# Experiment-6(A)

**Student Name:** Vikash upadhyay **UID:** 22BCS16124
**Branch:** CSE **Section/Group:** NTPP_602-A
**Semester:** 6 **Date of Performance:** 20-02-25
**Subject Name:** Advanced Programming Lab-2 **Subject Code:** 22CSH-359

1. **Title:** Dynamic Programming (Climbing Stairs)

2. **Objective:** The problem is to find the total number of distinct ways to reach the top of a staircase with n steps, where at each step, you can either climb 1 or 2 steps.

3. **Algorithm:**

- **Understanding the Problem:**
  - For `n = 1`: Only 1 way → `[1]`
  - For `n = 2`: Two ways → `[1,1]`, `[2]`
  - For `n = 3`: Three ways → `[1,1,1]`, `[1,2]`, `[2,1]`
  - For `n = 4`: Five ways → `[1,1,1,1]`, `[1,1,2]`, `[1,2,1]`, `[2,1,1]`, `[2,2]`
- **Pattern Identification:**
  - The problem resembles the Fibonacci sequence:
  - **Ways(n) = Ways(n-1) + Ways(n-2)**
  - **Base cases:**
    - `Ways(1) = 1`
    - `Ways(2) = 2`
- **Approach:**
  - Initialize two variables `first = 1` (Ways to reach step 1) and `second = 2` (Ways to reach step 2).
  - For steps from 3 to `n`, calculate the number of ways using:

```
python
CopyEdit
current = first + second
first = second
second = current
```

  - Return `second` as it will hold the answer for `n`.

## 4. Implementation/Code:

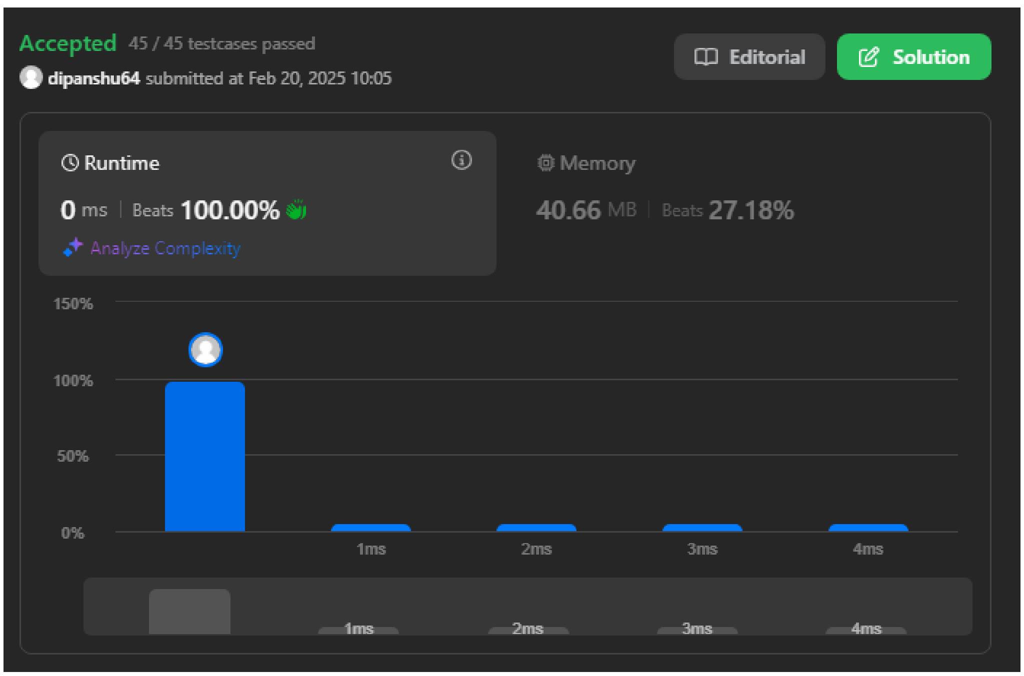
```
class Solution:
    def climbStairs(self, n: int) -> int:
        # Base cases
        if n <= 2:
            return n

        # Initialize the first two steps
        first, second = 1, 2

        # Compute the ways to reach each step from 3 to n
        for i in range(3, n + 1):
            current = first + second
            first = second
            second = current

        return second
```

## 5. Output:




## 6. Time Complexity: O(N)

## 7. Space Complexity: O(1)

# Experiment 6(B)

1. **Title:** Jump Game

2. **Objective:** Determine if you can reach the last index of an array where each element represents the maximum jump length from that position.

