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Program Structures & Algorithms

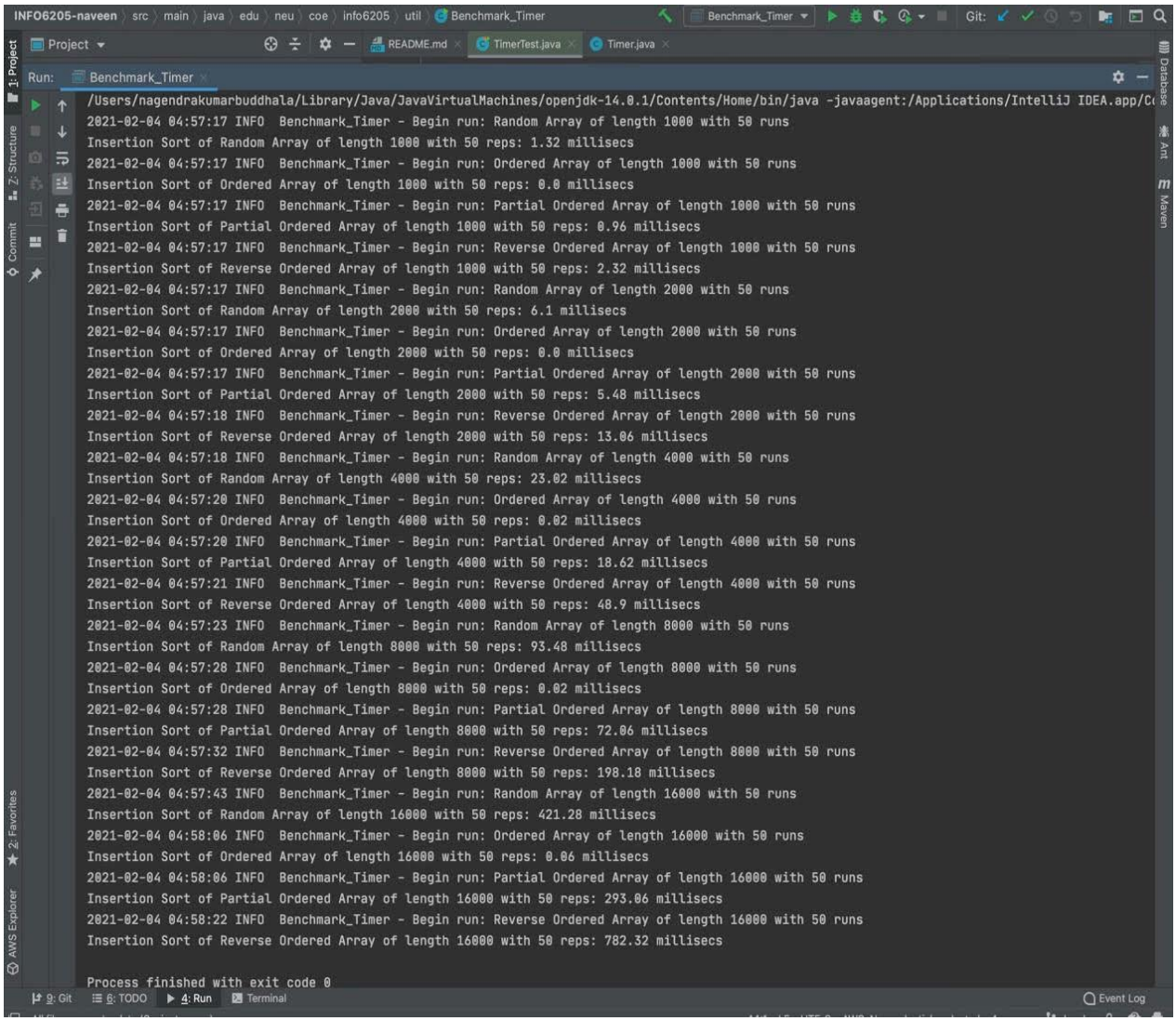
Spring 2021

Assignment No. 2

Task

Insertion sort – to deduce an expression for time taken for sorting an array using insertion sort where **n** is size of an array

