Ex. No: 4 **Date: 03.09.24**

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Divide and Conquer

4.a. Number of Zeros in a Given Array

Aim: Given an array of 1s and 0s this has all 1s first followed by all 0s. Aim is to find the number of 0s. Write a program using Divide and Conquer to Count the number of zeroes in the given array.

Input Format

First Line Contains Integer m – Size of array

Next m lines Contains m numbers – Elements of an array

Output Format

First Line Contains Integer – Number of zeroes present in the given array.

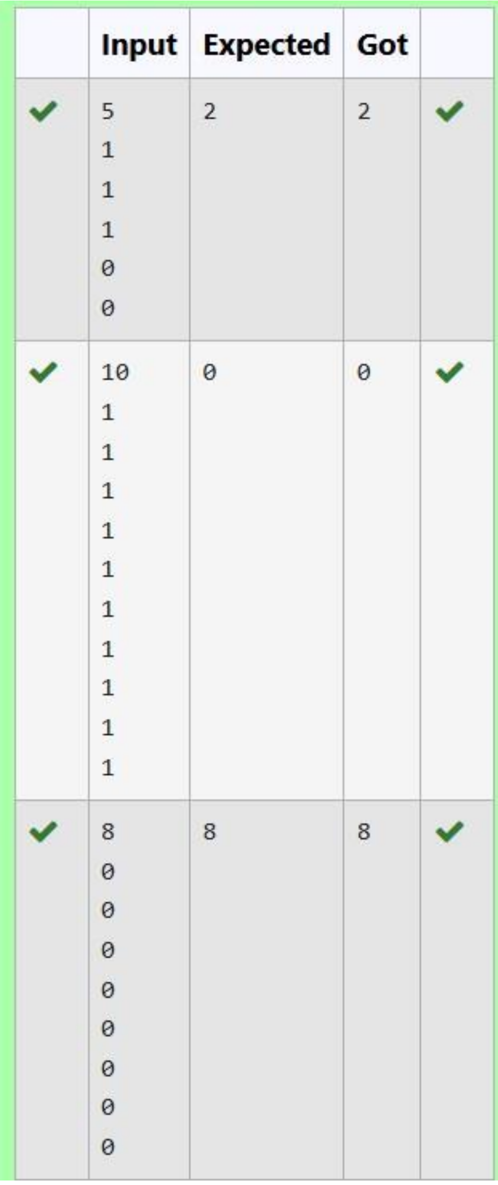
Algorithm:

```
function countZeroSubarrays(a):
    count = 0
    zero_count = 0
    for i from 0 to length(a) - 1:
        if a[i] == 0:
            zero_count += 1
        else:
            if zero_count > 0:
                count += (zero_count * (zero_count + 1)) / 2
                zero_count = 0

    if zero_count > 0:
        count += (zero_count * (zero_count + 1)) / 2


    return count
```

Program:

```
#include<stdio.h>
int count=0;
void findCount(int a[],int l,int r){
    if(a[l]==0){
        count+=(r-l+1);
    }else{
        if(l<r){
            int m=(l+r)/2;
            findCount(a,l,m);
            findCount(a,m+1,r);
        }
    }
}
int main(){
    int n;
    scanf("%d",&n);
    int a[n];
    for(int i=0;i<n;i++){
        scanf("%d",&a[i]);
    }
    findCount(a,0,n-1);
    printf("%d",count);
}
```

Output:



	Input	Expected	Got	
✓	5 1 1 1 0 0	2	2	✓
✓	10 1 1 1 1 1 1 1 1 1 1	0	0	✓
✓	8 0 0 0 0 0 0 0 0	8	8	✓

4.b. Majority Element

Aim: Given an array `nums` of size `n`, return *the majority element*.

The majority element is the element that appears more than `⌊n / 2⌋` times. You may assume that the majority element always exists in the array.

