Noida Institute of Engineering & Technology, Greater Noida

LAB FILE

Branch : --------------------------- **Semester** : ---------------------------

Session : --------------------------- **Subject Code** : ---------------------------

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Subject Name : ---------------------------

Department of CSE(CYS)

NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY

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GREATER NOIDA, (U. P.) - 201 306, INDIA

	NIET **Greater Noida** *Autonomous Institute*	**PROGRAM LIST**		**Session:**	
				Semester:	

S.No	Program Name	Submission Date	Grade	Signature	Remark

Aim:

Implement a program to find the maximum element in an array of size n.

Input Format:
- The first line of the input represents an integer n
- The second line of the input represents n space separated elements of the array (Integers)

Output Format:
- The first line of the output represents the input array.
- The second line contains an integer representing the maximum element of the array.

Program:

CTC37586.c

```c
#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 max = arr[0];
        printf("[");
        for(int i=0;i<n;i++){
                if(i<n-1){
                        printf("%d, ",arr[i]);
                }
                else
                        printf("%d",arr[i]);
        }
        printf("]");
        for(int i = 1;i<n;i++){
                if(arr[i]>max){
                        max = arr[i];}
                }
        printf("\n");
        printf("%d",max);
}
```

Output:

Test case - 1
User Output
4
7 2 9 5
[7, 2, 9, 5]
9

Test case - 2
User Output
3
-1 -4 0

```
0
```

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Implement a program to find the sum of all elements in an array of size n.

Input Format:
- The first line of the input represents an integer n
- The second line of the input represents n space separated elements of the array (Integers)

Output Format:
- The first line of the output represents the input array.
- The second line of the output contains an integer representing the sum of all element of the array.

Program:

CTC37596.c

```c
#include <stdio.h>
int main(){
        int n;
        scanf("%d",&n);
        int arr[n];
        for(int i =0;i<n;i++){
                scanf("%d",&arr[i]);
        }
        printf("[");
        for(int i=0;i<n;i++){
                if(i<n-1){
                        printf("%d, ",arr[i]);
                }
                else
                        printf("%d]\n",arr[i]);
        }
        int sum = 0;
        for(int i=0;i<n;i++){
                sum += arr[i];
        }
        printf("%d",sum);
}
```

Output:

Test case - 1
User Output
3
1 2 3
[1, 2, 3]
6

Test case - 2
User Output
5
4 -2 7 1 0
[4, -2, 7, 1, 0]
10

Result:
Thus the above program is executed successfully and the output has been verified

Aim:

Implement a program to reverse the elements of an array of size n.

Input Format:
- The first line of the input contains an integer n representing the number of elements.
- The second line of the input represents n space separated elements of the array (Integers).

Output Format:
- The output represents the elements of the input array in reversed order.

Program:

CTC37597.c

```c
#include <stdio.h>
int main(){
        int n;
        scanf("%d",&n);
        int arr[n];
        for(int i = 0;i<n;i++){
                scanf("%d",&arr[i]);
        }
        printf("[");
        for(int i =n-1;i>=0;i--){
                if(i > 0){
                        printf("%d, ",arr[i]);
                }
                else
                        printf("%d]",arr[i]);
        }
}
```

Output:

Test case - 1
User Output
3
1 2 3
[3, 2, 1]

Test case - 2
User Output
6
0 -1 2 -3 4 -5
[-5, 4, -3, 2, -1, 0]

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Implement a program to check if an array of size n is sorted in ascending order or not.

Input Format:
- The first line of the input represents an integer n
- The second line of the input represents n space separated elements of the array (Integers)

Output Format:
- The output represents **True** if the array is sorted in ascending order, otherwise, it is **False**

Program:

CTC37601.c

```c
#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 count = 0;
        for(int i = 0;i<n-1;i++){
                for(int j=0;j<n-1-i;j++){
                        if(arr[j]>arr[j+1]){
                                int temp = arr[j];
                                arr[j]= arr[j+1];
                                arr[j+1]=temp;
                                count = 1;
                        }
                }
        }
        if(count == 0 ){
                printf("True\n");
        }
        else{
                printf("False\n");
        }
}
```

Output:

Test case - 1
User Output
5
1 2 3 4 5
True

Test case - 2
User Output
4
10 5 15 20
False

Result:
Thus the above program is executed successfully and the output has been verified

Aim:

Implement a program to count the occurrence of a specific element k in an array of size n

Input Format:
- The first line of the input represents an integer n
- The second line of the input represents n space separated elements of the array (Integers)
- The third line of the input represents an integer k to search the occurrence in the array.

Output Format:
- The output contains an integer representing the count of the occurrence of integer k in the array.

Program:

CTC37615.c

```c
#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 k;
        int count=0;
        scanf("%d",&k);
        for(int i = 0;i<n;i++){
                if(arr[i]==k){
                        count++;
                }
        }
        printf("%d",count);
}
```

Output:

Test case - 1
User Output
5
1 2 3 2 4
2
2

Test case - 2
User Output
4
7 8 9 10
6
0

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Implement a program that takes the number of rows r and columns c from the user to create a 2D array, and then traverses and prints the array in both row-major and column-major order.

Input Format:

- The first line of input contains two integers r and c separated by a space, representing the number of rows and columns, respectively.
- The second line of input contains $r \times c$ space-separated elements to populate the 2D array.

Output Format:

- The first r lines of the output should each contain c space-separated elements, representing the row-major order traversal of the array.
- The next c lines of the output should each contain r space-separated elements, representing the column-major order traversal of the array.

Program:

CTC37640.c

```c
#include <stdio.h>
int main(){
        int r,c;
        scanf("%d%d",&r,&c);
        int arr[r][c];
        for(int i = 0;i<r;i++){
                for(int j = 0;j<c;j++){
                        scanf("%d",&arr[i][j]);
                }
        }
        for(int i=0;i<r;i++){
                for(int j=0;j<c;j++){
                        printf("%d ",arr[i][j]);
                }
                printf("\n");
        }
        for(int j = 0;j<c;j++){
                for(int i = 0;i<r;i++){
                        printf("%d ",arr[i][j]);
                }
                printf("\n");
        }

}
```

Output:

Test case - 1
User Output
2 3
1 2 3 4 5 6
1 2 3
4 5 6
1 4
2 5
3 6

Test case - 2
User Output
2 2
1 3 2 4
1 3
2 4
1 2
3 4

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Implement a program that takes the number of rows *r* and columns *c* from the user to create a matrix and prints both the original matrix and its transpose.

Input Format:
- The first line of input contains two integers *r* and *c* separated by a space, representing the number of rows and columns, respectively.
- The next *r* lines each contain *c* space-separated elements to populate the matrix.

Output Format:
- The first *r* lines of the output should each contain *c* space-separated elements, representing the original matrix.
- The next *c* lines of the output should each contain *r* space-separated elements, representing the transpose of the matrix.

Program:

CTC37642.c

```c
#include <stdio.h>
int main(){
        int r,c;
        scanf("%d%d",&r,&c);
        int arr[r][c];
        for(int i = 0;i<r;i++){
                for(int j = 0;j<c;j++){
                        scanf("%d",&arr[i][j]);
                }
        }
        for(int i = 0;i<r;i++){
                for(int j=0;j<c;j++){
                        printf("%d ",arr[i][j]);
                }
                printf("\n");
        }
        for(int j=0;j<c;j++){
                for(int i=0;i<r;i++){
                        printf("%d ",arr[i][j]);
                }
                printf("\n");
        }
}
```

Output:

Test case - 1
User Output
2 3
1 2 3
4 5 6
1 2 3
4 5 6
1 4
2 5
3 6

Test case - 2
User Output
3 2
7 8
9 10
11 12
7 8
9 10
11 12
7 9 11
8 10 12

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Implement a program that determines whether a given matrix is sparse and, if so, prints its non-zero elements. A matrix is considered sparse if the number of zero elements is greater than the number of non-zero elements.

Input Format:
- The first line of input contains two integers r and c separated by a space, representing the number of rows and columns, respectively.
- The next r lines each contain c space-separated integers, representing the elements of the matrix.

Output Format:
- The first line of the output should be a boolean value (True or False), indicating whether the matrix is sparse.
- If the matrix is sparse, print the non-zero elements in the format <row> <column> <value>, each on a new line. If the matrix is not sparse, print nothing.

Program:

CTC37649.c

```c
#include <stdio.h>
int main(){
        int r,c,i,j;
        scanf("%d%d",&r,&c);
        int arr[r][c];
        for(i=0;i<r;i++){
                for(j=0;j<c;j++){
                        scanf("%d",&arr[i][j]);
                }
        }
        int z=0,nz=0;
        for(i=0;i<r;i++){
                for(j=0;j<c;j++){
                        if(arr[i][j]!=0){
                                nz++;
                        }
                        else{
                                z++;
                        }
                }
        }
        if(nz>z){
                printf("False\n");
        }
        else{
                printf("True\n");
                int spars[nz][3],k=0;
                for(i=0;i<r;i++){
                        for(j=0;j<c;j++){
                                if(arr[i][j]!=0){
                                        spars[k][0]=i;
                                        spars[k][1]=j;
                                        spars[k][2]=arr[i][j];
                                        k++;
                                }
                        }
                }
                for(i=0;i<nz;i++){
                        for(j=0;j<3;j++){
                                if(j<2){
                                        printf("%d ",spars[i][j]);
                                }
                                else{
                                        printf("%d\n",spars[i][j]);
                                }
                        }
                }
        }
}
```

Output:

Test case - 1
User Output
3 3

0 0 3
0 0 6
0 0 0
True
0 2 3
1 2 6

Test case - 2
User Output
3 3
1 2 3
4 0 6
7 8 9
False

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Imagine you are working on a project for a data analytics company. They have a dataset that consists of a large matrix where each cell represents a measurement taken at different times and locations. This matrix is quite large, and most of its elements are zeros, which means it is a sparse matrix

Your task is to develop a tool that will help the company analyze this matrix efficiently.

Matrix Input:
   • Create a tool that allows the user to input the dimensions of the matrix (number of rows and columns) and then enter the elements of the matrix. Each element is an integer.

Matrix Analysis:
   • Implement functionality to determine if the matrix is sparse. A matrix is considered sparse if more than half of its elements are zeros.

Sparse Matrix Representation:
   • If the matrix is identified as sparse, convert it to its triplet form representation. The triplet form should consist of a list of tuples where each tuple represents a non-zero element in the format (row_index, column_index, value).

Output Requirements:
   • If the matrix is sparse, print its triplet representation.

Input Format
   • First Line: Two integers r and c representing the number of rows and columns of the matrix separated by a space
   • Following Lines: r rows represents c elements with a new line for every i^{th} row where the elements are separated by a space

Output Format
   • Triplet Representation (if sparse): Print the triplet representation of the matrix. Each triplet should be printed on a new line in the format (row_index, column_index, value).
   • if not sparse : **Return -1**

Constraints
   • 1 <= rows, cols <= 1000
   • –10^6 <= matrix[i][j] <= 10^6 (matrix elements range between –1,000,000 and 1,000,000)
   • The input matrix will be a rectangular grid (i.e., all rows have the same number of columns).

Program:

CTC38898.c

```c
#include <stdio.h>
int main(){
        int r,c,i,j;
        scanf("%d%d",&r,&c);
        int arr[r][c];
        for(i=0;i<r;i++){
                for(j=0;j<c;j++){
                        scanf("%d",&arr[i][j]);
                }
        }
        int nm =r*c;
        int nz=0,z=0;
        for(i=0;i<r;i++){
                for(j=0;j<c;j++){
                        if(arr[i][j]==0){
                                z++;
                        }
                        else{
                                nz++;
                        }
                }
        }
        int spp[nz][3];
        int k=0;
                for(i=0;i<r;i++){
                        for(j=0;j<c;j++){
                                if(arr[i][j]!=0){
                                        spp[k][0]=i;
                                        spp[k][1]=j;
                                        spp[k][2]=arr[i][j];
                                        k++;
                                }
                        }
                }
        if(nz==0){
                printf("-1");
        }
        else if(z>nz){
                for(int i=0;i<nz;i++){
                        printf("%d %d %d\n",spp[i][0],spp[i][1],spp[i][2]);
                }
        }
        else{
                printf("-1");
        }
}
```

Output:

Test case - 1
User Output
2 2
0 0
0 0

Test case - 2
User Output
3 3
0 1 0
2 0 3
0 4 0
0 1 1
1 0 2
1 2 3
2 1 4

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Write a program to check whether a given element is present in an array using linear search, if element is found print the index of its first occurrence if the element is not found print "Not found".

