Explanations

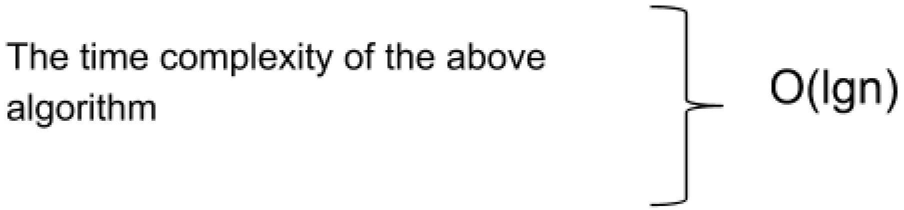
Algorithm

```
if(start>end){
            return -1;
        }
        int mid=start+((end-start)/2);
        if(arr[start]<x){
            if(x<arr[mid]){
                    return binarySearch(arr, start,mid-1, x);
            }else if(x>arr[mid]){
                if(arr[mid]<arr[start]){
                    return binarySearch(arr,start, mid-1, x);
                }else{
                    return binarySearch(arr, mid+1, end, x);
                }

            }else{
                return mid;
            }
        }else if(arr[start]>x){
            if(x>arr[mid]){
                return binarySearch(arr,mid+1,end,x);
            }else if(x<arr[mid]){
                if(arr[mid]>arr[start]){
                    return binarySearch(arr, mid+1,end,x);
                }else{
                    return binarySearch(arr, start,mid-1,x);
                }

            }else{
                return mid;
            }
        }else{
            return start;
        }
```

In this algorithm, every time it comes to the comparison half of the array elements will ignore. Therefore I can say this is just a binary search algorithm . And other words this is an optimized binary search algorithm for which is improved using given properties and what question says to do. As I said above every time it comes to the comparison half of the array elements will ignore, therefore,



The time complexity of the above algorithm $\Big\}$ O(lgn)