CSCI311 - Mar 14th, 2024
Nhat Anh Nguyen
Dr. Kun Tian

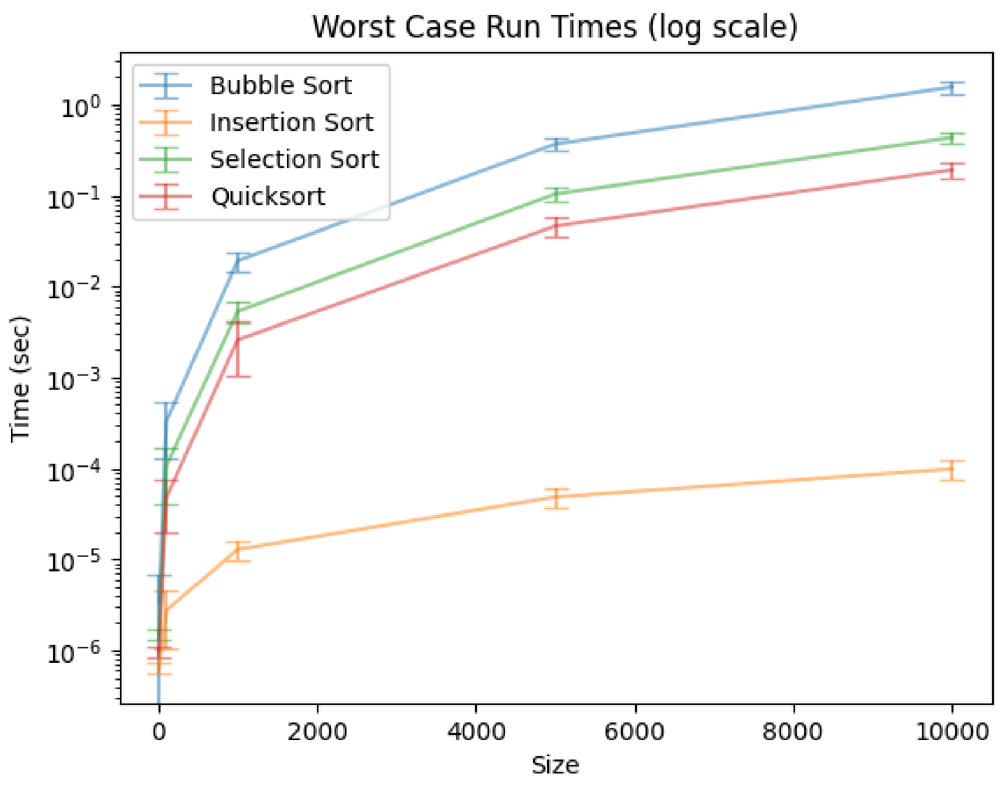
Project 1

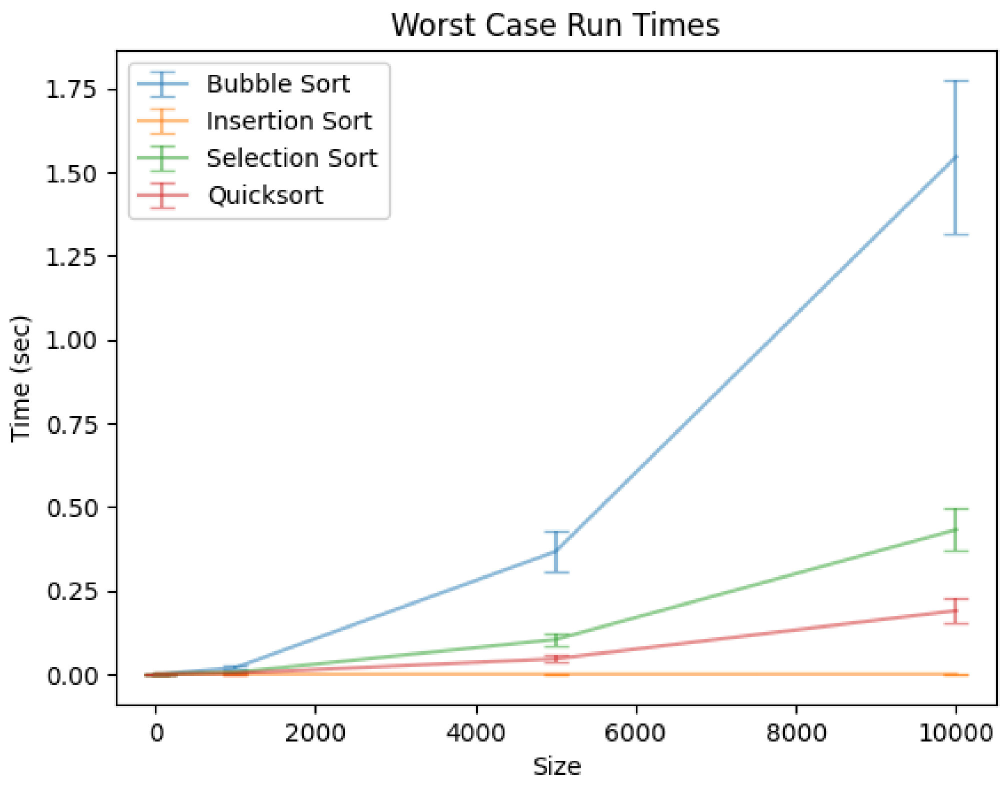
Part 3. Writing Questions

1. **(18 pts) For each algorithm, determine the worst-, average-, and best-case asymptotic run times (1 pt each). In addition, describe what kind of vectors (i.e. sorted, reversed, or something else) achieve these bounds (1 pt each).**

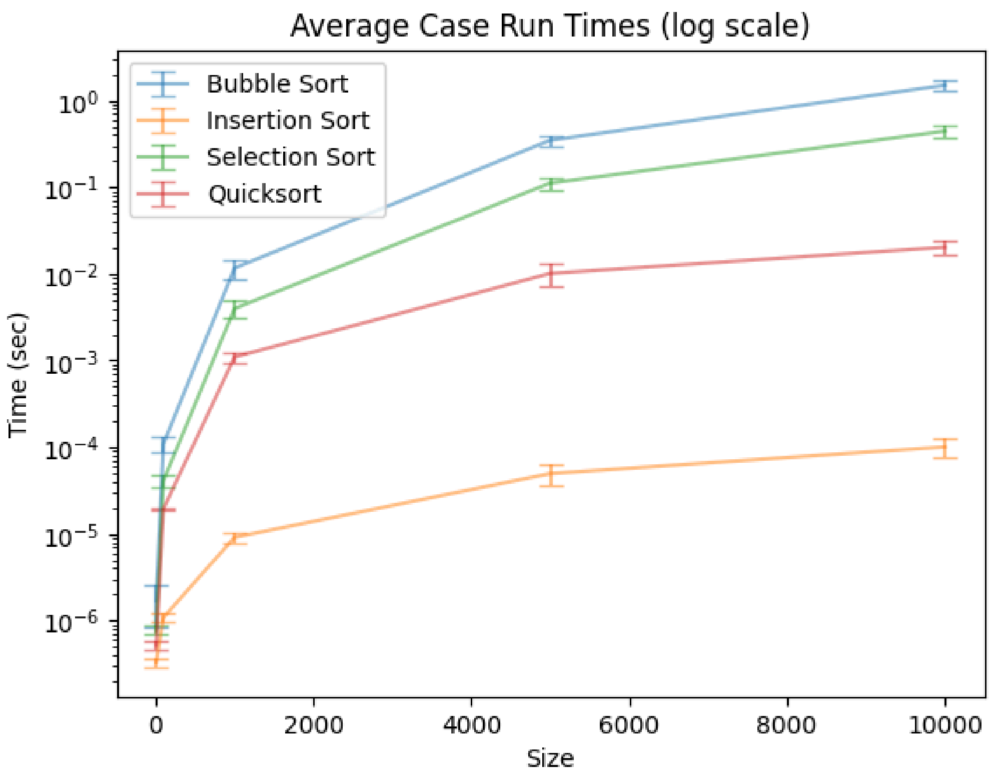
Algo	**Worst-case**	**Avg-case**	**Best-case**
Bubble sort	$O(n^2)$	$O(n^2)$	$O(n)$
	Reversed or nearly sorted	Random	Sorted
Insertion sort	$O(n^2)$	$O(n^2)$	$O(n)$
	Reversed or nearly sorted	Random	Sorted
Selection sort	$O(n^2)$	$O(n^2)$	$O(n^2)$
	Reversed, sorted, or random	Reversed, sorted, or random	Reversed, sorted, or random
Quicksort	$O(n^2)$	$O(nlogn)$	$O(nlogn)$
	Already sorted or nearly sorted, bad pivot choice leads to worst-case	Random pivot choice usually leads to average-case	Already sorted or nearly sorted, good pivot choice leads to best-case