Output



Relationship Conclusion

Out of 5 random experiments – for every value of n, each run for 50 times – for the order of n in case of an insertion sort, we derived –

For Random Array -

Milliseconds taken, $m \propto n^2$ where 'n' is the size of an array

For Ordered Array -

Milliseconds taken, $m \propto n$ where 'n' is the size of an array

For Partially Ordered Array -

Milliseconds taken, $m \propto n^2$ where 'n' is the size of an array

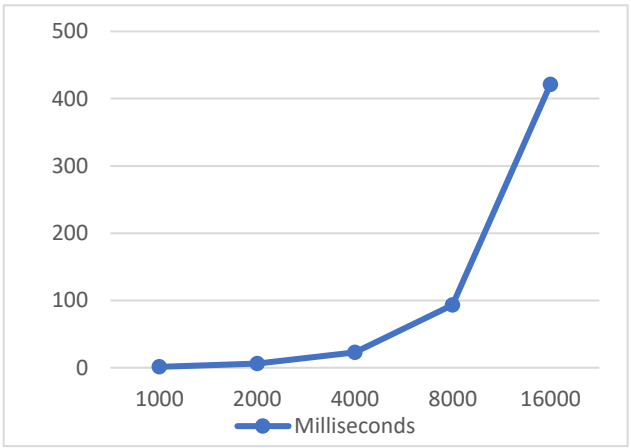
For Reverse Ordered Array -

Milliseconds taken, $m \propto n^2$ where 'n' is the size of an array

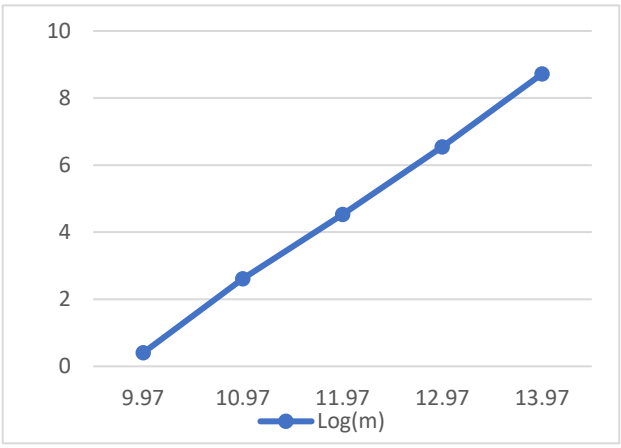
Evidence to support

Random Array –

Size of an Array(n)	Milliseconds(m)
1000	1.32
2000	6.1
4000	23.02
8000	93.48
16000	421.28



Log(n)	Log(m)
9.97	0.40
10.97	2.60
11.97	4.52
12.97	6.54
13.97	8.71

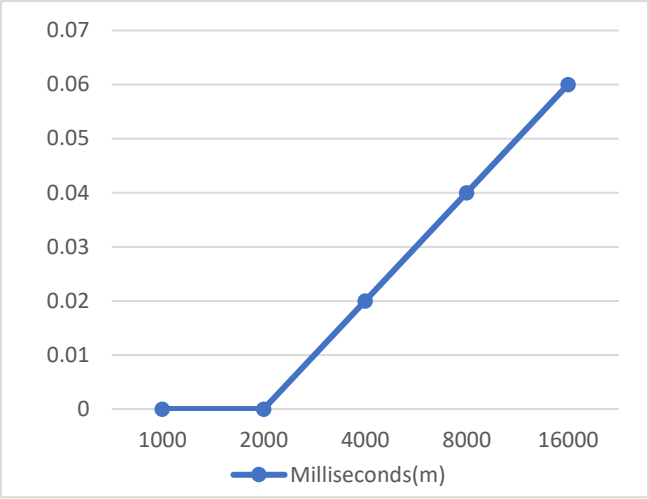


As we see the log n – log m graph is linear, the slope of the graph on an average is ~$\frac{1}{2}$, so the equation would be

$$log\ m = 2\ log\ n + c \ \text{ so } m \infty n^2$$

Ordered Array –

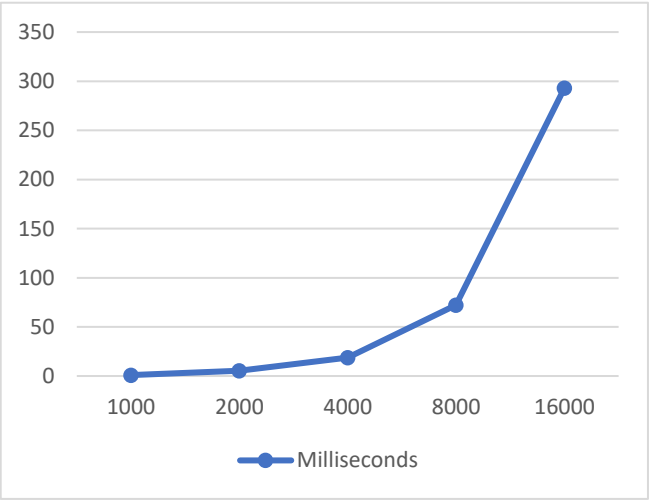
Size of an Array(n)	Milliseconds(m)
1000	0
2000	0
4000	0.02
8000	0.04
16000	0.06



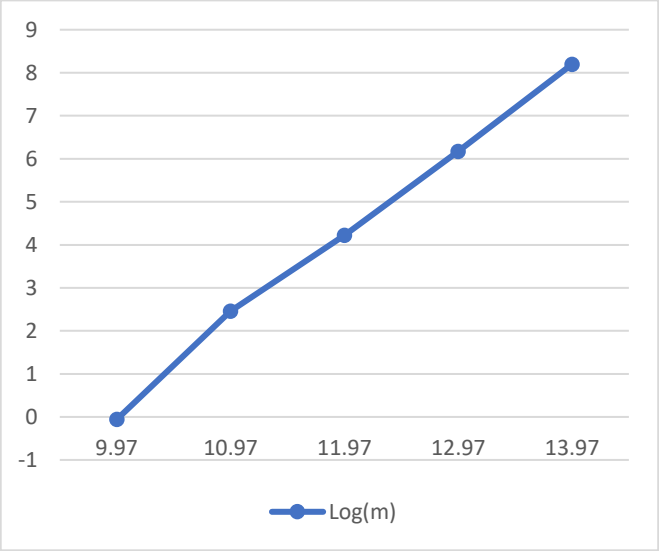
As the graph is linear, we can conclude that $m \infty n$

Partially Sorted Array –

Size of an Array(n)	Milliseconds(m)
1000	0.96
2000	5.48
4000	18.62
8000	72.06
16000	293.06



Log(n)	Log(m)
9.97	-0.05889
10.97	2.454176
11.97	4.218781
12.97	6.171127
13.97	8.195052

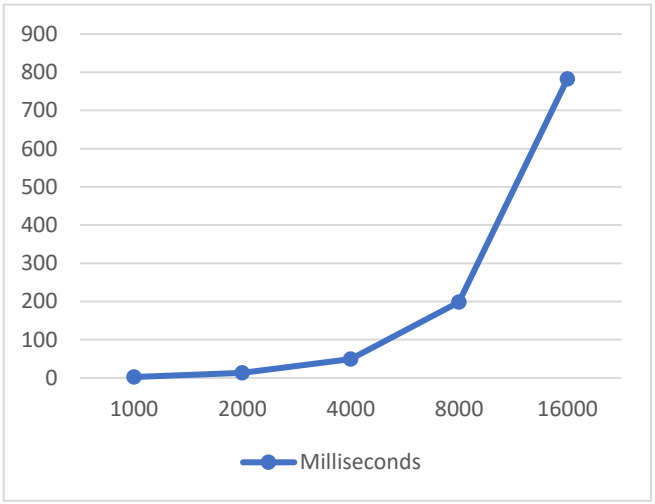


As we see the log n – log m graph is linear, the slope of the graph on an average is ~$\frac{1}{2}$, so the equation would be

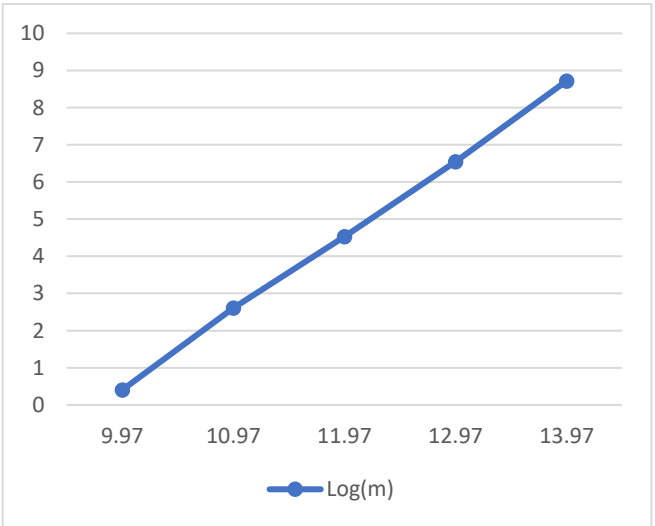
$$log\ m = 2\ log\ n + c \text{ so } m \propto n^2$$

Reverse Ordered Array –

Size of an Array(n)	Milliseconds(m)
1000	2.32
2000	13.06
4000	48.9
8000	198.18
16000	782.32



Log(n)	Log(m)
9.97	0.40
10.97	2.60
11.97	4.52
12.97	6.54
13.97	8.71

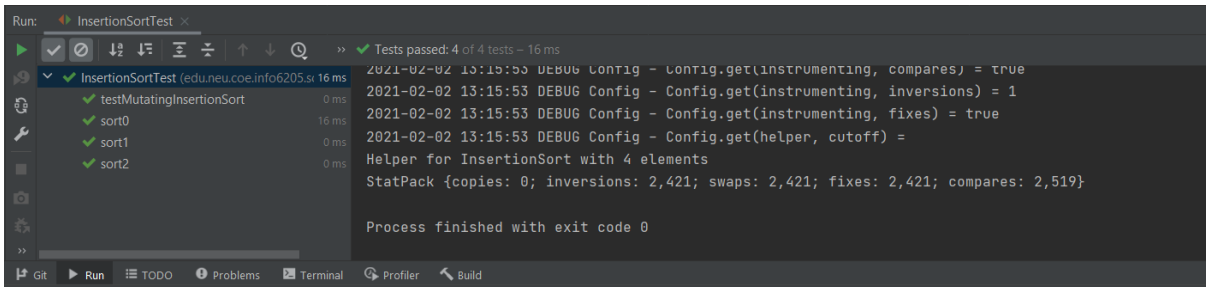


As we see the log n – log m graph is linear, the slope of the graph on an average is ~$\frac{1}{2}$, so the equation would be

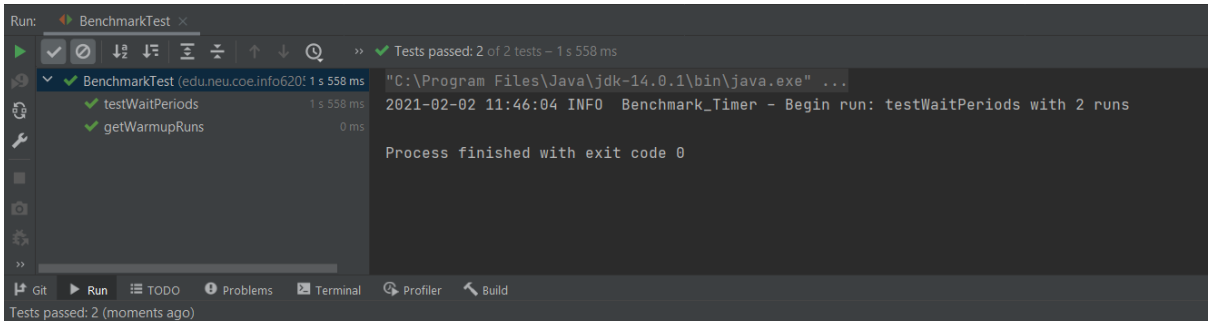
$$log\, m = 2\, log\, n + c \;\; \text{so} \; m \infty n^2$$

Unit Test

InsertionSortTest -



BenchmarkTest -



TimerTest -