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Section:3

Semester:4th

Subject: ADA Lab

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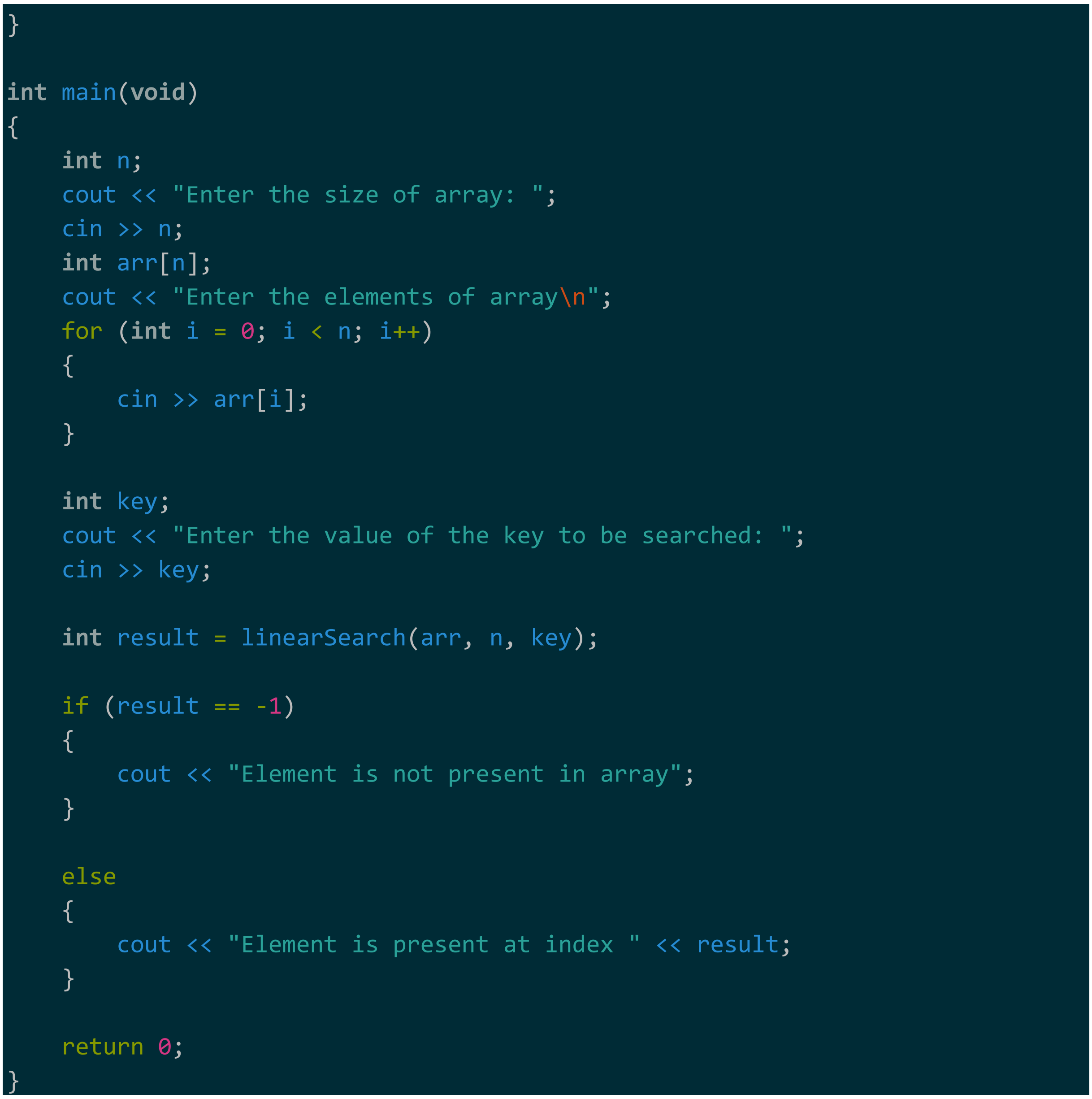
Subject	**Analysis and Design of Algorithms LAB**	**Session: Jan 2021**
Sub. Code:	**CSE-228**	**Semester: IV (CSE)**
Name of Teacher	**Prof. Manish Pandey**	

