Experiment - 7

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Subject: AP LAB - 2 **Subject Code:** 22ITP-351

1. Aim:

Problem 1.1.1: Climbing Stairs

Problem Statement: Climbing Stairs Find the number of ways to climb n stairs when you can take 1 or 2 steps at a time. This follows the Fibonacci sequence and can be solved using dynamic programming (DP) in O(n) time and O(1) space. Edge cases include n = 1 and n = 2.

2. Objectives:

Find the number of ways to climb n stairs using 1 or 2 steps at a time. Solve efficiently using DP in O(n) time and O(1) space, following the Fibonacci sequence while handling edge cases like n = 1 and n = 2.

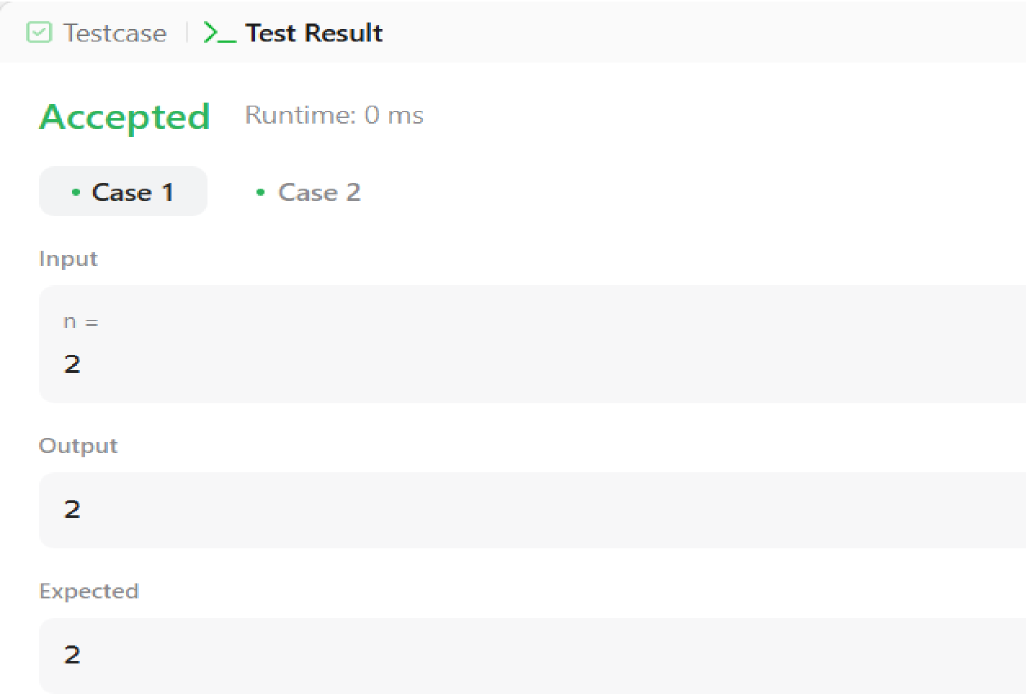
3. Implementation of Code:

```
class Solution {
public:
    int solve(int n,vector<int> &dp){
        //base case
        if(n<=2)
          return n;

        if(dp[n]!=-1)
          return dp[n];

        dp[n]=solve(n-1,dp)+solve(n-2,dp);
        return dp[n];
    }
    int climbStairs(int n) {
        if(n<=2)
         return n;
        vector<int> dp(n+1,-1);
        return solve(n,dp);
    }
};
```

4. Output:



Problem 1.1.2: Maximum Subarray

Problem Statement: - Maximum Subarray Find the contiguous subarray with the maximum sum using Kadane's Algorithm. This runs in O(n) time and O(1) space. Edge cases include an array of all negative numbers.

