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Seismic signals identification following a non strict hypothesis testing scenario; Implementation on synthetic and real data.

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The problem of seismic events extraction from the raw data constitutes one of the most important and vital tasks addressed in geosciences, since its solution plays a crucial role in events location, focal mechanism determination, early warning to name a few. Moreover, small-magnitude seismic events, either natural or induced microearthquakes, have increasingly been used in exploration seismology with applications ranging from hydrocarbon and geothermal reservoir exploration to high-resolution passive seismic tomography surveys.

The large number of small-magnitude events recorded, as well as the increasing number of instruments used, makes the process of manual detection, selection and picking of seismic events a tedious, costly and time consuming task. Most of the techniques that are applied up to now for seismic event detection, are mainly based on energy criteria (STA/LTA detectors), due to their simplicity and the low computational cost they require. Nevertheless, usually there is a large number of parameters that have to be set in order to work properly and in some cases, their efficiency is dramatically reduced in noisy environments.

In this work, we apply a thresholding type technique, tailored to fit real world situations where our knowledge on the statistical characteristics of the background noise process are unknown and a strict hypothesis testing framework cannot be followed. In such cases the replacement of the unknown probability density function under the null hypothesis by its empirical counterpart, constitutes a possibility. The detection algorithm is implemented in two stages: In the first stage by following sampling, autoregressive modeling and clustering procedures, segments from the initial seismic recording containing only noise samples, are isolated. Therefore, from these noise "blocks", an empirical probability distribution function (pdf) of the background noise process is estimated.

In the second stage, using the resulted empirical function, a thresholding scheme is applied in order to solve the problem of the identification of seismic events in a non strict hypothesis testing framework. It has to be stressed that by following the above mentioned approach, since the empirical pdf has been estimated, any of the well known statistics that measures the discrepancy between two density functions can be used eg. Pearson's Chi-Squared goodness-of-fit statistic, Kullback–Leibler divergence, Kolmogorov–Smirnov test etc.

The performance of the proposed technique is confirmed by its application in a series of experiments both in synthetic and real seismic data sets, and several issues concerning different thresholding scenarios as well as the efficiency of the above mentioned methodology are discussed.