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Program Structures & Algorithms

Fall 2021

Assignment No. 2

- ## Task

Benchmark

1. Implement three methods of a class called Timer.
2. Implement InsertionSort (in the InsertionSort class) by simply looking up the insertion code used by Arrays.sort. If you have the instrument = true setting in test/resources/config.ini, then you will need to use the helper methods for comparing and swapping (so that they properly count the number of swaps/compares). The easiest is to use the helper.swapStableConditional method, continuing if it returns true, otherwise breaking the loop. Alternatively, if you are not using instrumenting, then you can write (or copy) your own compare/swap code. Either way, you must run the unit tests in InsertionSortTest.
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. I suggest that your arrays to be sorted are of type Integer. Use the doubling method for choosing n and test for at least five values of n. Draw any conclusions from your observations regarding the order of growth.

- ## Relationship Conclusion:

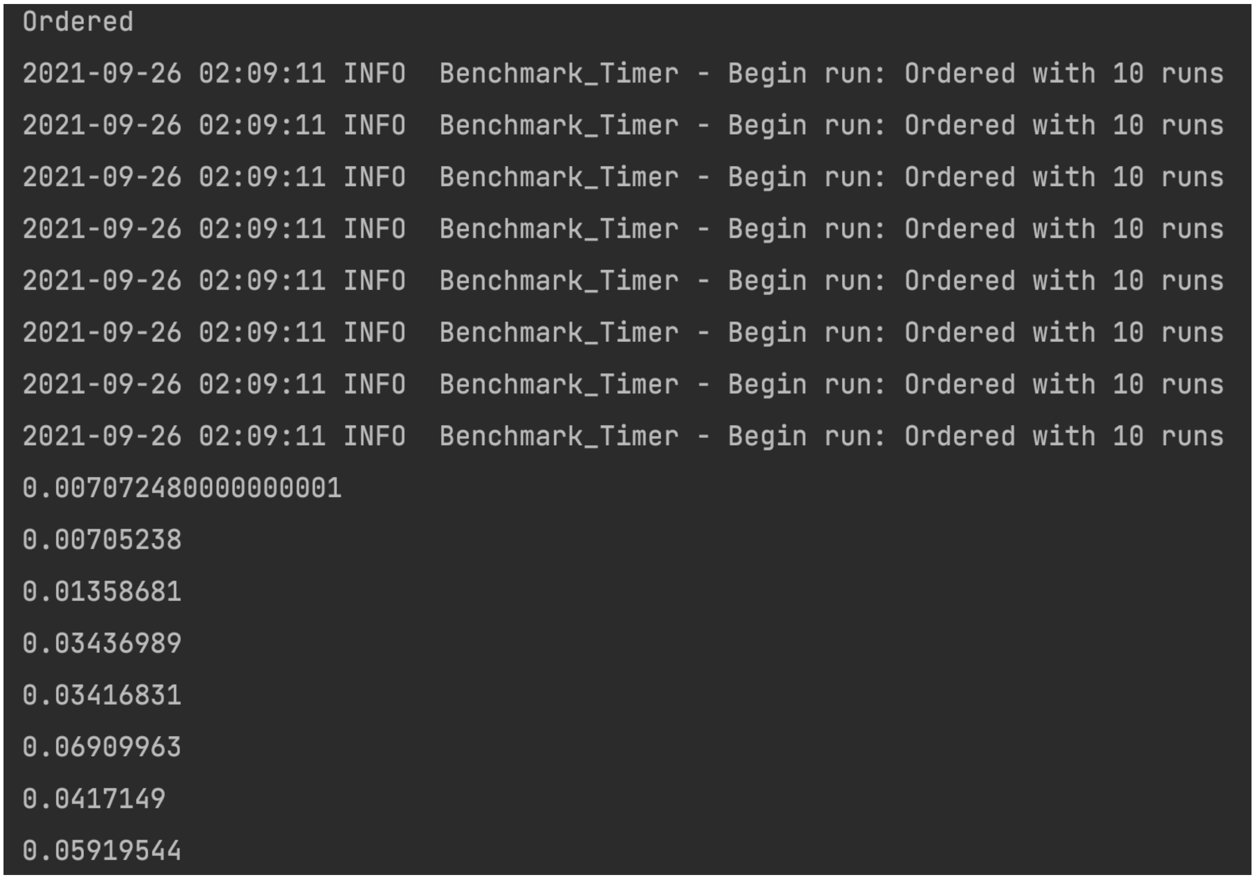
As the N increase doubling, the running time gradually increase. But for the ordered array, it is almost not increase like linear.

