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Applying the Ramer-Douglas-Peucker algorithm to compress and characterize time-series and spatial fields of precipitation

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Well known in image processing and computer graphics, the Ramer-Douglas-Peucker(RDP) algorithm (Ramer, 1972; Douglas and Peucker, 1973) is a procedure to approximate a polygon (lines or areas) by a subset of its nodes. Typically it is used to represent a polygonal feature on a larger scale, e.g. when zooming out of an image.

The algorithm is simple but effective: Starting from the simplest possible approximation of the original polygon (for a line it is the start and end point), the simplified polygon is built by successively adding always the node of the original polygon farthest from the simplified polygon. This is repeated until a chosen agreement between the original and the simplified polygon is reached. Compared to other smoothing and compression algorithms like moving-average filters or block aggregation, the RDP algorithm has the advantages that i) the simplified polygon is built from the original points, i.e. extreme values are preserved and ii) that the variability of the original polygon is preserved in a scale-independent manner, i.e. the simplified polygon is high-resolution where necessary and low-resolution where possible.

Applying the RDP algorithm to time series of precipitation or 2d spatial fields of radar rainfall often reveals a large degree of compressibility while losing almost no information. In general, this is the case for any auto-correlated polygon such as discharge time series etc.

While the RDP algorithm is thus interesting as a very efficient tool for compression, it can also be used to characterize time series or spatial fields with respect to their temporal or spatial structure by relating, over successive steps of simplification, the compression achieved and information lost.

We will present and discuss the characteristics of the RDP-based compression and characterization at various examples, both observed (rainfall and discharge time series, 2-d radar rainfall fields) and artificial (random noise fields, random fields with known auto covariance). We will compare the algorithm to existing methods of compression and smoothing and standard ways to characterize spatio-temporal structure in data (e.g. auto covariance).

References

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