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IUT Aix-Marseille
Département Informatique
S1.02 - Algorithmique et Programmation

SAE S1.02 Project Report

Algorithm Comparison and Analysis

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Contents

1 Algorithm Explanation

1.1 `std::sort`

The `std::sort` function is a sorting algorithm that is part of the C++ Standard Library. It is a comparison-based sorting algorithm that is a stable version of `std::sort`. The algorithm has a complexity of $O(n \log n)$ on average, where n is the number of elements to sort.

1.2 `std::stable_sort`

The `std::stable_sort` function is a sorting algorithm that is part of the C++ Standard Library. It is a comparison-based sorting algorithm that is a stable version of `std::sort`. The algorithm has a complexity of $O(n \log n)$ on average, where n is the number of elements to sort.

1.3 `qsort`

The `qsort` function is a sorting algorithm that is part of the C Standard Library. It is a comparison-based sorting algorithm that uses the quicksort algorithm. The algorithm has a complexity of $O(n \log n)$ on average, where n is the number of elements to sort.

1.4 `quicksortrnd`

The `quicksortrnd` function is a sorting algorithm that is a random version of the quicksort algorithm. The algorithm has a complexity of $O(n \log n)$ on average, where n is the number of elements to sort.

1.5 `quicksortdet`

The `quicksortdet` function is a sorting algorithm that is a deterministic version of the quicksort algorithm. The algorithm has a complexity of $O(n \log n)$ on average, where n is the number of elements to sort.

1.6 `Bubble Sort`

The `bubble sort` function is a sorting algorithm that is a comparison-based sorting algorithm that repeatedly steps through the list, compares adjacent elements, and swaps them if they are in the wrong order. The algorithm has a complexity of $O(n^2)$ on average, where n is the number of elements to sort.

1.7 `Insertion Sort`

The `insertion sort` function is a sorting algorithm that is a comparison-based sorting algorithm that builds the final sorted array one item at a time. The algorithm has a complexity of $O(n^2)$ on average, where n is the number of elements to sort.

1.8 Selection Sort

The `selection sort` function is a sorting algorithm that is a comparison-based sorting algorithm that divides the input list into two parts: the sublist of items already sorted and the sublist of items remaining to be sorted. The algorithm has a complexity of $O(n^2)$ on average, where n is the number of elements to sort.

1.9 ICan'tBelieveItCanSort

The `ICan'tBelieveItCanSort` function is a sorting algorithm that is a comparison-based sorting algorithm that is a joke algorithm. The algorithm has a complexity of $O(n^2)$ on average, where n is the number of elements to sort.

