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Algorithms' comparison report

1. Introduction

We have developed two programs written in Java that take a different approach to calculating the cross-correlation between two signals.

Both consist of a crosscorrelation() method and a main implemented by a CrossCorrelation1 class for the former and CrossCorrelation2 for the latter. The crosscorrelation() method takes two signals as parameters and returns an array of doubles containing the cross-correlation value.

We will first explain which calculation method each program uses, then present the results given on several different samples, then compare them in terms of execution time to determine which method is the most efficient, and conclude by explaining which program we think performs best.

2. Comparison of algorithms

2.1 Description of both programs

The first method contained in the CrossCorrelation1 class is the simplest, executing the formula used to calculate cross-correlation below :

$$\mathrm{corr}(offset) = \sum_{i=0}^{n-offset} \mathrm{sig1}[i] \cdot \mathrm{sig2}[i + offset]$$

⇒ It calculates a cross-correlation between two signals, noted here as sig1 and sig2, as a function of an offset, for i ranging from 0 to n-offset (limit not to exceed the size of the sig2 array).

The second method is based on the cross-correlation calculation method of the first, but uses the FFT (Fast Fourier Transform) method, which reduces the calculation time from n^2 to n log n, thus improving program efficiency.

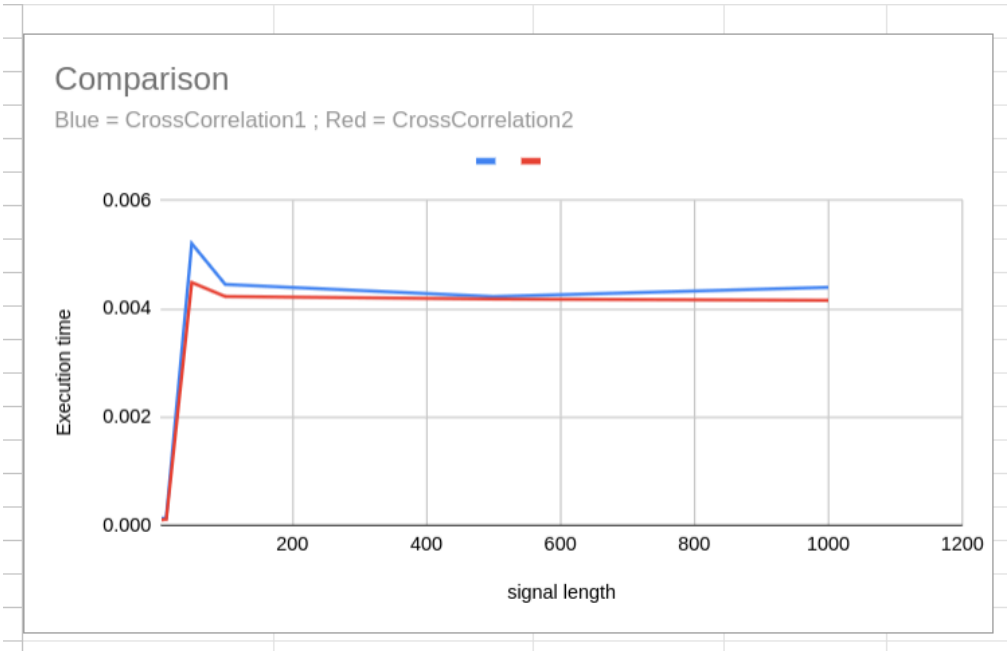
2.2 Returned results for both methods

In order to compare the two programs, we carried out seven calculations on each method, using signals of different sizes. The operations were carried out on an

HP laptop 17 equipped with an AMD Ryzen 5 5500 with 16 Gb RAM on an Ubuntu system.

CrossCorrelation1	
Signal length	Execution time (seconds)
4	0.00013
8	0.00013
12	0.00014
50	0.005201872
100	0.004447952
500	0.004222529
1000	0.004393398

CrossCorrelation2	
Signal length	Execution time (seconds)
4	0.0001
8	0.00011
12	0.00011
50	0.004485178
100	0.004226819
500	0.004179701
1000	0.004155763



The graph shows that the execution time of the CrossCorrelation2 class is always less than that of the first.

3. Conclusion

The graph shows that the execution time of the CrossCorrelation2 class is always less than that of the first:

For a signal length of 100 :

- CrossCorrelation1 : 0.00444s
- CrossCorrelation2 : 0.00422s

Only the CrossCorrelation2 class is much more complex, which could cause some problems in understanding the FFT method.

Moreover, the CrossCorrelation2 class appears to be the most accurate, thanks to the results obtained.

In conclusion, the second class seems to be the most efficient but the most complex compared to CrossCorrelation1.