Program Structures and Algorithms
Spring 2023(SEC – 8)

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Task:
(Part 1) You are to implement three (3) methods (repeat, getClock, and toMillisecs) of a class called Timer.
(Part 2) Implement *InsertionSort* (in the *InsertionSort* class).
(Part 3) Implement a main program (or you could do it via your own unit tests) to actually run the following benchmarks.

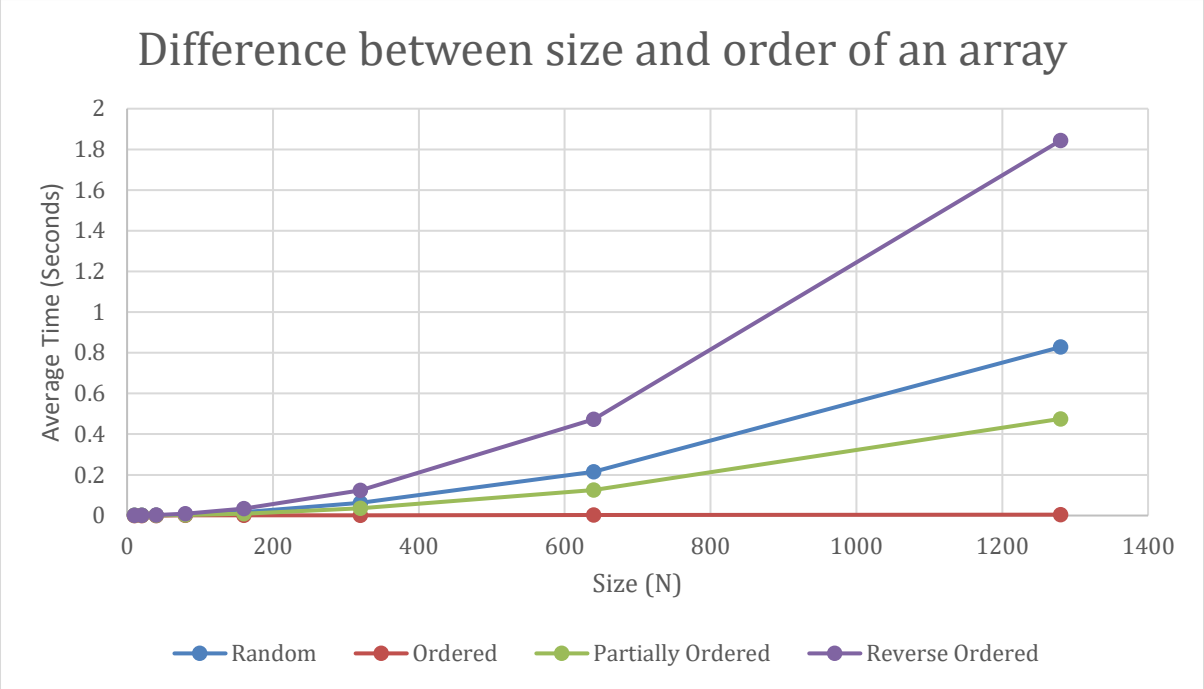
Relationship Conclusion:
After running the InsertionSORT_Benchmark class, the code is repeated several times by using the doubling method, to test for different array sizes. It ranges from 10 to 1280 for 4 different types of array types which are random ordered , ordered, partially ordered and reverse ordered, running for 10000 each. The conclusion I came up with after looking at the output on a graph is that, the insertion sort takes longest to run when it is reversely sorted, because it has to swap every 2nd element in the array. This is considered the worst possible outcome. The least amount of time is take with the ordered array.
The relation between all 4 types of array can be concluded as:

Reversely Ordered > Randomly Ordered > Partially Ordered > Ordered

This can be seen below in the graph showing all 4 array types together.