The total running time “Reversed” > “Random” > “Partially – Ordered” > “Ordered”.

⊙ Evidence to support the conclusion:

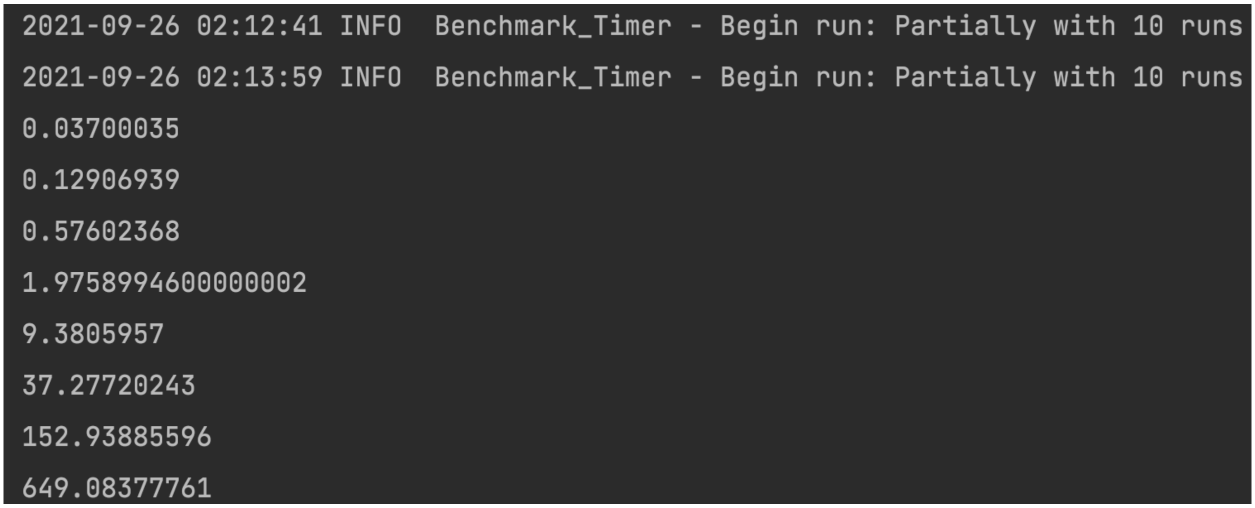
1. Output

Ordered



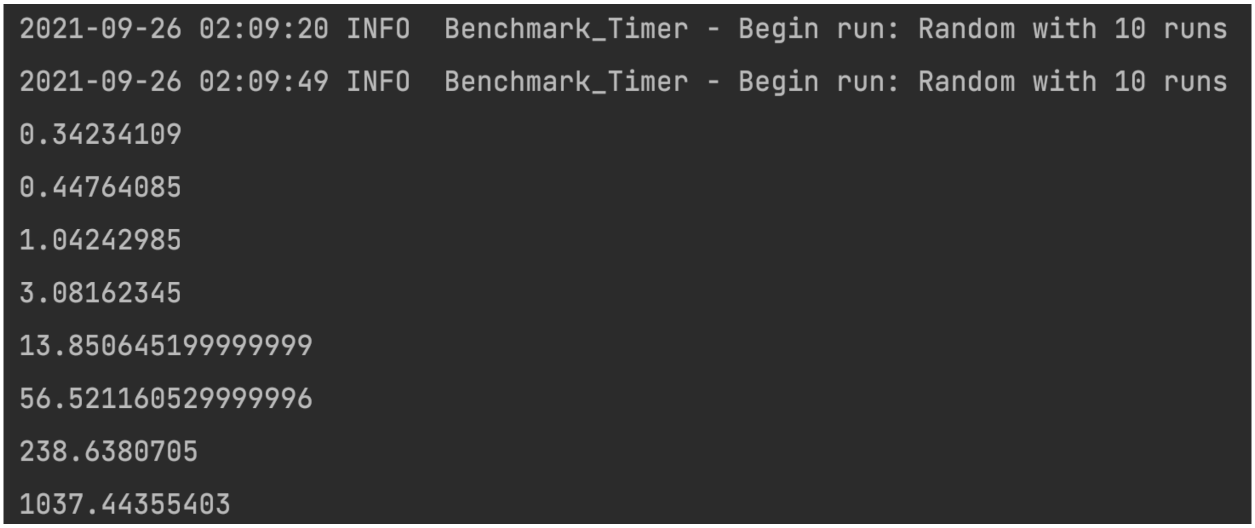
```
Ordered
2021-09-26 02:09:11 INFO  Benchmark_Timer - Begin run: Ordered with 10 runs
2021-09-26 02:09:11 INFO  Benchmark_Timer - Begin run: Ordered with 10 runs
2021-09-26 02:09:11 INFO  Benchmark_Timer - Begin run: Ordered with 10 runs
2021-09-26 02:09:11 INFO  Benchmark_Timer - Begin run: Ordered with 10 runs
2021-09-26 02:09:11 INFO  Benchmark_Timer - Begin run: Ordered with 10 runs
