PSA Assignment 3

Name- Padma Anaokar

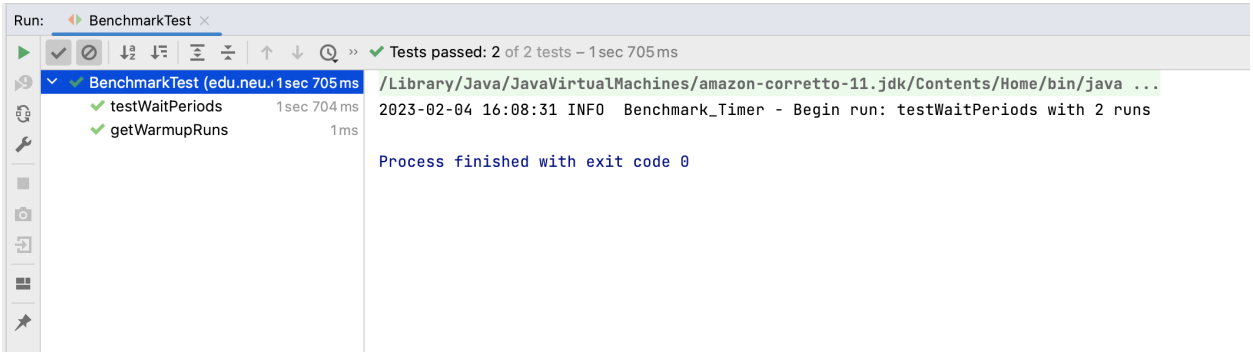
Part A:

Timer.java

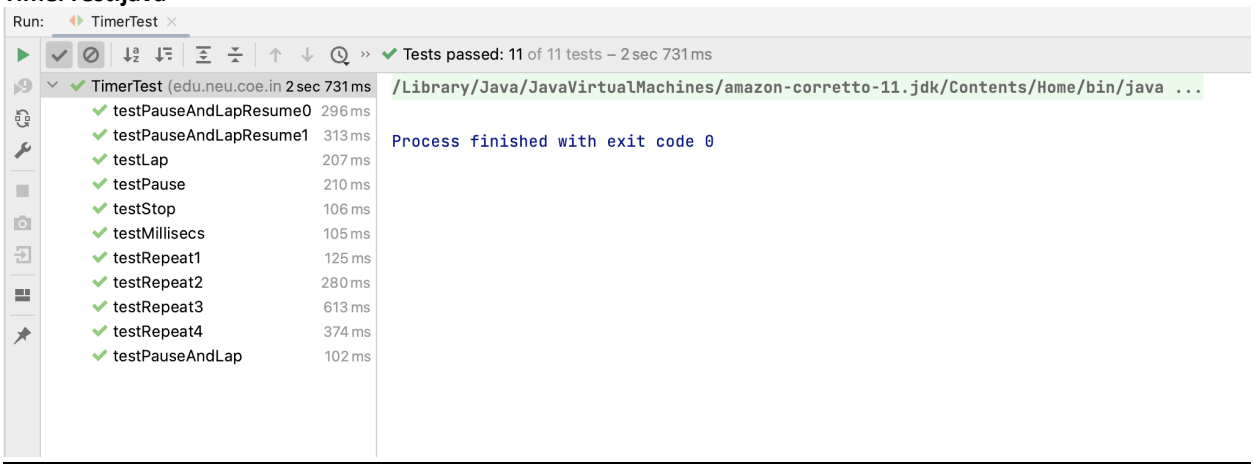
```
public <T, U> double repeat(int n, Supplier<T> supplier, Function<T, U> function,
UnaryOperator<T> preFunction, Consumer<U> postFunction) {
   logger.trace("repeat: with " + n + " runs");
   // FIXME: note that the timer is running when this method is called and should still be
running when it returns.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

   }
   double meantime = meanLapTime();
   resume();
   return meantime;
   // END

}

private static double toMillisecs(long ticks) {
   // FIXME by replacing the following code
   double milliSecs= (double)ticks/1000000;
   return milliSecs;
   // END
}

private static long getClock() {
   // FIXME by replacing the following code
```

```
    return System.nanoTime();
    // END
}
```