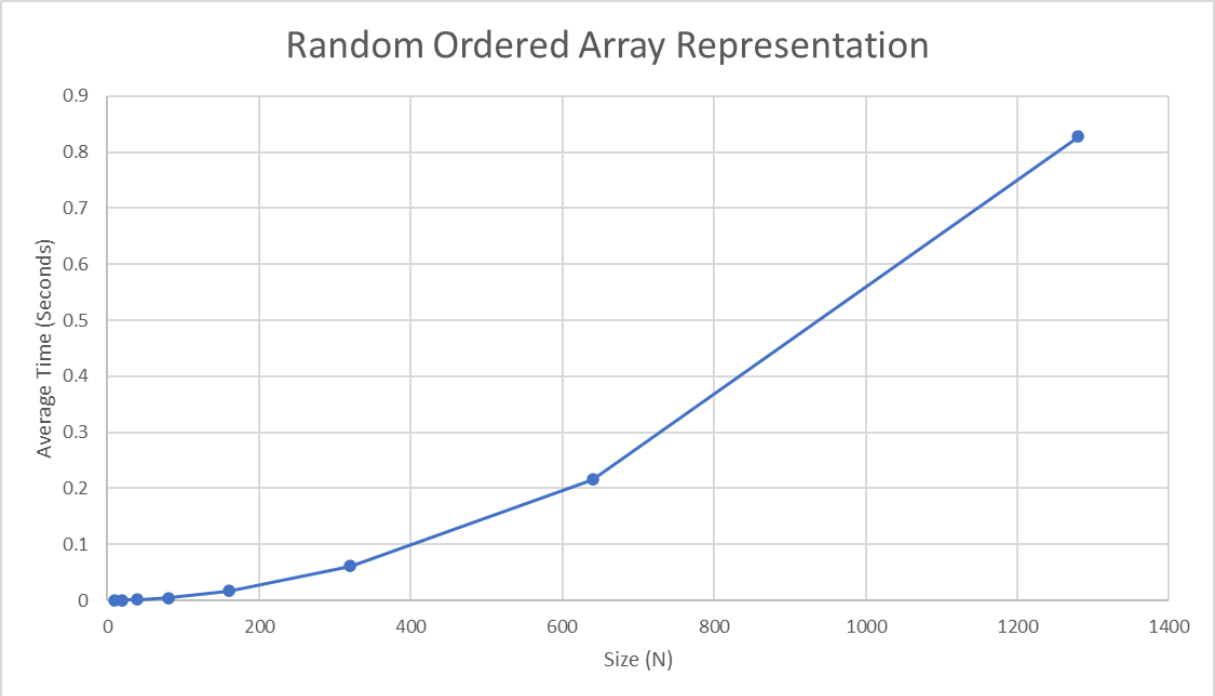
Evidence to support that conclusion:

N	Random	Ordered	Partially Ordered	Reverse Ordered
10	8.10E-04	1.78E-04	3.56E-04	2.48E-04
20	6.07E-04	1.34E-04	3.78E-04	6.72E-04
40	0.0014153	1.70E-04	7.33E-04	0.00237049
80	0.0043254	2.72E-04	0.00218614	0.00868187
160	0.016689	0.00120516	0.0089089	0.03398839
320	0.0618017	0.00119903	0.03521216	0.1232317
640	0.2156449	0.00243938	0.12484272	0.47282052
1280	0.8280267	0.00424189	0.47531732	1.84360869

