Program Structures and Algorithms
Spring 2023(SEC –8)

NAME: Mehul Natu
NUID: 002743870

Task:

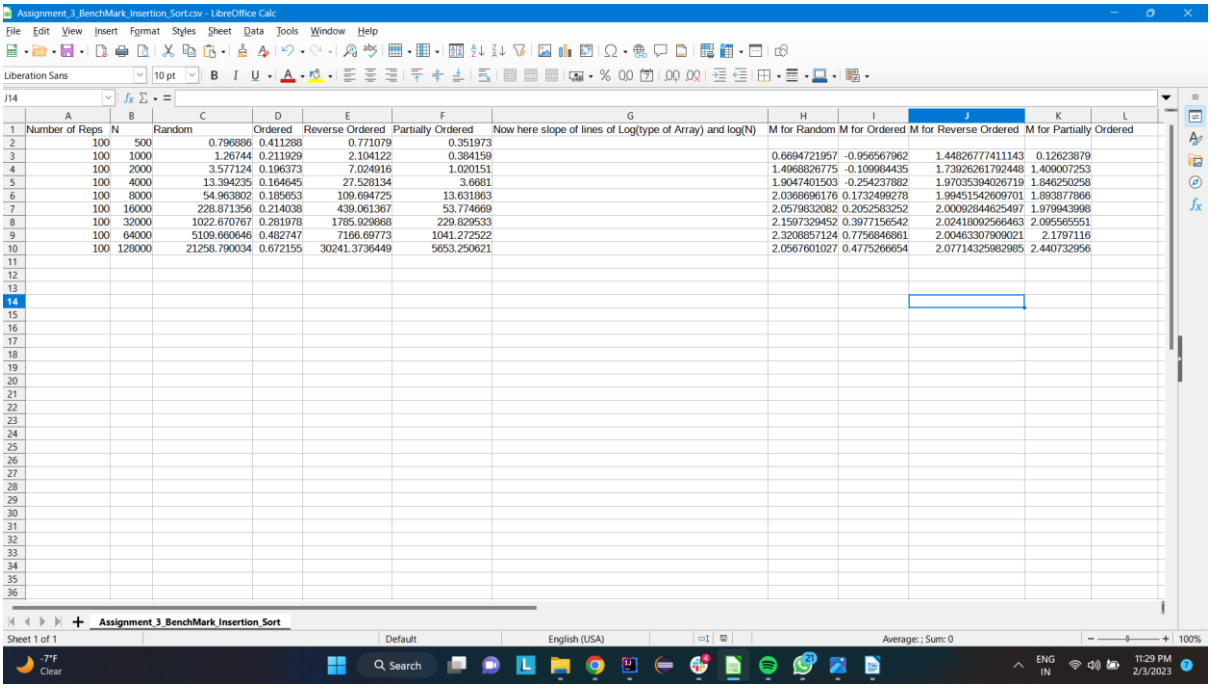
1. To implement three (3) methods (*repeat*, *getClock*, and *toMillisecs*) of a class called*Timer*.
2. Implement *InsertionSort and run InsertionSortUnitTests*
3. BenchMark - Random, Ordered, Partially-Ordered and Reverse-Ordered and draw conclusion from it.

Relationship Conclusion:

- For the 3rd task the conclusion is insertion sort take at most $O(n^2)$.
- And for Ordered Array it is nearly a constant. And for all the other cases it is $O(n^2)$

Evidence to support that conclusion:

- Down below is a screenshot of the spread sheet showing at what values of N(N is length of array) how much time did insertion sort take for different array Orders -
- Also in the column H,I,J,K we have slope of lines. Created between Log(time taken to sort a particular order of array) with log(N).
- H – slope of line between Log(time taken to sort for Random ordered Array) and Log(N). Where N is the length of Array. For this the slope appears to be around at 2 whne the value of N is significant. So again the in random case insertion sort works at $O(n^2)$
- I – slope of line between Log(time taken to sort for Sorted ordered Array) and Log(N). Where N is the length of Array. For this the slope appears to be around 0 which mean big $O(n^0)$ which is a constant and also from the time column D for ordered we can see that the time is almost 0 only for each value of N.
- M – slope of line between Log(time taken to sort for Reverse ordered Array) and Log(N). Where N is the length of Array. Similarly for Reverse ordered which should be the worst case for Insertion sort the slope appears to be around 2. Again confirming that for worst case also Big O is $O(n^2)$
- H – slope of line between Log(time taken to sort for Partially ordered Array) and Log(N). Where N is the length of Array. Again the slope for this also appears to be around at 2 thus Big O of $O(n^2)$.
- You can find the “Assignment_3_BenchMark_Insertion_Sort.csv” in the same name folder. Also you can produce this csv by running the class – InsertionSortBenchmark.



Assignment_3_BenchMark_Insertion_Sort.csv - LibreOffice Calc

Number of Reps	N	Random	Ordered	Reverse Ordered	Partially Ordered	Now here slope of lines of Log(type of Array) and log(N)	M for Random	M for Ordered	M for Reverse Ordered	M for Partially Ordered
100	500	0.796886	0.411288	0.771079	0.351973					
100	1000	1.26744	0.211929	2.104122	0.384159		0.6694721957	-0.956567962	1.44826777411143	0.12623879
100	2000	3.577124	0.196373	7.024916	1.020151		1.4968826775	-0.109984435	1.73926261792448	1.409007253
100	4000	13.394235	0.164645	27.528134	3.6681		1.9047401503	-0.254237882	1.97035394026719	1.846250258
100	8000	54.963802	0.185653	109.694725	13.631863		2.0308696176	0.1732499278	1.99451542609701	1.893877866
100	16000	228.871356	0.214038	438.061367	53.774669		2.0579832082	0.2052583252	2.00092844625497	1.979943998
100	32000	1022.670767	0.281978	1785.929888	229.829533		2.1597329452	0.3977156542	2.02418002566463	2.095565551
100	64000	5109.660646	0.482747	7166.69773	1041.272522		2.3208857124	0.7756846861	2.00463307909021	2.1797116
100	128000	21258.790034	0.672155	30241.3736449	5653.250621		2.0567601027	0.4775266654	2.07714325982985	2.440732956