ADA: LAB-ASSIGNMENT 1

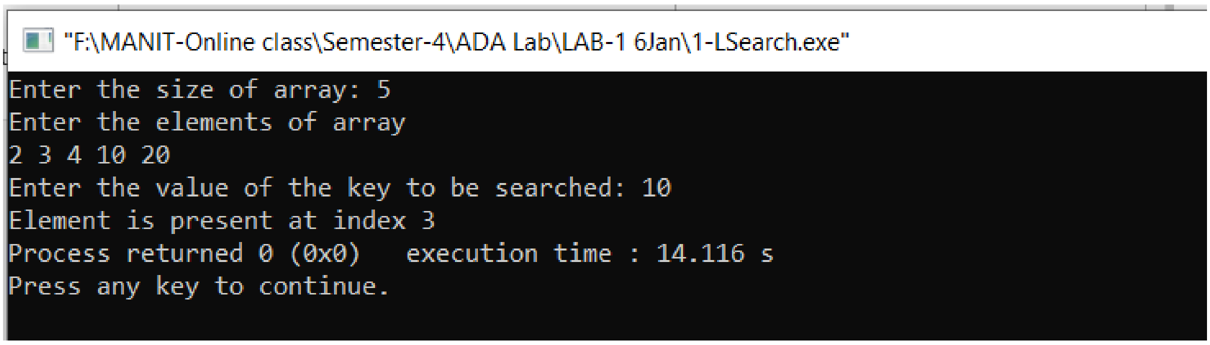
Prog.1: Implement Recursive Binary search and Linear search and determine the time taken to search an element

Linear Search

```
// Keep Changing....@Vi

#include <iostream>
using namespace std;

// Linear search function
int linearSearch(int arr[], int n, int x)
{
    int i = 0;
    for (i = 0; i < n; i++)
        if (arr[i] == x)
            return i;
    return -1;
```



```
}

int main(void)
{
    int n;
    cout << "Enter the size of array: ";
    cin >> n;
    int arr[n];
    cout << "Enter the elements of array\n";
    for (int i = 0; i < n; i++)
    {
        cin >> arr[i];
    }

    int key;
    cout << "Enter the value of the key to be searched: ";
    cin >> key;

    int result = linearSearch(arr, n, key);

    if (result == -1)
    {
        cout << "Element is not present in array";
    }

    else
    {
        cout << "Element is present at index " << result;
    }

    return 0;
}
```



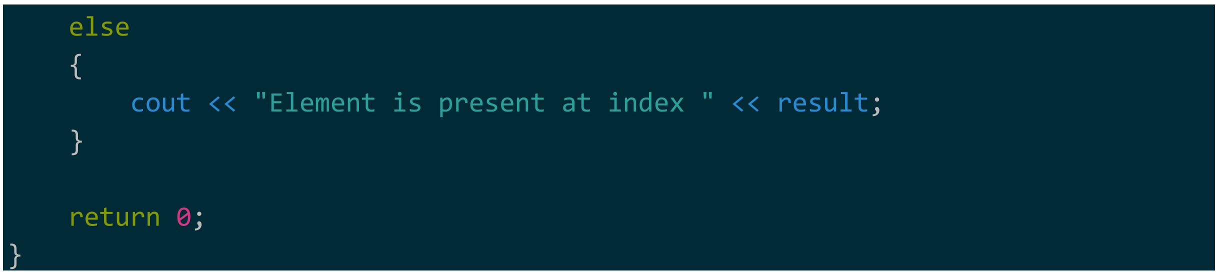
"F:\MANIT-Online class\Semester-4\ADA Lab\LAB-1 6Jan\1-LSearch.exe"

```
Enter the size of array: 5
Enter the elements of array
2 3 4 10 20
Enter the value of the key to be searched: 10
Element is present at index 3
Process returned 0 (0x0)   execution time : 14.116 s
Press any key to continue.
```