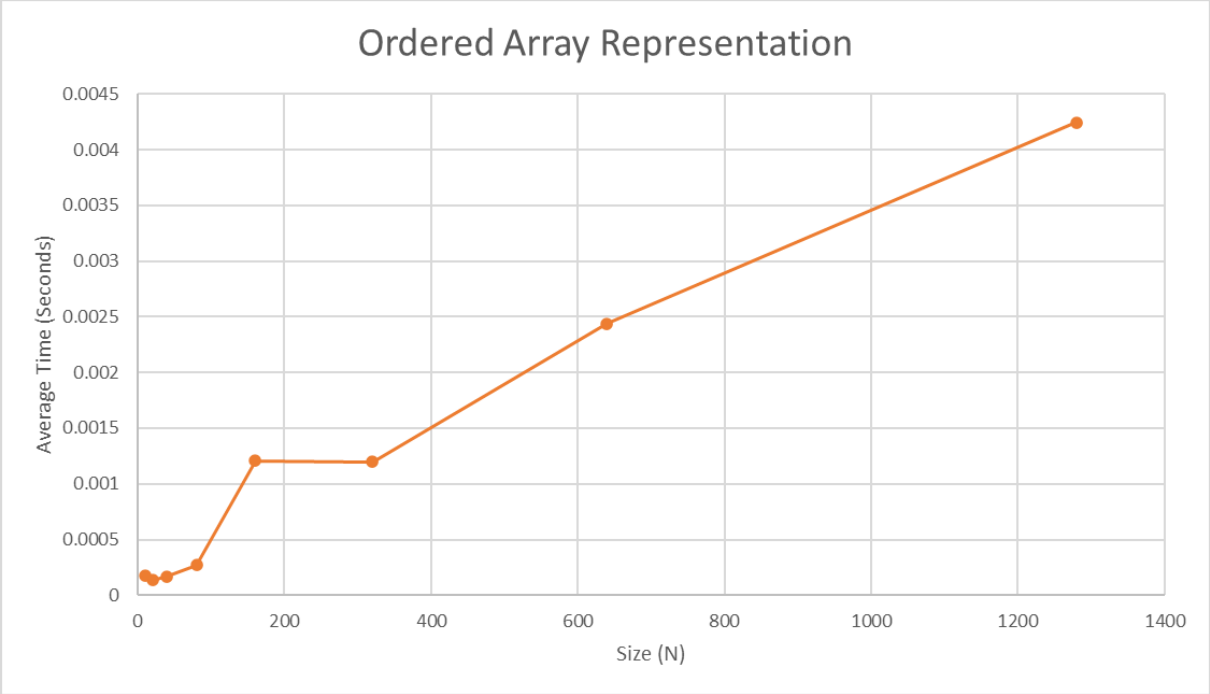


Graphical Representation:

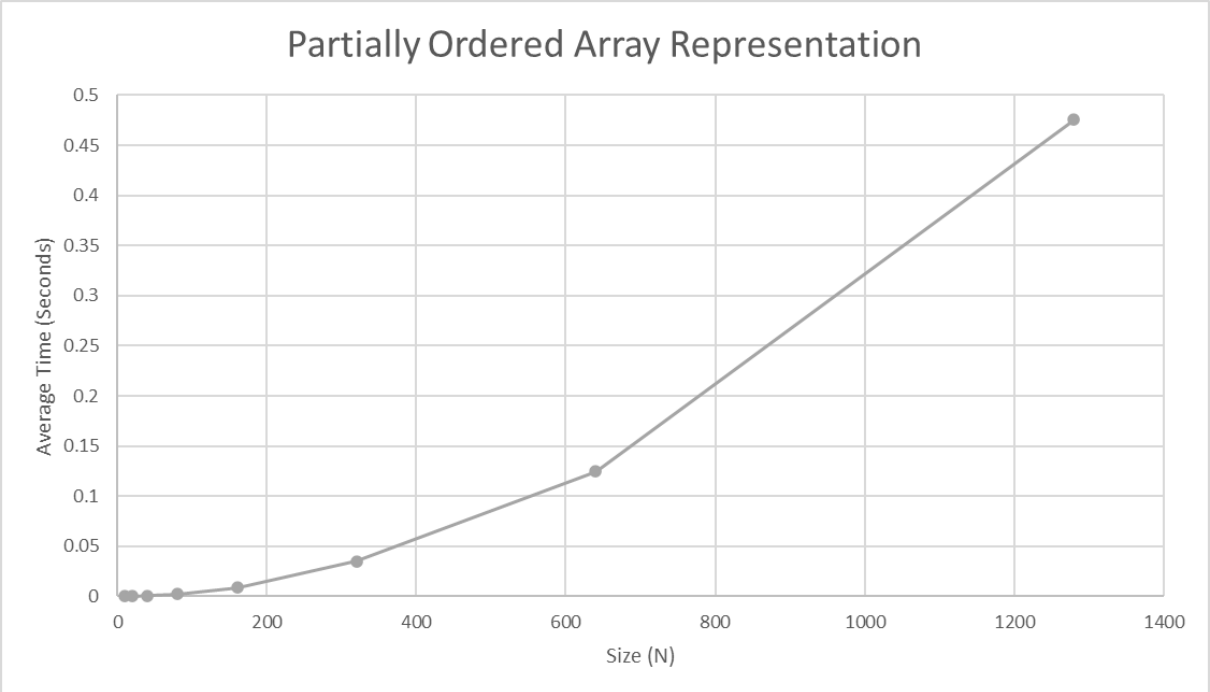
Random Ordered Array – Average Time vs Size of Array



