Day 19: Find the Missing Number

Abhinav Yadav

"Good code is its own best documentation."
— Steve McConnell

---

1 Introduction

Finding the missing number in an array is a classic problem that can be solved using mathematical formulas or bitwise operations. The array contains $n - 1$ integers ranging from 1 to n, with exactly one number missing.

2 Problem Statement

Problem: Find the missing number in an array of size $n - 1$ containing numbers from 1 to n. **Hint:** Use the formula for the sum of the first n natural numbers:

$$\text{Sum} = \frac{n \times (n + 1)}{2}.$$

Edge Case: Handle arrays with no missing numbers or duplicate entries.

3 Algorithm

1. Calculate the expected sum of the first n natural numbers using the formula:

$$\text{Sum} = \frac{n \times (n + 1)}{2}.$$

2. Calculate the actual sum of the elements in the array.

3. The missing number is the difference between the expected sum and the actual sum.

4 Code

```java
1   import java.util.Scanner;
2
3   public class MissingNumber {
4
5       static int findMissingNumber(int[] arr, int n) {
6           int expectedSum = n * (n + 1) / 2;
7           int actualSum = 0;
8
9           for (int i = 0; i < n - 1; i++) {
10              actualSum += arr[i];
11          }
12
13          return expectedSum - actualSum;
14      }
15
16      public static void main(String[] args) {
17          Scanner sc = new Scanner(System.in);
18
19          System.out.print("Enter the value of n (size of the full
                array): ");
20          int n = sc.nextInt();
21
22          int[] arr = new int[n - 1];
23          System.out.println("Enter the elements of the array: ");
24          for (int i = 0; i < n - 1; i++) {
25              arr[i] = sc.nextInt();
26          }
27
28          int missingNumber = findMissingNumber(arr, n);
29          System.out.println("The missing number is: " +
                missingNumber);
30
31          sc.close();
32      }
33  }
```

5   Alternate Approach: XOR Method

The XOR method is another efficient way to find the missing number:

- XOR all the numbers from 1 to n.

- XOR all the elements in the array.

- XOR of the two results gives the missing number.

6   Complexity Analysis

- **Time Complexity:** $O(n)$ (single traversal of the array).

- **Space Complexity:** $O(1)$ (no additional memory required).

7 Examples and Edge Cases

Input Array	Missing Number	Explanation
{1, 2, 4, 5, 6}	3	Sum = 21, Actual Sum = 18, Missing = 3
{2, 3, 1, 5}	4	Sum = 15, Actual Sum = 11, Missing = 4
{1, 2, 3, 4, 5}	6	Expected case with $n = 6$

8 Output


```
PS E:\25 days DSA\Day19>  & 'C:\Program Files\Java\jdk-20\bin\ja
Code\User\workspaceStorage\454eb2420ffda4e199d3cd00b47e9b86\redh
Enter the value of n (size of the full array): 6
Enter the elements of the array:
5
4
2
3
1
The missing number is: 6
PS E:\25 days DSA\Day19> & 'C:\Program Files\Java\jdk-20\bin\jav
ode\User\workspaceStorage\454eb2420ffda4e199d3cd00b47e9b86\redha
Enter the value of n (size of the full array): 4
Enter the elements of the array:
1
3
4
The missing number is: 2
PS E:\25 days DSA\Day19>
```

Figure 1: Program Output Screenshot

9 Conclusion

The problem of finding the missing number demonstrates the efficiency of mathematical formulas and bitwise operations in problem-solving. The formula-based method is intuitive, while the XOR approach is computationally elegant, making both valuable tools for solving similar problems.