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## An application of automatic event detection based on neural network at St Gallen (Switzerland) deep geothermal field

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In seismology, when dealing with low signal-to-noise recordings, traditional event detection methods are often unable to recognise all the weak events hidden within the seismic noise. We are interested in investigating how machine learning techniques can be a useful tool to improve automatic event detection by recognising the similarity between events. We are interested in studying areas where anthropogenic activity, related to the exploitation of subsoil resources, can generate induced seismicity. Therefore, it is essential to increase the detection of weak events to improve knowledge about the seismicity of the area and its related consequences.

The SOM (Self-Organizing Map) is an unsupervised machine learning approach that is widely used for clustering, visualization and data-exploration tasks in various applications. The SOM carries out a nonlinear mapping of data onto a two-dimensional map, preserving the most important topological and metric relationships of the data. One of the reasons for using SOM for clustering indeed is to benefit from its topological structure when interpreting the data clusters.

In the preprocessing stage, features extraction is done by using both the linear prediction coding (LPC) technique for coding the spectrograms, and a waveform parameterization for characterizing amplitude characteristics in the time domain, for each of the three components.

The SOM was trained on dataset, recorded at the St Gallen geothermal site, composed of 388 records of seismic noise and 347 earthquakes with magnitude ( $ML^{corr}$ ) between -1.2 and 3.5 collected by the Swiss Seismological Service in 2013 while realizing well control measures after drilling and acidizing the GT-1 well.

We obtained promising first results as SOM strategy correctly discriminates all known earthquakes events, clustering them into different nodes, distant from the group of nodes where noise falls. We also jointly tested synthetic traces in which we have hidden events traces within seismic noise or noise artificially generated. We studied the signals of each cluster individually, assessing the similarities of the waveform and spectral characteristics for the three components. In addition, the results are also evaluated in terms of events location, hypocentral distance, magnitude, and origin time.

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