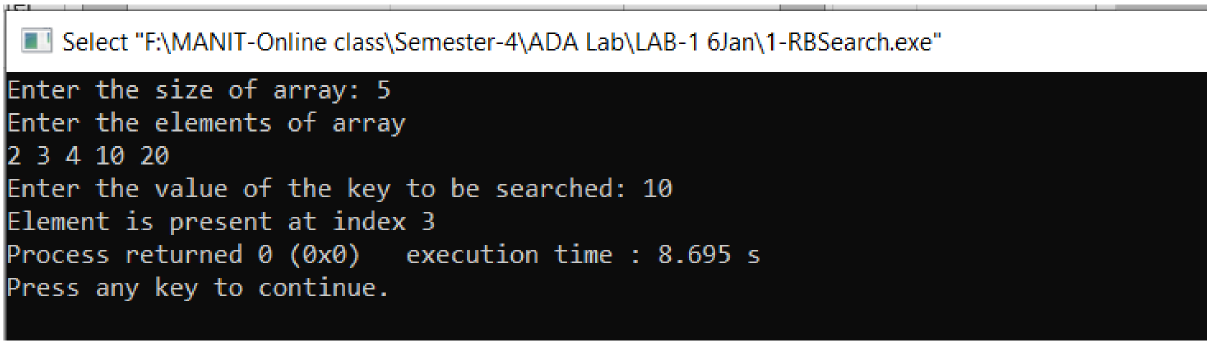
Time Taken is 14.116sec.

Recursive Binary Search

```cpp
// Keep Changing....@Vi

#include <bits/stdc++.h>
using namespace std;

// Recursive binary search function
int binarySearch(int arr[], int l, int r, int x)
{
    if (r >= l)
    {
        int mid = l + (r - l) / 2;

        if (arr[mid] == x)
            return mid;

        if (arr[mid] > x)
            return binarySearch(arr, l, mid - 1, x);

        return binarySearch(arr, mid + 1, r, x);
    }

    return -1;
}

int main(void)
{
    int n;
    cout << "Enter the size of array: ";
    cin >> n;
    int arr[n];
    cout << "Enter the elements of array\n";
    for (int i = 0; i < n; i++)
    {
        cin >> arr[i];
    }

    int key;
    cout << "Enter the value of the key to be searched: ";
    cin >> key;

    int result = binarySearch(arr, 0, n - 1, key);

    if (result == -1)
    {
        cout << "Element is not present in array";
    }
```



```
    else
    {
        cout << "Element is present at index " << result;
    }

    return 0;
}
```



Select "F:\MANIT-Online class\Semester-4\ADA Lab\LAB-1 6Jan\1-RBSearch.exe"

```
Enter the size of array: 5
Enter the elements of array
2 3 4 10 20
Enter the value of the key to be searched: 10
Element is present at index 3
Process returned 0 (0x0)   execution time : 8.695 s
Press any key to continue.
```

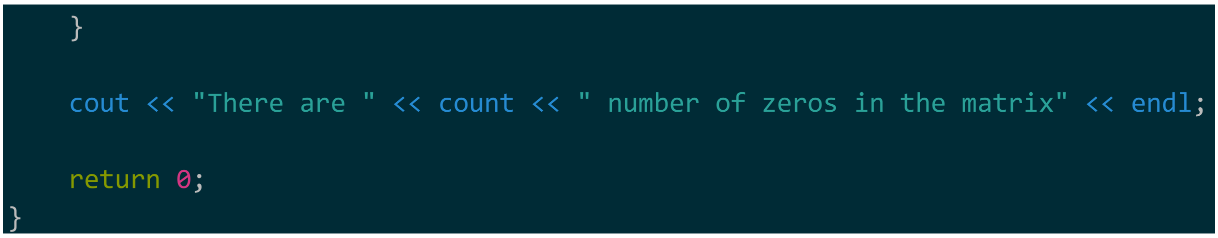
Time Taken is 8.695sec.

Time complexity of Linear search is O(n)

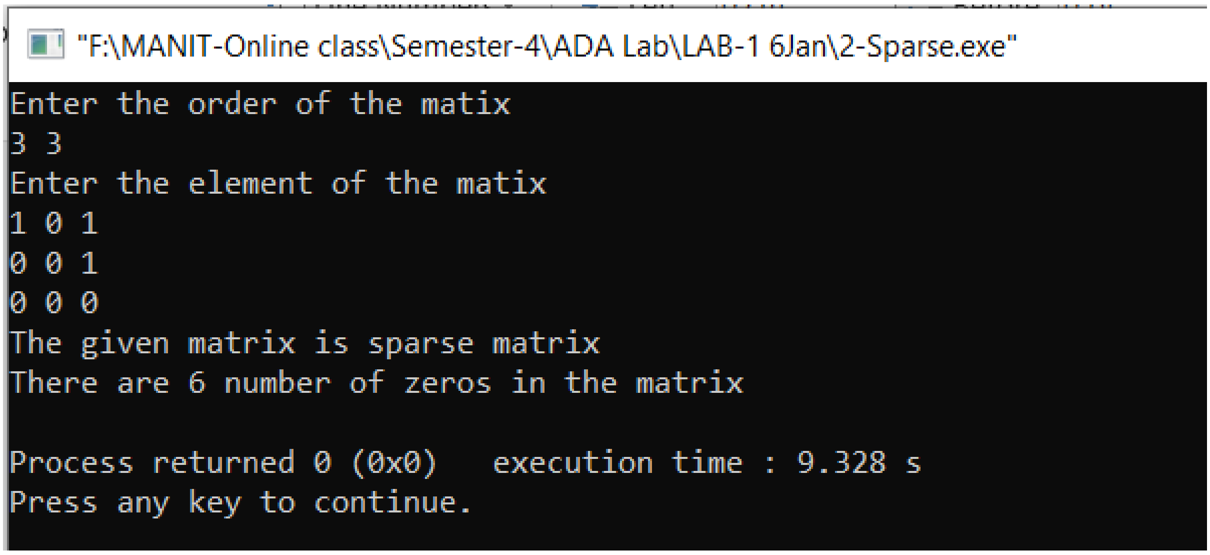
Time complexity of Recursive binary search is O(logn).

Prog.2: Write a program to determine if a given matrix is a sparse matrix? Calculate its time and Space complexity. How it is more efficient than the conventional matrix?

```
// Keep Changing....@Vi

/*
 * Write a program to determine if a given  matrix is a sparse matrix?
 * Calculate its time and Space complexity. How it is more efficient than the conventional matrix?
 * Sparse martix has more zero elements than nonzero elements.
 */

#include <iostream>
using namespace std;

int main()
{

    int i, j, m, n;
    int count = 0;

    cout << "Enter the order of the matix \n";
    cin >> m >> n;
    int a[m][n];

    cout << "Enter the element of the matix \n";

    for (i = 0; i < m; ++i)
    {
        for (j = 0; j < n; ++j)
        {
            cin >> a[i][j];

            if (a[i][j] == 0)
            {
                ++count;
            }
        }
    }

    if (count > ((m * n) / 2))
    {
        printf("The given matrix is sparse matrix \n");
    }
    else
    {
        printf("The given matrix is not a sparse matrix \n");
```



```
    }

    cout << "There are " << count << " number of zeros in the matrix" << endl;

    return 0;
}
```



"F:\MANIT-Online class\Semester-4\ADA Lab\LAB-1 6Jan\2-Sparse.exe"

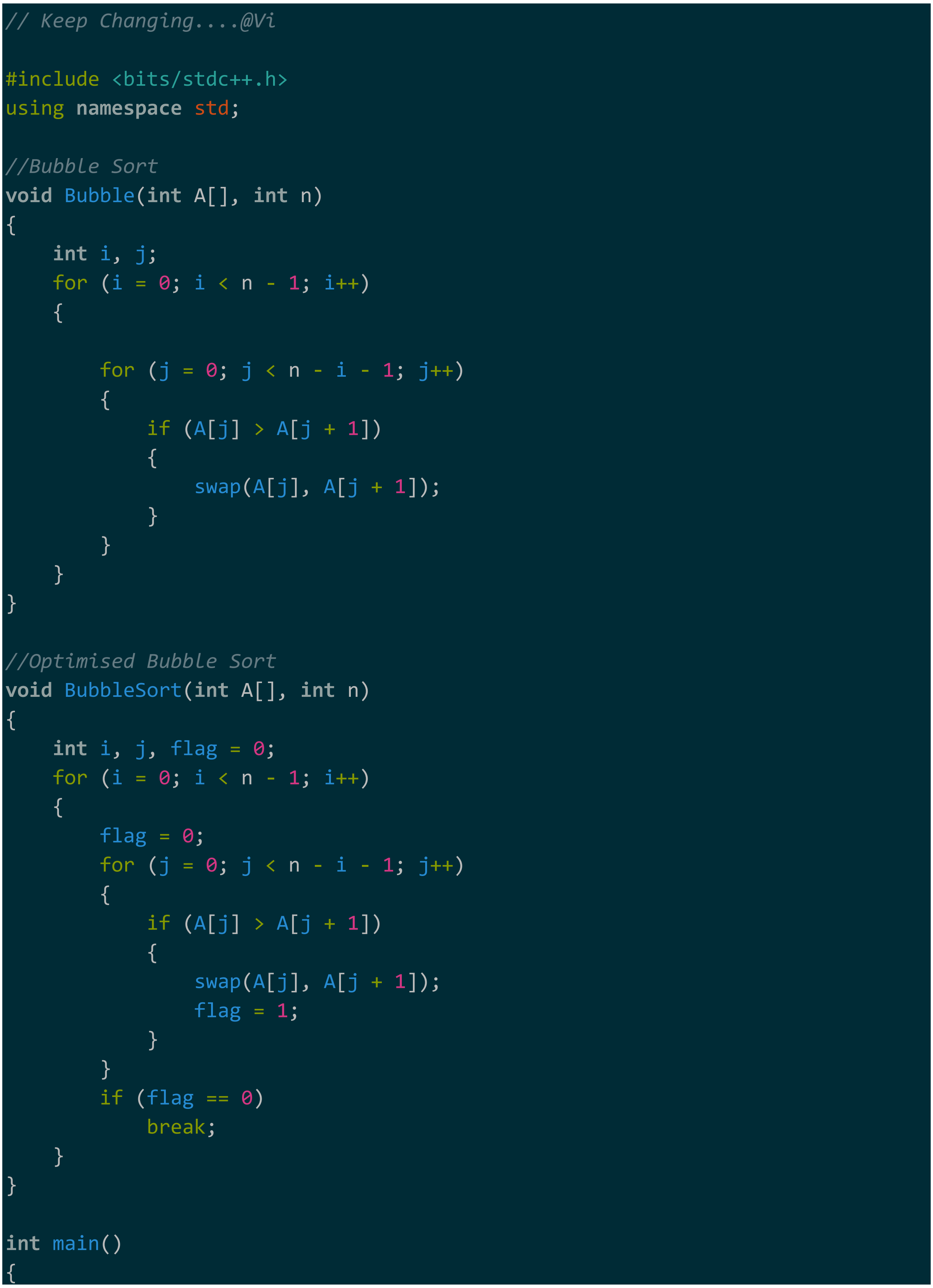
```
Enter the order of the matix
3 3
Enter the element of the matix
1 0 1
0 0 1
0 0 0
The given matrix is sparse matrix
There are 6 number of zeros in the matrix

Process returned 0 (0x0)   execution time : 9.328 s
Press any key to continue.
```

Time Complexity: The time complexity of this program is O(MN) if order of matrix is M*N.

