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# Comparing Sorting Algorithms

CPE202 — Lecturer Toshi
5/19/2019

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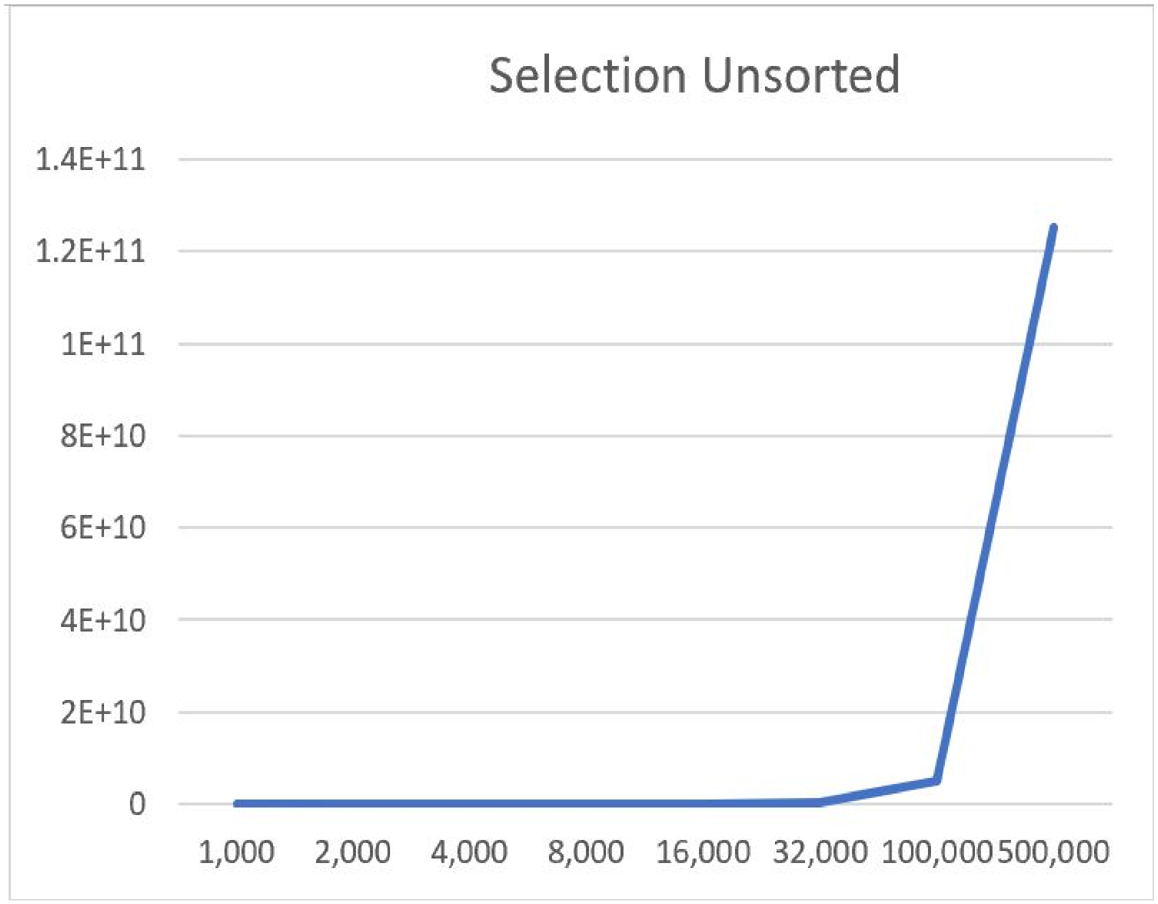
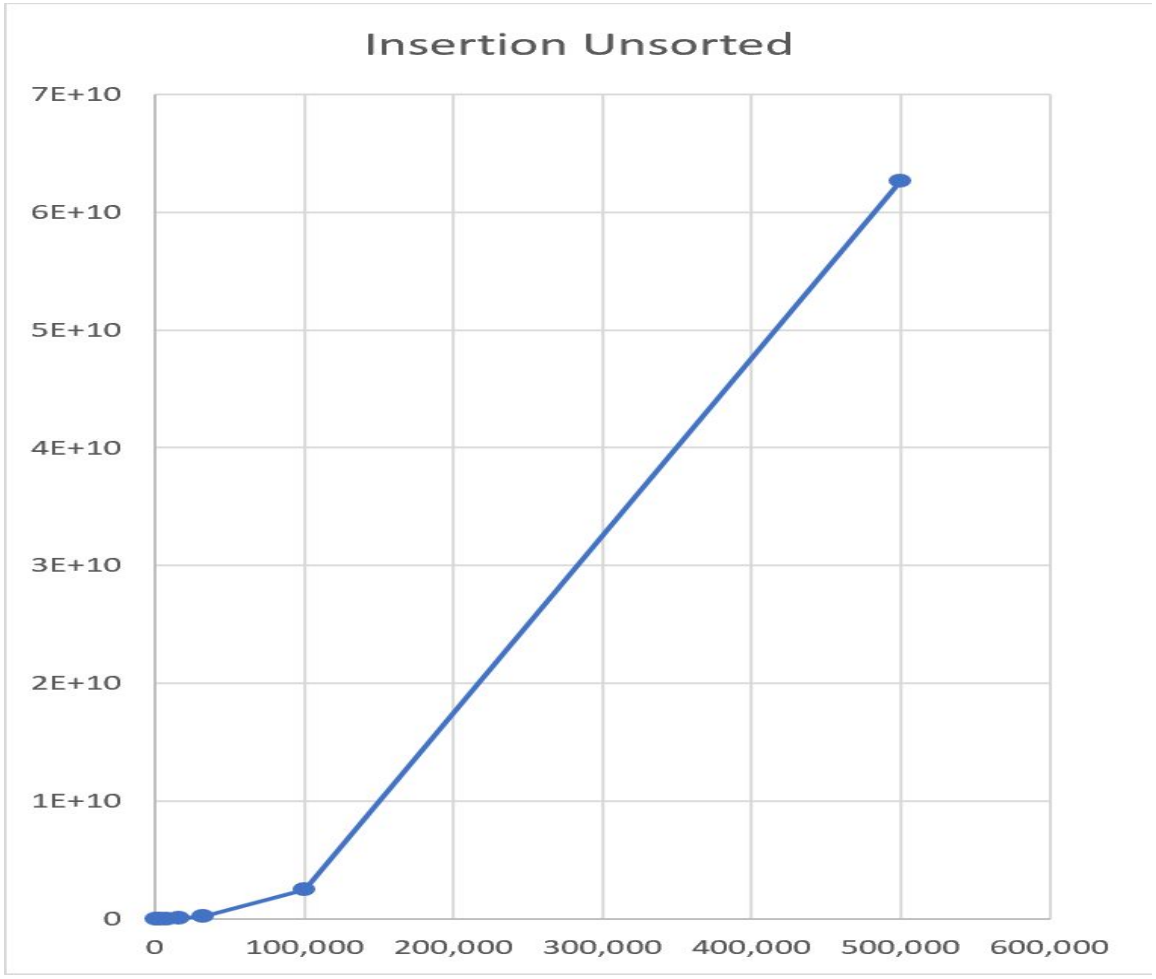
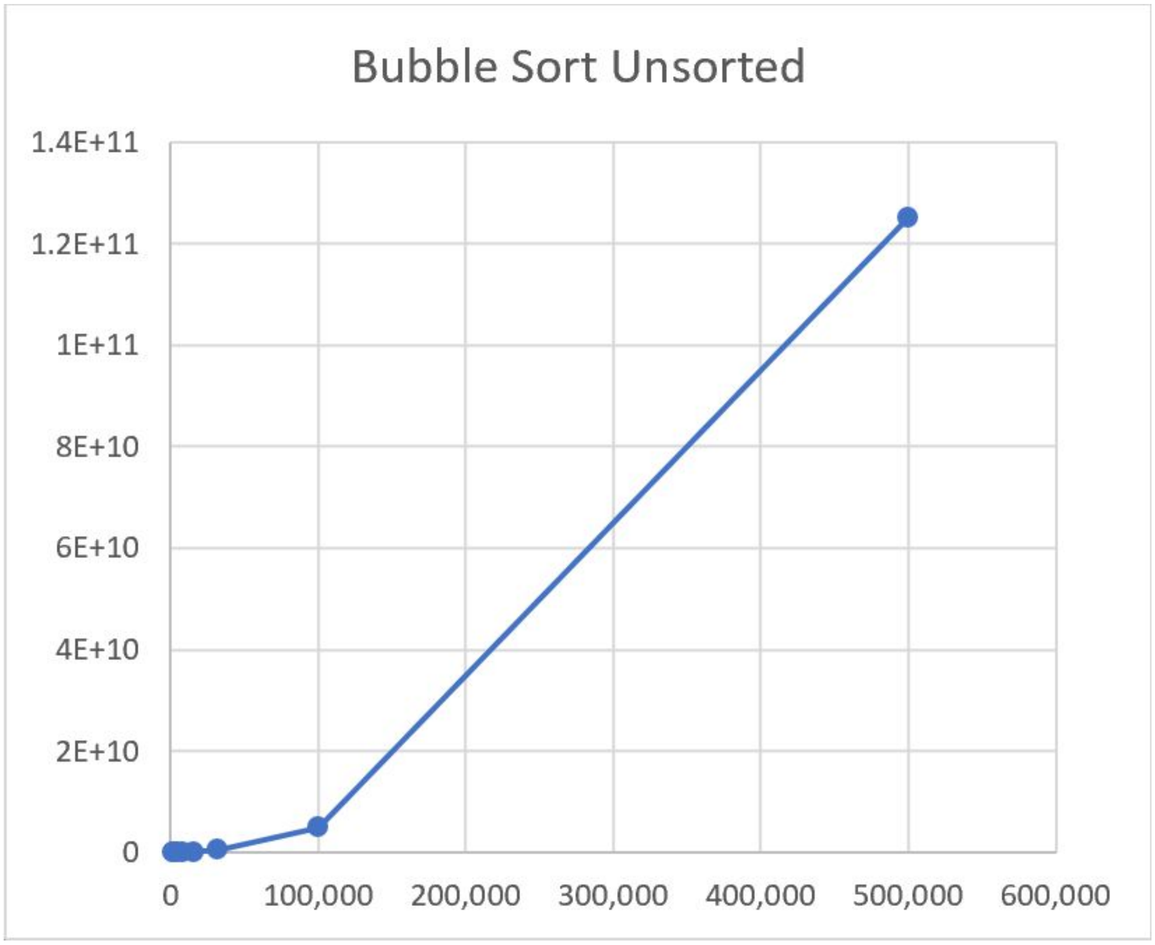
| **Algorithm Name:** Selection Sort **Type of list (sorted or unsorted):** Unsorted | | |
|---|---|---|
| **List Size** | **Comparisons** | **Time (seconds)** |
| ***1,000*** | 499500 | 0.100726843 |
| ***2,000*** | 1999000 | 0.177525759 |
| ***4,000*** | 7998000 | 0.695287943 |
| ***8,000*** | 31996000 | 2.842987537 |
| ***16,000*** | 127992000 | 13.24894118 |
| ***32,000*** | 511984000 | 52.55555224 |
| ***100,000*** | 4999950000 | 551.8558838 |
| ***500,000*** | 1.25E+11 | 13783.23895 |