Assignment_3_BenchMark_Insertion_Sort

Sheet 1 of 1 | Default | English (USA) | Average: ; Sum: 0 | 100%

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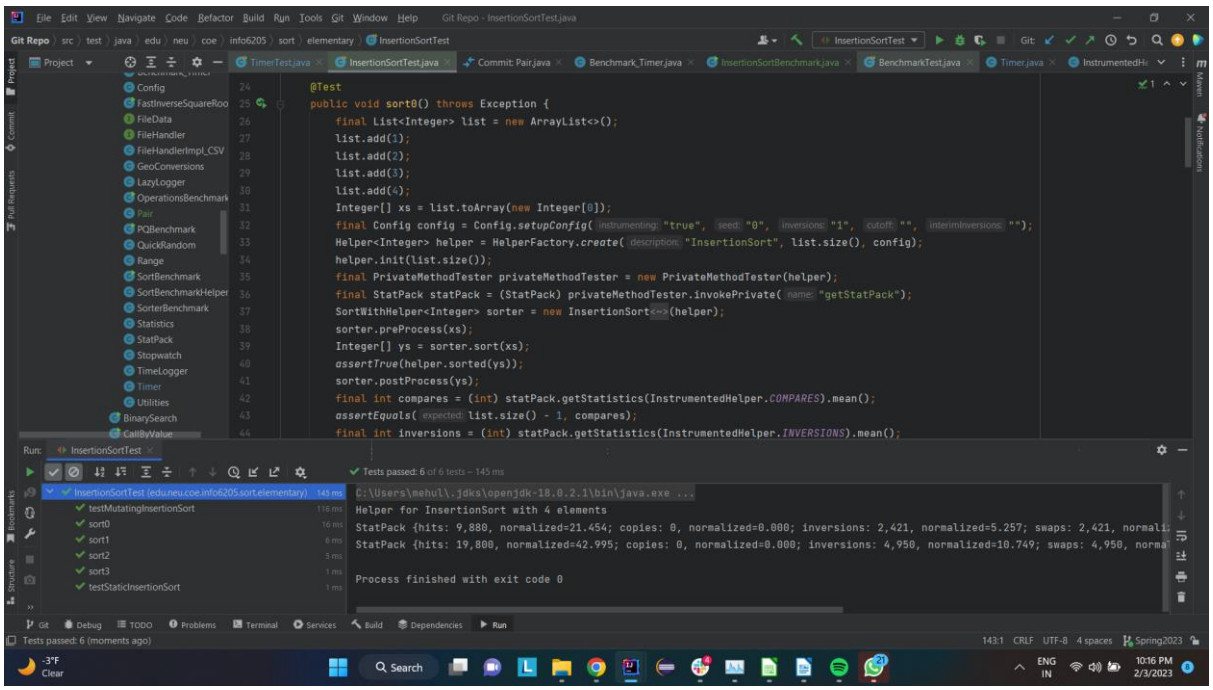
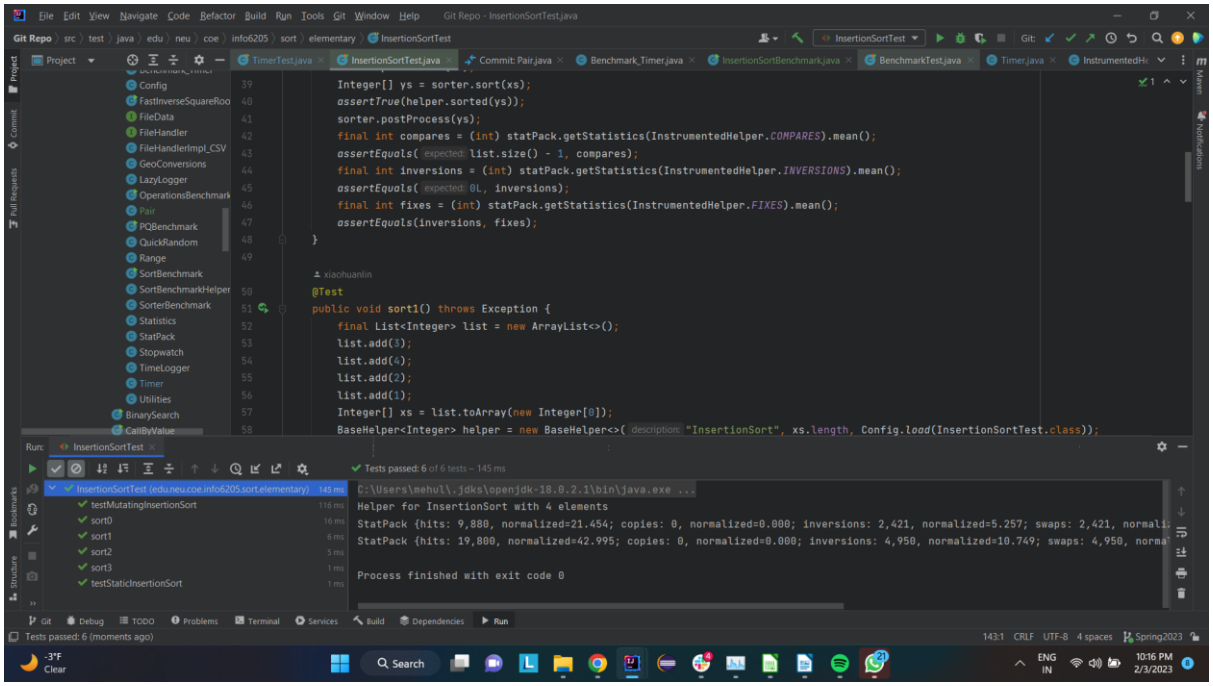
Graphical Representation: Not needed

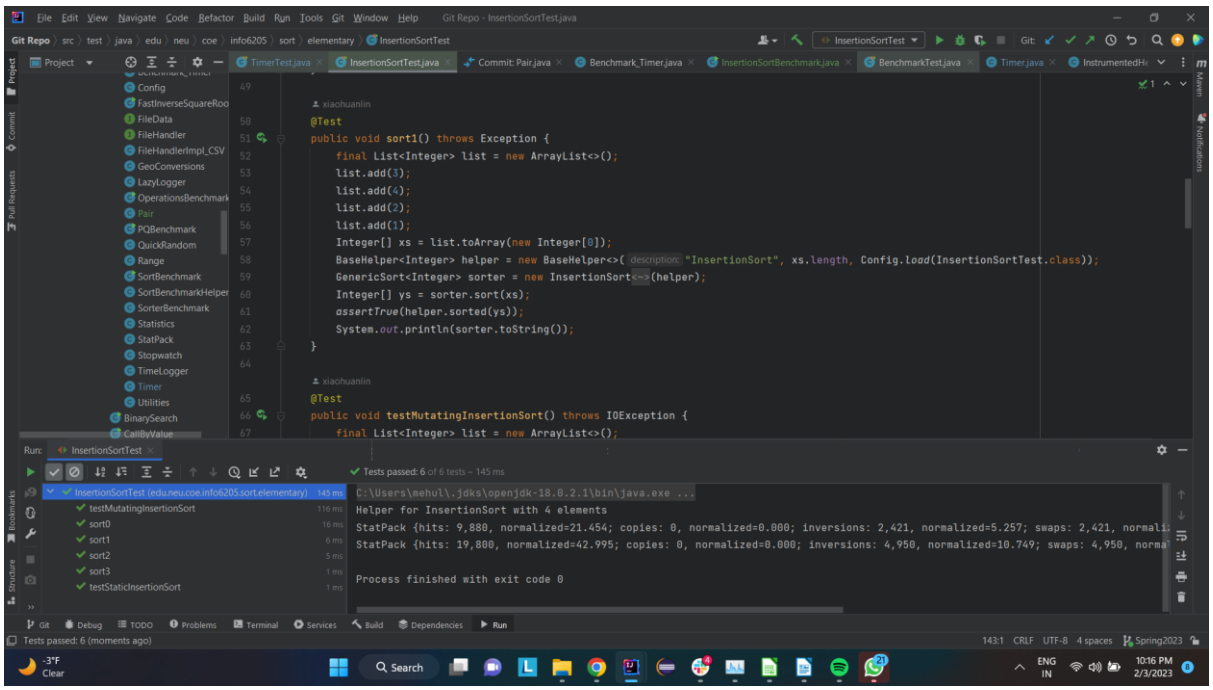
Extra Info: About the Timer test. For case “testRepeat2()” and “testRepeat3()”, in both of them the delta for 2nd assertEquals() is changed. As mentioned in the Assingment 3 itself that we could change the timings to pass the test. So only for these two assertEquals it has been changed.

Unit Test Screenshots:

- Present Below are the Screenshots of Insertion Sort Unit tests along with code.




Integer[] ys = sorter.sort(xs);
assertTrue(helper.sorted(ys));
sorter.postProcess(ys);
final int compares = (int) statPack.getStatistics(InstrumentedHelper.COMPARES).mean();
assertEquals(expected: list.size() - 1, compares);
final int inversions = (int) statPack.getStatistics(InstrumentedHelper.INVERSIONS).mean();
assertEquals(expected: 0L, inversions);
final int fixes = (int) statPack.getStatistics(InstrumentedHelper.FIXES).mean();
assertEquals(inversions, fixes);
}
xiaohuanlin
@Test
public void sort1() throws Exception {
final List<Integer> list = new ArrayList<>();
list.add(3);
list.add(4);
list.add(2);
list.add(1);
Integer[] xs = list.toArray(new Integer[0]);
BaseHelper<Integer> helper = new BaseHelper<>(description: "InsertionSort", xs.length, Config.load(InsertionSortTest.class));
Tests passed: 6 of 6 tests – 145 ms
C:\Users\mehul\.jdks\openjdk-18.0.2.1\bin\java.exe ...
Helper for InsertionSort with 4 elements
StatPack {hits: 9,880, normalized=21.454; copies: 0, normalized=0.000; inversions: 2,421, normalized=5.257; swaps: 2,421, normali
StatPack {hits: 19,800, normalized=42.995; copies: 0, normalized=0.000; inversions: 4,950, normalized=10.749; swaps: 4,950, norma
Process finished with exit code 0
testMutatingInsertionSort
sort0
sort1
sort2
sort3
testStaticInsertionSort


