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Modified DTW for a quantitative estimation of the similarity between rainfall time series

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The Precipitations are due to complex meteorological phenomenon and can be described as intermittent process. The spatial and temporal variability of this phenomenon is significant and covers large scales. To analyze and model this variability and / or structure, several studies use a network of rain gauges providing several time series of precipitation measurements. To compare these different time series, the authors compute for each time series some parameters (PDF, rain peak intensity, occurrence, amount, duration, intensity ...). However, and despite the calculation of these parameters, the comparison of the parameters between two series of measurements remains qualitative.
Due to the advection processes, when different sensors of an observation network measure precipitation time series identical in terms of intermitency or intensities, there is a time lag between the different measured series.
Analyzing and extracting relevant information on physical phenomena from these precipitation time series implies the development of automatic analytical methods capable of comparing two time series of precipitation measured by different sensors or at two different locations and thus quantifying the difference / similarity.
The limits of the Euclidean distance to measure the similarity between the time series of precipitation have been well demonstrated and explained (eg the Euclidian distance is indeed very sensitive to the effects of phase shift : between two identical but slightly shifted time series, this distance is not negligible).
To quantify and analysis these time lag, the correlation functions are well established, normalized and commonly used to measure the spatial dependences that are required by many applications. However, authors generally observed that there is always a considerable scatter of the inter-rain gauge correlation coefficients obtained from the individual pairs of rain gauges. Because of a substantial dispersion of estimated time lag, the interpretation of this inter-correlation is not straightforward.
We propose here to use an improvement of the Euclidian distance which integrates the global complexity of the rainfall series. The Dynamic Time Wrapping (DTW) used in speech recognition allows matching two time series instantly different and provide the most probable time lag. However, the original formulation of the DTW suffers from some limitations. In particular, it is not adequate to the rain intermittency.
In this study we present an adaptation of the DTW for the analysis of rainfall time series :
we used time series from the "Météo France" rain gauge network observed between January 1st, 2007 and December 31st, 2015 on 25 stations located in the Île de France area. Then we analyze the results (eg. The distance, the relationship between the time lag detected by our methods and others measured parameters like speed and direction of the wind...) to show the ability of the proposed similarity to provide usefull information on the rain structure.
The possibility of using this measure of similarity to define a quality indicator of a sensor integrated into an observation network is also envisaged.