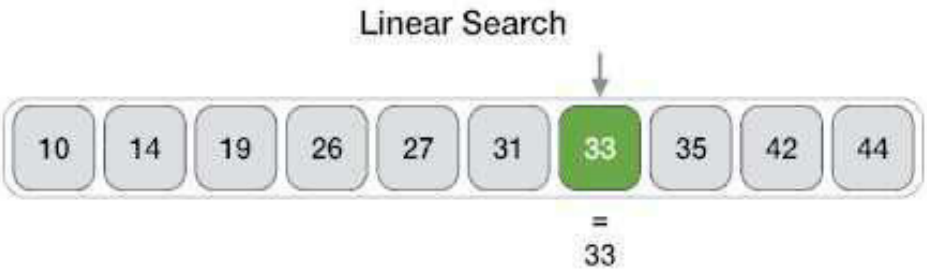
Linear search:

Linear search is a very simple search algorithm. In this type of search, a sequential search is made over all items one by one. Every item is checked and if a match is found then that particular item is returned, otherwise the search continues till the end of the data collection.



Algorithm:

```
Linear Search ( Array A, Value x)

Step 1: Set i to 1
Step 2: if i > n then go to step 7
Step 3: if A[i] = x then go to step 6
Step 4: Set i to i + 1
Step 5: Go to Step 2
Step 6: Print Element x Found at index i and go to step 8
Step 7: Print element not found
Step 8: Exit
```

Linear Search implementation in C:

```
#include <stdio.h>

#define MAX 20

// array of items on which linear search will be conducted.
int intArray[MAX] = {1,2,3,4,6,7,9,11,12,14,15,16,17,19,33,34,43,45,55,66};

void printline(int
   count){ int i;

   for(i = 0;i <count-1;i++){
      printf("=");
   }

   printf("=\n");
}

// this method makes a linear search.
int find(int data){

   int comparisons = 0;
   int index = -1;
   int i;
```

```
   // navigate through all
   items for(i = 0;i<MAX;i++){

      // count    the    comparisons
      made comparisons++;

      // if data found, break the loop

      if(data == intArray[i]){
         index = i;
         break;
      }

   }

   printf("Total comparisons made: %d", comparisons);
   return index;
}

void display(){
   int i;
   printf("[");

   // navigate through all
   items for(i = 0;i<MAX;i++){
      printf("%d ",intArray[i]);
   }

   printf("]\n");
}

main(){

   printf("Input Array: ");
   display();
   printline(50);
```

```
   //find location of 1
   int location = find(55);

   // if element was found
   if(location != -1)
      printf("\nElement found at location: %d"
   ,(location+1)); else
      printf("Element not found.");
}
```

If we compile and run the above program, it will produce the following result –

```
Input Array: [1 2 3 4 6 7 9 11 12 14 15 16 17 19 33 34 43 45 55 66 ]
==================================================
Total comparisons made: 19
Element found at location: 19
```

Binary search :

Binary search is a fast search algorithm with run-time complexity of O(log n). This search algorithm works on the **principle of divide and conquer**. For this algorithm to work properly, the data collection *should be* in the sorted form.

Binary search looks for a particular item by comparing the middle most item of the collection. If a match occurs, then the index of item is returned. If the middle item is greater than the item, then the item is searched in the sub-array to the right of the middle item. Otherwise, the item is searched for in the sub-array to the left of the middle item. This process continues on the sub-array as well until the size of the subarray reduces to zero.

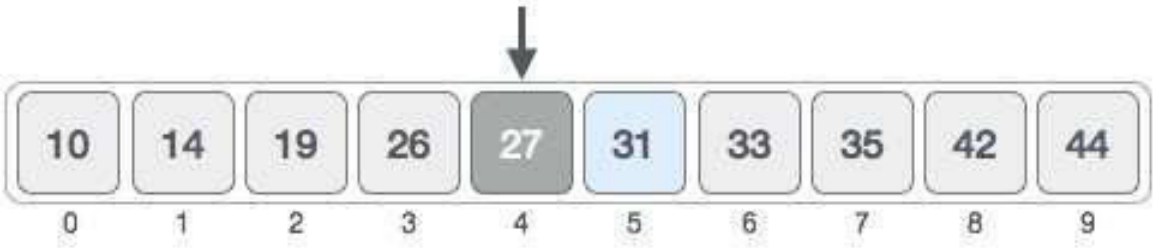
Binary Search Concept:

For a binary search to work, it is mandatory for the target array to be sorted. We shall learn the process of binary search with a pictorial example. The following is our sorted array and let us assume that we need to search the location of value 31 using binary search.

First, we shall determine half of the array by using this formula –

```
mid = low + (high - low) / 2
```

Here it is, 0 + (9 - 0) / 2 = 4 (integer value of 4.5). So, 4 is the mid of the array.



