Geophysical Research Abstracts
Vol. 16, EGU2014-14824, 2014
EGU General Assembly 2014

Fast computation of recurrences in long time series

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The quadratic time complexity of calculating basic RQA measures, doubling the size of the input time series leads to a quadrupling in operations, impairs the fast computation of RQA in many application scenarios. As an example, we analyze the Potsdamer Reihe, an ongoing non-interrupted hourly temperature profile since 1893, consisting of 1,043,112 data points. Using an optimized single-threaded CPU implementation this analysis requires about six hours. Our approach conducts RQA for the Potsdamer Reihe in five minutes.

We automatically split a long time series into smaller chunks (Divide) and distribute the computation of RQA measures across multiple GPU devices. To guarantee valid RQA results, we employ carryover buffers that allow sharing information between pairs of chunks (Recombine). We demonstrate the capabilities of our Divide and Recombine approach to process long time series by comparing the runtime of our implementation to existing RQA tools.

We support a variety of platforms by employing the computing framework OpenCL. Our current implementation supports the computation of standard RQA measures (recurrence rate, determinism, laminarity, ratio, average diagonal line length, trapping time, longest diagonal line, longest vertical line, divergence, entropy, trend) and also calculates recurrence times. To utilize the potential of our approach for a number of applications, we plan to release our implementation under an Open Source software license. It will be available at http://www.gfz-potsdam.de/fast-rqa/.

Since our approach allows to compute RQA measures for a long time series fast, we plan to extend our implementation to support multi-scale RQA.