1. Explain linear search and Binary Search.

Linear Search Algorithm

Linear search, also called as sequential search, is a very simple method used for searching an array for a particular value. It works by comparing the value to be searched with every element of the array one by one in a sequence until a match is found.

LINEAR_SEARCH(A, N, VAL)

```
Step 1: [INITIALIZE] SET POS = -1
Step 2: [INITIALIZE] SET I = 1
Step 3: Repeat Step 4 while I<=N
Step 4: IF A[I] = VAL
           SET POS = I
           PRINT POS
           Go to Step 6
        [END OF IF]
        SET I = I + 1
        [END OF LOOP]
Step 5: IF POS = –1
        PRINT VALUE IS NOT PRESENT IN THE ARRAY
        [END OF IF]
Step 6: EXIT
```

Binary search algorithm

Binary search algorithm is a search algorithm that finds the position of searched value within the array. In the binary search algorithm, the element in the middle of the array is checked each time for the searched element to be found. If the middle element is not equal to the searched element, the search is repeated in the other half of the searched element. In this way, the search space is halved at each step.

BINARY_SEARCH(A, lower_bound, upper_bound, VAL)

```
Step 1: [INITIALIZE] SET BEG = lower_bound
        END = upper_bound, POS = - 1
Step 2: Repeat Steps 3 and 4 while BEG <= END
Step 3: SET MID = (BEG + END)/2
Step 4: IF A[MID] = VAL           SET POS = MID
PRINT POS
Go to Step 6         ELSE IF A[MID] > VAL
          SET END = MID - 1
        ELSE
          SET BEG = MID + 1
        [END OF IF]
        [END OF LOOP]
Step 5: IF POS = -1
          PRINT “VALUE IS NOT PRESENT IN THE ARRAY”
        [END OF IF]
Step 6: EXIT
```

2. Explain their complexity.

Linear Search

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.

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.

Binary search

In each iteration or in each recursive call, the search gets reduced to half of the array.

So for n elements in the array, there are log2n iterations or recursive calls.

Thus, we have-

Time Complexity of Binary Search Algorithm as O(log2n).

Here, n is the number of elements in the sorted linear array.

3. Implement Linear search.

```
//Linear Search

#include <iostream>
using namespace std;
void display_array(int array[],int length){
    for(int i=0;i<length;i++){
        cout<<array[i];
        (i==length-1)? cout<<".":cout<<",";
    }
}

int find_number(int array[],int length,int search_number){
    int found=-1;
    for(int i=0;i<length;i++){
        if(array[i]==search_number){
            found=i;
            break;
        }
    }
    return found;
}

int main(){
    int array[10]={12,34,21,39,65,48,36,11,58,23};
    int number,found;
    cout<<"\n Linear Search";
    cout<<"\n -------------";
    cout<<"\n Elements in a Array ";
    display_array(array,10);
    cout<<"\n Enter Number to be Search : ";
    cin>>number;
    found = find_number(array,10,number);
    if(found>-1){
        cout<<"\n Number Found at index of "<<found<<endl;
    }else{
        cout<<"\n "<<number<<" is not Found in Array "<<endl;
    }
    cout << "Program developed by Umang 20U03031"<<endl;
}
```

Name : Umang Bhalla Date: 12 Aug 2020 Daa Lab assignment #2

```
d/DAA_ASS_2_Linear.cpp
1  //Linear Search
1  #include <iostream>
2  using namespace std;
3  void display_array(int array[],int length){
4      for(int i=0;i<length;i++){
5          cout<<array[i];
6          (i==length-1)? cout<<".":cout<<",";
7      }
8  }
9
10 int find_number(int array[],int length,int search_number){
11     int found=-1;
12     for(int i=0;i<length;i++){
13         if(array[i]==search_number){
14             found=i;
15             break;
16         }
17     }
18     return found;
19 }
20
21 int main(){
22     int array[10]={12,34,21,39,65,48,36,11,58,23};
23     int number,found;
24     cout<<"\n Linear Search";
25     cout<<"\n -------------";
26     cout<<"\n Elements in a Array ";
27     display_array(array,10);
28     cout<<"\n Enter Number to be Search : ";
29     cin>>number;
30     found = find_number(array,10,number);
31     if(found>-1){
32         cout<<"\n Number Found at index of "<<found<<endl;
33     }else{
34         cout<<"\n "<<number<<" is not Found in Array "<<endl;
35     }
36     cout << "Program developed by Umang 20U03031"<<endl;
37 }

NORMAL daa/DAA_ASS_2_Linear.cpp                cpp utf-8[unix] 2% ln :1/38 :61
```

```
    state:              charging
    time to full:       34.8 minutes
    percentage:         73%
~  cd Library/ccode/daa
daa
daa  clang++ DAA_ASS_2_Linear.cpp -o linear
daa  ./linear

 Linear Search
 -------------
 Elements in a Array 12,34,21,39,65,48,36,11,58,23.
 Enter Number to be Search : 34

 Number Found at index of 1
Program developed by Umang 20U03031
daa  ~/wai.sh
  Name : Umang
Sch-No : 20U03031
daa
```

