

ASSIGNMENT – 2

Tasks Required:

To Benchmark Insertion sort and draw conclusions for reverse, ordered, partially ordered and random ordered array.

Part 1: To Implement 3 methods in Timer Class.

```
public <T, U> double repeat(int n, Supplier<T> supplier, Function<T, U> function, UnaryOperator<T> preFunction, Consumer<U> postFunction) {  
    // TO BE IMPLEMENTED  
}  
  
private static long getClock() {  
    // TO BE IMPLEMENTED  
}  
  
private static double toMillisecs(long ticks) {  
    // TO BE IMPLEMENTED  
}
```

Part 2: Implementation of Insertion sort

Part 3: Implementing a main program as an entry point for the benchmarking process

Output Obtained:

The output obtained is after running the benchmark over 10 times per doubling input starting with 20 for Reversed, Ordered, Partially ordered and Random ordered arrays

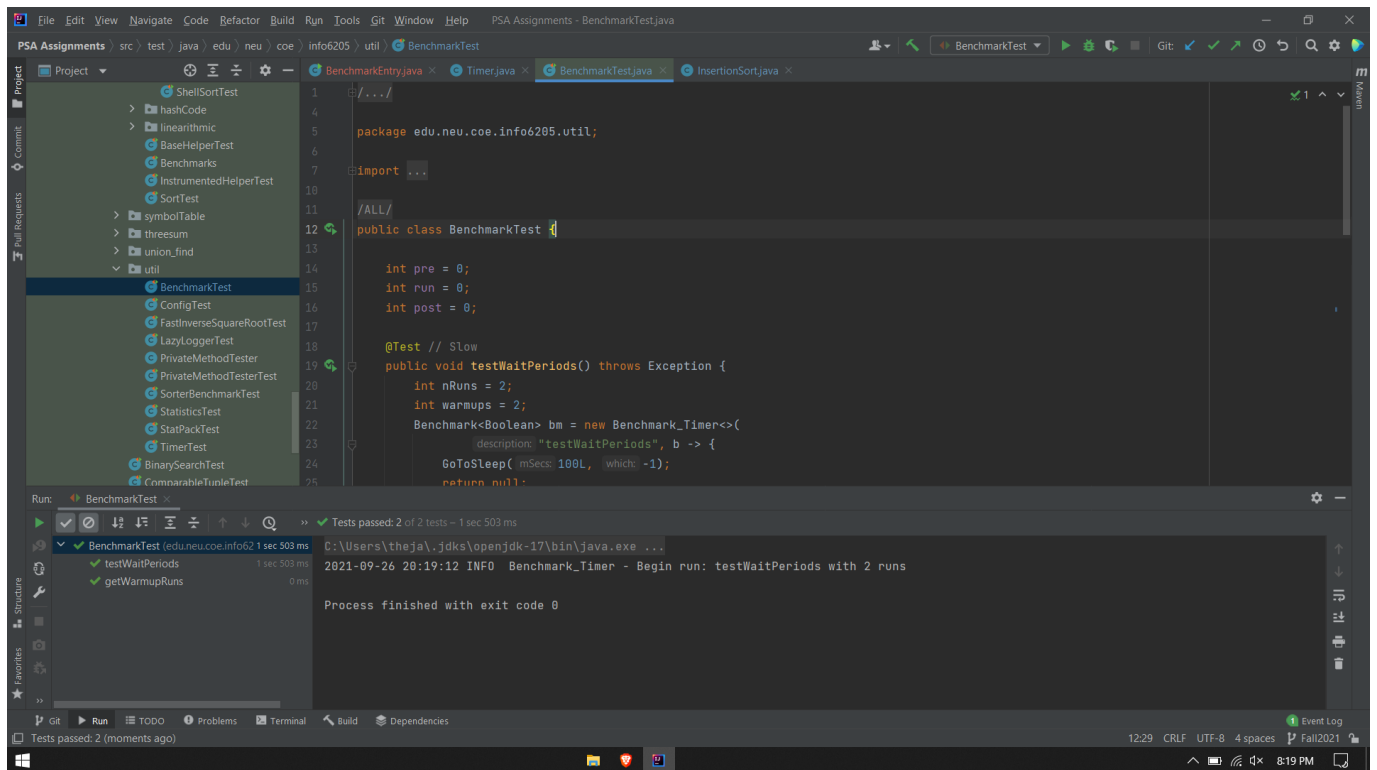
| Array Length | Reversed order | Ordered | Partially ordered | Random order |
|--------------|----------------|---------|-------------------|--------------|
| 20 | 0.01512 | 0.00119 | 0.00721 | 0.00128 |
| 40 | 0.0112 | 0.00155 | 0.00838 | 0.00187 |
| 80 | 0.03575 | 0.00175 | 0.01911 | 0.00213 |
| 160 | 0.12322 | 0.00298 | 0.02135 | 0.00913 |
| 320 | 0.23651 | 0.00572 | 0.06884 | 0.02863 |
| 640 | 1.41593 | 0.01008 | 0.15305 | 0.05009 |
| 1280 | 0.34849 | 0.01957 | 0.27203 | 0.17958 |
| 2560 | 1.41989 | 0.03903 | 0.50182 | 0.70052 |
| 5120 | 6.15856 | 0.07075 | 1.09717 | 2.63182 |
| 10240 | 23.99875 | 0.15919 | 4.54772 | 12.69387 |

