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Unsupervised classification of 30 years of near-fault seismological data: What can we learn about fault physics?

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The exponential growth of geophysical (seismological in particular) data we faced in the last years, made it hard to quantitatively label (e.g. systematical separation of earthquakes and noise) the daily and continuous stream of records. On the other hand, these data are likely to contain an enormous amount of information about the physical processes occurring inside our planet, including new and original signals that can shed light on new physics of the crustal rocks.

Of particular interest are data recorded near major faults,where one hope to detect and discover new signals possibly associated with precursory phase of significant and hazardous earthquakes.

With the above ideas in mind, we perform an unsupervised classification of 30 years of seismological data recorded at ~10km from the L'Aquila fault (in Italy), which hosted a magnitude 6 event (in 2009) and still poses a significant hazard for the region.

We based our classification on daily spectra of three component data and relative spectral features. We then utilize self-organizing map (SOM) to perform a crude clustering of the 30 years of data. The data reduction offered by SOM permits a rapid visualization of this large datasets (~11k spectra) and individuation of main spectral groups. In a further step, we test different clustering algorithms (including hierarchical ones) to isolate groups of records sharing similar features, in a non-subjective manner. We believe that from the quantitative analysis (e.g. temporal evolution) of the retrieved clusters, the signature of fault physical processes (e.g. preparation of the magnitude 6 earthquake, in our case) can be retrieved. The newly detected signals will then be analyzed to learn more about the causative processes, generating them.