Program Structures & Algorithms Spring 2023 Assignment No. 3

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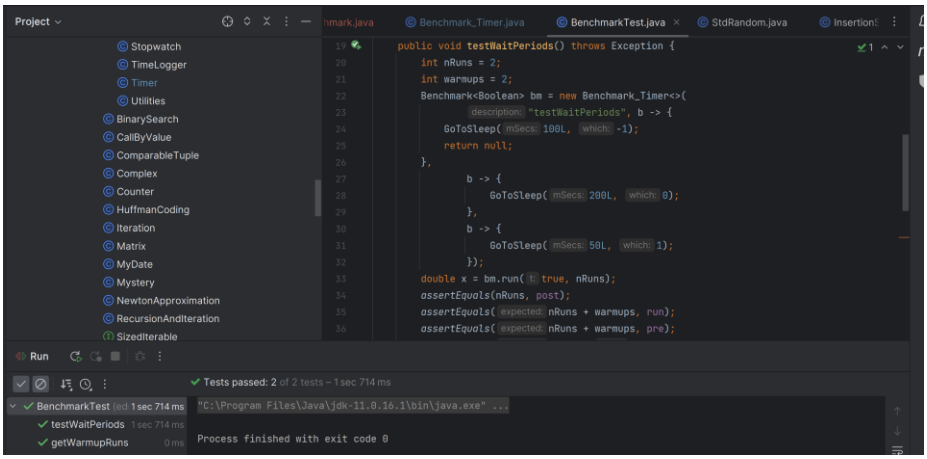
TASK:

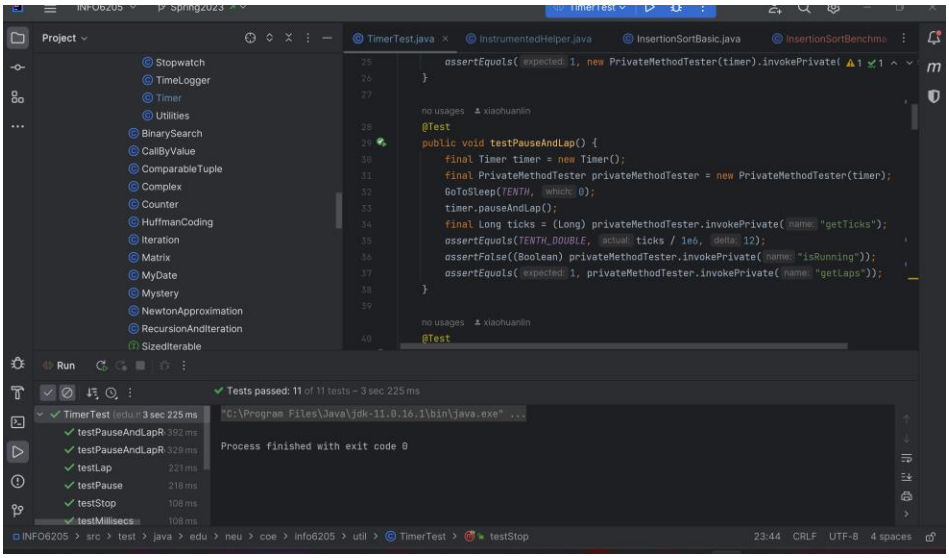
1)Implement three method of Timer class

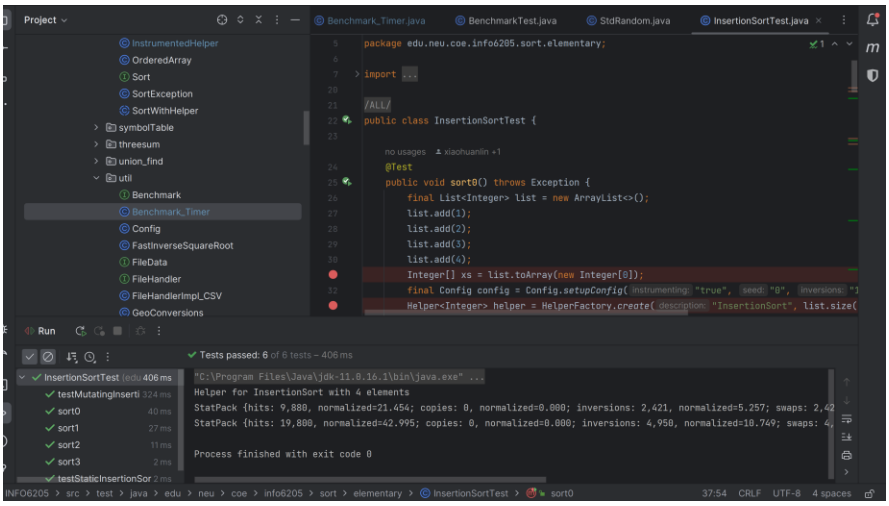
2)Implement Insertion Sort

3)Benchmarking for insertion sort

Unit Test Case:







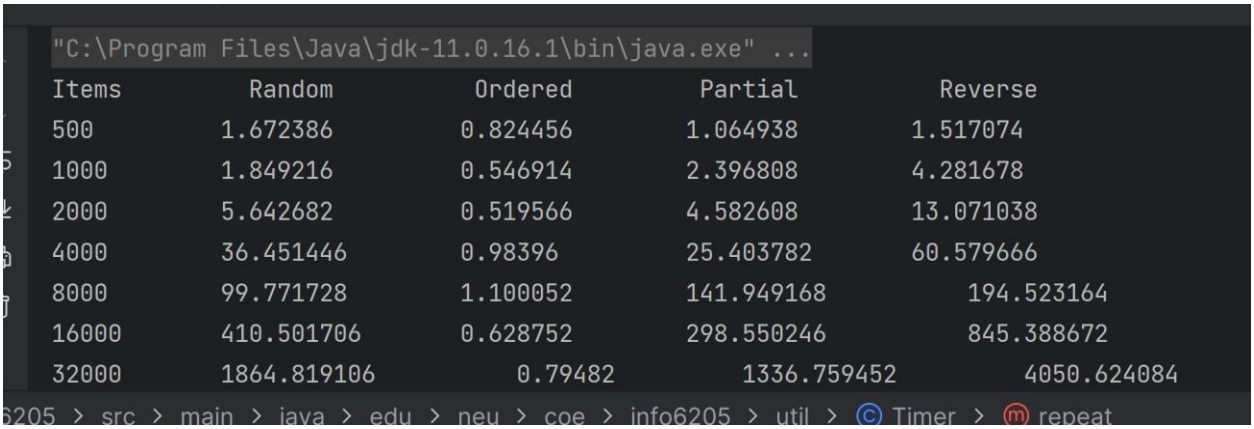
Conclusion

- In case of ordered arrays, the time taken by the algorithm is less compared to other cases as the elements are in a sorted order and the number of operations needed to sort the array is less.
- In the case of random arrays, the time taken by the algorithm increases as the number of elements in the array increases and this is close to the $\mathbf{T = aN^{1.777}}$
- In the case of partially sorted arrays, the time taken is intermediate between the ordered and reversed arrays as the elements are partially sorted, and the number of operations needed to sort the array is intermediate. $\mathbf{T = aN^{1.777}}$
- In the case of reversed arrays, the time taken by the algorithm is highest as the elements are in the reverse order and the number of operations needed to sort the array is highest. This is close to the N2 time complexity. $\mathbf{T = aN^{1.\ 9034}}$

