

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

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Experiment-6(A)

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Semester: 6

Subject Name: Advanced Programming Lab-2

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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 $\rightarrow [1]$
- For $n = 2$: Two ways $\rightarrow [1, 1], [2]$
- For $n = 3$: Three ways $\rightarrow [1, 1, 1], [1, 2], [2, 1]$
- For $n = 4$: Five ways $\rightarrow [1, 1, 1, 1], [1, 1, 2], [1, 2, 1], [2, 1, 1], [2, 2]$

- **Pattern Identification:**

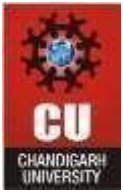
- The problem resembles the Fibonacci sequence:
- **$\text{Ways}(n) = \text{Ways}(n-1) + \text{Ways}(n-2)$**
- **Base cases:**
 - $\text{Ways}(1) = 1$
 - $\text{Ways}(2) = 2$

- **Approach:**

- Initialize two variables $\text{first} = 1$ (Ways to reach step 1) and $\text{second} = 2$ (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 .



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4. Implementation/Code:

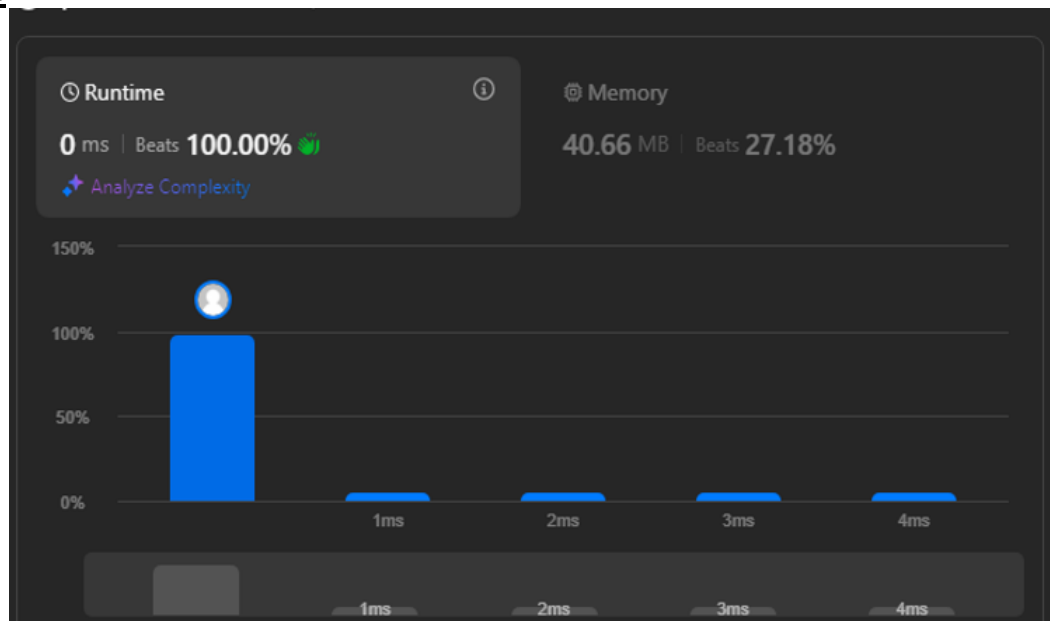
```
class Solution:
    def climbStairs(self, n: int) -> int:
        # Base cases
        if n <= 2:
            return n

        # 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

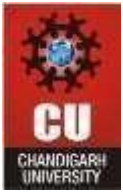
        return second
```

5. Output:



6. Time Complexity: $O(N)$

7. Space Complexity: $O(1)$



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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:

- o If `i > maxReach`, return false (i.e., current index is unreachable).
- o Update `maxReach` as `max(maxReach, i + nums[i])`.
- o If `maxReach` is greater than or equal to the last index, return true.

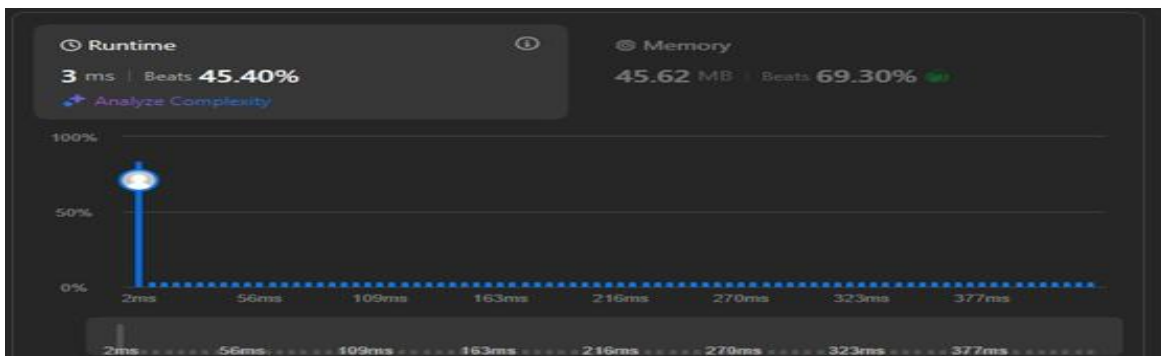
Return: If the loop completes without returning, it means the last index is reachable, so return true.

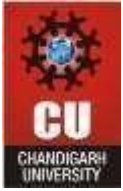
4. **Implementation/Code:**

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:**





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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.

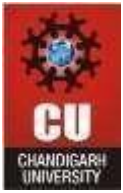
5. Implementation/Code:

```
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:



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8. Time Complexity: $O(N)$

9. Space Complexity: $O(1)$

10. Learning Outcomes:

- **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.