Design and Analysis of Algorithm (KCS503)

Analysis of Linear Search

Lecture - 2

Searching

- Searching is a process of finding a particular element among several given elements.
- The search is successful if the required element is found.
- Otherwise, the search is unsuccessful.

Searching

Searching Algorithms are a family of algorithms used for the purpose of searching.

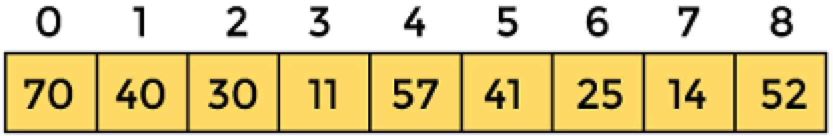
The searching of an element in the given array may be carried out in the following two ways-

- Linear Searching
- Binary Searching

Linear Searching

To understand the working of linear search algorithm, let's take an unsorted array. It will be easy to understand the working of linear search with an example.

Let the elements of array are :

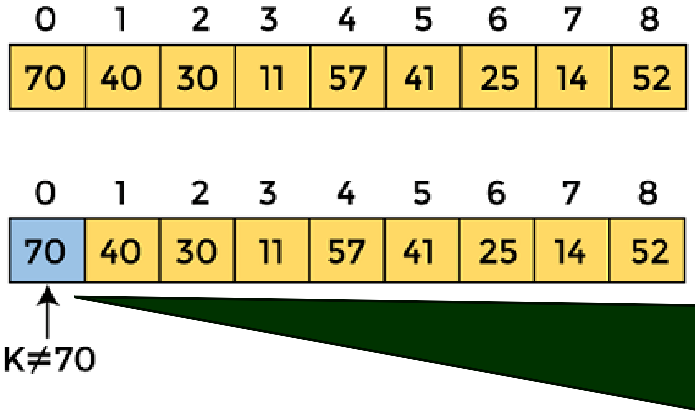


0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

Let the element to be searched is K = 41

Linear Searching

Now, start from the first element and compare **K=41** with each element of the array.



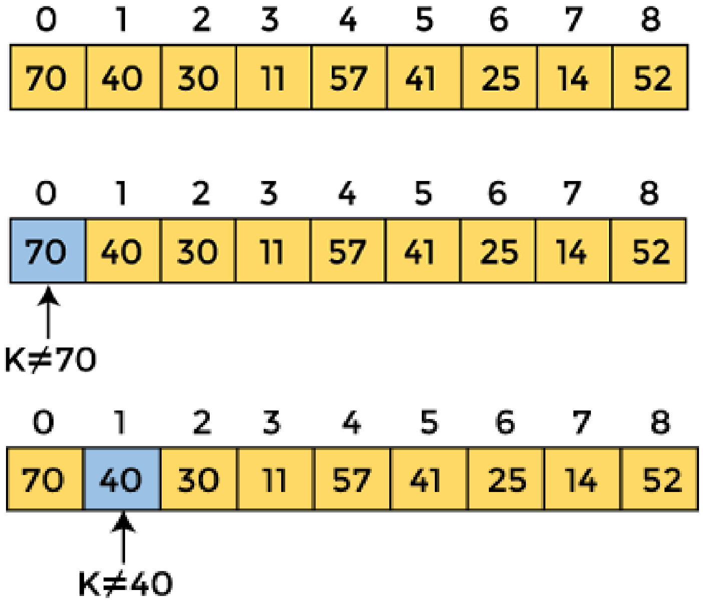
0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

The value of K=41, is not matched with the first element of the array. So, move to the next element. And follow the same process until the respective element is found.

Searching

Now, start from the first element and compare **K=41** with each element of the array.



0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

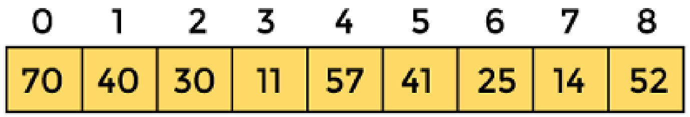
K≠70

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

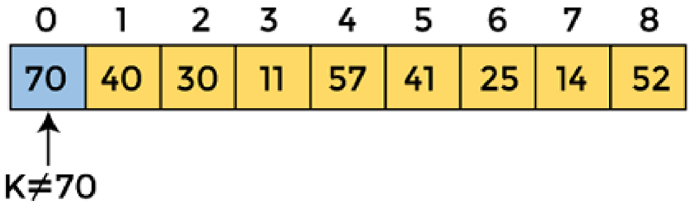
K≠40

Searching

Now, start from the first element and compare **K=41** with each element of the array.



