input:** [[5,4],[6,4],[6,7],[2,3]]

**Output:** 3

**Explanation:** The maximum number of envelopes you can Russian doll is 3 ([2,3] => [5,4] => [6,7])

```
class Solution {
public:
    int maxEnvelopes(vector<vector<int>>& envelopes) {
        sort(envelopes.begin(), envelopes.end(), [](vector<int> &a,
vector<int> &b){
            return a[0] < b[0] || (a[0] == b[0] && a[1] > b[1]);
        });
        vector<int> dp;
        for (auto &v : envelopes) {
            auto iter = lower_bound(dp.begin(), dp.end(), v[1]);
            if (iter == dp.end()) dp.push_back(v[1]);
            else if (v[1] < *iter) *iter = v[1];
        }
        return dp.size();
    }
};
```

# 355. Design Twitter

Medium

583148FavoriteShare

Design a simplified version of Twitter where users can post tweets, follow/unfollow another user and is able to see the 10 most recent tweets in the user's news feed. Your design should support the following methods:

1. **postTweet(userId, tweetId)**: Compose a new tweet.
2. **getNewsFeed(userId)**: Retrieve the 10 most recent tweet ids in the user's news feed. Each item in the news feed must be posted by users who the user followed or by the user herself. Tweets must be ordered from most recent to least recent.
3. **follow(followerId, followeeId)**: Follower follows a followee.
4. **unfollow(followerId, followeeId)**: Follower unfollows a followee.

**Example:**

```
Twitter twitter = new Twitter();

// User 1 posts a new tweet (id = 5).

twitter.postTweet(1, 5);

// User 1's news feed should return a list with 1 tweet id -> [5].

twitter.getNewsFeed(1);

// User 1 follows user 2.

twitter.follow(1, 2);

// User 2 posts a new tweet (id = 6).

twitter.postTweet(2, 6);

// User 1's news feed should return a list with 2 tweet ids -> [6, 5].

// Tweet id 6 should precede tweet id 5 because it is posted after tweet id 5.

twitter.getNewsFeed(1);

// User 1 unfollows user 2.

twitter.unfollow(1, 2);

// User 1's news feed should return a list with 1 tweet id -> [5],
```

```
// since user 1 is no longer following user 2.

twitter.getNewsFeed(1);
```

```
class Twitter {
public:
    struct cmp {
        template <typename T>
        bool operator() (T const &lhs, T const &rhs) {
            return lhs.first > rhs.first;
        }
    };
    Twitter() {}

    void postTweet(int userId, int tweetId) {
        follow(userId, userId);
        twitter[userId].push_back(make_pair(timestamp++, tweetId));
    }


    vector<int> getNewsFeed(int userId) {
        priority_queue<pair<int, int>, vector<pair<int, int>>, cmp> pq;
        for (auto &i : user[userId]) {
            for (auto &pii : twitter[i]) {
                if (!pq.empty()  && pq.top().first > pii.first && pq.size() > 10)
                    break;
                pq.push(pii);
                if (pq.size() > 10) pq.pop();
            }
        }
        vector<int> res;
        while (!pq.empty()) {
            res.push_back(pq.top().second);
            pq.pop();
        }
        reverse(res.begin(), res.end());
        return res;
    }
```

```
    void follow(int followerId, int followeeId) {
        user[followerId].insert(followeeId);
    }

    void unfollow(int followerId, int followeeId) {
        if (followerId != followeeId) {
            user[followerId].erase(followeeId);
        }
    }

private:
    int timestamp = 0;
    unordered_map<int, unordered_set<int>> user;
    unordered_map<int, vector<pair<int, int>>> twitter;
};
```

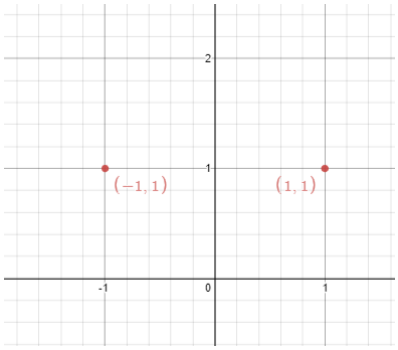
# 356. Line Reflection

Given n points on a 2D plane, find if there is such a line parallel to y-axis that reflect the given points symmetrically, in other words, answer whether or not if there exists a line that after reflecting all points over the given line the set of the original points is the same that the reflected ones.

Note that there can be repeated points.

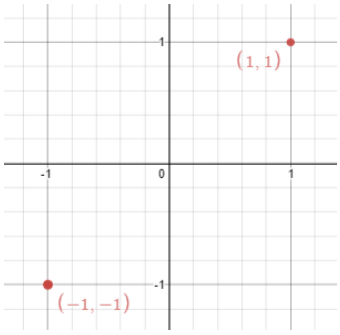
**Follow up:**
Could you do better than O($n^2$) ?

**Example 1:**




```
Input: points = [[1,1],[-1,1]]

Output: true

Explanation: We can choose the line x = 0.
```

**Example 2:**




```
Input: points = [[1,1],[-1,-1]]

Output: false

Explanation: We can't choose a line.
```

**Constraints:**

- `n == points.length`
- `1 <= n <= 10^4`
- `-10^8 <= points[i][j] <= 10^8`

```cpp
class Solution {
public:
    bool isReflected(vector<vector<int>>& points) {
        unordered_map<int, vector<int>> mp;
        for (auto v : points) {
            mp[v[1]].push_back(v[0]);
        }
        double mid;
        bool isFirst = true;
        for (auto &i : mp) {
            vector<int> &v = i.second;
            v.erase(unique(v.begin(), v.end()), v.end());
            sort(v.begin(), v.end());
            int l = 0, r = v.size()-1;
            while (l <= r) {
                double m = (v[l++] + v[r--]) / 2.0;
                if (isFirst) {
                    mid = m;
                    isFirst = false;
                }
                if (m != mid) return false;
            }
        }
        return true;
    }
};
```

# 357. Count Numbers with Unique Digits

Medium

Given a **non-negative** integer n, count all numbers with unique digits, x, where $0 \leq x < 10^n$.

**Example:**

**Input:** 2

**Output:** 91

**Explanation:** The answer should be the total numbers in the range of $0 \leq x < 100$,

excluding 11,22,33,44,55,66,77,88,99

```
class Solution {
public:
    int countNumbersWithUniqueDigits(int n) {
        int res = 1;
        while (n-- >= 1) {
            int t = 9;
            for (int i = 9; i >= 10-n; --i) {
                t *= i;
            }
            res += t;
        }
        return res;
    }
};
```

# 358. Rearrange String k Distance Apart

Given a non-empty string **s** and an integer **k**, rearrange the string such that the same characters are at least distance **k** from each other.

All input strings are given in lowercase letters. If it is not possible to rearrange the string, return an empty string `""`.

**Example 1:**

**Input:** `s = "aabbcc", k = 3`

**Output:** `"abcabc"`

**Explanation:** The same letters are at least distance 3 from each other.

**Example 2:**

**Input:** `s = "aaabc", k = 3`

**Output:** `""`

**Explanation:** It is not possible to rearrange the string.

**Example 3:**

**Input:** `s = "aaadbbcc", k = 2`

**Output:** `"abacabcd"`

**Explanation:** The same letters are at least distance 2 from each other.

```cpp
class Solution {
public:
    string rearrangeString(string str, int k) {
        if (k == 0) return str;
        string res;
        int len = str.size();
        unordered_map<char, int> mp;
        priority_queue<pair<int, char>> pq;
        for (auto i : str) ++mp[i];
        for (auto i : mp) pq.emplace(i.second, i.first);

        while (!pq.empty()) {
            vector<pair<int, char>> v;
            int cnt = min(k, len);
            for (int i = 0; i < cnt; ++i) {
                if (pq.empty()) return "";
                auto t = pq.top();
                pq.pop();
                if (--t.first > 0) v.push_back(t);
                res += t.second;
                --len;
            }
            for (auto a : v) pq.push(a);
        }
        return res;
    }
};
```

# 359. Logger Rate Limiter

Design a logger system that receive stream of messages along with its timestamps, each message should be printed if and only if it is **not printed in the last 10 seconds**.

Given a message and a timestamp (in seconds granularity), return true if the message should be printed in the given timestamp, otherwise returns false.

It is possible that several messages arrive roughly at the same time.