2021-09-26 02:09:11 INFO  Benchmark_Timer - Begin run: Ordered with 10 runs
2021-09-26 02:09:11 INFO  Benchmark_Timer - Begin run: Ordered with 10 runs
2021-09-26 02:09:11 INFO  Benchmark_Timer - Begin run: Ordered with 10 runs
0.007072480000000001
0.00705238
0.01358681
0.03436989
0.03416831
0.06909963
0.0417149
0.05919544
```

Partially – Ordered



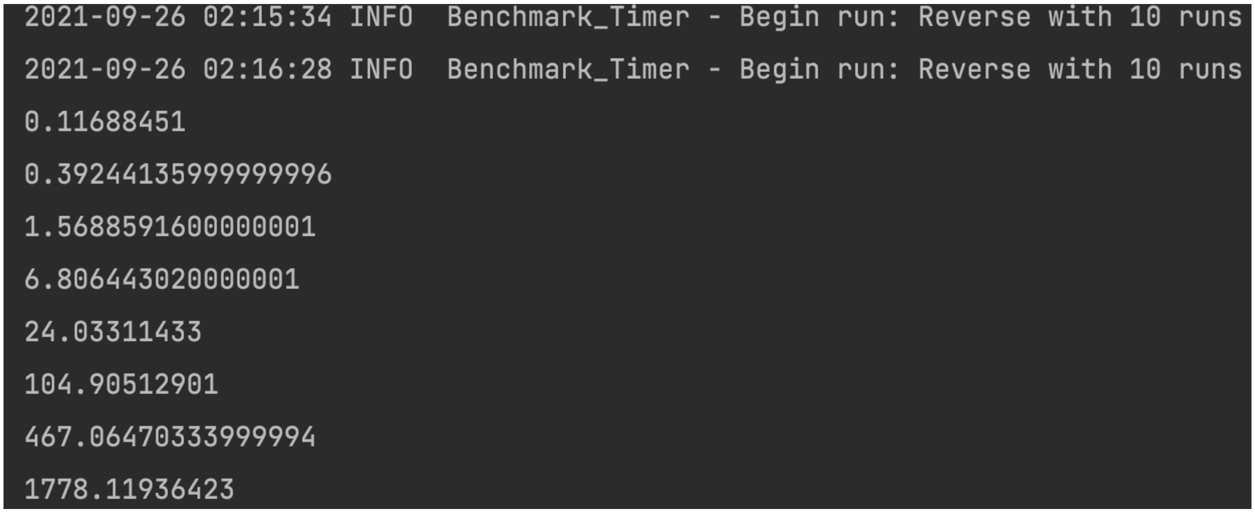
```
2021-09-26 02:12:41 INFO  Benchmark_Timer - Begin run: Partially with 10 runs
2021-09-26 02:13:59 INFO  Benchmark_Timer - Begin run: Partially with 10 runs
0.03700035
0.12906939
0.57602368
1.9758994600000002
9.3805957
37.27720243
152.93885596
649.08377761
```