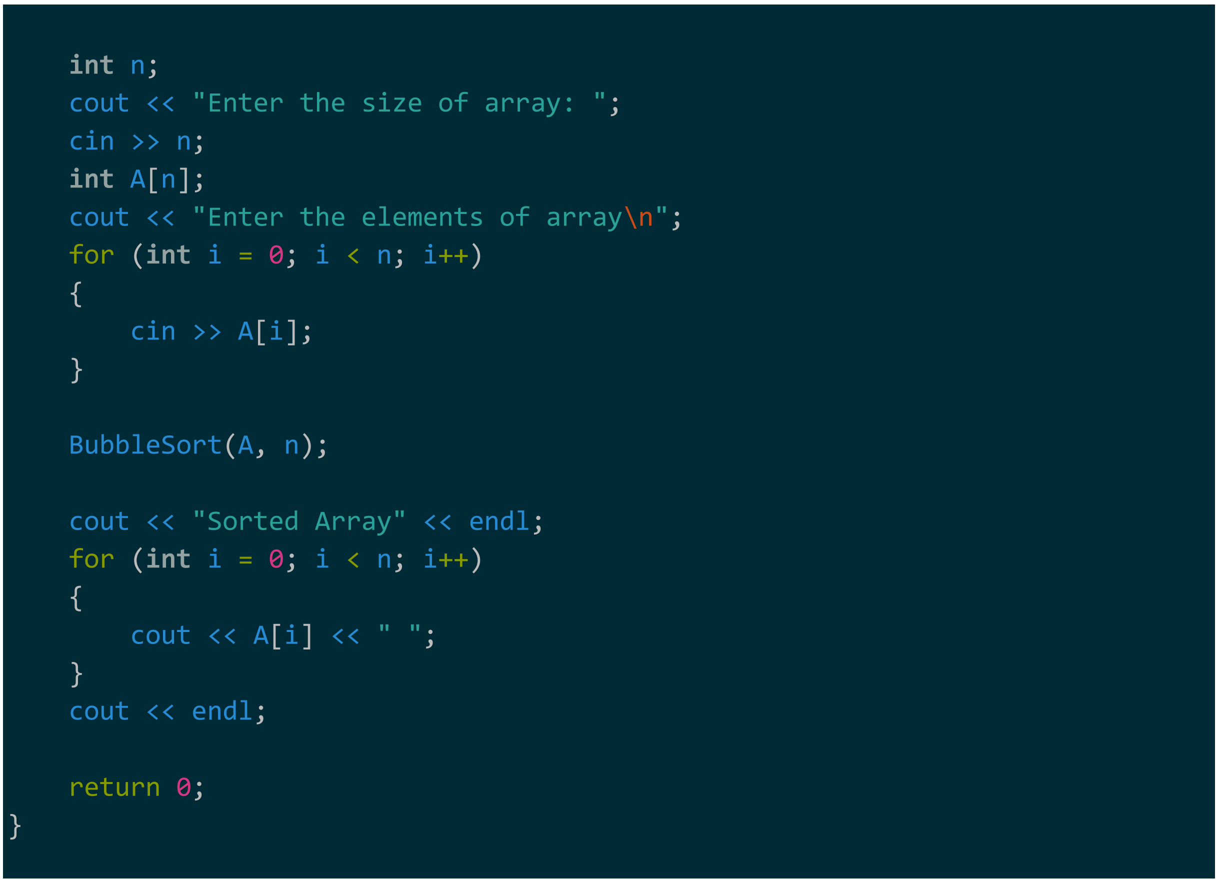
Sparse matrix is better then normal matrix because of following reasons

- **Storage:** There are lesser non-zero elements than zeros and thus lesser memory can be used to store only those elements.
- **Computing time:** Computing time can be saved by logically designing a data structure traversing only non-zero elements.