**Example:**

```
Logger logger = new Logger();

// logging string "foo" at timestamp 1

logger.shouldPrintMessage(1, "foo"); returns true;

// logging string "bar" at timestamp 2

logger.shouldPrintMessage(2,"bar"); returns true;

// logging string "foo" at timestamp 3

logger.shouldPrintMessage(3,"foo"); returns false;

// logging string "bar" at timestamp 8

logger.shouldPrintMessage(8,"bar"); returns false;

// logging string "foo" at timestamp 10

logger.shouldPrintMessage(10,"foo"); returns false;

// logging string "foo" at timestamp 11

logger.shouldPrintMessage(11,"foo"); returns true;
```

```cpp
class Logger {
public:
    Logger() {}

    bool shouldPrintMessage(int timestamp, string message) {
        if (!mp.count(message) || timestamp - mp[message] >= 10) {
            mp[message] = timestamp;
            return true;
        }
        return false;
    }
private:
    unordered_map<string, int> mp;
};
```

# 360. Sort Transformed Array

Given a **sorted** array of integers *nums* and integer values *a*, *b* and *c*. Apply a quadratic function of the form f(*x*) = $ax^2 + bx + c$ to each element *x* in the array.

The returned array must be in **sorted order**.

Expected time complexity: **O(*n*)**

**Example 1:**

**Input:** nums = [-4,-2,2,4], a = 1, b = 3, c = 5

**Output:** [3,9,15,33]

**Example 2:**

**Input:** nums = [-4,-2,2,4], a = -1, b = 3, c = 5

**Output:** [-23,-5,1,7]

```cpp
class Solution {
public:
    vector<int> sortTransformedArray(vector<int>& nums, int a, int b,
int c) {
        int n = nums.size();
        vector<int> res;
        double mid = -b / (2.0*a);
        int high = lower_bound(nums.begin(), nums.end(), mid)-
                  nums.begin(), low = high-1;
        for (int i = 0; i < n; i++) {
            int x;
            if (low >= 0 && (high == n ||nums[high]+nums[low] > 2*mid))
                  x = nums[low--];
            else x = nums[high++];
            res.push_back((a*x+b)*x + c);
        }
        if (a < 0) reverse(res.begin(), res.end());
        return res;
    }
};
```

# 361. Bomb Enemy

Given a 2D grid, each cell is either a wall `'W'`, an enemy `'E'` or empty `'0'` (the number zero), return the maximum enemies you can kill using one bomb.
The bomb kills all the enemies in the same row and column from the planted point until it hits the wall since the wall is too strong to be destroyed.
**Note:** You can only put the bomb at an empty cell.

**Example:**

**Input:** `[["0","E","0","0"],["E","0","W","E"],["0","E","0","0"]]`

**Output:** `3`

**Explanation:** `For the given grid,`

```
0 E 0 0

E 0 W E

0 E 0 0
```

```
Placing a bomb at (1,1) kills 3 enemies.
```

```cpp
class Solution {
public:
    int maxKilledEnemies(vector<vector<char>>& grid) {
        if (grid.empty()) return 0;
        int n = grid.size(), m = grid[0].size(), res = 0;
        vector<int> col(n, 0), row(m, 0);
        for (int i = 0; i < n; i++) {
            for (int j = 0; j < m; j++) {
                if (grid[i][j] == 'W') {
                    row[j] = col[i] = 0;
                    continue;
                }
                if (!col[i]) {
                   for (int jj = j; jj < m && grid[i][jj] !='W'; jj++){
                       if (grid[i][jj] == 'E') col[i]++;
                   }
                }
                if (!row[j]) {
                   for (int ii = i; ii < n && grid[ii][j] !='W'; ii++){
                       if (grid[ii][j] == 'E') row[j]++;
                   }
                }
                if (grid[i][j] == '0') res = max(res, col[i]+row[j]);
            }
        }
        return res;
    }
};
```

# 362. Design Hit Counter

Design a hit counter which counts the number of hits received in the past 5 minutes.

Each function accepts a timestamp parameter (in seconds granularity) and you may assume that calls are being made to the system in chronological order (ie, the timestamp is monotonically increasing). You may assume that the earliest timestamp starts at 1.

It is possible that several hits arrive roughly at the same time.

**Example:**

```
HitCounter counter = new HitCounter();

// hit at timestamp 1.

counter.hit(1);

// hit at timestamp 2.

counter.hit(2);

// hit at timestamp 3.

counter.hit(3);

// get hits at timestamp 4, should return 3.

counter.getHits(4);

// hit at timestamp 300.

counter.hit(300);

// get hits at timestamp 300, should return 4.

counter.getHits(300);

// get hits at timestamp 301, should return 3.

counter.getHits(301);
```

**Follow up:**
What if the number of hits per second could be very large? Does your design scale?

```cpp
class HitCounter {
public:
    HitCounter() {
        records.resize(300);
    }

    void hit(int timestamp) {
        int idx = timestamp % 300;
        if (records[idx].first != timestamp)
              records[idx] = {timestamp, 0};
        records[idx].second++;
    }


    int getHits(int timestamp) {
        int res = 0;
        for (auto &pii : records) {
            if (timestamp - pii.first < 300) {
                res += pii.second;
            }
        }
        return res;
    }

private:
    vector<pair<int, int>> records; // time, hit
};
```

# 363. Max Sum of Rectangle No Larger Than K★★

Hard

Given a non-empty 2D matrix *matrix* and an integer *k*, find the max sum of a rectangle in the *matrix* such that its sum is no larger than *k*.

**Example:**

**Input:** matrix = [[1,0,1],[0,-2,3]], k = 2

**Output:** 2

**Explanation:** Because the sum of rectangle [[0, 1], [-2, 3]] is 2,

and 2 is the max number no larger than k (k = 2).

**Note:**

1. The rectangle inside the matrix must have an area > 0.
2. What if the number of rows is much larger than the number of columns?

```cpp
class Solution {
public:
    int maxSumSubmatrix(vector<vector<int>>& v, int k) {
        int n = v.size(), m = v[0].size();
        if (n > m) {
            v = rotate(v);
            swap(n, m);
        }
        int res = INT_MIN;
        for (int i = 0; i < n; ++i) {
            vector<int> S(m, 0);
            for (int j = i; j < n; ++j) {
                for (int a = 0; a < m; ++a) S[a] += v[j][a];
                set<int> Myset{0};
                int sum = 0;
                for (auto a : S) {
                    sum += a;
                    auto it = Myset.lower_bound(sum-k);
                    if (it != Myset.end()) {
                        res = max(res, sum - *it);
                    }
                    Myset.insert(sum);
                }
            }
        }
        return res;
    }
private:
    vector<vector<int>> rotate(vector<vector<int>> &v) {
        int n = v.size(), m = v[0].size();
        vector<vector<int>> res(m, vector<int> (n));
        for (int i = 0; i < n; ++i) {
            for (int j = 0; j < m; ++j) {
                res[j][i] = v[i][j];
            }
        }
        return res;
    }
};
```

# 364. Nested List Weight Sum II

Given a nested list of integers, return the sum of all integers in the list weighted by their depth.

Each element is either an integer, or a list -- whose elements may also be integers or other lists.

Different from the previous question where weight is increasing from root to leaf, now the weight is defined from bottom up. i.e., the leaf level integers have weight 1, and the root level integers have the largest weight.

**Example 1:**

**Input:** `[[1,1],2,[1,1]]`

**Output:** `8`

**Explanation:** `Four 1's at depth 1, one 2 at depth 2.`

**Example 2:**

**Input:** `[1,[4,[6]]]`

**Output:** `17`

**Explanation:** `One 1 at depth 3, one 4 at depth 2, and one 6 at depth 1; 1*3 + 4*2 + 6*1 = 17.`

```
/**
 * // This is the interface that allows for creating nested lists.
 * // You should not implement it, or speculate about its implementatio
n
 * class NestedInteger {
 *   public:
 *     // Constructor initializes an empty nested list.
 *     NestedInteger();
 *
 *     // Constructor initializes a single integer.
 *     NestedInteger(int value);
 *
 *     // Return true if this NestedInteger holds a single integer, rat
her than a nested list.
 *     bool isInteger() const;
 *
 *     // Return the single integer that this NestedInteger holds, if i
t holds a single integer
 *     // The result is undefined if this NestedInteger holds a nested
list
 *     int getInteger() const;
 *
 *     // Set this NestedInteger to hold a single integer.
 *     void setInteger(int value);
 *
 *     // Set this NestedInteger to hold a nested list and adds a neste
d integer to it.
 *     void add(const NestedInteger &ni);
 *
 *     // Return the nested list that this NestedInteger holds, if it h
olds a nested list
 *     // The result is undefined if this NestedInteger holds a single
integer
 *     const vector<NestedInteger> &getList() const;
 * };
 */
```

```
class Solution {
public:
    int depthSumInverse(vector<NestedInteger>& nestedList) {
        return -dfs(1, nestedList) + sum *(1+Depth);
    }

private:
    int sum = 0, Depth = 0;

    int dfs(int depth, vector<NestedInteger>& nestedList) {
        Depth = max(Depth, depth);
        int ret = 0;
        for (auto &nest : nestedList) {
            if (nest.isInteger()) {
                ret += depth*nest.getInteger();
                sum += nest.getInteger();
            }
            else ret += dfs(depth+1, nest.getList());
        }
        return ret;
    }
};
```

```
class Solution {
public:
    int depthSumInverse(vector<NestedInteger>& nestedList) {
        int unweighted = 0, weighted = 0;
        while (!nestedList.empty()) {
            vector<NestedInteger> nextLevel;
            for (auto &a : nestedList) {
                if (a.isInteger()) unweighted += a.getInteger();
                else {
                    nextLevel.insert(nextLevel.end(),
                             a.getList().begin(), a.getList().end());
                }
            }
            weighted += unweighted;
            nestedList = nextLevel;
        }
        return weighted;
    }
};
```

# 365. Water and Jug Problem

Medium

You are given two jugs with capacities *x* and *y* litres. There is an infinite amount of water supply available. You need to determine whether it is possible to measure exactly *z* litres using these two jugs.

