



Experiment 6

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Semester: 6th

Date of Performance: 12/03/25

Subject Name: Advanced Programming Lab-2

Subject Code: 22CSP-351

Problem -1

1. Aim: Climbing Stairs

2. Objective:

- **Compute the Number of Ways to Climb Stairs:** - Determine how many distinct ways one can reach the top by taking either 1 or 2 steps at a time.
- **Optimize Space Complexity:-** Use only constant **O(1)** space instead of an **O(n)** array.
- **Improve Efficiency:** - Implement an **O(n)** time complexity solution using an iterative approach rather than recursion.
- **Leverage Fibonacci-like Transition:** - Utilize the relation $f(n) = f(n-1) + f(n-2)$ to compute results efficiently..
- **Handle Base Cases:-** Return **1** for **n = 1** and **2** for **n = 2** directly to avoid unnecessary computations.

3. Implementation/Code:

```
class Solution {  
  
public:  
  
    int climbStairs(int n) {  
  
        if (n == 1) return 1;  
  
        if (n == 2) return 2;  
  
        int a = 1, b = 2, c;  
  
        for (int i = 3; i <= n; i++) {  
  
            c = a + b; // Fibonacci-like transition  
  
            a = b;  
  
            b = c;  
        }  
    }  
};
```

```
}  
  
    return b;  
  
}  
  
};
```

4. Output:

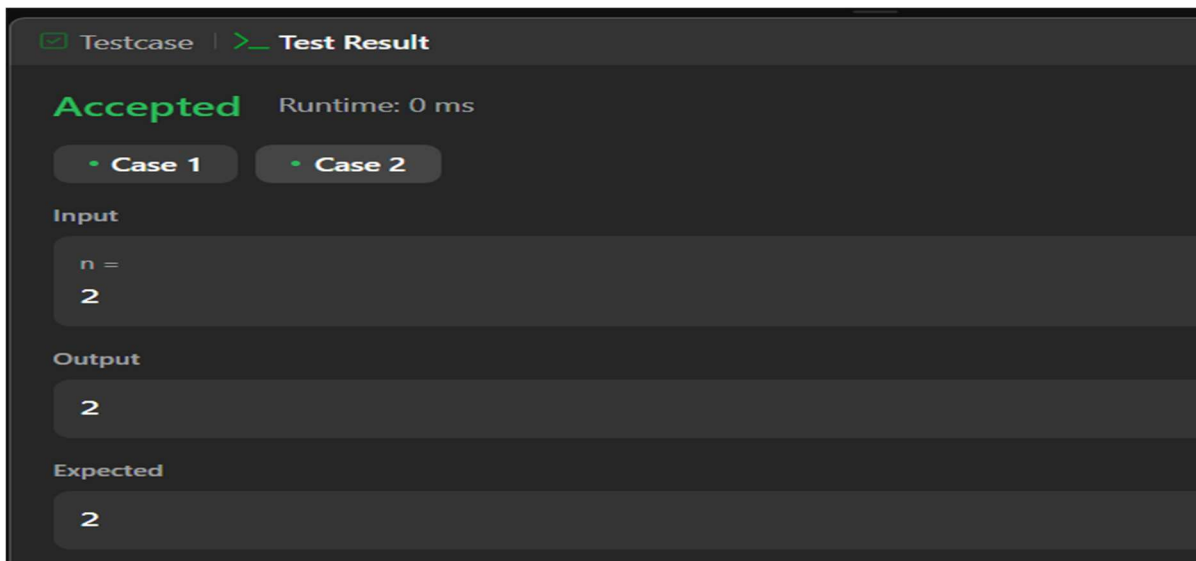


Figure 1

5. Learning Outcome:

- **Understanding Dynamic Programming (DP)** – Learn how to optimize recursive problems using an iterative DP approach with space efficiency.
- **Applying Fibonacci Sequence Logic** – Recognize how problems with overlapping subproblems can be solved using a Fibonacci-like recurrence relation.
- **Optimizing Space Complexity** – Learn how to reduce **O(n) space** (DP array) to **O(1) space** using only two variables.
- **Efficient Iterative Approach** – Understand how avoiding recursion improves performance and prevents stack overflow for large **n**.

Problem-2

1. **Aim:** Maximum subarray

2. **Objectives:**

- **Find the Maximum Subarray Sum:** - Identify the contiguous subarray with the highest sum in the given integer array.
- **Optimize Time Complexity:-** Implement **Kadane's Algorithm** to solve the problem in **O(n)** time, making it efficient for large inputs.
- **Use Dynamic Programming Approach:-** Maintain a running sum (curSum) and update the global maximum (maxSum) dynamically.
- **Handle Negative and Positive Values Efficiently:-** Decide whether to extend the current subarray or start a new one based on the given values.

3. **Implementation/Code:**

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

        for (int i = 1; i < nums.size(); i++) {
            curSum = max(nums[i], curSum + nums[i]); // Extend or start new subarray
            maxSum = max(maxSum, curSum); // Update global max
        }

