Hidden Markov Model for Extreme Stochastic Rainfall Generation

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Abstract:
The current climate change context necessitates for industrials a careful analysis of the resilience of their assets under future weather conditions, to anticipate possible adaptation needs. Such analyses imply the estimation of future extreme hydrometeorological scenarios, for example, the frequency of long-lasting dry spells for hydropower or nuclear generation. For these reasons, Stochastic Weather Generators are essential tools to estimate the future risks. They are used to sample climate statistics from models trained on observed or simulated data.
In our work, the rainfall model described and validated is based on a spatial Hidden Markov Model (HMM). It generates first rain occurrences spatially with a special attention to the correct reproduction of the distribution of dry and wet spells. Then it adds the rainfall quantities via Gaussian copula only for the sites where it rains. Model parameters slowly vary on a day-to-day basis to reproduce seasonality and are fully interpretable. If some model ingredients taken alone are not new, the combination of them is the innovation of this model, which achieves very good performance, specifically in terms of extreme events. These properties are indeed important to study rare dry sequences and their possible evolution in the future due to climate change.

Keywords:
Hidden Markov Model; Stochastic Weather Generator; Interpretability; Rainfall; Extreme Events; Copula