**Week 3:**

**Question 1:** Given an unsorted array of integers, design an algorithm and a program to sort the array using insertion sort. Your program should be able to find number of comparisons and shifts ( shifts total number of times the array elements are shifted from their place) required for sorting the array.

#include<iostream>

using namespace std;

void insertion\_sort(int A[],int n)

{

int comparisons=0,shift=0;

int i, j, x;

for (i = 1; i < n; i++)

{

j = i - 1;

x = A[i];

while (j > -1 && A[j] > x)

{

comparisons++;

A[j + 1] = A[j];

j--;

shift++;

}

A[j + 1] = x;

shift++;

}

cout<<"sorted array: "<<endl;

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

cout<<A[i]<<" ";

cout<<endl;

cout<<"Comparisons: "<<comparisons<<endl;

cout<<"Shift: "<<shift<<endl;

}

int main()

{

int t;

cin>>t;

while (t--)

{

int n;

cin>>n;

int arr[n];

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

cin>>arr[i];

insertion\_sort(arr,n);

}

}

**Output:**

enter the number of test cases

3

enter the number of elements

8

enter the elements

-23 65 -31 76 46 89 45 32

sorted array:

-31 -23 32 45 46 65 76 89

Comparisons: 13

Shift: 20

enter the number of elements

10

enter the elements

54 65 34 76 78 97 46 32 51 21

sorted array:

21 32 34 46 51 54 65 76 78 97

Comparisons: 28

Shift: 37

enter the number of elements

15

enter the elements

63 42 223 645 652 31 324 22 553 -12 54 65 86 46 325

sorted array:

-12 22 31 42 46 54 63 65 86 223 324 325 553 645 652

Comparisons: 54

Shift: 68

Process returned 0 (0x0) execution time : 91.906 s

Press any key to continue.

**Question 2:** Given an unsorted array of integers, design an algorithm and implement a program to sort this array using selection sort. Your program should also find number of comparisons and number of swaps required.

#include<iostream>

using namespace std;

void swap(int \*x, int \*y)

{

int temp = \*x;

\*x = \*y;

\*y = temp;

}

void Selection\_sort(int arr[],int n)

{

int comp=0,swaps=0;

int i,j,pos=0,min=0;

for (i=0;i<n-1;i++)

{

min=arr[i];

pos=i;

for (j=i+1;j<n;j++)

{

comp++;

if (min>arr[j])

{

min=arr[j];

pos=j;

}

}

if (pos!=i)

{

swap(&arr[pos],&arr[i]);

}

swaps++;

}

cout<<"sorted array is: "<<endl;

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

cout<<arr[i]<<" ";

cout<<endl;

cout<<"Comparisons:"<<comp<<endl;

cout<<"Swaps:"<<swaps<<endl;

}

int main()

{

int t;

cout<<"enter the number of test cases"<<endl;

cin>>t;

while (t--)

{

int n;

cout<<"enter the number of elements"<<endl;

cin>>n;

int arr[n];

cout<<"enter the array elements"<<endl;

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

cin>>arr[i];

Selection\_sort(arr,n);

}

}

**Output:**

enter the number of test cases

3

enter the number of elements

8

enter the array elements

-13 65 -21 76 46 89 45 12

sorted array is:

-21 -13 12 45 46 65 76 89

Comparisons:28

Swaps:7

enter the number of elements

10

enter the array elements

54 65 34 76 78 97 46 32 51 21

sorted array is:

21 32 34 46 51 54 65 76 78 97

Comparisons:45

Swaps:9

enter the number of elements

15

enter the array elements

63 42 223 645 652 31 324 22 553 12 54 65 86 46 325

sorted array is:

12 22 31 42 46 54 63 65 86 223 324 325 553 645 652

Comparisons:105

Swaps:14

Process returned 0 (0x0) execution time : 80.715 s

Press any key to continue.

**Question 3:** Given an unsorted array of positive integers, design an algorithm and implement it using a program to find whether there are any duplicate elements in the array or not. (use sorting) (Time Complexity = O(n log n))

#include<iostream>

using namespace std;

void merge(int arr[],int l,int mid,int h)

{

int count=0;

int i=l,j=mid+1;

int temp[h-l+1];

int k=0;

while (i<=mid && j<=h)

{

if (arr[i]<arr[j])

temp[k++]=arr[i++];

else

{

temp[k++]=arr[j++];

count+=mid-i+1;

}

}

for (;i<=mid;)

temp[k++]=arr[i++];

for (;j<=h;)

temp[k++]=arr[j++];

for (int f=0;f<k;f++)

arr[f+l]=temp[f];

}

void merge\_sort(int arr[],int l,int h)

{

if (l<h)

{

int mid=l+(h-l)/2;

merge\_sort(arr,l,mid);

merge\_sort(arr,mid+1,h);

merge(arr,l,mid,h);

}

}

int main()

{

int t;

cout<<"enter the number of test cases"<<endl;

cin>>t;

while (t--)

{

int n;

cout<<"enter the number of elements"<<endl;

cin>>n;

int arr[n];

cout<<"enter the array elements"<<endl;

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

cin>>arr[i];

merge\_sort(arr,0,n-1);

int flag=0;

for (int i=0;i<n-1;i++)

{

if (arr[i]==arr[i+1])

{

cout<<"YES"<<endl;

flag=1;

break;

}

}

if (flag==0)

cout<<"NO"<<endl;

}

}

**Output:**

enter the number of test cases

3

enter the number of elements

5

enter the array elements

28 52 83 14 75

NO

enter the number of elements

10

enter the array elements

75 65 1 65 2 6 86 2 75 8

YES

enter the number of elements

15

enter the array elements

75 35 86 57 98 23 73 1 64 8 11 90 61 19 20

NO

Process returned 0 (0x0) execution time : 62.287 s

Press any key to continue.