

# **Title: Earthquake Clustering with Cellular Automata and Machine Learning**

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## **Research program**

In recent years, the improved instrument sensitivity and the growing number of seismic stations in tectonically active regions have allowed to locate and characterize an increasing number of earthquakes with high precision and of very low magnitude. As a consequence, seismic catalogs are becoming increasingly larger.

Although large data sets potentially provide more accurate insights into local, regional, and global geological processes, extracting relevant information becomes challenging.

For exploratory analyses, clustering techniques can be very helpful to discover if a data set can be represented by groups of similar objects (natural clustering) and to identify their number, shape, and size. Many clustering algorithms have now been developed, but their application to earthquake catalogs, and in particular to the analysis of the spatiotemporal evolution of densely faulted/fractured regions, is still a poorly investigated field of research.

## **Proposal for a PhD position**

The Department of Earth, Environmental, and Resources Sciences at the University of Naples, Federico II invites applications for one PhD position in Earth Sciences. The PhD research project is aimed at developing and applying cellular automata and machine learning algorithms to characterize seismic sequences by studying synthetic and natural fracture networks. The development of cellular automata models will allow generating synthetic fracture networks, whose spatiotemporal evolution will be investigated under different stress conditions to eventually reproduce statistical features of earthquake distributions. An extensive study of unsupervised machine learning algorithms applied to natural seismic sequences that occurred in different geological settings (e.g., Central Italy, California, Taiwan) will allow to highlight advantages and disadvantages of each analyzed clustering algorithm. To place further constraints on the geometry and spatiotemporal evolution of seismicity and (active) fractures, the analyses will make use of the most up-to-date, literature knowledge about the 3D structure of fault surfaces, which may have significant implications for the seismic hazard assessment.

The project will involve the development and/or usage of numerical codes to model and analyze earthquake data. The candidate's expenses related to the PhD project will be covered by H2020 RISE funds. The candidate is expected to have a solid background in geophysics and statistics. Basic concepts of programming languages and basic knowledge of MATLAB and/or Python is highly desirable.