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Investigating earthquake clustering using probabilistic networks

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Studying spatiotemporal patterns of earthquake clustering can help us understand local and large-scale patterns of seismicity, yet there are few robust methods for identifying clustering. Recent methods of cluster identification depend on some measure of proximity of events and have become widely popular due to their ease of application, but often neglect uncertainty.

Zaliapin and Ben-Zion (2013) developed a popular method to identify nearest-neighbour pairs of events in a space-time-magnitude sense and identified background and clustered components of the combined distribution of nearest neighbour distances, separating these with a binary threshold. We believe that a probabilistic framework is more appropriate and have developed an MCMC method in the spirit of other probabilistic seismic methods, such as probabilistic declustering.

Our method provides a full uncertainty quantification to the classification process and we make use of these uncertainties to create probabilistic earthquake networks describing the spatiotemporal structure of the sequences. These can be used to explore differences in cluster structure, discriminate between mainshock-aftershock and swarm type clustering and inform future hazard estimates.