Program Structures and Algorithms

Spring 2023(SEC –01)

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**Task:**

In this assignment we must determine -what is the best predictor of total execution time: comparisons, swaps/copies, hits (array accesses), or something else for the sorting algorithms

The job is to determine the best predictor: that will mean the graph of the appropriate observation will match the graph of the timings most closely.

**Relationship Conclusion:** From the graphs, it can be concluded that the best predictor of total execution time is **hits and comparisons**

**Evidence to support that conclusion:**

1. **Heap sort:**

**Chart, line chart

Description automatically generated**

**Chart, line chart

Description automatically generated**

**For each sorting algorithms I have created driver classes in “src/test/edu/neu/coe/info6205/sort/”**

**The outputs of each driver classes is at the end of this report**

1. **Merge sort:**

**Chart, line chart

Description automatically generated**

**Chart, line chart

Description automatically generated**

1. **Quick Sort Dual Pivot**

**Chart, line chart

Description automatically generated**

**Chart, line chart

Description automatically generated**

**Unit Test Screenshots: I have implemented the merge sort class and run the tests. Following is the output of test cases:**

**Text

Description automatically generated**

**Driver Class outputs:**

--------------- HeapSort Instrument Variables -----------------

HeapSort instrument variables of 10000-sized array

Compares: 235358

Inversions : 25072583

Fixes: 75657401

Swaps: 124123

Copies: 0

Hits: 967208

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HeapSort instrument variables of 20000-sized array

Compares: 510744

Inversions : 100463350

Fixes: 302791982

Swaps: 268455

Copies: 0

Hits: 2095308

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HeapSort instrument variables of 40000-sized array

Compares: 1101301

Inversions : 401255943

Fixes: 1207945171

Swaps: 576692

Copies: 0

Hits: 4509370

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HeapSort instrument variables of 80000-sized array

Compares: 2362887

Inversions : 1595600601

Fixes: 542247809

Swaps: 1233643

Copies: 0

Hits: 9660346

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HeapSort instrument variables of 160000-sized array

Compares: 5046109

Inversions : 2112582720

Fixes: -2103419078

Swaps: 2626988

Copies: 0

Hits: 20600170

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HeapSort instrument variables of 256000-sized array

Compares: 8410973

Inversions : -791687146

Fixes: -1967449017

Swaps: 4371907

Copies: 0

Hits: 34309574

----------------- MergeSort Execution Time -----------------

2023-03-12 22:27:17 INFO Benchmark\_Timer - Begin run: MergeSort with 100 runs

Array size: 10000 - 6.32ms.

2023-03-12 22:27:18 INFO Benchmark\_Timer - Begin run: MergeSort with 100 runs

Array size: 20000 - 4.09ms.

2023-03-12 22:27:18 INFO Benchmark\_Timer - Begin run: MergeSort with 100 runs

Array size: 40000 - 8.39ms.

2023-03-12 22:27:19 INFO Benchmark\_Timer - Begin run: MergeSort with 100 runs

Array size: 80000 - 17.96ms.

2023-03-12 22:27:21 INFO Benchmark\_Timer - Begin run: MergeSort with 100 runs

Array size: 160000 - 38.23ms.

2023-03-12 22:27:25 INFO Benchmark\_Timer - Begin run: MergeSort with 100 runs

Array size: 256000 - 65.79ms.

--------------- MergeSort Instrumentation -----------------

MergeSort instrument variables of 10000-sized array

Compares: 123555

Inversions : 25061169

Fixes: 25061169

Swaps: 9661

Copies: 109972

Hits: 292834

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MergeSort instrument variables of 20000-sized array

Compares: 266905

Inversions : 99958312

Fixes: 99958312

Swaps: 19328

Copies: 239934

Hits: 625738

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MergeSort instrument variables of 40000-sized array

Compares: 574126

Inversions : 399316527

Fixes: 399316527

Swaps: 39059

Copies: 519862

Hits: 1333372

---------------------------------------------------------------

MergeSort instrument variables of 80000-sized array

Compares: 1228029

Inversions : 1609551723

Fixes: 1609551723

Swaps: 77596

Copies: 1119600

Hits: 2823708

---------------------------------------------------------------

MergeSort instrument variables of 160000-sized array

Compares: 2615643

Inversions : 2102666607

Fixes: 2102666607

Swaps: 155778

Copies: 2399306

Hits: 5970984

---------------------------------------------------------------

MergeSort instrument variables of 256000-sized array

Compares: 4361284

Inversions : -755167594

Fixes: -755167594

Swaps: 224317

Copies: 4050026

Hits: 9823178

----------------- QuickSort Execution Time -----------------

2023-03-12 22:38:47 INFO Benchmark\_Timer - Begin run: QuickSort Dual Pivots with 100 runs

Array size: 10000 - 2.34ms.

2023-03-12 22:38:47 INFO Benchmark\_Timer - Begin run: QuickSort Dual Pivots with 100 runs

Array size: 20000 - 2.86ms.

2023-03-12 22:38:48 INFO Benchmark\_Timer - Begin run: QuickSort Dual Pivots with 100 runs

Array size: 40000 - 5.89ms.

2023-03-12 22:38:48 INFO Benchmark\_Timer - Begin run: QuickSort Dual Pivots with 100 runs

Array size: 80000 - 13.57ms.

2023-03-12 22:38:50 INFO Benchmark\_Timer - Begin run: QuickSort Dual Pivots with 100 runs

Array size: 160000 - 29.09ms.

2023-03-12 22:38:53 INFO Benchmark\_Timer - Begin run: QuickSort Dual Pivots with 100 runs

Array size: 256000 - 48.06ms.

--------------- QuickSort Dual Pivots Instrument Variables -----------------

QuickSort Dual Pivots instrument variables of 10000-sized array

Instrumenting helper for QuickSort Dual Pivots with 10,000 elements

Compares: 151787

Inversions : 24835299

Fixes: 26745524

Swaps: 62014

Copies: 0

Hits:410395

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QuickSort Dual Pivots instrument variables of 20000-sized array

Instrumenting helper for QuickSort Dual Pivots with 20,000 elements

Compares: 338489

Inversions : 99832908

Fixes: 116888905

Swaps: 143257

Copies: 0

Hits:932709

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QuickSort Dual Pivots instrument variables of 40000-sized array

Instrumenting helper for QuickSort Dual Pivots with 40,000 elements

Compares: 712249

Inversions : 399394145

Fixes: 412346524

Swaps: 312090

Copies: 0

Hits:2003626

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QuickSort Dual Pivots instrument variables of 80000-sized array

Instrumenting helper for QuickSort Dual Pivots with 80,000 elements

Compares: 1534839

Inversions : 1600340564

Fixes: 1657079617

Swaps: 626596

Copies: 0

Hits:4126088

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QuickSort Dual Pivots instrument variables of 160000-sized array

Instrumenting helper for QuickSort Dual Pivots with 160,000 elements

Compares: 3265825

Inversions : 2086294638

Fixes: -2019215870

Swaps: 1377444

Copies: 0

Hits:8945731

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QuickSort Dual Pivots instrument variables of 256000-sized array

Instrumenting helper for QuickSort Dual Pivots with 256,000 elements

Compares: 5525002

Inversions : -791837983

Fixes: -348235107

Swaps: 2190632

Copies: 0

Hits:14559765

