Program Structures and Algorithms
Spring 2023(SEC 03) Assignment 03

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Task: Benchmark (Insertion Sort)

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) by simply looking up the insertion code used by *Arrays.sort.*

Part 3: Implement a main program (or you could do it via your own unit tests) to actually run the following benchmarks: measure the running times of this sort, using four different initial array ordering situations: random, ordered, partially-ordered and reverse-ordered

Relationship Conclusion:

The benchmark test was run for the insertion sort algorithm. The algorithm was tested by the doubling method with input array sizes as (1000, 2000, 4000, 8000 and 16000) and each of the input was run for 100 times with 100 iterations. Further, the input was classified in four different types: Ordered Input, partially ordered input, reverse ordered input and random input.

The benchmark results indicate that the average time required to sort the ordered input is the lowest. This is because the input is already sorted, and the number of swaps needed are zero.

The average time for the partially sorted input is greater than the ordered input, however it is lower than the reverse sorted input.

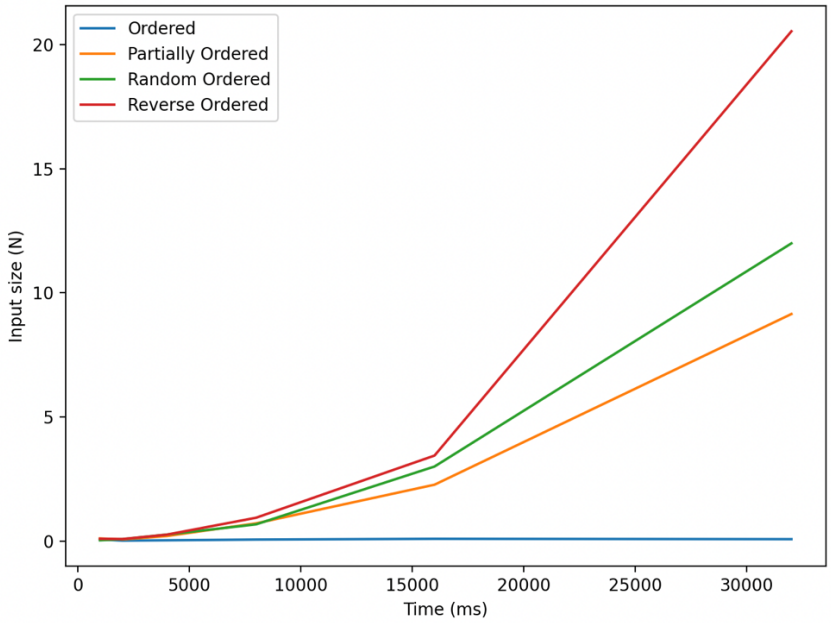
The average time for the randomly sorted input is intermediate between the partially sorted and reverse sorted array.

Also, the average time across all the input types is proportional to the input array size. It can be concluded that the time required to sort the array with insertion sort algorithm increases with the number of unordered elements. i.e., Time required to sort the input: Ordered array < partially ordered < random ordered < reverse ordered

Evidence to support that conclusion (Timing observations):

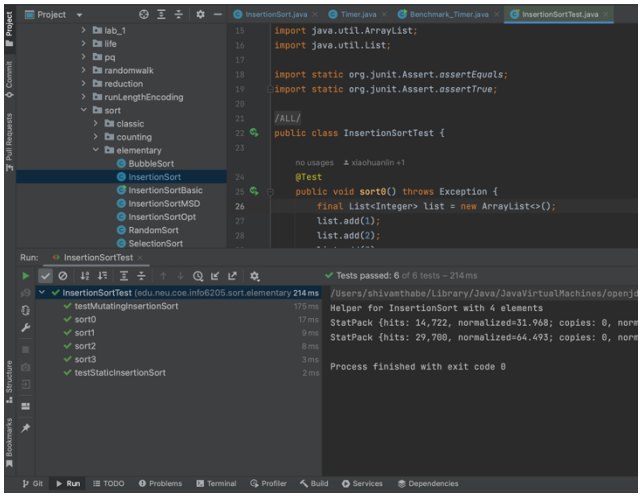
No.	Input size N	Ordered Time ms	Partially Ordered Time ms	Random Ordered Time ms	Reverse Ordered Time ms
1	1000	0.06802912	0.10170917	0.02816503	0.08838754
2	2000	0.01425169	0.05872581	0.07106128	0.07620836
3	4000	0.02840876	0.19919457	0.25910789	0.25561085
4	8000	0.05748545	0.7102762	0.67066835	0.93678499
5	16000	0.08569629	2.26819255	3.00083332	3.44194499
6	32000	0.07252716	9.14479587	11.9918242	20.5362225

Graphical Representation:

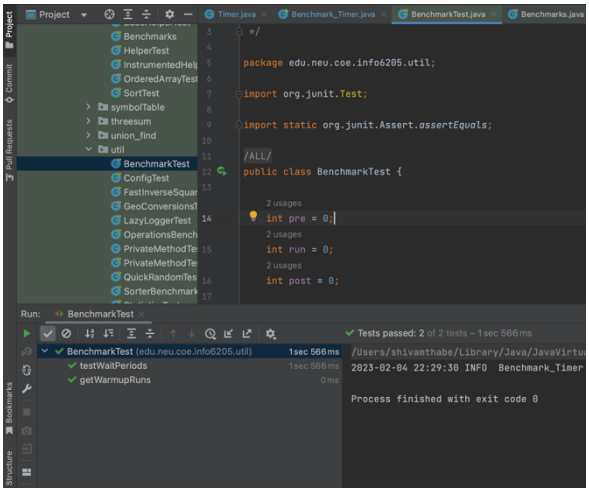


Unit Test Screenshots:

1. InsertionSortTest



2. BenchmarkTest



3. TimerTest