**Sites/Sources referred:**

* programiz.com
* geeksforgeeks
* javatpoint
* tutorialspoint

**Difference between the 3 Sorting Algorithms:**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Insertion Sort | Merge Sort | Quick Sort |
| Definition | Insertion Sort is a simple sorting algorithm that iteratively builds a sorted portion of an array by shifting elements into their correct positions one at a time. | Merge Sort is a divide-and-conquer sorting algorithm that recursively divides an array into halves, sorts them, and merges them back together to produce a sorted array. | Quick Sort is a divide-and-conquer sorting algorithm that selects a pivot element and partitions the array into smaller segments, then recursively sorts these segments |
| Best case time complexity | O(n) | O(n log n) | O(n log n) |
| Average Case | O(n²) | O(n log n) | O(n log n) |
| Worst Case | O(n²) | O(n log n) | O(n²) |
| Space Complexity | O(1) | O(n) | O(n log n) to O(n) |

**Experimental results (time it takes for algorithm to sort 4 lists of data structures of varying lengths).**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 20 lines | 100 lines | 2000 lines | 6000 lines |
| Insertion Sort | 0.00002549 | 0.000264100031927228 | 0.08510269992984831 | 0.7961562999989837 |
| Merge Sort | 0.00003459979 | 0.00021620001643896103 | 0.00417939992621541 | 0.011435699881985784 |
| Quick Sort | 0.000014099990949034 | 0.00006449990905821323 | 0.0024313998874276876 | 0.011600999860092998 |

A graph with a line and a number of lines

Description automatically generated

**Analysis and Differences between the experimental and theoretical results:**

This analysis is based on seeing the table and graph shown above. The graph is made using matplotlib library of python.

* As you can see the time taken by insertion sort increases exponentially as the number of inputs increases.
* The time taken by insertion sort is less than the time taken by merge sort for 20 lines. Therefore, insertion sort works better than merge sort for lesser number of inputs.
* Quick sort is relatively faster than the other two algorithms in 20,100 and 2000 lines of inputs but is beat by merge sort at 6000 lines of input. Therefore, in the above case we can conclude that merge sort worked better than quick sort for more number of inputs.

**Honors Code:**

A piece of paper with writing on it

Description automatically generated