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Program Structures & Algorithms

Fall 2021

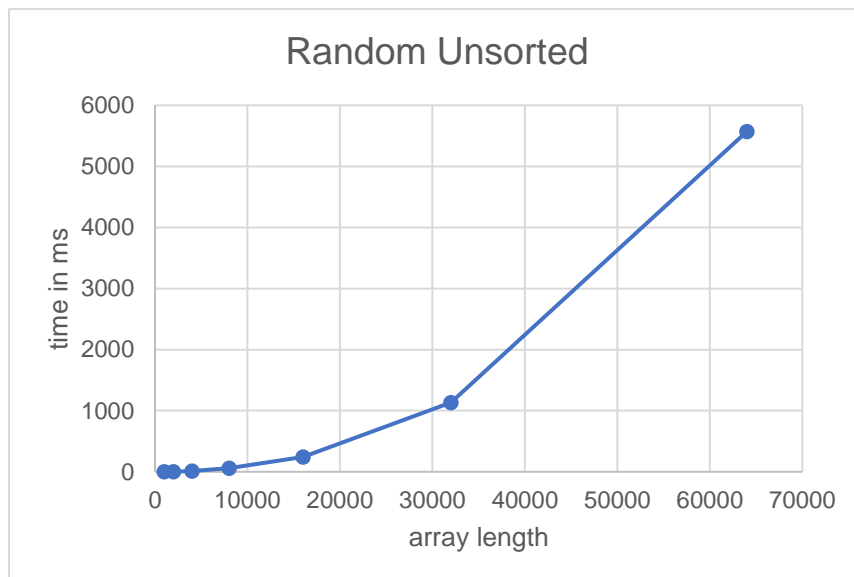
Assignment No. 2

- ◉ **Task (List down the tasks performed in the Assignment)**
- ◉ **Relationship Conclusion: (For ex : $z = a * b$)**
- ◉ **Evidence to support the conclusion:**
 1. **Output (Snapshot of Code output in the terminal)**
 2. **Graphical Representation(Observations from experiments should be tabulated and analyzed by plotting graphs(usually in excel) to arrive on the relationship conclusion)**
- ◉ **Unit tests result:(Snapshot of successful unit test run)**

Random Unsorted Array elements:

```
AssignmentBenchmark
"C:\Program Files\Java\jdk-15.0.1\bin\java.exe" ...
InsertionSort - random unsorted array elements - benchmark assignment:
2021-09-26 21:24:26 INFO Benchmark_Timer - Begin run: Insertion sort for 1000 Integers with 100 runs
0.93ms
2021-09-26 21:24:26 INFO Benchmark_Timer - Begin run: Insertion sort for 2000 Integers with 100 runs
3.7ms
2021-09-26 21:24:27 INFO Benchmark_Timer - Begin run: Insertion sort for 4000 Integers with 100 runs
14.33ms
2021-09-26 21:24:28 INFO Benchmark_Timer - Begin run: Insertion sort for 8000 Integers with 100 runs
60.17ms
2021-09-26 21:24:35 INFO Benchmark_Timer - Begin run: Insertion sort for 16000 Integers with 100 runs
243.93ms
2021-09-26 21:25:02 INFO Benchmark_Timer - Begin run: Insertion sort for 32000 Integers with 100 runs
1133.19ms
2021-09-26 21:27:07 INFO Benchmark_Timer - Begin run: Insertion sort for 64000 Integers with 100 runs
5570.29ms

Process finished with exit code 0
```