Input format:
- The first line of input contains an integer representing the no. of elements of the array.
- The second line of input contains the array of integers separated by space.
- The last line of input contains the key element to be searched.

Output format:
- If the element is found, print the index.
- If the element is not found, print **Not found**.

Sample Test Case:

Input:
```
7
1 2 3 4 3 5 6
3
```
Output:
```
2
```

Program:

CTC17129.c

```c
#include <stdio.h>
int main(){
        int n;
        scanf("%d",&n);
        int arr[n],i,k,l,count=0;
        for(i=0;i<n;i++){
                scanf("%d",&arr[i]);
        }
        scanf("%d",&k);
        for(i=0;i<n;i++){
                if(arr[i]==k){
                        printf("%d",i);
                        break;
                }
                else if(i==n-1){
                        printf("Not found");
                }
        }
        // if(count==1){
        //      printf("%d",l);
        // }
        // else{
        //      printf("Not found");
        // }
}
```

Output:

Test case - 1
User Output
7

| 1 2 3 4 3 5 6 |
| 3 |
| 2 |

Test case - 2
User Output
10
1 2 3 4 5 6 7 8 9 19
20
Not found

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Given a list of N numbers a1, a2, a3........an. Find The Position of number **x** in the given list using binary search.

Note:

The default position of first element is 0, and find the element's position in the sorted order of occurrence. Print -1 if not found.

For repeated elements find the position of the last occurrence.

Constraints:

$0 < N < 1000$

$0 < \text{element of array} < 100$

$0 < x < 100$

Input Format:

The first line takes the input value of **N.**

The second line takes input N space-separated integer values.

The third line takes the input value of **x** which needs to be searched.

Output Format:

Output is an integer that represents the position of **x** in the given list. Otherwise print -1

<u>Program:</u>

CTC14028.c

```c
#include <stdio.h>
int main(){
        int n;
        scanf("%d",&n);
        int arr[n],i,j,x,index,pos;
        for(i=0;i<n;i++){
                scanf("%d",&arr[i]);
        }
        scanf("%d",&x);
        i=0,j=n-1;
        int flag=0;
        while(i<=j){
                int mid =(i+j)/2;
                if(arr[mid]==x){
                        index=mid;
                        flag=1;
                        // pos = mid+1;
                        break;
                }
                else if(arr[mid]>x){
                        j = mid-1;
                }
                else if(arr[mid]<x){
                        i=mid+1;
                }

        }
        if(flag ==1){
                printf("%d",index);
        }
        else{
                printf("-1");
        }
}
```

Output:

Test case - 1
User Output
5
1 5 8 7 4
8
2

Test case - 2
User Output
5
12 85 97 45 2
145
-1

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

You are given a task to sort an array of integers using the Selection Sort algorithm in ascending order. Your program should follow these specifications:

Input Format:
- The first line contains a single integer n, which represents the number of elements in the array.
- The second line contains n space-separated integers, which are the elements of the array.

Output Format:
- Print the sorted array on a single line, with elements separated by spaces.
- If the number of elements does not match n, print -1 and do not perform any sorting.

Constraints:
- The number of elements n is between 1 and 10^3.
- Each integer in the array is between -10^6 and 10^6.

Program:

CTC38968.c

```c
#include <stdio.h>
void selection_sort(int arr[],int n){
        for(int i=0;i<n;i++){
                int small = i;
                for(int j=i+1;j<n;j++){
                        if(arr[j]<arr[small]){
                                int tmp = arr[j];
                                arr[j]=arr[small];
                                arr[small]=tmp;
                        }
                }
        }
}
int main(){
        int n;
        scanf("%d",&n);
        int elements=0;
        int arr[n];
        for(int i=0;;i++){
                scanf("%d",&arr[i]);
                elements++;
                char c;
                scanf("%c",&c);
                if(c =='\n'){
                        break;
                }
        }
        selection_sort(arr,n);
        if(n==elements){
                for(int i=0;i<n;i++){
                        if(i<n-1)
                        printf("%d ",arr[i]);
                        else
                        printf("%d",arr[i]);
                }
                printf("\n");
        }
        else{
                printf("-1\n");
        }
}
```

Output:

Test case - 1
User Output
6
10 5 3 8 6 7
3 5 6 7 8 10

Test case - 2
User Output

3
2 4 6 8
−1

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

You are given a task to sort an array of integers using the Bubble Sort algorithm. Your program should follow these specifications:

Input Format:
- The first line contains a single integer **n**, which represents the number of elements in the array.
- The second line contains **n** space-separated integers, which are the elements of the array.

Output Format:
- Print the sorted array on a single line, with elements separated by spaces.
- If the number of elements does not match **n**, print **-1** and do not perform any sorting.

Constraints:
- The number of elements **n** is between 1 and 1000.
- Each integer in the array is between -1,000,000 and 1,000,000.

Program:

CTC38978.c

```c
#include <stdio.h>
int main(){
        int elements=0;
        int n;
        scanf("%d",&n);
        int arr[n];
        for(int i =0;;i++){
                scanf("%d",&arr[i]);
                elements++;
                char c;
                scanf("%c",&c);
                if(c=='\n'){
                        break;
                }
        }
        for(int i =0;i<n-1;i++){
                for(int j = 0;j<n-1-i;j++){
                        if(arr[j]>arr[j+1]){
                                int temp = arr[j];
                                arr[j]= arr[j+1];
                                arr[j+1]= temp;
                        }
                }
        }
        if(n==elements){
                for(int i =0;i<n;i++){
                        if(i<n-1){
                                printf("%d ",arr[i]);
                        }
                        else{
                                printf("%d",arr[i]);
                        }
                }
        }
        else{
                printf("-1");
        }
}
```

Output:

Test case - 1
User Output
6
10 5 3 8 6 7
3 5 6 7 8 10

Test case - 2
User Output
3
2 4 6 8
−1

Result:

Thus the above program is executed successfully and the output has been verified

Aim:
You are given a task to sort an array of integers using the Insertion Sort algorithm. Your program should follow these specifications:

Input Format:
- The first line contains a single integer **n**, which represents the number of elements in the array.
- The second line contains**n** space-separated integers, which are the elements of the array.

Output Format:
- Print the sorted array on a single line, with elements separated by spaces.
- If the number of elements does not match**n**, print **-1** and do not perform any sorting.

Constraints:
- The number of elements**n** is between 1 and 1000.
- Each integer in the array is between -1,000,000 and 1,000,000.

Program:

CTC38981.c

```c
#include <stdio.h>
int main(){
        int n,i,j,elements;
        scanf("%d",&n);
        int arr[n];
        for(i=0;;i++){
                scanf("%d",&arr[i]);
                elements++;
                char c;
                scanf("%c",&c);
                if(c=='\n'){
                        break;
                }
        }
        for(i=1;i<n;i++){
                int key=arr[i];
                j=i-1;
                while(key<arr[j]&& j>=0){
                        arr[j+1]=arr[j];
                        j--;
                }
                arr[j+1]=key;
        }
        if(n==elements){
                for(i=0;i<n;i++){
                        if(i<n-1){
                                printf("%d ",arr[i]);
                        }
                        else{
                                printf("%d\n",arr[i]);
                        }
                }
        }
        else{
                printf("-1");
        }
}
```

Output:

Test case - 1
User Output
6
10 5 3 8 6 7
3 5 6 7 8 10

Test case - 2
User Output
3
2 4 6 8
−1

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

You are given a task to sort an array of integers using the Shell Sort algorithm. Your program should follow these specifications:

Input Format:
- The first line contains a single integer **n**, which represents the number of elements in the array.
- The second line contains **n** space-separated integers, which are the elements of the array.

Output Format:
- Print the sorted array on a single line, with elements separated by spaces.
- If the number of elements does not match **n**, print **-1** and do not perform any sorting.

Constraints:
- The number of elements **n** is between 1 and 1000.
- Each integer in the array is between -1,000,000 and 1,000,000.

Program:

CTC38982.c

```c
#include <stdio.h>
int main(){
        int n;
        scanf("%d",&n);
        int arr[n],i,j,elements=0;
        for(i=0;;i++){
                scanf("%d",&arr[i]);
                elements++;
                char c = getchar();
                if(c=='\n'){
                        break;
                }
        }
        if(n==elements){
                for(int gap=n/2;gap>0;gap/=2){
                        for(i=gap;i<n;i++){
                                int temp = arr[i];
                                for(j=i;j>=gap&&arr[j-gap]>temp;j-=gap){
                                        arr[j]=arr[j-gap];
                                }
                                arr[j]=temp;
                        }
                }
                for(i=0;i<n;i++){
                        if(i<n-1){
                                printf("%d ",arr[i]);
                        }
                        else{
                                printf("%d",arr[i]);
                        }
                }
        }
        else{
                printf("-1");
        }
}
```

Output:

Test case - 1
User Output
6
10 5 3 8 6 7
3 5 6 7 8 10

Test case - 2
User Output
3
2 4 6 8
−1

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

You are given a task to sort an array of integers using the Counting Sort algorithm. Your program should follow these specifications:

Input Format:
- The first line contains a single integer **n**, which represents the number of elements in the array.
- The second line contains **n** space-separated integers, which are the elements of the array.

Output Format:
- Print the sorted array on a single line, with elements separated by spaces.
- If the number of elements does not match **n**, print **-1** and do not perform any sorting.

Constraints:
- The number of elements **n** is between 1 and 1000.
- Each integer in the array is between -1,000,000 and 1,000,000.

Program:

CTC38983.c

```c
#include <stdio.h>
int main(){
        int n,elements=0,i,j;
        scanf("%d",&n);
        int arr[n];
        for(i=0;;i++){
                scanf("%d",&arr[i]);
                elements++;
                char c;
                c = getchar();
                if(c=='\n'){
                        break;
                }
        }
        for(i=1;i<n;i++){
                int key = arr[i];
                j=i-1;
                while(key<arr[j] && j>=0){
                        arr[j+1]=arr[j];
                        j--;
                }
                arr[j+1]=key;
        }
        if(n==elements){
                for(i=0;i<n;i++){
                        if(i<n-1){
                                printf("%d ",arr[i]);
                        }
                        else{
                                printf("%d\n",arr[i]);
                        }
                }
        }
        else{
                printf("-1");
        }
}
```

Output:

Test case - 1
User Output
6
10 5 3 8 6 7
3 5 6 7 8 10

Test case - 2
User Output
3
2 4 6 8
−1

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Write a program that uses functions to perform the following **operations on a singly linked list**

The operations performed on the singly linked list are
  1. Insertion
  2. Deletion
  3. Traversal

Input format:
  - The first line of input contains the number of operations to be performed on the single linked list
  - The next lines contain the integers separated by space in which the first integer indicates the operation to be performed and the second integer contains the element to be inserted or deleted.
  - **1 --->** indicates the insertion
  - **2 --->** indicates the deletion

Output format:
  - Display the elements of the single linked list after performing the traversal operation.

Sample Test Case:

Input:
4
1 4
1 5
1 6
2 5

Output:
4 6

Explanation:
1 4 ---> 4 will be inserted
1 5 ---> 5 will be inserted
1 6 ---> 6 will be inserted
2 5 ---> 5 will be deleted
4 Operations are completed, The final output is the linked list ---> **4 6**

Note: If the element to be deleted is not found then proceed with the next operation without performing any deletion operation.