The screenshot shows an IDE window titled "PSA Assignments - BenchmarkEntry.java". The main editor displays the output of a Java program. The output consists of ten lines of log messages, each representing a benchmark run for a different input size. Each line starts with a timestamp "2021-09-26 23:47:42 INFO", followed by "Benchmark_Timer - Begin run: Insertion Sort Benchmark testing: with 10 runs", and then "meantime For Reversed Array of input size: [input size] meantime of Insertion sort is [meantime]". The input sizes are 20, 40, 80, 160, 320, 640, 1280, 2560, 5120, and 10240. The meantime values increase as the input size increases. The IDE interface includes a menu bar at the top, a toolbar with icons for file operations, a sidebar on the left with tabs for "Project", "Runs", "Commits", "Full Requests", "Structure", and "Favorites", and a status bar at the bottom showing "Build completed successfully in 2 sec. 286 ms (moments ago)".

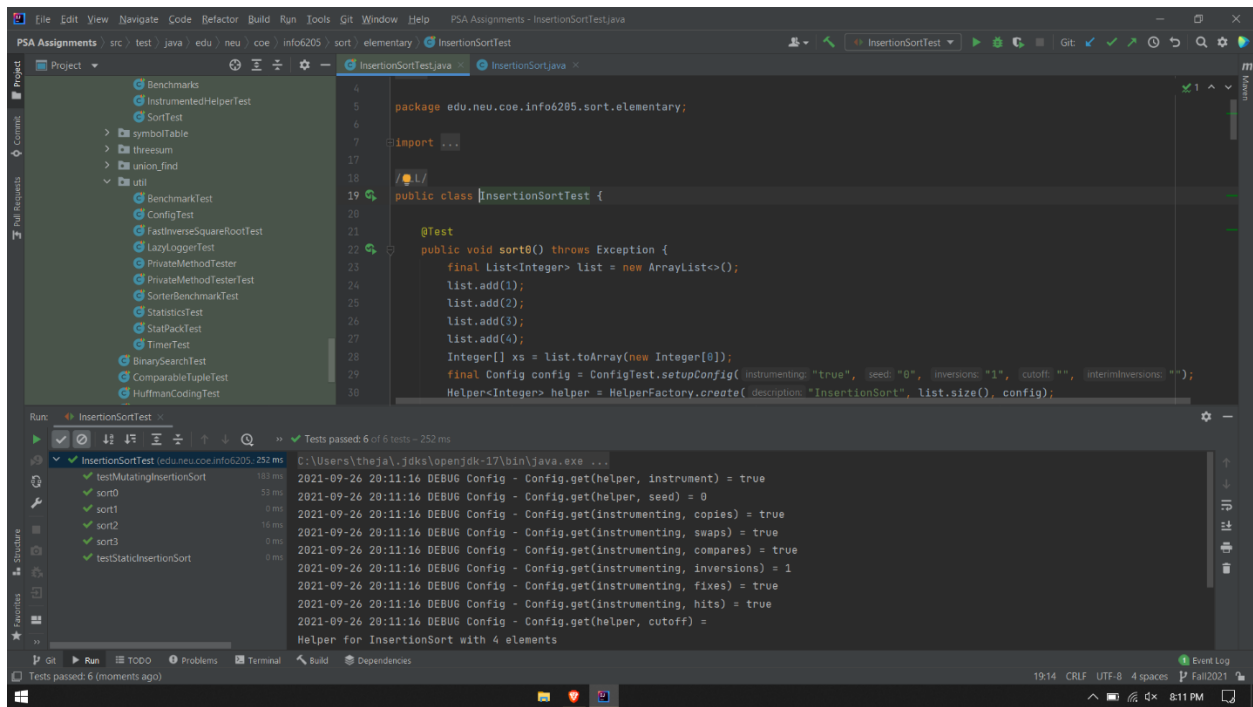
```
C:\Users\theja\jdk\openjdk-17\bin\java.exe ...
2021-09-26 23:47:42 INFO Benchmark_Timer - Begin run: Insertion Sort Benchmark testing: with 10 runs
meantime For Reversed Array of input size: 20 meantime of Insertion sort is 0.0176902
-----
2021-09-26 23:47:42 INFO Benchmark_Timer - Begin run: Insertion Sort Benchmark testing: with 10 runs
meantime For Reversed Array of input size: 40 meantime of Insertion sort is 0.013670199999999999
-----
2021-09-26 23:47:42 INFO Benchmark_Timer - Begin run: Insertion Sort Benchmark testing: with 10 runs