Implementation of Code:

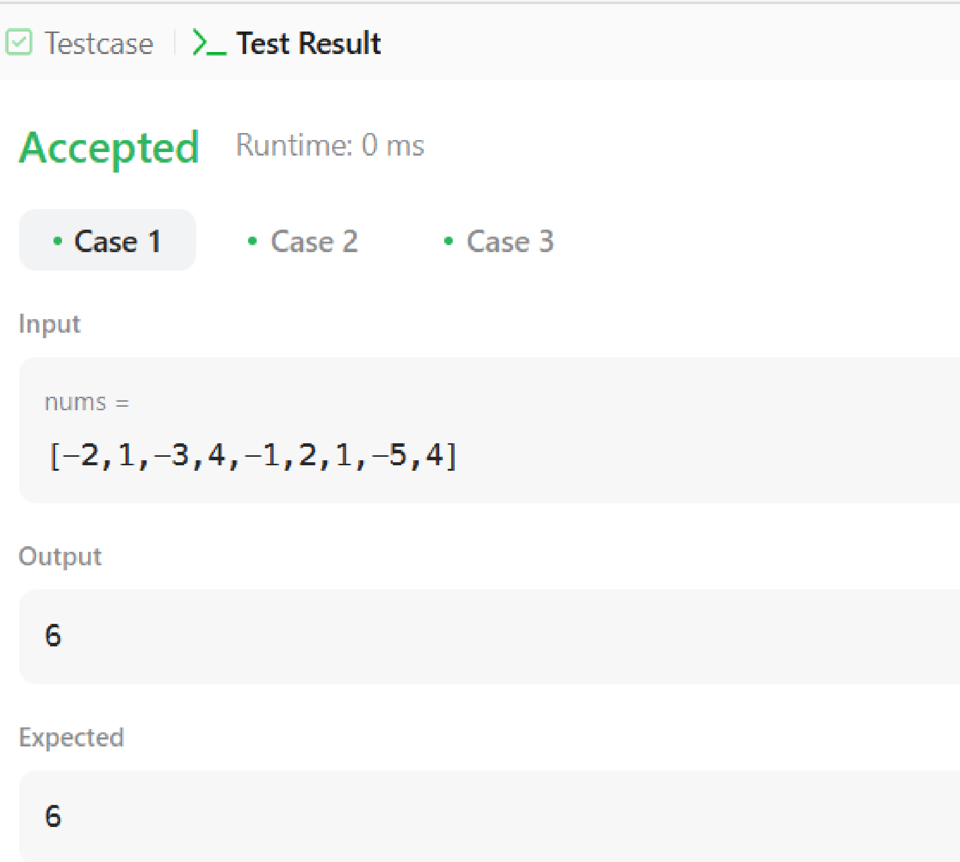
```
class Solution {
public:
    int maxSubArray(vector<int>& nums) {
        int res = nums[0];
        int total = 0;

        for (int n : nums) {
            if (total < 0) {
                total = 0;
            }

            total += n;
            res = max(res, total);
        }
```

```
        return res;
      }
};
```

Output:



1. **Problem 1.1.3: House Robber**

Problem Statement: You are given an array representing the amount of money in each house on a street. You cannot rob two adjacent houses. Determine the maximum amount you can rob without alerting the police.

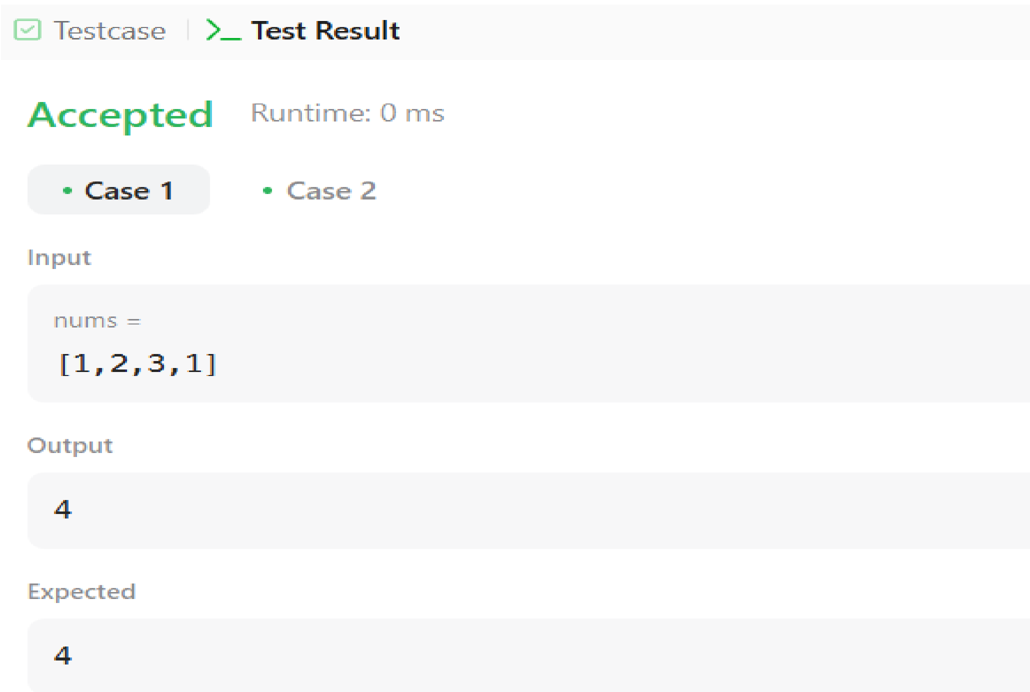
2. **Implementation of Code:**

```
class Solution {
public:
    int rob(vector<int>& nums) {
        int prevRob = 0;
        int maxRob = 0;

        for (int curValue : nums) {
            int temp = max(maxRob, prevRob + curValue);
            prevRob = maxRob;
            maxRob = temp;
        }

        return maxRob;
    }
};
```