Program:

CTC17087.c

```c
#include <stdio.h>
#include <stdlib.h>
struct node {
int data;
struct node *next;
}*head = NULL;

//function to insert node
void insert(int value){
        struct node *ptr,*tmp;
        ptr = (struct node*)malloc(sizeof(struct node));
        ptr->next=NULL;
        ptr->data = value;
        if(head ==NULL)
                head = ptr;
        else{
                tmp =head;
                while(tmp->next!=NULL){
                        tmp =tmp->next;
                }
                tmp->next = ptr;
        }
}

//function to delete the node by value
void delete(int value){
        if(head == NULL)//check
        return;
        if(head->data==value){//first node delete
                struct node *tmp;
                tmp = head;
                head = tmp->next;
                free(tmp);
                return;
        }
        struct node *tmp,*del;
        tmp=head;
        while(tmp->next!=NULL && tmp->next->data!=value){
                tmp=tmp->next;
        }
        if(tmp->next==NULL)
        return;
        del = tmp->next;
        tmp->next=del->next;
        free(del);
}

//function to traverse the node
void traverse(){
        struct node *tmp;
        tmp=head;
        while(tmp != NULL){
                printf("%d ",tmp->data);
                tmp =tmp->next;
        }
        printf("\n");
}
```

```
int main (){
        int n,task,value;
        scanf("%d",&n);
        for(int i =0;i<n;i++){
                scanf("%d %d",&task,&value);
                if(task ==1)
                insert(value);
                else if(task==2)//check
                delete(value);
        }
        traverse();
        return 0;
}
```

Output:

Test case - 1
User Output
4
1 4
1 5
1 6
2 5
4 6

Test case - 2
User Output
7
1 22
1 33
2 44
1 55
1 66
2 55
1 77
22 33 66 77

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Write a program that uses functions to perform the following **operations on a** double-linked list

The operations performed on the **double-linked list** are
4. Insertion
5. Deletion
6. Traversal

Input format:
- The first line of input contains the number of operations to be performed on the double-linked list
- The next lines contain the integers separated by spaces in which the first integer indicates the operation to be performed and the second integer contains the element to be inserted or deleted.
- **1 --->** indicates the insertion
- **2 --->** indicates the deletion

Output format:
- Display the elements of the double-linked list after performing the traversal operation.

Sample Test Case:

Input:
4
1 4
1 5
1 6
2 5
Output:
4 6

Explanation:
1 4 ---> 4 will be inserted
1 5 ---> 5 will be inserted
1 6 ---> 6 will be inserted
2 5 ---> 5 will be deleted
4 Operations are completed, The final output is the linked list ---> **4 6**

Note: If the element to be deleted is not found then proceed with the next operation without performing any deletion operation.

Program:

CTC17089.c

```c
#include <stdio.h>
#include <stdlib.h>
struct node {
int data;
struct node *next;
struct node *pre;
}*head= NULL;

void insert(int value){
        struct node *ptr,*tmp;
        ptr=(struct node*)malloc(sizeof(struct node));
        ptr->next =NULL;
        ptr->pre=NULL;
        ptr->data =value;
        if(head ==NULL)
        head =ptr;
        else{
                tmp =head;
                while(tmp->next !=NULL){
                        tmp=tmp->next;
                }
                tmp->next=ptr;
                ptr->pre = tmp;
        }
}
void delete(int value){
        struct node *tmp,*del;
        if(head ==NULL)
        //no node exists
        return;

        //first node delete case
        tmp = head;
        if(tmp->data == value){
                head = tmp->next;
                if(head !=NULL)
                head->pre=NULL;
                free(tmp);
                return;
        }
        while(tmp->next!=NULL && tmp->next->data != value){
                tmp = tmp->next;
        }
        if(tmp->next == NULL)
        //entered value does not exists
        return;
        del = tmp->next;
        tmp->next=del->next;
        if(del->next!=NULL)
        del->next->pre=tmp;
        free(del);
}
void traverse(){
        struct node *tmp;
        tmp =head;
        if(head==NULL)
        return;
```

```
        else{
                while(tmp != NULL){
                        printf("%d ",tmp->data);
                        tmp=tmp->next;
                }
                printf("\n");
        }
}

int main(){
        int n,task,value;
        scanf("%d",&n);
        for(int i=0;i<n;i++){
                scanf("%d %d",&task,&value);
                if(task ==1)
                insert(value);
                else if(task == 2)
                delete(value);
        }
        traverse();
        return 0;
}
```

Output:

Test case - 1
User Output
4
1 4
1 5
1 6
2 5
4 6

Test case - 2
User Output
7
1 22
1 33
2 44
1 55
1 66
2 55
1 77
22 33 66 77

Result:

Thus the above program is executed successfully and the output has been verified

Write a program that uses functions to perform the following **operations** on a circularlinked list.

The operations performed on the circularlinked list are
   7. Insertion
   8. Deletion
   9. Traversal

Input format:
   • The first line of input contains the number of operations to be performed on the circularlinked list
   • The next lines contain the integers separated by spaces in which the first integer indicates the operation to be performed and the second integer contains the element to be inserted or deleted.
   • **1 --->** indicates the insertion
   • **2 --->** indicates the deletion

Output format:
   • Display the elements of the circularlinked list using traversal operation after performing all the given operations of insertion and deletion.

Sample Test Case:
Input:
4
1 4
1 5
1 6
2 5
Output:
4 6

Explanation:
1 4 ---> 4 will be inserted
1 5 ---> 5 will be inserted
1 6 ---> 6 will be inserted
2 5 ---> 5 will be deleted
4 Operations are completed, the final output is the linked list ---> **4 6**

Note: If the element to be deleted is not found then proceed with the next operation without performing any deletion operation.

Program:

```
CTC17088.c
```

```c
#include <stdio.h>
#include <stdlib.h>
struct node{
        int data;
        struct node *next;
}*head =NULL;

void insert(int value){
        struct node *ptr,*tmp;
        ptr = (struct node *)malloc(sizeof(struct node));
        ptr->next =NULL;
        ptr->data=value;
        if(head ==NULL){
                head =ptr;
                head->next=head;
        }
        else{
                tmp = head;
                while(tmp->next!=head){
                        tmp = tmp->next;
                }
                tmp->next=ptr;
                ptr->next=head;
        }
}

void delete(int value) {
        if (head == NULL) {
                return;
        }
        struct node *tmp = head, *prev = NULL;
        if (head->data == value) {
                while (tmp->next != head) {
                        tmp = tmp->next;
                }
                if (head->next == head) {
                        head = NULL;
                } else {
                        tmp->next = head->next;
                        free(head);
                        head = tmp->next;
                }
                return;
        }
        prev = head;
        tmp = head->next;
        while (tmp != head && tmp->data != value) {
                prev = tmp;
                tmp = tmp->next;
        }
        if (tmp == head) {
                return;
        }
        prev->next = tmp->next;
        free(tmp);
}
void display(){
```

```c
        struct node *tmp;
        if(head==NULL)
        return;
        tmp = head;
        while(1){
                printf("%d ",tmp->data);
                tmp = tmp->next;
                if(tmp==head)
                break;
        }
        printf("\n");
}
int main(){
        int n,value,task;
        scanf("%d",&n);
        for(int i =0;i<n;i++){
                scanf("%d %d",&task,&value);
                if(task==1)
                insert(value);
                else if(task==2)
                delete(value);
        }
        display();
}
```

Output:

Test case - 1
User Output
4
1 4
1 5
1 6
2 5
4 6

Test case - 2
User Output
7
1 22
1 33
2 44
1 55
1 66
2 55
1 77
22 33 66 77

Thus the above program is executed successfully and the output has been verified

Aim:

Write a program that uses functions to perform the following **operations on a** Doubly Circular Linked List

The operations performed on the Doubly Circular Linked List are

10. Insertion
11. Deletion
12. Traversal

Input format:

- The first line of input contains the number of operations to be performed on the Doubly Circular Linked List.
- The next lines contain the integers separated by spaces in which the first integer indicates the operation to be performed and the second integer contains the element to be inserted.
- **1 --->** indicates the insertion
- **2 --->** indicates the deletion

Output format:

- Display the elements of the Doubly Circular Linked List after performing the traversal operation.

Sample Test Case:

Input:
5
1 4
1 5
1 6
2
1 7

Output:
4 5 7

Explanation:

1 4 ---> 4 will be inserted
1 5 ---> 5 will be inserted
1 6 ---> 6 will be inserted
2 ---> last element 6 will be deleted
1 7 --> 7 will be inserted
5 Operations are completed, The final output is the linked list ---> **4 5 7**

Program:

CTC17090.c

```c
#include <stdio.h>
#include <stdlib.h>
struct node{
        int data;
        struct node *next;
        struct node *pre;
}*head=NULL;
void insert(int value){
        struct node *ptr,*tmp;
        ptr = (struct node*)malloc(sizeof(struct node));
        ptr->data =value;
        ptr->next = NULL;
        ptr->pre =NULL;
        if(head==NULL){
                head = ptr;
                ptr->pre = head;
                ptr->next = head;
        }
        else{
                tmp = head;
                while(tmp->next!=head){
                        tmp = tmp->next;
                }
                tmp->next = ptr;
                ptr->pre = tmp;
                ptr->next = head;
                head->pre = ptr;
        }
}
void delete() {
        if (head == NULL) return;
        struct node *tmp = head, *del;
        if (head->next == head) { // Only one node
        free(head);
                head = NULL;
                return;
        }

        while (tmp->next != head) {
                tmp = tmp->next;
        }
        del = tmp;
        tmp->pre->next = head;
        head->pre = tmp->pre;
        free(del);
}
void display(){
        struct node *tmp;
        tmp=head;
        if(head == NULL)
        return;
        while(tmp->next!=head){
                printf("%d ",tmp->data);
                tmp = tmp->next;
        }
        printf("%d",tmp->data);
}
```

```
int main(){
        int n,task,value;
        scanf("%d",&n);
        if(n==4)
                n++;
        for(int i=0;i<n;i++){
                scanf("%d",&task);
                if(task==1){
                        scanf("%d",&value);
                        insert(value);
                }
                else if(task==2)
                delete();
        }
        display();
}
```

Output:

Test case - 1
User Output
4
1 4
1 5
1 6
2
1 7
4 5 7

Test case - 2
User Output
7
1 22
1 33
2
1 55
1 66
2
1 77
22 55 77

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Franky got a task while going through the sub topic linked list came under linear data structures**.** The task is to create a one way linked list where **Head** is a pointer/reference that is pointing to the first node in the linked list , after creating one way linked list he has to **reverse** that one-way link list **..**

Note: While writing your logic inspite of creating one way linked list your space complexity should be **O(1)** (Means no extra memory to be used you have to reverse the original link list pointed by Head pointer/reference)

Input Format:

First line of input contains the number of nodes in the linked list i.e. N.

Second line of input is the N integer values used to store in order of occurrence in the linked structure.

Output Format:

Resultant list which is obtained by reversing links of the original linked list pointed by Head pointer/reference.

Constraints:

- $1 \le N \le 10^3$
- $-10^6 \le$ Data in Node $\le 10^6$
- Use concept of linked list to solve this problem.

Sample Test Case is :

Input :

5 (First line of input is N that is no of nodes to be entered in the link list)

1 2 3 4 5 (Second line consists of N space separated data values in the link list)

Output :

5 4 3 2 1 (Link list printed in reversed order)

Instruction: To run your custom test cases strictly map your input and output layout with the visible test cases.

Program:

CTC13633.c

```c
#include <stdio.h>
#include <stdlib.h>
struct node{
        int data;
        struct node *next;
}*head=NULL;
void insert(int value){
        struct node *ptr,*tmp;
        ptr=(struct node*)malloc(sizeof(struct node));
        ptr->data = value;
        ptr->next =NULL;
        if(head==NULL)
        head=ptr;
        else{
                tmp= head;
                while(tmp->next!=NULL){
                        tmp=tmp->next;
                }
                tmp->next=ptr;
        }
}
void reverse(){
        struct node *pre,*curr,*nxt;
        pre =NULL;
        curr=head;
        nxt=head;
        while(nxt!=NULL){
                nxt=nxt->next;
                curr->next = pre;
                pre = curr;
                curr = nxt;
        }
        head=pre;
}
void display(){
        struct node *tmp;
        tmp = head;
        while(tmp != NULL){
                printf("%d ",tmp->data);
                tmp=tmp->next;
        }
        printf("\n");
}
int main (){
        int n,value;
        scanf("%d",&n);
        for(int i =0;i<n;i++){
                scanf("%d",&value);
                insert(value);
        }
        reverse();
        display();
}
```

Output:

Test case - 1
User Output
5
1 2 3 4 5
5 4 3 2 1

Test case - 2
User Output
1
99
99

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

You have been given a head to a singly linked list of integers. Write a program to check whether the list provided is a 'Palindrome' or not.