xiaohuanlin
@Test
public void sort1() throws Exception {
final List<Integer> list = new ArrayList<>();
list.add(3);
list.add(4);
list.add(2);
list.add(1);
Integer[] xs = list.toArray(new Integer[0]);
BaseHelper<Integer> helper = new BaseHelper<>(description: "InsertionSort", xs.length, Config.load(InsertionSortTest.class));
GenericSort<Integer> sorter = new InsertionSort<>(helper);
Integer[] ys = sorter.sort(xs);
assertTrue(helper.sorted(ys));
System.out.println(sorter.toString());
}
xiaohuanlin
@Test
public void testMutatingInsertionSort() throws IOException {
final List<Integer> list = new ArrayList<>();
Tests passed: 6 of 6 tests – 145 ms
C:\Users\mehul\.jdks\openjdk-18.0.2.1\bin\java.exe ...
Helper for InsertionSort with 4 elements
StatPack {hits: 9,880, normalized=21.454; copies: 0, normalized=0.000; inversions: 2,421, normalized=5.257; swaps: 2,421, normali
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testMutatingInsertionSort
sort0
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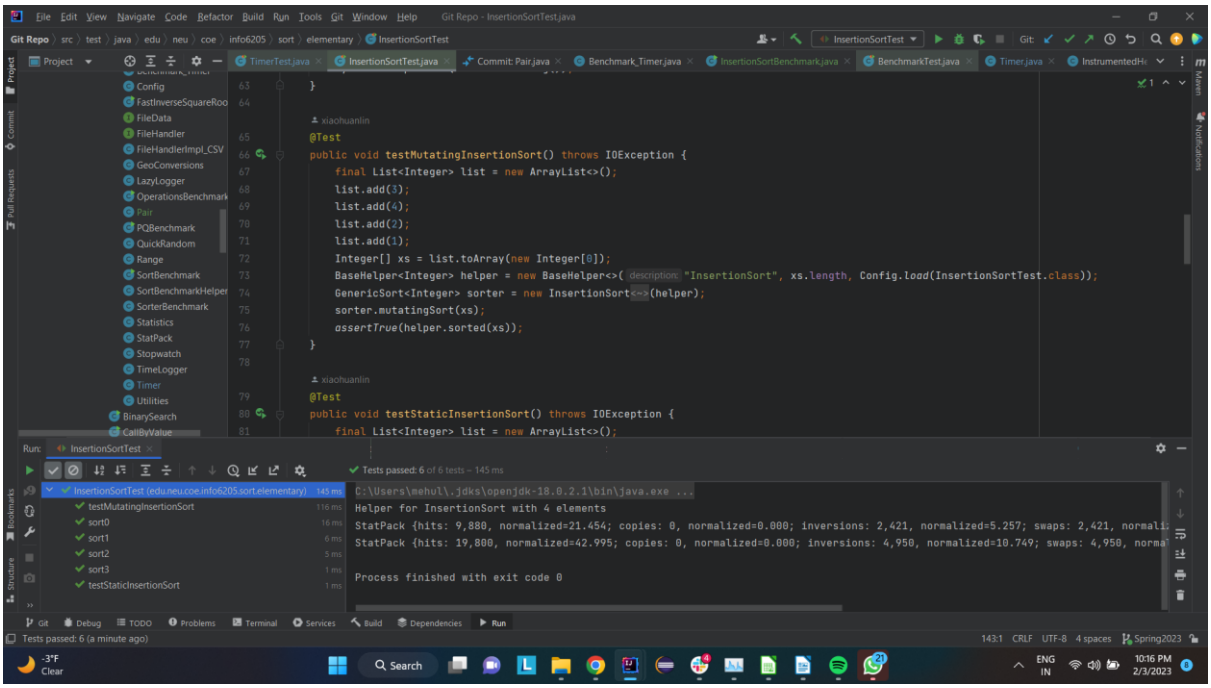
sort2
sort3
testStaticInsertionSort