If *z* liters of water is measurable, you must have *z* liters of water contained within **one or both buckets** by the end.

Operations allowed:

- Fill any of the jugs completely with water.
- Empty any of the jugs.
- Pour water from one jug into another till the other jug is completely full or the first jug itself is empty.

**Example 1:** (From the famous *"Die Hard"* example)

```
Input: x = 3, y = 5, z = 4

Output: True
```

**Example 2:**

```
Input: x = 2, y = 6, z = 5

Output: False
```

```cpp
class Solution {
public:
    bool canMeasureWater(int x, int y, int z) {
        return z == 0 || (z - x <= y && z % gcd(x, y) == 0);
    }

private:
    int gcd(int x, int y) {
        return y == 0 ? x : gcd(y, x % y);
    }
};
```

# 366. Find Leaves of Binary Tree

Given a binary tree, collect a tree's nodes as if you were doing this: Collect and remove all leaves, repeat until the tree is empty.

**Example:**

**Input:** `[1,2,3,4,5]`

```
          1
         / \
        2   3
       / \
      4   5
```

**Output:** `[[4,5,3],[2],[1]]`

**Explanation:**

1. Removing the leaves `[4,5,3]` would result in this tree:

```
          1
         /
        2
```

2. Now removing the leaf `[2]` would result in this tree:

```
          1
```

3. Now removing the leaf `[1]` would result in the empty tree:

```
          []
```

[[3,5,4],[2],[1]], [[3,4,5],[2],[1]], etc, are also consider correct answers since per each level it doesn't matter the order on which elements are returned.

```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<vector<int>> findLeaves(TreeNode* root) {
        vector<vector<int>> res;
        dfs(root);
        for (auto &it : mp) res.push_back(it.second);
        return res;
    }

private:
    map<int, vector<int>> mp;

    int dfs(TreeNode *p) {
        if (!p) return 0;
        int l = dfs(p->left), r = dfs(p->right);
        int depth = (!l && !r) ? 1 : max(l, r);
        mp[depth].push_back(p->val);
        return depth+1;
    }
};
```

# 367. Valid Perfect Square

Easy

Given a positive integer *num*, write a function which returns True if *num* is a perfect square else False.

**Note: Do not** use any built-in library function such as `sqrt`.

**Example 1:**

**Input:** 16

**Output:** true

**Example 2:**

**Input:** 14

**Output:** false

```cpp
class Solution {
public:
    bool isPerfectSquare(int num) {
       long r = num;
       while (r*r > num)
          r = (r + num/r) / 2;
       return r*r == num;
    }
};
```

```cpp
class Solution {
public:
    bool isPerfectSquare(int num) {
        long long l = 0, r = num;
        while (l <= r) {
            auto mid = l + (r-l)/2;
            auto sqmid = mid * mid;
            if (sqmid == num) return true;
            else if (sqmid < num) l = mid + 1;
            else r = mid - 1;
        }
        return false;
    }
};
```

# 368. Largest Divisible Subset

Medium

Given a set of **distinct** positive integers, find the largest subset such that every pair ($S_i$, $S_j$) of elements in this subset satisfies:

$S_i$ % $S_j$ = 0 or $S_j$ % $S_i$ = 0.

If there are multiple solutions, return any subset is fine.

**Example 1:**

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

**Output:** [1,2] (of course, [1,3] will also be ok)

**Example 2:**

**Input:** [1,2,4,8]

**Output:** [1,2,4,8]

```cpp
class Solution {
public:
    vector<int> largestDivisibleSubset(vector<int>& nums) {
        vector<int> res;
        if (nums.empty()) return res;
        int n = nums.size(), p = 0;
        sort(nums.begin(), nums.end());
        vector<pair<int, int>> dp(n);
        for (int i = 0; i < n; i++) {
            dp[i] = {1, -1};
            for (int j = 0; j < i; j++) {
                if (nums[i] % nums[j] == 0) {
                    if (dp[j].first+1 > dp[i].first) {
                        dp[i] = {dp[j].first+1, j};
                    }
                }
            }
            if (dp[i].first > dp[p].first) p = i;
        }
        while (p != -1) {
            res.push_back(nums[p]);
            p = dp[p].second;
        }
        return res;
    }
};
```

# 369. Plus One Linked List

Given a non-negative integer represented as **non-empty** a singly linked list of digits, plus one to the integer.

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

The digits are stored such that the most significant digit is at the head of the list.

**Example :**

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

**Output:** [1,2,4]

```cpp
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     ListNode *next;
 *     ListNode(int x) : val(x), next(NULL) {}
 * };
 */
class Solution {
public:
    ListNode* plusOne(ListNode* head) {
        ListNode *p, *q = new ListNode(0);
        q->next = head;
        p = head = q ;

        while (q->next) {
            q = q->next;
            if (q->val != 9) p = q;
        }
        q = p->next;
        while (q) {
            q->val = 0;
            q = q->next;
        }
        ++p->val;
        return head->val ==  0 ? head->next : head;
    }
};
```

# 370. Range Addition

Assume you have an array of length ***n*** initialized with all **0**'s and are given ***k*** update operations.

Each operation is represented as a triplet: **[startIndex, endIndex, inc]** which increments each element of subarray **A[startIndex ... endIndex]** (startIndex and endIndex inclusive) with **inc**.

Return the modified array after all ***k*** operations were executed.

**Example:**

```
Input: length = 5, updates = [[1,3,2],[2,4,3],[0,2,-2]]

Output: [-2,0,3,5,3]
```

**Explanation:**

```
Initial state:

[0,0,0,0,0]

After applying operation [1,3,2]:

[0,2,2,2,0]

After applying operation [2,4,3]:

[0,2,5,5,3]

After applying operation [0,2,-2]:

[-2,0,3,5,3]
```

```cpp
class Solution {
public:
    vector<int> getModifiedArray(int length, vector<vector<int>> update
s){
        vector<int> res(length, 0);
        for (auto &tuple : updates) {
            int start = tuple[0], end = tuple[1], val = tuple[2];
            res[start] += val;
            if (end < length - 1) res[end + 1] -= val;
        }
        partial_sum(res.begin(), res.end(), res.begin());
        return res;
    }
};
```

# 371. Sum of Two Integers★★

Easy

Calculate the sum of two integers *a* and *b*, but you are **not allowed** to use the operator `+` and `-`.

**Example 1:**

**Input:** a = 1, b = 2

**Output:** 3

**Example 2:**

**Input:** a = -2, b = 3

**Output:** 1

```
class Solution {
public:
   int getSum(int a, int b) {
       while (b != 0) {
           int carry = a & b;
           a = a ^ b;
           b = (carry & 0x7fffffff) << 1;
       }
       return a;
   }
};
```

# 372. Super Pow

Medium

Your task is to calculate $a^b$ mod 1337 where $a$ is a positive integer and $b$ is an extremely large positive integer given in the form of an array.

**Example 1:**

**Input:** a = 2, b = [3]

**Output:** 8

**Example 2:**

**Input:** a = 2, b = [1,0]

**Output:** 1024

```cpp
class Solution {
public:
    const int MOD = 1337;
    int superPow(int a, vector<int>& b) {
        int pre = 1;
        a %= MOD;
        for (int i = b.size()-1; i >= 0; i--) {
            int cur = POW(a, b[i]);
            pre = pre*cur % MOD;
            a = POW(a, 10);
        }
        return pre;
    }

private:
    int POW(int x, int n) {
       int ret = 1;
       while (n--) {
           ret = ret*x % MOD;
       }
       return ret;
    }
};
```

# 373. Find K Pairs with Smallest Sums★★

Medium

You are given two integer arrays **nums1** and **nums2** sorted in ascending order and an integer **k**.

Define a pair **(u,v)** which consists of one element from the first array and one element from the second array.

Find the k pairs $(u_1,v_1),(u_2,v_2) \ldots(u_k,v_k)$ with the smallest sums.