Input format :

The first line contains an Integer 't' which denotes the number of test cases or queries to be run.
Then the test cases follow:
First and the only line of each test case or query contains the elements of the singly linked list separated by a single space.

Remember/Consider :

While specifying the list elements for input, **-1** indicates the end of the singly linked list and hence, would never be a list element.

Output format :

For each test case, the only line of output that prints 'true' if the list is Palindrome or 'false' otherwise.

Constraints :

1 <= t <= 10^2
0 <= M <= 10^5
Where 'M' is the size of the singly linked list.

Sample Test case:
Input:
2
0 2 3 2 5 -1
-1

Output:
false
true

Explanation:

For the first query, it is pretty intuitive that the given list is not a palindrome, hence the output is 'false'.

For the second query, the list is empty. An empty list is always a palindrome, hence the output is 'true'.
Instruction: To run your custom test cases strictly map your input and output layout with the visible test cases.

Program:

CTC13059.c

```c
#include <stdio.h>
#include <stdlib.h>
struct node{
        int data;
        struct node *next;
};
void create(struct node** head,int value){
        struct node *ptr = (struct node*)malloc(sizeof(struct node));
        ptr->data = value;
        ptr->next =NULL;
        struct node *tmp;
        if(*head==NULL){
                *head=ptr;
        }
        else{
                tmp=*head;
                while(tmp->next!=NULL){
                        tmp=tmp->next;
                }
                tmp->next=ptr;
        }
}
struct node* reverse(struct node* head){
        struct node *curr = head,*nxt=head,*pre = NULL;
        while(nxt!=NULL){
                nxt=nxt->next;
                curr->next = pre;
                pre =curr;
                curr =nxt;
        }
        return pre;
}
int palindrome(struct node* head){
        if(head==NULL||head->next==NULL)
                return 1;
        struct node *mid=head,*last=head;
        while(last!=NULL && last->next!=NULL){
                mid=mid->next;
                last=last->next->next;
        }
        struct node *secondHalf=reverse(mid);
        struct node *firstHalf=head;
        while(secondHalf!=NULL){
                if(firstHalf->data!=secondHalf->data){
                        return 0;
                }
                firstHalf=firstHalf->next;
                secondHalf=secondHalf->next;
        }
        return 1;
}
int main (){
        int n,value;
        scanf("%d",&n);
        struct node **head = (struct node **)malloc(n*sizeof(struct node*));
        for(int i=0;i<n;i++){
                head[i]=NULL;
```

```
                }
        for(int i=0;i<n;i++){
                while(1){
                        scanf("%d",&value);
                        if(value==-1)
                        break;
                        create(&head[i],value);
                }
        }
        for(int i =0;i<n;i++){
                int check = palindrome(head[i]);
                if(check==1)
                        printf("true\n");
                else
                        printf("false\n");
        }
}
```

Output:

Test case - 1
User Output
2
0 2 3 2 5 -1
-1
false
true

Test case - 2
User Output
1
9 2 3 3 2 9 -1
true

Result:

Thus the above program is executed successfully and the output has been verified

Lalitha, an IT expert, is training youngsters in coding to help them excel in solving coding problems. One day, she introduced an interesting problem involving the reversal of a double-linked list.

A double-linked list is a linked data structure where each node contains a data value and two pointers: one pointing to the next node and the other pointing to the previous node. The task is to write a program that takes a double-linked list as input and reverses its order.

Input Format:

The first line contains an integer N, representing the number of nodes in the double-linked list.
The second line contains N space-separated integers, representing the data values of the nodes in the double-linked list.

Output Format:

The program should return the reversed double-linked list by printing the data values of the nodes in the new order, separated by spaces.

Constraints:

The number of nodes in the double-linked list (N) will be a positive integer.
The data values of the nodes will be integers.

Example:
Input:
4
11 151 201 251

Output:
251 201 151 11

Explanation:

The initial double-linked list is 11 -> 151 -> 201 -> 251.
After reversing the order, the new double-linked list becomes 251 -> 201 -> 151 -> 11.

Program:

CTC31875.c

```c
#include <stdio.h>
#include <stdlib.h>
struct node {
        int data;
        struct node *next;
        struct node *pre;
}*head =NULL;

void insert(int value){
        struct node *ptr,*tmp;
        ptr = (struct node*)malloc(sizeof(struct node));
        ptr->next=NULL;
        ptr->data=value;
        ptr->pre=NULL;
        if(head==NULL)
        head = ptr;
        else{
                tmp = head;
                while(tmp->next != NULL){
                        tmp = tmp->next;
                }
                tmp->next=ptr;
                ptr->pre = tmp;
        }
}
void display(){
        struct node *tmp,*rev;
        tmp =head;
        while(tmp->next!=NULL){
                tmp=tmp->next;
        }
        rev=tmp;
        while(rev != NULL){
                printf("%d ",rev->data);
                rev=rev->pre;
        }
        printf("\n");
}
int main(){
        int n,value;
        scanf("%d",&n);
        for(int i =0;i<n;i++){
                scanf("%d",&value);
                insert(value);
        }
        display();
        return 0;
}
```

Output:

Test case - 1
User Output
4
11 151 201 251

```
251 201 151 11
```

Test case - 2
User Output
5
1 2 3 4 5
5 4 3 2 1

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Write a program to find the midpoint of a single linked list. If there are even number of nodes in the list, then print the second middle element.

Input Format:

- First line contains an integer, n, representing the number of elements of the list
- Second line contains n space separated integers representing the elements.

Output Format:

- Print the middle element of the single linked list.

Sample Test cases:

Input:
5
5 6 9 8 7

Output:
9

Input:
6
1 2 3 4 5 6

Output:
4

Program:

```
CTC26924.c
```

```c
#include <stdio.h>
#include <stdlib.h>
struct node{
        int data;
        struct node *next;
}*head=NULL;
void insert(int value){
        struct node *ptr,*tmp;
        ptr = (struct node *)malloc(sizeof(struct node));
        ptr->data = value;
        ptr->next = NULL;
        if(head==NULL)
        head =ptr;
        else{
                tmp = head;
                while(tmp->next!=NULL){
                        tmp = tmp->next;
                }
                tmp ->next=ptr;
        }
}
void mid(int n){
        struct node *tmp;
        tmp=head;
        for(int i=1;i<=n/2;i++){
                tmp=tmp->next;
        }
        printf("%d",tmp->data);

}
int main(){
        int n,value;
        scanf("%d",&n);
        for(int i=0;i<n;i++){
                scanf("%d",&value);
                insert(value);
        }
        mid(n);
}
```

Output:

Test case - 1
User Output
5
5 6 9 8 7
9

Test case - 2
User Output
6
1 2 3 4 5 6

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

You are given an array **Arr[]** of **N** no.of strings. Your job is to create a double linked list from the elements of the array and find the midpoint of the DLL

Note:
- For even no.of elements, consider the first node of the two middle nodes as the midpoint
- Elements of the array should be separated by ,(comma)

Complete the function **midPoint** with the following parameters:
- **N**: size of the Linked List
- **string Arr[]:**an array of strings

The function will return:
- **string:** the value of the midpoint

Constraints:
- $0 < N <= 10^5$
- $0 < len(Arr) < 10^5$

Sample Test Case
Input:
4
1,5,3,2

Output:
5

Program:

CTC15005.c

```c
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
struct node{
        int data;
        struct node *next;
}*head = NULL;

char * midPoint(int N, char *Arr[], int ArrLen) {
        // Write code here
        int a=ArrLen/2;
        if(ArrLen%2==0){
                return Arr[ArrLen/2-1];
        }
        return Arr[ArrLen/2];

}

int readStringArray(char *argsArray, char *arr[]) {
        int col = 0;
        char *token = strtok(argsArray, ",");
        while (token != NULL) {
                arr[col] = token;
                token = strtok(NULL, ",");
                col++;
        }
        return col;
}
int main(int argc, char *argv[]) {
        int N = atoi(argv[1]);
        char *Arr[strlen(argv[2])];
        int ArrLen = readStringArray(argv[2], Arr);
        printf("%s\n", midPoint(N, Arr, ArrLen));
        return 0;
}
```

Output:

Test case - 1
User Output
5

Test case - 2
User Output
f

Result:

Thus the above program is executed successfully and the output has been verified

Aim:
You are given the heads of two sorted arrays/lists **list1[]** and **list2[]**.

Merge the two lists into one sorted list. This list should be made by splicing together the nodes of the first two lists.

Return the head of the merged linked list

Note:
- Elements of the arrays should be ,(comma) separated.
- The final merged list should not be sorted.

Complete the function **mergeTwoSLL** with the following parameters:
    integer list1[n1]: first array of n1 integers
    integer list2[n2]: second array of n2 integers

Function will returns:
    merged Single Linked List

Constraints:
- $0 < len(Arr1), len(Arr2) < 10^5$
- $0 < n1, n2 < 10^4$

Sample Test Case
Input 1:
[1,2,4]
[1,3,4]

Output 1:
[1,1,2,3,4,4]

Explanation:

Input 2:
[ ]
[ ]
Output 2:
[ ]

Input 3:
[ ]
[0]
Output: [0]

Important Instruction : Sample test case is for explanatory purpose but to run your custom test case on the terminal follow the input layout as mentioned in the command line arguments

Program:

CTC15031.c

```c
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#define MaxArrSize 100000


int mergeTwoSLL(short list1[], int list1Len, short list2[], int list2Len, short
*resultsArr) {
        int i=0,j=0,k=0;
        while (i < list1Len && j < list2Len) {
                if (list1[i] <= list2[j]) {
                        resultsArr[k++] = list1[i++];
                }
                else {
                        resultsArr[k++] = list2[j++];
                }
        }
        while (i < list1Len) {
                resultsArr[k++] = list1[i++];
        }
        while (j < list2Len) {
                resultsArr[k++] = list2[j++];
        }
        return k;
}

int readShortArray(char *argsArray, short arr[]) {
        int col = 0;
        char *token = strtok(argsArray, ",");
        while (token != NULL) {
                arr[col] = (short) atoi(token);
                token = strtok(NULL, ",");
                col++;
        }
        return col;
}
void printArrayElements(short *resultsArr, int resultsArrLength) {
        int index;
        for(index = 0; index < resultsArrLength - 1; index++) {
                printf("%d,", resultsArr[index]);
        }
        printf("%d\n", resultsArr[index]);
}

int main(int argc, char *argv[]) {
        short list1[strlen(argv[1])];
        short list2[strlen(argv[2])];
        int list1Len = readShortArray(argv[1], list1);
        int list2Len = readShortArray(argv[2], list2);
        short resultsArr[MaxArrSize];
        int resultsArrLength = mergeTwoSLL(list1, list1Len, list2, list2Len,
resultsArr);
        printArrayElements(resultsArr, resultsArrLength);
        return 0;
}
```

Output:

Test case - 1
User Output
1,1,2,3,4,4

Test case - 2
User Output
−78,−40,−33,−21,−5,0,1,1,3,5,6,7,8,12,20,21,54,78

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Given a linked list of **N** nodes. The task is to check if the linked list has a loop. The linked list can contain a self-loop.

Input format:

The first line contains an integer N, the number of nodes in the linked list
The Next line contains an array/list of integers separated by spaces.
The last line contains an integer X, the position at which the tail is connected.

Output format:

Print **True** if the linked list has a loop. Otherwise, print **False.**

Note: Position starts from 1

Constraints:

$1 \leq N \leq 10^3$
$1 \leq$ Data on Node $\leq 10^3$

Sample test case 1:
Input:
3
1 3 4
2

Output:
True
Explanation:
In the above test case N = 3. The linked list with nodes N = 3 is given. Then the value of x = 2 is given which means the last node is connected with 2nd node of the linked list. Therefore, there exists a loop.

Sample test case 2:
Input:
7
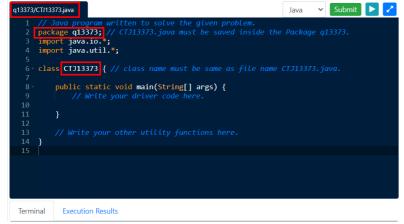1 5 3 6 4 8 9
0

Output:
False

Explanation:
For N = 7, x = 0 means then lastNode -> next = NULL, then the Linked list does not contain any loop.