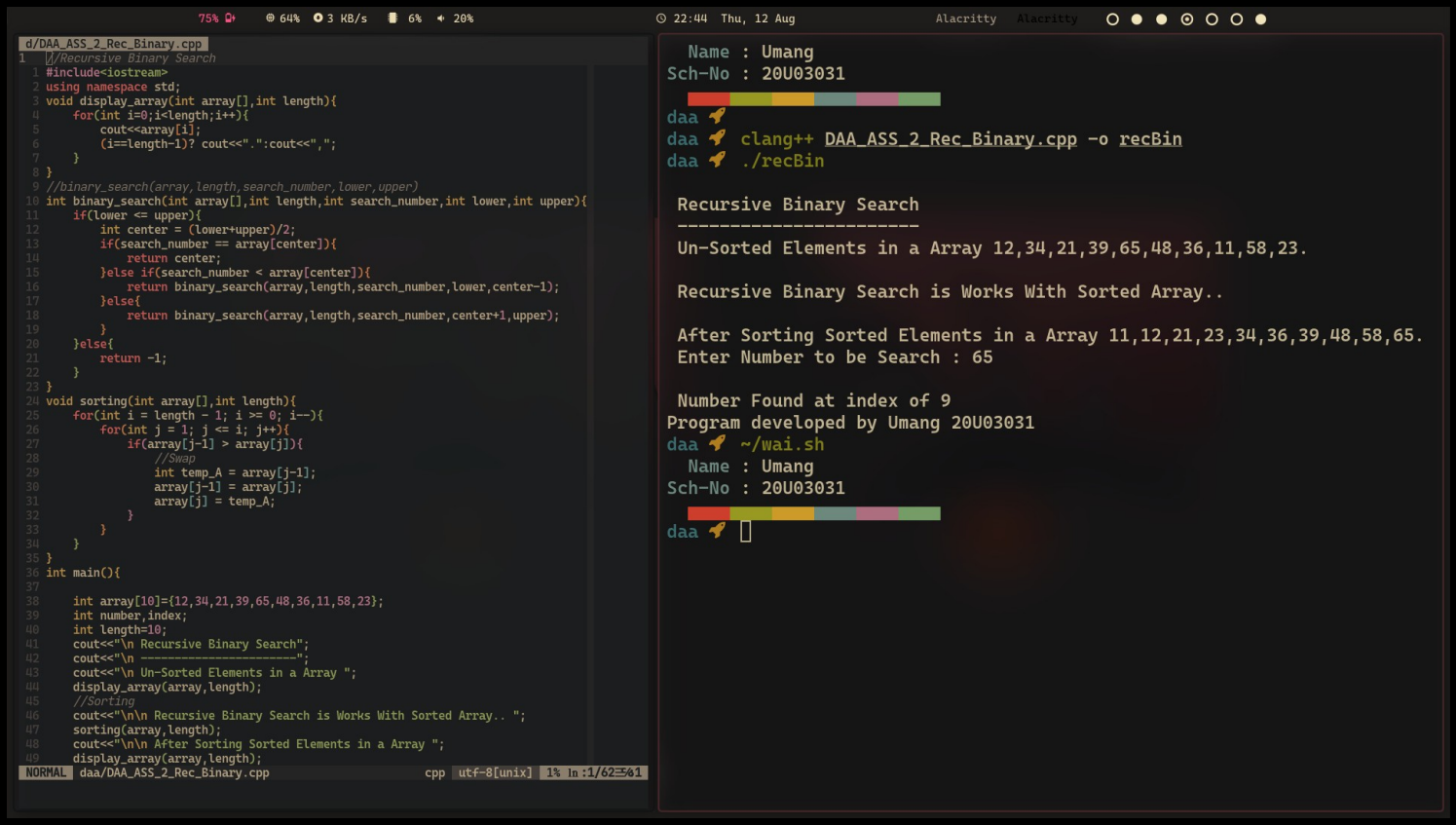
4. Implement Binary search with recursion.

```
//Recursive Binary Search

#include<iostream>
using namespace std;
void display_array(int array[],int length){
   for(int i=0;i<length;i++){
      cout<<array[i];
      (i==length-1)? cout<<".":cout<<",";
   }
}
//binary_search(array,length,search_number,lower,upper)
int binary_search(int array[],int length,int search_number,int lower,int upper){
   if(lower <= upper){
      int center = (lower+upper)/2;
      if(search_number == array[center]){
         return center;
      }else if(search_number < array[center]){
         return binary_search(array,length,search_number,lower,center-1);
      }else{
         return binary_search(array,length,search_number,center+1,upper);
      }
   }else{
      return -1;
   }
}
void sorting(int array[],int length){
   for(int i = length - 1; i >= 0; i--){
      for(int j = 1; j <= i; j++){
         if(array[j-1] > array[j]){
            //Swap
            int temp_A = array[j-1];
            array[j-1] = array[j];
            array[j] = temp_A;
         }
      }
   }
}
int main(){

   int array[10]={12,34,21,39,65,48,36,11,58,23};
   int number,index;
   int length=10;
   cout<<"\n Recursive Binary Search";
   cout<<"\n ----------------------";
   cout<<"\n Un-Sorted Elements in a Array ";
   display_array(array,length);
   //Sorting
   cout<<"\n\n Recursive Binary Search is Works With Sorted Array.. ";
   sorting(array,length);
   cout<<"\n\n After Sorting Sorted Elements in a Array ";
   display_array(array,length);
   cout<<"\n Enter Number to be Search : ";
   cin>>number;
   int lower=0; // Left of Array Segment
```

```
  int upper=length-1; // Right of Array Segment
  index = binary_search(array,length,number,lower,upper);
  if(index>-1){
     cout<<"\n Number Found at index of "<<index<<endl;
  }else{
     cout<<"\n "<<number<<" is not Found in Array \n";
  }
  cout << "Program developed by Umang 20U03031"<<endl;
}
```



