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Analysis of Algorithms 1
Project 1 Report

In this Project, we have coded insertion sort algorithm, merge sort algorithm and linear search algorithm. After finish the coding, we have analyzed running time of these algorithms, therefore we have reached some results about running time of them. These results are shown as following.

Part a.

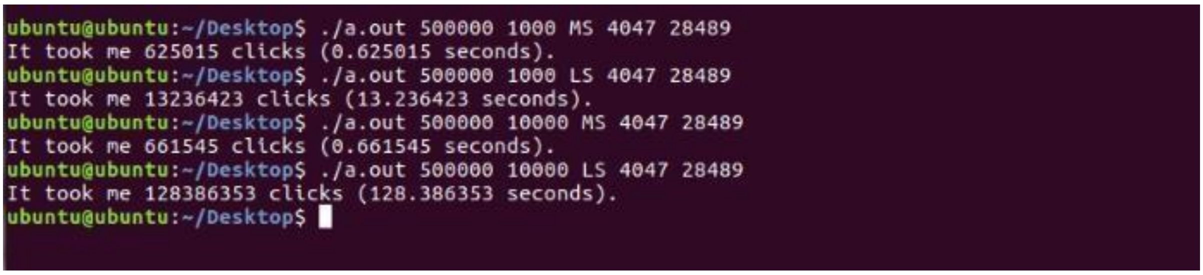
Big-O notation describes an upper bound. Assume we use Big-O notation to bind the worst case running time of an algorithm.

- Merge Sort's asymptotic upper bound is O(n*log2n)
- Insertion Sort's asymptotic upper bound is O(n^2)
- Linear Search's asymptotic upper bound is O(n*k)

Part b.

In this part, we calculate running time of these algorithms for different values of N and K. These time data is shown in below table and screenshot.

<table>
<tr><th rowspan="2"></th><th colspan="8">N and K</th><th rowspan="2">Average of Running Time (Second)</th></tr>
<tr><th>100</th><th>50</th><th>100000</th><th>1000</th><th>250000</th><th>50000</th><th>500000</th><th>1</th></tr>
<tr><td><b>Merge Sort</b></td><td colspan="2">0,001</td><td colspan="2">0,12</td><td colspan="2">0,49</td><td colspan="2">0,62</td><td>0.3</td></tr>
<tr><td><b>Insertion Sort</b></td><td colspan="2">0,0009</td><td colspan="2">26,73</td><td colspan="2">168,14</td><td colspan="2">726,34</td><td>230,3</td></tr>
<tr><td><b>Linear Search</b></td><td colspan="2">0,001</td><td colspan="2">2,55</td><td colspan="2">290,40</td><td colspan="2">0,31</td><td>73,3</td></tr>
</table>



```
ubuntu@ubuntu:~/Desktop$ ./a.out 500000 1000 MS 4047 28489
It took me 625015 clicks (0.625015 seconds).
ubuntu@ubuntu:~/Desktop$ ./a.out 500000 1000 LS 4047 28489
It took me 13236423 clicks (13.236423 seconds).
ubuntu@ubuntu:~/Desktop$ ./a.out 500000 10000 MS 4047 28489
It took me 661545 clicks (0.661545 seconds).
ubuntu@ubuntu:~/Desktop$ ./a.out 500000 10000 LS 4047 28489
It took me 128386353 clicks (128.386353 seconds).
ubuntu@ubuntu:~/Desktop$ 
```