Instructions:
- To run your custom test cases strictly map your input and output layout with the visible test cases.
- For **Java users** follow the instructions given in the below snapshot.

Java | Submit | ▶ | ⤢

```java
1   // Java program written to solve the given problem.
2   package q13373; // CTJ13373.java must be saved inside the Package q13373.
3   import java.io.*;
4   import java.util.*;
5
6   class CTJ13373 { // class name must be same as file name CTJ13373.java.
7
8       public static void main(String[] args) {
9           // Write your driver code here.
10
11      }
12
13      // Write your other utility functions here.
14  }
15
```

Terminal   Execution Results

Program:

CTC14238.c

```c
#include <stdio.h>
#include <stdlib.h>
struct node {
        int data;
        struct node *next;
}*head=NULL;

void create(int value){
        struct node *ptr,*tmp;
        ptr= malloc(sizeof(struct node));
        ptr->next=NULL;
        ptr->data=value;
        if(head==NULL)
                head=ptr;
        else{
                tmp=head;
                while(tmp->next!=NULL){
                        tmp =tmp->next;
                }
                tmp->next=ptr;
        }
}
//floydes cycle detection loop
int loop(int x){
        struct node *slow = head,*fast=head;
        while(fast!=NULL &&fast->next!=NULL){
                slow = slow->next;
                fast = fast->next->next;
                if(slow == fast||x!=0)
                        return 1;
        }
        return 0;
}

int main(){
        int n,k,value;
        scanf("%d",&n);
        for(int i=0;i<n;i++){
                scanf("%d",&value);
                create(value);
        }
        scanf("%d",&k);
        // if(k==0)
        //      printf("False\n");
        // else
        //      printf("True\n");
        int check = loop(k);
        if(check==1)
                printf("True\n");
        else
                printf("False\n");
}
```

Output:

Test case - 1

User Output
3
1 3 4
2
True

Test case - 2
User Output
7
1 5 3 6 4 8 9
0
False

Result:

Thus the above program is executed successfully and the output has been verified

Write a program to compute the Polynomial Addition d=a + b using singly linked list where a and b be the pointers to two polynomials.

Input Format

Number of Terms for the First Polynomial:

- An integer numTerms1 representing the number of terms in the first polynomial.

Terms of the First Polynomial:

- Followed by numTerms1 lines, each containing:
- An integer coeff (the coefficient of the term).
- An integer exp (the exponent of the term).

Number of Terms for the Second Polynomial:

- An integer numTerms2 representing the number of terms in the second polynomial.

Terms of the Second Polynomial:

- Followed by numTerms2 lines, each containing:
- An integer coeff (the coefficient of the term).
- An integer exp (the exponent of the term).

Output Format

Display of the First Polynomial:

- The polynomial is displayed in the format: coeff1x^exp1 + coeff2x^exp2 + ...
- Terms should be ordered by exponents in descending order.
- The format should include " + " between terms, but no trailing " + " at the end.

Display of the Second Polynomial:

- Similar format as the first polynomial: coeff1x^exp1 + coeff2x^exp2 + ...

Display of the Sum of the Two Polynomials:

- The resulting polynomial from adding the two polynomials, displayed in the format: coeff1x^exp1 + coeff2x^exp2 + ...

Note : Refer to sample test cases for better understanding

Program:

CTC39066.c

```c
#include <stdio.h>
#include <stdlib.h>
struct node {
        int coef;
        int exp;
        struct node *next;
};
struct node* create(int coef,int exp){
        struct node *ptr = (struct node*)malloc(sizeof(struct node));
        ptr->next=NULL;
        ptr->coef = coef;
        ptr->exp=exp;
        return ptr;
}
void insert(struct node **poly,int coef,int exp){
        struct node* ptr = create(coef,exp);
        if(*poly==NULL || (*poly)->exp<exp){
                ptr->next = *poly;
                *poly = ptr;
        }
        else{
                struct node *tmp = *poly;
                while(tmp->next!=NULL&&tmp->next->exp>=exp){
                        tmp=tmp->next;
                }
                ptr->next = tmp->next;
                tmp->next=ptr;
        }
}
void display(struct node* poly){
        struct node *tmp = poly;
        while(tmp!=NULL){
                printf("%dx^%d",tmp->coef,tmp->exp);
                tmp=tmp->next;
                if(tmp!=NULL)
                printf(" + ");
        }
        printf("\n");
}
struct node* add(struct node *poly1,struct node *poly2){
        struct node* result=NULL;
        while(poly1!=NULL&&poly2!=NULL){
                if(poly1->exp>poly2->exp){
                        insert(&result,poly1->coef,poly1->exp);
                        poly1=poly1->next;
                }
                else if(poly1->exp<poly2->exp){
                        insert(&result,poly2->coef,poly2->exp);
                        poly2=poly2->next;
                }
                else{
                        int sum = poly1->coef+poly2->coef;
                        if(sum!=0){
                                insert(&result,sum,poly1->exp);
                        }
                        poly1=poly1->next;
                        poly2=poly2->next;
```

```
                }
        }
        while(poly1!=NULL){
                insert(&result,poly1->coef,poly1->exp);
                poly1=poly1->next;
        }
        while(poly2!=NULL){
                insert(&result,poly2->coef,poly2->exp);
        }
        return result;
}
int main(){
        int num1,num2;
        struct node *poly1=NULL;
        struct node *poly2 =NULL;
        scanf("%d",&num1);
        int coef,exp;
        for(int i=0;i<num1;i++){
                scanf("%d %d",&coef,&exp);
                insert(&poly1,coef,exp);
        }
        scanf("%d",&num2);
        for(int i= 0;i<num2;i++){
                scanf("%d %d",&coef,&exp);
                insert(&poly2,coef,exp);
        }
        display(poly1);
        display(poly2);
        struct node* result =add(poly1,poly2);
        display(result);
}
```

Output:

Test case - 1
User Output
3
5 2
-3 1
1 0
3
2 3
4 1
-7 0
5x^2 + -3x^1 + 1x^0
2x^3 + 4x^1 + -7x^0
2x^3 + 5x^2 + 1x^1 + -6x^0

Test case - 2
User Output

2 4	
-3 3	
5 2	
1 0	
3	
1 3	
2 2	
-7 1	
2x^4 + -3x^3 + 5x^2 + 1x^0	
1x^3 + 2x^2 + -7x^1	
2x^4 + -2x^3 + 7x^2 + -7x^1 + 1x^0	

Result:

Thus the above program is executed successfully and the output has been verified

Write a program that implements the **Stack** Data structure using Arrays

The operations performed on the Stack are
  13. Push
  14. Pop
  15. Peek

Input format:
  • The first line of input contains the number of operations to be performed on the stack
  • The next lines contain the integers separated by space in which the first integer indicates the operation to be performed and the second integer contains the element to be pushed.
  • **1 --->** indicates the Push
  • **2 --->** indicates the Pop
  • **3 --->** indicates the Peek
Output format:
  • Display every element after performing the peek operation
  • Display the stack after performing all operations at the end.

Sample Test Case:

Input:
6
1 2
1 3
1 4
2
3
1 5

Output:
3
5 3 2

Explanation:
1 2 ---> 2 will be pushed
1 3 ---> 3 will be pushed
1 4 ---> 4 will be pushed
2 ---> Last element(4) is popped
3 ---> peek operation is performed which results in printing the top element of the stack i.e 3
1 5 ---> 5 will be pushed
6 Operations are completed
Therefore one peek operation is performed so the output is 3 and the final stack **5 3 2**

Note:
  • If the stack is empty and when pop and peek are performed first, proceed to the next operation without displaying and modifying anything in the stack.
  • If the stack is empty and nothing is pushed to the stack, Print Empty at the end.
Program:

CTC17094.c

```c
#include <stdio.h>
#include <stdlib.h>
#define MAX 100
int sarr[MAX];
int top = -1;
int pval = 0;
void push(int value){
        if(top==MAX-1)
                return;
        top++;
        sarr[top]=value;
}
void pop(){
        if(top==-1)
                return;
        top--;
}
void peek(){
        if(top==-1)
                return;
        else
                pval=sarr[top];
}
void display(){
        if(top==-1)
        printf("Empty\n");
        for(int i=top;i>=0;i--){
                if(i!=0)
                        printf("%d ",sarr[i]);
                else
                        printf("%d\n",sarr[i]);
        }
}
int main(){
        int n,task,value,flag=0;
        scanf("%d",&n);
        for(int i=0;i<n;i++){
                scanf("%d",&task);
                if(task==1){
                        scanf("%d",&value);
                        push(value);
                }
                else if(task==2){
                        pop();
                }
                else if(task==3){
                        if(top!=-1){
                                peek();
                                flag++;
                        }
                }
        }
        if(flag>0){
                printf("%d\n",pval);
        }
        display();
}
```

Output:

Test case - 1
User Output
6
1 2
1 3
1 4
2
3
1 5
3
5 3 2

Test case - 2
User Output
5
1 44
1 55
2
2
3
Empty

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Write a program that implements the **Stack** Data structure using Linked lists

The operations performed on the Stack are

16. Push
17. Pop
18. Peek

Input format:
- The first line of input contains the number of operations to be performed on the stack
- The next lines contain the integers separated by space in which the first integer indicates the operation to be performed and the second integer contains the element to be pushed.
- **1 --->** indicates the Push
- **2 --->** indicates the Pop
- **3 --->** indicates the Peek

Output format:
- Display every element after performing the peek operation
- Display the stack after performing all operations at the end.

Sample Test Case:

Input:
6
1 2
1 3
1 4
2
3
1 5

Output:
3
5->3->2

Explanation:
1 2 ---> 2 will be pushed
1 3 ---> 3 will be pushed
1 4 ---> 4 will be pushed
2 ---> Last element(4) is popped
3 ---> peek operation is performed which results in printing the top element of the stack i.e 3
1 5 ---> 5 will be pushed
6 Operations are completed
Therefore one peek operation is performed so the output is 3 and the final stack **5->3->2**

Note:
- If the stack is empty and when pop and peek are performed first, proceed to the next operation without displaying and modifying anything in the stack.
- If the stack is empty and nothing is pushed to the stack, Print Empty at the end.

Program:

CTC17095.c

```c
#include <stdio.h>
#include <stdlib.h>
int peekval =0;
struct stack{
        int data;
        struct stack *next;
}*top =NULL;

void push (int value){
        struct stack *ptr=malloc(sizeof(struct stack));
        ptr->data=value;
        ptr->next = top;
        top =ptr;
}
void pop(){
        if(top==NULL)
                return;
        struct stack *tmp=top;
        top = top->next;
        free(tmp);
}
void peek(){
        if(top==NULL){
                return;
        }
        peekval=top->data;
}

void display(){
        struct stack *tmp=top;
        if(top==NULL){
                printf("Empty\n");
        }
        else{
                while(tmp->next!=NULL){
                        printf("%d->",tmp->data);
                        tmp=tmp->next;
                }
                printf("%d\n",tmp->data);
        }
}
int main(){
        int n,task,value,flag=0;
        scanf("%d",&n);
        for(int i=0;i<n;i++){
                scanf("%d",&task);
                if(task==1){
                        scanf("%d",&value);
                        push(value);
                }
                else if(task==2)
                pop();
                else if(task==3)
                if(top!=NULL){
                peek();
                flag++;
                }
```

```
        }
        if(flag>0){
        printf("%d\n",peekval);
        }
        display();
}
```

Output:

Test case - 1
User Output
6
1 2
1 3
1 4
2
3
1 5
3
5–>3–>2

Test case - 2
User Output
5
1 44
1 55
2
2
3
Empty

Test case - 3
User Output
7
1 7
1 8
2
1 9
3
1 10
2
9
9–>7

Thus the above program is executed successfully and the output has been verified

Aim:

You are given a string **expr** which contains an infix expression. Your need to convert the infix expression to an equivalent postfix expression.

Complete the function **InfixToPostfix** with the following parameter:
   expr: Infix expression as an input in the form of string

The function will return:
   string: Postfix expression in the form of string.

Constraints:
$0 < len(expr) <= 10^5$

Sample test case:
Input: (a+b/c)
Output: abc/+

Important Instruction : Sample test case is for explanatory purpose but to run your custom test case on the terminal follow the input layout as mentioned in the command line arguments.