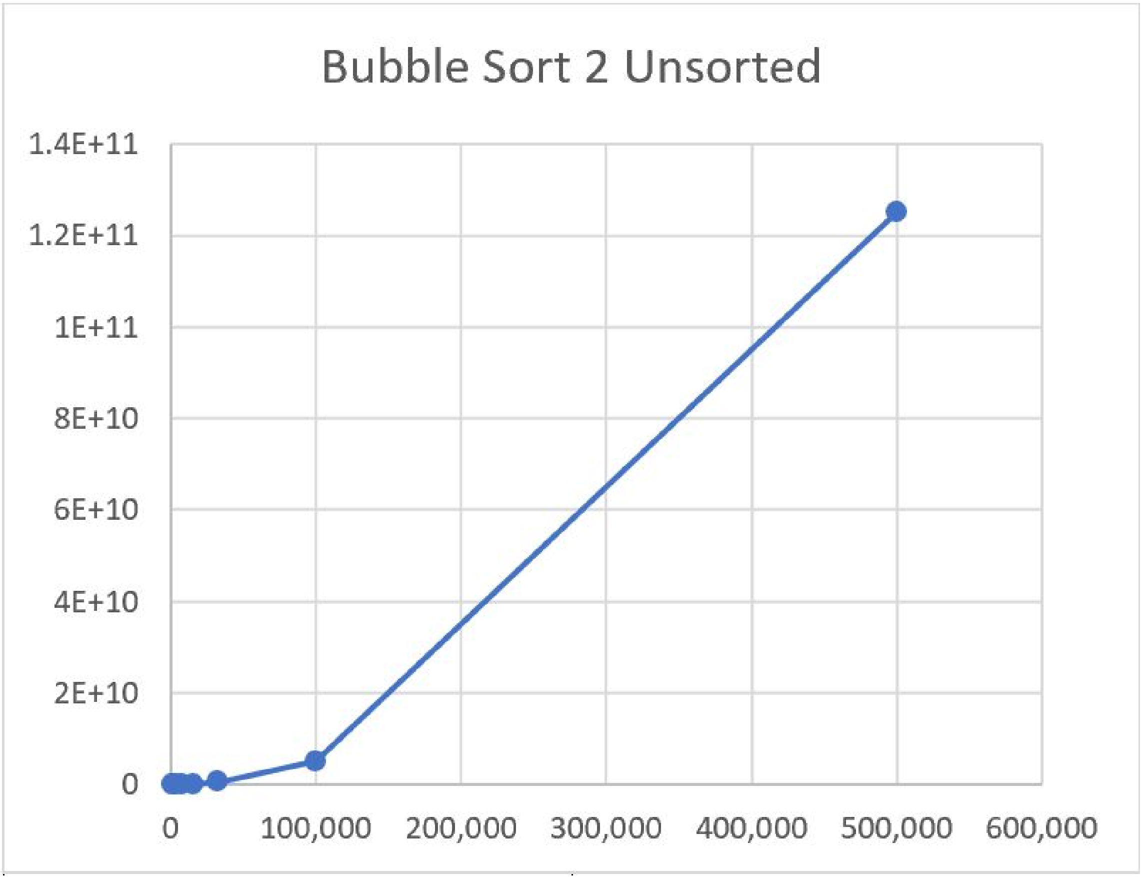
| **Algorithm Name:** Insertion Sort **Type of list (sorted or unsorted)**: Unsorted | | |
|---|---|---|
| **List Size** | **Comparisons** | **Time (seconds)** |
| ***1,000*** | 254537 | 0.106714725 |
| ***2,000*** | 1001444 | 0.365089893 |
| ***4,000*** | 3924671 | 1.202913761 |
| ***8,000*** | 15805755 | 7.329817772 |
| ***16,000*** | 64168190 | 25.53038287 |
| ***32,000*** | 255484302 | 127.7474024 |
| ***100,000*** | 2503767894 | 1104.433815 |
| ***500,000*** | 62604042310 | 26861.54812 |