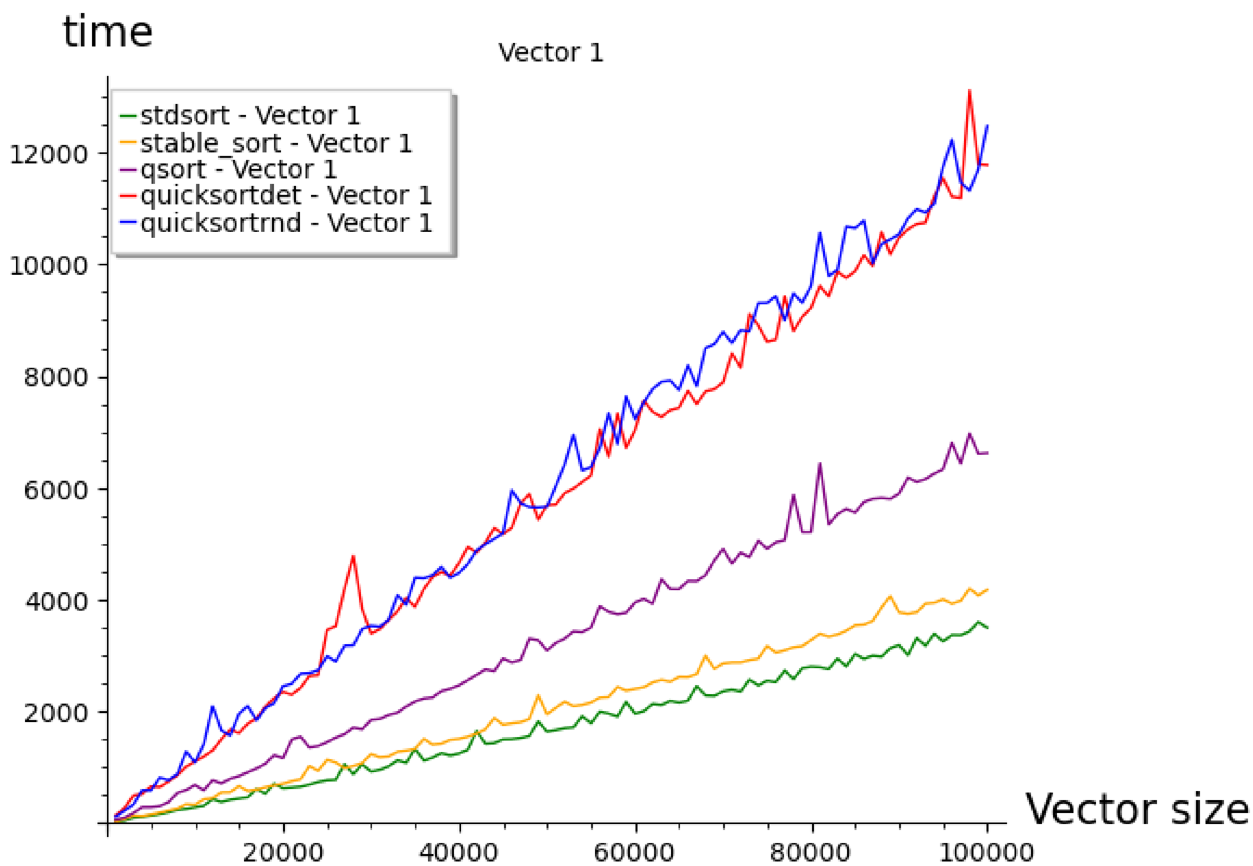
2 Comparison of Algorithms

- We separated the algorithms into two categories: fast and slow algorithms. The fast algorithms are `std::sort`, `std::stable_sort`, `qsort`, `quicksortrnd` because they have a complexity of $O(n \log n)$ on average.

- The slow algorithms are `quicksortdet`, `bubble sort`, `insertion sort`, `selection sort`, and `ICan'tBelieveItCanSort` because they have a complexity of $O(n^2)$ on average.