**Example 1:**

**Input:** nums1 = [1,7,11], nums2 = [2,4,6], k = 3

**Output:** [[1,2],[1,4],[1,6]]

**Explanation:** The first 3 pairs are returned from the sequence:

[1,2],[1,4],[1,6],[7,2],[7,4],[11,2],[7,6],[11,4],[11,6]

**Example 2:**

**Input:** nums1 = [1,1,2], nums2 = [1,2,3], k = 2

**Output:** [1,1],[1,1]

**Explanation:** The first 2 pairs are returned from the sequence:

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

**Example 3:**

**Input:** nums1 = [1,2], nums2 = [3], k = 3

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

**Explanation:** All possible pairs are returned from the sequence: [1,3],[2,3]

```cpp
class Solution {
public:
    struct node{
        int x, y, val;
        node (int x, int y, int val) : x(x), y(y), val(val) {}
        bool operator < (const node& rhs) const {
            return val > rhs.val;
        }
    };

    vector<vector<int>> kSmallestPairs(vector<int>& nums1, vector<int>&
 nums2, int k) {
        vector<vector<int>> res;
        if (nums1.empty() || nums2.empty()) return res;
        int n = nums1.size(), m = nums2.size();
        priority_queue<node> pq;
        pq.emplace(0, 0, nums1[0] + nums2[0]);
        while (!pq.empty() && res.size() < k) {
            auto t = pq.top();
            res.push_back({nums1[t.x], nums2[t.y]});
            pq.pop();
            if (t.x+1 < n)
                pq.emplace(t.x+1, t.y, nums1[t.x+1] + nums2[t.y]);
            if (t.x == 0 && t.y+1 < m)
                pq.emplace(t.x, t.y+1, nums1[t.x] + nums2[t.y+1]);
        }
        return res;
    }
};
```

# 374. Guess Number Higher or Lower

Easy

We are playing the Guess Game. The game is as follows:

I pick a number from **1** to ***n***. You have to guess which number I picked.

Every time you guess wrong, I'll tell you whether the number is higher or lower.

You call a pre-defined API `guess(int num)` which returns 3 possible results (`-1`, `1`, or `0`):

```
-1 : My number is lower

 1 : My number is higher

 0 : Congrats! You got it!
```

**Example :**

```
Input: n = 10, pick = 6

Output: 6
```

```cpp
class Solution {
public:
    int guessNumber(int n) {
        int l = 1, r = n;
        while (l <= n) {
            int mid = l + (r-l)/2;
            switch(guess(mid)) {
                case 0: return mid; break;
                case -1: r = mid-1; break;
                case 1: l = mid+1; break;
            }
        }
        return -1;
    }
};
```

# 375. Guess Number Higher or Lower II

Medium

We are playing the Guess Game. The game is as follows:

I pick a number from **1** to **n**. You have to guess which number I picked.

Every time you guess wrong, I'll tell you whether the number I picked is higher or lower.

However, when you guess a particular number x, and you guess wrong, you pay **$x**. You win the game when you guess the number I picked.

**Example:**

```
n = 10, I pick 8.

First round:  You guess 5, I tell you that it's higher. You pay $5.

Second round: You guess 7, I tell you that it's higher. You pay $7.

Third round:  You guess 9, I tell you that it's lower. You pay $9.

Game over. 8 is the number I picked.

You end up paying $5 + $7 + $9 = $21.
```

Given a particular **n ≥ 1**, find out how much money you need to have to guarantee a **win**.

```cpp
//存在O(n^2) algorithm,  待补充

class Solution {
public:
    int getMoneyAmount(int n) {
        dp.resize(n+1, vector<int>(n+1));
        return f(1, n);
    }
private:
    vector<vector<int>> dp;

    int f(int i, int j) {
        if (i >= j) return 0;
        else if (dp[i][j] > 0) return dp[i][j];
        else if (i == j) return dp[i][j] = i;
        dp[i][j] = INT_MAX;
        for (int k = i; k <= j; ++k) {
            dp[i][j] = min(dp[i][j], k + max(f(i, k-1), f(k+1, j)));
        }
        return dp[i][j];
    }
};
```

# 376. Wiggle Subsequence

Medium

A sequence of numbers is called a **wiggle sequence** if the differences between successive numbers strictly alternate between positive and negative. The first difference (if one exists) may be either positive or negative. A sequence with fewer than two elements is trivially a wiggle sequence.

For example, `[1,7,4,9,2,5]` is a wiggle sequence because the differences `(6,-3,5,-7,3)` are alternately positive and negative. In contrast, `[1,4,7,2,5]` and `[1,7,4,5,5]` are not wiggle sequences, the first because its first two differences are positive and the second because its last difference is zero.

Given a sequence of integers, return the length of the longest subsequence that is a wiggle sequence. A subsequence is obtained by deleting some number of elements (eventually, also zero) from the original sequence, leaving the remaining elements in their original order.

**Example 1:**

**Input:** [1,7,4,9,2,5]

**Output:** 6

**Explanation:** The entire sequence is a wiggle sequence.

**Example 2:**

**Input:** [1,17,5,10,13,15,10,5,16,8]

**Output:** 7

**Explanation:** There are several subsequences that achieve this length. One is [1,17,10,13,10,16,8].

**Example 3:**

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

**Output:** 2

**Follow up:**
Can you do it in O(*n*) time?

```cpp
class Solution {
public:
    int wiggleMaxLength(vector<int>& nums) {
        int n = nums.size();
        if (n < 2) return n;
        int down = 1, up = 1;
        for (int i = 1; i < n; i++) {
            if (nums[i] > nums[i-1])
                up = down + 1;
            else if (nums[i] < nums[i-1])
                down = up + 1;
        }
        return max(down, up);
    }
};
```

# 377. Combination Sum IV★★

Medium

Given an integer array with all positive numbers and no duplicates, find the number of possible combinations that add up to a positive integer target.

**Example:**

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

***target*** = 4

The possible combination ways are:

(1, 1, 1, 1)

(1, 1, 2)

(1, 2, 1)

(1, 3)

(2, 1, 1)

(2, 2)

(3, 1)

Note that different sequences are counted as different combinations.

Therefore the output is ***7***.

**Follow up:**
What if negative numbers are allowed in the given array?
How does it change the problem?
What limitation we need to add to the question to allow negative numbers?

**Credits:**
Special thanks to @pbrother for adding this problem and creating all test cases.

```cpp
class Solution {
public:
    int combinationSum4(vector<int>& nums, int target) {
        vector<unsigned int> dp(target + 1, 0);
        dp[0] = 1;
        for (int i = 1; i <= target; ++i) {
            for (int x : nums) {
                if (i >= x) dp[i] += dp[i - x];
            }
        }
        return dp[target];
    }
};
```

# 378. Kth Smallest Element in a Sorted Matrix

Medium

Given a *n* x *n* matrix where each of the rows and columns are sorted in ascending order, find the kth smallest element in the matrix.

Note that it is the kth smallest element in the sorted order, not the kth distinct element.

**Example:**

```
matrix = [
   [ 1,  5,  9],
   [10, 11, 13],
   [12, 13, 15]
],
k = 8,


return 13.
```

**Note:**
You may assume k is always valid, $1 \le k \le n^2$.

```
class Solution {
public:
    struct node{
        int x, y, value;
        node(int x, int y, int value):x(x), y(y), value(value){}
        bool operator < (const node &rhs) const{
            return value > rhs.value;
        }
    };



    int kthSmallest(vector<vector<int>>& matrix, int k) {
        const int dx[] = {1, 0};
        const int dy[] = {0, 1};
        int n = matrix.size();
        priority_queue<node> pq;
        pq.push({0, 0, matrix[0][0]});
        matrix[0][0] = INT_MIN;
        while(--k) {
            node t = pq.top();
            pq.pop();
            for (int i = 0; i < 2; i++) {
                int x = t.x+dx[i], y = t.y+dy[i];
                if (x < n && y < n && matrix[x][y] != INT_MIN) {
                    pq.push(node{x, y, matrix[x][y]});
                    matrix[x][y] = INT_MIN;
                }
            }
        }
        return pq.top().value;
    }
};
```

# 379. Design Phone Directory

Design a Phone Directory which supports the following operations:

1. `get`: Provide a number which is not assigned to anyone.
2. `check`: Check if a number is available or not.
3. `release`: Recycle or release a number.

