Linear and Binary Search Times

By: Vaishak Menon

Due to a fight for resources on my laptop, my timing data is inconsistent. I have done extensive testing to find out that this is the real reason the timing is not consistent with the number of items being processed.

(All times are in nanoseconds)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Array Size | 2^4 | 2^5 | 2^6 | 2^7 | 2^8 | 2^9 | 2^10 | 2^11 | 2^12 | 2^13 | 2^14 |
| Linear Time (ns) | 14100 | 7600 | 12900 | 9200 | 14900 | 22100 | 83200 | 55300 | 185000 | 510800 | 615400 |
| Binary Time  (ns) | 20000 | 8000 | 14100 | 6200 | 10700 | 11900 | 15400 | 11500 | 8600 | 9700 | 11200 |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Array Size | 2^15 | 2^16 | 2^17 | 2^18 | 2^19 | 2^20 | 2^21 | 2^22 | 2^23 | 2^24 | 2^25 |
| Linear Time | 1141900 | 560700 | 843000 | 1167300 | 2562800 | 3236900 | 1796700 | 3648900 | 10549700 | 20101500 | 36445100 |
| Binary Time | 12800 | 63500 | 16200 | 14400 | 14700 | 24500 | 44600 | 39600 | 36200 | 5400 | 6600 |

Problem Specification:

The goal of this assignment is to search an array using linear and binary search to understand and make sense of time complexity with search algorithms. We were to create a txt file that had 1000 numbers within the range of 1 to 2^25 and use those numbers as search keys for the array that only has numbers from 1 to the size of the array.

Program Design:

This program required both a SearchFunction class and a HW1Driver class. The SearchFunction class was to create and define the linear and binary search functions. The binary search function includes many if statements checking if mid is equal to any of the extremes or the value at mid and if the input is less than or greater than the value being checked at mid. The linear search linearly searches through the array as mentioned in the name without any extra steps.

Testing Plan:

Using the driver class, I was able to test a thousand different search keys against one array to see if the searches would find the number. Unfortunately, due to the range of the search keys the probability of finding a number is very low. Every array is of size 2 to the power of something within the range of 4 to 25.

Test Cases:

All test cases have been recorded at the top of the document.

Analysis/Conclusion:

The binary search is clearly shown to be better when using large arrays. Subsequently, the linear search works much better. Unfortunately, my data does seem to be wrong due to many variations in the timings for each test case. I thoroughly believe after testing that this is due to resource problems in my own laptop. Either way the trend is followed and for the most part binary is better for large arrays and linear for smaller arrays.

References:

I used this website to recap on my Array knowledge: <https://www.geeksforgeeks.org/arrays-in-java/>

Everything else I needed I found information on it from the Java Documentation.