Experiment No: 1

Title: Implementation of Binary search algorithm using Divide & Conquer method.

Theory/Description:

Binary search can be performed on a sorted array. In this approach, the index of an element **x** is determined if the element belongs to the list of elements. If the array is unsorted, linear search is used to determine the position.

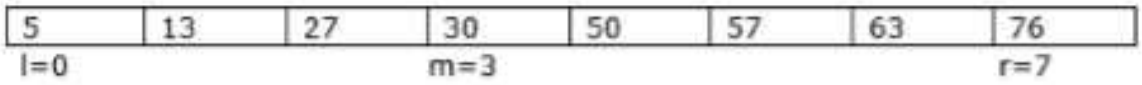
In this algorithm, we want to find whether element **x** belongs to a set of numbers stored in an array ***numbers[]***. Where ***l*** and ***r*** represent the left and right index of a sub-array in which searching operation should be performed.

Algorithm: Binary-Search (numbers[], x, l, r)
if l = r then
return l
else
m := ⌊(l + r) / 2⌋
if x ≤ numbers[m] then
return Binary-Search(numbers[], x, l, m)
else
return Binary-Search(numbers[], x, m+1, r)

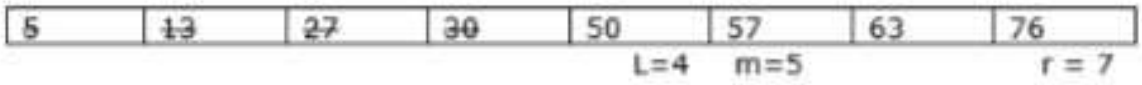
Example:

In this example, we are going to search element 63.

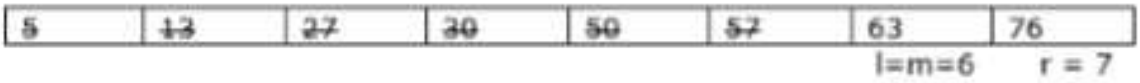
First **m** is determined and the element at index **m** is compared to **x**.



As x > numbers[3], the element may reside in numbers[4...7]. Hence, the first half is discarded and the values of l, m and r are updated as shown below.



Now the element **x** needs to be searched in numbers[4...7]. As x > numbers[5], new values of l, m and r are updated in a similar way.



Now, comparing **x** with numbers[6], we get the match. Hence, the position of x = 63 have been determined.

Program:

```
#include <stdio.h>

int main()
{
  int c, first, last, middle, n, search, array[100];

  printf("Enter number of elements\n");
  scanf("%d",&n);

  printf("Enter %d integers\n", n);

  for (c = 0; c < n; c++)
    scanf("%d",&array[c]);

  printf("Enter value to find\n");
  scanf("%d", &search);

  first = 0;
  last = n - 1;
  middle = (first+last)/2;

  while (first <= last) {
    if (array[middle] < search)
      first = middle + 1;
    else if (array[middle] == search) {
```

```
        printf("%d found at location %d.\n",
        search, middle+1);break;
      }
      else
        last
=
middle -
1;
middle
= (first
+
last)/2;
   }
   if (first > last)
     printf("Not found! %d isn't present in the
   list.\n", search);return 0;
     }
```

Conclusion(must include analysis of program):

Analysis : Linear search runs in *O(n)* **time. Whereas binary search produces the result in** *O(logn)* **time. Let** T(n) **be the number of comparisons in worst-case in an array of** n**elements.**

Hence,T(n)={0.....fn=1

T(n/2)+1 .....otherwise

Using this recurrence
relation T(n)=(logn)
Therefore, binary search
uses O(logn)time.

VIVA-VOCE QUESTIONS:

1. Differentiate between recursive approach than an iterative approach?
2. What is the worst case complexity of binary search using recursion?
3. What are the applications of binary search?