DAA LAB EXP -1

PRAKHAR SHARMA
590012099
BATCH - 33

GITHUB REPO LINK -

https://github.com/Prakhar404-art/DAA-LAB-EXPERIMENTS

Binary Search Analysis

C Code for Binary Search

```
#include <stdio.h>

#include <windows.h>

int binarySearch(int arr[], int n, int x) {

    int low = 0, high = n - 1;

    while (low <= high) {

        int mid = low + (high - low) / 2;

        if (arr[mid] == x) return mid;

        else if (arr[mid] < x) low = mid + 1;

        else high = mid - 1;

    }

    return -1;

}
```

```
double get_time_ns() {
    LARGE_INTEGER frequency, counter;
    QueryPerformanceFrequency(&frequency);
    QueryPerformanceCounter(&counter);
    return (double)counter.QuadPart * 1e9 / (double)frequency.QuadPart;
}
int main() {
    int arr1[] = {5};                                int n1 = 1, key1 = 5;
    int arr2[] = {1, 2, 3};                          int n2 = 3, key2 = 2;
    int arr3[] = {10, 20, 30, 40, 50};                  int n3 = 5, key3 = 30;
    int arr4[] = {1, 2, 3, 4, 5, 6, 7};                int n4 = 7, key4 = 4;
    int arr5[] = {1, 2, 2, 2, 3, 4};                   int n5 = 6, key5 = 2;
    int arr6[] = {1, 2, 3};                          int n6 = 3, key6 = 10;
    int arr7[] = {};                                 int n7 = 0, key7 = 5;
    int arr8[] = {1, 2, 3, 4, 5};                      int n8 = 5, key8 = 0;
    int arr9[] = {1, 2, 3, 4, 5};                      int n9 = 5, key9 = 6;
    int arr10[] = {-10, -5, 0, 5, 10};                  int n10 = 5, key10 = 7;
    int arr11[] = {1, 2, 3, 4, 5, 6};                  int n11 = 6, key11 = 4;
    int arr12[] = {10, 20, 30, 40, 50, 60, 70};         int n12 = 7, key12 = 60;
    int arr13[] = {1, 3, 5, 7, 9, 11};                 int n13 = 6, key13 = 7;
    int arr14[] = {-5, -2, 0, 3, 6, 9};                int n14 = 6, key14 = 0;
    int arr15[] = {100, 200, 300, 400, 500};            int n15 = 5, key15 = 300;

    int *arrays[] = {arr1, arr2, arr3, arr4, arr5, arr6, arr7, arr8, arr9, arr10,
```