        return maxSum;
    }
};
```

4. **Output:**



The screenshot shows a code execution interface with a dark theme. At the top, there are tabs for 'Testcase' and 'Test Result', with 'Test Result' being the active tab. Below the tabs, the status 'Accepted' is displayed in green, followed by 'Runtime: 0 ms'. There are three case buttons: 'Case 1' (selected), 'Case 2', and 'Case 3'. Under 'Case 1', the 'Input' section shows 'nums = [-2, 1, -3, 4, -1, 2, 1, -5, 4]'. The 'Output' section shows the value '6'. The 'Expected' section also shows the value '6'.

5. Learning Outcomes:

- **Understanding Kadane's Algorithm:-** Learn how to efficiently find the maximum subarray sum using a greedy and dynamic programming approach.
- **Optimizing Time Complexity:** - Recognize how an **O(n) linear scan** can be used instead of brute-force **O(n²)** or **O(n³)** approaches.
- **Handling Complex Sorting Problems:** - You will gain confidence in solving sorting problems efficiently. This improves your problem-solving ability in technical interviews.
- **Writing Optimized Code:** - The approach ensures sorting is done in one pass. This makes the code faster and reduces unnecessary computations.
- **Better Preparation for Interviews:** - This problem is commonly asked in coding interviews. Practicing it will strengthen your ability to solve sorting-based challenges.

Problem – 3

1. Aim: House Robber

2. Objectives:

- **Maximize the Loot Without Triggering Security:** - Compute the maximum amount of money that can be robbed without robbing adjacent houses.
- **Optimize Space Complexity:** - Use only **O(1) space** by maintaining two variables (prev1 and prev2) instead of an **O(n) DP array**.
- **Implement Dynamic Programming Efficiently:** - Use a **bottom-up approach** to iteratively compute the best solution without recursion.
- **Ensure Optimal Decision at Each Step:** - At each house, decide whether to rob it (add its value to prev2) or skip it (carry forward prev1).

3. Implementation/Code:

```
class Solution {
public:
    int rob(vector<int>& nums) {
        if (nums.empty()) return 0;
        if (nums.size() == 1) return nums[0];

        int prev2 = 0, prev1 = 0; // prev2: max sum till i-2, prev1: max sum till i-1
        for (int money : nums) {
            int curr = max(prev1, prev2 + money); // Either rob or skip
            prev2 = prev1; // Move prev1 to prev2
            prev1 = curr; // Update prev1 to current max
        }
        return prev1;
    }
}
```

};

4. Output:

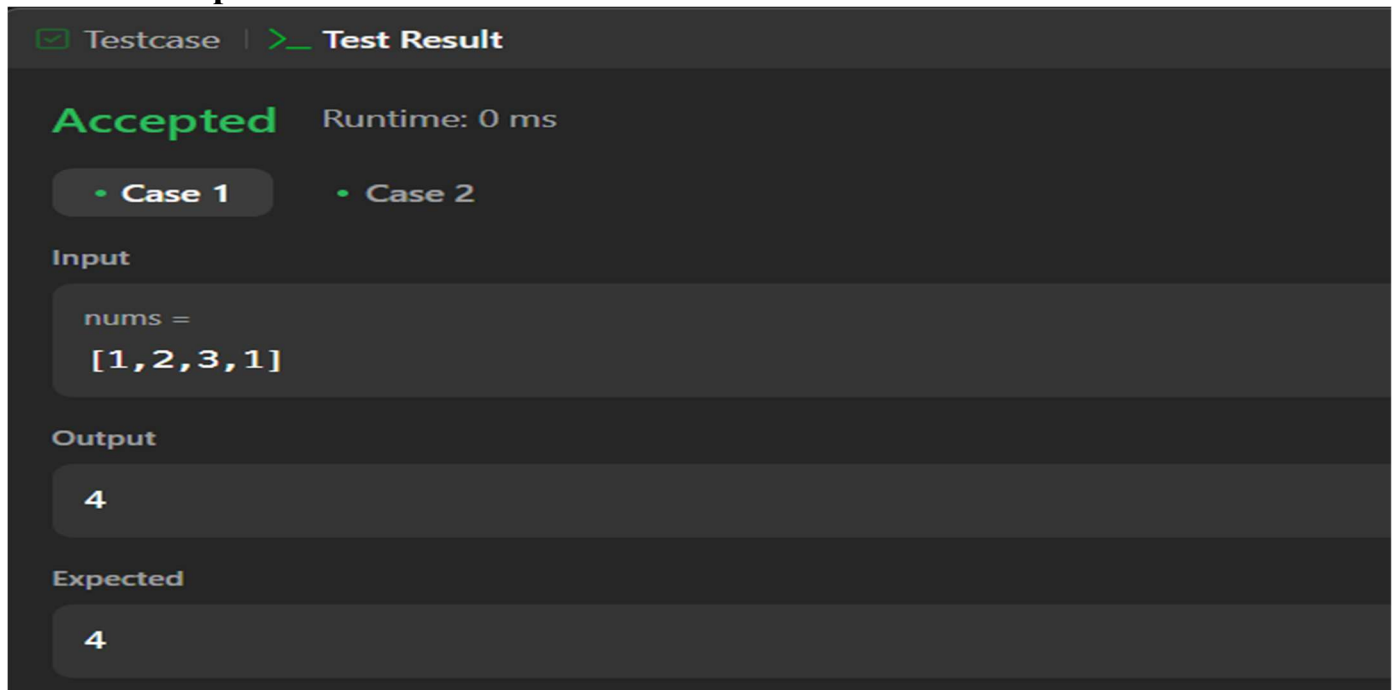


Figure 3

5. Learning Outcomes

- **Efficient Peak Finding:** - You will learn how to locate a peak element without scanning the entire array, using a smarter approach with binary search.
- **Mastering Binary Search Variations:** - You will understand how binary search can be adapted for different problems beyond simple number searching.
- **Developing a Logical Approach:** - You will improve your ability to break down problems logically, making it easier to apply efficient solutions in coding interviews and real-world tasks.
- **Understanding Search Space Reduction:** - You will gain insights into how reducing the search space step by step can lead to significant performance improvements.
- **Building Optimized and Scalable Solutions:-** You will develop the skills to write code that is both time-efficient and scalable, a crucial requirement for competitive programming and software development.