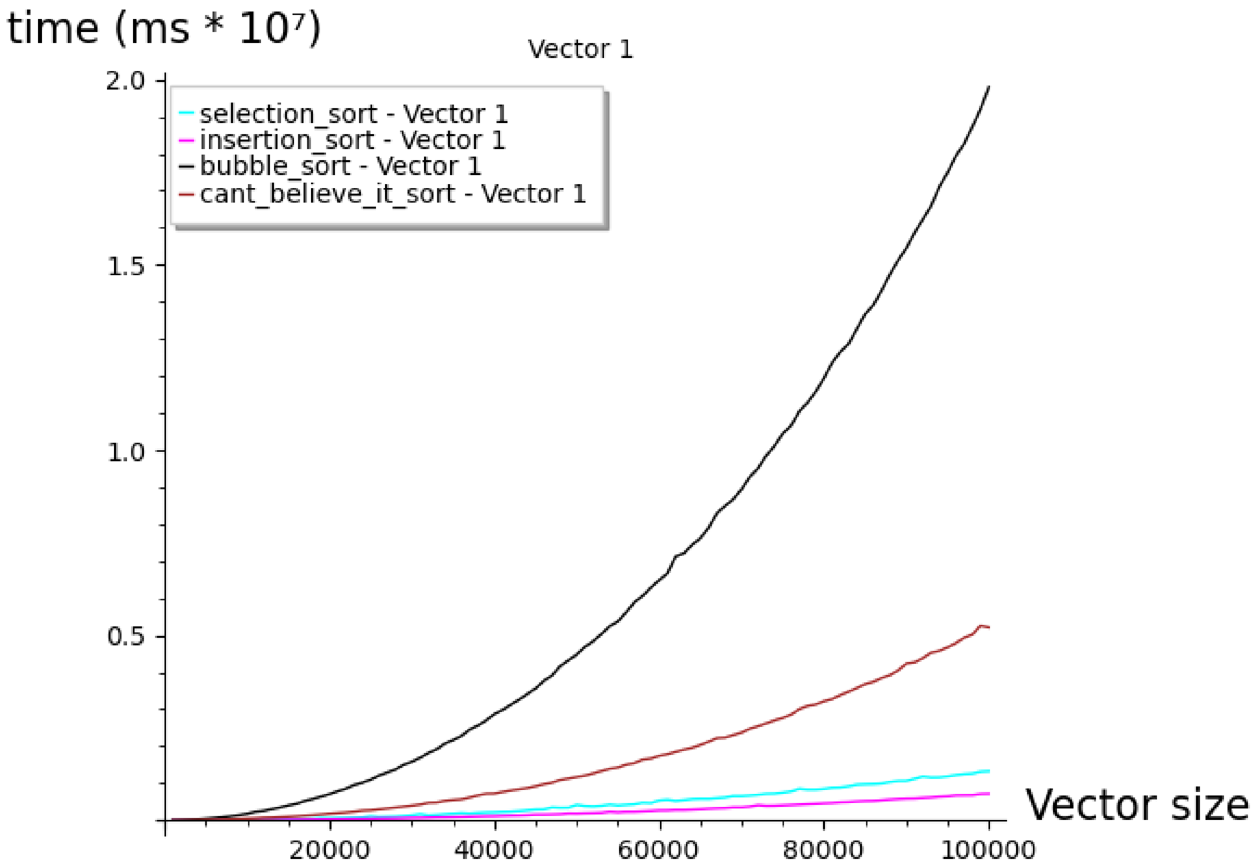
2.1 Random Vector

2.1.1 Fast Algorithms



We can see that the `std::sort` algorithm is the fastest algorithm for the random vector, followed by the `std::stable_sort` algorithm. The `quicksortrnd` algorithm is the slowest of the fast algorithms. The `qsort` algorithm is faster than the `quicksortrnd` algorithm, we can see that the `quicksortrnd` take less then thirteen hundred milliseconds to sort the vector, for the other algorithms, they take less than seven hundred milliseconds to sort the vector.

2.1.2 Slow Algorithms



We can see that the `quicksortdet` algorithm is the fastest algorithm for the random vector, followed by `insertion sort`, the `selection sort` algorithm, the `ICan'tBelieveItCanSort` algorithm and the `bubble sort` algorithm. The `bubble sort` algorithm is the slowest of the slow algorithms with a lot of difference with the other algorithms because it just go take million of milliseconds to sort the vector compared to the other algorithms.