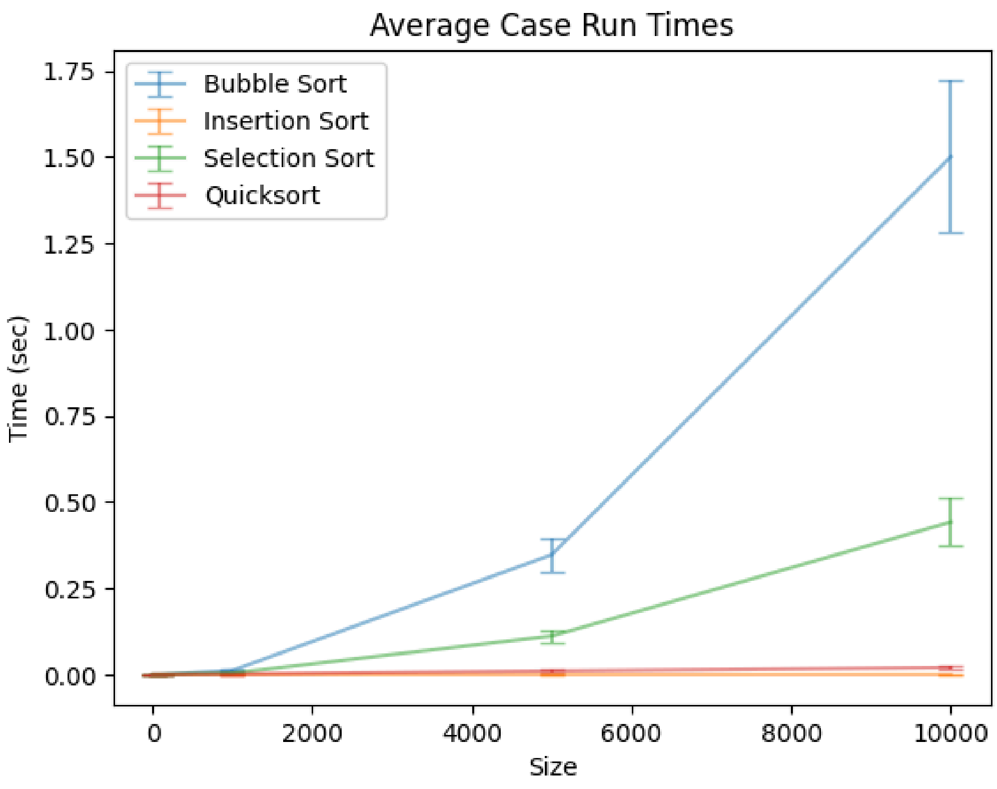
2. **(5 pts) Generate three graphs, one for best-, average-, and worst-case scenarios, using the data collected in your experiments and the plotData executable provided on Canvas.**
    a. Worst case