3. **Output:**



Problem 1.1.4: Jump Game

Problem Statement: Given an array where each element represents the maximum jump length from that position, determine if you can reach the last index starting from the first index

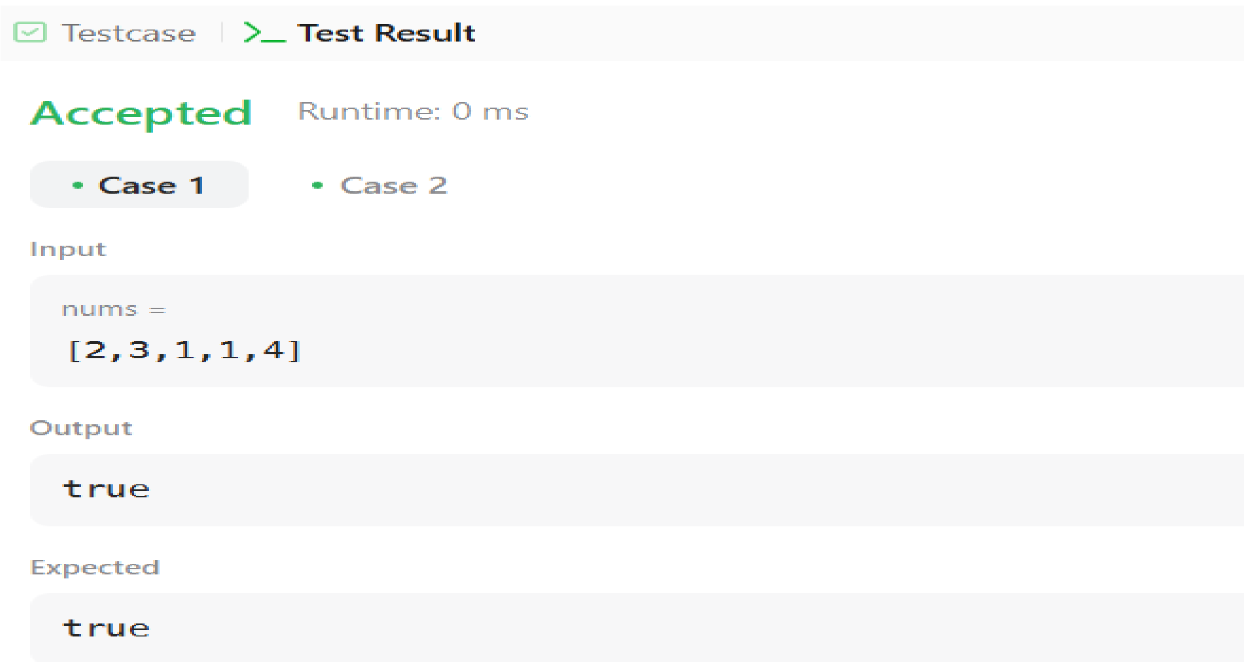
Implementation of code:

```
class Solution {
public:
    bool canJump(vector<int>& nums) {
        int goal = nums.size() - 1;

        for (int i = nums.size() - 2; i >= 0; i--) {
            if (i + nums[i] >= goal) {
                goal = i;
            }
        }

        return goal == 0;
    }
};
```

Output:



Problem 1.1.5: Unique Paths

Problem Statement: You are given an m x n grid where a robot starts at the top-left and can only move right or down. Determine the number of unique paths the robot can take to reach the bottom-right corner.