| **Algorithm Name:** Bubble Sort **Type of list (sorted or unsorted)**: Unsorted | | |
|---|---|---|
| **List Size** | **Comparisons** | **Time (seconds)** |
| ***1,000*** | 499500 | 0.130650759 |
| ***2,000*** | 1999000 | 0.602388859 |
| ***4,000*** | 7998000 | 1.55147934 |
| ***8,000*** | 31996000 | 8.487509727 |
| ***16,000*** | 127992000 | 28.08123088 |
| ***32,000*** | 511984000 | 145.7774777 |
| ***100,000*** | 4999950000 | 1360.640545 |
| ***500,000*** | 1.25E+11 | 34023.29184 |

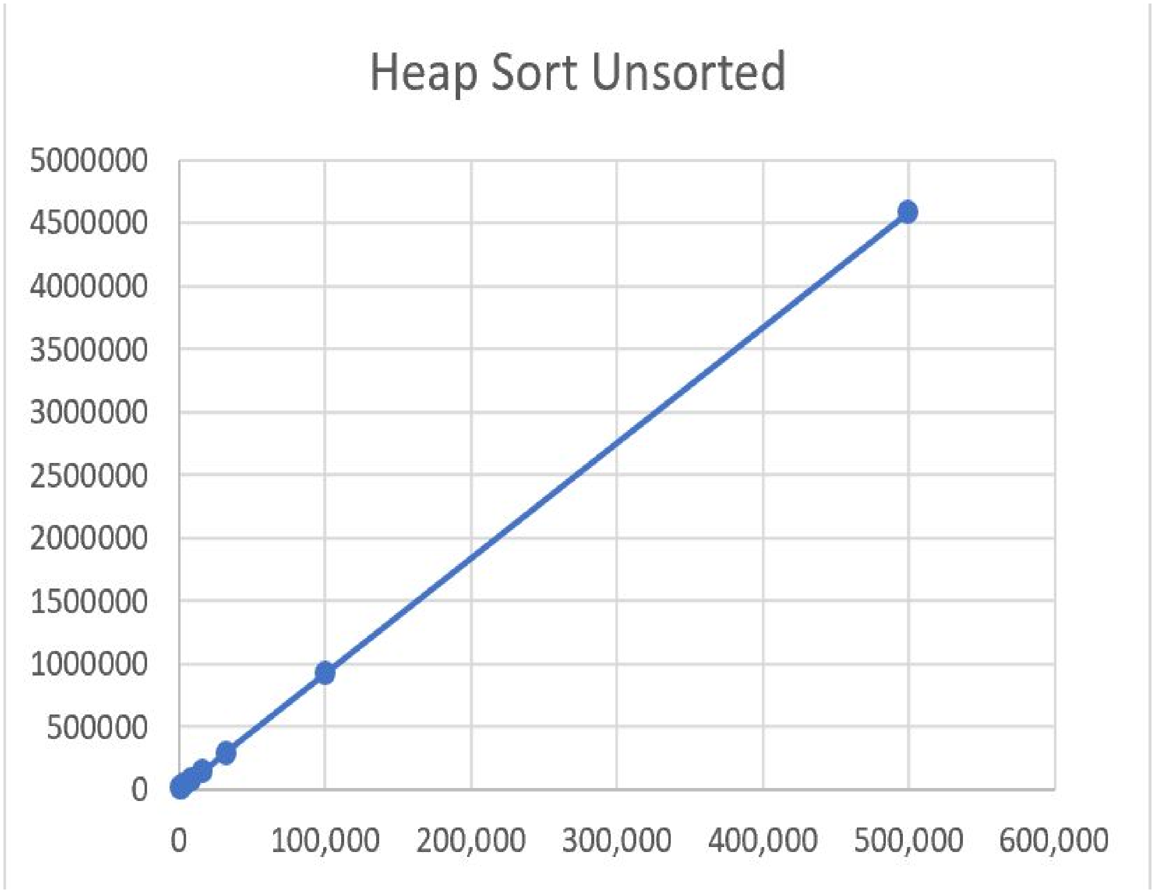


| **Algorithm Name:** Bubble Sort 2 **Type of list (sorted or unsorted)**: Unsorted | | |
|---|---|---|
| **List Size** | **Comparisons** | **Time (seconds)** |
| ***1,000*** | 499500 | 0.13463974 |
| ***2,000*** | 1999000 | 0.41385293 |
| ***4,000*** | 7998000 | 1.650394678 |
| ***8,000*** | 31996000 | 11.02213001 |
| ***16,000*** | 127992000 | 31.46189952 |
| ***32,000*** | 511984000 | 153.6349974 |
| ***100,000*** | 4999950000 | 1547.440754 |
| ***500,000*** | 1.25E+11 | 38567.18947 |