2.1.3 Conclusion for random vector

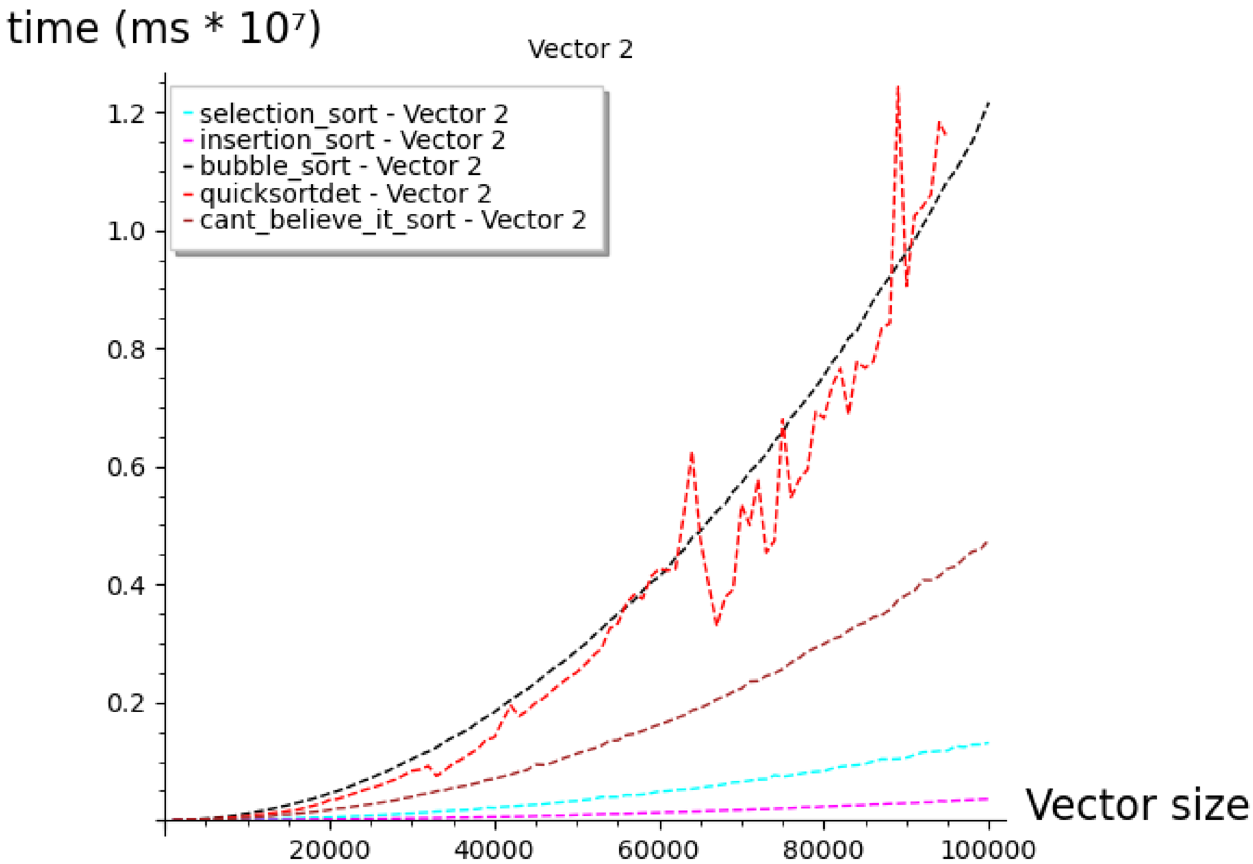
To conclude, the `std::sort` algorithm is the fastest algorithm of the fast algorithm for the random vector and the `insertion sort` algorithm is the fastest algorithm of the slow algorithm for the random vector.

2.2 Half-Sorted Vector

2.2.1 Fast Algorithms

We can see that the `stable_sort` is faster than the `std::sort` for this one followed by the `qsort`, we can see that they are faster than with the random vector. The `quicksortrnd`, him, is slower than with the random vector.

