DOMAIN WINTER WINNING CAMP

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Day 9 : BackTracking

Very Easy:

1. Generate Numbers with a Given Sum

Generate all numbers of length n whose digits sum up to a target value sum, The digits of the number will be between 0 and 9, and we will generate combinations of digits such that their sum equals the target.

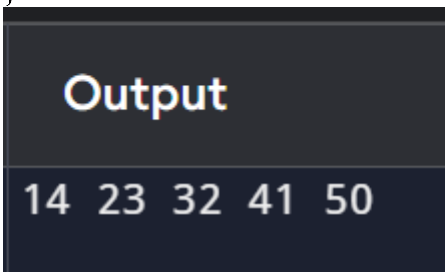
Example 1:
Input: n = 2 and sum = 5
Output: 14 23 32 41 50

Example 2:
Input: n = 3 and sum = 5
Output: 104 113 122 131 140 203 212 221 230 302 311 320 401 410 500

Constraints:
1 <= n <= 9: The number of digits must be between 1 and 9.
1 <= sum <= 100: The sum of the digits must be between 1 and 100.
The first digit cannot be zero if n > 1.

CODE:
```
#include <iostream>
#include <vector>
using namespace std;

void generateNumbers(int n, int sum, string current, vector<string> &result) {
    if (n == 0 && sum == 0) {
        result.push_back(current);
        return;
    }
    if (n == 0 || sum < 0) return;

    int start = current.empty() ? 1 : 0;
    for (int i = start; i <= 9; ++i) {
        generateNumbers(n - 1, sum - i, current + to_string(i), result);
```

```
    }
}

int main() {
    int n = 2, sum = 5;
    vector<string> result;
    generateNumbers(n, sum, "", result);
    for (const string &num : result) {
        cout << num << " ";
    }
    return 0;
}
```

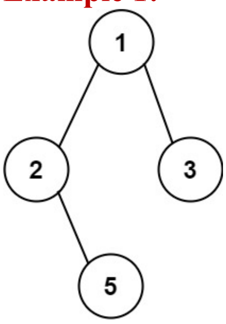


Easy:

2. Binary Tree Paths

Given the root of a binary tree, return all root-to-leaf paths in any order.
A leaf is a node with no children.

Example 1:

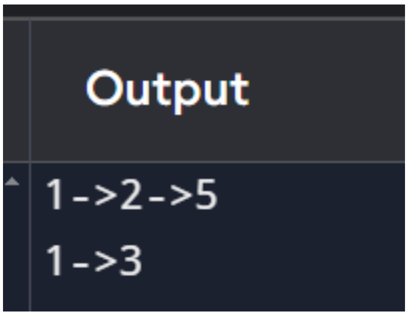


Input: root = [1,2,3,null,5]Output: ["1->2->5","1->3"]
Example 2:
Input: root = [1]Output: ["1"]

Constraints:
The number of nodes in the tree is in the range [1, 100].
-100 <= Node.val <= 100

CODE:

```
#include <iostream>
#include <vector>
#include <string>
using namespace std;

struct TreeNode {
    int val;
    TreeNode *left, *right;
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};

void dfs(TreeNode *root, string path, vector<string> &paths) {
    if (!root) return;
    path += to_string(root->val);
    if (!root->left && !root->right) {
        paths.push_back(path);
        return;
    }
    path += "->";
    dfs(root->left, path, paths);
    dfs(root->right, path, paths);
}

vector<string> binaryTreePaths(TreeNode *root) {
    vector<string> paths;
    dfs(root, "", paths);
    return paths;
}

int main() {
    TreeNode *root = new TreeNode(1);
    root->left = new TreeNode(2);
    root->right = new TreeNode(3);
    root->left->right = new TreeNode(5);

    vector<string> result = binaryTreePaths(root);
    for (const string &path : result) {
        cout << path << endl;
    }
    return 0;
}
```



Medium:

3. Combinations

Given two integers n and k, return all possible combinations of k numbers chosen from the range [1, n].

You may return the answer in any order.

Example 1:

Input: n = 4, k = 2
Output: [[1,2],[1,3],[1,4],[2,3],[2,4],[3,4]]
Explanation: There are 4 choose 2 = 6 total combinations.
Note that combinations are unordered, i.e., [1,2] and [2,1] are considered to be the same combination.
Example 2:

Input: n = 1, k = 1
Output: [[1]]
Explanation: There is 1 choose 1 = 1 total combination.

Constraints:

1 <= n <= 20
1 <= k <= n
CODE:

```
#include <iostream>
#include <vector>
using namespace std;

void combineHelper(int start, int n, int k, vector<int> &current, vector<vector<int>>
&result) {
    if (k == 0) {
        result.push_back(current);
```

```
        return;
    }
    for (int i = start; i <= n; ++i) {
        current.push_back(i);
        combineHelper(i + 1, n, k - 1, current, result);
        current.pop_back();
    }
}

vector<vector<int>> combine(int n, int k) {
    vector<vector<int>> result;
    vector<int> current;
    combineHelper(1, n, k, current, result);
    return result;
}

int main() {
    int n = 4, k = 2;
    vector<vector<int>> result = combine(n, k);
    for (const auto &comb : result) {
        cout << "[";
        for (int num : comb) cout << num << " ";
        cout << "]" << endl;
    }
    return 0;
}
```

