

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:

$1 \leq n \leq 9$: The number of digits must be between 1 and 9.

$1 \leq sum \leq 100$: 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;  
}
```

Output

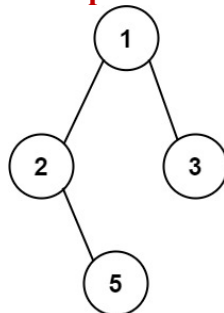
14 23 32 41 50

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;

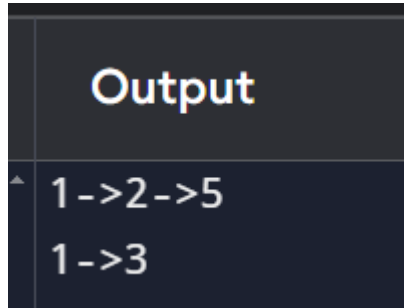
struct TreeNode {
    int val;
    TreeNode *left, *right;
    TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
};

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 $4 \text{ choose } 2 = 6$ 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 $1 \text{ choose } 1 = 1$ total combination.

Constraints:

$1 \leq n \leq 20$

$1 \leq k \leq n$

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 ]
```

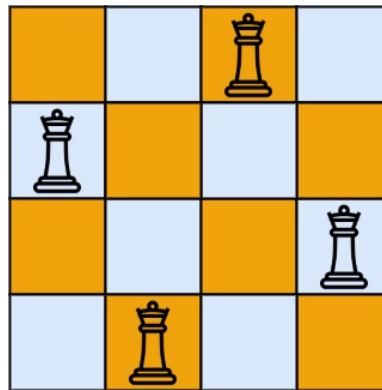
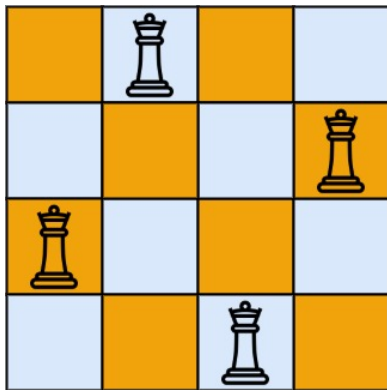
Hard:

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 s_i for $1 \leq i \leq k$ 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;
}
```



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Output

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