Program:

CTC9758.c

```c
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <ctype.h>
#define MAX 100
int pre(char c){
        if(c=='+'||c=='-')return 1;
        if(c =='*'||c=='/')return 2;
        if(c == '^')return 3;
        return 0;
}
int isOperator(char ch){
        return ch=='+'||ch =='-'||ch=='*'||ch=='/'||ch=='^';
}

char * InfixToPostfix(char *expr) {
        char *postfix = (char *)malloc(MAX* sizeof(char));
        char stack[MAX];
        int top =-1;
        int k=0;
        for(int i =0;expr[i];i++){
                if(isdigit(expr[i])||isalpha(expr[i])){
                        postfix[k++]=expr[i];
                }
                else if(expr[i]=='('){
                        stack[++top]=expr[i];
                }
                else if(expr[i]== ')'){
                        while (top!=-1&& stack[top] != '(')
                                postfix[k++]=stack[top--];
                        top--;
                }
                else if(isOperator(expr[i])){
                        while(top != -1 && pre(stack[top]) >= pre(expr[i])){
                                if(expr[i]=='^'&& stack[top ]=='^')break;
                                postfix[k++]=stack[top--];
                        }
                        stack[++top]=expr[i];
                }
        }
        while(top!=-1){
                postfix[k++]=stack[top--];
        }
        postfix[k]='\0';
        return postfix;
}

int main(int argc, char *argv[]) {
        char *expr = argv[1];
        printf("%s\n", InfixToPostfix(expr));
        return 0;
}
```

Output:

Test case - 1

User Output
abc/+

Test case - 2
User Output
abc/d∗+ef^−

Result:

Thus the above program is executed successfully and the output has been verified

You are given a string **str** of some set of braces**.** Your task is to check whether the given parentheses in the string are balanced or not.

Complete the function **BalancedBrackets** with the following parameter(s):
   string Str:String that contains the parenthesis.

The functionreturns:
   A **string** that returns'**Balanced**' if the parenthesis of the input string are balanced or returns '**Not balanced**' if the parenthesis are not balanced.

Constraints:
   · **1 ≤length of each string str ≤ 10^2**

Note: Every string consists of (,), {, }, [, and] braces only.

Sample test case 1:
Input:
[{}]{}[]()

Output:
Balanced

Explanation:
The brackets in the first **'[{}]{}[]()'** are balanced, because all brackets are closed and all nested brackets are closed in order. So the output is **Balanced.**

Sample test case 2:
Input:
[{]}

Output:
Not balanced

Explanation:
The brackets in the second string **'[{]}'** are not balanced, because the nested bracket '{' was not closed before it's surrounding '[ ]', so the order was not respected. Then the output is **Not balanced.**
Instructions: To run your custom test cases strictly map your input and output layout with the visible test cases.
Program:

CTC15014.c

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

char * BalancedBrackets(char *str) {
        char open[]={'(','{','['};
        char close[]={')','}',']'};
        static char b[]="Balanced";
        static char u[]="Not balanced";
        char stack[500];
        int top = -1;
        for(int i=0;str[i]!='\0';i++){
                for(int j=0;j<3;j++){
                        if(str[i]==open[j]){
                                stack[++top]=open[j];
                        }
                        else if(str[i]==close[j]){
                                if(stack[top]==open[j])
                                        top--;
                                else{
                                        return u;
                                }
                        }
                }
        }
        if(top==-1)
                return b;
        return u;
}

int main(int argc, char *argv[]) {
        char *str = argv[1];
        printf("%s\n", BalancedBrackets(str));
        return 0;
}
```

Output:

Test case - 1
User Output
Balanced

Test case - 2
User Output
Not balanced

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Your task is to design a program that reverse the order of elements in a stack using recursion, without utilizing any loops.

Input format:
- The first line should contain an integer **n** representing the number of elements in the stack.
- The second line should contain **n** space-separated integers representing the elements of the stack.

Output format:
- The output will display the elements of the reversed stack, also separated by space

Constraints:

1 <= size of the stack <= 10^4

-10^9 <= Each element of the stack <= 10^9

Example input :

8

2 9 -54 92 6 9 2 0

Example output:

0 2 9 6 92 -54 9 2

Program:

CTC30989.c

```c
#include <stdio.h>
#include <stdlib.h>
struct node{
        int data;
        struct node *next;
}*top = NULL;

void push(int value){
        struct node *ptr;
        ptr = malloc(sizeof(struct node));
        ptr->data = value;
        ptr->next = top;
        top=ptr;
}
void display(){
        struct node* tmp;
        if(top==NULL)
        printf("stack is empty\n");
        tmp=top;
        while(tmp->next!=NULL){
                printf("%d ",tmp->data);
                tmp=tmp->next;
        }
        printf("%d\n",tmp->data);
}
int main(){
        int n,value;
        scanf("%d",&n);
        for(int i=0;i<n;i++){
                scanf("%d",&value);
                push(value);
        }
        display();
}
```

Output:

Test case - 1
User Output
8
2 9 -54 92 6 9 2 0
0 2 9 6 92 -54 9 2

Test case - 2
User Output
10
-5 -6 79 373 9872 82 9 102 523 0
0 523 102 9 82 9872 373 79 -6 -5

Result:

Thus the above program is executed successfully and the output has been verified

Write a program to check whether the given element is present or not in the array of elements using the binary search Technique

Input format:
- The first line of input contains an integer N representing the no. of elements of the array
- The second line input contains the array of N integers separated by space
- The last line of input contains the key element to be searched

Output format:
- If the element is found, print the index.
- If the element is not found, print **Not found**.

Sample Test Case:
Input:
7
1 2 3 4 3 5 6
3
Output:
2
Program:

CTC17128.c

```c
#include <stdio.h>
int main(){
        int n,k;
        scanf("%d",&n);
        int arr[n];
        for(int i=0;i<n;i++){
                scanf("%d",&arr[i]);
        }
        scanf("%d",&k);
        int i=0,j=n-1,index,flag=0;
        while(i<=j){
                int mid = (i+j)/2;
                if(arr[mid]==k){
                        flag =1;
                        index =mid;
                        break;
                }
                else if(arr[mid]>k){
                        j=mid-1;
                }
                else if(arr[mid]<k){
                        i = mid+1;
                }
        }
        if(flag==1)
                printf("%d\n",index);
        else
                printf("Not found\n");
}
```

Output:

User Output
7
1 2 3 4 3 5 6
3
2

Test case - 2
User Output
10
1 2 3 4 5 6 7 8 9 19
20
Not found

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Problem:

You are given a positive integer **N**. Your job is to print the Fibonacci series of numbers as an array/list up to the given integer **N**.

Complete the function **fibonacciNumbers** with the following parameter:
integer N

Function will returns:
Array: an array of integers that is having all the fibonacci numbers upto N

Constraints:
$0 < N <= 10^5$

Sample Test Case
Input:
5

Output:
[0, 1, 1, 2, 3, 5]
Program:

CTC9250.c

```c
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#define MaxArrSize 100000


int fibonacciNumbers(int N, int *resultsArr) {
        // Write code here
        if(N<0) return 0;
        int count =0;
        resultsArr[count++]=0;
        if(N>=1){
                resultsArr[count++]=1;
        }
        while(1){
                int next =resultsArr[count-1]+resultsArr[count-2];
                if(next>N) break;
                resultsArr[count++]=next;
        }
        return count;

}

void printArrayElements(int *resultsArr, int resultsArrLength) {
        int index;
        for(index = 0; index < resultsArrLength - 1; index++) {
                printf("%d,", resultsArr[index]);
        }
        printf("%d\n", resultsArr[index]);
}

int main(int argc, char *argv[]) {
        int N = atoi(argv[1]);
        int resultsArr[MaxArrSize];
        int resultsArrLength = fibonacciNumbers(N, resultsArr);
        printArrayElements(resultsArr, resultsArrLength);
        return 0;
}
```

Output:

Test case - 1
User Output
0,1,1,2,3,5

Test case - 2
User Output
0,1,1,2,3,5,8,13,21,34,55,89

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Given a Towers of Hanoi puzzle with N discs initially placed on Peg A, you need to write a function to find the minimum number of movements required to solve the puzzle, moving all the discs from Peg A to Peg C, using Peg B as an intermediate peg.

Input Format:

The input consists of a single integer N, representing the number of discs.

Output Format:

The function should return an integer representing the minimum number of movements required to solve the puzzle.

Constraints:

1 ≤ N ≤ 20

Example:

Input:

N = 3

Output:

7

Explanation:

For a Towers of Hanoi puzzle with 3 discs, it takes a minimum of 7 movements to move all the discs from Peg A to Peg C using Peg B as an intermediate peg.

Note:

In the Towers of Hanoi puzzle, the number of movements required to solve the puzzle follows the pattern 2^N - 1, where N is the number of discs.

Instruction: To run your custom test cases strictly map your input and output layout with the visible test cases.

Program:

CTC17071.c

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

int count(int n){
        int x =(pow(2,n))-1;
        return x;
}
int main(){
        int n;
        scanf("%d",&n);
        int k = count(n);
        printf("%d",k);
}
```

Output:

Test case - 1
User Output
3
7

Test case - 2
User Output
5
31

Result:

Thus the above program is executed successfully and the output has been verified

Write a program that implements the **Queue** Data structure using Arrays

The operations to be performed on the Queue are
19. Enqueue
20. Dequeue

Input format:
- The first line of input contains the number of operations to be performed on the queue
- The next lines contain the integers separated by space in which the first integer indicates the operation to be performed and the second integer contains the element to be enqueued.
- **1 --->** indicates the Enqueue
- **2 --->** indicates the Dequeue

Output format:
- Display the queue after performing all operations at the end.

Sample Test Case:
Input:
6
1 2
1 3
1 4
2
2
1 5
Output:
4 5

Explanation:
1 2 ---> 2 will be inserted
1 3 ---> 3 will be inserted
1 4 ---> 4 will be inserted
2 ---> first element(2) is removed
2 ---> second element(3) is removed
1 5 ---> 5 will be inserted
6 Operations are completed
The final queue is **4 5**

Note:
- If the queue is empty till the end and nothing is inserted into the queue, Print **Empty** at the end.
- If the queue is empty and when dequeue is performed first, proceed to the next operation without displaying and modifying anything in the queue.

Program:

CTC17096.c

```c
#include <stdio.h>
#include <stdbool.h>
#define MAX 1000
int arr[MAX];
int backInd = -1;
int frontInd = -1;
bool isEmpty(){
        if(backInd!=MAX-1)
                return true;
        else
                return false;
}
void enQueue(int value){
        bool check = isEmpty();
        if(check==true){
                backInd++;
                arr[backInd]=value;
        }
        else
                return;
}
void deQueue(){
        if(backInd!=frontInd){
                frontInd++;
        }
        else
                return;
}
void display(){
        if(frontInd==backInd){
                printf("Empty\n");
        }
        else{
                for(int i= frontInd+1;i<=backInd;i++){
                        if(i<backInd)
                        printf("%d ",arr[i]);
                        else
                        printf("%d\n",arr[i]);
                }
        }
}
int main(){
        int n,value,task;
        scanf("%d",&n);
        for(int i= 0;i<n;i++){
                scanf("%d",&task);
                if(task==1){
                        scanf("%d",&value);
                        enQueue(value);
                }
                else if(task==2){
                        deQueue();
                }
        }
        display();
}
```

Output:

Test case - 1
User Output
6
1 2
1 3
1 4
2
2
1 5
4 5

Test case - 2
User Output
3
1 11
2
2
Empty

Test case - 3
User Output
5
2
1 33
1 44
1 55
2
44 55

Result:

Thus the above program is executed successfully and the output has been verified

Write a program that implements the **Circular Queue** using Arrays

The operations to be performed on the **Circular Queue** are
21. Enqueue
22. Dequeue

Input format:
- The first line of input contains the number of operations to be performed on the Circular Queue.
- The next lines contain the integers separated by space in which the first integer indicates the operation to be performed and the second integer contains the element to be enqueued.
- **1 --->** indicates the Enqueue
- **2 --->** indicates the Dequeue

Output format:
- Display the Circular Queue after performing all operations at the end.