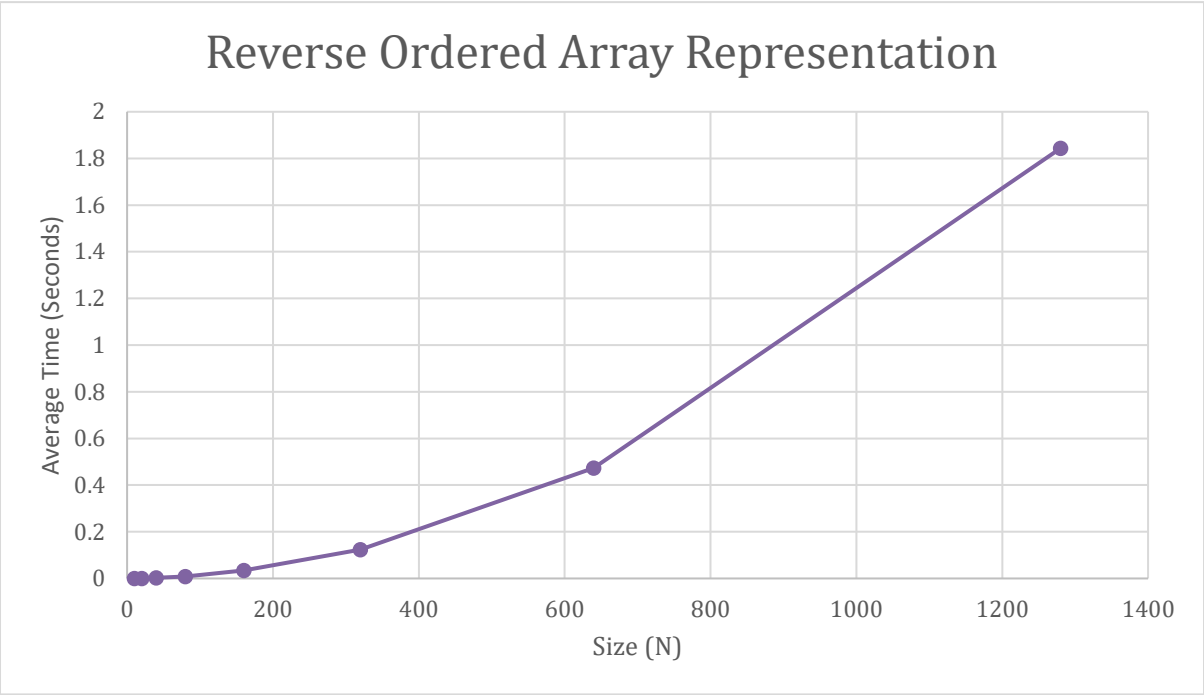
Ordered Array – Average Time vs Size of Array