Ordered < Partial-ordered < Random < Reverse order

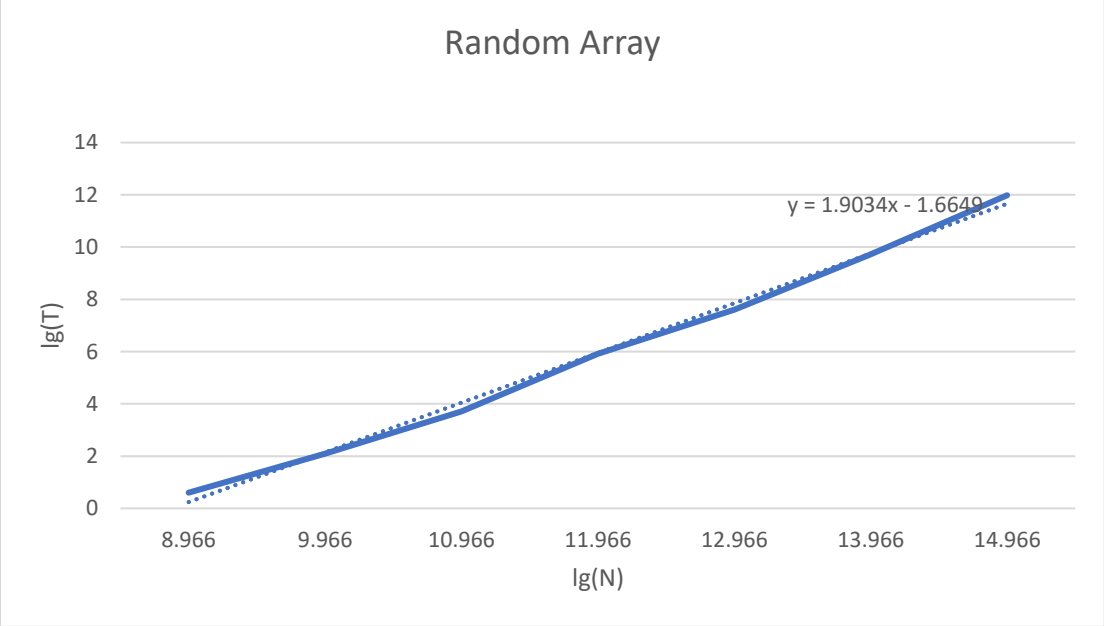
Evidence

Following data is collected after calling Insertion sort method by varying array size from 500 and doubling the array size till 32000. Mean time is calculated after running 50 times.



1) **Elements of the array in Random way**

Random				
N	T	lg(N)	lg(T)	Log Ratio
500	1.672386	8.966	0.741907871	
1000	1.849216	9.966	0.88691375	0.1450059
2000	5.642682	10.966	2.496381047	1.6094673
4000	36.45145	11.966	5.187904141	2.6915231
8000	99.77173	12.966	6.640559156	1.452655
16000	410.5017	13.966	8.681244407	2.0406853
32000	1864.819	14.966	10.86481998	2.1835756