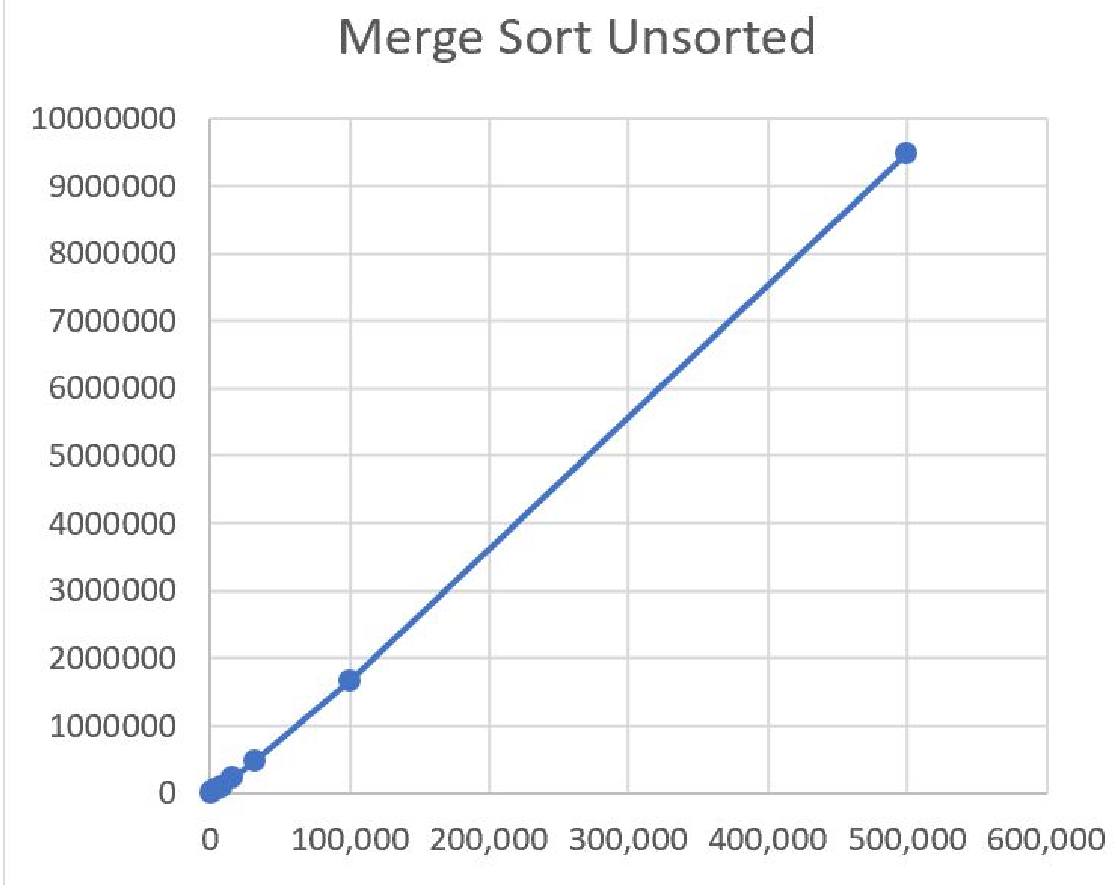


**Algorithm Name:** Heap Sort **Type of list (sorted or unsorted)**: Unsorted

| **List Size** | **Comparisons** | **Time (seconds)** |
|---|---|---|
| ***1,000*** | 9133 | 0.018948793 |
| ***2,000*** | 18378 | 0.028922081 |
| ***4,000*** | 36754 | 0.065820456 |
| ***8,000*** | 73320 | 0.127655029 |
| ***16,000*** | 147049 | 0.319850445 |
| ***32,000*** | 293736 | 0.627655029 |
| ***100,000*** | 918058 | 2.368775129 |
| ***500,000*** | 4589859 | 12.45573926 |

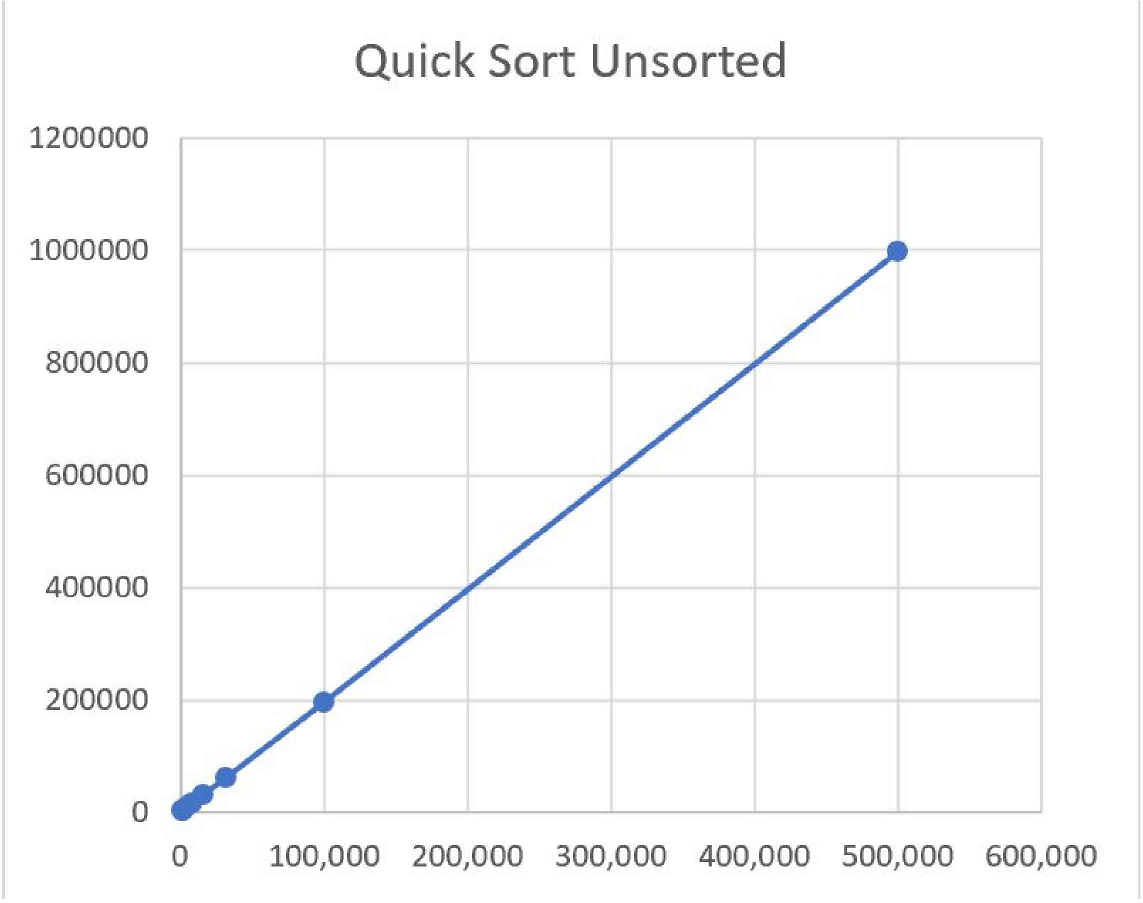


| **Algorithm Name:** Merge Sort **Type of list (sorted or unsorted)**: Unsorted | | |
|---|---|---|
| **List Size** | **Comparisons** | **Time (seconds)** |
| ***1,000*** | 9976 | 0.0039807 |
| ***2,000*** | 21952 | 0.007977724 |
| ***4,000*** | 47904 | 0.018950224 |
| ***8,000*** | 103808 | 0.035952091 |
| ***16,000*** | 223616 | 0.076794624 |
| ***32,000*** | 479232 | 0.169531583 |
| ***100,000*** | 1668928 | 0.624393992 |
| ***500,000*** | 9475712 | 4.560798407 |