File Edit View Navigate Code Refactor Build Run Tools Git Window Help
Git Repo - InsertionSortTest.java
Git Repo › src › test › java › edu › neu › coe › info6205 › sort › elementary › InsertionSortTest
InsertionSortTest
TimerTest.java
InsertionSortTest.java
Commit: Pair.java
Benchmark_Timer.java
InsertionSortBenchmark.java
BenchmarkTest.java
Timer.java
InstrumentedHe
63 }
64
xiaohuanlin
65 @Test
66 public void testMutatingInsertionSort() throws IOException {
67 final List<Integer> list = new ArrayList<>();
68 list.add(3);
69 list.add(4);
70 list.add(2);
71 list.add(1);
72 Integer[] xs = list.toArray(new Integer[0]);
73 BaseHelper<Integer> helper = new BaseHelper<>(description: "InsertionSort", xs.length, Config.load(InsertionSortTest.class));
74 GenericSort<Integer> sorter = new InsertionSort<>(helper);
75 sorter.mutatingSort(xs);
76 assertTrue(helper.sorted(xs));
77 }
78
xiaohuanlin
79 @Test
80 public void testStaticInsertionSort() throws IOException {
81 final List<Integer> list = new ArrayList<>();
Run: InsertionSortTest
Tests passed: 6 of 6 tests – 145 ms
InsertionSortTest (edu.neu.coe.info6205.sort.elementary) 145 ms
testMutatingInsertionSort 116 ms
sort0 16 ms
sort1 6 ms
sort2 5 ms
sort3 1 ms
testStaticInsertionSort 1 ms
C:\Users\mehul\.jdks\openjdk-18.0.2.1\bin\java.exe ...
Helper for InsertionSort with 4 elements
StatPack {hits: 9,880, normalized=21.454; copies: 0, normalized=0.000; inversions: 2,421, normalized=5.257; swaps: 2,421, normali
StatPack {hits: 19,800, normalized=42.995; copies: 0, normalized=0.000; inversions: 4,950, normalized=10.749; swaps: 4,950, norma
Process finished with exit code 0
Git Debug TODO Problems Terminal Services Build Dependencies Run
Tests passed: 6 (a minute ago)
143:1 CRLF UTF-8 4 spaces Spring2023
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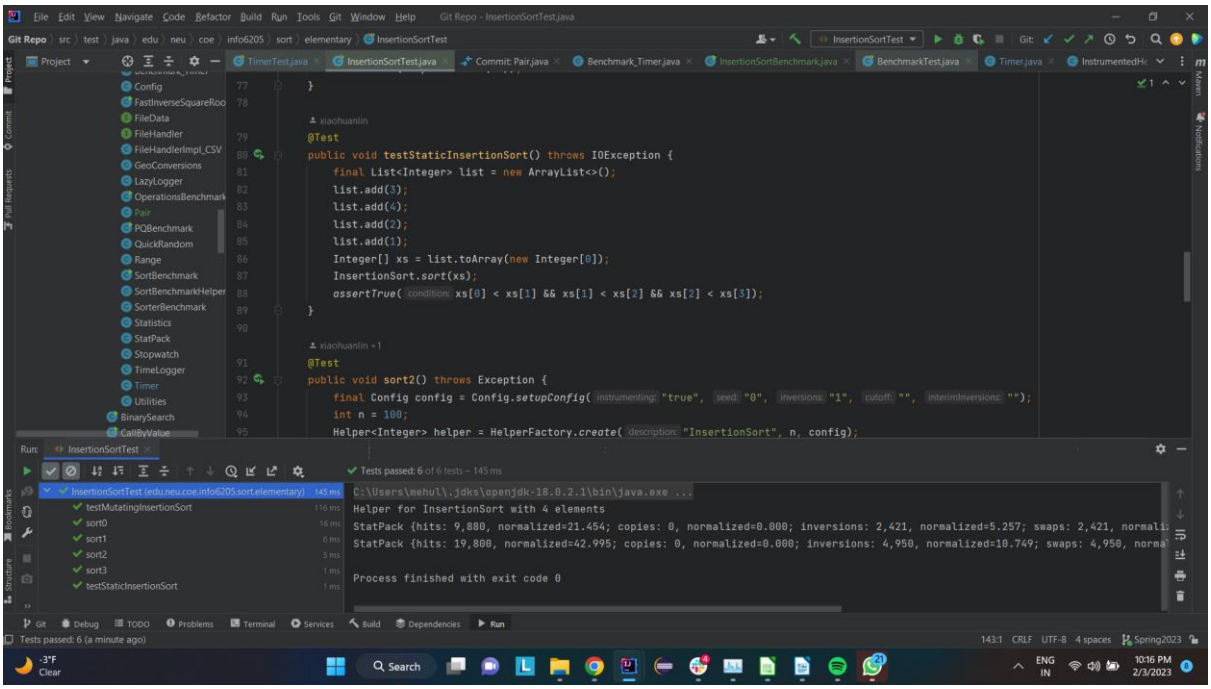
File Edit View Navigate Code Refactor Build Run Tools Git Window Help
Git Repo - InsertionSortTest.java
Git Repo › src › test › java › edu › neu › coe › info6205 › sort › elementary › InsertionSortTest
InsertionSortTest
TimerTest.java
InsertionSortTest.java
Commit: Pair.java
Benchmark_Timer.java
InsertionSortBenchmark.java
BenchmarkTest.java
Timer.java
InstrumentedHe
77 }
78
xiaohuanlin
79 @Test
80 public void testStaticInsertionSort() throws IOException {
81 final List<Integer> list = new ArrayList<>();
82 list.add(3);
83 list.add(4);
84 list.add(2);
85 list.add(1);
86 Integer[] xs = list.toArray(new Integer[0]);
87 InsertionSort.sort(xs);
88 assertTrue(condition: xs[0] < xs[1] && xs[1] < xs[2] && xs[2] < xs[3]);
89 }
90
xiaohuanlin +1
91 @Test
92 public void sort2() throws Exception {
93 final Config config = Config.setupConfig(instrumenting: "true", seed: "0", inversions: "1", cutoff: "", interimInversions: "");
94 int n = 100;
95 Helper<Integer> helper = HelperFactory.create(description: "InsertionSort", n, config);
Run: InsertionSortTest
Tests passed: 6 of 6 tests – 145 ms
InsertionSortTest (edu.neu.coe.info6205.sort.elementary) 145 ms
testMutatingInsertionSort 116 ms
sort0 16 ms
sort1 6 ms
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Process finished with exit code 0
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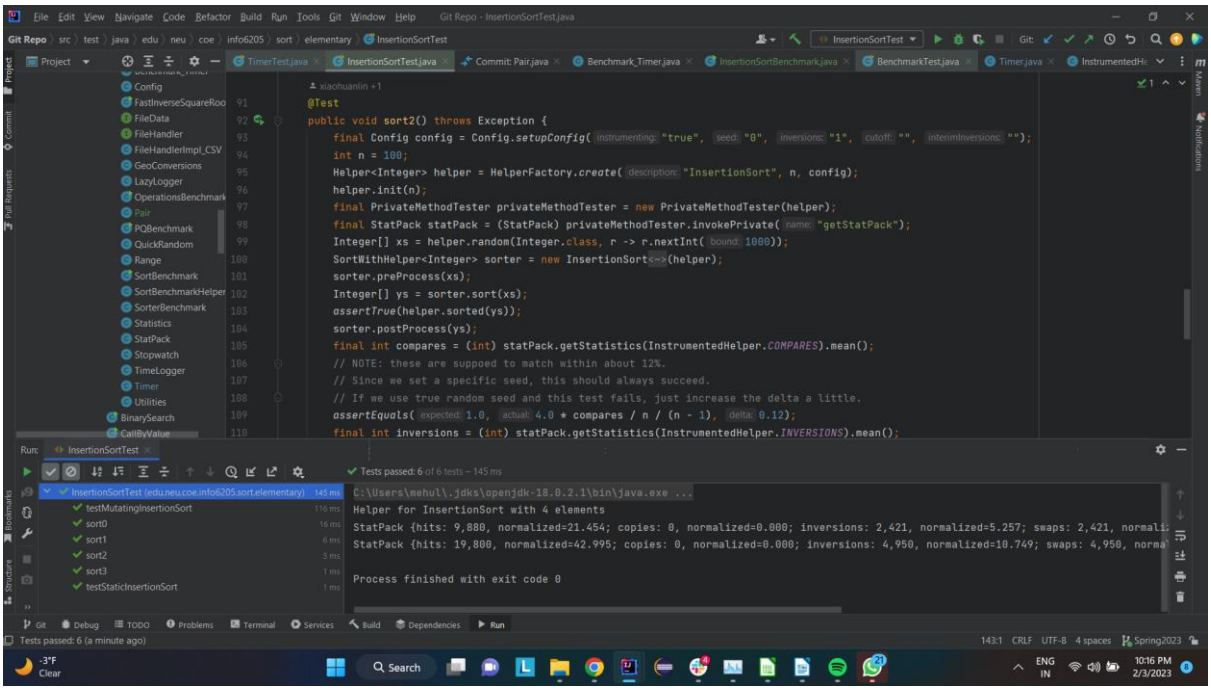
@Test
public void sort2() throws Exception {
final Config config = Config.setupConfig(instrumenting: "true", seed: "0", inversions: "1", cutoff: "", interimInversions: "");
int n = 100;
Helper<Integer> helper = HelperFactory.create(description: "InsertionSort", n, config);
helper.init(n);
final PrivateMethodTester privateMethodTester = new PrivateMethodTester(helper);
final StatPack statPack = (StatPack) privateMethodTester.invokePrivate(name: "getStatPack");
Integer[] xs = helper.random(Integer.class, r -> r.nextInt(bound: 1000));
SortWithHelper<Integer> sorter = new InsertionSort<>(helper);
sorter.preProcess(xs);
Integer[] ys = sorter.sort(xs);
assertTrue(helper.sorted(ys));
sorter.postProcess(ys);
final int compares = (int) statPack.getStatistics(InstrumentedHelper.COMPARES).mean();
// NOTE: these are suppoed to match within about 12%.
// Since we set a specific seed, this should always succeed.
// If we use true random seed and this test fails, just increase the delta a little.
assertEquals(expected: 1.0, actual: 4.0 * compares / n / (n - 1), delta: 0.12);
final int inversions = (int) statPack.getStatistics(InstrumentedHelper.INVERSIONS).mean();
Tests passed: 6 of 6 tests – 145 ms
C:\Users\mehul\.jdks\openjdk-18.0.2.1\bin\java.exe ...
Helper for InsertionSort with 4 elements
StatPack {hits: 9,880, normalized=21.454; copies: 0, normalized=0.000; inversions: 2,421, normalized=5.257; swaps: 2,421, normali
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Process finished with exit code 0
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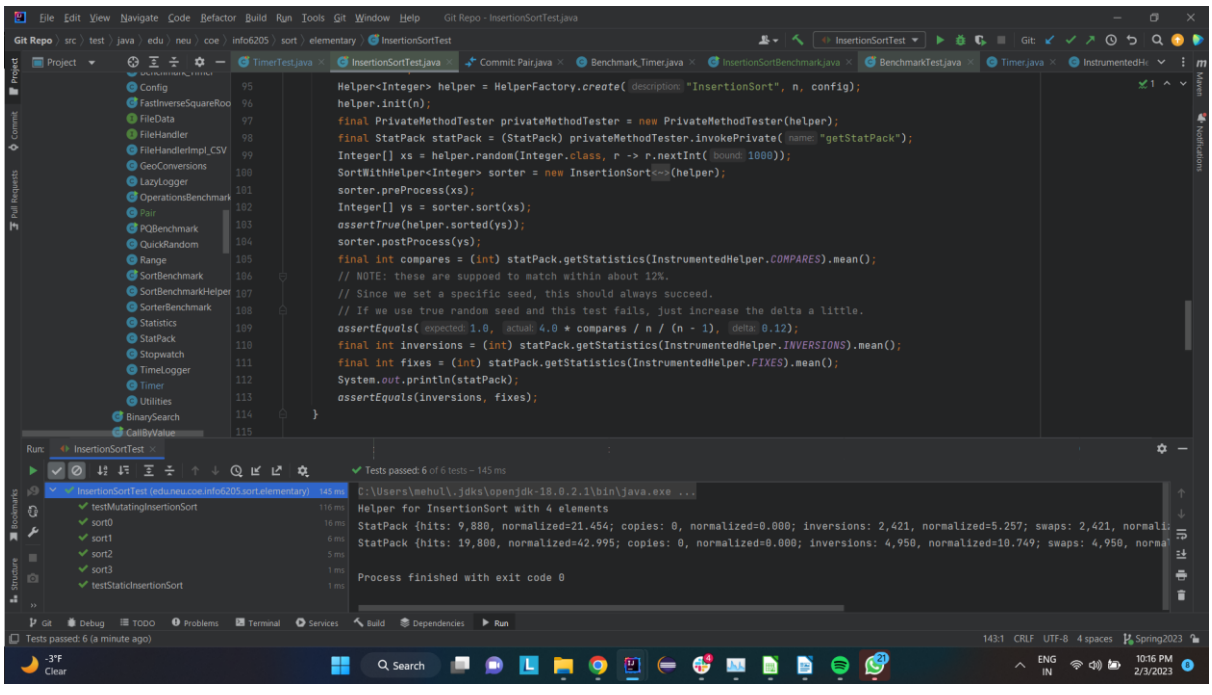
Helper<Integer> helper = HelperFactory.create(description: "InsertionSort", n, config);
helper.init(n);
final PrivateMethodTester privateMethodTester = new PrivateMethodTester(helper);
final StatPack statPack = (StatPack) privateMethodTester.invokePrivate(name: "getStatPack");
Integer[] xs = helper.random(Integer.class, r -> r.nextInt(bound: 1000));
SortWithHelper<Integer> sorter = new InsertionSort<>(helper);
sorter.preProcess(xs);
Integer[] ys = sorter.sort(xs);
assertTrue(helper.sorted(ys));
sorter.postProcess(ys);
final int compares = (int) statPack.getStatistics(InstrumentedHelper.COMPARES).mean();
// NOTE: these are suppoed to match within about 12%.
// Since we set a specific seed, this should always succeed.
// If we use true random seed and this test fails, just increase the delta a little.
assertEquals(expected: 1.0, actual: 4.0 * compares / n / (n - 1), delta: 0.12);
final int inversions = (int) statPack.getStatistics(InstrumentedHelper.INVERSIONS).mean();
final int fixes = (int) statPack.getStatistics(InstrumentedHelper.FIXES).mean();
System.out.println(statPack);
assertEquals(inversions, fixes);
}
Tests passed: 6 of 6 tests – 145 ms
C:\Users\mehul\.jdks\openjdk-18.0.2.1\bin\java.exe ...
Helper for InsertionSort with 4 elements
StatPack {hits: 9,880, normalized=21.454; copies: 0, normalized=0.000; inversions: 2,421, normalized=5.257; swaps: 2,421, normali
StatPack {hits: 19,800, normalized=42.995; copies: 0, normalized=0.000; inversions: 4,950, normalized=10.749; swaps: 4,950, norma
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143:1 CRLF UTF-8 4 spaces Spring2023
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Search
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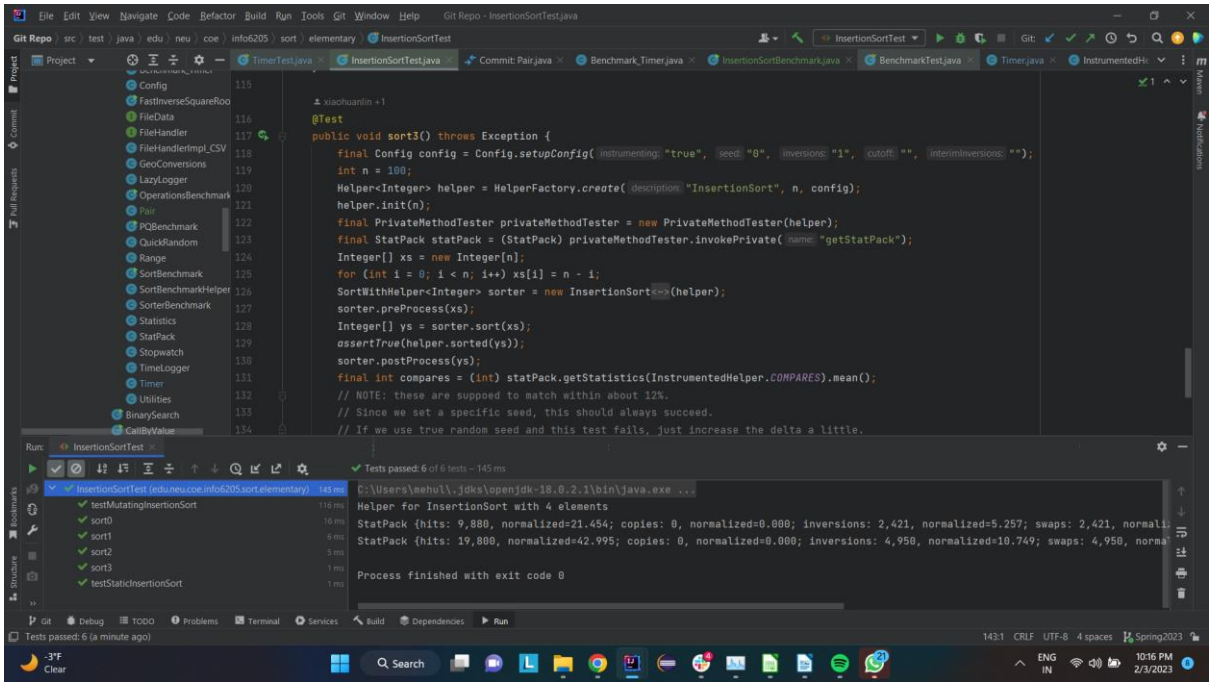
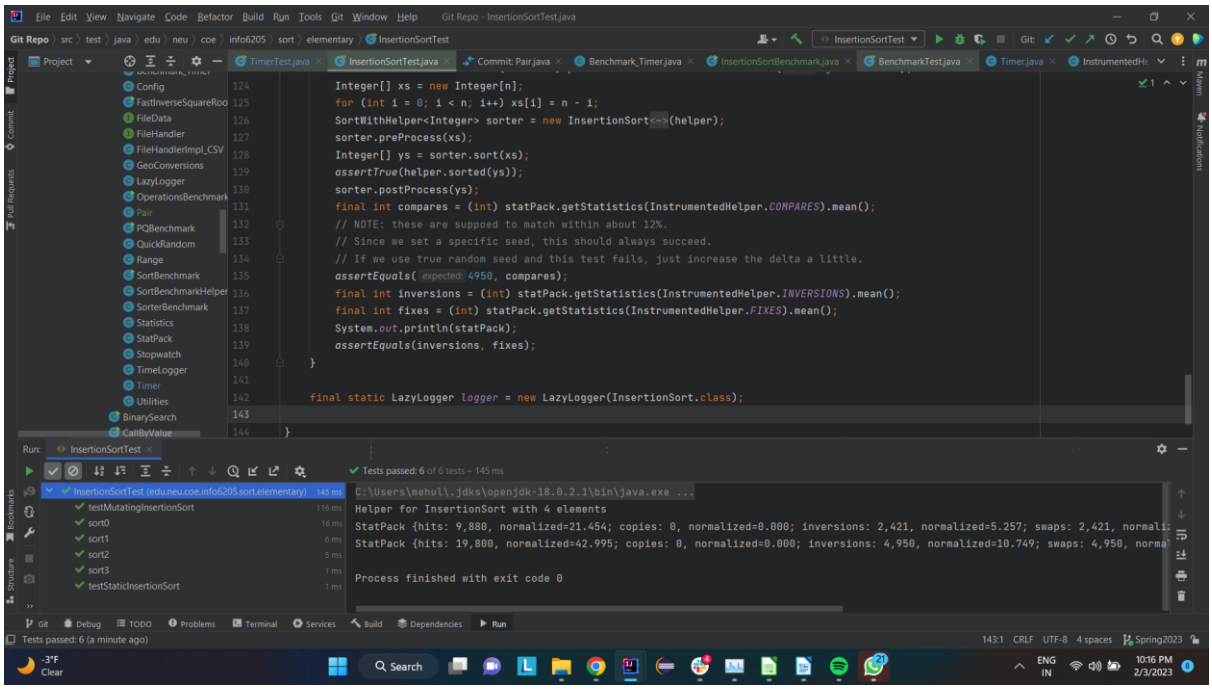
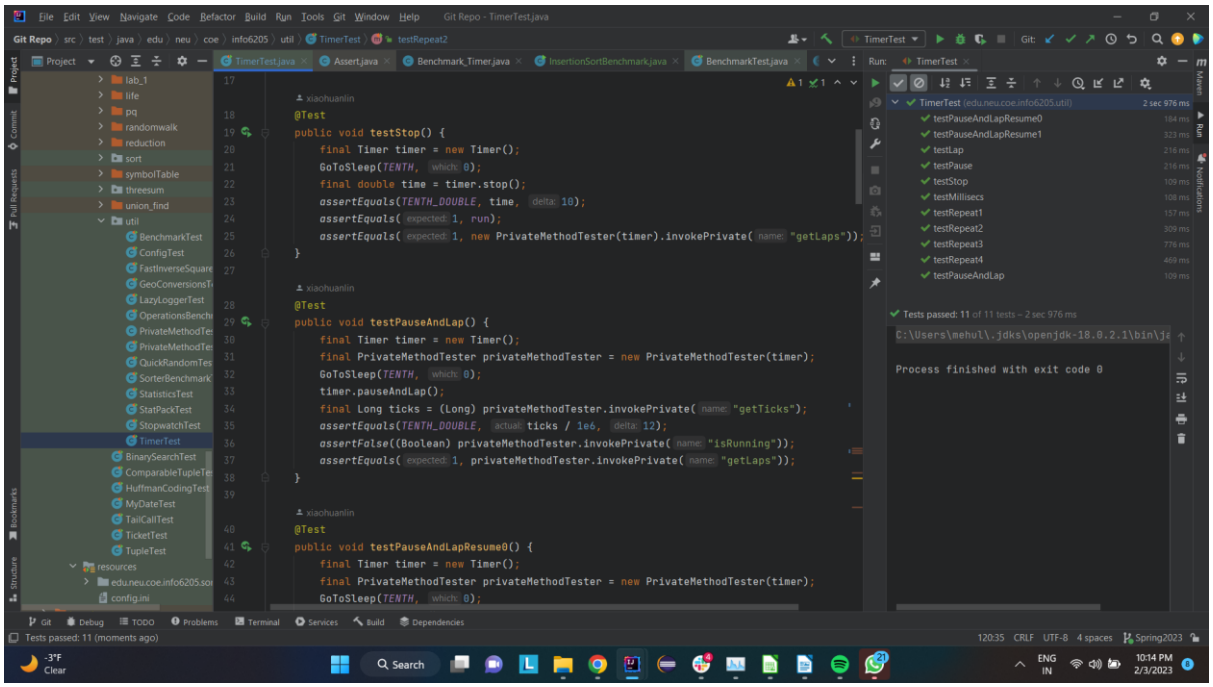
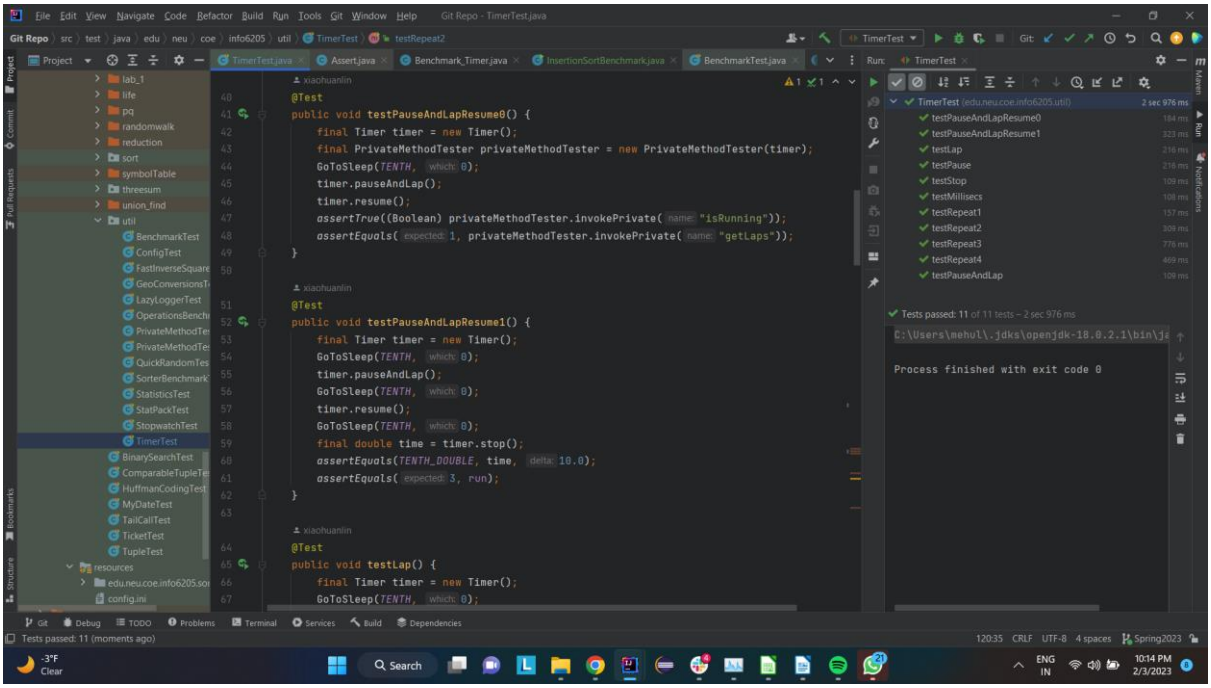
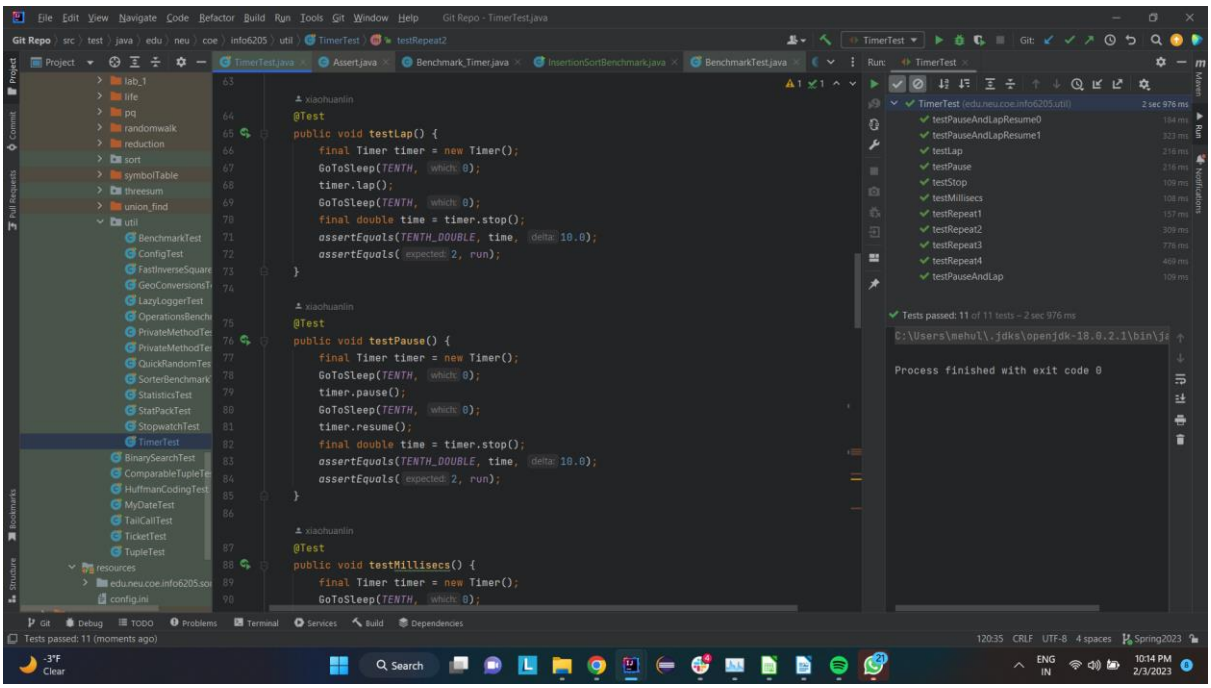

