PROGRAM STRUCTURES AND ALGORITHMS

FALL 2021
Assignment - 2
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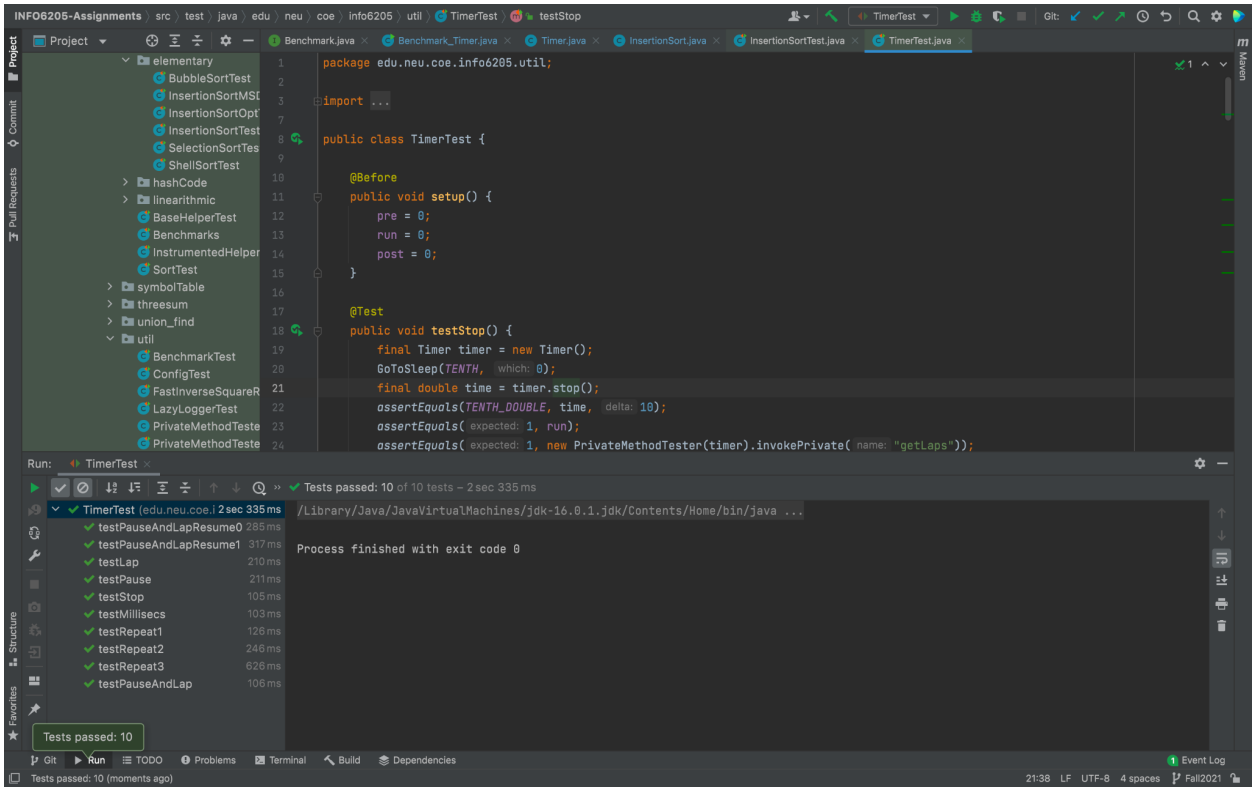
Tasks Performed :
1.Implemented the 3 functions in timer.java
2.Implemented Insertion Sort
3.Plotted a graphical relation for growth in random ordered , partially ordered , ordered and reverse ordered arrays.

1.Timer.java
First 3 images are the executed functions, last image is the unit test

```
private static double toMillisecs(long ticks) {
    // TO BE IMPLEMENTED
    return ticks / Math.pow(10,6);
}
```