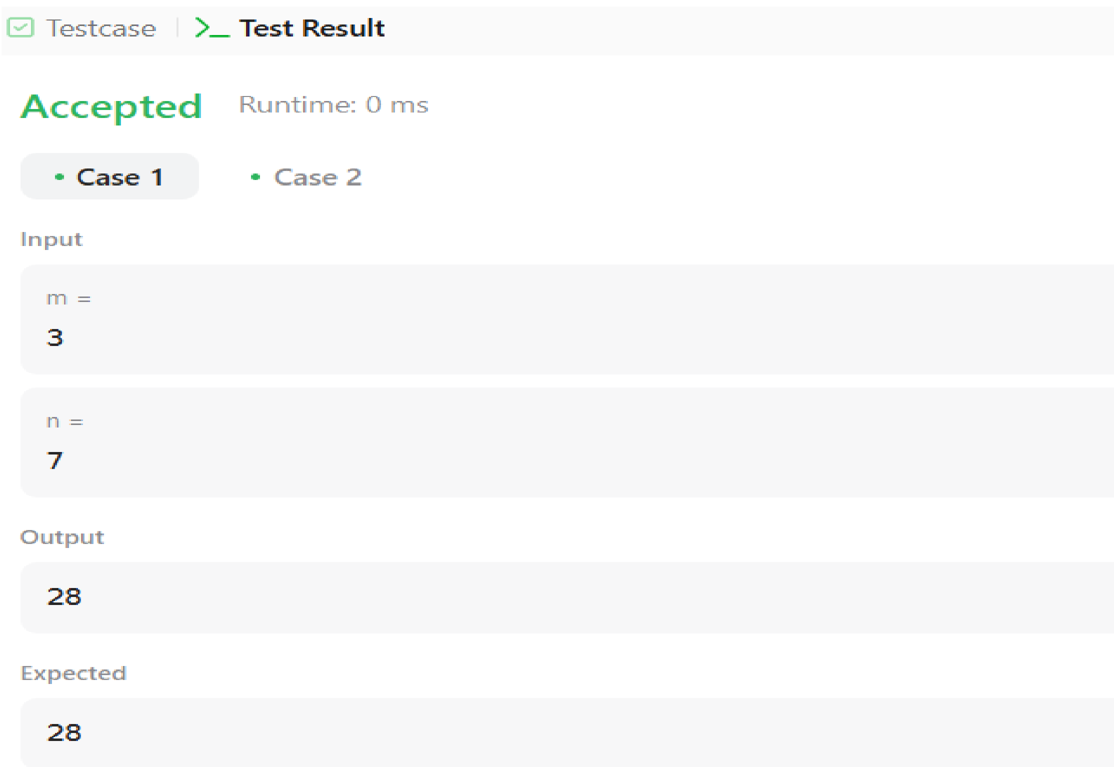
Implementation of code:

```
class Solution {
public:
    int uniquePaths(int m, int n) {
        std::vector<int> aboveRow(n, 1);

        for (int row = 1; row < m; row++) {
            std::vector<int> currentRow(n, 1);
            for (int col = 1; col < n; col++) {
  currentRow[col] = currentRow[col - 1] + aboveRow[col];
            }
            aboveRow = currentRow;
        }

        return aboveRow[n - 1];
    }
};
```

Output:



Problem 1.1.6: Coin Change

Problem Statement: Given an array of coin denominations and an amount, determine the minimum number of coins needed to make up that amount. If it is impossible, return -1.

Implementation of Code:

```
class Solution {
public:
    int minCoin(vector<int> &coins, int amount) {
        if (amount <= 0) {
            return 0;
        }

        int ans = INT_MAX;
        for (int i = 0; i < coins.size(); i++) {
            int coin = coins[i];
            if (coin <= amount) {
                int recAns = minCoin(coins, amount - coin);

                if (recAns != INT_MAX) {
                    recAns += 1;
                    ans = min(ans, recAns);
                }
            }
        }
        return ans;
    }

    int coinChange(vector<int>& coins, int amount) {
        int ans = minCoin(coins, amount);
        if (ans == INT_MAX) {
            return -1;
        }
        return ans;
    }
};
```

Output:

Problem 1.1.7: Longest Increasing Subsequence

Problem Statement: Given an array of integers, find the length of the longest subsequence where the elements are strictly increasing.