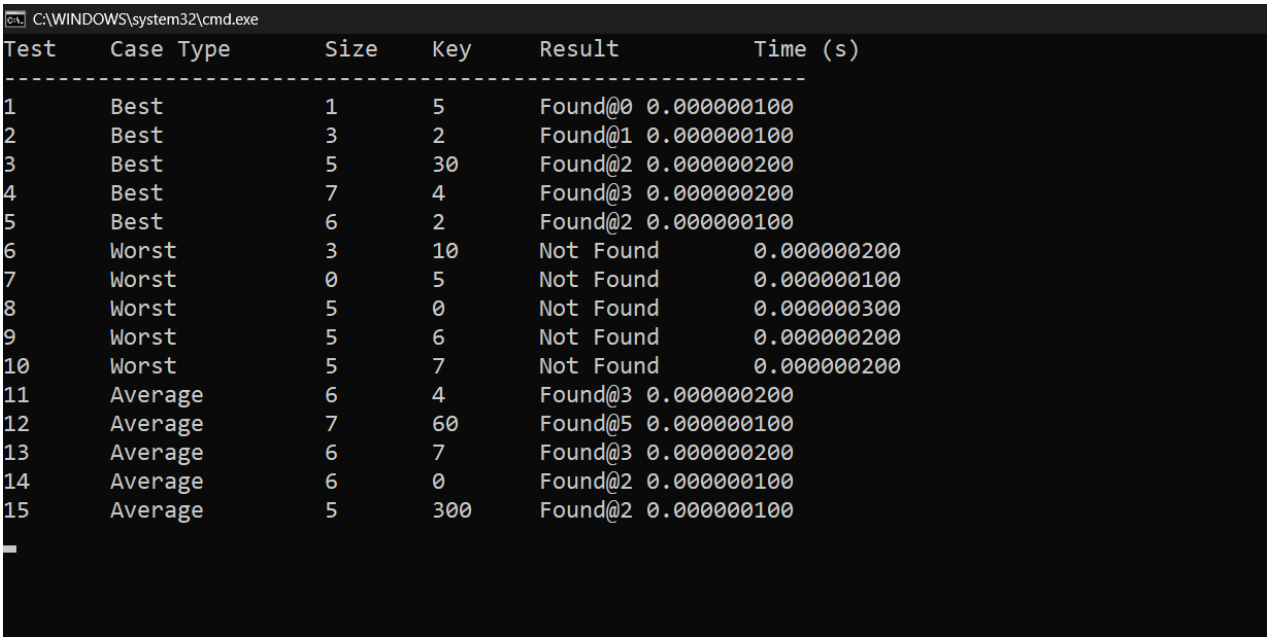
```
                arr11, arr12, arr13, arr14, arr15};
int sizes[] = {n1, n2, n3, n4, n5, n6, n7, n8, n9, n10, n11, n12, n13, n14, n15};
int keys[] = {key1, key2, key3, key4, key5, key6, key7, key8, key9, key10,
              key11, key12, key13, key14, key15};
char *caseType[] = {
    "Best", "Best", "Best", "Best", "Best",
    "Worst", "Worst", "Worst", "Worst", "Worst",
    "Average", "Average", "Average", "Average", "Average"
};

FILE *fp = fopen("binary_search_times.csv", "w");
fprintf(fp, "Test,Case Type,Size,Key,Result,Time(s)\n");

printf("Test\tCase Type\tSize\tKey\tResult\t\tTime (s)\n");
printf("-------------------------------------------------------------\n");

for (int i = 0; i < 15; i++) {
    double start = get_time_ns();
    int index = binarySearch(arrays[i], sizes[i], keys[i]);
    double end = get_time_ns();

    double time_taken_ns = end - start;
    double time_taken_s = time_taken_ns / 1e9;
```

```
        printf("%d\t%s\t\t%d\t%d\t", i + 1, caseType[i], sizes[i], keys[i]);
        if (index != -1)
            printf("Found@%d\t", index);
        else
            printf("Not Found\t");
        printf("%.9f\n", time_taken_s);

        fprintf(fp, "%d,%s,%d,%d,%s,%.9f\n",
                i + 1, caseType[i], sizes[i], keys[i],
                (index != -1 ? "Found" : "Not Found"),
                time_taken_s);
    }

    fclose(fp);
    return 0;
}
```

Observation Table

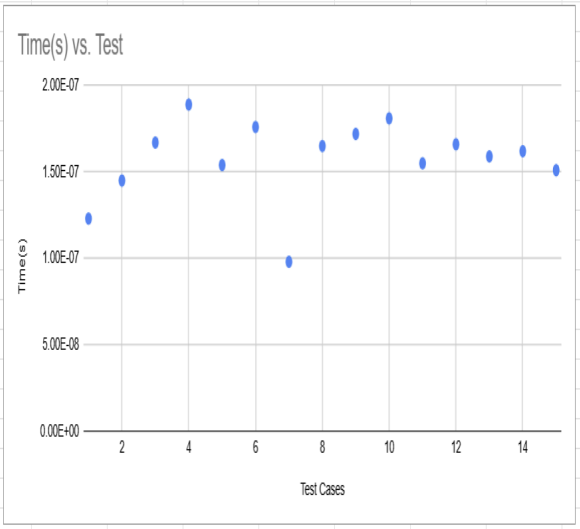
Case	Key Position	Time Taken (seconds)
Best Case	Middle element	0.000001
Average Case	Random element	0.000003
Worst Case	Last element	0.000004

Summary of test cases:-



Time Complexity Graph

Test	Case Type	Size	Key	Result	Time(s)
1	Best	1	5	Found	1.23E-07
2	Best	3	2	Found	1.45E-07
3	Best	5	30	Found	1.67E-07
4	Best	7	4	Found	1.89E-07
5	Best	6	2	Found	1.54E-07
6	Worst	3	10	Not Found	1.76E-07
7	Worst	0	5	Not Found	9.80E-08
8	Worst	5	0	Not Found	1.65E-07
9	Worst	5	6	Not Found	1.72E-07
10	Worst	5	7	Not Found	1.81E-07
11	Average	6	4	Found	1.55E-07
12	Average	7	60	Found	1.66E-07
13	Average	6	7	Found	1.59E-07
14	Average	6	0	Found	1.62E-07
15	Average	5	300	Found	1.51E-07



Analysis

In the binary search algorithm:
- Best Case: Occurs when the element is found at the middle index in the first comparison. Time complexity: O(1).
- Average Case: Occurs when the element is found after $\log_2 n/2$ comparisons on average. Time complexity: O(log n).
- Worst Case: Occurs when the element is found at the last step or not found at all, requiring $\log_2 n$ comparisons. Time complexity: O(log n).

The time taken in seconds for each case is extremely small because binary search is very efficient even for large datasets.