**Example:**

```
// Init a phone directory containing a total of 3 numbers: 0, 1, and 2.

PhoneDirectory directory = new PhoneDirectory(3);

// It can return any available phone number. Here we assume it returns 0.

directory.get();

// Assume it returns 1.

directory.get();

// The number 2 is available, so return true.

directory.check(2);

// It returns 2, the only number that is left.

directory.get();

// The number 2 is no longer available, so return false.

directory.check(2);

// Release number 2 back to the pool.

directory.release(2);

// Number 2 is available again, return true.

directory.check(2);
```

**Constraints:**

- `1 <= maxNumbers <= 10^4`
- `0 <= number < maxNumbers`
- The total number of call of the methods is between `[0 - 20000]`

```
class PhoneDirectory {
public:
    /** Initialize your data structure here
        @param maxNumbers - The maximum numbers that can be stored in t
he phone directory. */
    PhoneDirectory(int maxNumbers) {
        for (int i = 0; i < maxNumbers; ++i) {
            unused.insert(i);
        }
    }

    /** Provide a number which is not assigned to anyone.
        @return - Return an available number. Return -
1 if none is available. */
    int get() {
        if (unused.empty()) return -1;
        int ret = *unused.begin();
        unused.erase(ret);
        used.insert(ret);
        return ret;
    }

    /** Check if a number is available or not. */
    bool check(int number) {
        return unused.count(number);
    }

    /** Recycle or release a number. */
    void release(int number) {
        used.erase(number);
        unused.insert(number);
    }
private:
    unordered_set<int> used, unused;
};
/**
 * Your PhoneDirectory object will be instantiated and called as such:
 * PhoneDirectory* obj = new PhoneDirectory(maxNumbers);
 * int param_1 = obj->get();
 * bool param_2 = obj->check(number);
 * obj->release(number);
 */
```

# 380. Insert Delete GetRandom O(1) ★★

Medium

Design a data structure that supports all following operations in *average* **O(1)** time.

1. `insert(val)`: Inserts an item val to the set if not already present.
2. `remove(val)`: Removes an item val from the set if present.
3. `getRandom`: Returns a random element from current set of elements. Each element must have the **same probability** of being returned.

**Example:**

```
// Init an empty set.

RandomizedSet randomSet = new RandomizedSet();

// Inserts 1 to the set. Returns true as 1 was inserted successfully.

randomSet.insert(1);

// Returns false as 2 does not exist in the set.

randomSet.remove(2);

// Inserts 2 to the set, returns true. Set now contains [1,2].

randomSet.insert(2);

// getRandom should return either 1 or 2 randomly.

randomSet.getRandom();

// Removes 1 from the set, returns true. Set now contains [2].

randomSet.remove(1);

// 2 was already in the set, so return false.

randomSet.insert(2);

// Since 2 is the only number in the set, getRandom always return 2.

randomSet.getRandom();
```

```
class RandomizedSet {
public:
    /** Initialize your data structure here. */
    RandomizedSet() {}

    /** Inserts a value to the set. Returns true if the set did not alr
eady contain the specified element. */
    bool insert(int val) {
        if (m.count(val)) return false;
        m[val] = nums.size();
        nums.push_back(val);
        return true;
    }

    /** Removes a value from the set. Returns true if the set contained
 the specified element. */
    bool remove(int val) {
        if (!m.count(val)) return false;
        int pos = m[val];
        m[nums.back()] = pos;
        nums[pos] = nums.back();
        m.erase(val);
        nums.pop_back();
        return true;
    }

    /** Get a random element from the set. */
    int getRandom() {
        return nums[rand() % nums.size()];
    }

private:
    unordered_map<int, int> m;  // <number, pos>
    vector<int> nums;
};
```

# 381. Insert Delete GetRandom O(1) - Duplicates allowed

★★

Hard

Design a data structure that supports all following operations in *average* **O(1)** time.

**Note: Duplicate elements are allowed.**

1. `insert(val)`: Inserts an item val to the collection.
2. `remove(val)`: Removes an item val from the collection if present.
3. `getRandom`: Returns a random element from current collection of elements. The probability of each element being returned is **linearly related** to the number of same value the collection contains.

**Example:**

```
// Init an empty collection.

RandomizedCollection collection = new RandomizedCollection();

// Inserts 1 to the collection. Returns true as the collection did not contain 1.

collection.insert(1);

// Inserts another 1 to the collection. Returns false as the collection contained 1. Collection now contains [1,1].

collection.insert(1);

// Inserts 2 to the collection, returns true. Collection now contains [1,1,2].

collection.insert(2);

// getRandom should return 1 with the probability 2/3, and returns 2 with the probability 1/3.

collection.getRandom();

// Removes 1 from the collection, returns true. Collection now contains [1,2].

collection.remove(1);

// getRandom should return 1 and 2 both equally likely.

collection.getRandom();
```

```cpp
class RandomizedCollection {
public:
    RandomizedCollection() {}

    bool insert(int val) {
        bool ret = !mp.count(val);
        mp[val].push_back(nums.size());
        nums.emplace_back(val, mp[val].size()-1);
        return ret;
    }

    bool remove(int val) {
        if (!mp.count(val)) return false;
        auto last = nums.back();
        mp[last.first][last.second] = mp[val].back();
        nums[mp[val].back()] = last;
        mp[val].pop_back();
        if (mp[val].empty()) mp.erase(val);
        nums.pop_back();
        return true;
    }

    /** Get a random element from the collection. */
    int getRandom() {
        return nums[rand() % nums.size()].first;
    }
private:
    vector<pair<int, int>> nums;
    unordered_map<int, vector<int>> mp;
};
```

# 382. Linked List Random Node★★

Medium

Given a singly linked list, return a random node's value from the linked list. Each node must have the **same probability** of being chosen.

**Follow up:**
What if the linked list is extremely large and its length is unknown to you? Could you solve this efficiently without using extra space?

**Example:**

```
// Init a singly linked list [1,2,3].

ListNode head = new ListNode(1);

head.next = new ListNode(2);

head.next.next = new ListNode(3);

Solution solution = new Solution(head);

// getRandom() should return either 1, 2, or 3 randomly. Each element should have equal probability of returning.

solution.getRandom();
```

```cpp
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     ListNode *next;
 *     ListNode(int x) : val(x), next(NULL) {}
 * };
 */
class Solution {
public:
    /** @param head The linked list's head.
        Note that the head is guaranteed to be not null, so it contains
 at least one node. */
    Solution(ListNode* head) : head(head) {}

    /** Returns a random node's value. */
    int getRandom() {
        //在此我扩展为 k 个随机取样(水塘抽样问题)
        int k = 1, cnt = 0;
        vector<int> ret;
        ListNode *cur = head;
        while (cur) {
            if (cnt++ < k) ret.push_back(cur->val);
            else {
               int t = rand() % cnt;
               if (t < k) ret[t] = cur->val;
            }
            cur = cur->next;
        }
        return ret[0];
    }

private:
    ListNode *head;
};
//tip 并行水塘抽样  https://www.jianshu.com/p/7a9ea6ece2af

/**
 * Your Solution object will be instantiated and called as such:
 * Solution* obj = new Solution(head);
 * int param_1 = obj->getRandom();
 */
```

# 383. Ransom Note

Easy

Given an arbitrary ransom note string and another string containing letters from all the magazines, write a function that will return true if the ransom note can be constructed from the magazines ; otherwise, it will return false.

Each letter in the magazine string can only be used once in your ransom note.

**Note:**
You may assume that both strings contain only lowercase letters.

```
canConstruct("a", "b") -> false

canConstruct("aa", "ab") -> false

canConstruct("aa", "aab") -> true
```

```
class Solution {
public:
    bool canConstruct(string ransomNote, string magazine) {
        vector<int> vec(256, 0);
        for (const auto &c : magazine) vec[c]++;
        for (const auto &c : ransomNote) {
           if (--vec[c] < 0) return false;
        }
        return true;
    }
};
```

# 384. Shuffle an Array★★

Medium

Shuffle a set of numbers without duplicates.

**Example:**

```
// Init an array with set 1, 2, and 3.

int[] nums = {1,2,3};

Solution solution = new Solution(nums);

// Shuffle the array [1,2,3] and return its result. Any permutation of [1,2,3] must equally likely to be returned.

solution.shuffle();

// Resets the array back to its original configuration [1,2,3].

solution.reset();

// Returns the random shuffling of array [1,2,3].

solution.shuffle();
```

```cpp
class Solution {
public:
    Solution(vector<int> nums) : arr(nums), nums(nums) {};

   /** Resets the array to its original configuration and return it. */
    vector<int> reset() {
        return arr = nums;
    }

    /** Returns a random shuffling of the array. */
    vector<int> shuffle() {
        //random_shuffle(arr.begin(), arr.end());
        int n = nums.size();
        for (int i = 0; i < n; ++i) {
            swap(arr[i], arr[rand() % (i+1)]);
        }
        return arr;
    }
private:
    vector<int> arr, nums;
};
```

# 385. Mini Parser

Medium

Given a nested list of integers represented as a string, implement a parser to deserialize it.

Each element is either an integer, or a list -- whose elements may also be integers or other lists.

**Note:** You may assume that the string is well-formed:

- String is non-empty.
- String does not contain white spaces.
- String contains only digits `0-9`, `[`, `-` `,`, `]`.