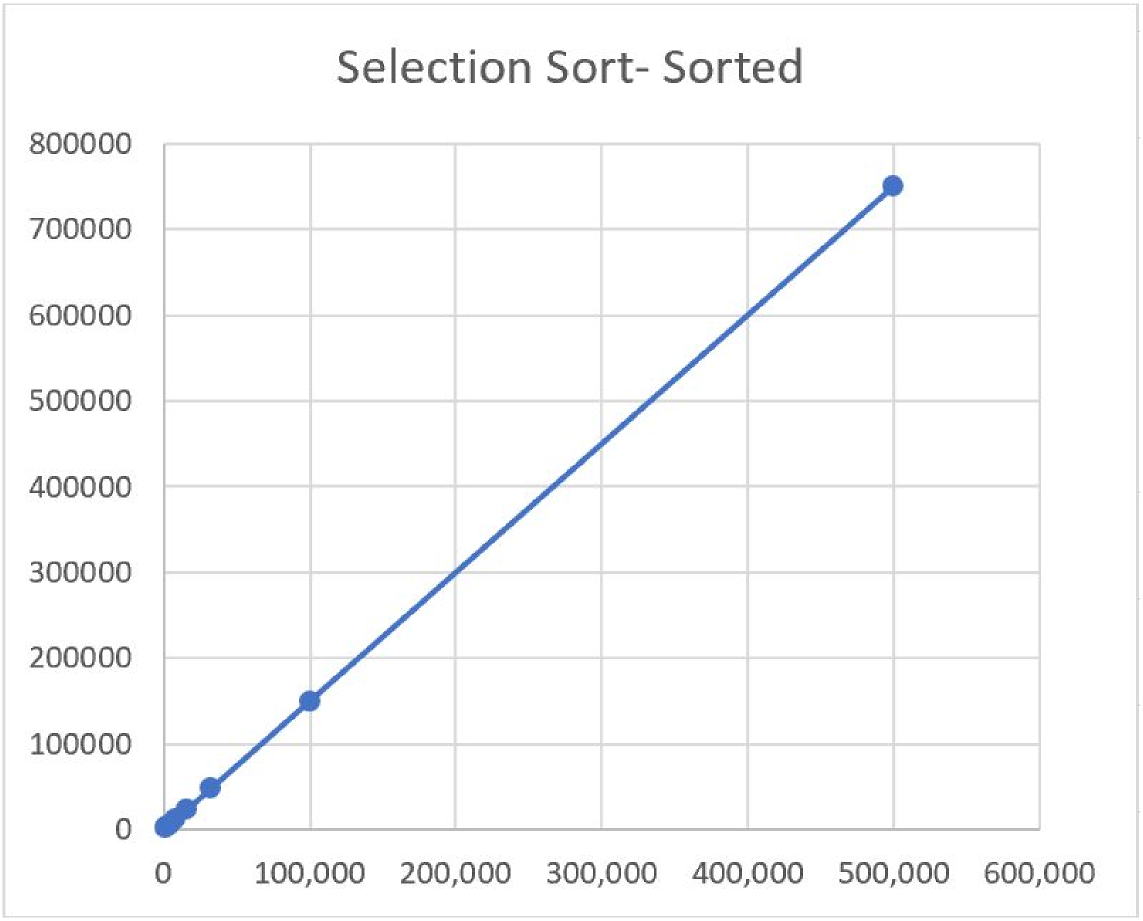
**Algorithm Name:** Quick Sort **Type of list (sorted or unsorted)**: Unsorted

| **List Size** | **Comparisons** | **Time (seconds)** |
|---|---|---|
| ***1,000*** | 1955 | 0.00498676 |
| ***2,000*** | 3921 | 0.006979942 |
| ***4,000*** | 7994 | 0.01600551 |
| ***8,000*** | 15410 | 0.0628314 |
| ***16,000*** | 30946 | 0.13364219 |
| ***32,000*** | 61431 | 0.151594161 |
| ***100,000*** | 196318 | 0.5575098 |
| ***500,000*** | 998307 | 3.179448307 |