2.2.2 Slow Algorithms



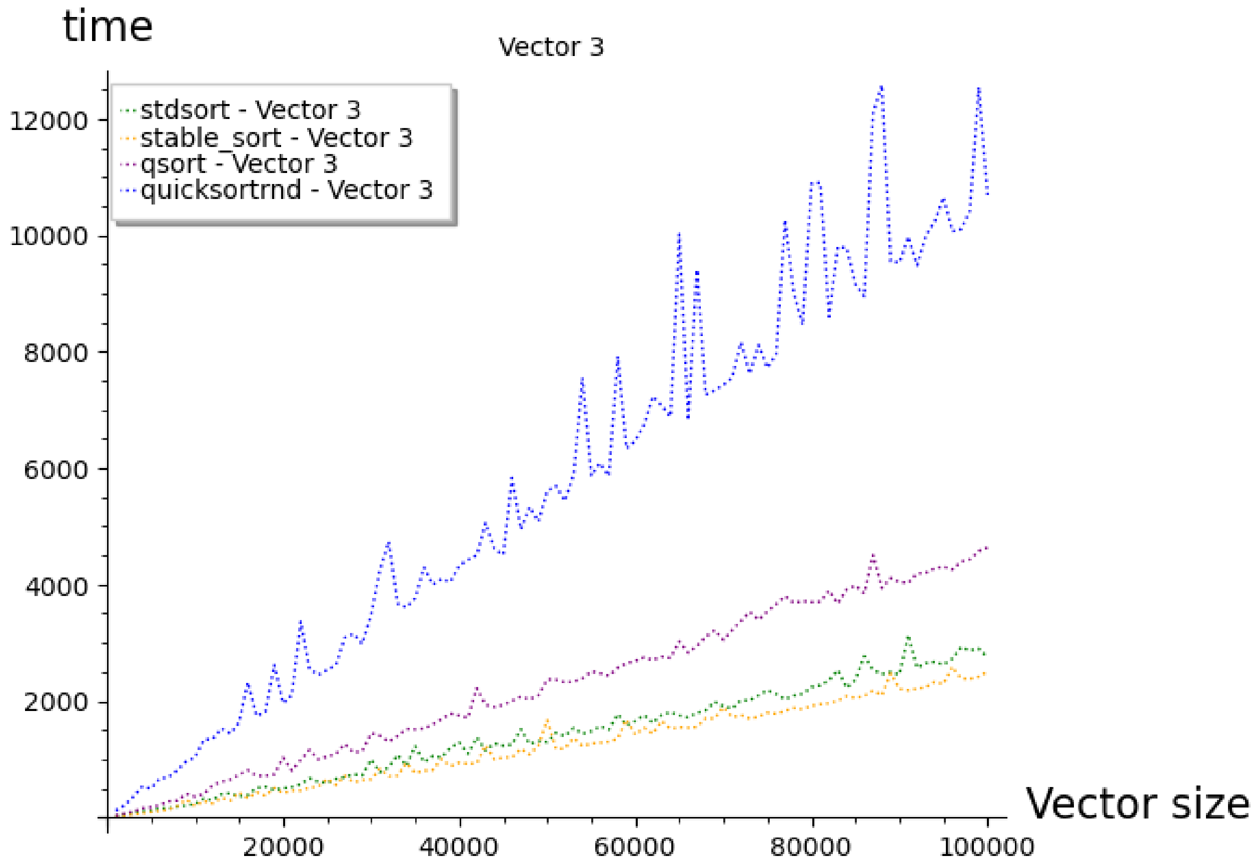
We can see that the `quicksortdet` algorithm is really more slower than with the random vector, it is mostly equal to the `bubble sort` algorithm because he was faster for this vector than for the random vector, the `insertion sort` algorithm is the fastest of the slow algorithms for the half sorted vector followed by the `selection sort` algorithm and the `ICan'tBelieveItCanSort` algorithm, we can see that the `ICan'tBelieveItCanSort` sorting time is pretty the same as the random vector.

2.2.3 Conclusion for half-sorted vector

To conclude, the `std::stable_sort` algorithm is the fastest algorithm of the fast algorithm for the half sorted vector and the `insertion sort` algorithm is the fastest algorithm of the slow algorithm for the half sorted vector.