**Example 1:**

```
Given s = "324",

You should return a NestedInteger object which contains a single integer 324.
```

**Example 2:**

```
Given s = "[123,[456,[789]]]",

Return a NestedInteger object containing a nested list with 2 elements:

1. An integer containing value 123.

2. A nested list containing two elements:

    i.  An integer containing value 456.

    ii. A nested list with one element:

         a. An integer containing value 789.
```

```
* class NestedInteger {
 *   public:
*     NestedInteger();
*     NestedInteger(int value);
 *     // Return true if this NestedInteger holds a single integer, rather than a nested list.
 *     bool isInteger() const;
 *     // Return the single integer that this NestedInteger holds, if it holds a single integer
 *     // The result is undefined if this NestedInteger holds a nested list
 *     int getInteger() const;
 *     // Set this NestedInteger to hold a single integer.
 *     void setInteger(int value);
 *       // Set this NestedInteger to hold a nested list and adds a nested integer to it.
 *     void add(const NestedInteger &ni);
 *     // Return the nested list that this NestedInteger holds, if it holds a nested list
 *     // The result is undefined if this NestedInteger holds a single integer
 *     const vector<NestedInteger> &getList() const;
 * };
class Solution {
public:
    NestedInteger deserialize(string s) {
        istringstream in(s);
        return deserialize1(in);
    }
private:
    NestedInteger deserialize1(istringstream &in) {
        if (isdigit(in.peek()) || in.peek() == '-') {
            int number;
            in >> number;
            return NestedInteger(number);
        }
        in.get();
        NestedInteger list;
        while (in.peek() != ']') {
            list.add(deserialize1(in));
            if (in.peek() == ',') in.get();
        }
        in.get();
        return list;
    }
};
```

# 386. Lexicographical Numbers

Medium

Given an integer *n*, return 1 - *n* in lexicographical order.

For example, given 13, return: [1,10,11,12,13,2,3,4,5,6,7,8,9].

Please optimize your algorithm to use less time and space. The input size may be as large as 5,000,000.

```
class Solution {
public:
    vector<int> lexicalOrder(int n) {
        dfs(0, n);
        return res;
    }

private:
    vector<int> res;
    void dfs(int i, int n) {
       if (i > n) return;
       for (int j = (i == 0 ? 1 : 0); j <= 9; ++j) {
           int k = i*10 + j;
           if (k <= n) {
               res.push_back(k);
               dfs(k, n);
           }
       }
    }
};
```

# 387. First Unique Character in a String

Easy

Given a string, find the first non-repeating character in it and return it's index. If it doesn't exist, return -1.

**Examples:**

```
s = "leetcode"

return 0.

s = "loveleetcode",

return 2.
```

**Note:** You may assume the string contain only lowercase letters.

```
class Solution {
public:
    int firstUniqChar(string s) {
        unordered_map<char, int> m;
        for (const auto &c : s) m[c]++;
        for (int i = 0; i < s.length(); i++) {
            if (m[s[i]] == 1) return i;
        }
        return -1;
    }
};
```

# 388. Longest Absolute File Path

Medium

Suppose we abstract our file system by a string in the following manner:

The string `"dir\n\tsubdir1\n\tsubdir2\n\t\tfile.ext"` represents:

```
dir
    subdir1
    subdir2
        file.ext
```

The directory `dir` contains an empty sub-directory `subdir1` and a sub-directory `subdir2` containing a file `file.ext`.

The string `"dir\n\tsubdir1\n\t\tfile1.ext\n\t\tsubsubdir1\n\tsubdir2\n\t\tsubsubdir2\n\t\t\tfile2.ext"` represents:

```
dir
    subdir1
        file1.ext
        subsubdir1
    subdir2
        subsubdir2
            file2.ext
```

The directory `dir` contains two sub-directories `subdir1` and `subdir2`. `subdir1` contains a file `file1.ext` and an empty second-level sub-directory `subsubdir1`. `subdir2` contains a second-level sub-directory `subsubdir2` containing a file `file2.ext`.

We are interested in finding the longest (number of characters) absolute path to a file within our file system. For example, in the second example above, the longest absolute path is `"dir/subdir2/subsubdir2/file2.ext"`, and its length is `32` (not including the double quotes).

Given a string representing the file system in the above format, return the length of the longest absolute path to file in the abstracted file system. If there is no file in the system, return `0`.

**Note:**

- The name of a file contains at least a `.` and an extension.
- The name of a directory or sub-directory will not contain a `.`.

Time complexity required: `O(n)` where `n` is the size of the input string.

Notice that `a/aa/aaa/file1.txt` is not the longest file path, if there is another path `aaaaaaaaaaaaaaaaaaaa/sth.png`.

```
class Solution {
public:
    int lengthLongestPath(string input) {
        input += "\n";
        stack<int> stk;
        stk.push(0);
        int res = 0, left = 0, pre = -1;
        while (1) {
            auto pos0 = input.find('\n', left);
            auto pos1 = input.find('.', left);
            if (pos0 == string::npos) break;
            int cur = 0;
            while (input[left] == '\t') {
                cur++;
                left += 1;
            }
            for (int i = cur; i <= pre; i++) stk.pop();
            stk.push((int)pos0-left+stk.top()+1);
            if (pos1 != string::npos && pos1 < pos0)
                res = max(res, stk.top()-1);
            pre = cur;
            left = pos0 + 1;
        }
        return res;
    }
};
```

# 389. Find the Difference

Easy

Given two strings ***s*** and ***t*** which consist of only lowercase letters.

String ***t*** is generated by random shuffling string ***s*** and then add one more letter at a random position.

Find the letter that was added in ***t***.

**Example:**

Input:

s = "abcd"

t = "abcde"

Output:

e

Explanation:

'e' is the letter that was added.

```
class Solution {
public:
    char findTheDifference(string s, string t) {
        char res = 0;
        for (auto &c : s) res ^= c;
        for (auto &c : t) res ^= c;
        return res;
    }
};
```

# 390. Elimination Game

Medium

There is a list of sorted integers from 1 to *n*. Starting from left to right, remove the first number and every other number afterward until you reach the end of the list.

Repeat the previous step again, but this time from right to left, remove the right most number and every other number from the remaining numbers.

We keep repeating the steps again, alternating left to right and right to left, until a single number remains.

Find the last number that remains starting with a list of length *n*.

**Example:**

```
Input:

n = 9,

1 2 3 4 5 6 7 8 9

2 4 6 8

2 6

6



Output:

6
```

```cpp
class Solution {
public:
    int lastRemaining(int n) {
        int A = 1, B = 0;
        int flag = 0;
        while (n != 1) {
            if (n % 2 == 0 && flag) B -= A;
            A *= 2;
            n /= 2;
            flag ^= 1;
        }
        return A + B;
    }
};
```

# 391. Perfect Rectangle★★

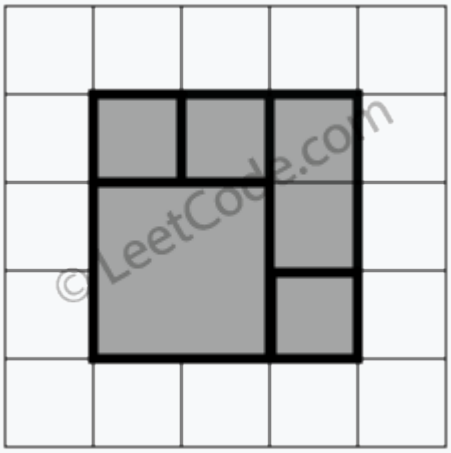
Hard

Given N axis-aligned rectangles where N > 0, determine if they all together form an exact cover of a rectangular region.

Each rectangle is represented as a bottom-left point and a top-right point. For example, a unit square is represented as [1,1,2,2]. (coordinate of bottom-left point is (1, 1) and top-right point is (2, 2)).

**Example 1:**

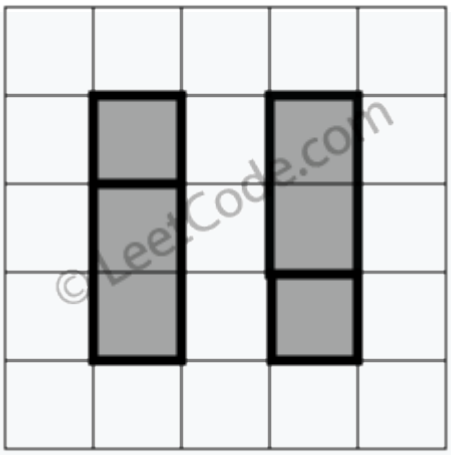
```
rectangles = [
  [1,1,3,3],
  [3,1,4,2],
  [3,2,4,4],
  [1,3,2,4],
  [2,3,3,4]
]
```




Return true. All 5 rectangles together form an exact cover of a rectangular region.

**Example 2:**

```
rectangles = [
  [1,1,2,3],
  [1,3,2,4],
  [3,1,4,2],
  [3,2,4,4]
]
```




Return false. Because there is a gap between the two rectangular regions.