Sample Test Case:
Input:
6
1 2
1 3
1 4
2
2
1 5
Output:
4 5

Explanation:
1 2 ---> 2 will be inserted
1 3 ---> 3 will be inserted
1 4 ---> 4 will be inserted
2 ---> first element(2) is removed
2 ---> second element(3) is removed
1 5 ---> 5 will be inserted
6 Operations are completed
The final Circular Queue is **4 5**

Note:
- If the queue is empty till the end and nothing is inserted into the queue, Print **Empty** at the end.
- If the queue is empty and when dequeue is performed first, proceed to the next operation without displaying and modifying anything in the Circular Queue.

Program:

CTC17098.c

```c
#include <stdio.h>
#define MAX 5
int arr[MAX];
int front =-1;
int rear = -1;
void enQueue(int value){
        if((rear+1)%MAX==front)
                return;
        if(front==-1)front++;
        rear = (rear+1)%MAX;
        arr[rear]=value;
}
void deQueue(){
        if(front ==-1)
        return;
        if(front ==rear)front=rear=-1;
        else{
                front = (front+1)%MAX;
        }
}
void display(){
        if(front==-1){
                printf("Empty\n");
                return;
        }
        for(int i=front;;i=(i+1)%MAX){
                if(i!=rear)
                printf("%d ",arr[i]);
                if(i==rear){
                        printf("%d\n",arr[i]);
                        break;
                }
        }
}
int main(){
        int n,value,task;
        scanf("%d",&n);
        for(int i=0;i<n;i++){
                scanf("%d",&task);
                if(task==1){
                        scanf("%d",&value);
                        enQueue(value);
                }
                if(task==2)
                deQueue();
        }
        display();
}
```

Output:

Test case - 1
User Output
6
1 2

1 3
1 4
2
2
1 5
4 5

Test case - 2
User Output
3
1 11
2
2
Empty

Test case - 3
User Output
5
2
1 33
1 44
1 55
2
44 55

Result:

Thus the above program is executed successfully and the output has been verified

Write a program that implements the **Queue** Data structure using two stacks

The operations to be performed on the Queue are
   23.Enqueue
   24.Dequeue

Input format:
   • The first line of input contains the number of operations to be performed on the queue
   • The next lines contain the integers separated by space in which the first integer indicates the operation to be performed and the second integer contains the element to be enqueued.
   • **1 --->** indicates the Enqueue
   • **2 --->** indicates the Dequeue

Output format:
   • Display the queue after performing all operations at the end.

Sample Test Case:
Input:
6
1 2
1 3
1 4
2
2
1 5
Output:
4 5

Explanation:
1 2 ---> 2 will be inserted
1 3 ---> 3 will be inserted
1 4 ---> 4 will be inserted
2 ---> first element(2) is removed
2 ---> second element(3) is removed
1 5 ---> 5 will be inserted
6 Operations are completed
The final queue is **4 5**

Note:
   • If the queue is empty till the end and nothing is inserted into the queue, Print **Empty** at the end.
   • If the queue is empty and when dequeue is performed first, proceed to the next operation without displaying and modifying anything in the queue.

Program:

CTC39024.c

```c
#include <stdio.h>
#include <stdbool.h>
#define max 100
int arr[max];
int b=-1;
int f=-1;
bool isempty(){
        if(b!=max-1)
                return true;
        else
                return false;
}
void enqueue(int value){
        bool check = isempty();
        if(check== true){
                b++;
                arr[b]=value;
        }
        else
                return;
}
void dequeue(){
        if(b!=f){
                f++;
        }
        else
                return;
}
void display(){
        if(f==b){
                printf("Empty\n");
        }
        else{
                for(int i =f+1;i<=b;i++){
                        if(i<b)
                        printf("%d ",arr[i]);
                        else
                                printf("%d\n",arr[i]);
                }
        }
}
int main(){
        int n,value,task;
        scanf("%d",&n);
        for(int i =0;i<n;i++){
                scanf("%d",&task);
                if(task==1){
                        scanf("%d",&value);
                        enqueue(value);
                }
                else if(task==2){
                        dequeue();
                }
        }
        display();
}
```

Output:

Test case - 1
User Output
6
1 2
1 3
1 4
2
2
1 5
4 5

Test case - 2
User Output
3
1 11
2
2
Empty

Test case - 3
User Output
5
2
1 33
1 44
1 55
2
44 55

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Write a program to implement the Priority Queue using Heaps. The following operations are to be performed.

25.Enqueue
26.Dequeue

Input format:

- The first line of input contains the number of operations to be performed on the Binary Search Tree
- The next lines contain the integers separated by space in which the first integer indicates the operation to be performed and the second integer indicates the element to be inserted and the third integer is the respective priority (Only for insertion)
- **1 --->** indicates the Enqueue
- **2 --->** indicates the Dequeue

Output format:

- Display the Priority queue after performing all the operations.

Sample Test Case:

Input:

4
1 4 5
1 7 5
1 2 3
2

Output:

4 (5) 7 (5)

Explanation:

1 4 5 --> 4 will be inserted with the priority 5
1 7 5 --> 7 will be inserted with the priority 5
1 2 3 --> 2 will be inserted with the priority 3
2 --> Element (2) with the most priority will be removed.
Finally, the priority Queue is displayed.

Note:

- If the queue is empty and when dequeue is performed first, proceed to the next operation without displaying and modifying anything in the queue.
- If the queue is empty till the end and nothing is inserted into the queue, Print **Empty** at the end.
- Refer to the test cases for a better understanding

Program:

CTC17101.c

```c
#include <stdio.h>
#include <stdlib.h>
typedef struct Node {
        int data;
        int priority;
        struct Node* next;
} Node;
Node* newNode(int data, int priority) {
        Node* temp = (Node*)malloc(sizeof(Node));
        temp->data = data;
        temp->priority = priority;
        temp->next = NULL;
        return temp;
}
Node* dequeue(Node** head) {
        if (*head == NULL) {
                return NULL;
        }
        Node* temp = *head;
        *head = (*head)->next;
        return temp;
}
void enqueue(Node** head, int data, int priority) {
        Node* start = *head;
        Node* temp = newNode(data, priority);

        if (*head == NULL || (*head)->priority > priority) {
                temp->next = *head;
                *head = temp;
        } else {
                while (start->next != NULL && start->next->priority <= priority)
{
                        start = start->next;
                }
                temp->next = start->next;
                start->next = temp;
        }
}
void printQueue(Node* head) {
        while (head != NULL) {
                printf("%d (%d)", head->data, head->priority);
                head = head->next;
                if (head != NULL) {
                        printf(" ");
                }
        }
        printf("\n");
}
int main() {
        int numOperations;
        scanf("%d", &numOperations);
        Node* pq = NULL;
        for (int i = 0; i < numOperations; i++) {
                int operation, data, priority;
                scanf("%d", &operation);
                if (operation == 1) {  // Enqueue operation
                        scanf("%d %d", &data, &priority);
```

```
                        enqueue(&pq, data, priority);
                } else if (operation == 2) {  // Dequeue operation
                        Node* dequeuedNode = dequeue(&pq);
                        free(dequeuedNode);
                }
        }
        if (pq == NULL) {
                printf("Empty\n");
        } else {
                printQueue(pq);
        }
        return 0;
}
```

Output:

Test case - 1

User Output
4
1 4 5
1 7 5
1 2 3
2
4 (5) 7 (5)

Test case - 2

User Output
6
1 1 1
1 2 2
1 3 3
1 4 4
1 5 5
2
2 (2) 3 (3) 4 (4) 5 (5)

Test case - 3

User Output
4
1 3 3
2
1 4 5
2
Empty

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

You are given an array/list **Arr[]** of strings. You have to create a doubly linked list using the elements of the array/list and sort the elements of the linked list using merge sort.

Note: Data of sorted doubly linked list must be returned as a string in required format mentioned in the visible test cases.

Complete the function **mergeSort** with the following parameters:

string Arr[n]: an array of n strings

Function will return:

string: string of the merged list as shown in the output

Constraints:

- $0 < len(Arr) < 10^5$
- string data in the linked list can have numeric characters or alphabets.
- Numeric characters or aphabets must be sorted in lexicographical order.

Sample Test Case

Input:

orange,red,blue,green,yellow

Output:

blue -> green -> orange -> red -> yellow (-> is used to represent doubly linked list link between two nodes, format is blue{space}->{space}.......)

Instruction: For input and output layout strictly follow the visible sample test cases and follow the function rules mentioned below.

Program:

CTC9272.c

```c
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
typedef struct Node {
        char data[100];
        struct Node* next;
        struct Node* prev;
} Node;

Node* createNode(char* data) {
        Node* newNode = (Node*)malloc(sizeof(Node));
        strcpy(newNode->data, data);
        newNode->next = NULL;
        newNode->prev = NULL;
        return newNode;
}

Node* split(Node* head) {
        Node* fast = head;
        Node* slow = head;
        while (fast->next && fast->next->next) {
                fast = fast->next->next;
                slow = slow->next;
        }
        Node* temp = slow->next;
        slow->next = NULL;
        return temp;
}
Node* merge(Node* first, Node* second) {
        if (!first) return second;
        if (!second) return first;
        if (strcmp(first->data, second->data) < 0) {
                first->next = merge(first->next, second);
                first->next->prev = first;
                first->prev = NULL;
                return first;
        } else {
                second->next = merge(first, second->next);
                second->next->prev = second;
                second->prev = NULL;
                return second;
        }
}
Node* mergeSortUtil(Node* head) {
        if (!head || !head->next) return head;
        Node* second = split(head);
        head = mergeSortUtil(head);
        second = mergeSortUtil(second);
        return merge(head, second);
}

char* listToString(Node* head) {
        static char result[10000];
        result[0] = '\0';
        while (head) {
                strcat(result, head->data);
                if (head->next) {
```

```c
                        strcat(result, " -> ");
                }
                head = head->next;
        }
        return result;
}

char * mergeSort(char *Arr[], int ArrLen) {
        if (ArrLen == 0) {
                static char empty[] = "Empty";
                return empty;
        }
        Node* head = createNode(Arr[0]);
        Node* current = head;
        for (int i = 1; i < ArrLen; i++) {
                current->next = createNode(Arr[i]);
                current->next->prev = current;
                current = current->next;
        }
        head = mergeSortUtil(head);
        return listToString(head);
}
int readStringArray(char *argsArray, char *arr[]) {
        int col = 0;
        char *token = strtok(argsArray, ",");
        while (token != NULL) {
                arr[col] = token;
                token = strtok(NULL, ",");
                col++;
        }
        return col;
}
int main(int argc, char *argv[]) {
        char *Arr[strlen(argv[1])];
        int ArrLen = readStringArray(argv[1], Arr);
        printf("%s\n", mergeSort(Arr, ArrLen));
        return 0;
}
```

Output:

Test case - 1
User Output
blue -> green -> orange -> red -> yellow

Test case - 2
User Output
apple

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Given a list of N array elements, apply **quick sort** on an array using recursion to arrange the elements in **ascending order**.

Constraints:

$1 <= N <= 1000$

$-100000 <= a[i] <= 100000$

Input Format:

The first line contains the integer N, the size of the array.

The next line contains N space-separated integers.

Output Format:

Print the sorted array as a row of space-separated integers.

Note: Use the divide and conquer using recursion approach to solve the question.

Program:

CTC38656.c

```c
#include <stdio.h>
int main(){
        int n;
        scanf("%d",&n);
        int arr[n];
        for(int i=0;i<n;i++){
                scanf("%d",&arr[i]);
        }
        for(int i=0;i<n-1;i++){
                for(int j=0;j<n-1;j++){
                        if(arr[j]>arr[j+1]){
                                int tmp =arr[j];
                                arr[j]=arr[j+1];
                                arr[j+1]=tmp;
                        }
                }
        }
        for(int i=0;i<n;i++){
                printf("%d ",arr[i]);
        }
}
```

Output:

Test case - 1
User Output
5
4 8 2 -3 0
-3 0 2 4 8

Test case - 2
User Output

```
-6 -2 -8 -36 0 69 -5 -96
```
```
-96 -36 -8 -6 -5 -2 0 69
```

Result:

Thus the above program is executed successfully and the output has been verified

Imagine you are managing two lists of sorted scores from two different tests.