Random



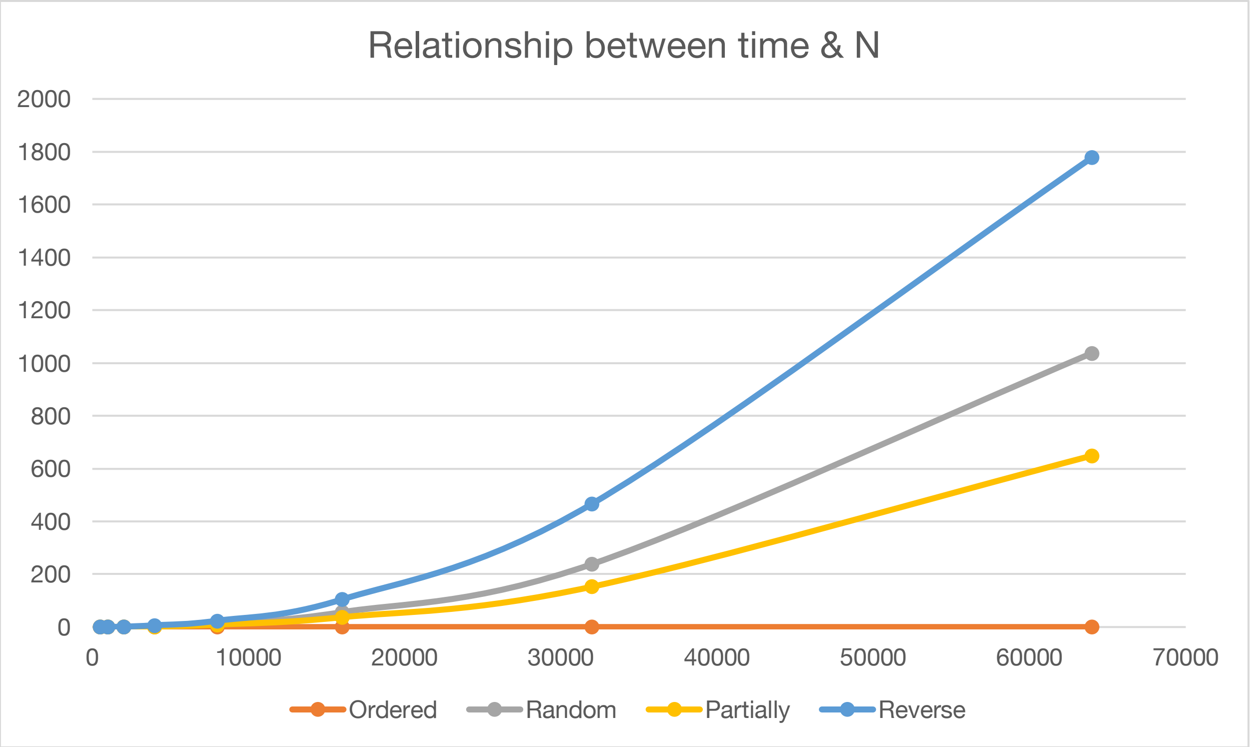
```
2021-09-26 02:09:20 INFO  Benchmark_Timer - Begin run: Random with 10 runs
2021-09-26 02:09:49 INFO  Benchmark_Timer - Begin run: Random with 10 runs
0.34234109
0.44764085
1.04242985
3.08162345
13.850645199999999
56.521160529999996
238.6380705
1037.44355403
```