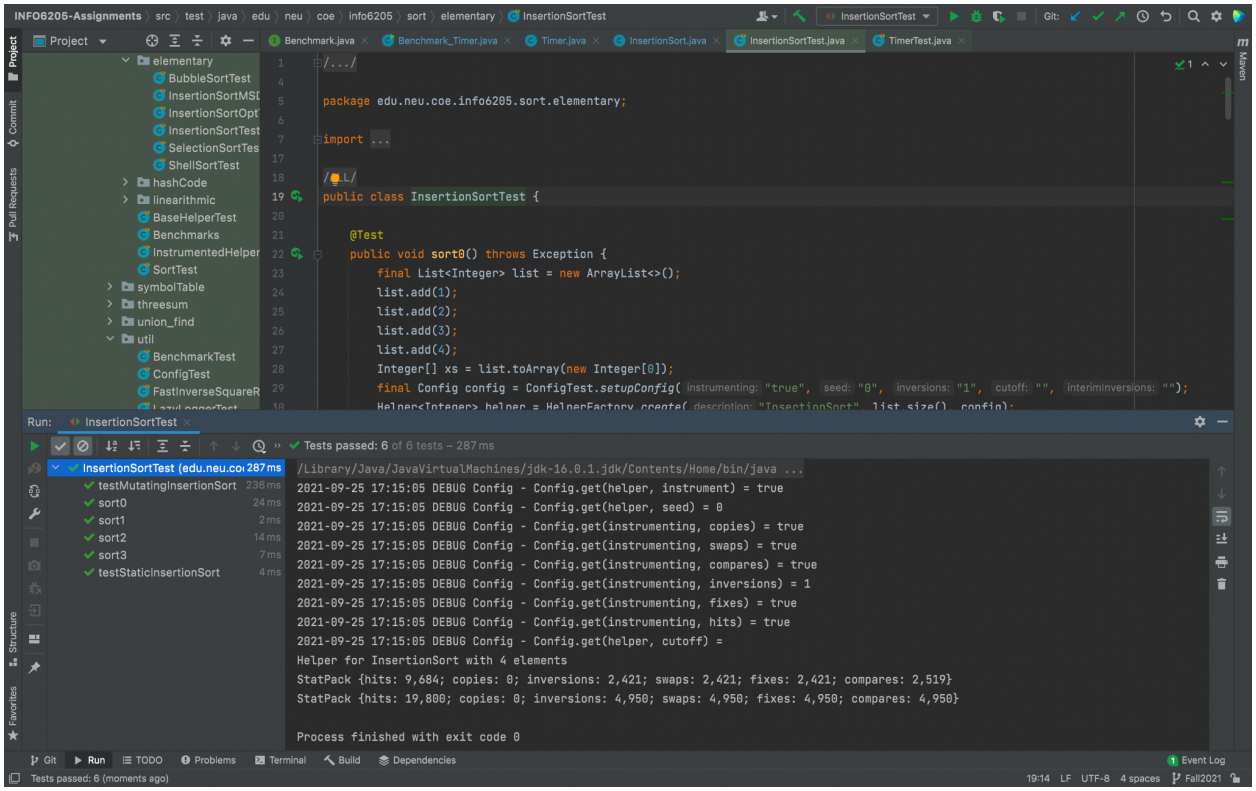
```
 */
private static long getClock() {
    // TO BE IMPLEMENTED
    return System.nanoTime();
}
```

```java
public <T, U> double repeat(int n, Supplier<T> supplier, Function<T, U> function, UnaryOperator<T> preFunction, Consumer<U> postFu
    logger.trace("repeat: with " + n + " runs");
    // TO BE IMPLEMENTED: note that the timer is running when this method is called and should still be running when it returns
    pause();
    T input = supplier.get();
    for(int i = 0; i< n ; i++){
        if(preFunction != null){
            preFunction.apply(input);
        }
        resume();
        U output = function.apply(input);
        pauseAndLap();
        if(postFunction != null){
            postFunction.accept(output);
        }
    }

    //meanLapTime();

    return meanLapTime();
}
```



2.InsertionSort(First image is the code and second image is of the unit tests

```java
public void sort(X[] xs, int from, int to) {
    final Helper<X> helper = getHelper();
    int start = from;
    int items = from + to;
    for(int i = start; i < items; i++){
        for(int j = i; j > from && helper.compare(xs, j - 1, j) > 0; j-- ){
            helper.swap(xs, j - 1, j);
        }
        start++;
    };
}
```



3.Analysis of random , ordered, partially ordered and reverse ordered array.