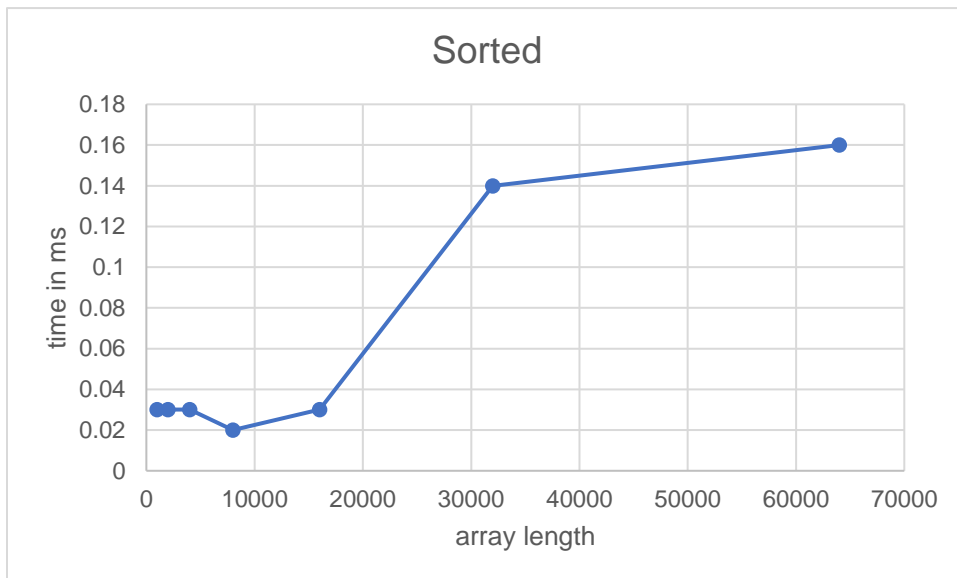


$O(N^2)$ for random unsorted

Ascending order sorted Array elements:

```
test 47 // Supplier<Integer[]> supplier = ()
AssignmentBenchmark x
"C:\Program Files\Java\jdk-15.0.1\bin\java.exe" ...
InsertionSort - ascending sorted array elements - benchmark assignment:
2021-09-26 21:42:55 INFO Benchmark_Timer - Begin run: Insertion sort for 1000 Integers with 100 runs
0.03ms
2021-09-26 21:42:55 INFO Benchmark_Timer - Begin run: Insertion sort for 2000 Integers with 100 runs
0.03ms
2021-09-26 21:42:55 INFO Benchmark_Timer - Begin run: Insertion sort for 4000 Integers with 100 runs
0.03ms
2021-09-26 21:42:55 INFO Benchmark_Timer - Begin run: Insertion sort for 8000 Integers with 100 runs
0.02ms
2021-09-26 21:42:55 INFO Benchmark_Timer - Begin run: Insertion sort for 16000 Integers with 100 runs
0.03ms
2021-09-26 21:42:55 INFO Benchmark_Timer - Begin run: Insertion sort for 32000 Integers with 100 runs
0.14ms
2021-09-26 21:42:55 INFO Benchmark_Timer - Begin run: Insertion sort for 64000 Integers with 100 runs
0.16ms

Process finished with exit code 0
```