**Example 3:**

rectangles = [

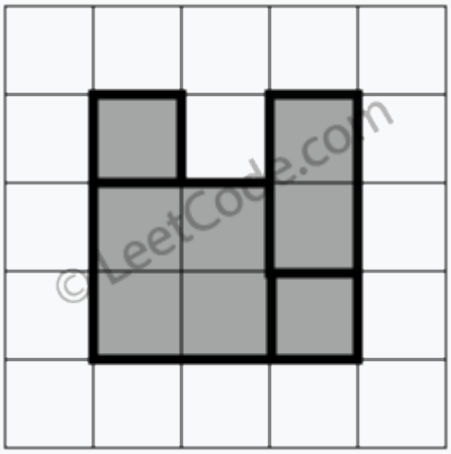
[1,1,3,3],

[3,1,4,2],

[1,3,2,4],

[3,2,4,4]

]




Return false. Because there is a gap in the top center.

**Example 4:**

rectangles = [

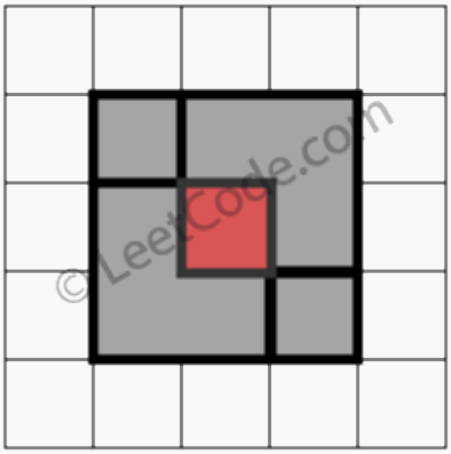
[1,1,3,3],

[3,1,4,2],

[1,3,2,4],

[2,2,4,4]

]




Return false. Because two of the rectangles overlap with each other.

```cpp
class Solution {
public:
    using pii = pair<int, int>;

    bool isRectangleCover(vector<vector<int>>& rectangles) {
        auto cmp = [](const pii& a, const pii& b) {
            return a.second <= b.first;
        };
        int area = 0;
        int xmin = INT_MAX, ymin = INT_MAX;
        int xmax = INT_MIN, ymax = INT_MIN;
        vector<vector<int>> verticalEdges;
        multiset<pii, decltype(cmp)> s(cmp);

        for (const auto &v : rectangles) {
            area += (v[2] - v[0]) * (v[3] - v[1]);
            xmin = min(xmin, v[0]), ymin = min(ymin, v[1]);
            xmax = max(xmax, v[2]), ymax = max(ymax, v[3]);
            verticalEdges.push_back({v[0], 1, v[1], v[3]});
            verticalEdges.push_back({v[2], -1, v[1], v[3]});
        }
        if (area != (xmax - xmin) * (ymax - ymin)) return false;

        sort(verticalEdges.begin(), verticalEdges.end());
        for (const auto &v : verticalEdges) {
            auto it = s.find({v[2], v[3]});
            if (v[1] > 0) {
                if (it != s.end())  return false;
                s.insert({v[2], v[3]});
            }
            else s.erase(it);
        }
        return true;
    }
};
```

```cpp
class Solution {
    struct pairhash {
        template <typename T, typename U>
        size_t operator()(const pair<T, U> &p) const {
            size_t l = hash<T>()(p.first), r = hash<U>()(p.second);
            return l + 0x9e3779b9 + (r << 6) + (r >> 2);
        }
    };
public:
    using pii = pair<int, int>;

    bool isRectangleCover(vector<vector<int>>& rectangles) {
        int area = 0;
        int xmin = INT_MAX, ymin = INT_MAX;
        int xmax = INT_MIN, ymax = INT_MIN;
        unordered_map<pii, int, pairhash> m;

        vector<pii> points = {{0, 1}, {0, 3}, {2, 3}, {2, 1}};
        for (const auto &v : rectangles) {
            for (auto [x, y] : points) {
                if (++m[{v[x], v[y]}] > 4) return false;
            }
            area += (v[2] - v[0]) * (v[3] - v[1]);
            xmin = min(xmin, v[0]), ymin = min(ymin, v[1]);
            xmax = max(xmax, v[2]), ymax = max(ymax, v[3]);
        }
        if (area != (xmax - xmin) * (ymax - ymin)) return false;

        unordered_set<pii, pairhash> s
            = {{xmin, ymin}, {xmin, ymax}, {xmax, ymax}, {xmax, ymin}};
        for (const auto &[pii, cnt] : m) {
            if (cnt & 1 == 1) {
                if (!s.count(pii)) return false;
                s.erase(pii);
            }
        }
        return s.empty();
    }
};
```

# 392. Is Subsequence

Easy

Given a string **s** and a string **t**, check if **s** is subsequence of **t**.

You may assume that there is only lower case English letters in both **s** and **t**. **t** is potentially a very long (length ~= 500,000) string, and **s** is a short string (<=100).

A subsequence of a string is a new string which is formed from the original string by deleting some (can be none) of the characters without disturbing the relative positions of the remaining characters. (ie, `"ace"` is a subsequence of `"abcde"` while `"aec"` is not).

**Example 1:**
**s** = `"abc"`, **t** = `"ahbgdc"`

Return `true`.

**Example 2:**
**s** = `"axc"`, **t** = `"ahbgdc"`

Return `false`.

**Follow up:**
If there are lots of incoming S, say S1, S2, ... , Sk where k >= 1B, and you want to check one by one to see if T has its subsequence. In this scenario, how would you change your code?

**Credits:**
Special thanks to @pbrother for adding this problem and creating all test cases.

```cpp
class Solution {
public:
    bool isSubsequence(string s, string t) {
        int n = s.length(), m = t.length(), j = 0;
        for (int i = 0; i < n; i++) {
            while (j < m && t[j] != s[i]) j++;
            if (j++ == m) return false;
        }
        return true;
    }
};
```

```cpp
class Solution {
public:
    bool isSubsequence(string s, string t) {
        unordered_map<char, vector<int>> mp;
        for (int i = 0; i < t.size(); ++i) {
            mp[t[i]].push_back(i);
        }
        int pos = 0;
        for (auto c : s) {
            auto it = lower_bound(mp[c].begin(), mp[c].end(), pos);
            if (it == mp[c].end()) return false;
            pos = *it + 1;
        }
        return true;
    }
};
```

# 393. UTF-8 Validation

Medium

A character in UTF8 can be from **1 to 4 bytes** long, subjected to the following rules:

1. For 1-byte character, the first bit is a 0, followed by its unicode code.
2. For n-bytes character, the first n-bits are all one's, the n+1 bit is 0, followed by n-1 bytes with most significant 2 bits being 10.

This is how the UTF-8 encoding would work:

```
   Char. number range  |        UTF-8 octet sequence
      (hexadecimal)    |              (binary)
   --------------------+---------------------------------------------
   0000 0000-0000 007F | 0xxxxxxx
   0000 0080-0000 07FF | 110xxxxx 10xxxxxx
   0000 0800-0000 FFFF | 1110xxxx 10xxxxxx 10xxxxxx
   0001 0000-0010 FFFF | 11110xxx 10xxxxxx 10xxxxxx 10xxxxxx
```

Given an array of integers representing the data, return whether it is a valid utf-8 encoding.

**Note:**
The input is an array of integers. Only the **least significant 8 bits** of each integer is used to store the data. This means each integer represents only 1 byte of data.

**Example 1:**

```
data = [197, 130, 1], which represents the octet sequence: 11000101 10000010 00000001.

Return true.

It is a valid utf-8 encoding for a 2-bytes character followed by a 1-byte character.
```

**Example 2:**

```
data = [235, 140, 4], which represented the octet sequence: 11101011 10001100 00000100.

Return false.
```

The first 3 bits are all one's and the 4th bit is 0 means it is a 3-bytes character.

The next byte is a continuation byte which starts with 10 and that's correct.

But the second continuation byte does not start with 10, so it is invalid.

```
class Solution {
public:
    bool validUtf8(vector<int>& data) {
        int cnt = 0;
        for (auto c : data) {
            if (cnt == 0) {
                if ((c >> 5) == 0b110) cnt = 1;
                else if ((c >> 4) == 0b1110) cnt = 2;
                else if ((c >> 3) == 0b11110) cnt = 3;
                else if ((c >> 7) == 0b1) return false;
            } else {
                if ((c >> 6) != 0b10) return false;
                cnt--;
            }
        }
        return cnt == 0;
    }
};
```

# 394. Decode String

Medium

Given an encoded string, return its decoded string.

The encoding rule is: `k[encoded_string]`, where the *encoded_string* inside the square brackets is being repeated exactly *k* times. Note that *k* is guaranteed to be a positive integer.

You may assume that the input string is always valid; No extra white spaces, square brackets are well-formed, etc.

Furthermore, you may assume that the original data does not contain any digits and that digits are only for those repeat numbers, *k*. For example, there won't be input like `3a` or `2[4]`.

