<u>DOMAIN WINTER CAMP</u>

<u>DAY - 8</u>

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Dynamic Programming

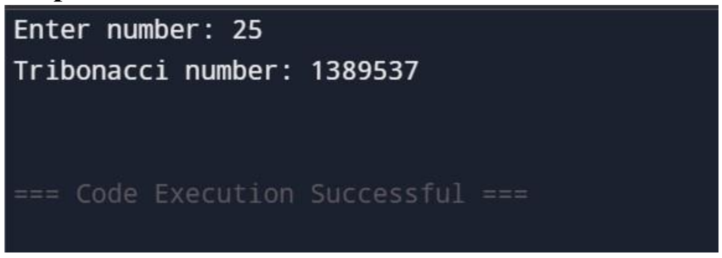
Very Easy:

1. N-th Tribonacci Number

The Tribonacci sequence Tn is defined as follows:
T0 = 0, T1 = 1, T2 = 1, and Tn+3 = Tn + Tn+1 + Tn+2 for n >= 0. Given
n, return the value of Tn.

Solution:
```
#include
<iostream> using
namespace std;

class Solution { public:    int
tribonacci(int n) {        if (n ==
0) return 0;        if (n == 1 || n ==
2) return 1;

        int t0 = 0, t1 = 1, t2 = 1;
int t3;
        for (int i = 3; i <= n; ++i) {
t3 = t0 + t1 + t2;            t0 = t1;
t1 = t2;            t2 = t3;
        }
return t3;
    }
};

int main() {
Solution solution;
int n;
    cout << "Enter number: ";
cin >> n;
    cout << "Tribonacci number: " << solution.tribonacci(n) << endl;
return 0;
}
```

Output:



```
Enter number: 25
Tribonacci number: 1389537


=== Code Execution Successful ===
```

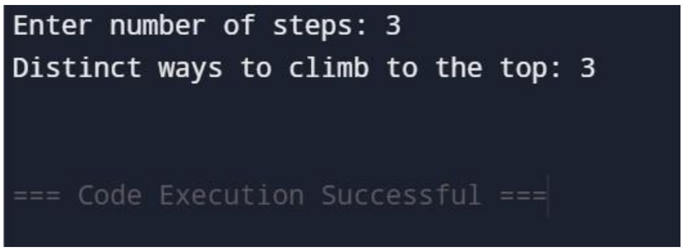
Easy:

2. Climbing Stairs

You are climbing a staircase. It takes n steps to reach the top. Each time you can either climb 1 or 2 steps. In how many distinct ways can you climb to the top?

Solution:
```
#include
<iostream> using
namespace std;

class Solution { public:
int climbStairs(int n) {
if (n == 1) return 1;

        int prev1 = 1, prev2 = 2;
for (int i = 3; i <= n; ++i) {
int curr = prev1 + prev2;
prev1 = prev2;           prev2 =
curr;
        }        return
prev2;
    }
};

int main() {
Solution solution;
int n;
    cout << "Enter number of steps: ";
cin >> n;
    cout << "Distinct ways to climb to the top: " << solution.climbStairs(n) << endl;
return 0;
}
```

Output:



```
Enter number of steps: 3
Distinct ways to climb to the top: 3


=== Code Execution Successful ===
```

Medium:

3. Longest Palindromic Substring

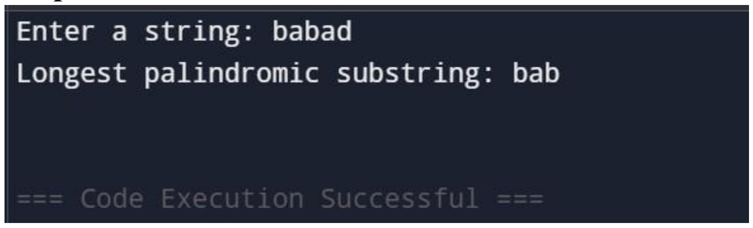
Given a string s, return the longest palindromic substring in s.

Solution:

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

class Solution { public:     string
longestPalindrome(string s) {         int
start = 0, maxLength = 0;         for (int
i = 0; i < s.size(); ++i) {
            expandAroundCenter(s, i, i, start, maxLength);
expandAroundCenter(s, i, i + 1, start, maxLength);
        }
        return s.substr(start, maxLength);
    }

private:      void expandAroundCenter(const string& s, int left, int right, int&
start, int& maxLength) {
        while (left >= 0 && right < s.size() && s[left] == s[right]) {
int length = right - left + 1;             if (length > maxLength) {
                maxLength = length;
start = left;
            }
            --left;
            ++right;
        }
    }
};

int main() {
Solution solution;
string s;
    cout << "Enter a string: ";
cin >> s;
```

```
    cout << "Longest palindromic substring: " << solution.longestPalindrome(s) <<
endl;     return 0;
}
```

Output:



```
Enter a string: babad
Longest palindromic substring: bab


=== Code Execution Successful ===
```

Hard:

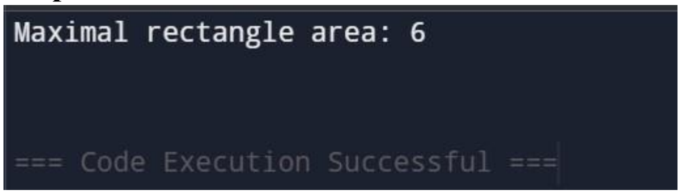
4. Maximal Rectangle

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

Solution:

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

class Solution { public:
    int maximalRectangle(vector<vector<char>>& matrix) {
if (matrix.empty() || matrix[0].empty()) return 0;

        int rows = matrix.size();
int cols = matrix[0].size();
vector<int> heights(cols, 0);
int maxArea = 0;

        for (int i = 0; i < rows; i++) {
for (int j = 0; j < cols; j++) {
                heights[j] = matrix[i][j] == '1' ? heights[j] + 1 : 0;
            }
            maxArea = max(maxArea, largestRectangleArea(heights));
        }

        return maxArea;
    }
    int largestRectangleArea(vector<int>& heights) {
stack<int> s;        int maxArea = 0;
heights.push_back(0);

        for (int i = 0; i < heights.size(); i++) {
            while (!s.empty() && heights[i] < heights[s.top()]) {
int h = heights[s.top()];                s.pop();
                int width = s.empty() ? i : i - s.top() - 1;
maxArea = max(maxArea, h * width);            }
            s.push(i);
        }

        return maxArea;
    }
};

int main() {
    vector<vector<char>> matrix = {
        {'1', '0', '1', '0', '0'},
        {'1', '0', '1', '1', '1'},
        {'1', '1', '1', '1', '1'},
        {'1', '0', '0', '1', '0'}
    };

    Solution solution;
    int result = solution.maximalRectangle(matrix);
cout << "Maximal rectangle area: " << result << endl;

    return 0;
}
```

Output:



```
Maximal rectangle area: 6


=== Code Execution Successful ===
```

Very Hard:

5. Cherry Pickup

You are given an n x n grid representing a field of cherries, each cell is one of three possible integers.
0 means the cell is empty, so you can pass through,
1 means the cell contains a cherry that you can pick up and pass through, or -1 means the cell contains a thorn that blocks your way.

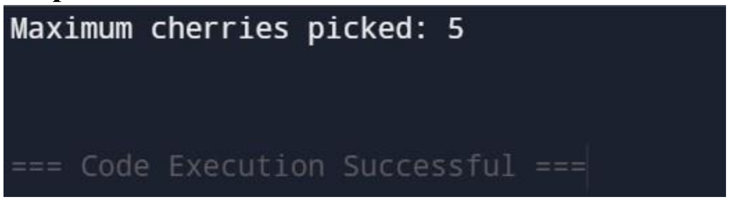
Return the maximum number of cherries you can collect by following the rules below:
Starting at the position (0, 0) and reaching (n - 1, n - 1) by moving right or down through valid path cells (cells with value 0 or 1).
After reaching (n - 1, n - 1), returning to (0, 0) by moving left or up through valid path cells.
When passing through a path cell containing a cherry, you pick it up, and the cell becomes an empty cell 0.
If there is no valid path between (0, 0) and (n - 1, n - 1), then no cherries can be collected.

Solution:

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

class Solution { public:     int
cherryPickup(vector<vector<int>>& grid) {
int n = grid.size();

    // DP table: dp[step][r1][r2] = max cherries collected by two people at step 'step'
vector<vector<vector<int>>> dp(2 * n - 1, vector<vector<int>>(n, vector<int>(n, -1)));

    // Initialize the base case
    dp[0][0][0] = grid[0][0]; // Starting position for both people

    // Fill the DP table for each step          for
(int step = 1; step < 2 * n - 1; ++step) {
        for (int r1 = max(0, step - (n - 1)); r1 <= min(n - 1, step); ++r1) {
for (int r2 = max(0, step - (n - 1)); r2 <= min(n - 1, step); ++r2) {
int c1 = step - r1;                  int c2 = step - r2;
            if (grid[r1][c1] == -1 || grid[r2][c2] == -1) continue; // Skip blocked cells

            int cherries = grid[r1][c1] + (r1 != r2 ? grid[r2][c2] : 0); // Collect cherries

            // Explore all possible ways to move from the previous step
int maxPrev = -1;
            for (int prevR1 = r1 - 1; prevR1 <= r1; ++prevR1) {
for (int prevR2 = r2 - 1; prevR2 <= r2; ++prevR2) {
int prevC1 = step - prevR1;                      int prevC2 = step -
prevR2;
                if (prevR1 >= 0 && prevR1 < n && prevR2 >= 0 && prevR2 < n
&&
                  prevC1 >= 0 && prevC1 < n && prevC2 >= 0 && prevC2 < n
&&
                  dp[step - 1][prevR1][prevR2] != -1) {
                  maxPrev = max(maxPrev, dp[step - 1][prevR1][prevR2]);
                }
```

```
                    }
                }

                if (maxPrev != -1) {
                    dp[step][r1][r2] = max(dp[step][r1][r2], maxPrev + cherries);
                }
            }
        }
    }

    return dp[2 * n - 2][n - 1][n - 1] == -1 ? 0 : dp[2 * n - 2][n - 1][n - 1];
  }
};

int main() {
  vector<vector<int>> grid = {
    {0, 1, -1},
    {1, 0, -1},
    {1, 1, 1}
  };

  Solution solution;
  cout << "Maximum cherries picked: " << solution.cherryPickup(grid) << endl;
return 0;
}
```

Output:



```
Maximum cherries picked: 5


=== Code Execution Successful ===
```