4. Implement Binary search without recursion.

```
//Iterative Binary Search
#include<iostream>
using namespace std;
void display_array(int array[],int length){
   for(int i=0;i<length;i++){
      cout<<array[i];
      (i==length-1)? cout<<".":cout<<",";
   }
}
//binary_search(array,length,search_number,lower,upper)

int binarySearch(int arr[], int l, int r, int x)
{ while (l <= r)
   { int mid = l + (r - l) / 2;
      if (arr[mid] == x) {
         return mid;
      }
      if (arr[mid] < x) {
         l = mid + 1;
      } else {
         r = mid - 1;
      }
   }
   return -1;
}
void sorting(int array[],int length){
   for(int i = length - 1; i >= 0; i--){
      for(int j = 1; j <= i; j++){
         if(array[j-1] > array[j]){
            //Swap
            int temp_A = array[j-1];
            array[j-1] = array[j];
            array[j] = temp_A;
         }
      }
   }
}
int main(){

   int array[10]={12,34,21,39,65,48,36,11,58,23};
   int number,index;
   int length=10;
   cout<<"\n Recursive Binary Search";
   cout<<"\n ----------------------";
   cout<<"\n Un-Sorted Elements in a Array ";
   display_array(array,length);
   //Sorting
   cout<<"\n\n Recursive Binary Search is Works With Sorted Array.. ";
   sorting(array,length);
   cout<<"\n\n After Sorting Sorted Elements in a Array ";
   display_array(array,length);
   cout<<"\n Enter Number to be Search : ";
   cin>>number;
   int lower=0; // Left of Array Segment
```

```
  int upper=length-1; // Right of Array Segment

  index = binarySearch(array,lower,upper,number);
  if(index>-1){
     cout<<"\n Number Found at index of "<<index<<endl;
  }else{
     cout<<"\n "<<number<<" is not Found in Array \n";
  }
  cout << "Program developed by Umang 20U03031"<<endl;
}
```