INFO 6205 - Program Structure & Algorithms – Assignment 2

Algorithmic Benchmarking

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1. Introduction

Benchmarking is the method of comparing performance of algorithms with respect to certain predefined set of tests against it.

In our experiments we will be running the benchmark tests on an implementation of insertion sort and determine its performance in 4 major scenarios when the algorithm is fed – sorted input, input that is sorted but I reverse order, random input and semi sorted input. We will be comparing the runtime of the algorithm on an initial set of 100 values and will go on doubling the input size. We shall be running each cycle at least 100 times and calculate the mean runtime in case of every run. The system clock time will be recorded using the System.nanoTIme() directive in java.

2. Insertion Sort

Insertion works like one would sort cards in hand. Smallest valued cards are repeatedly pushed to one end repeatedly till they are in desired order.

Algorithm:

- Iterate from inputArray[1] -> inputArray[n].
- Compare current element to the previous element in array.
- Switch if it is smaller than the previous and then compare with the previous items of the array (if any).
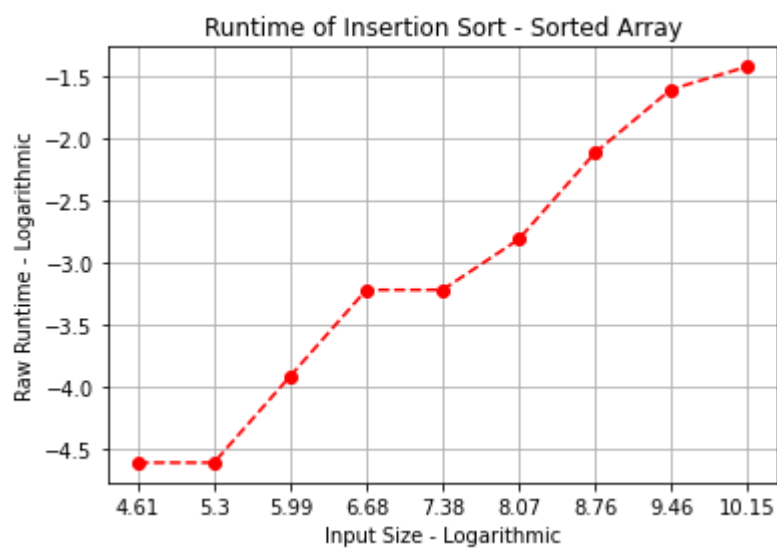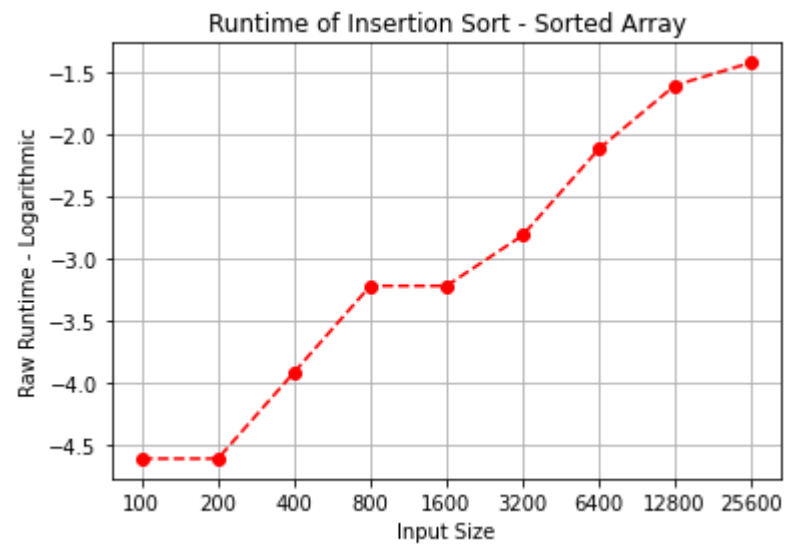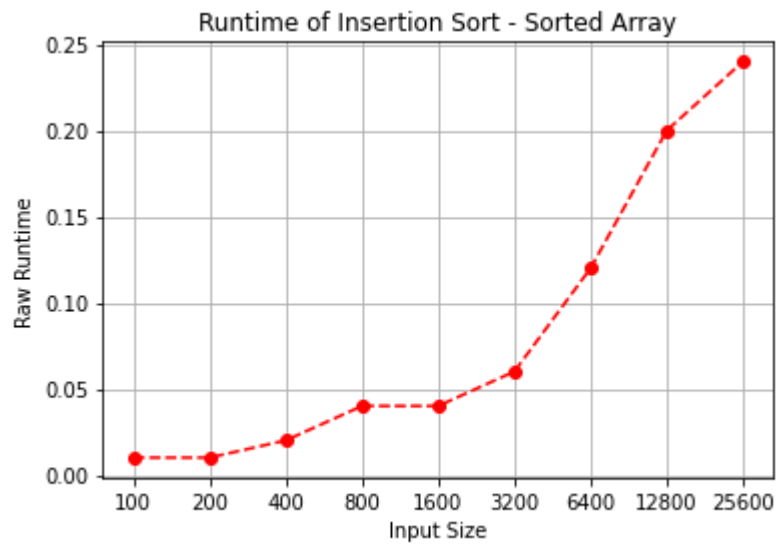
3. Benchmarks