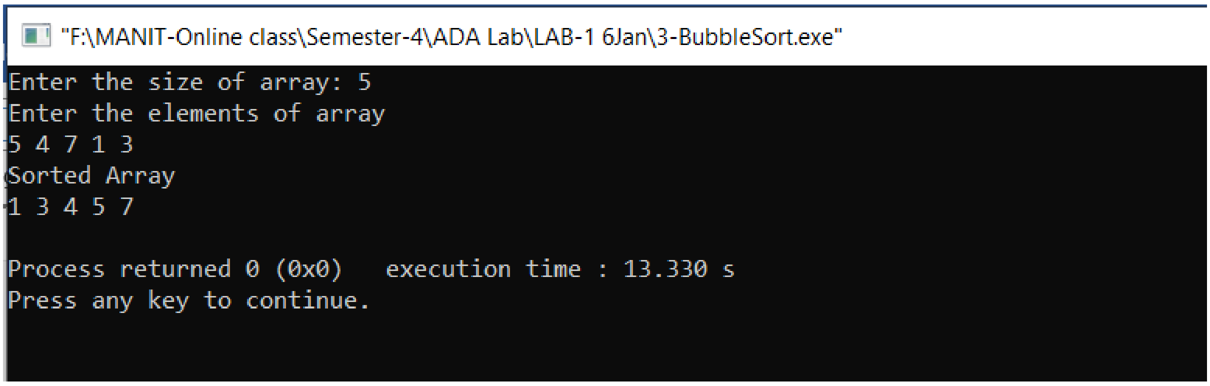
Prog.3: What is Bubble Sort. Write algorithm of mention the Time & Space complexity of the Algorithm. Also suggest improvements which will improve the best case running time of Algorithm to O(n).



```
// Keep Changing....@Vi

#include <bits/stdc++.h>
using namespace std;

//Bubble Sort
void Bubble(int A[], int n)
{
    int i, j;
    for (i = 0; i < n - 1; i++)
    {

        for (j = 0; j < n - i - 1; j++)
        {
            if (A[j] > A[j + 1])
            {
                swap(A[j], A[j + 1]);
            }
        }
    }
}

//Optimised Bubble Sort
void BubbleSort(int A[], int n)
{
    int i, j, flag = 0;
    for (i = 0; i < n - 1; i++)
    {
        flag = 0;
        for (j = 0; j < n - i - 1; j++)
        {
            if (A[j] > A[j + 1])
            {
                swap(A[j], A[j + 1]);
                flag = 1;
            }
        }
        if (flag == 0)
            break;
    }
}

int main()
{
```



```
    int n;
    cout << "Enter the size of array: ";
    cin >> n;
    int A[n];
    cout << "Enter the elements of array\n";
    for (int i = 0; i < n; i++)
    {
        cin >> A[i];
    }

    BubbleSort(A, n);

    cout << "Sorted Array" << endl;
    for (int i = 0; i < n; i++)
    {
        cout << A[i] << " ";
    }
    cout << endl;

    return 0;
}
```



"F:\MANIT-Online class\Semester-4\ADA Lab\LAB-1 6Jan\3-BubbleSort.exe"

```
Enter the size of array: 5
Enter the elements of array
5 4 7 1 3
Sorted Array
1 3 4 5 7

Process returned 0 (0x0)   execution time : 13.330 s
Press any key to continue.
```

Bubble Sort is the simplest sorting algorithm that works by repeatedly swapping the adjacent elements if they are in wrong order

Worst and Average Case Time Complexity: O(n*n): Worst case occurs when array is reverse sorted.

Best Case Time Complexity: O(n): Best case occurs when array is already sorted.

Space: O (1)

Bubble sort is **stable** sorting algorithm.