0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52



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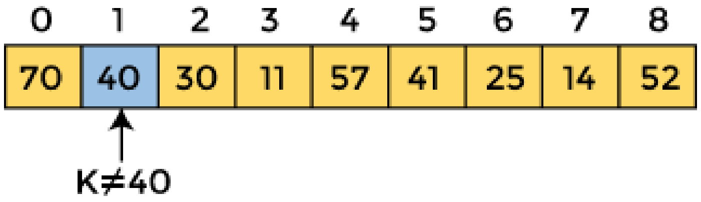
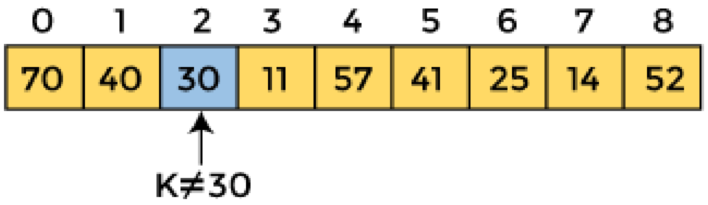
70	40	30	11	57	41	25	14	52



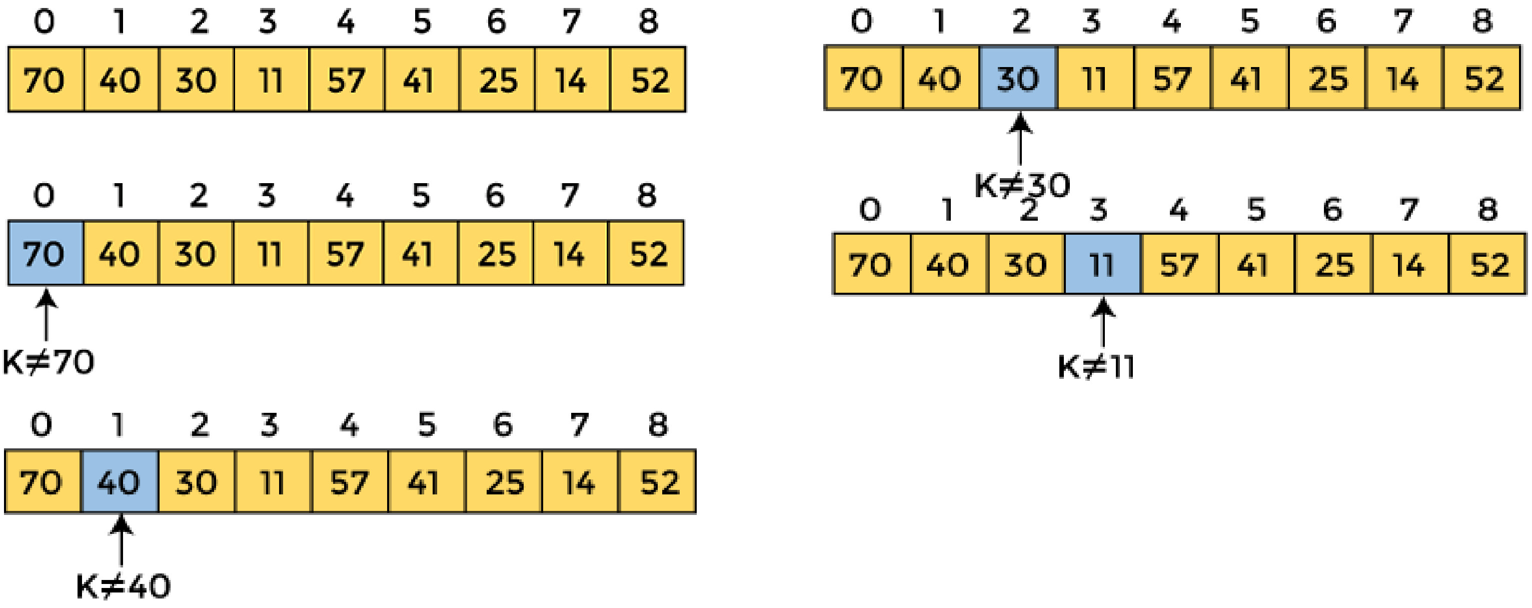
0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52



0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

Searching

Now, start from the first element and compare **K=41** with each element of the array.