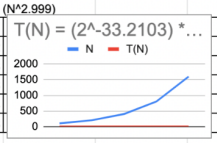
```
======Reverse======
2021-09-25 16:54:04 INFO  Benchmark_Timer - Begin run: Reverse -> 100 with 100 runs
4.896E-4
2021-09-25 16:54:04 INFO  Benchmark_Timer - Begin run: Reverse -> 200 with 100 runs
8.4871E-4
2021-09-25 16:54:04 INFO  Benchmark_Timer - Begin run: Reverse -> 400 with 100 runs
0.00312921
2021-09-25 16:54:04 INFO  Benchmark_Timer - Begin run: Reverse -> 800 with 100 runs
0.00274078
2021-09-25 16:54:04 INFO  Benchmark_Timer - Begin run: Reverse -> 1600 with 100 runs
0.00540955
```

```
==========Random==========
2021-09-25 16:52:23 INFO  Benchmark_Timer - Begin run: Random -> 10000 with 100 runs
0.09413500000000001
2021-09-25 16:52:23 INFO  Benchmark_Timer - Begin run: Random -> 20000 with 100 runs
0.07234498
2021-09-25 16:52:25 INFO  Benchmark_Timer - Begin run: Random -> 40000 with 100 runs
0.14900833
2021-09-25 16:52:34 INFO  Benchmark_Timer - Begin run: Random -> 80000 with 100 runs
0.28785962000000004
2021-09-25 16:54:04 INFO  Benchmark_Timer - Begin run: Random -> 160000 with 100 runs
0.5908650200000001
======Ordered======
2021-09-25 16:54:04 INFO  Benchmark_Timer - Begin run: Ordered -> 100 with 100 runs
5.890100000000001E-4
2021-09-25 16:54:04 INFO  Benchmark_Timer - Begin run: Ordered -> 200 with 100 runs
9.174799999999999E-4
2021-09-25 16:54:04 INFO  Benchmark_Timer - Begin run: Ordered -> 400 with 100 runs
0.0015146100000000002
2021-09-25 16:54:04 INFO  Benchmark_Timer - Begin run: Ordered -> 800 with 100 runs
0.00276623
2021-09-25 16:54:04 INFO  Benchmark_Timer - Begin run: Ordered -> 1600 with 100 runs
0.00529169
=======Partially ordered=======
2021-09-25 16:54:04 INFO  Benchmark_Timer - Begin run: PartiallyOrdered ->100 with 100 runs
4.4336E-4
2021-09-25 16:54:04 INFO  Benchmark_Timer - Begin run: PartiallyOrdered ->200 with 100 runs
8.320700000000001E-4
2021-09-25 16:54:04 INFO  Benchmark_Timer - Begin run: PartiallyOrdered ->400 with 100 runs
0.0028120899999999997
2021-09-25 16:54:04 INFO  Benchmark_Timer - Begin run: PartiallyOrdered ->800 with 100 runs
0.00273625
2021-09-25 16:54:04 INFO  Benchmark_Timer - Begin run: PartiallyOrdered ->1600 with 100 runs
0.00549628
```

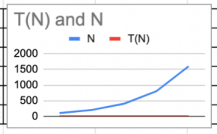
GRAPH(Mathematical Relation) , Growth - ~N)

T(N) = (2^-33.2103) * (N^2.999)

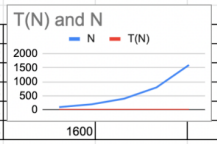
RANDOM	N	TIME	T(N)	log(N)	log(T(N))	log(T(N) / log(N)		
	100	0.00454086	0.0001001621262	-7.782818727	-13.28537529	1.707013327		
	200	0.00245126	0.0008007417853	-8.672260769	-10.28637529	1.186123845	Mean ->	0.9638174009
	400	0.00340501	0.006401495566	-8.198125249	-7.287375287	0.8889075325		
	800	0.01140583	0.0511764794	-6.454084755	-4.288375287	0.6644435966		
	1600	0.05852463	0.4091281508	-4.094812281	-1.289375287	0.3148801943		
					Average - >	0.952273699		



ORDERED	N	T	T(N)	log(N)	log(T(N))	log(T(N) / log(N)
	100	0.0039479	0.0001001621262	-7.984698838	-13.28537529	1.663854274
	200	0.00747792	0.0008007417853	-7.063147248	-10.28637529	1.456344449
	400	0.02043042	0.006401495566	-5.613137327	-7.287375287	1.298271334
	800	0.02912919	0.0511764794	-5.101390605	-4.288375287	0.8406286871
	1600	0.05802542	0.4091281508	-4.10717113	-1.289375287	0.3139326914
					Average - >	1.114606287



PARTIALLY ORDERED	N	T	T(N)	log(N)	log(T(N))	log(T(N) / log(N)
	100	0.00384331	0.0001001621262	-8.023434936	-13.28537529	1.655821402
	200	0.00743536	0.0008007417853	-7.071381689	-10.28637529	1.454648573
	400	0.01910835	0.006401495566	-5.709652982	-7.287375287	1.276325428
	800	0.01976669	0.0511764794	-5.660784883	-4.288375287	0.7575584262
	1600	0.00508419	0.4091281508	-7.619766339	-1.289375287	0.1692145441
					Average - >	1.062713675



REVERSE	N	T	T(N)	log(N)	log(T(N))	log(T(N) / log(N)
	100	4.34E-04	0.0001001621262	-11.16941911	-13.28537529	1.189441918
	200	7.91E-04	0.0008007417853	-10.30346939	-10.28637529	0.9983409371
	400	0.00141625	0.006401495566	-9.463708329	-7.287375287	0.7700338001
	800	0.00267488	0.0511764794	-8.546310114	-4.288375287	0.5017809124
	1600	0.00501586	0.4091281508	-7.639287204	-1.289375287	0.1687821458
					Average - >	0.7256759427