Lab Report-02

(Binary_Search)

CSE-2212 (Design and Analysis of Algorithms Lab)

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#2_Binary Search

Problem Definition

Given a sorted array of integers arr[] of size n and a key integer key, the problem is to find the index of the key in the array arr[]. If the key is not present, return -1.

Formal Statement of the Algorithm

- Set the lower bound left to 0 and the upper bound right to n - 1.
- Repeat until left is less than or equal to right:
    - Set the mid index mid as the average of left and right.
    - If arr[mid] is equal to the key, return mid.
    - If arr[mid] is greater than the key, update right to mid - 1.
    - If arr[mid] is less than the key, update left to mid + 1.
- If the key is not found after the loop, return -1.

Complexity Analysis of the Algorithm

- Time Complexity: O(log n) (since the array is sorted, the search space reduces by half in each iteration).
- Space Complexity: O(1) (constant space, as no extra space is used apart from a few variables).

Actual Code

```cpp
#include <iostream>
using namespace std;

int binary_search(int arr[],int n,int key){
    int s = 0;
    int e = n - 1;
    while(s<=e){
        int mid = (s+e)/2;
        if(arr[mid]==key){
            return mid;
        }else if(arr[mid]>key){
            e = mid - 1;
        }else{
            s = mid + 1;
        }
    }
    return -1;
}

int main() {
    cout << "Binary Search Algorithms\n";
    int arr[] = {3,4,5,8,10,13,21,28,32};
    int n = sizeof(arr)/sizeof(arr[0]);
    int key = 32;
    int k = binary_search(arr,n,key);
    if(k!=-1){
        cout<<key<<" found at index : "<<k<<endl;
    }else{
        cout<<"Key not found"<<endl;
    }
    return 0;
}
```

Output

```
/Documents/GitHub/DSA$ cd "/home/eyasir/Documents/GitHub
/DSA/Searching/" && g++ binary_search.cpp -o binary_sear
ch && "/home/eyasir/Documents/Gh
Binary Search Algorithmsry_search
32 found at index : 8
```