UNIVERSITY OF VIRGINIA
DATA SCIENCE INSTITUTE

CS 5012: Foundations of Computer Science

Time Complexity Test for Insertion Sort

Application of big 'O' notation to predict the Execution Time

1	2	3	4	5	6	7
n	n^2	Actual Execution Time	Time predicted by $O(n^2)$	Error (%)	Time in minutes	
					Actual	Predicted
100000	10000000000	5875			0.1	
200000	40000000000	23313	23500	-0.796	0.4	0.4
300000	90000000000	52406	52875	-0.887	0.9	0.9
400000	160000000000	93172	94000	-0.881	1.6	1.6
500000	250000000000	145610	146875	-0.861	2.4	2.4
1 Million	What is the estimated time here ---------->					?
2 Million	What is the estimated time here ---------->					?
1 Billion	Estimated execution time in YEARS ---------->					19

Column 3: Actual execution time was recorded capturing system time, in milliseconds, at the beginning and end of the sorting loops

Column 4: Calculated by this formula: 5875 * n2 of the current cell / base n2

Column 5: 100 * (Col 3 - Col 4) / Col 4 (time difference as percentage of predicted time)
Actual execution was slightly faster than the predicted time at all levels.
Closeness of the actual and predicted time validates the accuracy of $O(n^2)$

Predicted Time Calculation Example:

For second row (n = 200k), the predicted time is calculated as follows:

23500 = 5875 * 40000000000 / 10000000000

Conceptually, this is how we predict the execution time for 1 Billion data items:

A) Find total milliseconds: 5875 * $(1 \text{ billion})^2$ / $(100000)^2$.

B) Convert the above milliseconds to years as follows:
C) Answer from A above / 1000 / 60 / 60 / 24 / 365 gives years