**Examples:**

```
s = "3[a]2[bc]", return "aaabcbc".

s = "3[a2[c]]", return "accaccacc".

s = "2[abc]3[cd]ef", return "abcabccdcdcdef".
```

```
class Solution {
public:
    string decodeString(string s) {
        auto in = stringstream(s);
        return myDecodeString(in);
    }

private:
    string myDecodeString(stringstream& in) {
        string res;
        while (in.peek() != EOF && in.peek() != ']') {
            if (!isdigit(in.peek())) {
                char c;
                in >> c;
                res += c;
            }
            else {
                int number;
                in >> number;
                in.get();
                string t = myDecodeString(in);
                in.get();
                while (number--) res += t;
            }
        }
        return res;
    }
};
```

# 395. Longest Substring with At Least K Repeating Characters★★

Medium

Find the length of the longest substring ***T*** of a given string (consists of lowercase letters only) such that every character in ***T*** appears no less than *k* times.

**Example 1:**

```
Input:

s = "aaabb", k = 3

Output:

3

The longest substring is "aaa", as 'a' is repeated 3 times.
```

**Example 2:**

```
Input:

s = "ababbc", k = 2

Output:

5

The longest substring is "ababb", as 'a' is repeated 2 times and 'b' is repeated 3 times.
```

```cpp
class Solution {
public:
    int longestSubstring(string s, int k) {
        int cnt[256] = {0};
        for (auto &c : s)  cnt[c]++;
        bool ok = true;
        for (auto &c : s) if (cnt[c] < k) {
            c = ' ';
            ok = false;
        }
        if (ok) return s.length();
        stringstream ss(s);
        int res = 0;
        while (ss >> s) {
            res = max(res, longestSubstring(s, k));
        }
        return res;
    }
};
```

# 396. Rotate Function

Medium

Given an array of integers `A` and let *n* to be its length.

Assume $B_k$ to be an array obtained by rotating the array `A` *k* positions clock-wise, we define a "rotation function" `F` on `A` as follow:

$F(k) = 0 * B_k[0] + 1 * B_k[1] + ... + (n-1) * B_k[n-1]$.

Calculate the maximum value of `F(0), F(1), ..., F(n-1)`.

**Note:**
*n* is guaranteed to be less than $10^5$.

**Example:**

A = [4, 3, 2, 6]

F(0) = (0 * 4) + (1 * 3) + (2 * 2) + (3 * 6) = 0 + 3 + 4 + 18 = 25

F(1) = (0 * 6) + (1 * 4) + (2 * 3) + (3 * 2) = 0 + 4 + 6 + 6 = 16

F(2) = (0 * 2) + (1 * 6) + (2 * 4) + (3 * 3) = 0 + 6 + 8 + 9 = 23

F(3) = (0 * 3) + (1 * 2) + (2 * 6) + (3 * 4) = 0 + 2 + 12 + 12 = 26

So the maximum value of F(0), F(1), F(2), F(3) is F(3) = 26.

```
class Solution {
public:
    int maxRotateFunction(vector<int>& A) {
        long long n = A.size(), sum = 0, res = 0;
        for (int i = 0; i < n; ++i) {
            sum += A[i];
            res += i * A[i];
        }
        long long temp = res;
        for (int i = 0; i < n; ++i) {
            temp += n*A[i] - sum;
            res = max(temp, res);
        }
        return res;
    }
};
```

# 397. Integer Replacement

Medium

Given a positive integer *n* and you can do operations as follow:

1. If *n* is even, replace *n* with `n/2`.
2. If *n* is odd, you can replace *n* with either `n + 1` or `n - 1`.

What is the minimum number of replacements needed for *n* to become 1?

**Example 1:**

**Input:**

8

**Output:**

3

**Explanation:**

8 -> 4 -> 2 -> 1

**Example 2:**

**Input:**

7

**Output:**

4

**Explanation:**

7 -> 8 -> 4 -> 2 -> 1

or

7 -> 6 -> 3 -> 2 -> 1

```cpp
class Solution {
public:
    int integerReplacement(int n) {
        if (n == 1) return 0;
        else if (n == INT_MAX) return 32;
        if (m.find(n) != m.end()) return m[n];
        if (n % 2 == 0) {
            return m[n] = 1 + integerReplacement(n/2);
        }
        int a = 1 + integerReplacement(n-1);
        int b = 1 + integerReplacement(n+1);
        return m[n] = min(a, b);
    }

private:
    unordered_map<int, int> m;
};
```

# 398. Random Pick Index

Medium

Given an array of integers with possible duplicates, randomly output the index of a given target number. You can assume that the given target number must exist in the array.

**Note:**
The array size can be very large. Solution that uses too much extra space will not pass the judge.

**Example:**

```
int[] nums = new int[] {1,2,3,3,3};

Solution solution = new Solution(nums);

// pick(3) should return either index 2, 3, or 4 randomly. Each index should have equal probability of returning.

solution.pick(3);

// pick(1) should return 0. Since in the array only nums[0] is equal to 1.

solution.pick(1);
```

```cpp
class Solution {
public:
    Solution(vector<int>& nums) : beg(nums.begin()), end(nums.end()) {}

    int pick(int target) {
        int res, n = 0;
        for (auto it = beg; it != end; ++it) {
            if (*it != target) continue;
            if (rand() % ++n == 0) res = distance(beg, it);
        }
        return res;
    }
private:
    vector<int>::iterator beg, end;
};

/**
 * Your Solution object will be instantiated and called as such:
 * Solution* obj = new Solution(nums);
 * int param_1 = obj->pick(target);
 */
```

# 399. Evaluate Division★★

Medium

Equations are given in the format `A / B = k`, where `A` and `B` are variables represented as strings, and `k` is a real number (floating point number). Given some queries, return the answers. If the answer does not exist, return `-1.0`.

**Example:**

Given `a / b = 2.0, b / c = 3.0.`

queries are: `a / c = ?, b / a = ?, a / e = ?, a / a = ?, x / x = ? .`

return `[6.0, 0.5, -1.0, 1.0, -1.0 ].`

The input is: `vector<pair<string, string>> equations, vector<double>& values, vector<pair<string, string>> queries` , where `equations.size() == values.size()`, and the values are positive. This represents the equations. Return `vector<double>`.

According to the example above:

```
equations = [ ["a", "b"], ["b", "c"] ],

values = [2.0, 3.0],

queries = [ ["a", "c"], ["b", "a"], ["a", "e"], ["a", "a"], ["x", "x"] ].
```

The input is always valid. You may assume that evaluating the queries will result in no division by zero and there is no contradiction.

```cpp
class Solution {
public:
    vector<double> calcEquation(vector<vector<string>> &es,
                    vector<double> &vs, vector<vector<string>> &qs) {
        for (int i = 0; i < es.size(); i++) {
            string a = es[i][0], b = es[i][1];
            if (!id.count(a)) id[a] = node(a);
            if (!id.count(b)) id[b] = node(b);
            Union(a, b, vs[i]);
        }
        vector<double> res;
        for (auto q : qs) {
            if (!id.count(q[0]) || !id.count(q[1]))
                res.push_back(-1);
            else {
                double va = 1, vb = 1;
                string fa_a = find(q[0], va);
                string fa_b = find(q[1], vb);
                if (fa_a != fa_b) res.push_back(-1);
                else res.push_back(va / vb);
            }
        }
        return res;
    }

private:
    struct node {
        node(string p = "", double v = 1.0) : parent(p), val(v){};
        string parent;
        double val;
    };


    unordered_map<string, node> id;

    string find(string s, double &v) {
        while (id[s].parent != s) {
            v = v * id[s].val;
            s = id[s].parent;
        }
        return s;
    }
```

```
    void Union(string a, string b, double v) {
        double va = 1.0, vb = 1.0;
        string fa_a = find(a, va);
        string fa_b = find(b, vb);
        id[fa_a] = node(fa_b, v*vb/va);
    }
};
```

# 400. Nth Digit

Medium

Find the $n^{th}$ digit of the infinite integer sequence 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, ...

**Note:**
$n$ is positive and will fit within the range of a 32-bit signed integer ($n < 2^{31}$).

**Example 1:**

**Input:**

3

**Output:**

3

**Example 2:**

**Input:**

11

**Output:**

0

**Explanation:**

The 11th digit of the sequence 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, ... is a 0, which is part of the number 10.

```cpp
class Solution {
public:
    int findNthDigit(int n) {
        int k = 1;
        // k 位数第 n 个
        while (n > 9*pow(10, k-1)*k) {
            n -= 9*pow(10, k-1)*k;
            k++;
        }
        int m = (n-1)/k, num = pow(10, k-1)+m;
        n -= m*k;
        // num 的第 n 位, 即从右往左数第 k+1-n 位
        return (num / (int)pow(10, k-n)) % 10;
    }
};
```