@Test
public void sort3() throws Exception {
final Config config = Config.setupConfig(instrumenting: "true", seed: "0", inversions: "1", cutoff: "", interimInversions: "");
int n = 100;
Helper<Integer> helper = HelperFactory.create(description: "InsertionSort", n, config);
helper.init(n);
final PrivateMethodTester privateMethodTester = new PrivateMethodTester(helper);
final StatPack statPack = (StatPack) privateMethodTester.invokePrivate(name: "getStatPack");
Integer[] xs = new Integer[n];
for (int i = 0; i < n; i++) xs[i] = n - i;
SortWithHelper<Integer> sorter = new InsertionSort<>(helper);
sorter.preProcess(xs);
Integer[] ys = sorter.sort(xs);
assertTrue(helper.sorted(ys));
sorter.postProcess(ys);
final int compares = (int) statPack.getStatistics(InstrumentedHelper.COMPARES).mean();
// NOTE: these are suppoed to match within about 12%.
// Since we set a specific seed, this should always succeed.
// If we use true random seed and this test fails, just increase the delta a little.
Tests passed: 6 of 6 tests – 145 ms
C:\Users\mehul\.jdks\openjdk-18.0.2.1\bin\java.exe ...
Helper for InsertionSort with 4 elements
StatPack {hits: 9,880, normalized=21.454; copies: 0, normalized=0.000; inversions: 2,421, normalized=5.257; swaps: 2,421, normali
StatPack {hits: 19,800, normalized=42.995; copies: 0, normalized=0.000; inversions: 4,950, normalized=10.749; swaps: 4,950, norma
Process finished with exit code 0