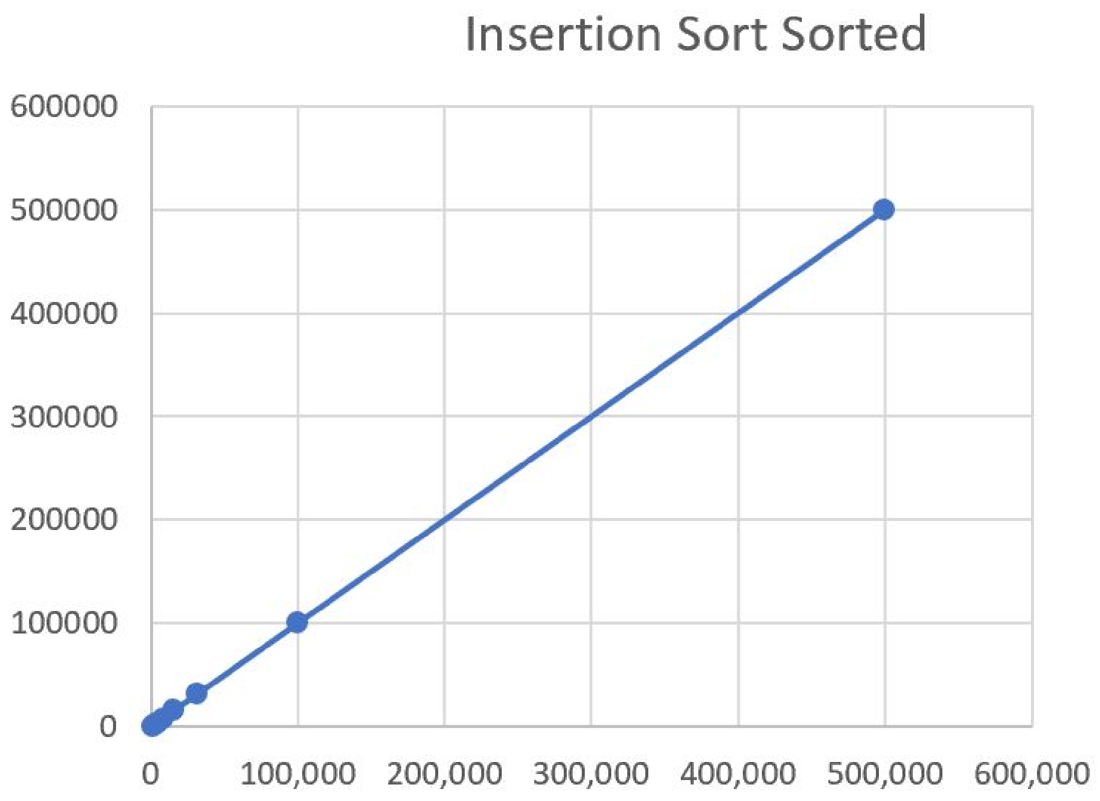


**Algorithm Name:** Selection Sort **Type of list (sorted or unsorted)**: Sorted

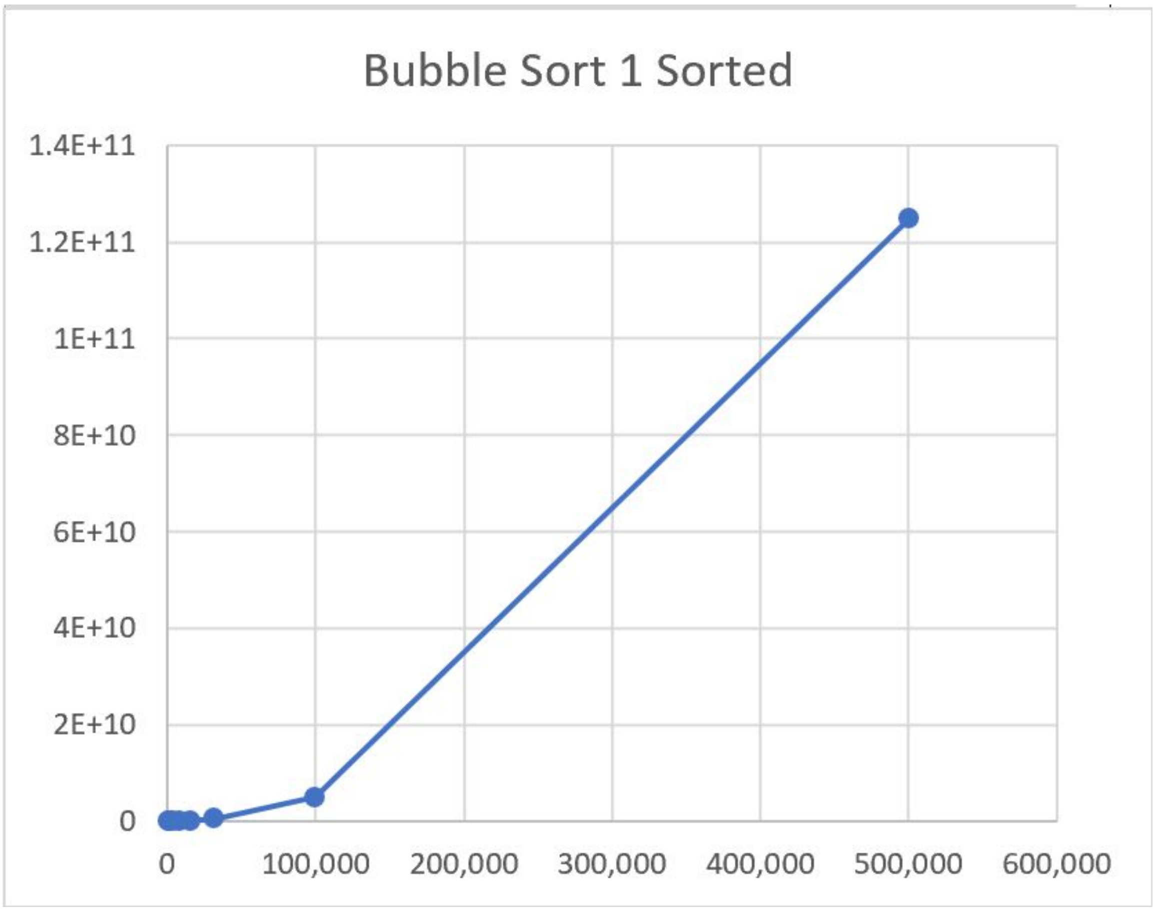
| **List Size** | **Comparisons** | **Time (seconds)** |
|---|---|---|
| ***1,000*** | 499500 | 0.044880629 |
| ***2,000*** | 1999000 | 0.261283398 |
| ***4,000*** | 7998000 | 1.317755699 |
| ***8,000*** | 31996000 | 4.2546556 |
| ***16,000*** | 127992000 | 21.27978373 |
| ***32,000*** | 511984000 | 121.7652142 |
| ***100,000*** | 4999950000 | 631.2235355 |
| ***500,000*** | 1.25E+11 | 16536.82662 |



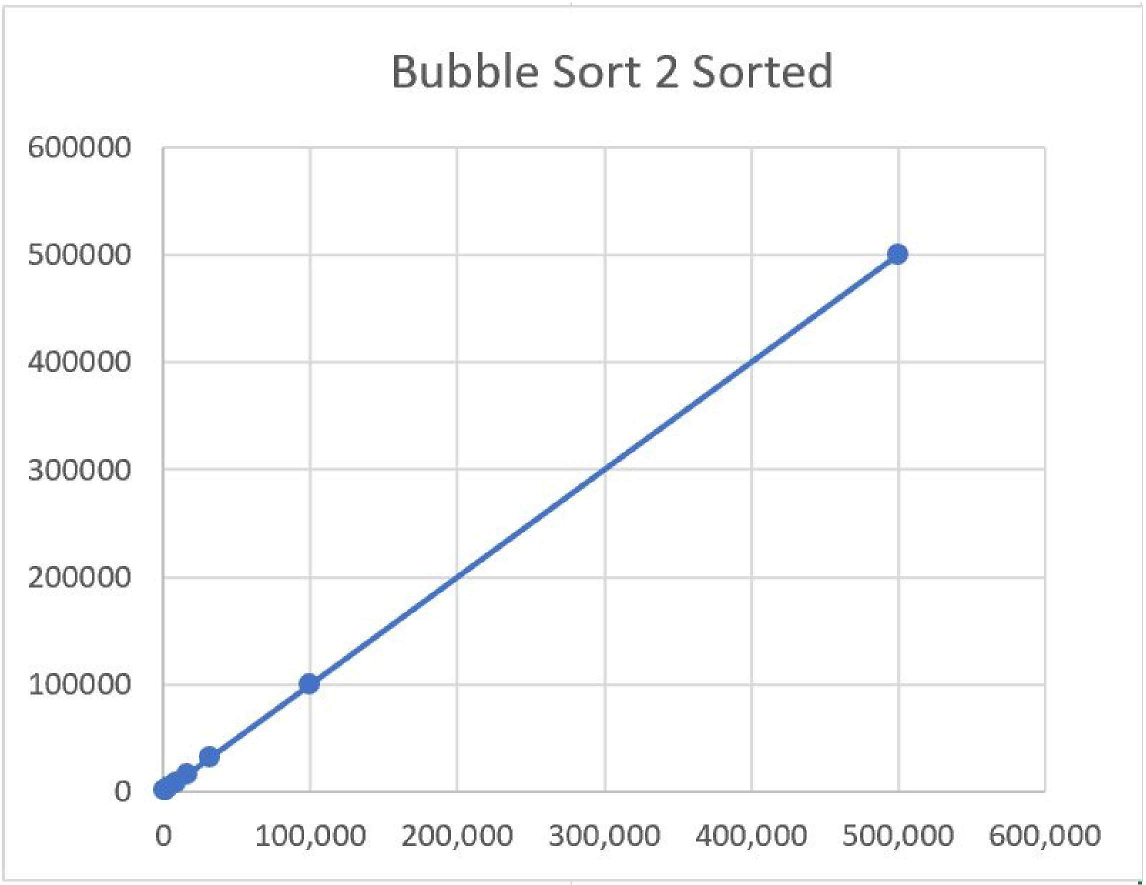
| **Algorithm Name:** Insertion Sort **Type of list (sorted or unsorted)**: Sorted | | |
|---|---|---|
| **List Size** | **Comparisons** | **Time (seconds)** |
| ***1,000*** | 1000 | 0 |
| ***2,000*** | 2000 | 0.000998259 |
| ***4,000*** | 4000 | 0 |
| ***8,000*** | 8000 | 0.001994848 |
| ***16,000*** | 16000 | 0.002992153 |
| ***32,000*** | 32000 | 0.008135319 |
| ***100,000*** | 100000 | 0.023546467 |
| ***500,000*** | 500000 | 0.099812327 |