Now we compare the value stored at location 4, with the value being searched, i.e. 31. We find that the value at location 4 is 27, which is not a match. As the value is greater than 27 and we have a sorted array, so we also know that the target value must be in the upper portion of the array.

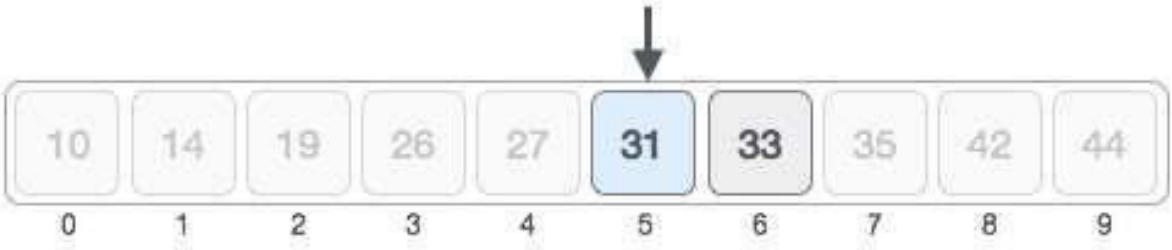
We change our low to mid + 1 and find the new mid value again.

```
low = mid + 1
mid = low + (high - low) / 2
```

Our new mid is 7 now. We compare the value stored at location 7 with our target value 31.

The value stored at location 7 is not a match, rather it is less than what we are looking for. So, the value must be in the lower part from this location.

Hence, we calculate the mid again. This time it is 5.



We compare the value stored at location 5 with our target value. We find that it is a match.

We conclude that the target value 31 is stored at location 5.

Binary search halves the searchable items and thus reduces the count of comparisons to be made to very less numbers.

Binary Search implementation in C:

Binary search is a fast search algorithm with run-time complexity of O(log n). This search algorithm works on the principle of divide and conquer. For this algorithm to work properly, the data collection should be in a sorted form.

Implementation in C

```
#include <stdio.h>


#define MAX 20


// array of items on which linear search will be conducted.
int intArray[MAX] = {1,2,3,4,6,7,9,11,12,14,15,16,17,19,33,34,43,45,55,66};


void printline(int
   count){ int i;


   for(i = 0;i <count-1;i++){
      printf("=");
   }


   printf("=\n");
}


int find(int data){ int
   lowerBound = 0;
   int upperBound = MAX -1;
   int midPoint = -1;
   int comparisons = 0;
   int index = -1;


   while(lowerBound <= upperBound){
      printf("Comparison %d\n" , (comparisons +1) ) ;
      printf("lowerBound : %d, intArray[%d] = %d\n",
            lowerBound,lowerBound,intArray[lowerBound]);
      printf("upperBound : %d, intArray[%d] =
%d\n", upperBound,upperBound,intArray[upperBound]);
```

```
      comparisons++;

      // compute the mid point
      // midPoint = (lowerBound + upperBound) / 2;
      midPoint = lowerBound + (upperBound - lowerBound) / 2;

      // data found
      if(intArray[midPoint] == data){
         index =
         midPoint; break;
      }else {
         // if data is larger
         if(intArray[midPoint] < data){
            // data is in upper half
            lowerBound = midPoint + 1;
         }
         // data is smaller
         else{
            // data is in lower half
            upperBound = midPoint -1;
         }
      }
   }
   printf("Total comparisons made: %d" ,
   comparisons); return index;
}

void display(){
   int i;
   printf("[");

   // navigate through all
   items for(i = 0;i<MAX;i++){
      printf("%d ",intArray[i]);
   }

   printf("]\n");
```

```
}

main(){
   printf("Input Array: ");
   display(); printline(50);

   //find location of 1
   int location = find(55);

   // if element was found
   if(location != -1)
      printf("\nElement found at location: %d" ,(location+1));
   else
      printf("\nElement not found.");
}
```

If we compile and run the above program, it will produce the following result –

```
Input Array: [1 2 3 4 6 7 9 11 12 14 15 16 17 19 33 34 43 45 55 66 ]
==================================================
Comparison 1
lowerBound : 0, intArray[0] = 1
upperBound : 19, intArray[19] = 66
Comparison 2
lowerBound  :  10,  intArray[10]  =  15
upperBound  :  19,  intArray[19]  =  66
Comparison 3
lowerBound  :  15,  intArray[15]  =  34
upperBound  :  19,  intArray[19]  =  66
Comparison 4
lowerBound  :  18,  intArray[18]  =  55
upperBound  :  19,  intArray[19]  =  66
Total comparisons made: 4
Element found at location: 19
```

References:

1. “Data Structures & Algorithm” , Tutorials Point India (https://www.tutorialspoint.com)