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Graphical models for automatic seismic signal classification

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We present a novel method for automatic seismic event classification, focusing on earthquake signals recorded at single stations at local and regional distances. The approach can classify a broad range of seismic patterns by modeling the interrelationships between essential characteristics of seismograms in a graphical model. The graphical models formalism is an intuitively attractive and very flexible statistical framework, in which several statistical inference and learning mechanism have been developed.

The essential characteristics of a seismogram are derived from a time-frequency decomposition such as a DWT (Discrete Wavelet Transform). These *features* obey certain Markov properties, making it feasible to form a joint distribution on the features expressed in terms of a dynamic Bayesian network, a special kind of graphical model. Similar to hidden Markov models, dynamic Bayesian networks account for the dynamic time aspect, but dynamic Bayesian networks additionally enjoy the expressive power of (static) Bayesian networks. In terms of a dynamic Bayesian network the time-frequency decomposition in conjunction with the Markov properties of the features leads to a representation of the frequency (in)dependences as intra-frame links, and to a representation of the time (in)dependences as inter-frame links.

In a first test phase, we apply this generic method to continuous waveform data at single stations within the European Broadband Network. The continuous classification output at those stations is evaluated for a selected set of seismic events recorded in the years between 2003 and 2005.