meantime For Reversed Array of input size: 80 meantime of Insertion sort is 0.04428
-----
2021-09-26 23:47:42 INFO Benchmark_Timer - Begin run: Insertion Sort Benchmark testing: with 10 runs
meantime For Reversed Array of input size: 160 meantime of Insertion sort is 0.1265502
-----
2021-09-26 23:47:42 INFO Benchmark_Timer - Begin run: Insertion Sort Benchmark testing: with 10 runs
meantime For Reversed Array of input size: 320 meantime of Insertion sort is 0.379870000000000004
-----
2021-09-26 23:47:42 INFO Benchmark_Timer - Begin run: Insertion Sort Benchmark testing: with 10 runs
meantime For Reversed Array of input size: 640 meantime of Insertion sort is 0.224240199999999997
-----
2021-09-26 23:47:42 INFO Benchmark_Timer - Begin run: Insertion Sort Benchmark testing: with 10 runs
meantime For Reversed Array of input size: 1280 meantime of Insertion sort is 0.4154501
-----
2021-09-26 23:47:42 INFO Benchmark_Timer - Begin run: Insertion Sort Benchmark testing: with 10 runs
meantime For Reversed Array of input size: 2560 meantime of Insertion sort is 1.8147699
-----
2021-09-26 23:47:42 INFO Benchmark_Timer - Begin run: Insertion Sort Benchmark testing: with 10 runs
meantime For Reversed Array of input size: 5120 meantime of Insertion sort is 6.7232798
-----
2021-09-26 23:47:42 INFO Benchmark_Timer - Begin run: Insertion Sort Benchmark testing: with 10 runs
meantime For Reversed Array of input size: 10240 meantime of Insertion sort is 36.3605099
-----
```

Test case Results:

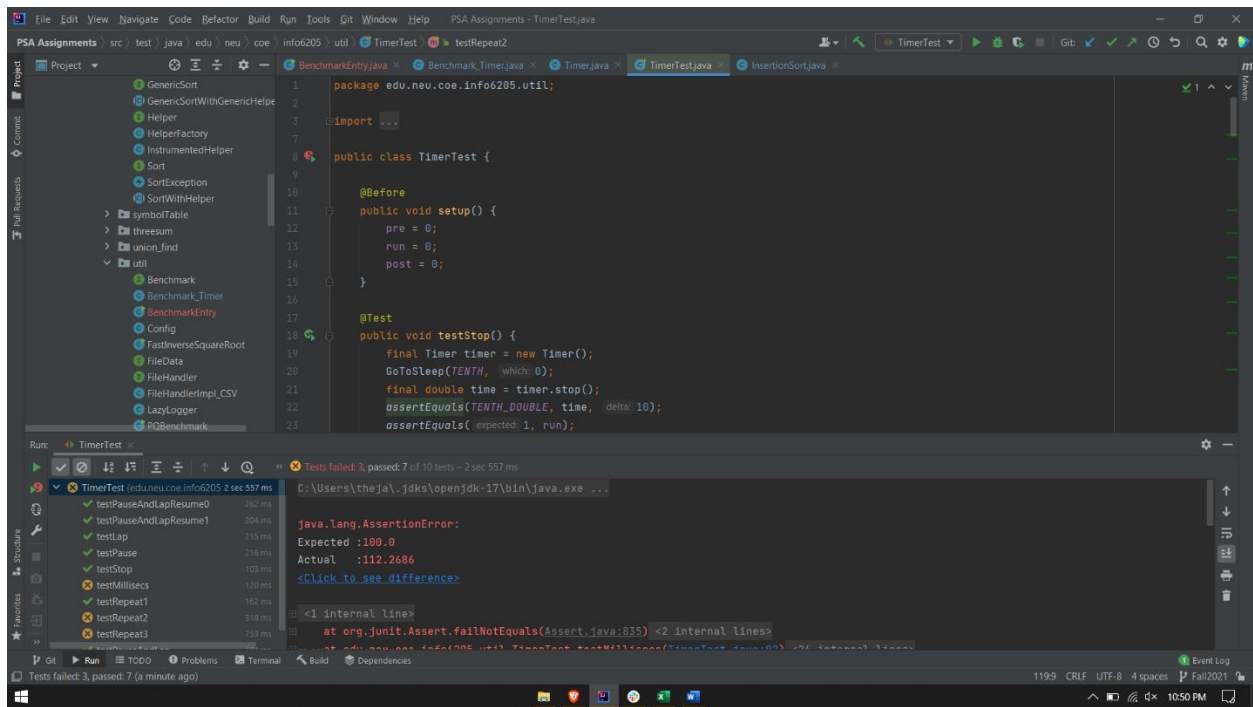
Benchmark Test Result:



InsertionSort Test Result:

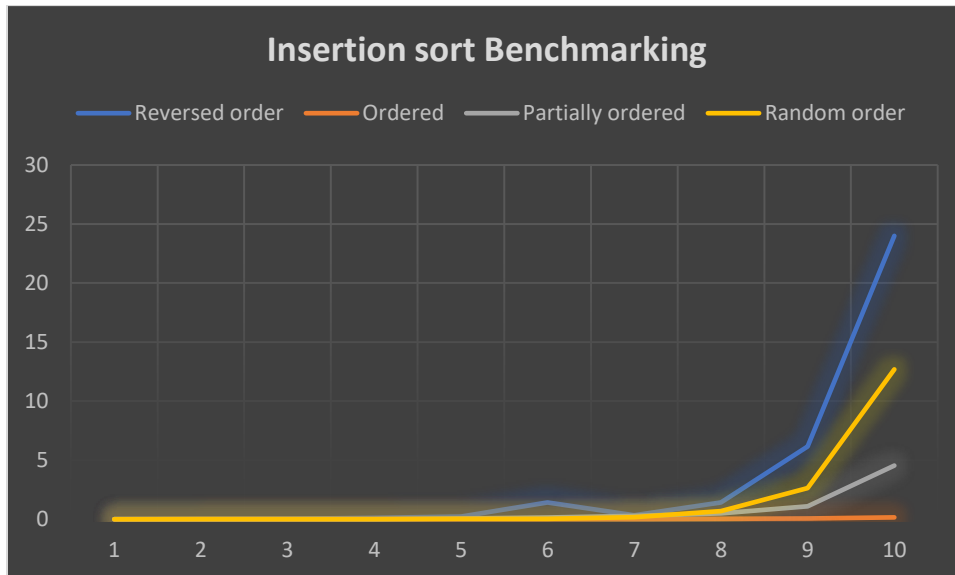


Timer Test Results:



Observations and Conclusions:

Plotting a line graph from the obtained outputs for the differently sorted inputs with mean sorting times on the y-axis and array length on the x-axis.



- We observe that with increase in array length the mean time taken to sort also increases, irrespective of the sorting of the input.

Meantime to sort is proportional to array length.

- From the same graph we can also observe that the sorting of the input array affects the meantime to sort in the below way.

Meantime for sorting of

Reverse ordered array > Random ordered > Partially ordered > Ordered array

- We can also observe that the time complexity for sorting varies from $O(n^2)$ for the worst case i.e. reverse ordered input to $O(n)$ which is the best case scenario i.e. ordered input with partially ordered and random lying in between these two limits.