**Assignment – 6 (Hits as time predictor)**

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***In this assignment, your task is to determine--for sorting algorithms--what is the best predictor of total execution time: comparisons, swaps/copies, hits (array accesses), or something else. You will run the benchmarks for merge sort, (dual-pivot) quick sort, and heap sort. You will sort randomly generated arrays of between 10,000 and 256,000 elements (doubling the size each time). If you use the SortBenchmark, as I expect, the number of runs is chosen for you. So, you can ignore the instructions about setting the number of runs. For each experiment (a sort method of a given size), you will run it twice: once for the instrumentation, once (without instrumentation) for the timing.***

**\*\*\*All codes, outputs, test cases and report is added in this folder, kindly refer\*\*\***

**Conclusion:**  
A comparative analysis of Merge Sort, Quick Dual Pivot sort, and Heap Sort was conducted, using various array lengths (N) and measuring the number of compares, swaps, and execution time (T). The findings reveal that the number of compares serves as the most reliable predictor of execution time. This conclusion was drawn after analyzing Log-Log graphs of N vs. T and N vs. compares, which indicated that the Comparison values are highly correlated with the execution time (T). Conversely, the Log-Log graph of N vs. T and N vs. Swaps yielded significantly different results for all three sorting techniques. Thus, the evidence suggests that **comparisons** offer the best predictor of execution time among the three sorting techniques.

**Results:**

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Heap Sort 20 runs** | | | | | | | |
| **Array Size** | **Compares** | **Log(Compares)** | **Swaps** | **Log(Swaps)** | **Hits** | **Time (ns)** | **Log(Time)** |
| 1000 | 402046 | 12.90432179 | 220923 | 12.3055695 | 1687784 | 1.8738875 | 0.62801515 |
| 2000 | 899720 | 13.70983888 | 490942 | 13.10408127 | 3763208 | 3.63381665 | 1.29028351 |
| 4000 | 1987168 | 14.50222107 | 1077138 | 13.88981808 | 8282888 | 13.721725 | 2.61898034 |
| 8000 | 4347595 | 15.28513338 | 2337815 | 14.66472729 | 18046450 | 68.3265271 | 4.22429808 |
| 16000 | 9437306 | 16.06018112 | 5044293 | 15.43376806 | 39051784 | 298.744844 | 5.69958984 |
| 32000 | 20355982 | 16.82888538 | 10837995 | 16.19856857 | 84063944 | 1187.47557 | 7.07958497 |
| 64000 | 43678047 | 17.59235618 | 23182016 | 16.95888736 | 180084158 | 5759.08222 | 8.6585334 |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Merge Sort 20 runs** | | | | | | | |
| **Array Size** | **Compares** | **Log(Compares)** | **Swaps** | **Log(Swaps)** | **Hits** | **Time (ns)** | **Log(Time)** |
| 1000 | 363699 | 12.80408188 | 256277 | 12.45401417 | 1413664 | 0.6358375 | -0.4528123 |
| 2000 | 1240875 | 14.03132733 | 1004005 | 13.81950756 | 4881184 | 0.45551875 | -0.7863184 |
| 4000 | 4526426 | 15.32544322 | 4008664 | 15.20396858 | 17941028 | 0.50321875 | -0.6867303 |
| 8000 | 17247440 | 16.66317428 | 16123889 | 16.59581252 | 68660354 | 0.82983125 | -0.1865329 |
| 16000 | 66423764 | 18.01156544 | 64000626 | 17.97440342 | 265036172 | 1.2005625 | 0.1827902 |
| 32000 | 260879182 | 19.37956795 | 255680875 | 19.35944064 | 1042198898 | 2.54606045 | 0.93454724 |
| 64000 | 1032736073 | 20.7554775 | 1021635435 | 20.74467055 | -166658712 | 6.248975 | 1.83241745 |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Quick Sort Dual Pivot 20 runs** | | | | | | | |
| **Array Size** | **Compares** | **Log(Compares)** | **Swaps** | **Log(Swaps)** | **Hits** | **Time (ns)** | **Log(Time)** |
| 1000 | 3946346 | 15.18830065 | 25361 | 10.14096784 | 4079680 | 1.36486875 | 0.31105827 |
| 2000 | 16705940 | 16.6312749 | 51380 | 10.84700427 | 16975474 | 6.9749271 | 1.94232188 |
| 4000 | 68624884 | 18.04416577 | 105060 | 11.56228689 | 69173423 | 7.48161875 | 2.01244918 |
| 8000 | 242872534 | 19.30804731 | 212901 | 12.26858255 | 243980825 | 15.6632646 | 2.75131814 |
| 16000 | 1433900579 | 21.08366425 | 451702 | 13.02077795 | 1436220951 | 96.0446979 | 4.56481369 |
| 32000 | 847856347 | 20.55822178 | 883260 | 13.69137489 | 852416978 | 304.5439 | 5.71881525 |
| 64000 | 1370958447 | 21.03877593 | 1812041 | 14.40996439 | 1380262089 | 1293.25075 | 7.16491429 |