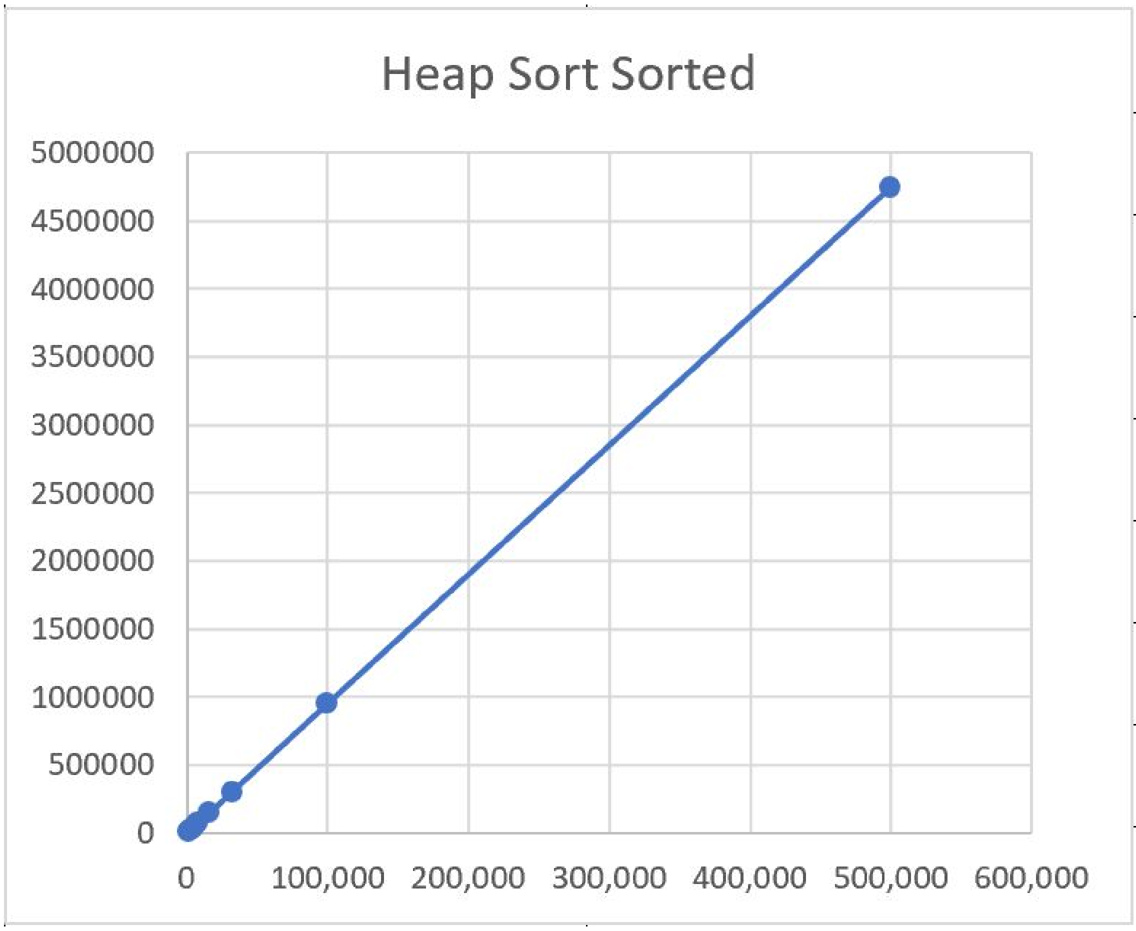
| **Algorithm Name:** Bubble Sort **Type of list (sorted or unsorted)**: Sorted | | |
|---|---|---|
| **List Size** | **Comparisons** | **Time (seconds)** |
| ***1,000*** | 499500 | 0.054882765 |
| ***2,000*** | 1999000 | 0.384944677 |
| ***4,000*** | 7998000 | 1.298999071 |
| ***8,000*** | 31996000 | 4.727323532 |
| ***16,000*** | 127992000 | 19.35224652 |
| ***32,000*** | 511984000 | 82.82352614 |
| ***100,000*** | 4999950000 | 264.896219 |
| ***500,000*** | 1.25E+11 | 6,605.99 |



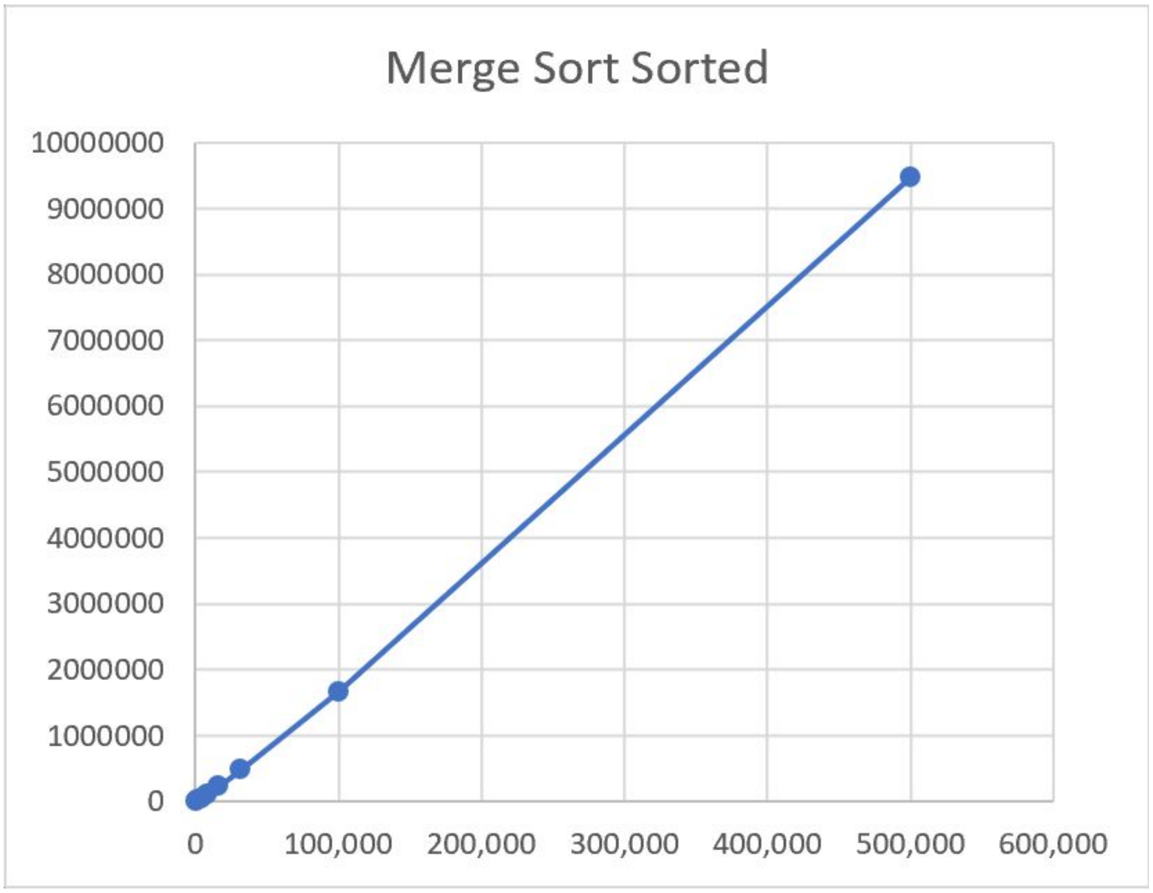
| **Algorithm Name:** Bubble Sort 2 **Type of list (sorted or unsorted)**: Sorted | | |
|---|---|---|
| **List Size** | **Comparisons** | **Time (seconds)** |
| ***1,000*** | 999 | 0 |
| ***2,000*** | 1999 | 0.001991749 |
| ***4,000*** | 3999 | 0.001005173 |
| ***8,000*** | 7999 | 0.000997305 |
| ***16,000*** | 15999 | 0.002991676 |
| ***32,000*** | 31999 | 0.005835533 |
| ***100,000*** | 99999 | 0.018264299 |
| ***500,000*** | 499999 | 0.090095116 |



