Program Structures & Algorithms

Spring 2022

Assignment No. N2

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- **Task**
- **Output screenshot**
- **Relationship Conclusion**
- **Evidence / Graph**
- **Unit tests result**

➢ Task

(Part 1)

a. You are to implement three (3) methods (*repeat*, *getClock*, and *toMillisecs*) of a class called *Timer*.
b. check the implementation by running the unit tests in *BenchmarkTest* and *TimerTest*.

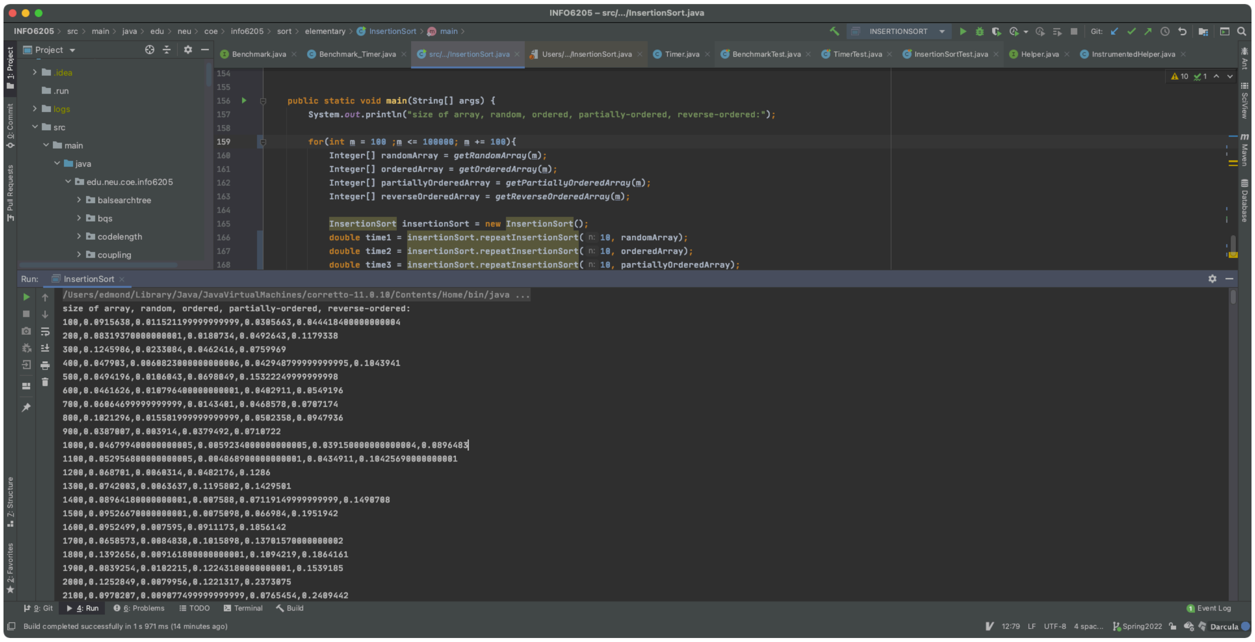
(Part 2)

a. Implement *InsertionSort* by simply looking up the insertion code used by *Arrays.sort*.
b. run the unit tests in *InsertionSortTest*.

(Part 3)

a. 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.
b. 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.