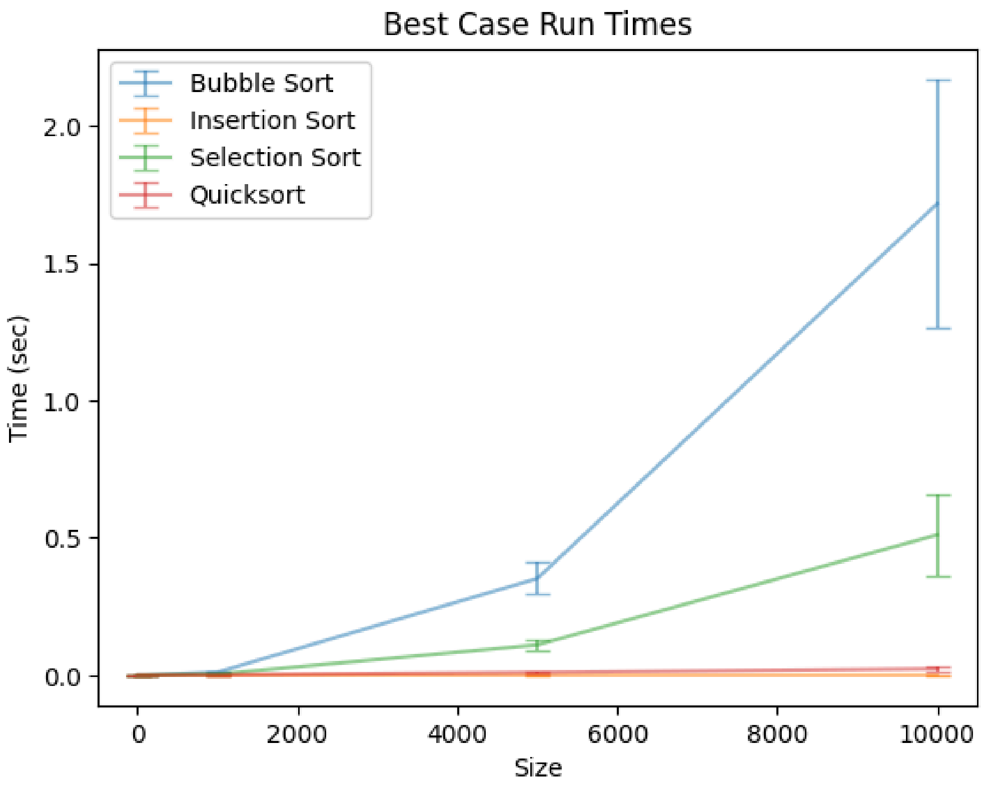


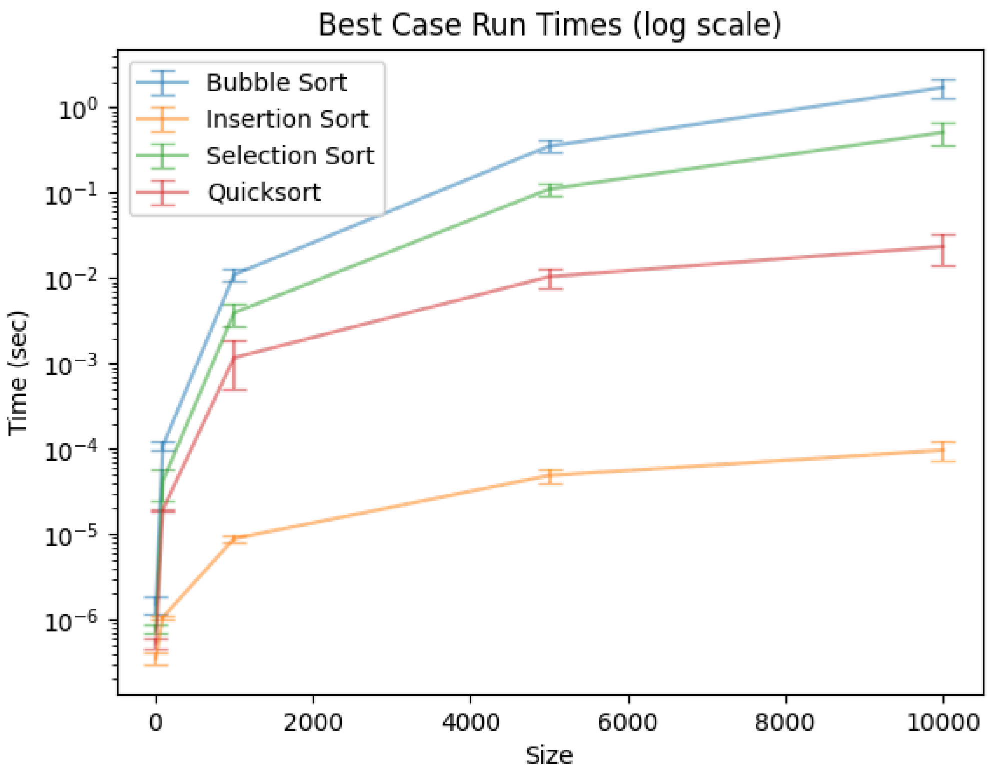
b. Average case





c. Best case


Best Case Run Times
Bubble Sort
Insertion Sort
Selection Sort
Quicksort
Time (sec)
Size
0.0
0.5
1.0
1.5
2.0
0
2000
4000
6000
8000
10000


Best Case Run Times (log scale)
Bubble Sort
Insertion Sort
Selection Sort
Quicksort
Time (sec)
Size
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
0
2000
4000
6000
8000
10000

3. **(7 pts) For each of the graphs generated in (2), what do you see? Do the curves follow the patterns that we expect? Do certain algorithms seem faster than others in different cases? Are there any surprises? Be specific and refer back to your answers to question 3.1.**

   The curves should generally align with the expected runtime complexities and behaviours of the sorting algos. Quicksort is expected to outperform the other algorithms, especially on average and best-case scenarios, while Bubble Sort and Selection Sort exhibit poorer performance, particularly for larger input sizes and worst-case scenarios. However, Insertion Sort seems to outperform all other sorting algo in all cases. This and any deviations from the expectations, which quicksort should outperforms all, could indicate anomalies or inefficiencies in the implementation or dataset