0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K≠70

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K≠40

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

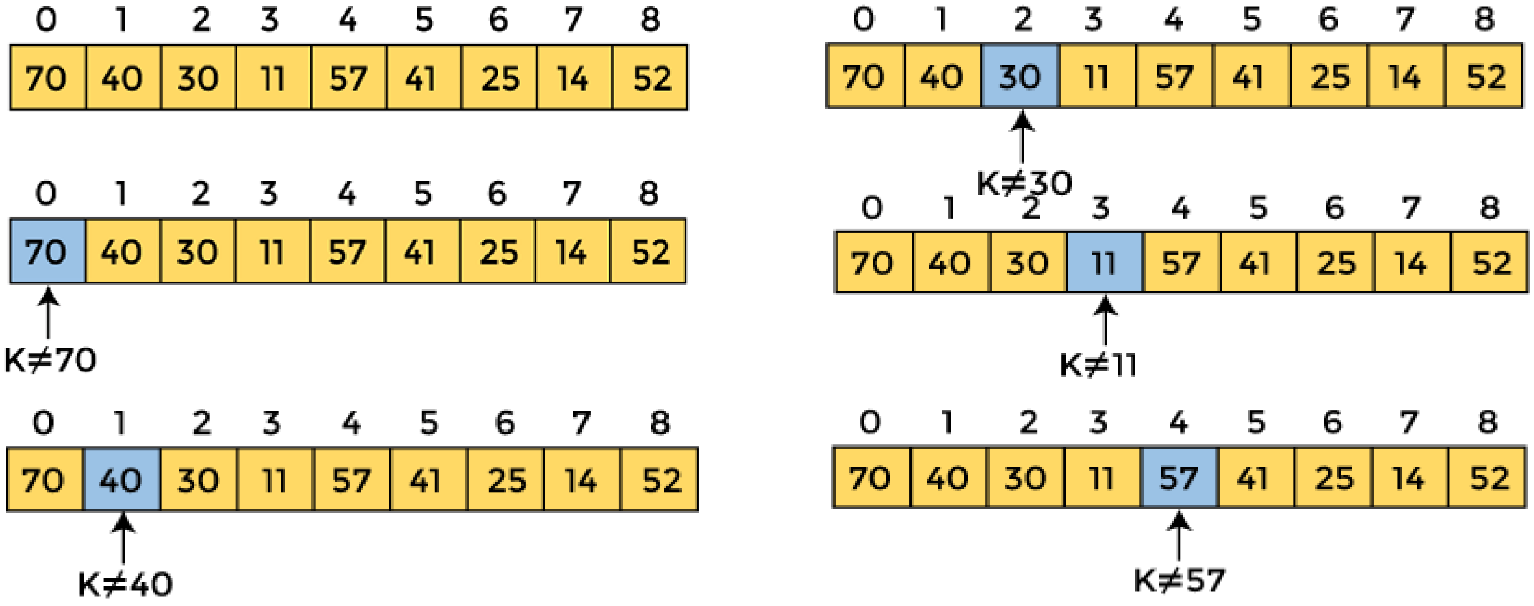
K≠30

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K≠11

Searching

Now, start from the first element and compare **K=41** with each element of the array.