3. **Algorithm:**

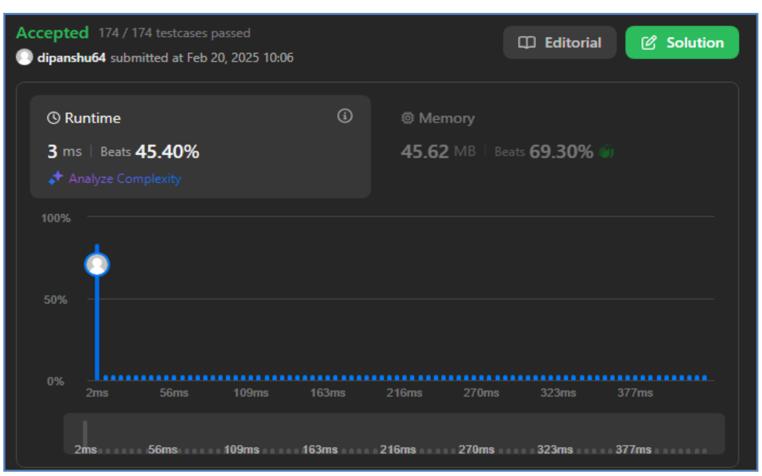
1.**Initialize:** A variable `maxReach` to `0`, representing the furthest index we can reach.
2.**Iterate:** Through each index `i` in the array:
   - If `i > maxReach`, return `false` (i.e., current index is unreachable).
   - Update `maxReach` as `max(maxReach, i + nums[i])`.
   - If `maxReach` is greater than or equal to the last index, return `true`.

**Return:** If the loop completes without returning, it means the last index is reachable, so return `true`.

4. **Implementation/Code:**

```
class Solution:
    def canJump(self, nums: list[int]) -> bool:
        maxReach = 0
        for i in range(len(nums)):
            if i > maxReach:
                return False
            maxReach = max(maxReach, i + nums[i])
            if maxReach >= len(nums) - 1:
                return True
        return True
```

6. **Output:**




8. **Time Complexity:** O(N)    9.**Space Complexity:** O(1)

# Experiment 6(C)

1. **Title:** Maximum Subarray

2. **Objective:** To find the contiguous subarray with the largest sum in a given integer array nums.

3. **Algorithm:**

- **Initialization:**
  - `currentSum` = 0 (stores sum of the current subarray)
  - `maxSum` = `-infinity` (stores the maximum sum found so far)
- **Iteration through the array:**
  - For each element `num` in `nums`:
    - Add `num` to `currentSum`.
    - Update `maxSum` to the maximum of `maxSum` and `currentSum`.
    - If `currentSum` becomes negative, reset it to 0 (discard the current subarray).
- **Result:**
  - Return `maxSum` as the maximum sum of the subarray.

5. **Implementation/Code:**

```
class Solution:
    def maxSubArray(self, nums: list[int]) -> int:
        currentSum = 0
        maxSum = float('-inf')

        for num in nums:
            currentSum += num
            maxSum = max(maxSum, currentSum)
            if currentSum < 0:
                currentSum = 0

        return maxSum
```

6. **Output:**


**8. <u>Time Complexity:</u>** O(N) **9. <u>Space Complexity:</u>** O(1)

## 10. <u>LearningOutcomes:</u>

- **Kadane's Algorithm:** A powerful technique to solve maximum subarray problems in linear time.
- **Handling Negatives:** Resetting `currentSum` when it goes negative is key to maintaining the optimal subarray.
- **Optimized Approach:** Avoids nested loops, ensuring efficiency even for large input sizes.