Partially Ordered Array – Average Time vs Size of Array

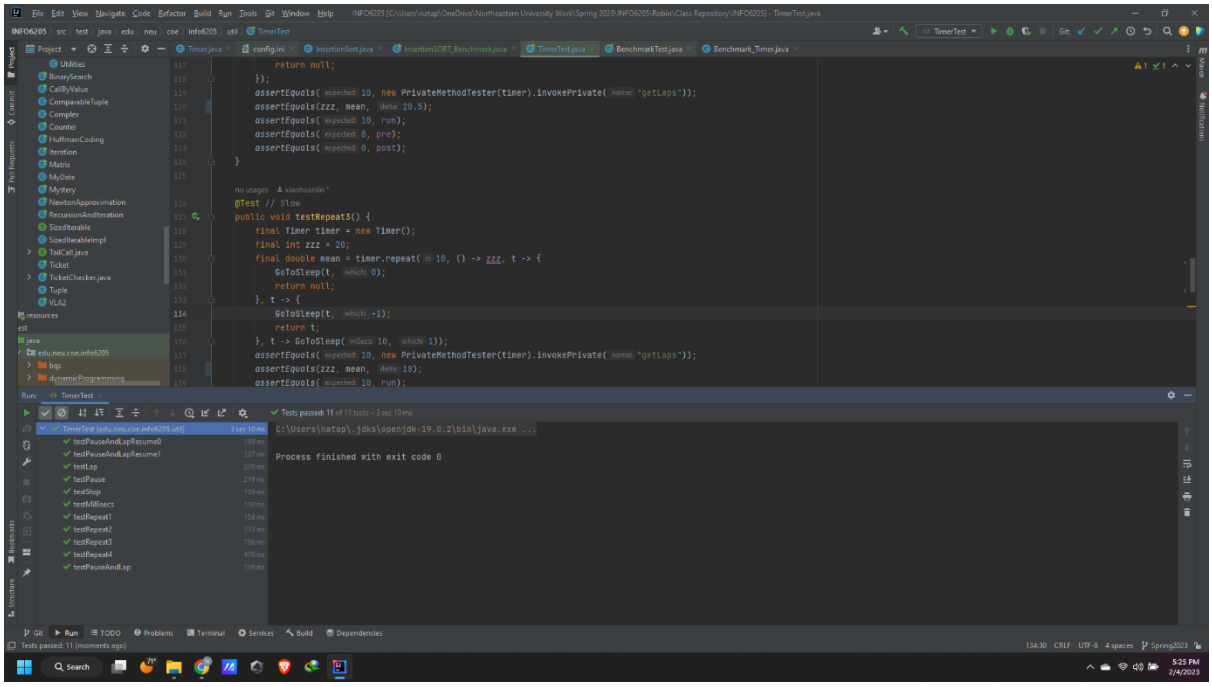


Reverse Ordered Array – Average Time vs Size of Array

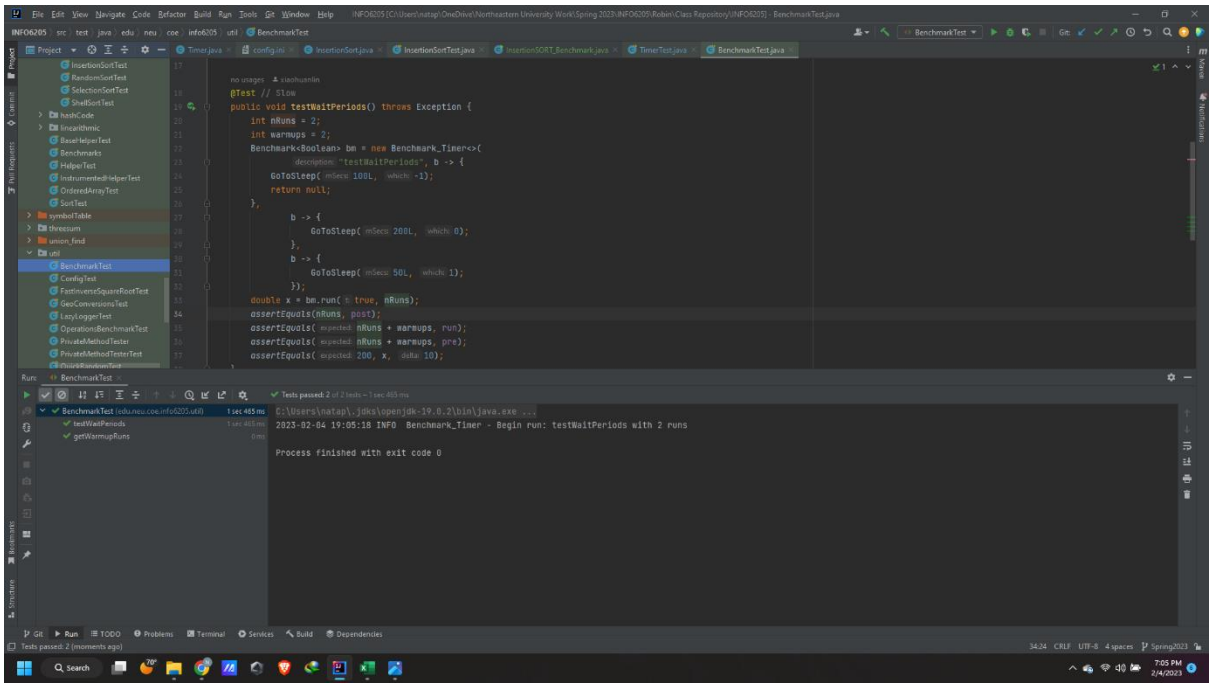


Unit Test Screenshots:

TimerTest



Benchmark Test



InsertionSort Test