➢ Output screenshot



```java

    public static void main(String[] args) {
        System.out.println("size of array, random, ordered, partially-ordered, reverse-ordered:");

        for(int m = 100 ;m <= 100000; m += 100){
            Integer[] randomArray = getRandomArray(m);
            Integer[] orderedArray = getOrderedArray(m);
            Integer[] partiallyOrderedArray = getPartiallyOrderedArray(m);
            Integer[] reverseOrderedArray = getReverseOrderedArray(m);

            InsertionSort insertionSort = new InsertionSort();
            double time1 = insertionSort.repeatInsertionSort( n: 10, randomArray);
            double time2 = insertionSort.repeatInsertionSort( n: 10, orderedArray);
            double time3 = insertionSort.repeatInsertionSort( n: 10, partiallyOrderedArray);
```

```
/Users/edmond/Library/Java/JavaVirtualMachines/corretto-11.0.10/Contents/Home/bin/java ...
size of array, random, ordered, partially-ordered, reverse-ordered:
100,0.0915638,0.011521199999999999,0.0305663,0.044418400000000004
200,0.08319370000000001,0.0180734,0.0492643,0.1179338
300,0.1245986,0.0233084,0.0462416,0.0759969
400,0.047903,0.006082300000000006,0.042948799999999995,0.1043941
500,0.0494196,0.0106043,0.0698049,0.15322249999999998
600,0.0461626,0.010796400000000001,0.0402911,0.0549196
700,0.06064699999999999,0.0143401,0.0468578,0.0707174
800,0.1021296,0.015581999999999999,0.0502358,0.0947936
900,0.0387007,0.003914,0.0379492,0.0710722
1000,0.046799400000000005,0.005923400000000005,0.039150000000000004,0.0896483
1100,0.052956800000000005,0.004868900000000001,0.0434911,0.10425690000000001
1200,0.068701,0.0060314,0.0482176,0.1286
1300,0.0742003,0.0063637,0.1195802,0.1429501
1400,0.08964180000000001,0.007588,0.07119149999999999,0.1490708
1500,0.09526670000000001,0.0075098,0.066984,0.1951942
1600,0.0952499,0.007595,0.0911173,0.1856142
1700,0.0658573,0.0084838,0.1015898,0.13701570000000002
1800,0.1392656,0.009161800000000001,0.1094219,0.1864161
1900,0.0839254,0.0102215,0.12243180000000001,0.1539185
2000,0.1252849,0.0079956,0.1221317,0.2373075
2100,0.0970207,0.009077499999999999,0.0765454,0.2409442
```

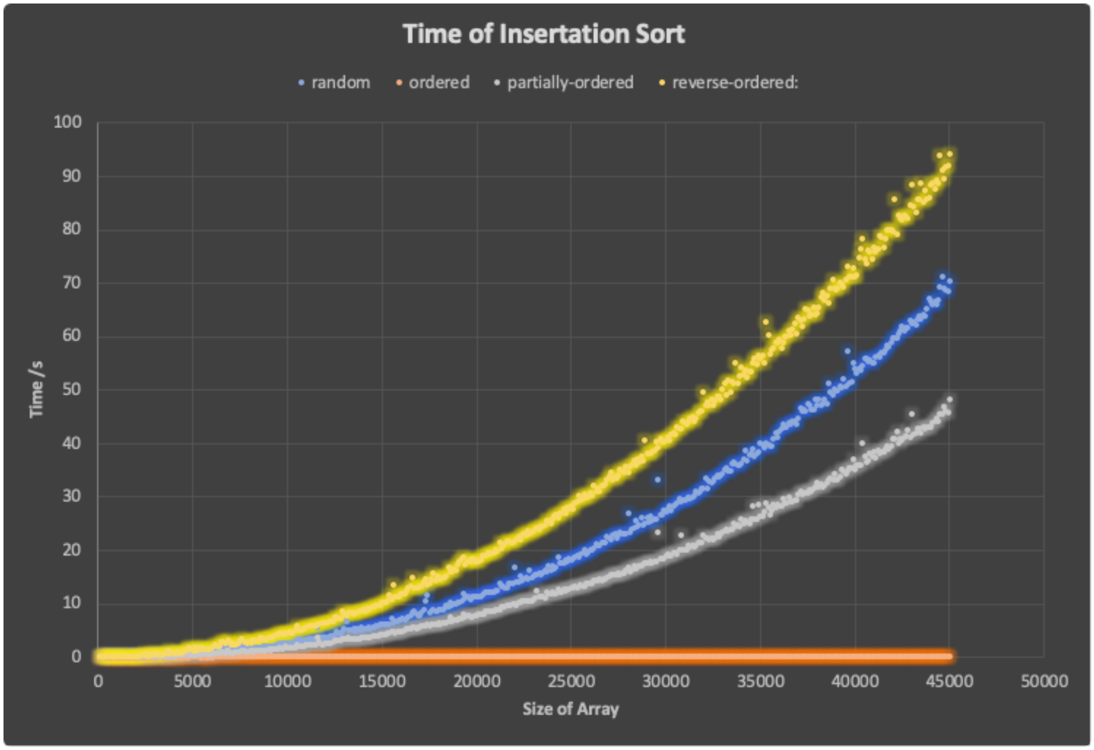
Build completed successfully in 1 s 971 ms (14 minutes ago)