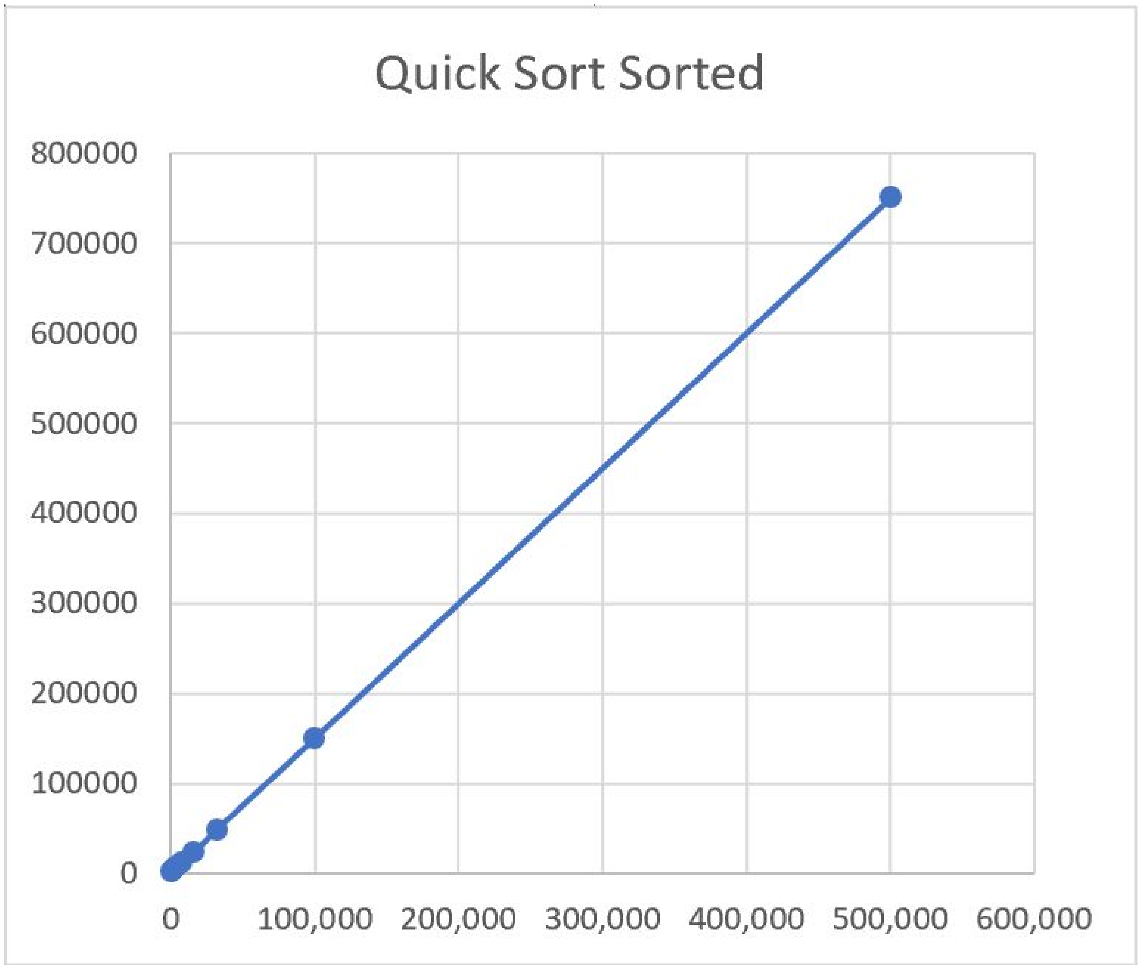
| **Algorithm Name:** Heap Sort **Type of list (sorted or unsorted)**: Sorted | | |
|---|---|---|
| **List Size** | **Comparisons** | **Time (seconds)** |
| ***1,000*** | 9487 | 0.010970116 |
| ***2,000*** | 18987 | 0.044883966 |
| ***4,000*** | 37987 | 0.049902916 |
| ***8,000*** | 75990 | 0.118682384 |
| ***16,000*** | 151987 | 0.252325535 |
| ***32,000*** | 303987 | 0.51361537 |
| ***100,000*** | 949987 | 1.66358279 |
| ***500,000*** | 4,749,987 | 8.533004693 |



| **Algorithm Name:** Merge Sort **Type of list (sorted or unsorted)**: Sorted | | |
|---|---|---|
| **List Size** | **Comparisons** | **Time (seconds)** |
| ***1,000*** | 9976 | 0.003044605 |
| ***2,000*** | 21952 | 0.005984545 |
| ***4,000*** | 47904 | 0.013013601 |
| ***8,000*** | 103808 | 0.033909559 |
| ***16,000*** | 223616 | 0.064824819 |
| ***32,000*** | 479232 | 0.142617702 |
| ***100,000*** | 1668928 | 0.472735404 |
| ***500,000*** | 9475712 | 2.891264677 |



| **Algorithm Name:** Quick Sort **Type of list (sorted or unsorted)**: Sorted | | |
|---|---|---|
| **List Size** | **Comparisons** | **Time (seconds)** |
| ***1,000*** | 1500 | 0.001995325 |
| ***2,000*** | 3000 | 0.00398922 |
| ***4,000*** | 6000 | 0.008959055 |
| ***8,000*** | 12000 | 0.017952204 |
| ***16,000*** | 24000 | 0.040890217 |
| ***32,000*** | 48000 | 0.085768938 |
| ***100,000*** | 150000 | 0.285238743 |
| ***500,000*** | 750000 | 1.740348816 |



***1. Which sort do you think is better? Why?***

Meha and Sullivan came to the conclusion that Merge Sort is probably the best of out of all of these algorithms. It is the most consistent because it's stable, fast O(nlog(n)), and easy to implement. It also has the ability to be implemented in constant space, however in naive implementation it is O(n) space.

***2. Which sort is better when sorting a list that is already sorted (or mostly sorted)? Why?***

Insertion sort is the best when sorting a list that is already sorted because it only swaps IF the current unsorted is less than the last sorted, this means that the best case time complexity is O(n). It's also stable so it is better than bubble sort 2.

***3. You probably found that insertion sort had about half as many comparisons as selection sort. Why? Why are the times for insertion sort not half what they are for selection sort?***

The times for insertion sort isn't half what the time is for selection sort even though insertion has half the amount of comparisons is because swapping things takes a lot more time than searching for the largest item and then swapping once.