0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K≠70

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K≠40

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K≠30

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

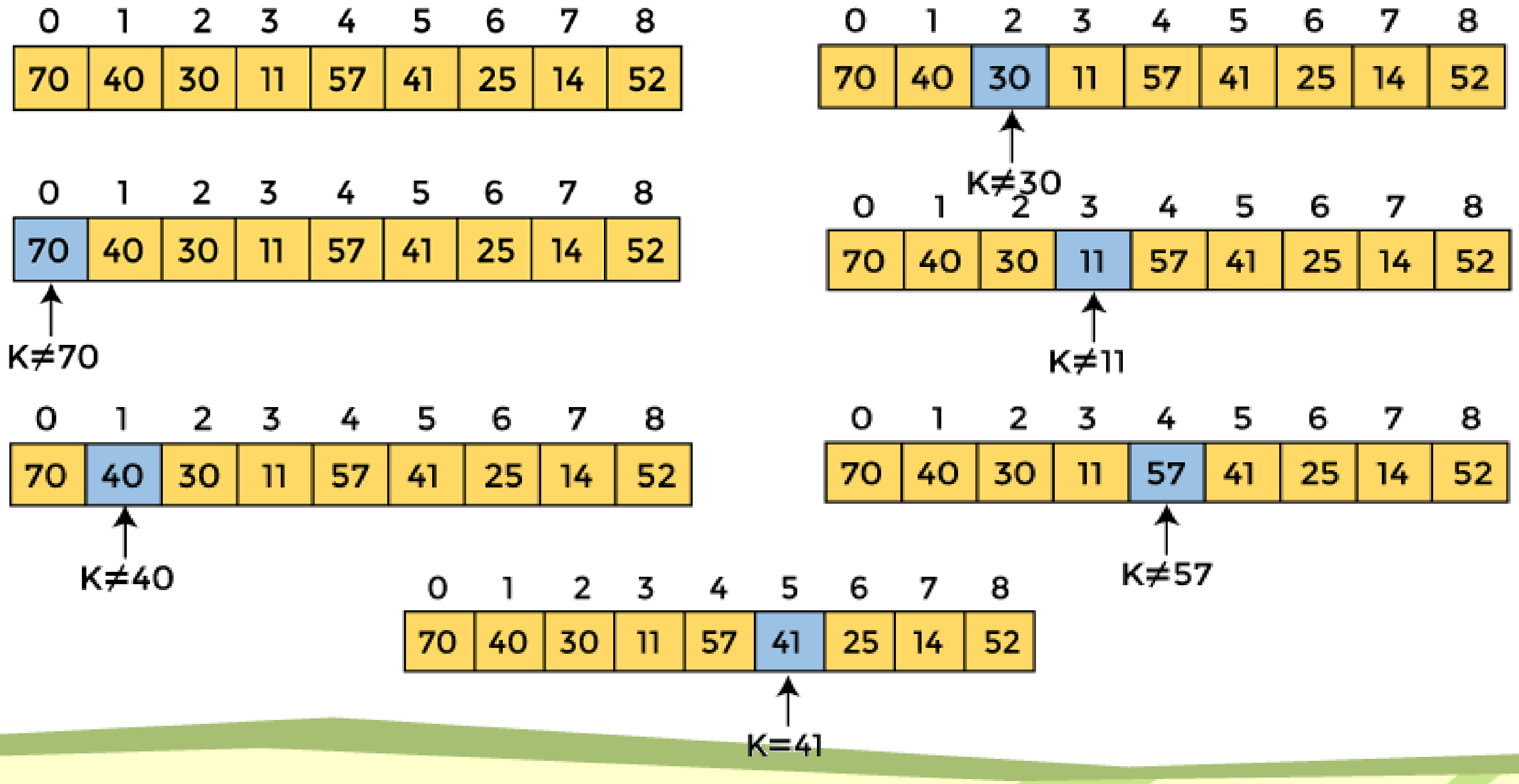
K≠11

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K≠57

Searching

Now, start from the first element and compare **K=41** with each element of the array.



