In this project we implemented two simple search algorithms and tested their respective run times in order to understand whether binary and linear algorithms perform as we would expect them to given their big O time. The two search algorithms we implemented were linear search and binary search. In order to properly test the runtime of linear search and binary search we looked at the runtimes for the worst case scenario possible, that the search algorithm didn't find the value being searched for. Given that linear search must go through the elements in a list one by one until it finds the value it is looking for, running a linear search code N times will result in a big O time of O(N). Binary search, on the other hand, cuts the list in half each time comparing the value being searched for to the middle value in the list and creating a sublist accordingly. Therefore, when considering the worst case, Binary search is much faster for very large lists, and has a big O notation $O(\log_2 N)$.

In order to test whether our search algorithms' run times corresponded to what we would expect given big O notation we ran each algorithm through a list of all the words in the English language several times(from 200,000,000 to 2,000,000,000 by intervals of 200,000,000). Our data is shown in Table 1 below.

Table 1: RunTime Data for Linear and Binary Search Algorithms

	type	N_millions	time
1	Linear	200	1.676
2	Binary	200	0.001
3	Linear	400	5.834
4	Binary	400	0.002
5	Linear	600	8.867
6	Binary	600	0.003
7	Linear	800	9.672
8	Binary	800	0.003
9	Linear	1,000	14.915
10	Binary	1,000	0.004
11	Linear	1,200	11.448
12	Binary	1,200	0.004
13	Linear	1,400	12.825
14	Binary	1,400	0.004
15	Linear	1,600	14.169
16	Binary	1,600	0.005
17	Linear	1,800	23.541
18	Binary	1,800	0.004
19	Linear	2,000	29.738
20	Binary	2,000	0.004

After obtaining our data we plotted several graphs comparing the runtimes of the two search algorithms at different numbers of iterations (Figure 1 and Figure 2). As you can see in Figure 1, though there appears to be some autocorrelation within the results for Linear Search, the data points generally appear to follow a linear trend, which corresponds to our expected value of O(N). Though this would not be enough information to confirm our assumption in a statistical study, it is good enough to judge that it generally appears our assumptions about the run time of Linear Search were correct. While Figure 1 shows a good mapping of our results for Linear Search, the runtime for Binary Search increases at such a comparatively shallow rate we cannot judge if it increases at the expected rate of $O(\log_2 N)$ just by looking at Figure 1. However, if we select specifically for Binary Search, as shown in Figure 2, we can see that (excluding the pull from the point at N = 1.6billion) the runtime for Binary Search does appear to conform to a logged distribution, gradually shallowing out over time. This leads us to believe that our binary search algorithm's run time corresponds to our expected value of $O(\log_2 N)$.

Figure 1: Time Taken to Run Linear and Binary search Algorithms v. Number of Times They Were Run

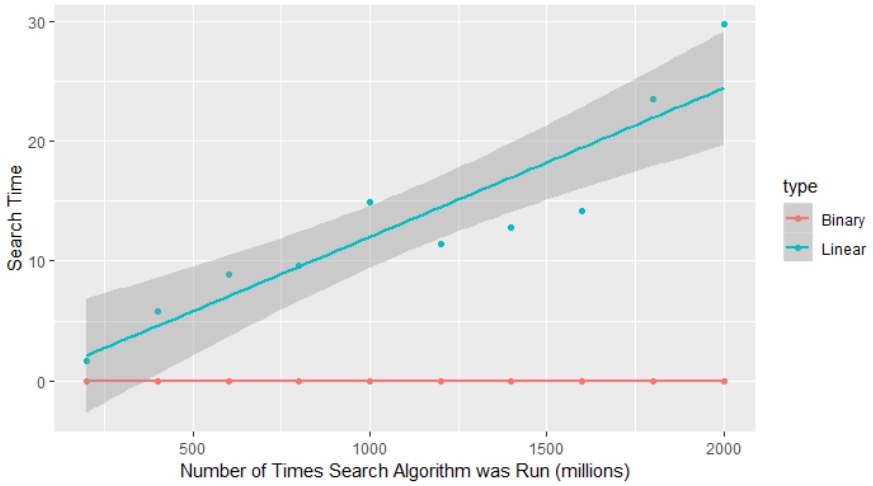
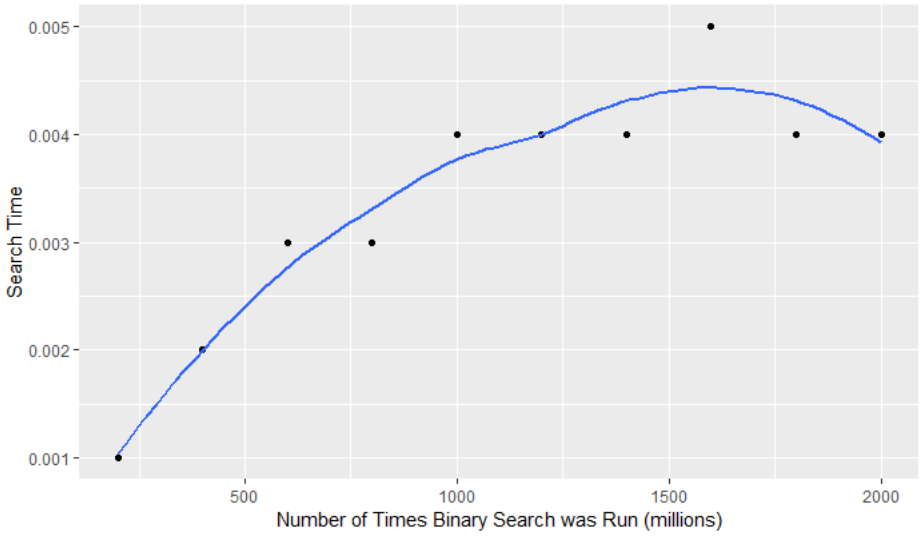


Figure 2: Time Taken to Run Binary Search v. Millions of Times Run



Overall, after examining our visualizations of the data we collected we can conclude that our linear and binary search algorithms appear to conform to the efficiency levels we expected.