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Explainable community detection of extreme rainfall events using the tangles algorithmic framework

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Climate networks have helped to uncover complex structures in climatic observables from large time series data sets. For instance, climate networks were used to reduce rainfall data to relevant patterns that can be linked to geophysical processes. However, the identification of regions that show similar behavior with respect to the timing and spatial distribution of extreme rainfall events (EREs) remains challenging.
To address this, we apply a recently developed algorithmic framework based on tangles [1] to discover community structures in the spatial distribution of EREs and to obtain inherently interpretable communities as an output. First, we construct a climate network using time-delayed event synchronization and create a collection of cuts (bipartitions) from the EREs data. By using these cuts, the tangles algorithmic framework allows us to both exploit the climate network structure and incorporate prior knowledge from the data. Applying tangles enables us to create a hierarchical tree representation of communities including the likelihood that spatial locations belong to a community. Each tree layer can be associated to an underlying cut, thus making the division of different communities transparent.
Applied to global precipitation data, we show that tangles is a promising tool to quantify community structures and to reveal underlying geophysical processes leading to these structures.

[1] S. Klepper, C. Elbracht, D. Fioravanti, J. Kneip, L. Rendsburg, M. Teegen, and U. von Luxburg. Clustering with Tangles: Algorithmic Framework and Theoretical Guarantees. CoRR, abs/2006.14444v2, 2021. URL https://arxiv.org/abs/2006.14444v2.