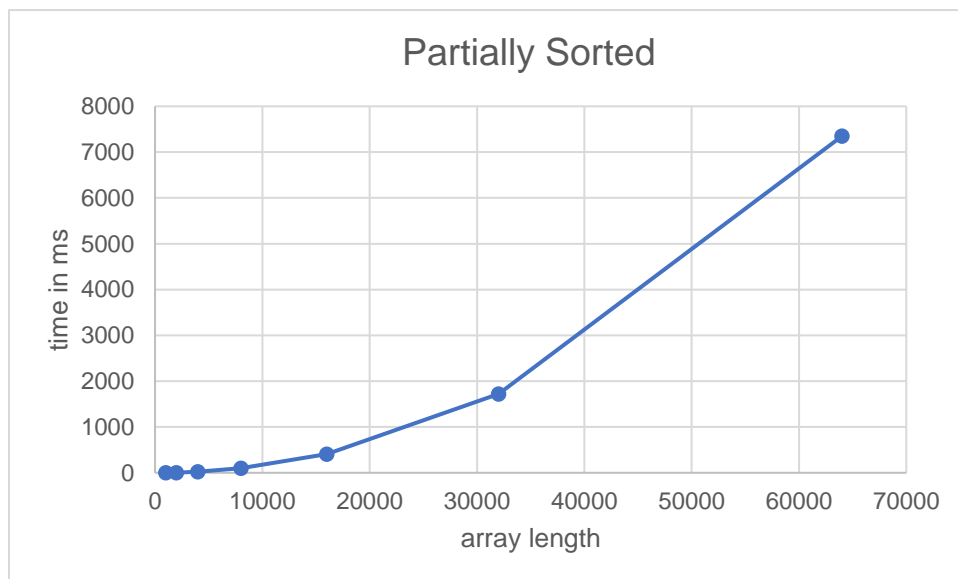
$O(N)$ for sorted

Partially sorted Array elements:

```
test
AssignmentBenchmark x
"C:\Program Files\Java\jdk-15.0.1\bin\java.exe" ...
InsertionSort - partially sorted array elements - benchmark assignment:
2021-09-26 21:43:37 INFO Benchmark_Timer - Begin run: Insertion sort for 1000 Integers with 100 runs
1.04ms
2021-09-26 21:43:37 INFO Benchmark_Timer - Begin run: Insertion sort for 2000 Integers with 100 runs
5.2ms
2021-09-26 21:43:38 INFO Benchmark_Timer - Begin run: Insertion sort for 4000 Integers with 100 runs
23.39ms
2021-09-26 21:43:40 INFO Benchmark_Timer - Begin run: Insertion sort for 8000 Integers with 100 runs
100.16ms
2021-09-26 21:43:51 INFO Benchmark_Timer - Begin run: Insertion sort for 16000 Integers with 100 runs
410.33ms
2021-09-26 21:44:37 INFO Benchmark_Timer - Begin run: Insertion sort for 32000 Integers with 100 runs
1723.55ms
2021-09-26 21:47:46 INFO Benchmark_Timer - Begin run: Insertion sort for 64000 Integers with 100 runs
7348.02ms

Process finished with exit code 0

Git Run TODO Problems Terminal Build Dependencies
d completed successfully in 1 sec, 397 ms (18 minutes ago)
```

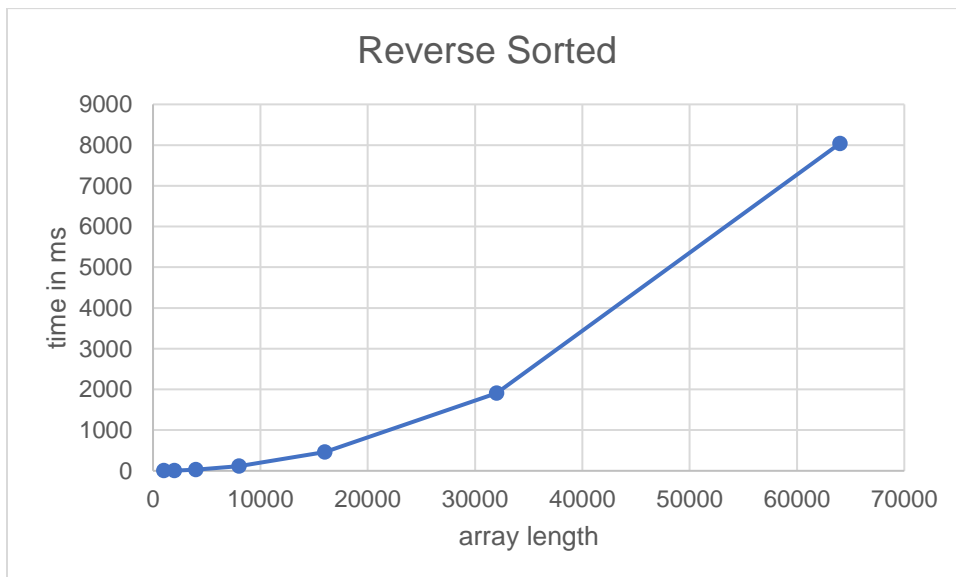


$O(N^2)$ for partially sorted

Reverse sorted Array elements:

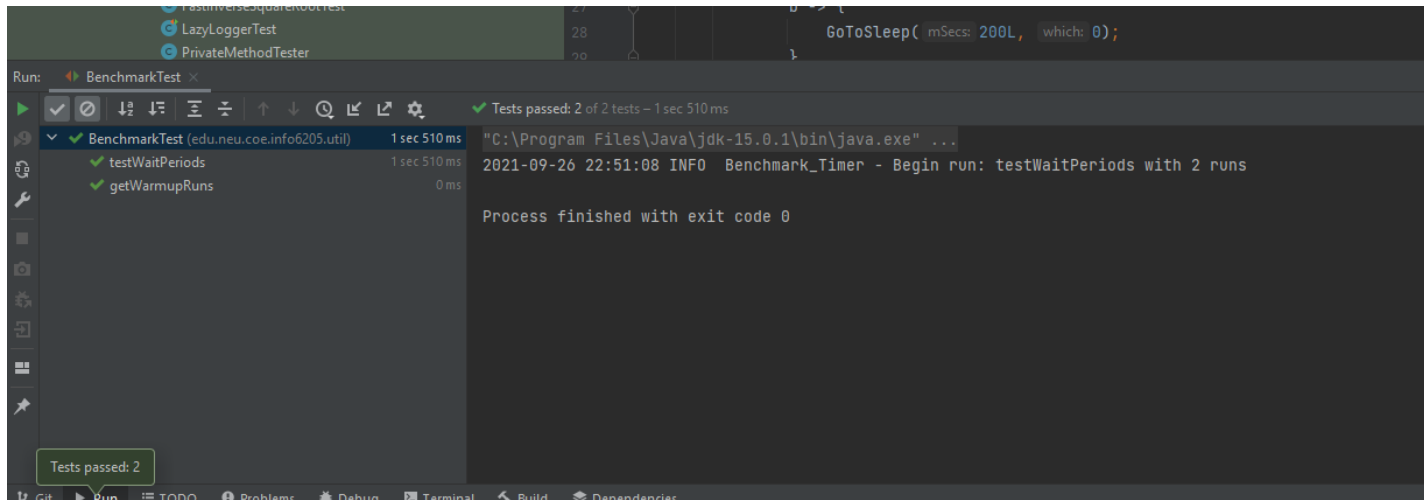
```
AssignmentBenchmark x
resources
test
n: AssignmentBenchmark x
"C:\Program Files\Java\jdk-15.0.1\bin\java.exe" ...
InsertionSort - reverse sorted array elements - benchmark assignment:
2021-09-26 22:02:05 INFO Benchmark_Timer - Begin run: Insertion sort for 1000 Integers with 100 runs
1.91ms
2021-09-26 22:02:05 INFO Benchmark_Timer - Begin run: Insertion sort for 2000 Integers with 100 runs
7.45ms
2021-09-26 22:02:06 INFO Benchmark_Timer - Begin run: Insertion sort for 4000 Integers with 100 runs
28.48ms
2021-09-26 22:02:09 INFO Benchmark_Timer - Begin run: Insertion sort for 8000 Integers with 100 runs
114.34ms
2021-09-26 22:02:22 INFO Benchmark_Timer - Begin run: Insertion sort for 16000 Integers with 100 runs
463.43ms
2021-09-26 22:03:13 INFO Benchmark_Timer - Begin run: Insertion sort for 32000 Integers with 100 runs
1908.27ms
2021-09-26 22:06:43 INFO Benchmark_Timer - Begin run: Insertion sort for 64000 Integers with 100 runs
8040.58ms

Process finished with exit code 0
Git Run TODO Problems Terminal Build Dependencies
```

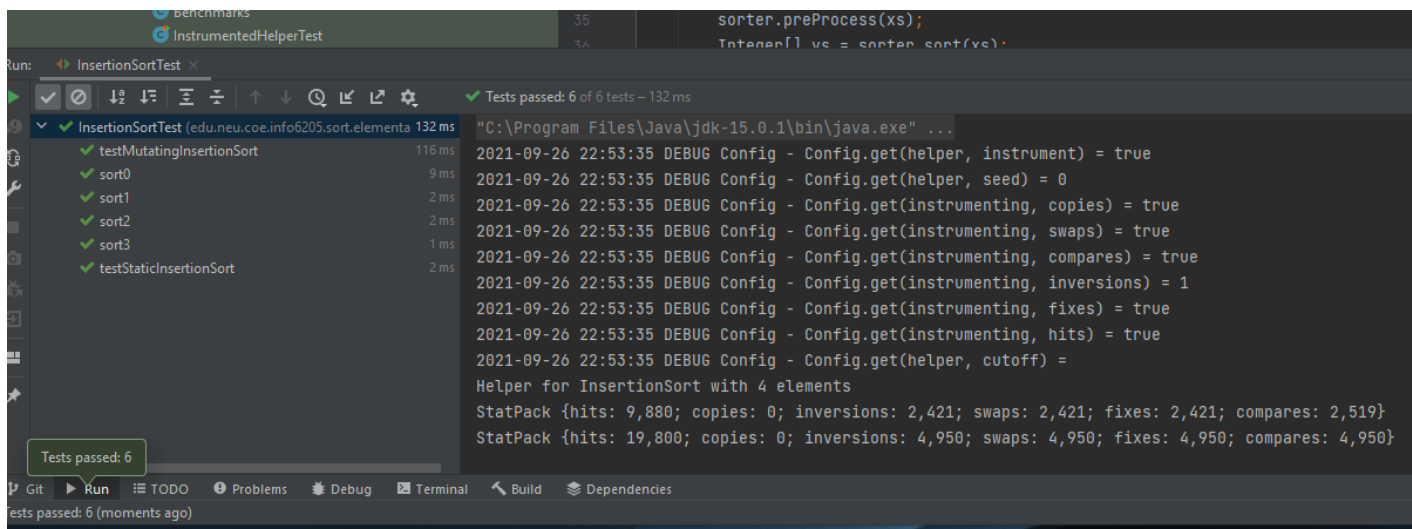


$O(N^2)$ for reverse sorted

Result of BenchmarkTest.java



Result of InsertionSortTest.java



Result of TimerTest.java