➢ Relationship Conclusion

As the graph showed in evidence, the relationship among times of four different arrays for insertion sort is:

Reverse-ordered > Random > Partially ordered > Order

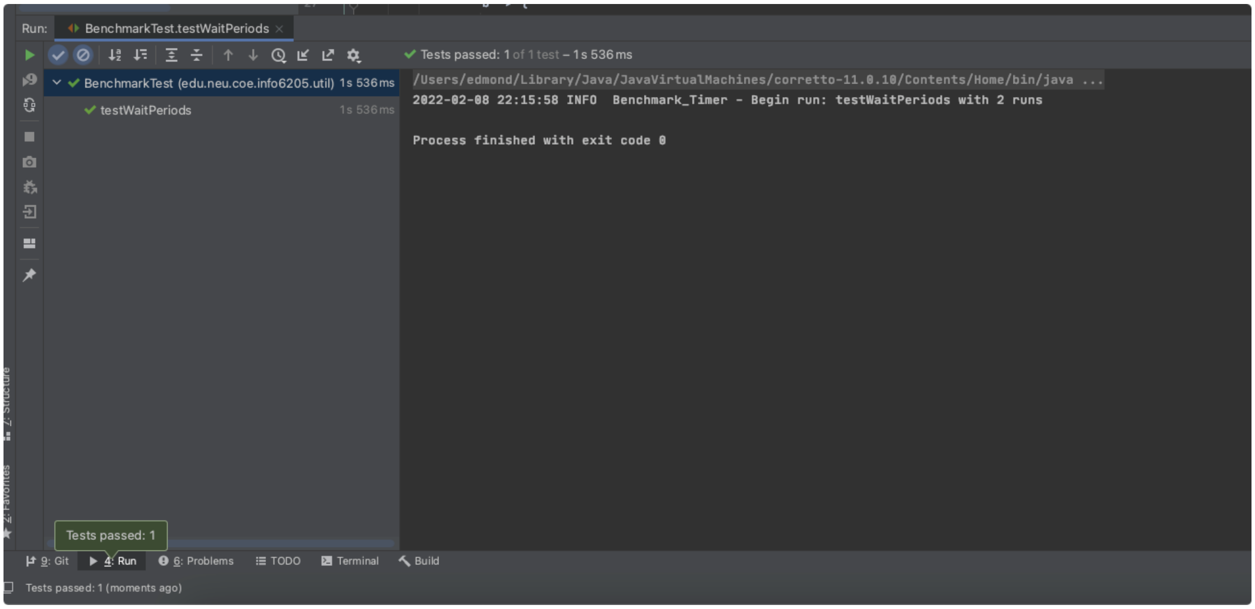
➢ Evidence / Graph



Picture 1- Evidence of Relationship Conclusion

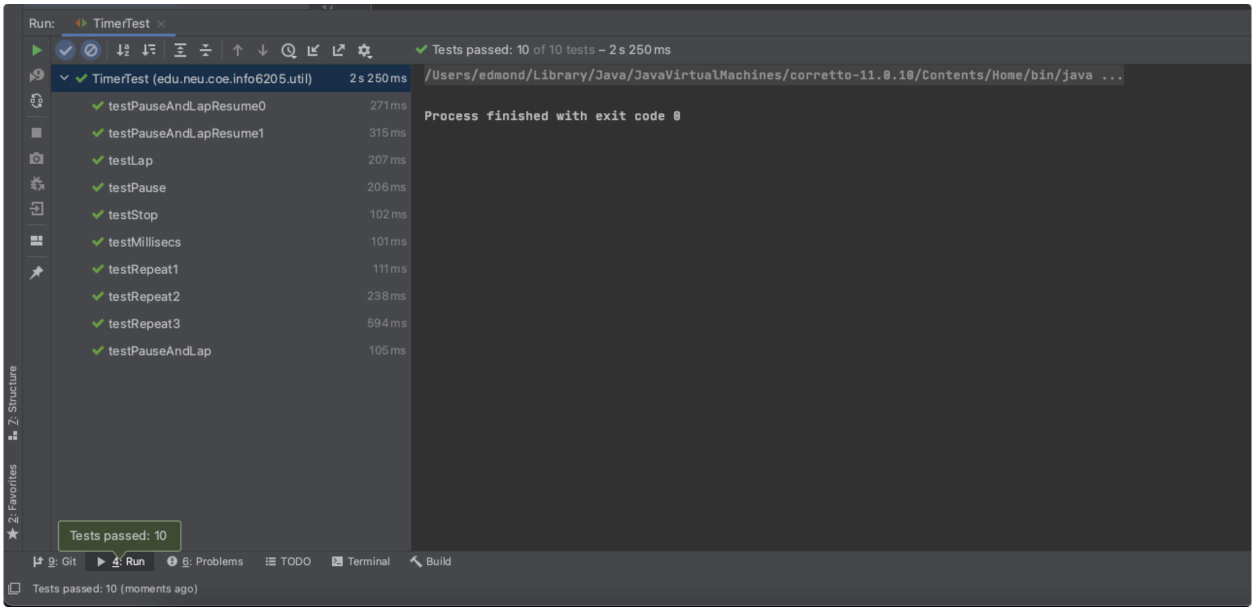
➢ Unit tests result

(Part 1) unit tests in *BenchmarkTest* and *TimerTest*.


Run:
BenchmarkTest.testWaitPeriods
✓ Tests passed: 1 of 1 test – 1 s 536 ms
✓ BenchmarkTest (edu.neu.coe.info6205.util) 1 s 536 ms
✓ testWaitPeriods 1 s 536 ms
Tests passed: 1
9: Git
4: Run
6: Problems
TODO
Terminal
Build
Tests passed: 1 (moments ago)
Z: Structure
2: Favorites

```
/Users/edmond/Library/Java/JavaVirtualMachines/corretto-11.0.10/Contents/Home/bin/java ...
2022-02-08 22:15:58 INFO  Benchmark_Timer - Begin run: testWaitPeriods with 2 runs

Process finished with exit code 0
```

Picture 2-unit tests in BenchmarkTest



✓ Tests passed: 10 of 10 tests – 2 s 250 ms

```
✓ TimerTest (edu.neu.coe.info6205.util)   2 s 250 ms
    ✓ testPauseAndLapResume0              271 ms
    ✓ testPauseAndLapResume1              315 ms
    ✓ testLap                             207 ms
    ✓ testPause                           206 ms
    ✓ testStop                            102 ms
    ✓ testMillisecs                       101 ms
    ✓ testRepeat1                         111 ms
    ✓ testRepeat2                         238 ms
    ✓ testRepeat3                         594 ms
    ✓ testPauseAndLap                     105 ms
```