Implementation of Code:

```
class Solution {
public:
    int LISRec(vector<int> &nums, int prev, int curr) {
        if (curr >= nums.size()) {
            return 0;
        }

        int include = 0;
        if (prev == -1 || nums[prev] < nums[curr]) {
            include = 1 + LISRec(nums, curr, curr + 1);
        }
        int exclude = LISRec(nums, prev, curr + 1);
        return max(include, exclude);
```

```
        }

        int lengthOfLIS(vector<int>& nums) {
            int prev = -1;
            int curr = 0;
            return LISRec(nums, prev, curr);
        }
    };
```

Output:

Problem 1.1.8: Maximum Product Subarray
Problem Statement: Given an array of integers, find the contiguous subarray (of at least one element) that has the largest product and return its product.

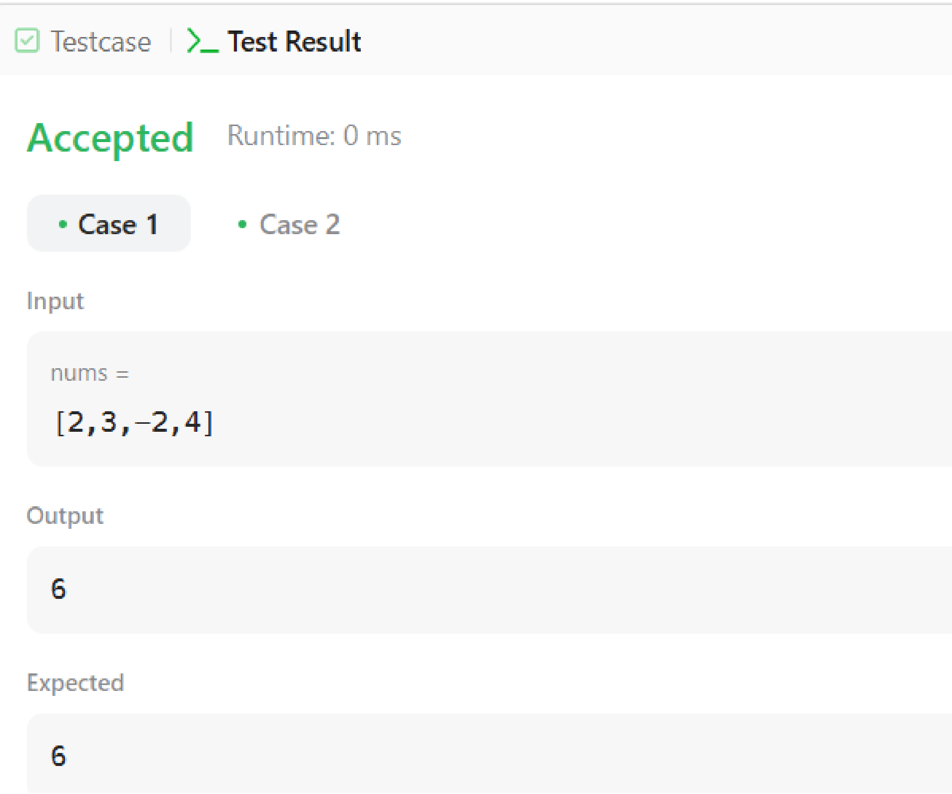
Implementation of Code:

```
class Solution {
public:
    int maxProduct(vector<int>& nums) {
        int maxi = INT_MIN;
        int prod=1;

        for(int i=0;i<nums.size();i++)
        {
          prod*=nums[i];
          maxi=max(prod,maxi);
          if(prod==0)
           prod=1;
        }
        prod=1;
        for(int i=nums.size()-1;i>=0;i--)
        {
          prod*=nums[i];

          maxi=max(prod,maxi);
          if(prod==0)
           prod=1;
        }
        return maxi;
    }
};
```

Output:



Learning Outcomes:

- Understand how to solve problems using dynamic programming by breaking them into smaller subproblems.
- Learn to optimize time and space complexity using DP techniques.
- Recognize how the Fibonacci sequence applies to real-world problems like climbing stairs.
- Understand how to handle constraints (e.g., not robbing adjacent houses) while maximizing a value.
- Learn to solve problems like the Jump Game using greedy approaches to determine reachability.