BenchMarkTest.java



TimerTest.java



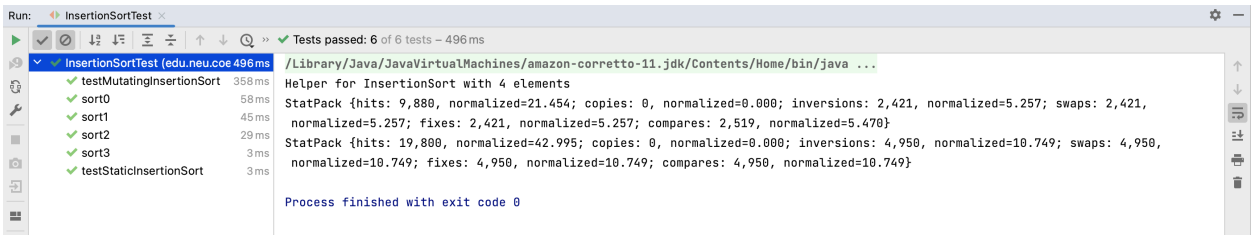
Part B:

Code changes in InsertionSort.java

```
public void sort(X[] xs, int from, int to) {
    final Helper<X> helper = getHelper();
    for(int i = from+1; i < to ; i++){
```

```
    int k =i;
    while(k > from && helper.swapStableConditional(xs, k) ){
       k--;
    }
  }
  // FIXME
  // END
}
```

InsertionSortTest cases :



Part C:

Time took to perform insertion sort on Different arrays

Code Changes in **InsertionSortBenchMark.java**

```
public static void main(String[] args) {

    Random r = new Random();
    InsertionSort insertionSort = new InsertionSort();

    for (int n = 200; n <= 3200; n = n * 2) {
        //Insertion sort on Randomly Ordered Array
        ArrayList<Integer> randomArrayLst = new ArrayList<>();
        for (int i = 0; i < n; i++) {
            randomArrayLst.add(r.nextInt(n));
        }
        Integer[] randomIntArray = randomArrayLst.toArray(new Integer[0]);
        Benchmark<Boolean> benchmarkRandomArr = new Benchmark_Timer<>(
                "Running Insertion sort on :Randomly Ordered Array ", b -> {
            insertionSort.sort(randomIntArray.clone(), 0,
randomIntArray.length);
        });
        double randomArrayResult = benchmarkRandomArr.run(true, 10);

        //Insertion sort on Ordered Array
        ArrayList<Integer> orderedArrayList = new ArrayList<>();
        for (int i = 0; i < n; i++) {
            orderedArrayList.add(i);
        }
        Integer[] orderedArr = orderedArrayList.toArray(new Integer[0]);
```

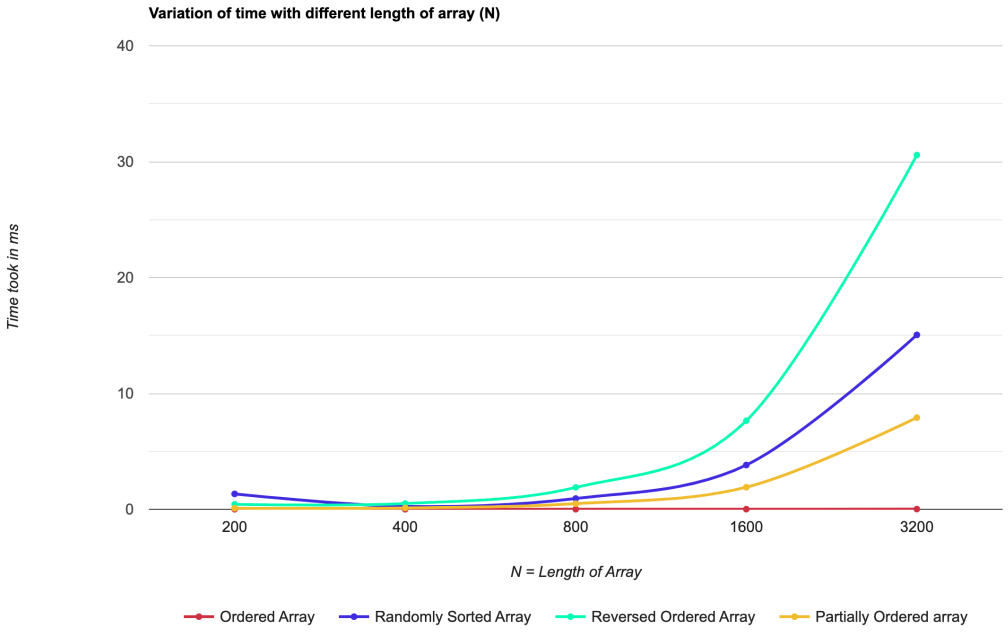
```
        Benchmark<Boolean> benchmarkOrderedArr = new Benchmark_Timer<>(
                "Running Insertion sort on :Ordered Array ", b -> {
            insertionSort.sort(orderedArr.clone(), 0, orderedArr.length);
        });
        double orderedArrayResult = benchmarkOrderedArr.run(true, 10);

        //Insertion sort on Reverse Ordered Array
        ArrayList<Integer> reverseArrayList = new ArrayList<>();
        for (int i = 0; i < n; i++) {
            reverseArrayList.add(n - i);//reverseList[100-00]=
reverseList[100],reverseList[99]
        }
        Integer[] reverseIntArray = reverseArrayList.toArray(new Integer[0]);
        Benchmark<Boolean> benchmarkReverseArr = new Benchmark_Timer<>(
                "Running Insertion sort on :Reversely Ordered Array", b -> {
            insertionSort.sort(reverseIntArray.clone(), 0,
reverseIntArray.length);
        });
        double reversedArrayResult = benchmarkReverseArr.run(true, 10);

        //Insertion sort on Partially Ordered Array
        ArrayList<Integer> partialArrayList = new ArrayList<>();
        for (int j = 0; j < n; j++) {
            if (j > n / 2) {
                partialArrayList.add(r.nextInt(n));//randomly arranged
            } else {
                partialArrayList.add(j);//ordered array
            }
        }
        Integer[] partialIntArray = partialArrayList.toArray(new Integer[0]);
        Benchmark<Boolean> benchmarkPartial = new Benchmark_Timer<>(
                "Running Insertion sort on :Partially Ordered Array", b -> {
            insertionSort.sort(partialIntArray.clone(), 0,
partialIntArray.length);
        });
        double partialArrayResult = benchmarkPartial.run(true, 10);

        System.out.println("N is : " + n);
        System.out.println("Random Array takes : " + randomArrayResult+"ms");
        System.out.println("Ordered Array takes : " + orderedArrayResult
+"ms");
        System.out.println("Reversed Array takes : " +
reversedArrayResult+"ms");
        System.out.println("Partial Array takes : " +
partialArrayResult+"ms");
    }
```