Example 1:

```
Input: nums = [3,2,3]
Output: 3
```

Example 2:

```
Input: nums = [2,2,1,1,1,2,2]
Output: 2
```

Constraints:

- `n == nums.length`
- `1 <= n <= 5 * 10`^{4}
- `-2`^{31} `<= nums[i] <= 2`^{31} `- 1`

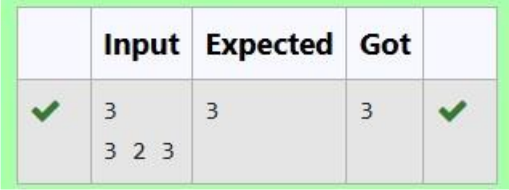
Algorithm:

```
function Count(a[], l, r, key):
    mid = l + (r - l) / 2
    if a[mid] == key:
        increment count
    if l < mid:
        Count(a, l, mid, key)
    if mid + 1 < r:
        Count(a, mid + 1, r, key)
    return count


function main():
    n = input()  // Read the size of the array
    arr[] = input()  // Read the array of size n
    k = arr[0]  // Set the first element as the key
    if Count(arr, 0, n, k) > n / 2:
        print(k)  // If the count of k exceeds n/2, print it as the majority element
    else:
        for i = 0 to n / 2 - 1:
            if arr[i] != k:
                print(k)  // If the first half contains an element different from k, print k
                break
```

Program:

```
#include <stdio.h>
int count=0;
int Count(int a[],int l,int r,int key)
{
    int mid=l+(r-l)/2;
    if (a[mid]==key)
        count++;
    else
    {
        Count(a,l,mid,key);
        Count(a,mid+1,r,key);
    }
    return count;


}


int main()
{
    int n;
    scanf("%d",&n);
    int arr[n];

    for (int i=0;i<n;i++)

        scanf("%d",&arr[i]);

    int k=arr[0];

    if (Count(arr,0,n,k)>n/2)

         printf("%d",k);

    else

    {

       for (int i=0;i<n/2;i++)

          if (arr[i]!=k)

           {

               printf("%d",k);

               break;

           }

    }


}
```

Output:



	Input	Expected	Got	
✓	3 3 2 3	3	3	✓

4.c. Finding Floor Value

Aim: Given a sorted array and a value x, the floor of x is the largest element in array smaller than or equal to x. Write divide and conquer algorithm to find floor of x. Input Format

First Line Contains Integer n – Size of array

Next n lines Contains n numbers – Elements of an array

Last Line Contains Integer x – Value for x

Output Format

First Line Contains Integer – Floor value for x

Algorithm:

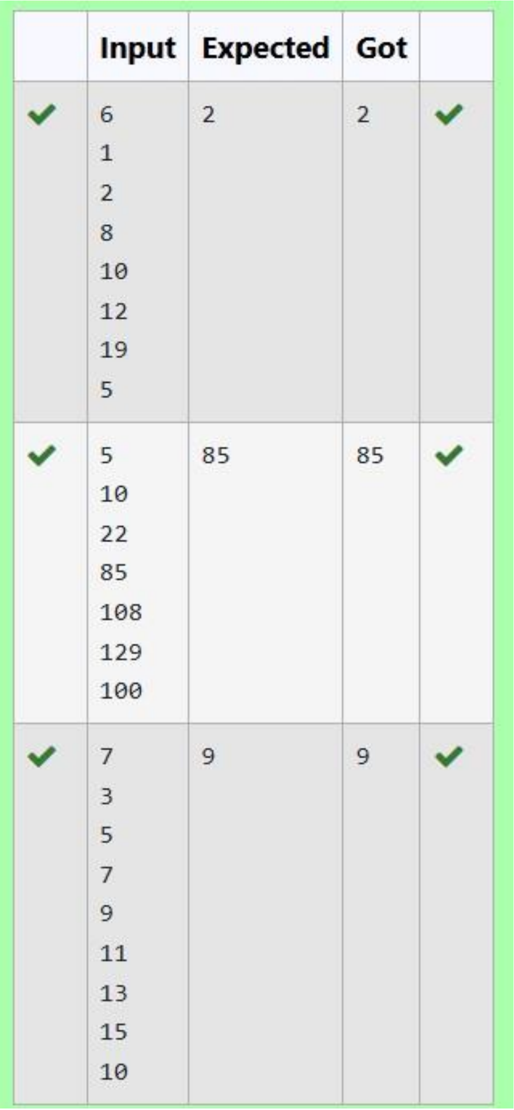
```
function find(a[], l, r, key):
    if l <= r:
        if a[l] <= key:
            print a[l]  // Print elements less than or equal to the key
        // Recursive case: divide the array into two parts and continue searching
        mid = (l + r) / 2
        find(a, l, mid, key)  // Search left half
        find(a, mid + 1, r, key)  // Search right half

function main():
    n = input()  // Read the size of the array
    a[] = input()  // Read the array of size n
    k = input()  // Read the key
    find(a, 0, n-1, k)  // Call the recursive function to print values <= key
```

Program:

```
#include<stdio.h>
void find(int a[],int l,int r,int key)
{
    if(a[l]<=key)
    {
        printf("%d",a[l]);
    }
    else
    {
        if(l>r){
            int mid=(l+r)/2;
            find(a,l,mid+1,key);
            find(a,mid,r,key);
        }
    }
}
int main()
{
    int n;
    scanf("%d",&n);
    int a[n];

    for(int i=0;i<n;i++)
    {
        scanf("%d",&a[i]);
    }
    int k;
    scanf("%d",&k);
    find(a,n-1,0,k);
```

```
}
```

Output:



	Input	Expected	Got	
✓	6 1 2 8 10 12 19 5	2	2	✓
✓	5 10 22 85 108 129 100	85	85	✓
✓	7 3 5 7 9 11 13 15 10	9	9	✓

4.d. Two Elements Sum to X

Aim: Given a sorted array of integers say arr[] and a number x. Write a recursive program using divide and conquer strategy to check if there exist two elements in the array whose sum = x. If there exist such two elements then return the numbers, otherwise print as "No".

Note: Write a Divide and Conquer Solution

Input Format

First Line Contains Integer n – Size of array

Next n lines Contains n numbers – Elements of an array

Last Line Contains Integer x – Sum Value

Output Format

First Line Contains Integer – Element1

Second Line Contains Integer – Element2 (Element 1 and Elements 2 together sums to value "x")

Algorithm:

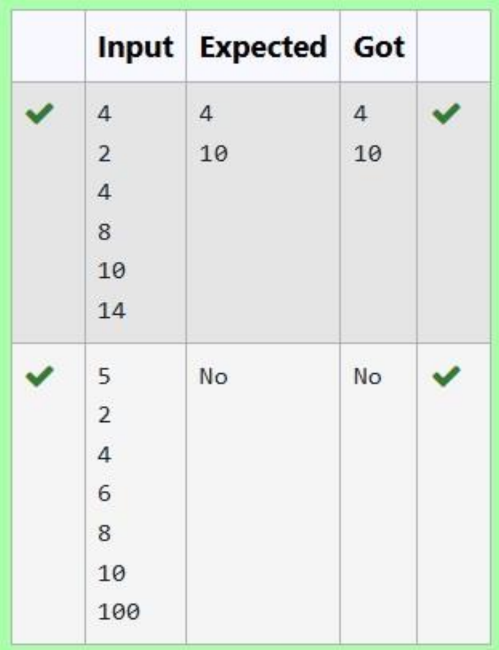
```
function sum(a[], l, r, s):
    if l < r:
        mid = (l + r) / 2  // Find the middle index
        if a[mid] + a[r] == s:  // Check if the sum of a[mid] and a[r] equals s
            s1 = a[mid]
            s2 = a[r]
            return 1  // Pair found
        else:
            return sum(a, l, r - 1, s)  // Continue searching in the subarray

function main():
    n = input()  // Read the size of the array
    a[] = input()  // Read the array of size n
    x = input()  // Read the target sum x
```

```
result = sum(a, 0, n - 1, x)  // Call the sum function
if result == 0:
    print("No")  // If no pair is found, print "No"
else:
    print(s1)
    print(s2)  // Print the two numbers found that add up to x
```

Program:

```
 #include<stdio.h>
int s1=0,s2=0;
int sum(int a[],int l,int r,int s)
{
    if(l<r)
    {
        int mid=(l+r)/2;
        if(a[mid]+a[r]==s)
        {
            s1=a[mid];
            s2=a[r];
            return 1;
        }
        sum(a,l,r-1,s);

    }
    return 0;
}
int main()
{
    int n;
    scanf("%d",&n);
    int a[n];
    for(int i=0;i<n;i++)
    {
        scanf("%d",&a[i]);
    }
    int x;
    scanf("%d",&x);
    int y=sum(a,0,n-1,x);
    if (y==0)
    printf("%s","No");
    else
    {
        printf("%d\n%d",s1,s2);
    }

}
```

Output:



	Input	Expected	Got	
✓	4 2 4 8 10 14	4 10	4 10	✓
✓	5 2 4 6 8 10 100	No	No	✓

4.e. Implementation of Quick Sort

Aim: Write a Program to Implement the Quick Sort Algorithm

Input Format:

The first line contains the no of elements in the list-n The

next n lines contain the elements.

Output:

Sorted list of elements **Algorithm:**

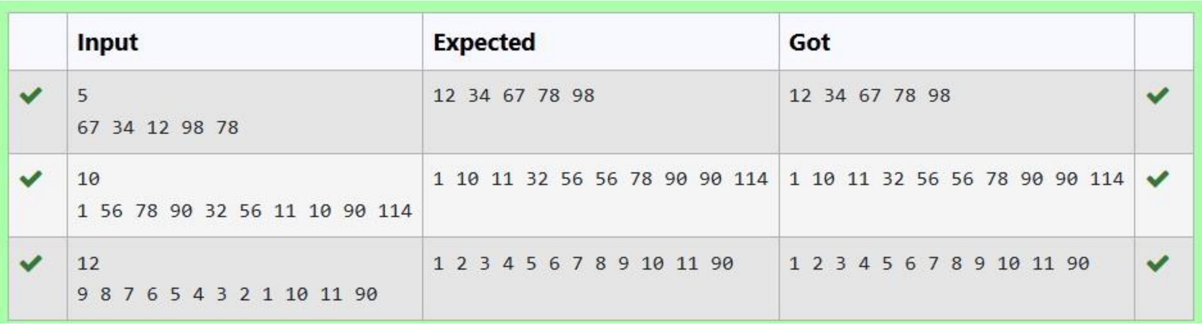
```
function quickSort(a[], l, r):
    if l < r:
        pivotIndex = partition(a, l, r)  // Partition the array and get the pivot index
        quickSort(a, l, pivotIndex - 1)  // Recursively sort the left subarray
        quickSort(a, pivotIndex + 1, r)  // Recursively sort the right subarray


function partition(a[], l, r):
    pivot = a[r]  // Select the pivot (using the last element)
    i = l - 1  // Pointer for the smaller element
    for j = l to r - 1:  // Iterate through the array
        if a[j] <= pivot:  // If current element is smaller than or equal to the pivot
            i = i + 1
            swap(a[i], a[j])  // Swap elements
    swap(a[i + 1], a[r])  // Move the pivot to the correct position
    return i + 1  // Return the pivot index


function main():
    n = input()  // Read the size of the array
    a[] = input()  // Read the array of size n
    quickSort(a, 0, n - 1)  // Call the quickSort function to sort the array
    print(a[])  // Print the sorted array
```

Program:

```
 #include<stdio.h>
void quick(int a[],int l,int r)
{
    if(l<r)
    {


        int p=(l+r)/2;
        int i=l;
        int j=r;


        while(i<j)
        {
            while(a[p]>=a[i] )
            {
                i++;
            }

            while(a[p]<a[j] )
            {
                j--;
            }
            if(i<=j)
            {
                int temp=a[i];
                a[i]=a[j];
                a[j]=temp;
            }int temp=a[j];
        a[j]=a[p];
        a[p]=temp;
        quick(a,l+1,r);



    }
}
```

```
int main()

{

    int n;

    scanf("%d",&n);

    int a[n];

    for(int i=0;i<n;i++)

    {

        scanf("%d",&a[i]);

    }

    quick(a,0,n-1);

    for(int i=0;i<n;i++)

    {

        printf("%d ",a[i]);

    }

}


        }
```

Output:



	Input	Expected	Got	
✓	5 67 34 12 98 78	12 34 67 78 98	12 34 67 78 98	✓
✓	10 1 56 78 90 32 56 11 10 90 114	1 10 11 32 56 56 78 90 90 114	1 10 11 32 56 56 78 90 90 114	✓
✓	12 9 8 7 6 5 4 3 2 1 10 11 90	1 2 3 4 5 6 7 8 9 10 11 90	1 2 3 4 5 6 7 8 9 10 11 90	✓