Reversed

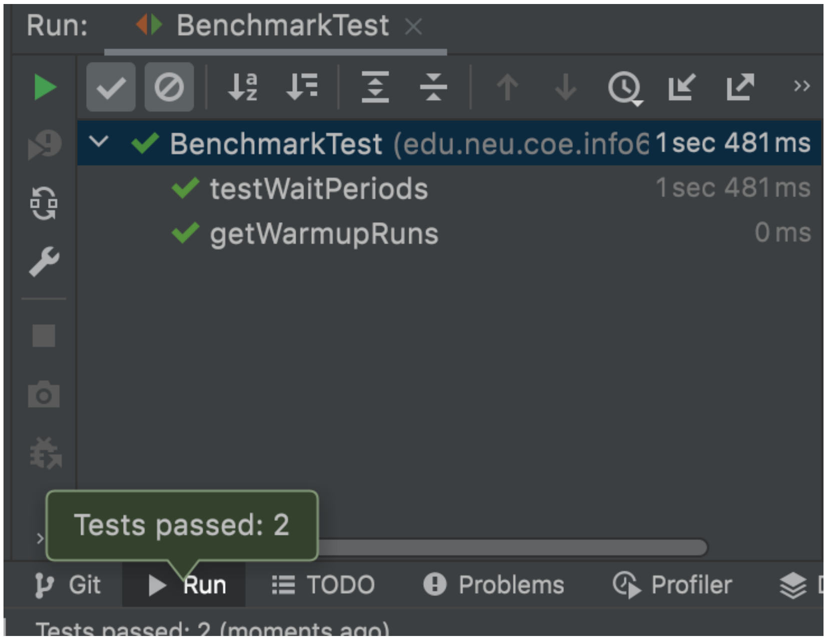


```
2021-09-26 02:15:34 INFO  Benchmark_Timer - Begin run: Reverse with 10 runs
2021-09-26 02:16:28 INFO  Benchmark_Timer - Begin run: Reverse with 10 runs
0.11688451
0.39244135999999996
1.5688591600000001
6.806443020000001
24.03311433
104.90512901
467.06470333999994
1778.11936423
```