Output

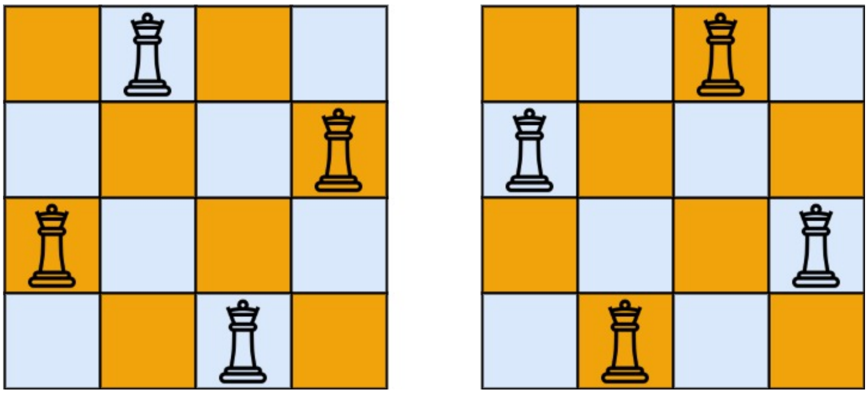
```
[1 2 ]
[1 3 ]
[1 4 ]
[2 3 ]
[2 4 ]
[3 4 ]
```

Hard:

4. N-Queens II

The n-queens puzzle is the problem of placing n queens on an n x n chessboard such that no two queens attack each other.
Given an integer n, return the number of distinct solutions to the n-queens puzzle.

Example 1:



Input: n = 4
Output: 2
Explanation: There are two distinct solutions to the 4-queens puzzle as shown.

Example 2:
Input: n = 1
Output: 1

Constraints:
1 <= n <= 9
CODE:

```
#include <iostream>
#include <vector>
using namespace std;

void solve(int row, int n, vector<int> &cols, vector<int> &diags1, vector<int>
&diags2, int &count) {
    if (row == n) {
        ++count;
        return;
    }
    for (int col = 0; col < n; ++col) {
        if (cols[col] || diags1[row - col + n - 1] || diags2[row + col]) continue;
        cols[col] = diags1[row - col + n - 1] = diags2[row + col] = 1;
        solve(row + 1, n, cols, diags1, diags2, count);
```

```
        cols[col] = diags1[row - col + n - 1] = diags2[row + col] = 0;
    }
}

int totalNQueens(int n) {
    vector<int> cols(n, 0), diags1(2 * n - 1, 0), diags2(2 * n - 1, 0);
    int count = 0;
    solve(0, n, cols, diags1, diags2, count);
    return count;
}

int main() {
    int n = 4;
    cout << "Number of solutions for " << n << "-Queens: " << totalNQueens(n) << 
endl;
    return 0;
}
```

```
Output                                  Clear
Number of solutions for 4-Queens: 2
```

Very Hard:

5. Word Ladder II

A transformation sequence from word beginWord to word endWord using a dictionary wordList is a sequence of words beginWord -> s1 -> s2 -> ... -> sk such that:
Every adjacent pair of words differs by a single letter.
Every si for 1 <= i <= k is in wordList. Note that beginWord does not need to be in wordList.
sk == endWord
Given two words, beginWord and endWord, and a dictionary wordList, return all the shortest transformation sequences from beginWord to endWord, or an empty list if no such sequence exists. Each sequence should be returned as a list of the words [beginWord, s1, s2, ..., sk].

Example 1:
Input: beginWord = "hit", endWord = "cog", wordList = ["hot","dot","dog","lot","log","cog"]
Output: [["hit","hot","dot","dog","cog"],["hit","hot","lot","log","cog"]]

Explanation: There are 2 shortest transformation sequences:
"hit" -> "hot" -> "dot" -> "dog" -> "cog"
"hit" -> "hot" -> "lot" -> "log" -> "cog"

Example 2:
Input: beginWord = "hit", endWord = "cog", wordList = ["hot","dot","dog","lot","log"]
Output: []
Explanation: The endWord "cog" is not in wordList, therefore there is no valid transformation sequence.

Constraints:
1 <= beginWord.length <= 5
endWord.length == beginWord.length
1 <= wordList.length <= 500
wordList[i].length == beginWord.length
beginWord, endWord, and wordList[i] consist of lowercase English letters.
beginWord != endWord
All the words in wordList are unique.
The sum of all shortest transformation sequences does not exceed 105.
CODE:

```
#include <iostream>
#include <vector>
#include <unordered_set>
#include <queue>
using namespace std;

vector<vector<string>> findLadders(string beginWord, string endWord,
vector<string> &wordList) {
    unordered_set<string> dict(wordList.begin(), wordList.end());
    vector<vector<string>> result;
    if (dict.find(endWord) == dict.end()) return result;

    queue<vector<string>> paths;
    paths.push({beginWord});
    int level = 1, minLevel = INT_MAX;
    unordered_set<string> visited;

    while (!paths.empty()) {
        vector<string> path = paths.front();
        paths.pop();
        if (path.size() > level) {
            for (const string &word : visited) dict.erase(word);
            visited.clear();
            level = path.size();
```

```
            if (level > minLevel) break;
        }

        string last = path.back();
        for (int i = 0; i < last.size(); ++i) {
            string next = last;
            for (char c = 'a'; c <= 'z'; ++c) {
                next[i] = c;
                if (!dict.count(next)) continue;
                visited.insert(next);
                vector<string> newPath = path;
                newPath.push_back(next);
                if (next == endWord) {
                    result.push_back(newPath);
                    minLevel = level;
                } else {
                    paths.push(newPath);
                }
            }
        }
    }
    return result;
}

int main() {
    string beginWord = "hit", endWord = "cog";
    vector<string> wordList = {"hot", "dot", "dog", "lot", "log", "cog"};
    vector<vector<string>> result = findLadders(beginWord, endWord, wordList);
    for (const auto &path : result) {
        for (const string &word : path) {
            cout << word << " ";
        }
        cout << endl;
    }
    return 0;
}
```

Output

```
hit hot dot dog cog
hit hot lot log cog
```