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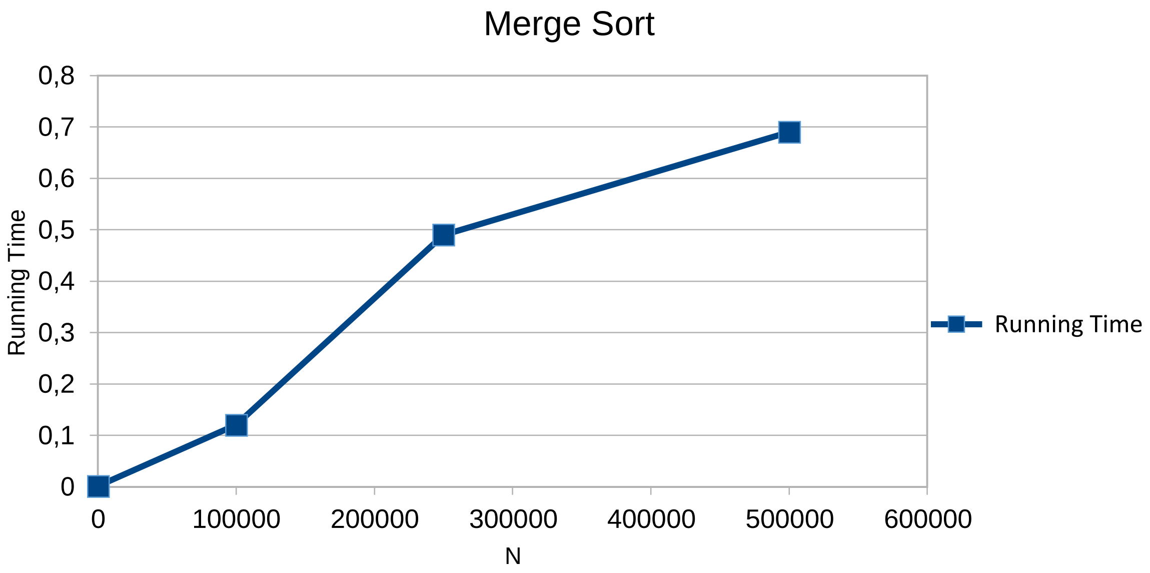
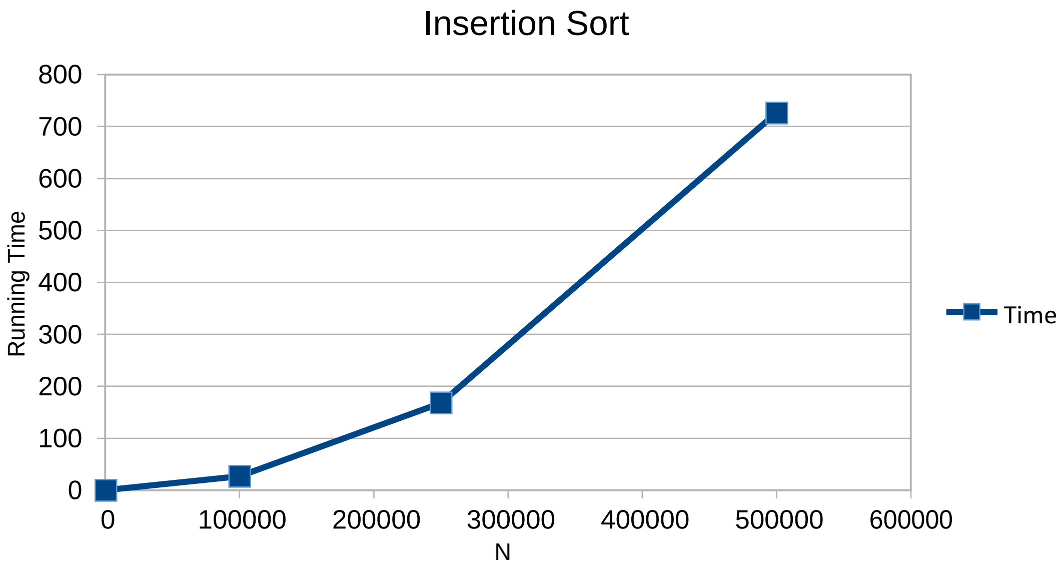
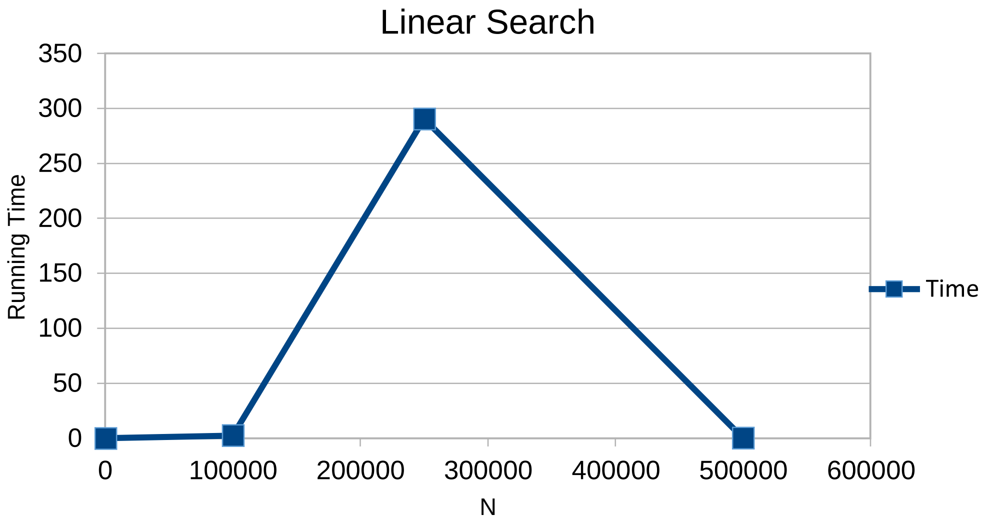
Part c.

After calculating running times, we have prepared three line plots in Excel in order to visualize the runtime complexity of insertion sort, merge sort and linear search for values of N and K in table.







When we viewed above table, screenshot and plots we have seen that if we choose small value for N, all of them have same running time. However, we have increased the value of N, difference of running time among these algorithms becomes clear. According to these result, we can say that merge sort algorithm is faster than other in all cases except one case. This case is that if K is minimal value, linear search algorithm is faster than merge sort algorithm. However, when we look the screenshot we see that we have increased the value of K, we understand clearly that merge algorithm is faster than linear search.

As a result, for small value of N and K, we can choose any of them because running time of them is almost the same. For large value of N and K, we must choose merge sort algorithm because it is faster clearly.

If we discuss these results in terms of the asymptotic upper bounds given in part a, we can conclude that insertion sort is type of $O(n^2)$, and merge sort is type of O(n*log2n) and linear search algorithm is type of O(n*k).