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-Linear Kernel Methods for Seismic Event Characterization

Characterization of seismic events is an important component of the CTBT verification regime. Non-linear machine learning techniques are capable of compactly modeling complex datasets by using a local similarity metric. This process results in a low-dimensional representation of the dataset, in which each data item is characterized by a small number of intrinsic parameters. In this work, we apply a machine learning technique called diffusion maps for automatic earthquake-explosion discrimination and explosion classification. Diffusion maps construct a geometric representation of the seismograms that capture the intrinsic structure of the signal at each channel. As a pre-processing step, the seismograms are converted to normalized sonograms. In the obtained low-dimensional representation, seismic events with similar source mechanism from the same region have a similar representation. In addition, the single channel based classification method is extended to a multi-station one by introducing a kernel multiplication technique. This method extends the standard diffusion maps framework by providing a solution to handle multi-views and multi-source inputs. Our approach is demonstrated on several seismic data sets that are embedded and can also be visualized in a low-dimensional space. High accuracy discrimination results are achieved by using simple classification analysis methods in the low-dimensional space.

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