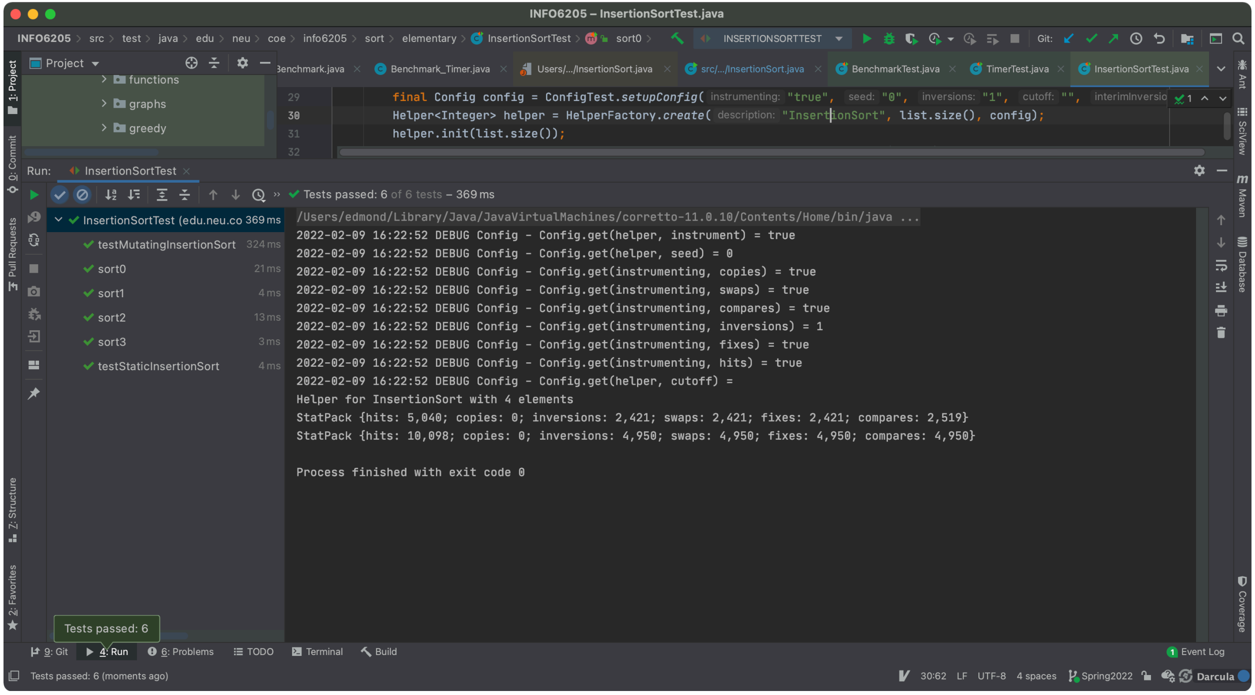
```
/Users/edmond/Library/Java/JavaVirtualMachines/corretto-11.0.10/Contents/Home/bin/java ...

Process finished with exit code 0
```

Tests passed: 10

Tests passed: 10 (moments ago)

Picture 3-unit tests in TimerTest

(Part 2) unit tests in *InsertionSortTest*.



```
        final Config config = ConfigTest.setupConfig( instrumenting: "true",  seed: "0",  inversions: "1",  cutoff: "",  interimInversio
        Helper<Integer> helper = HelperFactory.create( description: "InsertionSort", list.size(), config);
        helper.init(list.size());
```

✓ Tests passed: 6 of 6 tests – 369 ms

```
✓ InsertionSortTest (edu.neu.co  369 ms
    ✓ testMutatingInsertionSort  324 ms
    ✓ sort0                       21 ms
    ✓ sort1                        4 ms
    ✓ sort2                       13 ms
    ✓ sort3                        3 ms
    ✓ testStaticInsertionSort      4 ms
```

```
/Users/edmond/Library/Java/JavaVirtualMachines/corretto-11.0.10/Contents/Home/bin/java ...
2022-02-09 16:22:52 DEBUG Config - Config.get(helper, instrument) = true
2022-02-09 16:22:52 DEBUG Config - Config.get(helper, seed) = 0
2022-02-09 16:22:52 DEBUG Config - Config.get(instrumenting, copies) = true
2022-02-09 16:22:52 DEBUG Config - Config.get(instrumenting, swaps) = true
2022-02-09 16:22:52 DEBUG Config - Config.get(instrumenting, compares) = true
2022-02-09 16:22:52 DEBUG Config - Config.get(instrumenting, inversions) = 1
2022-02-09 16:22:52 DEBUG Config - Config.get(instrumenting, fixes) = true
2022-02-09 16:22:52 DEBUG Config - Config.get(instrumenting, hits) = true
2022-02-09 16:22:52 DEBUG Config - Config.get(helper, cutoff) =
Helper for InsertionSort with 4 elements
StatPack {hits: 5,040; copies: 0; inversions: 2,421; swaps: 2,421; fixes: 2,421; compares: 2,519}
StatPack {hits: 10,098; copies: 0; inversions: 4,950; swaps: 4,950; fixes: 4,950; compares: 4,950}

Process finished with exit code 0
```

Tests passed: 6

Tests passed: 6 (moments ago)

Picture 4-unit tests in InsertionSortTest