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Programming Assignment 01

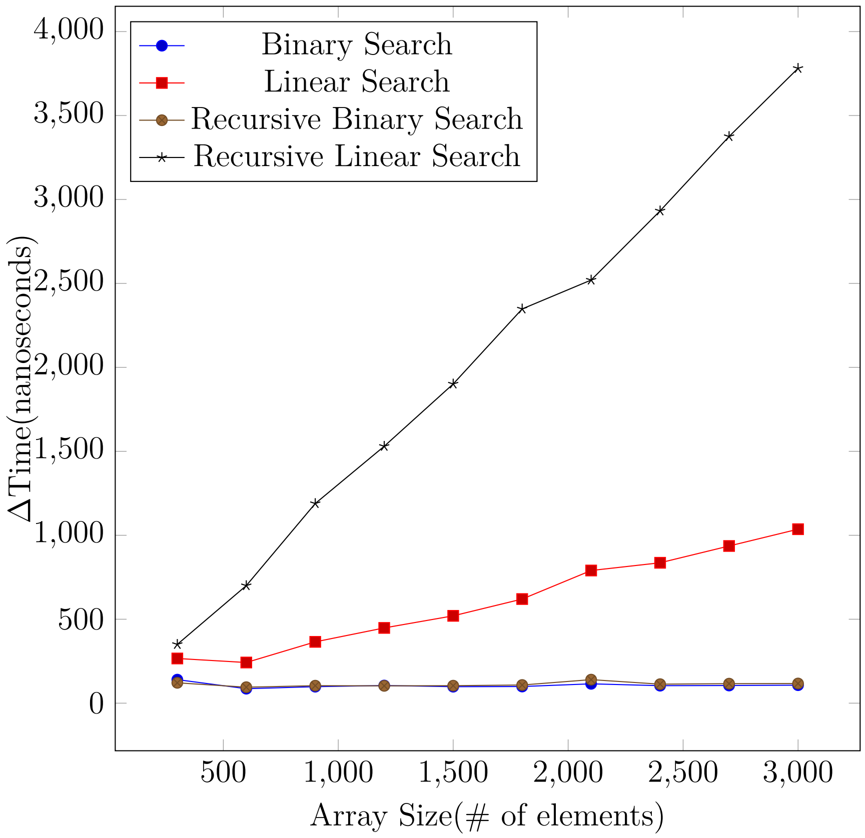
PART 1

1. Note that $2n^3 - 7n^2 + 100n - 36 \leq (2 + 7 + 100 + 36)n^3 = cn^3$, for $c = 145$, when $n \geq n_0 = 1$. Therefore, the function is $O(n^3)$.
2. Note that $10n + 3log(n) \leq (10 + 3)n = cn$, for $c = 13$, when $n \geq n_0 = 1$. Therefore, the function is $O(n)$.
3. Note that $n/1000 \leq (1/1000)n = cn$, for $c = 1/1000$, when $n \geq n_0 = 1$. Therefore, the function is $O(n)$, not $O(1)$.
4. Note that $log(n)^2 + log(n)/30 \leq (1 + 1/30)log(n)^2$, for $c = 31/30$, when $n \geq n_0 = 2$. Therefore, the function is $O(log(n)^2)$.
5. Note that $n^2/log(n) + 3n \leq (1 + 3)n^2$, for $c = 4$, when $n \geq n_0 = 2$. Therefore, the function is $O(n^2)$.
6. The function is $O(n)$.
7. The function is $O(n^2)$.
8. The function is $O(n)$.
9. The function is $O(n)$.
10. The function is $O(1)$.
11. Function *m1FindLargest* is $O(n)$. It loops through the domain fully just once, so the complexity is 1:1.
12. Function *m2PrintTriangle* is $O(n)$. It loops through the domain fully just once, so the complexity is 1:1. This function is tricky because it contains a nested for loop, but the inner loop never loops more or less than once.

13. Function *m3PrintBooks* is $O(n)$. This function's complexity is harder to determine because the domain contains n, the size of the *books* or *stars* arrays, as well as n more axes, one axis for the value of each integer stored in the *stars* array. I determined the complexity in respect to only the first axis, the size of the *books* or *stars* arrays.

PART 2

The following figure is the result of plotting the averages of the length of time it takes for four algorithms to complete. The averages have been computed by running each function 200,000 times per array size.



As the graph shows, Recursive Linear Search quickly becomes the slowest algorithm as its given larger arrays. By inspection, we see that Linear Search is in the same order as Recursive Linear Search, but is scaled such that it will take nearly one fourth the time that Recursive Linear Search will take for the same array size. This makes sense because rapid function calls impose significant overhead in Java.

Comparatively, both Binary Search and Recursive Binary Search take a very small amount of time to complete. This makes sense as Binary Search is $O(log(n))$ while Linear Search is $O(n)$. However, I was surprised to see that the recursive and linear versions of the algorithm are very similar in timing. I would expect the recursive version to take four times as long as the linear search.

From these results, we can conclude that some recursive or linear implementation of Binary Search is more efficient than Linear Search when searching through sorted data.