lg(T) vs lg(N) graph

Equation

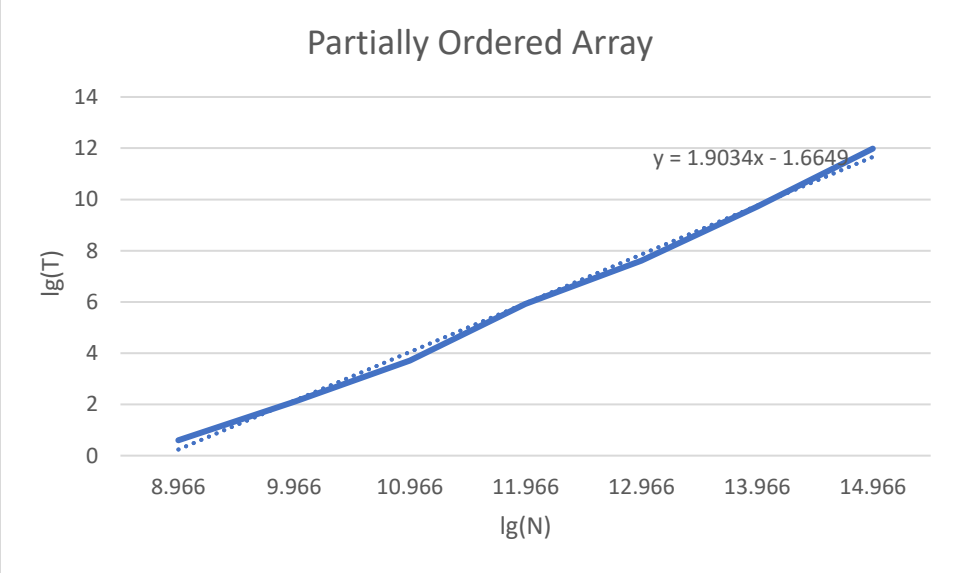
$$lg(T) = 1.777lg(N) - 2.086$$

Equivalent

$$T = aN^{1.777}$$

2) Elements of the array in partial ordered way

Partially Ordered				
N	T	lg(N)	lg(T)	Log Ratio
500	1.064938	8.966	0.09076944	
1000	2.396808	9.966	1.261114344	1.1703449
2000	4.582608	10.966	2.196168882	0.9350545
4000	25.40378	11.966	4.66697139	2.4708025
8000	141.9492	12.966	7.149230583	2.4822592
16000	298.5502	13.966	8.221829947	1.0725994
32000	1336.759	14.966	10.38452416	2.1626942



lg(T) vs lg(N) graph

Equation

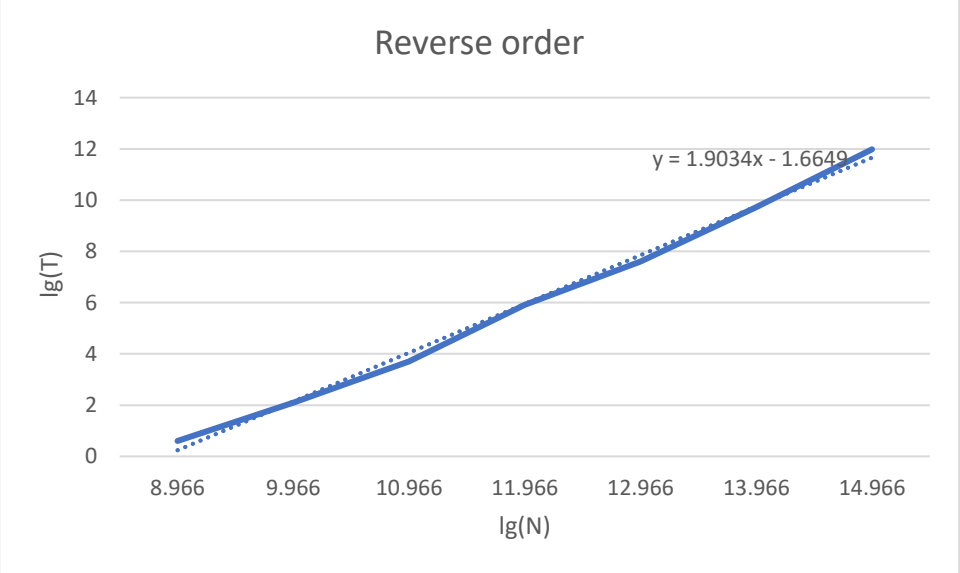
$$lg(T) = 1.777lg(N) - 2.255$$

Equivalent

$$\mathbf{T = aN^{1.777}}$$

3) Elements of the array in reverse ordered way

Reverse Ordered				
N	T	lg(N)	lg(T)	Log Ratio
500	1.517074	8.966	0.601291459	
1000	4.281678	9.966	2.098176303	1.4968848
2000	13.07104	10.966	3.708301808	1.6101255
4000	60.57967	11.966	5.920761719	2.2124599
8000	194.5232	12.966	7.603798153	1.6830364
16000	845.3887	13.966	9.723470971	2.1196728
32000	4050.624	14.966	11.98392849	2.2604575



lg(T) vs lg(N) graph

Equation

$$lg(T) = 1.9034lg(N) - 1.6649$$

Equivalent

$$\mathbf{T = aN^{1.9034}}$$