Integer[] xs = new Integer[n];
for (int i = 0; i < n; i++) xs[i] = n - i;
SortWithHelper<Integer> sorter = new InsertionSort<>(helper);
sorter.preProcess(xs);
Integer[] ys = sorter.sort(xs);
assertTrue(helper.sorted(ys));
sorter.postProcess(ys);
final int compares = (int) statPack.getStatistics(InstrumentedHelper.COMPARES).mean();
// NOTE: these are suppoed to match within about 12%.
// Since we set a specific seed, this should always succeed.
// If we use true random seed and this test fails, just increase the delta a little.
assertEquals(expected: 4950, compares);
final int inversions = (int) statPack.getStatistics(InstrumentedHelper.INVERSIONS).mean();
final int fixes = (int) statPack.getStatistics(InstrumentedHelper.FIXES).mean();
System.out.println(statPack);
assertEquals(inversions, fixes);
}
final static LazyLogger logger = new LazyLogger(InsertionSort.class);
}
Tests passed: 6 of 6 tests – 145 ms
C:\Users\mehul\.jdks\openjdk-18.0.2.1\bin\java.exe ...
Helper for InsertionSort with 4 elements
StatPack {hits: 9,880, normalized=21.454; copies: 0, normalized=0.000; inversions: 2,421, normalized=5.257; swaps: 2,421, normali
StatPack {hits: 19,800, normalized=42.995; copies: 0, normalized=0.000; inversions: 4,950, normalized=10.749; swaps: 4,950, norma
Process finished with exit code 0

