EXPERIMENT - 4

Student Name: Sandeep Kumar **UID: 20BCS4885**

Branch: CSE **Section/Group: 603/A**

Semester: 6th semester **Subject: Competitive Coding**

Aim: To demonstrate the concept of Hashing

Objective:

a) Missing number
b) Longest Duplicate Substring

Problem 1: Missing number

Solution code:

```
class Solution {
public:
   int missingNumber(vector<int>& nums) {
      int ans=0;
      for(int i=0;i<nums.size();i++)
      {
         ans^=nums[i];
         ans^=i+1;
      }
      return ans;
   }
};
```

Explanation of code:

- The given code defines a class Solution with a public method missingNumber which takes a vector of integers nums as input and returns an integer. The method implements a solution for the "missing number" problem which involves finding the missing number in an array of integers from 0 to n, where n is the length of the array.

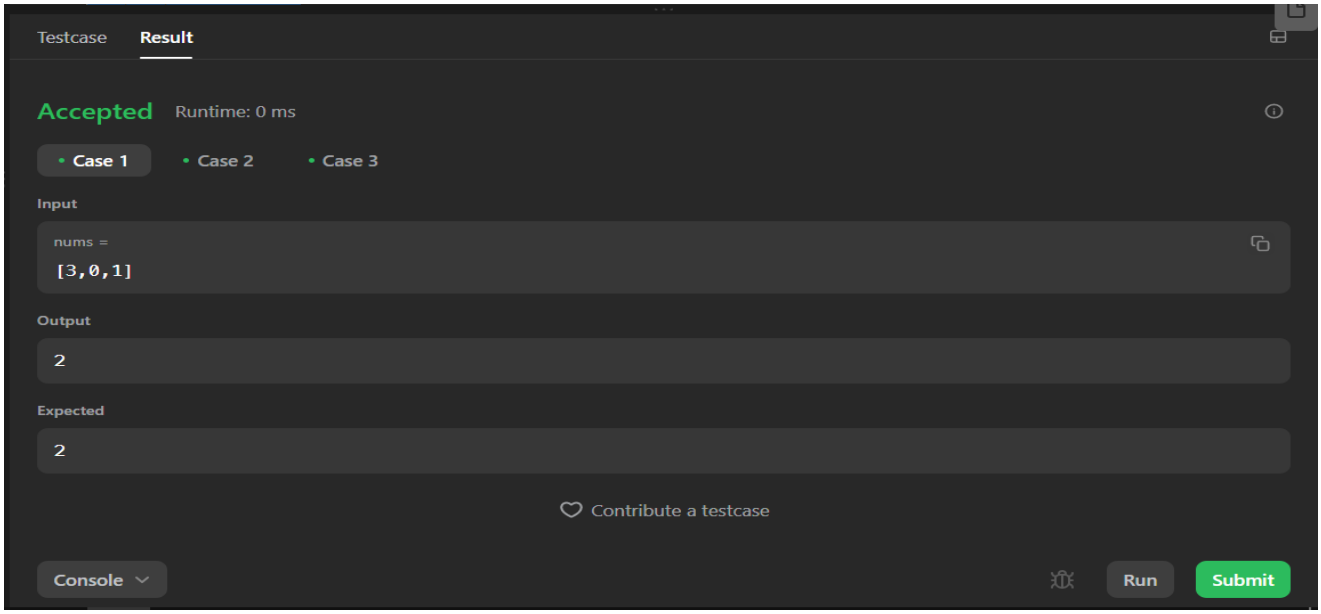
- The method initializes an integer variable ans to 0. It then uses a loop to iterate over all the elements in the input array nums. For each element nums[i], it XORs it with ans to toggle the bits that are different between the two numbers. It also XORs ans with i+1 to toggle the bits corresponding to the missing number. This effectively XORs all the

integers from 1 to n with nums[0] to nums[n-1], and cancels out all the XORed pairs except for the missing number and the XORed result of all the integers from 1 to n.

- Finally, the method returns the value of ans, which represents the missing number.

  Overall, this code appears to be a correct and efficient solution to the "missing number" problem using bitwise XOR operation.

Output:



Problem 2: Longest Duplicate Substring

Input Code:

```
class Solution {
public:
   string longestDupSubstring(string s) {

            // map to store the indices of each character
      unordered_map<char, vector<int>> hash;
      int n = s.length();

      for(int i=0; i<n; i++)
         hash[s[i]].push_back(i);

            // Max stores the length of the longest duplicate substring found till now
            // index stores the starting position of the substring
```

```
    int Max = 0, index = -1;

    for(int i=0; i<n; i++)
    {
                    // Here f stores the current character
      char f = s[i];

                    // erasing the current index
      hash[f].erase(hash[f].begin());

                    // after erasing, checking the longest substring possible starting with the
current character
      for(int it : hash[f])
      {
                            // j stores the max length of the duplicate substring found till
        int j = 0;

                            // incrementing j till index not out of bound and both characters are
duplicate
        while(i+j < n and it+j < n and s[i+j] == s[it+j])
          j++;

        if(j > Max)
        {
          Max = j;
          index = i;
        }

                            // this is required when we achieved the longest substring possible
        if(Max == n-i-1)
          return s.substr(index, Max);
      }
    }

    if(Max == 0)
      return "";

    else
      return s.substr(index, Max);
  }
};
```

Explanation of Code:

- The given code defines a class Solution with a public method longestDupSubstring which takes a string s as input and returns a string. The method implements a solution to find the longest duplicate substring in the input string s.

- The method uses an unordered map hash to store the indices of each character in the input string s. It then initializes two integer variables Max and index to 0 and -1 respectively. These variables will be used to store the length of the longest duplicate substring found till now and its starting index.

- The method then loops through each character of the input string s. For each character f, it erases the current index from the hash map hash[f]. It then checks all the remaining indices for the current character f in the hash map hash[f] and finds the length of the longest duplicate substring possible starting with the current character f. It does this by incrementing an integer variable j until either the index is out of bounds or the characters at the current position are no longer duplicate.

- If the length j of the longest duplicate substring found for the current character f is greater than the value stored in Max, then the values of Max and index are updated to store the new maximum length and starting index respectively.

- Finally, the method returns the longest duplicate substring found in the input string s by using the substr function with the starting index and the length of the substring stored in Max.

Overall, this code appears to be a correct and efficient solution to finding the longest duplicate substring in the input string using an unordered map to store the indices of each character.

Output: