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## Competitive Programming

### 6.a. Finding Duplicates- $O(n^2)$ Time Complexity (1) Space Complexity

**Aim:** Find Duplicate in Array.

Given a read only array of  $n$  integers between 1 and  $n$ , find one number that repeats.

Input Format:

First Line - Number of elements

$n$  Lines -  $n$  Elements

Output Format:

Element  $x$  - That is repeated

**Algorithm:**

```
function main()
```

```
{
```

```
    initialize n // Number of elements in the array
```

```
    read n from user
```

```
    initialize arr[n] // Array to hold input values
```

```
    // Read values into the array
```

```
    for i from 0 to  $n - 1$ 
```

```

{
    read arr[i] from user
}

flag = 0 // Initialize a flag to indicate if a duplicate is found

// Search for the first duplicate element
for i from 0 to n - 1
{
    el1 = arr[i] // Current element

    for j from 0 to n - 1
    {
        // Check for duplicates and ensure indices are different
        if el1 == arr[j] and i != j
        {
            print el1 // Print the duplicate element
            flag = 1 // Set flag to indicate a duplicate was found
            break // Exit inner loop
        }
    }

    if flag
        break // Exit outer loop if a duplicate was found
}
}

```

**Program:**

```
#include<stdio.h>

int main(){

int n;

scanf("%d",&n);

int arr[n];

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

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

}


int flag=0;

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

    int el1=arr[i];

    for(int j=0;j<n;j++){

        if (el1==arr[j] && i!=j){

            printf("%d",el1);

            flag=1;

            break;

        }

    }

    if(flag)

        break;

}

}
```

**Output:**

	Input	Expected	Got	
✓	11 10 9 7 6 5 1 2 3 8 4 7	7	7	✓
✓	5 1 2 3 4 4	4	4	✓
✓	5 1 1 2 3 4	1	1	✓

## 6.b. Finding Duplicates- $O(n)$ Time Complexity (1) Space Complexity

**Aim:** Find Duplicate in Array.

Given a read only array of  $n$  integers between 1 and  $n$ , find one number that repeats.

Input Format:

First Line - Number of elements

$n$  Lines -  $n$  Elements

Output Format:

Element  $x$  - That is repeated

**Algorithm:**

```
function main()
{
    initialize n // Number of elements in the array
    read n from user

    initialize a[n] // Array to hold input values

    // Read values into the array
    for i from 0 to n - 1
    {
        read a[i] from user
    }

    initialize b[n] // Array to keep track of seen elements
    for i from 0 to n - 1
    {
        b[i] = 0 // Initialize the tracking array
```

```

    }

    // Search for the first duplicate element
    for i from 0 to n - 1
    {
        // If the element is already present, i.e., b[a[i]] = 1
        if b[a[i]]
        {
            print a[i] // Print the duplicate element
            break // Exit the loop
        }
        else
        {
            b[a[i]] = 1 // Mark the element as seen
        }
    }
}

```

### **Program:**

```

#include <stdio.h>

int main(){
    int n;

    scanf("%d",&n);

    int a[n];

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

    int b[n];

```

```

for(int i=0;i <n;i++){
    b[i]=0;
}
for(int i=0;i<n;i++){
    //if el already present i.e, b[i]=1
    if(b[a[i]]){
        printf("%d",a[i]);
        break;
    }
    else
        b[a[i]]=1;
}
}

```

**Output:**

	Input	Expected	Got	
✓	11 10 9 7 6 5 1 2 3 8 4 7	7	7	✓
✓	5 1 2 3 4 4	4	4	✓
✓	5 1 1 2 3 4	1	1	✓

## 6.c. Print Intersection of 2 sorted arrays- $O(m*n)$ Time Complexity, $O(1)$ Space Complexity

### Aim:

Find the intersection of two sorted arrays.

OR in other words,

Given 2 sorted arrays, find all the elements which occur in both the arrays.

Input Format

· The first line contains T, the number of test cases. Following T lines contain:

1. Line 1 contains N1, followed by N1 integers of the first array
2. Line 2 contains N2, followed by N2 integers of the second array

Output Format

The intersection of the arrays in a single line

Example

Input:

1

3 10 17 57

6 2 7 10 15 57 246

Output:

10 57

Input:

1

6 1 2 3 4 5 6

2 1 6

Output:

1 6

### Algorithm:

function main()



```
{  
  
    initialize n // Number of test cases  
    read n from user  
  
    for i from 0 to n - 1  
    {  
        initialize n1 // Size of the first array  
        read n1 from user  
  
        initialize arr1[n1] // First array  
  
        // Read values into the first array  
        for j from 0 to n1 - 1  
        {  
            read arr1[j] from user  
        }  
  
        initialize n2 // Size of the second array  
        read n2 from user  
  
        initialize arr2[n2] // Second array  
  
        // Read values into the second array  
        for j from 0 to n2 - 1  
        {  
            read arr2[j] from user  
        }  
    }  
}
```

```

// Check for common elements in both arrays
for j from 0 to n1 - 1
{
    for k from 0 to n2 - 1
    {
        if arr1[j] == arr2[k]
        {
            print arr1[j] // Print the common element
        }
    }
}
}
}

```

### **Program:**

```

#include<stdio.h>

int main(){
    int n;
    scanf("%d",&n);
    for(int i=0;i<n;i++){
        int n1;
        scanf("%d",&n1);
        int arr1[n1];
        for(int j=0;j<n1;j++){
            scanf("%d",&arr1[j]);
        }
        int n2;
        scanf("%d",&n2);
    }
}

```

```

int arr2[n2];

for(int j=0;j<n2;j++){
    scanf("%d",&arr2[j]);
}

for(int j=0;j<n1;j++){
    for(int k=0;k<n2;k++){
        if(arr1[j]==arr2[k]){
            printf("%d ",arr1[j]);
        }
    }
}
}
}

```

### Output:

	Input	Expected	Got	
✓	1 3 10 17 57 6 2 7 10 15 57 246	10 57	10 57	✓
✓	1 6 1 2 3 4 5 6 2 1 6	1 6	1 6	✓

## 6.d. Print Intersection of 2 sorted arrays- $O(m+n)$ Time Complexity, $O(1)$ Space Complexity

### Aim:

Find the intersection of two sorted arrays.

OR in other words,

Given 2 sorted arrays, find all the elements which occur in both the arrays.

Input Format

· The first line contains T, the number of test cases. Following T lines contain:

1. Line 1 contains N1, followed by N1 integers of the first array
2. Line 2 contains N2, followed by N2 integers of the second array

Output Format

The intersection of the arrays in a single line

Example

Input:

1

3 10 17 57

6 2 7 10 15 57 246

Output:

10 57

Input:

1

6 1 2 3 4 5 6

2 1 6

Output:

1 6

### Algorithm:

```
function main()
```

```
{  
  
    initialize T // Number of test cases  
    read T from user  
  
    while T > 0  
    {  
        // Decrement the test case counter  
        T--  
  
        initialize n1, n2 // Sizes of the two arrays  
        read n1 from user  
        initialize arr1[n1] // First array  
  
        // Read values into the first array  
        for i from 0 to n1 - 1  
        {  
            read arr1[i] from user  
        }  
  
        read n2 from user  
        initialize arr2[n2] // Second array  
  
        // Read values into the second array  
        for i from 0 to n2 - 1  
        {  
            read arr2[i] from user  
        }  
    }  
}
```

```
initialize i = 0, j = 0 // Indices for both arrays
```

```
// Iterate through both arrays to find common elements
```

```
while i < n1 and j < n2
```

```
{
```

```
    if arr1[i] < arr2[j]
```

```
    {
```

```
        i++ // Move to the next element in arr1
```

```
    }
```

```
    else if arr2[j] < arr1[i]
```

```
    {
```

```
        j++ // Move to the next element in arr2
```

```
    }
```

```
    else
```

```
    {
```

```
        print arr1[i] // Print the common element
```

```
        i++ // Move to the next element in arr1 j++
```

```
        // Move to the next element in arr2
```

```
    }
```

```
}
```

```
print new line // Move to the next line for output
```

```
}
```

```
}
```

### **Program:**

```
#include <stdio.h>
```

```
int main() {  
  
    int T;  
  
    scanf("%d", &T);  
  
    while (T-->0) {  
  
        int n1, n2;  
  
  
        scanf("%d", &n1);  
  
        int arr1[n1];  
  
        for (int i = 0; i < n1; i++) {  
  
            scanf("%d", &arr1[i]);  
  
        }  
  
  
        scanf("%d", &n2);  
  
        int arr2[n2];  
  
        for (int i = 0; i < n2; i++) {  
  
            scanf("%d", &arr2[i]);  
  
        }  
  
  
        int i = 0, j = 0;  
  
        while (i < n1 && j < n2) {  
  
            if (arr1[i] < arr2[j]) {  
  
                i++;  
  
            }  
  
            else if (arr2[j] < arr1[i]) {  
  
                j++;  
  
            }  
  
            else {  
  

```

```

        printf("%d ", arr1[i]);

        i++; j++;

    }

}

printf("\n");

}

}

```

### Output:

	Input	Expected	Got	
✓	1 3 10 17 57 6 2 7 10 15 57 246	10 57	10 57	✓
✓	1 6 1 2 3 4 5 6 2 1 6	1 6	1 6	✓



## 6.e. Pair with Difference- $O(n^2)$ Time Complexity, $O(1)$ Space Complexity

### Aim:

Given an array A of sorted integers and another non negative integer k, find if there exists 2 indices i and j such that  $A[j] - A[i] = k$ ,  $i \neq j$ .

Input Format:

First Line n - Number of elements in an array

Next n Lines - N elements in the array

k - Non - Negative Integer

Output Format:

1 - If pair exists 0 - If no pair exists

Explanation for the given Sample Testcase:

YES as  $5 - 1 = 4$

So Return 1.

### Algorithm:

```
function main()
{
    initialize n // Number of elements in the array
    read n from user

    initialize arr[n] // Array to hold input values

    // Read values into the array
    for i from 0 to n - 1
    {
        read arr[i] from user
```

```
}
```

```
initialize t // Target difference
```

```
read t from user
```

```
initialize flag = 0 // Flag to indicate if a pair is found
```

```
// Check for pairs with the specified difference
```

```
for i from 0 to n - 1
```

```
{
```

```
    for j from 0 to n - 1
```

```
    {
```

```
        if i != j and abs(arr[i] - arr[j]) == t
```

```
        {
```

```
            flag = 1 // Pair found
```

```
            break
```

```
        }
```

```
    }
```

```
if flag
```

```
{
```

```
    break
```

```
}
```

```
}
```

```
// Output the result based on the flag
```

```
if flag
```

```
{
```

```
    print 1 // Pair found
```

```
}  
  
else  
  
{  
  
    print 0 // No pair found  
  
}  
  
  
return 0  
  
}
```

### **Program:**

```
#include <stdio.h>  
  
#include <stdlib.h>
```

```
int main() {  
  
    int n;  
  
    scanf("%d", &n);  
  
  
    int arr[n];  
  
  
  
    for (int i = 0; i < n; i++) {  
  
        scanf("%d", &arr[i]);  
  
    }  
  
  
    int t;  
  
    scanf("%d", &t);  
  
  
    int flag = 0;
```

```
for (int i = 0; i < n; i++) {  
    for (int j = 0; j < n; j++) {  
        if (i!=j && abs(arr[i] - arr[j]) == t) {  
            flag = 1;  
            break;  
        }  
    }  
    if (flag) {  
        break;  
    }  
}  
  
if (flag) {  
    printf("%d\n", 1);  
} else {  
    printf("%d\n", 0);  
}  
  
return 0;  
}
```

**Output:**

	Input	Expected	Got	
✓	3 1 3 5 4	1	1	✓
✓	10 1 4 6 8 12 14 15 20 21 25 1	1	1	✓
✓	10 1 2 3 5 11 14 16 24 28 29 0	0	0	✓
✓	10 0 2 3 7 13 14 15 20 24 25 10	1	1	✓

## 6.f. Pair with Difference - $O(n)$ Time Complexity, $O(1)$ Space Complexity

**Aim:** Given an array A of sorted integers and another non negative integer k, find if there exists 2 indices i and j such that  $A[j] - A[i] = k$ ,  $i \neq j$ .

Input Format:

First Line n - Number of elements in an array

Next n Lines - N elements in the array

k - Non - Negative Integer

Output Format:

1 - If pair exists 0 - If no pair exists Explanation for the given Sample Testcase: YES as  $5 - 1 = 4$  So Return 1.

### Algorithm:

```
function main()
{
    initialize n // Number of elements in the array
    read n from user

    initialize arr[n] // Array to hold input values

    // Read values into the array
    for i from 0 to n - 1
    {
        read arr[i] from user
    }
```

```
initialize t // Target difference
```

```
read t from user
```

```
initialize flag = 0 // Flag to indicate if a pair is found
```

```
initialize i = 0 // First index
```

```
initialize j = 1 // Second index
```

```
// Loop to find pairs with the specified difference
```

```
while i < n and j < n
```

```
{
```

```
    diff = abs(arr[i] - arr[j]) // Calculate the difference
```

```
    if i != j and diff == t
```

```
    {
```

```
        flag = 1 // Pair found
```

```
        break
```

```
    }
```

```
    else if diff < t
```

```
    {
```

```
        j++ // Increment second index
```

```
    }
```

```
    else
```

```
    {
```

```
        i++ // Increment first index
```

```
    }
```

```
}
```

```
// Output the result based on the flag
if flag
{
    print 1 // Pair found
}
else
{
    print 0 // No pair found
}

return 0
}
```

### **Program:**

```
#include <stdio.h>
#include <stdlib.h>

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

    int arr[n];

    for (int i = 0; i < n; i++) {
        scanf("%d", &arr[i]);
    }
```



```
int t;
```

```
scanf("%d", &t);
```

```
int flag = 0;
```

```
int i=0; int j=1;
```

```
while(i<n && j<n){
```

```
    int diff = abs(arr[i] - arr[j]);
```

```
    if(i!=j && diff==t){
```

```
        flag=1;
```

```
        break;
```

```
    }
```

```
    else if(diff<t){
```

```
        j++;
```

```
    }
```

```
    else{
```

```
        i++;
```

```
    }
```

```
}
```

```
if (flag) {
```

```
    printf("%d\n", 1);
```

```
} else {
```

```
    printf("%d\n", 0);
```

```
}
```

```
return 0;
```

```
}
```

**Output:**

	Input	Expected	Got	
✓	3 1 3 5 4	1	1	✓
✓	10 1 4 6 8 12 14 15 20 21 25 1	1	1	✓
✓	10 1 2 3 5 11 14 16 24 28 29 0	0	0	✓
✓	10 0 2 3 7 13 14 15 20 24 25 10	1	1	✓