Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS01-01 Room:102B Time:May 24 14:15-14:30

Real-time Classifier of Foreshocks Using Probability Density Ratio Estimation

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Foreshock discremination is one of the most effective ways for short-time forecast of large earthquakes. Though many large earthquakes accompany their foreshocks, discreminating them from enormous small earthquakes is difficult and only probabilistic judgement may be available. Probability density ratio estimation is the statistical learning method best suited to such binary pattern recognition problems where estimates of a-posteriori probability of class membership are required. Statistical learning methods can keep learning discreminating features from updating catalog and give probabilistic recognition of forecast in real time. By using kernel functions, we can composite non-linear distribution of foreshock frequency by smooth kernel function and evaluate the possibility of foreshocks by the logit function. In this research, we classify forecasts from earthquake catalog by the Japan Meteorological Agency by some clustering methods and learn spatial and temporal features of foreshocks by the probability density ratio estimation. We use the hypocentral locations, relative locations from their mainshocks and difference in magnitudes for learning and forecasting. We discuss the spatial pattern of foreshocks from the classifier composed by our model. We also implement a back test to validate predictive performance of the model by this catalog.

Keywords: foreshock, probabilistic recognition, probability density ratio estimation, kernel method