A machine learning approach for strong aftershock forecasting by the NESTORE algorithm. Comparison of California, Italy and Greece results

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It is well known that large earthquakes are often followed by aftershocks that can affect numerous structures in cities and exacerbate the damage caused by the initial quake. In particular, the ground motion produced by strong aftershocks can cause further building collapses and fatalities. To forecast the occurrence of these subsequent large earthquakes (SLEs), we proposed a pattern recognition approach based on seismological features. The method, called NESTORE, has been successfully applied in northeastern Italy and western Slovenia (Gentili and Di Giovambattista, 2020), in all of Italy (Gentili and Di Giovambattista, 2017), in California (Gentili and Di Giovambattista, 2022), and in Greece (Gentili et al., 2023). The NESTORE algorithm has recently been optimized and made available in the form of a software called NESTOREv1.0. This software (Gentili et al., 2023), written in MATLAB, uses a machine learning approach to produce a probabilistic forecast of clusters in which a strong mainshock is followed by at least one subsequent earthquake of comparable magnitude. In particular, the algorithm distinguishes between clusters in which the magnitude difference between the mainshock and the strongest aftershock is less than or equal to 1 (type A), and other cases (type B). NESTOREv1.0 is trained to distinguish between the two classes using cluster seismicity parameters (features) in a training dataset. Specifically, NESTOREv1.0 trains one-node decision trees on individual features at increasing time intervals, selects the best classifiers, and merges the resulting classifications using a Bayesian method. It is then able to produce type A cluster forecasting for both retrospective analyzes on a test database and for ongoing clusters. Supervised training allows NESTOREv1.0 to adapt to the region under study. On the other hand, the classification structure based on single-layer decision trees allows the definition and comparison of thresholds identified in different regions to infer the characteristics of their seismicity. In this work, we compare the results obtained in Greece, Italy and California. In particular, both the performances on an independent test set and the characteristics of seismicity found by using all available data are shown.

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