0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K≠70

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K≠40

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K≠30

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K≠11

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

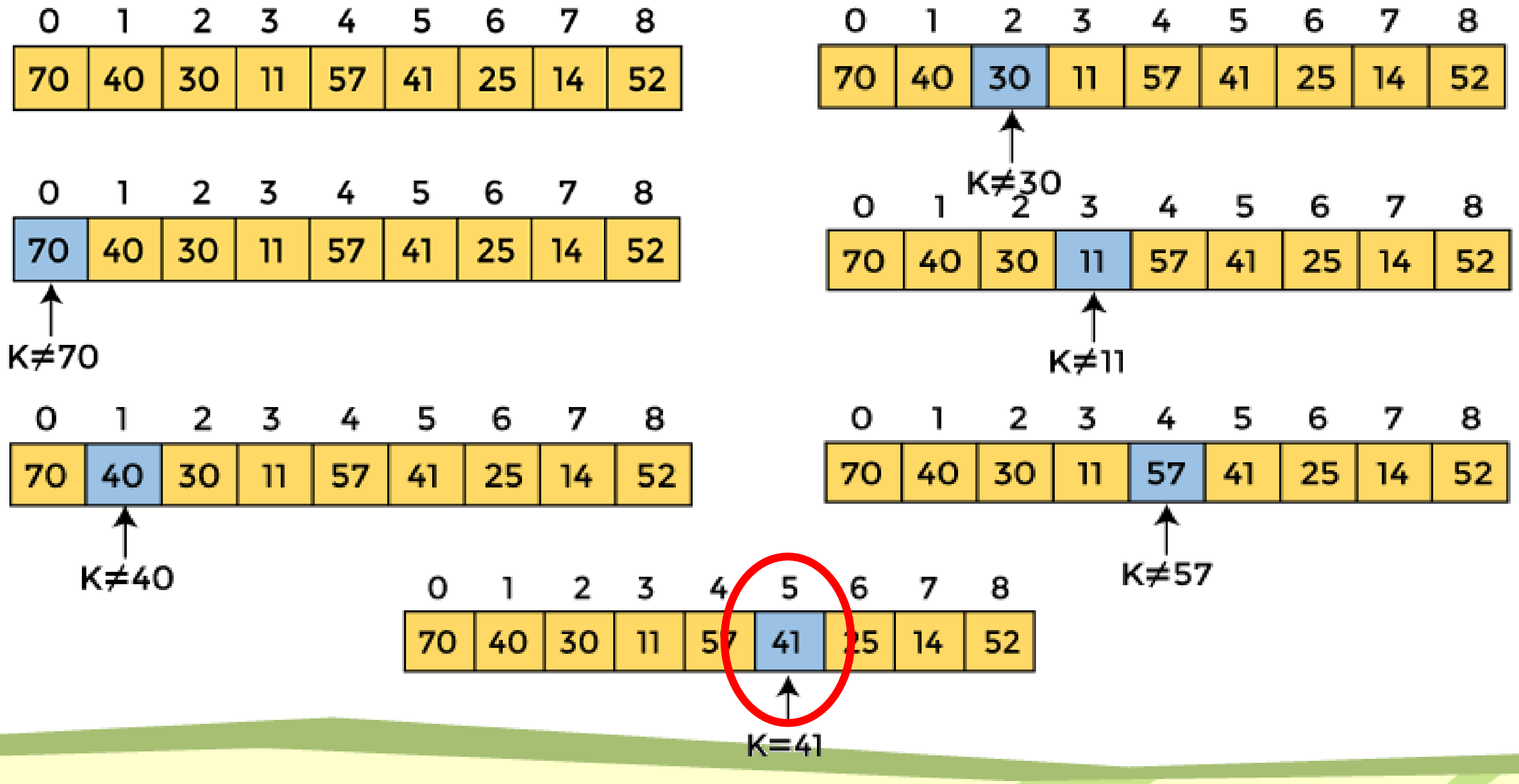
K≠57

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K=41

Searching

Now, the element to be searched is found. So, algorithm will return the index of the element matched.



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70	40	30	11	57	41	25	14	52

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K≠70

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K≠40

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K≠30

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K≠11

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K≠57

0	1	2	3	4	5	6	7	8
70	40	30	11	57	41	25	14	52

K=41

Linear Searching

What Is Linear Search?

- A linear Search is the simplest searching algorithm.
- It traverses the array sequentially to locate the required element.
- It searches for an element by comparing it with each element of the array one by one.
- So, it is also called as Sequential Search.

Linear Searching

When Linear Search Algorithm is applied-

- No information is given about the array.
- The given array is unsorted, or the elements are unordered.
- The list of data items is smaller.

Linear Searching

Linear Search Algorithm –

```
Linear_Search (a , n , item , loc)
Begin
for i = 0 to (n - 1) by 1 do
    if (a[i] = item) then
        set loc = i
        exit
    endif
end for
set loc = -1
End
```

Linear Searching

Time Complexity Analysis- (Best case)

In the best possible case,

- The element being searched may be found at the first position.
- In this case, the search terminates in success with just one comparison.
- Thus in best case, linear search algorithm takes O(1) operations.

Linear Searching

Time Complexity Analysis- (Worst Case)

In the worst possible case,

- The element being searched may be present at the last position or not present in the array at all.
- In the former case, the search terminates in success with n comparisons.
- In the later case, the search terminates in failure with n comparisons.
- Thus in worst case, linear search algorithm takes O(n) operations.

Linear Searching

Time Complexity Analysis- (Worst Case)

In the worst possible case,(Mathematically)

$T(n) = O(1) + T(n - 1)$

Linear Searching

Time Complexity Analysis- (Worst Case)

In the worst possible case,(Mathematically)

$$T(n) = O(1) + T(n-1)$$

$$= O(1) + O(1) + T(n-2)$$

Linear Searching

Time Complexity Analysis- (Worst Case)

In the worst possible case,(Mathematically)

$$T(n) = O(1) + T(n-1)$$
$$= O(1) + O(1) + T(n-2)$$
$$= O(1) + O(1) + O(1) + T(n-3)$$
$$= O(1) + O(1) + O(1) + O(1) + T(n-4)$$

after n times of iteration

$$= O(1) + O(1) + O(1) + O(1) + \cdots + O(1) + T(0)$$
$$= O(n) + O(0)$$
$$= O(n)$$

Linear Searching

Time Complexity Analysis-

Thus, we can say that in general:

The time Complexity of Linear Search Algorithm is O(n). where, n is the number of elements in the linear array.