Program Structures and Algorithms

Spring 2023(SEC – 03)

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**Task: Hits as time predictor**

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.

Of course, you will be using the Benchmark and/or Timer classes, as you did in a previous assignment.

You must support your (clearly stated) conclusions with evidence from the benchmarks (you should provide log/log charts and spreadsheets typically).

**Relationship Conclusion:**

Swaps determine the Execution Time in MergeSort Dual Pivots algorithm.

Compares and Swaps determine the Execution Time in QuickSort Dual Pivots algorithm.

Compares and Swaps determine the Execution Time in HeapSort Dual Pivots algorithm.

**Evidence to support that conclusion:**

**MergeSort:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Size** | **Compares** | **Swaps** | **Copies** | **Time/ms** |
| **10000** | **123510** | **9845** | **109924** | **3.1** |
| **20000** | **267222** | **19623** | **239911** | **5.02** |
| **40000** | **574245** | **39141** | **519768** | **10.22** |
| **80000** | **1228367** | **78047** | **1119614** | **21.96** |
| **160000** | **2616730** | **156242** | **2399267** | **46.58** |
| **256000** | **4361088** | **224134** | **4050043** | **83.63** |

**QuickSort:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Size** | **Compares** | **Swaps** | **Copies** | **Time/ms** |
| **10000** | **151787** | **62014** | **0** | **2.44** |
| **20000** | **338489** | **143257** | **0** | **3.19** |
| **40000** | **712249** | **312090** | **0** | **6.32** |
| **80000** | **1534839** | **626596** | **0** | **14.21** |
| **160000** | **3265825** | **1377444** | **0** | **32.03** |
| **256000** | **5525002** | **2190632** | **0** | **51.07** |

**HeapSort:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Size** | **Compares** | **Swaps** | **Copies** | **Time/ms** |
| **10000** | **235428** | **124359** | **0** | **1.46** |
| **20000** | **510871** | **268486** | **0** | **3.41** |
| **40000** | **1101626** | **576966** | **0** | **8.14** |
| **80000** | **2362945** | **1233684** | **0** | **18.12** |
| **160000** | **5046377** | **2627574** | **0** | **40.77** |
| **256000** | **8409908** | **4371737** | **0** | **72.94** |

**Graphical Representation:**

**MergeSort:**

**QuickSort:**

**HeapSort:**

**Unit Test Screenshots:**

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