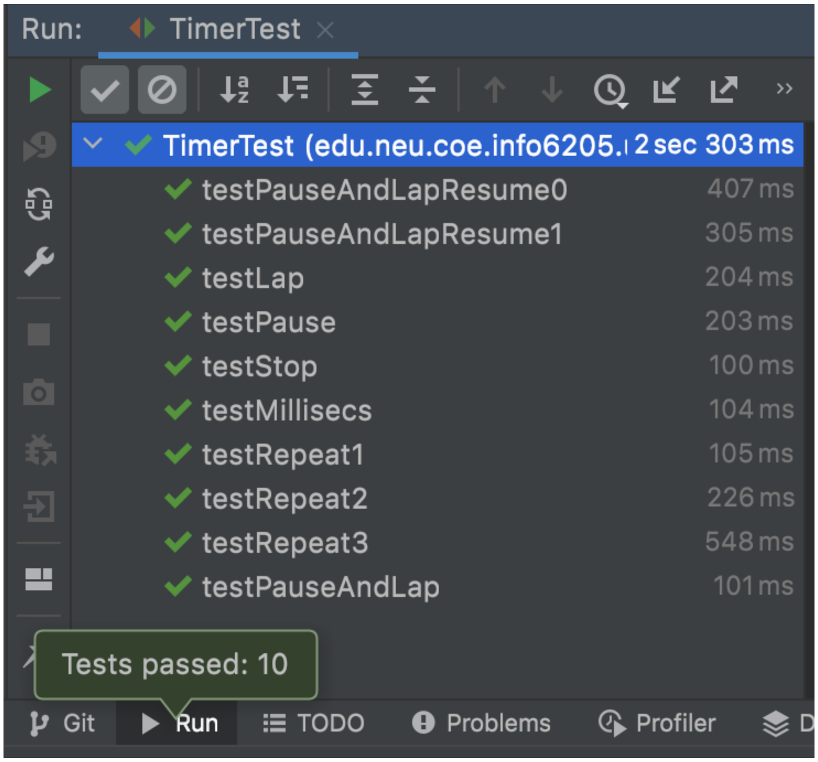
2. Graphical Representation



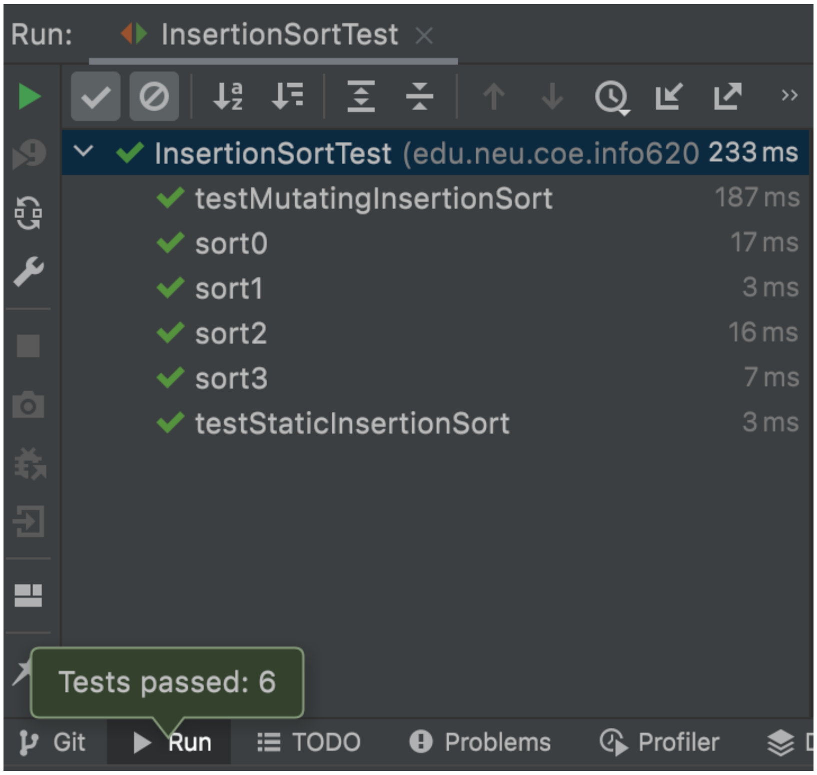
- **Unit tests result:**



```
BenchmarkTest (edu.neu.coe.info6 1 sec 481 ms
    testWaitPeriods              1 sec 481 ms
    getWarmupRuns                        0 ms

Tests passed: 2

Tests passed: 2 (moments ago)
```



```
✓ TimerTest (edu.neu.coe.info6205.  2 sec 303 ms
    ✓ testPauseAndLapResume0          407 ms
    ✓ testPauseAndLapResume1          305 ms
    ✓ testLap                         204 ms
    ✓ testPause                       203 ms
    ✓ testStop                        100 ms
    ✓ testMillisecs                   104 ms
    ✓ testRepeat1                     105 ms
    ✓ testRepeat2                     226 ms
    ✓ testRepeat3                     548 ms
    ✓ testPauseAndLap                 101 ms

Tests passed: 10
```



```
✓ InsertionSortTest (edu.neu.coe.info620 233 ms
    ✓ testMutatingInsertionSort       187 ms
    ✓ sort0                            17 ms
    ✓ sort1                             3 ms
    ✓ sort2                            16 ms
    ✓ sort3                             7 ms
    ✓ testStaticInsertionSort           3 ms

Tests passed: 6
```