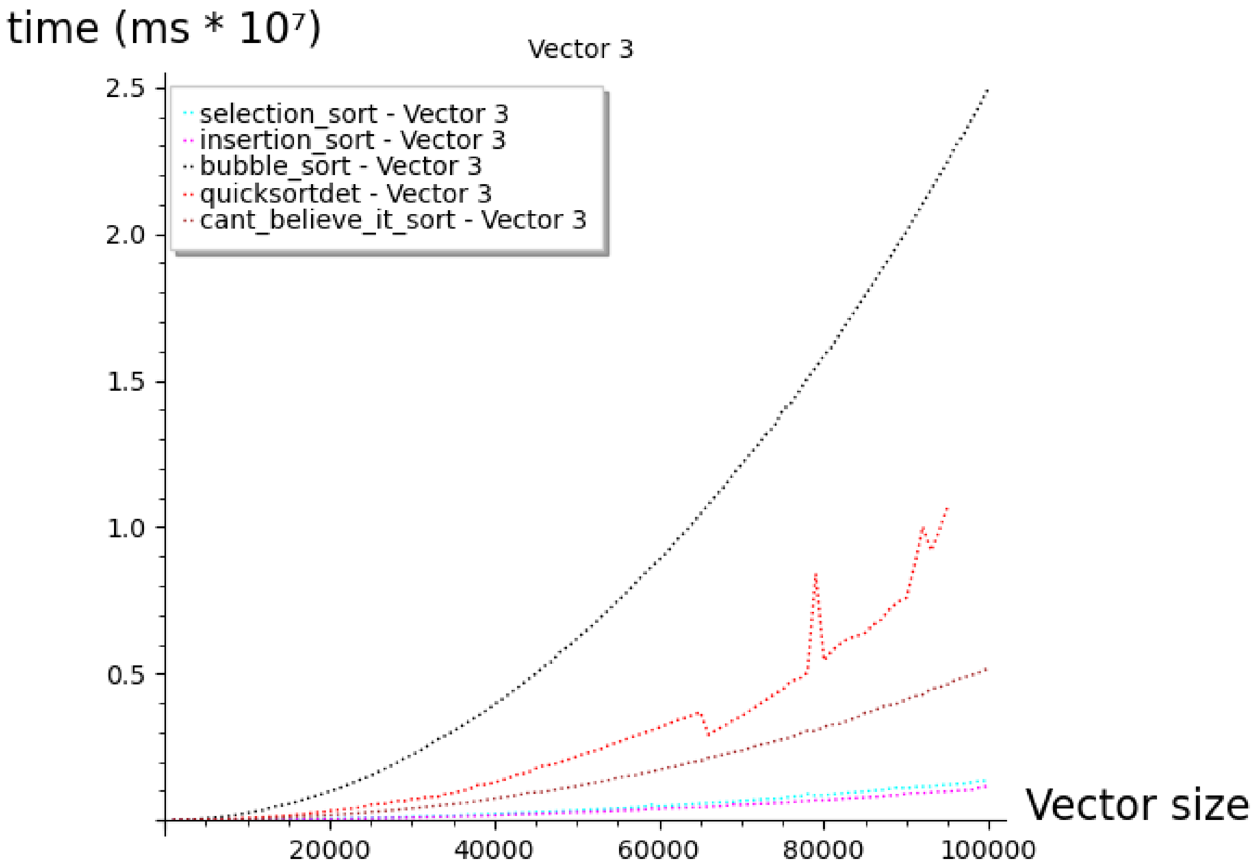
2.3 Half Reverse-Sorted Vector

2.3.1 Fast Algorithms



We can see that the `stable_sort` is the faster algorithm for the half reverse sorted vector, followed by the `std::sort` algorithm, the `qsort` and the `quicksortrnd`, there is not a lot of difference with this vector compared to the half sorted vector.

2.3.2 Slow Algorithms



We can see that the `insertion sort` is always the faster, followed by `selection sort`, the `ICan'tBelieveItCanSort`. The `quicksortdet` is much faster than with the half sorted vector, the `bubble sort` algorithm is always the slowest algorithm for this vector.

2.3.3 Conclusion for half reverse-sorted vector

To conclude, the `std::stable_sort` algorithm is always the fastest algorithm of the fast algorithm for the half reverse sorted vector and the `insertion sort` algorithm is the fastest algorithm of the slow algorithm for the half reverse sorted vector.

2.4 Remarks

In all the plots, we can see some peaks or some variation, for most of the algorithms, this is because the computer is doing some other tasks at the same time, so the time is not really accurate, but we observe that the `std::stable_sort` is always the most stable because he has the less variation, this is why he is sometimes a bit slower than the `std::sort` algorithm.

3 Conclusion

In conclusion, we can see that the `std::sort` algorithm is the fastest algorithm for the random vector, the `std::stable_sort` algorithm is the fastest algorithm for the half sorted vector and the half reverse sorted vector. The `insertion sort` algorithm is the fastest algorithm of the slow algorithm for the random vector, the half sorted vector and the half reverse sorted vector. The `bubble sort` algorithm is always the slowest algorithm for the random vector, the half sorted vector and the half reverse sorted vector. The worst algorithm with millions of milliseconds is the `bubble sort` algorithm.

There is a big difference between the fast and the slow algorithm ($O(n \log n)$ and $O(n^2)$), the $O(n \log n)$ just take less than thirteen hundred milliseconds to sort the vector, for the $O(n^2)$, they more than millions of milliseconds to sort a vector.