Graphs:

Time Taken for different length and differently Ordered Array

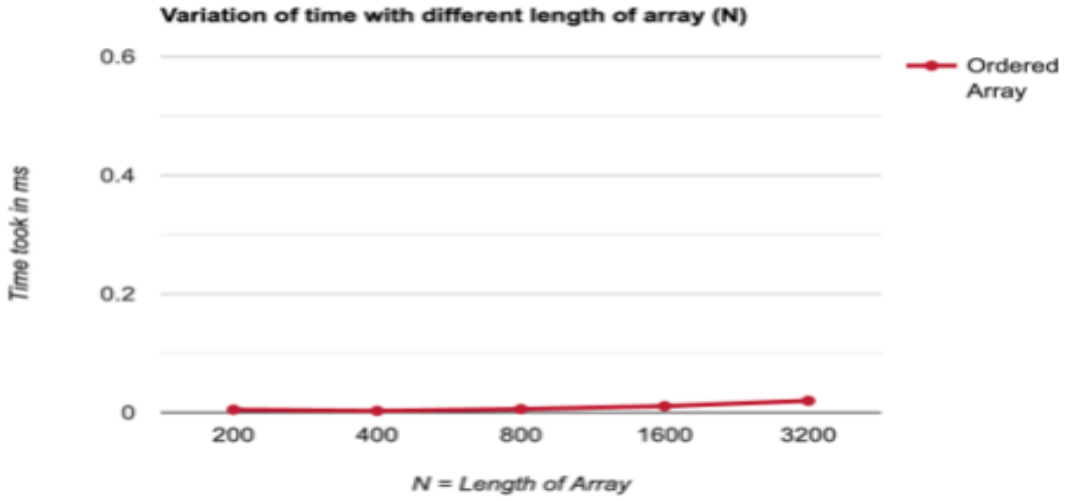
N	Random	Ordered	Partially-Ordered	Reverse
200	1.33	0.005	0.092	0.43
400	0.25	0.003	0.118	0.5
800	0.93	0.006	0.488	1.89