ScreenShots for TimerTest -






File Edit View Navigate Code Refactor Build Run Tools Git Window Help
Git Repo - TimerTest.java
TimerTest.java
Assert.java
Benchmark_Timer.java
InsertionSortBenchmark.java
BenchmarkTest.java
xiaohuanlin
@Test
public void testLap() {
final Timer timer = new Timer();
GoToSleep(TENTH, which: 0);
timer.lap();
GoToSleep(TENTH, which: 0);
final double time = timer.stop();
assertEquals(TENTH_DOUBLE, time, delta: 10.0);
assertEquals(expected: 2, run);
}
xiaohuanlin
@Test
public void testPause() {
final Timer timer = new Timer();
GoToSleep(TENTH, which: 0);
timer.pause();
GoToSleep(TENTH, which: 0);
timer.resume();
final double time = timer.stop();
assertEquals(TENTH_DOUBLE, time, delta: 10.0);
assertEquals(expected: 2, run);
}
xiaohuanlin
@Test
public void testMillisecs() {
final Timer timer = new Timer();
GoToSleep(TENTH, which: 0);
Run: TimerTest
TimerTest (edu.neu.coe.info6205.util) 2 sec 976 ms
testPauseAndLapResume0 184 ms
testPauseAndLapResume1 323 ms
testLap 216 ms
testPause 216 ms
testStop 109 ms
testMillisecs 108 ms
testRepeat1 157 ms
testRepeat2 309 ms
testRepeat3 776 ms
testRepeat4 469 ms
testPauseAndLap 109 ms
Tests passed: 11 of 11 tests – 2 sec 976 ms
C:\Users\mehul\.jdks\openjdk-18.0.2.1\bin\ja
Process finished with exit code 0
Tests passed: 11 (moments ago)
120:35 CRLF UTF-8 4 spaces Spring2023
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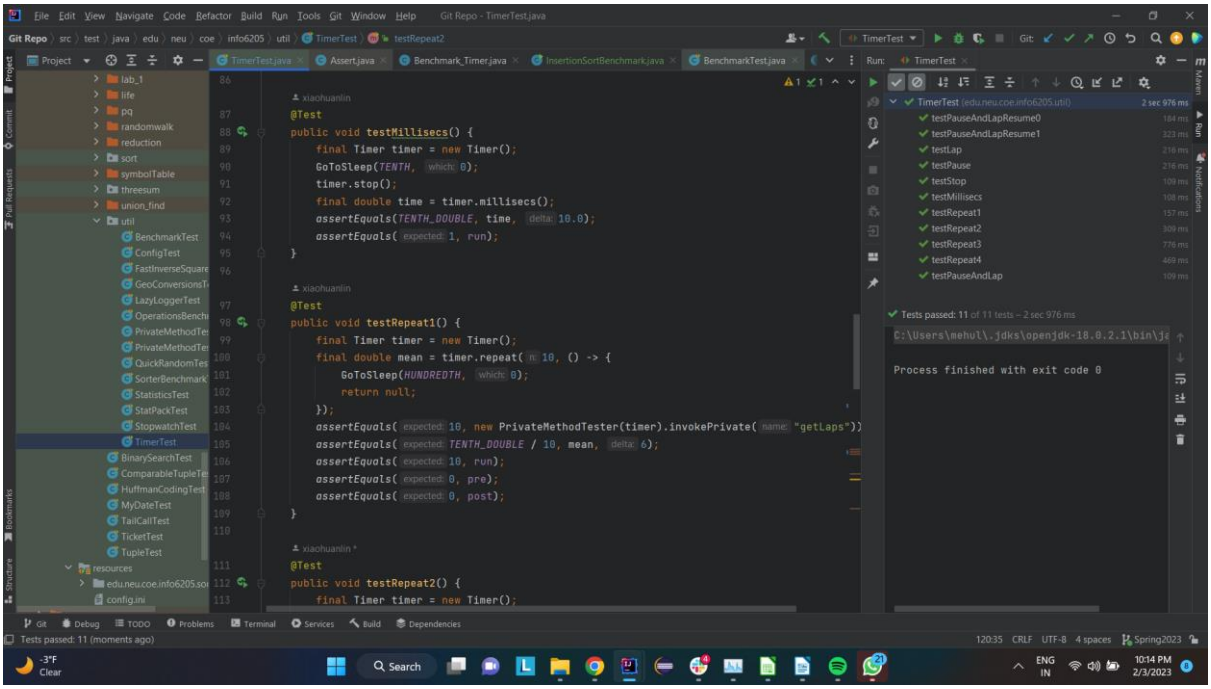
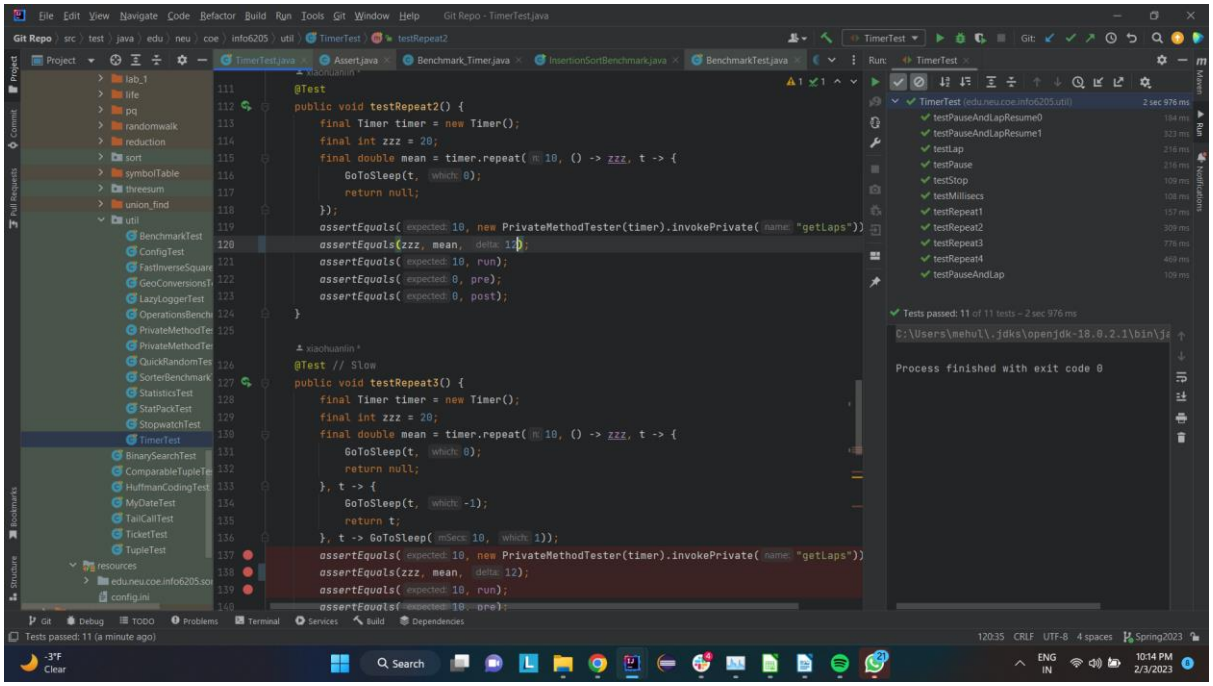
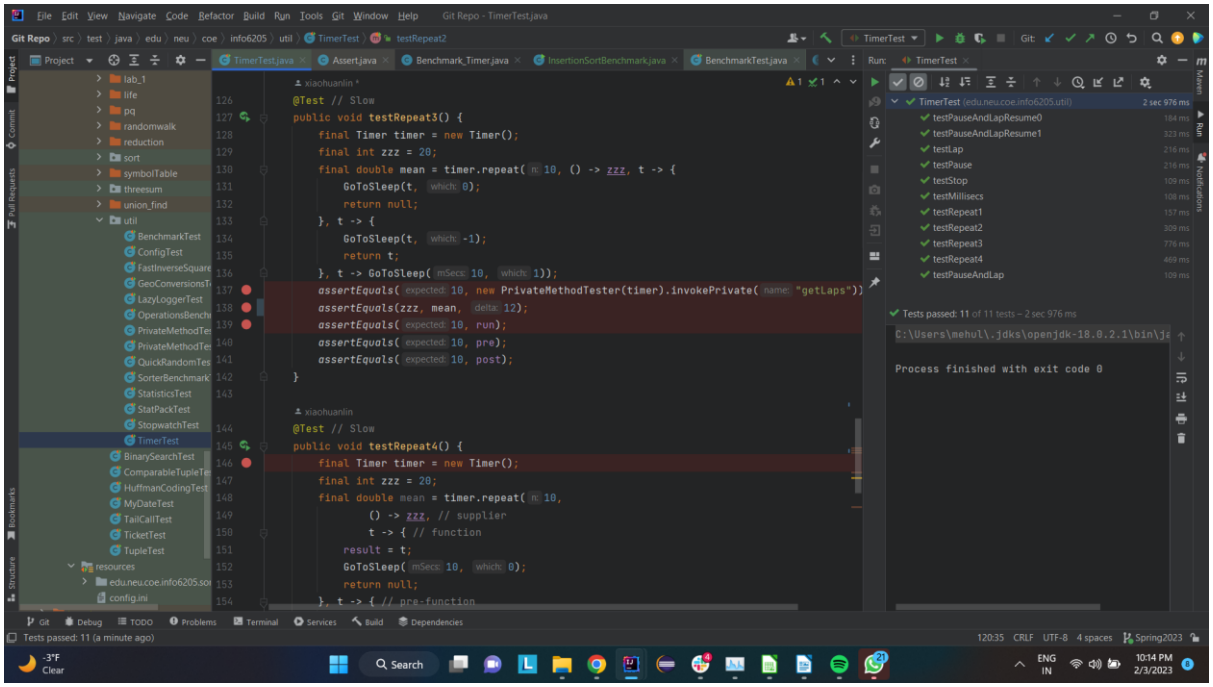
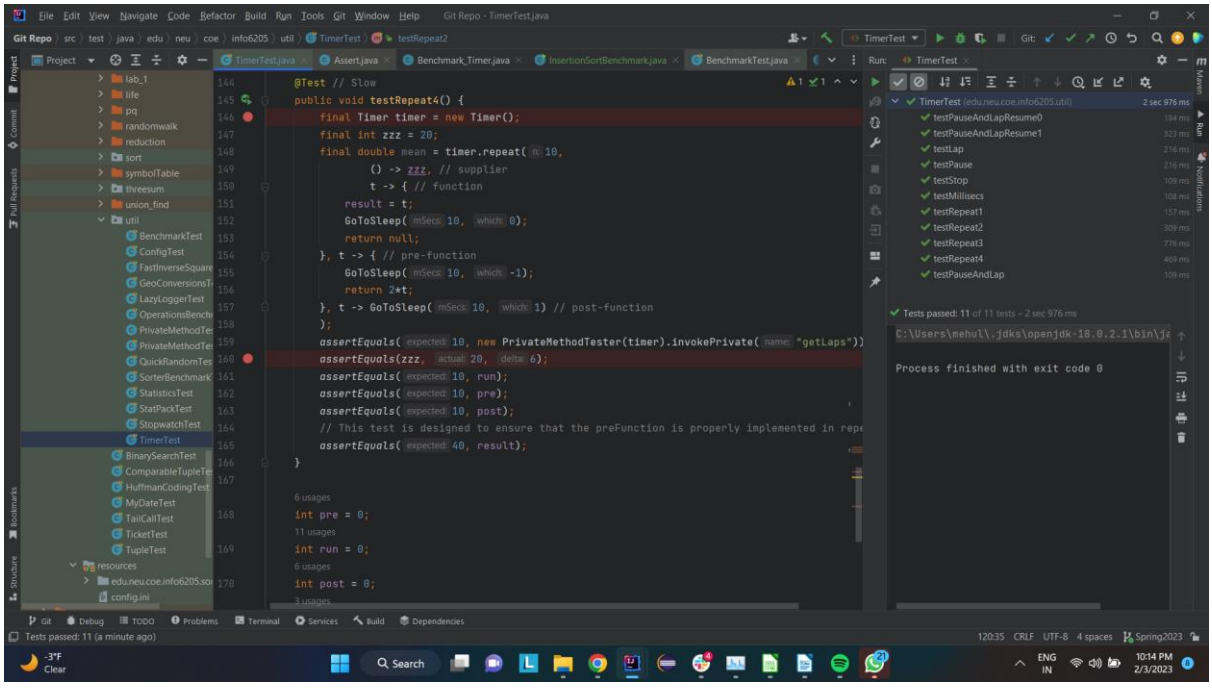