- **Sorted Array**

By convention this should be the fastest as the input array is already sorted.

The following table documents the run time of the algorithm on various input sizes and its normalized runtime.
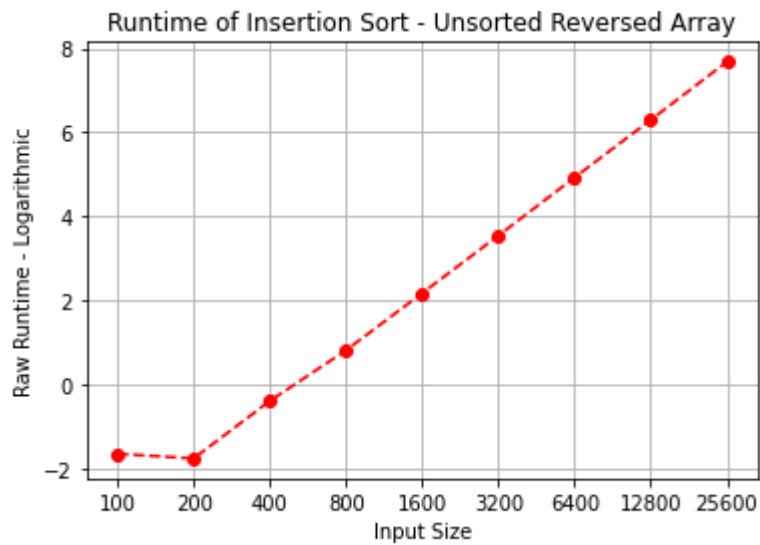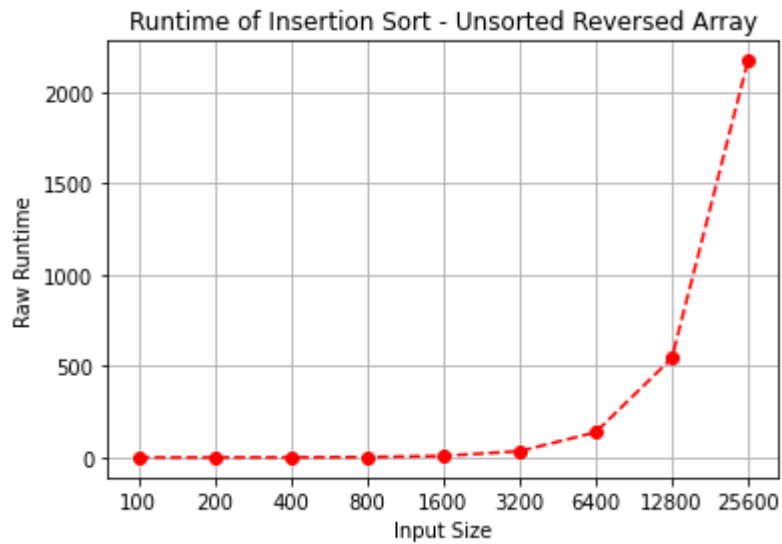
Input Size	Raw time per run (mSec)	Normalized time per run(nlogn)
100	0.01	3.18
200	0.01	1.73
400	0.02	1.34
800	0.04	0.51
1600	0.04	0.34
3200	0.06	0.31
6400	0.12	0.28
12800	0.20	0.26
25600	0.24	0.10

Runtime of Insertion Sort - Sorted Array

Runtime of Insertion Sort - Sorted Array

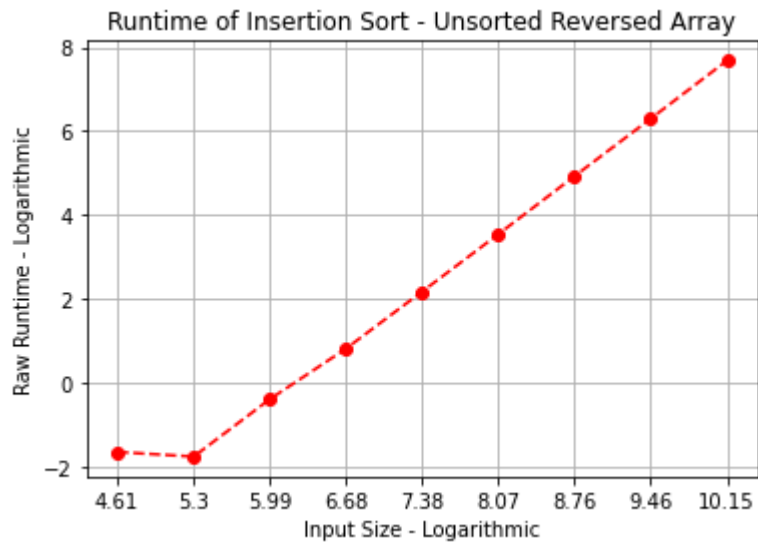Runtime of Insertion Sort - Sorted Array

- **Unsorted Array**
  We will be considering an array that as been reversed for this case. The run times have been documented below.

Input Size	Raw time per run (mSec)	Normalized time per run(nlogn)
100	0.19	60.34
200	0.17	22.75
400	0.67	38.69
800	2.24	56.85
1600	8.75	99.01
3200	34.46	174.78
6400	137.70	320.11
12800	543.47	579.95
25600	2171.90	1071.09

Runtime of Insertion Sort - Unsorted Reversed Array

Runtime of Insertion Sort - Unsorted Reversed Array

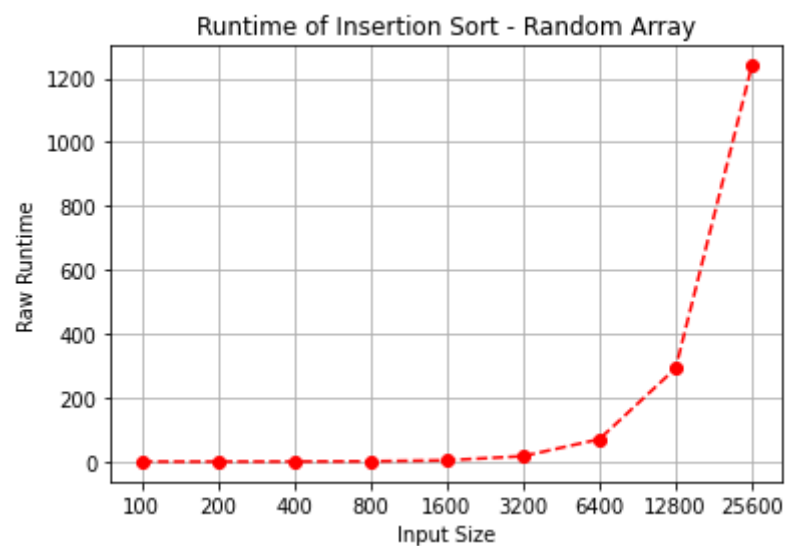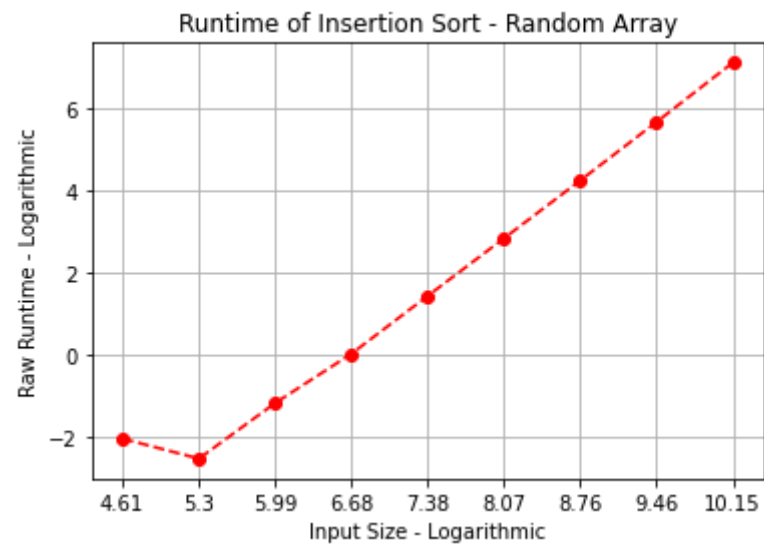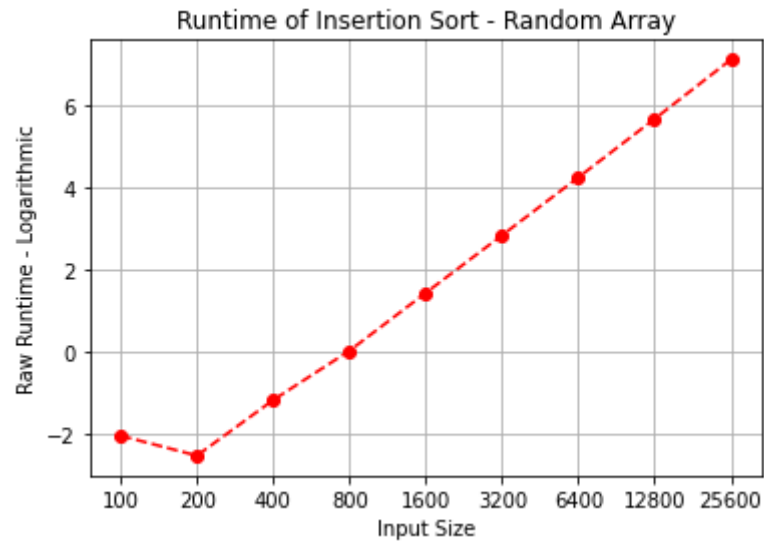Runtime of Insertion Sort - Unsorted Reversed Array

- **Radom Array**
  We will be considering a random array for this case. We will be using the java's in-built random number generator for this test case.

Input Size	Raw time per run (mSec)	Normalized time per run(nlogn)
100	0.13	41.29
200	0.08	10.71
400	0.31	17.90
800	1.03	26.14
1600	4.22	47.75
3200	17.16	87.59
6400	70.26	163.33
12800	292.20	311.81
25600	1239.82	611.43

Runtime of Insertion Sort - Random Array

Runtime of Insertion Sort - Random Array
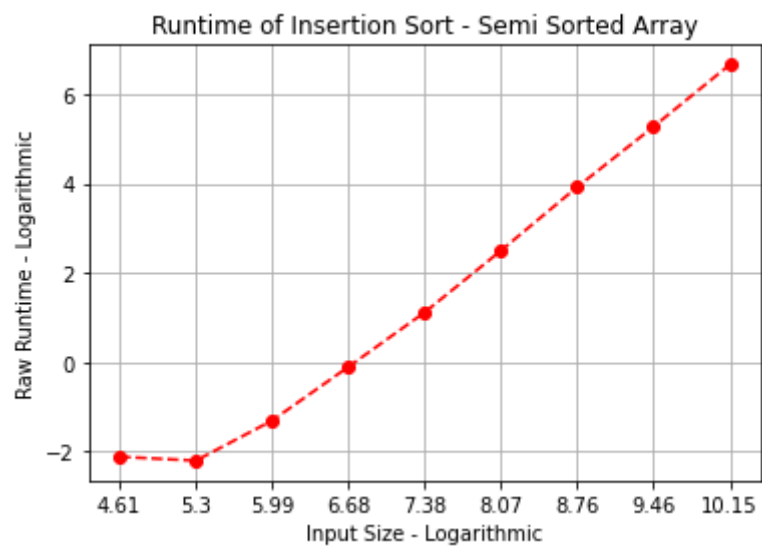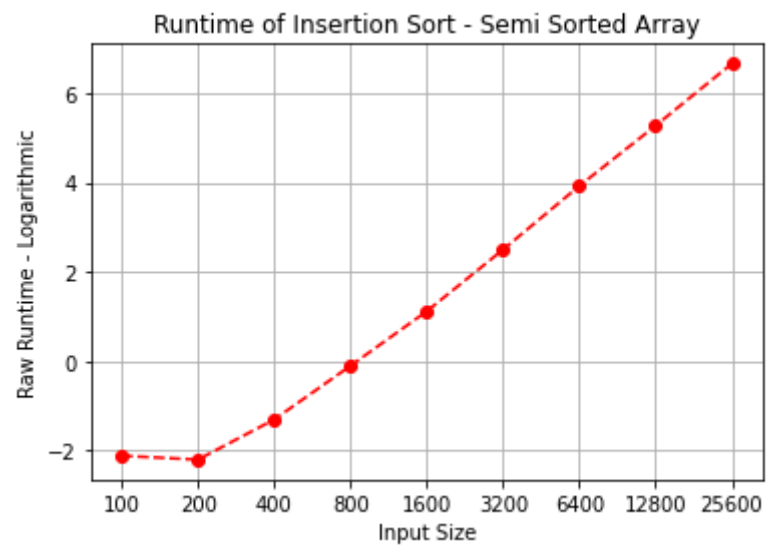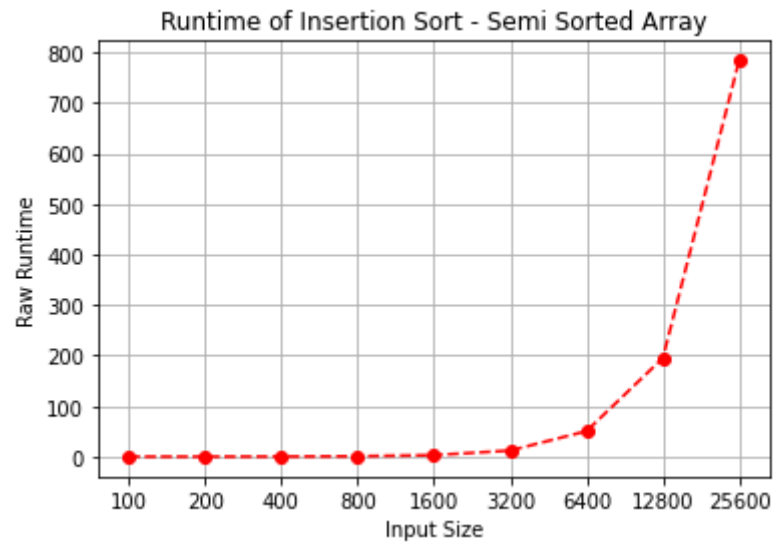

Runtime of Insertion Sort - Random Array

- **Semi sorted array**
  For this case we have taken an array where first n/2 numbers will be sorted, and the remaining n/2 numbers will be randomly generated. Here n in the size of the input.

Input Size	Raw time per run (mSec)	Normalized time per run(nlogn)
100	0.12	38.11
200	0.11	14.72
400	0.27	15.59
800	0.90	22.84
1600	3.05	34.51
3200	12.15	62.02
6400	50.56	117.53
12800	195.04	208.13
25600	783.40	386.34

Runtime of Insertion Sort - Semi Sorted Array

Runtime of Insertion Sort - Semi Sorted Array

Runtime of Insertion Sort - Semi Sorted Array

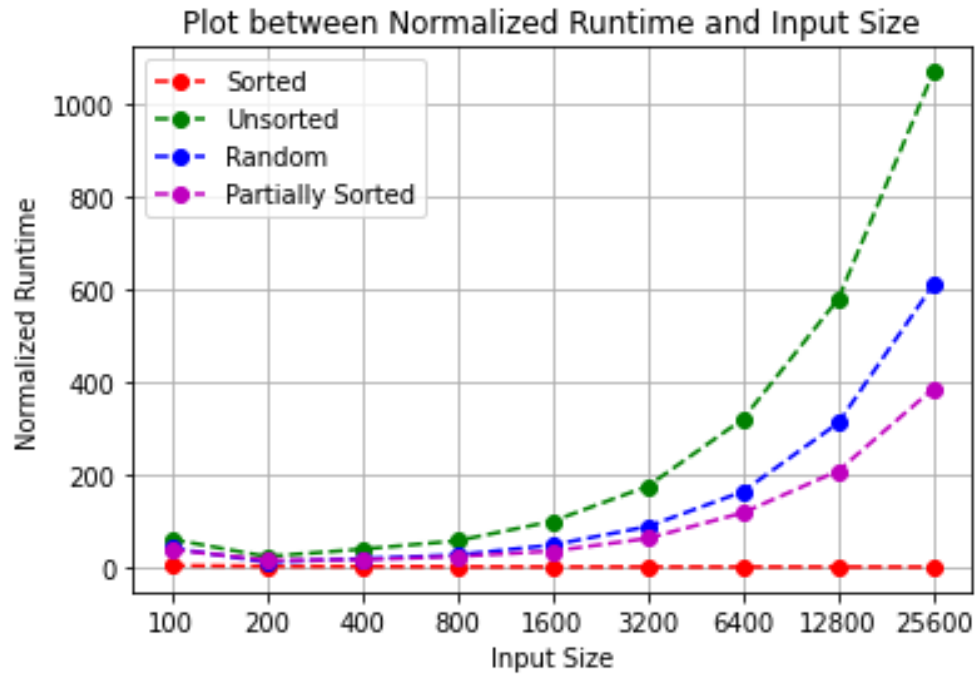## 4. Comparisons Between Different Types of Arrays

As we see from the graphs below, sorted array takes minimum time followed by semi sorted array, random array and finally reversed array.

Sorted Array < Partially Sorted Array < Random Array < Unsorted Array

Plot between Normalized Runtime and Input Size
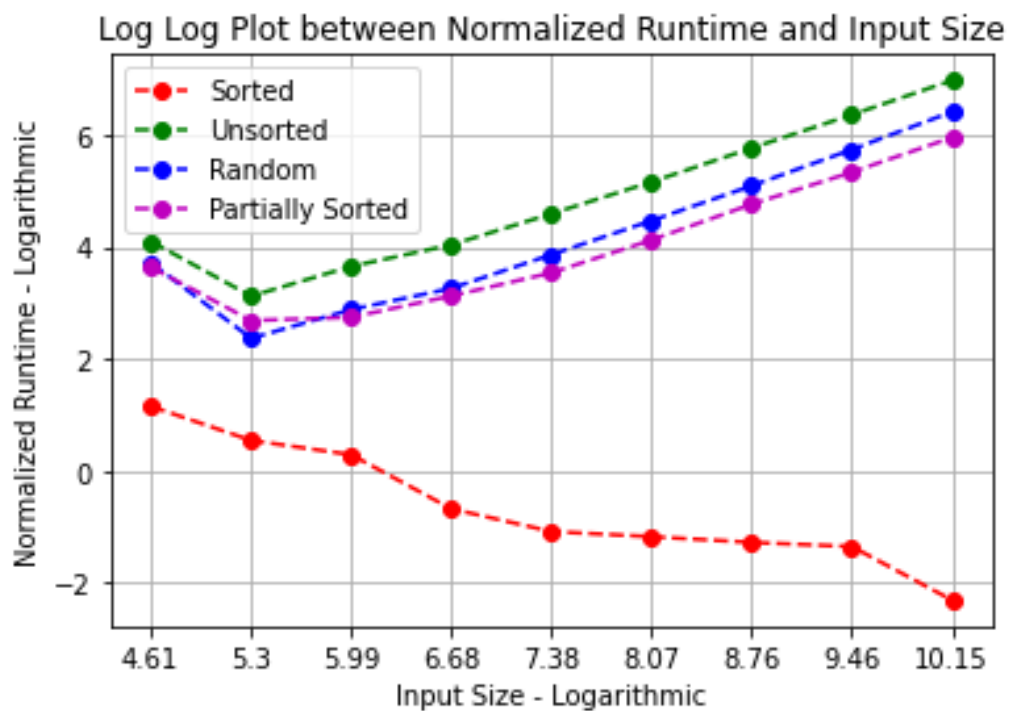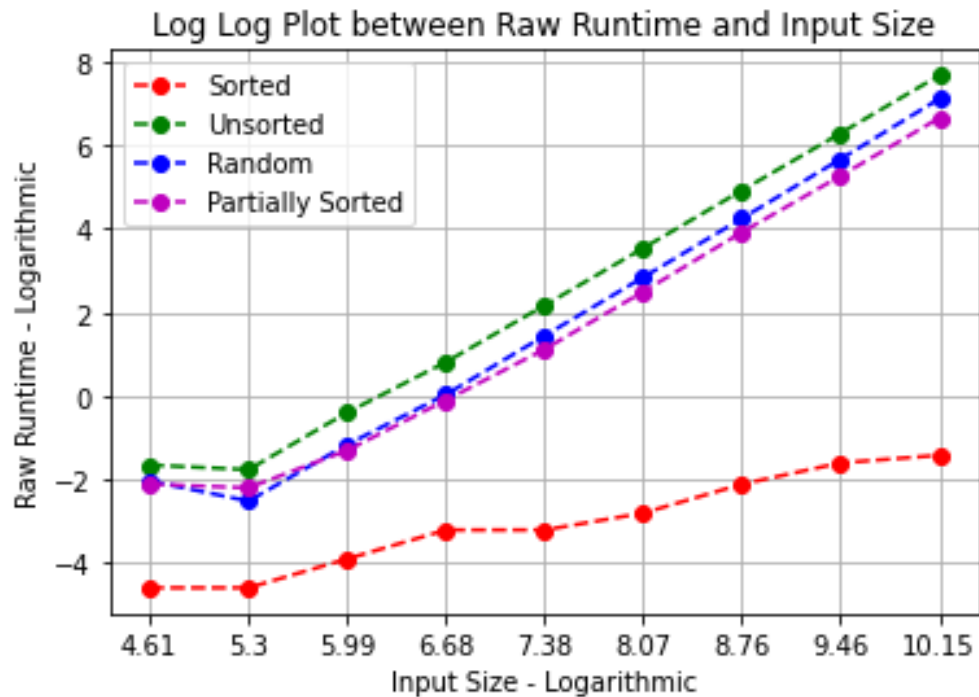
5. Unit Tests

Screenshots from successful unit tests are given below

Finished after 2.182 seconds

Runs: 10/10   Errors: 0   Failures: 0

> edu.neu.coe.info6205.util.TimerTest [Runner: JUnit 4] (2.096 s)
  testPauseAndLapResume0 (0.204 s)
  testPauseAndLapResume1 (0.305 s)
  testLap (0.203 s)
  testPause (0.203 s)
  testStop (0.101 s)
  testMillisecs (0.101 s)
  testRepeat1 (0.113 s)
  testRepeat2 (0.223 s)
  testRepeat3 (0.541 s)
  testPauseAndLap (0.102 s)

TimeTest.java

Finished after 1.483 seconds

Runs:	2/2	Errors:	0	Failures:	0

- edu.neu.coe.info6205.util.BenchmarkTest [Runner: JUnit 4] (1.409 s)
  - testWaitPeriods (1.408 s)
  - getWarmupRuns (0.001 s)

BenchmarkTest.java

Finished after 0.33 seconds

Runs:	4/4	Errors:	0	Failures:	0

- edu.neu.coe.info6205.sort.simple.InsertionSortTest [Runner: JUnit 4] (0.120 s)
  - testMutatingInsertionSort (0.000 s)
  - sort0 (0.115 s)
  - sort1 (0.000 s)
  - sort2 (0.005 s)

InsertionSortTest.java