1600	3.82	0.011	1.908	7.64
3200	15.05	0.022	7.913	30.57

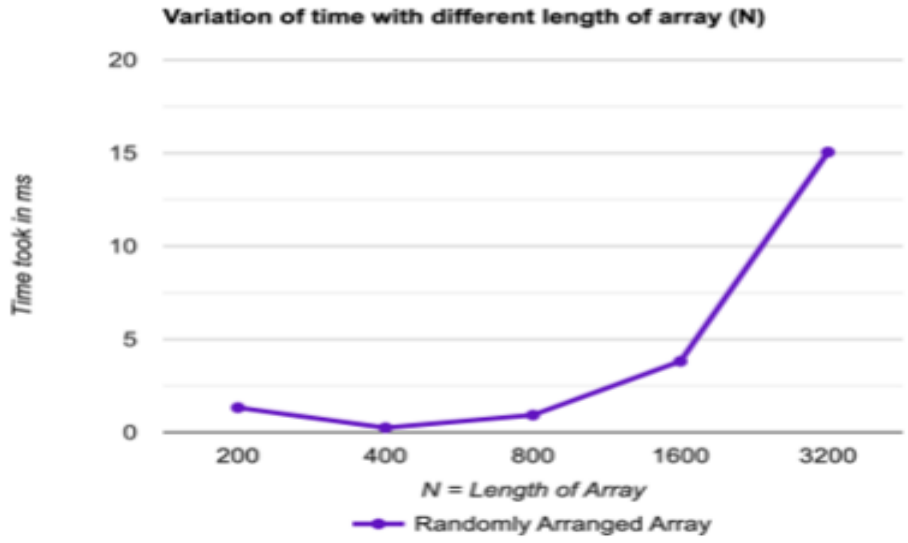


Separate Graphs:

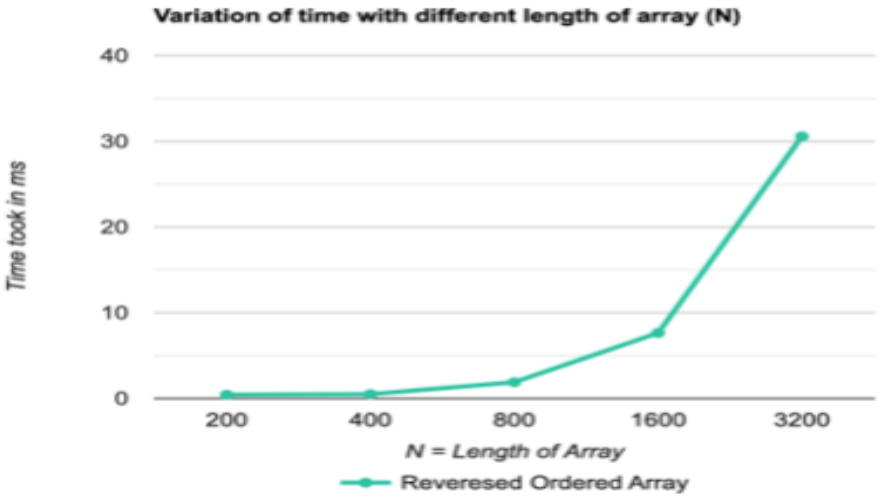
Ordered Array:



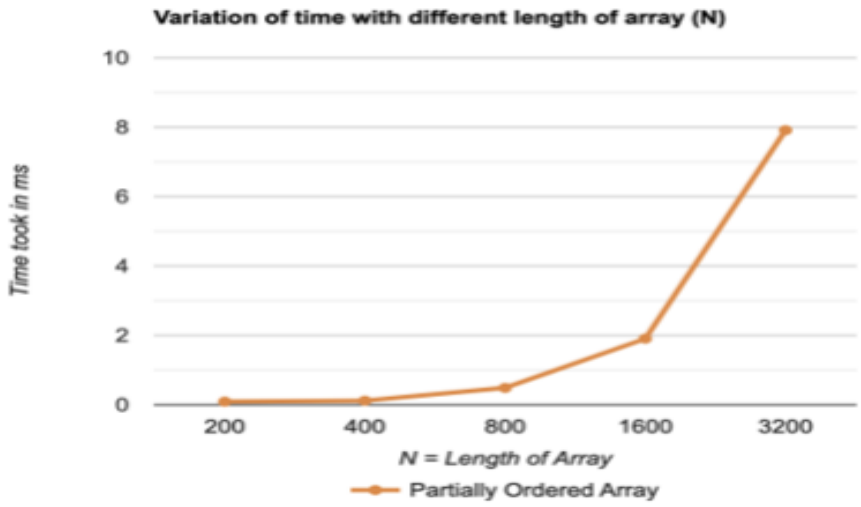
Randomly Ordered Array:



Reversed ordered Array:



Partially Ordered Array:



- Graphs attached in Excel Sheet as well

Conclusion:

- It can be observed from the graph that the reverse ordered array takes most time for larger array sizes when sorting it using insertion sort because it must move all the elements to its respective places
- Random array takes a little lesser time than the reverse ordered array since there are high chances that the random numbers generated the random function have some of the numbers already in the correct position
- Partially sorted order takes more lesser time than the random array since half of the array would already be in the sorted position.
- The best case would be an already sorted array which takes the least time which is expected as well since the array is already in the sorted order.