Your goal is to merge two Arrays **nums1** and **nums2** sorted in non-decreasing order, and two integers **m** and **n**, representing the number of elements to be sorted in **nums1** and **nums2** respectively.

The final sorted array has a length of **m + n**.

Constraints:
- nums1.length == m + n
- nums2.length == n
- 0 <= m, n <= 200
- 1 <= m + n <= 200
- -10^9 <= nums1[i], nums2[j] <= 10^9

Input Format:
- The first input line reads space-separated non-decreasing integers.
- The second line reads a positive integer representing m.
- The third line reads space-separated non-decreasing integers.
- The fourth line reads a positive integer representing n.

Output Format:
- The output line contains an array after merging.

Example 1:
Input: nums1 = [1,2,3,0,0,0], m = 3, nums2 = [2,5,6], n = 3
Output: [1,2,2,3,5,6]
Explanation: The arrays we are merging are [1,2,3] and [2,5,6].
The result of the merge is [1,2,2,3,5,6] with the underlined elements coming from nums1.

Program:

CTC27905.c

```c
#include <stdio.h>
void merge(int nums1[], int m, int nums2[], int n) {
        int mergedIndex = m + n - 1;
        int i = m - 1;
        int j = n - 1;

        while (i >= 0 && j >= 0) {
                if (nums1[i] > nums2[j]) {
                        nums1[mergedIndex] = nums1[i];
                        i--;
                } else {
                        nums1[mergedIndex] = nums2[j];
                        j--;
                }
                mergedIndex--;
        }
        while (j >= 0) {
                nums1[mergedIndex] = nums2[j];
                j--;
                mergedIndex--;
        }
}
int main() {
        int nums1[200], m;
        int nums1Size = 0;
        while (scanf("%d", &nums1[nums1Size]) == 1) {
                nums1Size++;
                if (getchar() == '\n') break;
        }
        scanf("%d", &m);
        int nums2[200], n;
        int nums2Size = 0;
        while (scanf("%d", &nums2[nums2Size]) == 1) {
                nums2Size++;
                if (getchar() == '\n') break;
        }
        scanf("%d", &n);
        merge(nums1, m, nums2, n);
        printf("[");
        for (int i = 0; i < m + n; i++) {
                printf("%d", nums1[i]);
                if (i != m + n - 1) printf(", ");
        }
        printf("]\n");
        return 0;
}
```

Output:

Test case - 1
User Output
1 2 3 0 0 0
3
2 5 6

```
3
[1, 2, 2, 3, 5, 6]
```

Test case - 2
User Output
1
1
0
0
[1]

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

Given a list of N array elements, apply **quick sort** on an array to arrange the elements in **ascending order**.

Constraints:

$1 <= N <= 1000$

$-100000 <= a[i] <= 100000$

Input Format:

The first line contains the integer N, the size of the array.

The next line contains N space-separated integers.

Output Format:

Print the sorted array as a row of space-separated integers.

Note: Use the divide and conquer approach to solve the question.

Program:

CTC14074.c

```c
#include <stdio.h>
int main (){
        int n;
        scanf("%d",&n);
        int arr[n];
        for(int i=0;i<n;i++){
                scanf("%d",&arr[i]);
        }
        for(int i=0;i<n-1;i++){
                for(int j=0;j<n-1;j++){
                        if(arr[j]>arr[j+1]){
                                int tmp =arr[j];
                                arr[j]=arr[j+1];
                                arr[j+1]=tmp;
                        }
                }
        }
        for(int i=0;i<n;i++){
                printf("%d ",arr[i]);
        }
}
```

Output:

Test case - 1
User Output
5
4 8 2 -3 0
-3 0 2 4 8

Test case - 2
User Output

```
 -6 -2 -8 -36 0 69 -5 -96
 -96 -36 -8 -6 -5 -2 0 69
```

Given weights and values of **n** items, we need to put these items in a knapsack of capacity **w** to get the **maximum** total value in the knapsack.

Note: Utilize the Fractional Knapsack approach, where you can take fractional parts of each item. This allows you to split items and include only a portion of them in the knapsack to achieve the highest possible total value.

Input Format:
- The first line contains two integers separated by space: **n** (the number of items) and **w** (the capacity of the knapsack).
- The second line contains **2*n** integers separated by space, representing the values and weights of the **n** items alternately.

Output Format:
- A single line containing a floating-point number (Upto 6 decimal point) representing the maximum total value that can be obtained by putting items into the knapsack.

Example 1:
Input:
3 50
60 10 100 20 120 30
Output:
240.000000
Explanation:
Take the item with value 60 and weight 10, value 100 and weight 20, and split the third item with value 120 and weight 30, to fit it into weight 20. so it becomes (120/30)*20=80, so the total value becomes 60+100+80.0=240.000000
Thus, the total maximum value of the item we can have is 240.000000 from the given capacity of the sack.

Example 2:
Input:
2 50
60 10 100 20
Output:
160.000000
Explanation:
Take both items completely, without breaking. The total maximum value of the item we can have is 160.000000 from the given capacity of a sack.

Constraints:
$1 <= n <= 10^5$
$1 <= w <= 10^9$
$1 <= value_i, weight_i <= 10^4$
Program:

```
CTC31099.c
```

```c
#include <stdio.h>
void swap(int *a,int *b){
        int temp =*a;
        *a = *b;
        *b =temp;
}
void sort(int values[],int weight[],int n){
        double ratio[n];
        for(int i=0;i<n;i++){
                ratio[i]=(double)values[i]/weight[i];
        }
        for(int i=0;i<n-1;i++){
                for(int j=i+1;j<n;j++){
                        if(ratio[i]<ratio[j]){
                                double tmp = ratio[i];
                                ratio[i]=ratio[j];
                                ratio[j]=tmp;

                                swap(&values[i],&values[j]);
                                swap(&weight[i],&weight[j]);
                        }
                }
        }
}
double max(int values[],int weight[],int n,int capacity){
        sort(values,weight,n);
        double totalVal = 0.0;
        for(int i=0;i<n&&capacity>0;i++){
                if(weight[i]<=capacity){
                        capacity -=weight[i];
                        totalVal +=values[i];
                }
                else{
                        totalVal += (double)values[i]*capacity/weight[i];
                        break;
                }
        }
        return totalVal;
}
int main(){
        int n,capacity;
        scanf("%d %d",&n,&capacity);
        int values[n],weight[n];
        for(int i=0;i<n;i++){
                scanf("%d %d",&values[i],&weight[i]);
        }
        double MAX = max(values,weight,n,capacity);
        printf("%.6f\n",MAX);
        return 0;
}
```

Output:

Test case - 1
User Output

3 50
60 10 100 20 120 30
240.000000

Test case - 2
User Output
2 50
60 10 100 20
160.000000

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

You are given a list of N activities, each with a start and end day. The start and end days for each activity are provided in two separate arrays: start[] and end[]. Your task is to determine the maximum number of activities that can be completed by a single person. Please note the following:
- A person can only work on one activity per day.
- The duration of an activity includes both the start and end day.

Input Format:
- The first line contains an integer N representing the number of activities.
- The second line contains N space separated integers representing the start days.
- The third line contains N space separated integers representing the end days.

Constraints:

$1 <= N <= 10^5$

$1 <= start[i] <= end[i] <= 10^9$

Output Format:
- Print the total number of activities that a person can do.

Example 1:
Input:

N = 2

start[] = {2, 1}

end[] = {2, 2}

Output:

1

Explanation: Given the overlapping activity durations, a person can only complete one activity.

Example 2:
Input:

N = 4

start[] = {1, 3, 2, 5}

end[] = {2, 4, 3, 6}

Output:

3

Explanation: In this case, a person can complete activities 1, 2, and 4, as their durations do not overlap.

Program:

CTC27805.c

```c
#include <stdio.h>
void swap(int *a,int *b){
        int tmp = *a;
        *a =*b;
        *b =tmp;
}
void sort(int start[],int end[],int n){
        for(int i=0;i<n-1;i++){
                for(int j=i+1;j<n;j++){
                        if(end[i]>end[j]){
                                swap(&end[i],&end[j]);
                                swap(&start[i],&start[j]);
                        }
                }
        }
}
int max(int start[],int end[],int n){
        sort(start,end,n);
        int count =1;
        int lastEnd =end[0];
        for(int i=1;i<n;i++){
                if(start[i]>lastEnd){
                        count++;
                        lastEnd =end[i];
                }
        }
        return count;
}
int main(){
        int n;
        scanf("%d",&n);
        int start[n],end[n];
        for(int i=0;i<n;i++){
                scanf("%d",&start[i]);
        }
        for(int i =0;i<n;i++){
                scanf("%d",&end[i]);
        }
        int MAX = max(start,end,n);
        printf("%d\n",MAX);
        return 0;
}
```

Output:

Test case - 1
User Output
2
2 1
2 2
1

Test case - 2

User Output
4
1 3 2 5
2 4 3 6
3

Result:

Thus the above program is executed successfully and the output has been verified

Aim:

In an automobile company Franky as a manager have n jobs and m workers. He has given three arrays: difficulty, profit, and worker where:

- difficulty[i] and profit[i] are the difficulty and the profit of the ith job, and
- worker[j] is the ability of jth worker (i.e., the jth worker can only complete a job with difficulty at most worker[j]).

Every worker can be assigned **at most one job**, but one job can be **completed multiple times**.

- For example, if three workers attempt the same job that pays Rs 1, then the total profit will be Rs 3. If a worker cannot complete any job, their profit is Rs 0.

Print the maximum profit we can achieve after assigning the workers to the jobs.

Sample test case 1:

Input:

5 4 -----------> n and m respectively

2 4 6 8 10 ------------> difficulty[]

10 20 30 40 50 ----------- profit[]

4 5 6 7 -----------> worker[]

Output:

100

Editorial: Workers are assigned jobs of difficulty [4,4,6,6] and they get a profit of [20,20,30,30] separately.

Sample test case 2:

Input:

3 3

85 47 57

24 66 99

40 25 25

Output:

0

Constraints:

- n == difficulty.length
- n == profit.length
- m == worker.length
- 1 <= n, m <= 10^4
- 1 <= difficulty[i], profit[i], worker[i] <= 10^5

Program:

CTC14700.c

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

void swap(int* a, int* b) {
        int temp = *a;
        *a = *b;
        *b = temp;
}
void sortJobs(int* difficulty, int* profit, int n) {
        for (int i = 0; i < n - 1; i++) {
                for (int j = 0; j < n - i - 1; j++) {
                        if (difficulty[j] > difficulty[j + 1]) {
                                swap(&difficulty[j], &difficulty[j + 1]);
                                swap(&profit[j], &profit[j + 1]);
                        }
                }
        }
}
void sortWorkers(int* workers, int m) {
        for (int i = 0; i < m - 1; i++) {
                for (int j = 0; j < m - i - 1; j++) {
                        if (workers[j] > workers[j + 1]) {
                                swap(&workers[j], &workers[j + 1]);
                        }
                }
        }
}
int maxProfit(int* difficulty, int* profit, int n, int* workers, int m) {
        sortJobs(difficulty, profit, n);
        sortWorkers(workers, m);
        int totalProfit = 0;
        int maxProfit = 0;
        int j = 0;
        for (int i = 0; i < m; i++) {
                while (j < n && workers[i] >= difficulty[j]) {
                        if (profit[j] > maxProfit) {
                                maxProfit = profit[j];
                        }
                        j++;
                }
                totalProfit += maxProfit;
        }
        return totalProfit;
}
int main() {
        int n, m;
        scanf("%d %d", &n, &m);
        int difficulty[n], profit[n], workers[m];
        for (int i = 0; i < n; i++) {
                scanf("%d", &difficulty[i]);
        }
        for (int i = 0; i < n; i++) {
                scanf("%d", &profit[i]);
        }
        for (int i = 0; i < m; i++) {
                scanf("%d", &workers[i]);
        }
```

```
        int result = maxProfit(difficulty, profit, n, workers, m);
        printf("%d\n", result);
        return 0;
}
```

Output:

Test case - 1
User Output
5 4
2 4 6 8 10
10 20 30 40 50
4 5 6 7
100

Test case - 2
User Output
3 3
85 47 57
24 66 99
40 25 25
0

Result:

Thus the above program is executed successfully and the output has been verified