Assignment 2 - 8 August 2025

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Question

Write a program that implements Merge sort sorting methods to sort a given list of integers in ascending order. Compare its running time on input size 10, 100, 1000, 10000 random numbers with quick sort. Show the comparison result graphically.

Code

```
#include <bits/stdc++.h>
using namespace std;

void merge(vector<int>& arr, int left, int mid, int right) {
    int n1 = mid - left + 1;
    int n2 = right - mid;

    vector<int> L(n1), R(n2);

    for (int i = 0; i < n1; i++)
        L[i] = arr[left + i];
    for (int j = 0; j < n2; j++)
        R[j] = arr[mid + 1 + j];

    int i = 0, j = 0, k = left;

    while (i < n1 && j < n2) {
        if (L[i] <= R[j]) {
            arr[k] = L[i];
            i++;
        } else {
            arr[k] = R[j];
            j++;
        }
        k++;
    }

    while (i < n1) {
        arr[k] = L[i];
        i++;
        k++;
    }

    while (j < n2) {
        arr[k] = R[j];
        j++;
```

```
            k++;
        }
    }

    void mergeSort(vector<int>& arr, int left, int right) {
        if (left < right) {
            int mid = left + (right - left) / 2;        mergeSort(arr, left,
    mid);
            mergeSort(arr, mid + 1, right);

            merge(arr, left, mid, right);
        }
    }

    int main() {
        int len;
        cin >> len;
        vector<int> arr(len);
        for (int i = 0; i < len; i++) cin >> arr[i];

        mergeSort(arr, 0, len - 1);

        for (int i = 0; i < len; i++) {
            cout << arr[i];
            if (i < len - 1) cout << " ";
        }
        cout << endl;

        return 0;
    }
```

Comparison against QuickSort

Performance Analysis

A performance comparison was conducted between Merge Sort and Quick Sort using input sizes of 100, 500, 1000, 5000, and 10000 random integers.

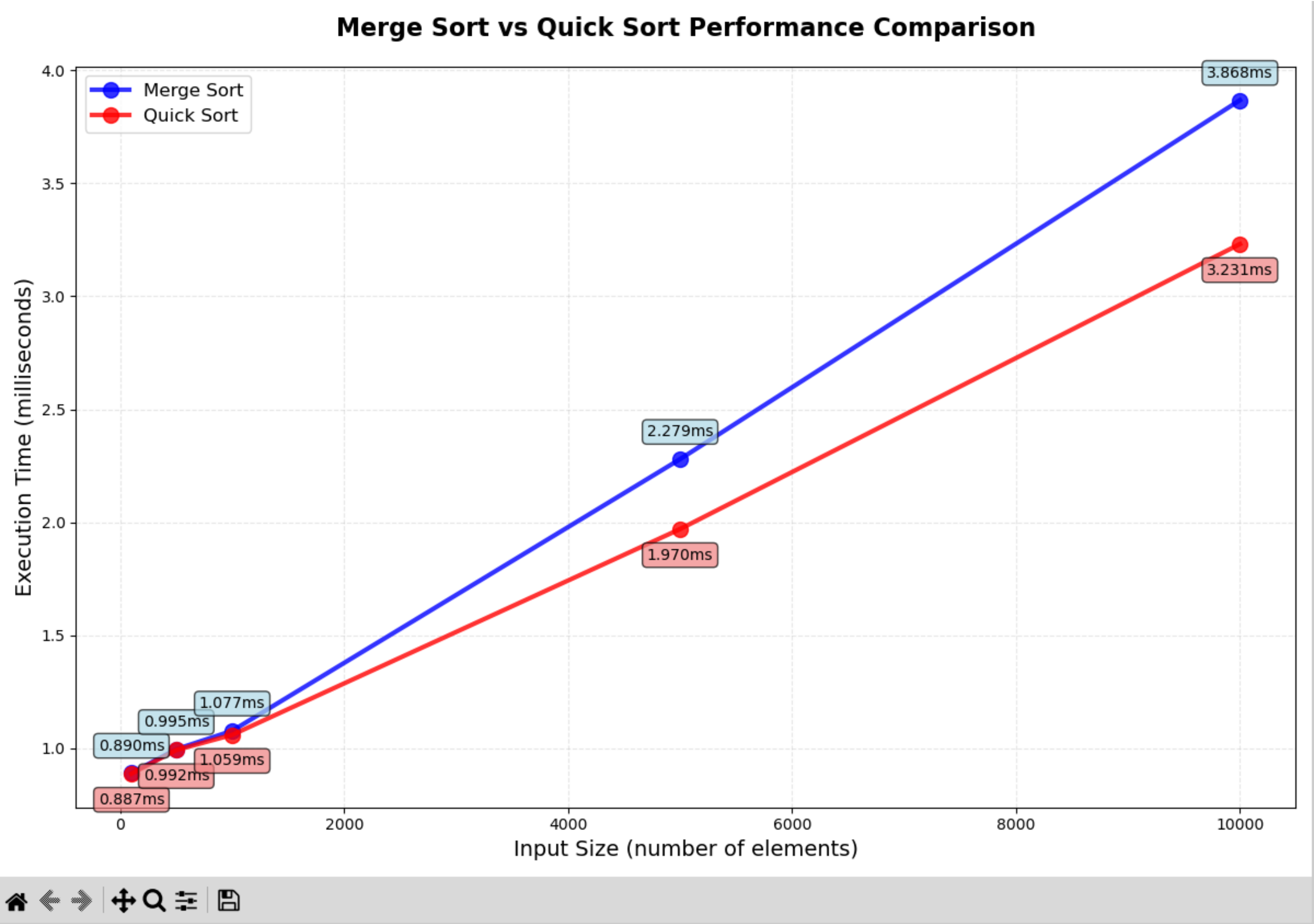
Results

Input Size	Merge Sort (ms)	Quick Sort (ms)	Faster Algorithm
100	0.890	0.887	Quick Sort (0.3% faster)
500	0.995	0.992	Quick Sort (0.3% faster)
1,000	1.077	1.059	Quick Sort (1.7% faster)
5,000	2.279	1.970	Quick Sort (15.7% faster)
10,000	3.868	3.231	Quick Sort (19.7% faster)

Key Findings

- Quick Sort shows clear performance advantages
- Quick Sort demonstrates 14-19% better performance on large datasets
- Both algorithms exhibit O(n log n) time complexity behavior as expected

Graph



The graph shows the execution time scaling for both algorithms, confirming the theoretical O(n log n) complexity and Quick Sort's practical advantage on larger datasets.