File Edit View Navigate Code Refactor Build Run Tools Git Window Help
Git Repo - TimerTest.java
TimerTest.java
Assert.java
Benchmark_Timer.java
InsertionSortBenchmark.java
BenchmarkTest.java
xiaohuanlin
@Test
public void testMillisecs() {
final Timer timer = new Timer();
GoToSleep(TENTH, which: 0);
timer.stop();
final double time = timer.millisecs();
assertEquals(TENTH_DOUBLE, time, delta: 10.0);
assertEquals(expected: 1, run);
}
xiaohuanlin
@Test
public void testRepeat1() {
final Timer timer = new Timer();
final double mean = timer.repeat(n: 10, () -> {
GoToSleep(HUNDREDTH, which: 0);
return null;
});
assertEquals(expected: 10, new PrivateMethodTester(timer).invokePrivate(name: "getLaps"))
assertEquals(expected: TENTH_DOUBLE / 10, mean, delta: 6);
assertEquals(expected: 10, run);
assertEquals(expected: 0, pre);
assertEquals(expected: 0, post);
}
xiaohuanlin *
@Test
public void testRepeat2() {
final Timer timer = new Timer();
Run: TimerTest
TimerTest (edu.neu.coe.info6205.util) 2 sec 976 ms
testPauseAndLapResume0 184 ms
testPauseAndLapResume1 323 ms
testLap 216 ms
testPause 216 ms
testStop 109 ms
testMillisecs 108 ms
testRepeat1 157 ms
testRepeat2 309 ms
testRepeat3 776 ms
testRepeat4 469 ms
testPauseAndLap 109 ms
Tests passed: 11 of 11 tests – 2 sec 976 ms
C:\Users\mehul\.jdks\openjdk-18.0.2.1\bin\ja
Process finished with exit code 0
Tests passed: 11 (moments ago)
120:35 CRLF UTF-8 4 spaces Spring2023
-3°F Clear
Search
ENG IN
10:14 PM 2/3/2023


File Edit View Navigate Code Refactor Build Run Tools Git Window Help
Git Repo - TimerTest.java
Git Repo › src › test › java › edu › neu › coe › info6205 › util › TimerTest › testRepeat2
TimerTest
Project
TimerTest.java
Assert.java
Benchmark_Timer.java
InsertionSortBenchmark.java
BenchmarkTest.java
Run: TimerTest
lab_1
life
pq
randomwalk
reduction
sort
symbolTable
threesum
union_find
util
BenchmarkTest
ConfigTest
FastInverseSquare
GeoConversionsT
LazyLoggerTest
OperationsBench
PrivateMethodTes
PrivateMethodTes
QuickRandomTes
SorterBenchmark
StatisticsTest
StatPackTest
StopwatchTest
TimerTest
BinarySearchTest
ComparableTupleTe
HuffmanCodingTest
MyDateTest
TailCallTest
TicketTest
TupleTest
resources
edu.neu.coe.info6205.sor
config.ini
@Test
public void testRepeat2() {
final Timer timer = new Timer();
final int zzz = 20;
final double mean = timer.repeat(n: 10, () -> zzz, t -> {
GoToSleep(t, which: 0);
return null;
});
assertEquals(expected: 10, new PrivateMethodTester(timer).invokePrivate(name: "getLaps"))
assertEquals(zzz, mean, delta: 12);
assertEquals(expected: 10, run);
assertEquals(expected: 0, pre);
assertEquals(expected: 0, post);
}
@Test // Slow
public void testRepeat3() {
final Timer timer = new Timer();
final int zzz = 20;
final double mean = timer.repeat(n: 10, () -> zzz, t -> {
GoToSleep(t, which: 0);
return null;
}, t -> {
GoToSleep(t, which: -1);
return t;
}, t -> GoToSleep(mSecs: 10, which: 1));
assertEquals(expected: 10, new PrivateMethodTester(timer).invokePrivate(name: "getLaps"))
assertEquals(zzz, mean, delta: 12);
assertEquals(expected: 10, run);
TimerTest (edu.neu.coe.info6205.util) 2 sec 976 ms
testPauseAndLapResume0 184 ms
testPauseAndLapResume1 323 ms
testLap 216 ms
testPause 216 ms
testStop 109 ms
testMillisecs 108 ms
testRepeat1 157 ms
testRepeat2 309 ms
testRepeat3 776 ms
testRepeat4 469 ms
testPauseAndLap 109 ms
Tests passed: 11 of 11 tests – 2 sec 976 ms
C:\Users\mehul\.jdks\openjdk-18.0.2.1\bin\ja
Process finished with exit code 0
Git Debug TODO Problems Terminal Services Build Dependencies
Tests passed: 11 (a minute ago)
120:35 CRLF UTF-8 4 spaces Spring2023
-3°F
Clear
Search
ENG
IN
10:14 PM
2/3/2023



```
@Test // Slow
public void testRepeat3() {
    final Timer timer = new Timer();
    final int zzz = 20;
    final double mean = timer.repeat( n: 10, () -> zzz, t -> {
        GoToSleep(t,  which: 0);
        return null;
    }, t -> {
        GoToSleep(t,  which: -1);
        return t;
    }, t -> GoToSleep( mSecs: 10,  which: 1));
    assertEquals( expected: 10, new PrivateMethodTester(timer).invokePrivate( name: "getLaps"));
    assertEquals(zzz, mean,  delta: 12);
    assertEquals( expected: 10, run);
    assertEquals( expected: 10, pre);
    assertEquals( expected: 10, post);
}

@Test // Slow
public void testRepeat4() {
    final Timer timer = new Timer();
    final int zzz = 20;
    final double mean = timer.repeat( n: 10,
            () -> zzz, // supplier
            t -> { // function
        result = t;
        GoToSleep( mSecs: 10,  which: 0);
        return null;
    }, t -> { // pre-function
```



```
@Test // Slow
public void testRepeat4() {
    final Timer timer = new Timer();
    final int zzz = 20;
    final double mean = timer.repeat( n: 10,
            () -> zzz, // supplier
            t -> { // function
        result = t;
        GoToSleep( mSecs: 10,  which: 0);
        return null;
    }, t -> { // pre-function
        GoToSleep( mSecs: 10,  which: -1);
        return 2*t;
    }, t -> GoToSleep( mSecs: 10,  which: 1) // post-function
    );
    assertEquals( expected: 10, new PrivateMethodTester(timer).invokePrivate( name: "getLaps"));
    assertEquals(zzz,  actual: 20,  delta: 6);
    assertEquals( expected: 10, run);
    assertEquals( expected: 10, pre);
    assertEquals( expected: 10, post);
    // This test is designed to ensure that the preFunction is properly implemented in repe
    assertEquals( expected: 40, result);
}

6 usages
int pre = 0;
11 usages
int run = 0;
6 usages
int post = 0;
```

Screenshots for benchmark timer-