Short-term forecast by foreshock discrimination models using magnitude frequency and spatio-temporal features of seismic clusters

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Foreshock activity is a powerful key for short-time prediction of large main shocks. Though many large earthquakes are preceded by their foreshocks, it is very difficult to declare foreshock clusters before occurrence of their main shocks and only probabilistic identification may be available.

Logistic regression is a statistical learning method appropriate to such binary classification problems where a-posteriori probability of class membership given observed features is required. Statistical learning methods can keep learning discreminating features from updating catalog and give probabilistic recognition of forecast in real time. There are some characteristic features of foreshock clusters reported by previous studies, such as law b-values and power-law increase in seismicity. Our approach uses these features to discriminate foreshocks from other seismic clusters by a non-linear logistic regression model. Seismic clusters are constructed from JMA hypocenter catalog by using the single-link clustering method and their magnitude frequencies and spatio-temporal features are extracted for foreshock discrimination. Deviding the catalog into two periods, the model parameters are learned from the earlier period and predictive performance of the learned model is evaluated in the latter period. In addition, probabilities that main shocks larger than certain magnitudes occur are also evaluated by fitting extreme value distribution to the main-shock magnitudes. For the foreshock sequence of the 2016 Kumamoto earthquake of M7.3, the learned model gives relatively high probability forecast.

Keywords: foreshock, short-term forecast, logistic regression, extreme value distribution

