Prediction of Aftershocks With Gaussian Process Regression: Application to the 2004 Chuetsu Earthquake

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The main shock of a large earthquake often makes it difficult to identify a number of subsequent aftershocks. Knowing the distribution of magnitudes and arrival times of the aftershocks is essential to figure out the characteristics of the sequence of earthquakes, which enables us to predict the frequency of earthquakes depending on space and time. Such the distribution of aftershocks should be estimated within a couple of days eventually since most of the large aftershocks occur within one day from the main shock. However, an exact count of all aftershocks right after a main shock is very hard due to large signal-to-noise ratio, so that an estimated distribution of the aftershocks is usually biased.

To overcome the difficulty, we incorporate a detection function into the likelihood, and apply the gaussian process regression, which is a Bayesian and nonparametric method, to the detection function. The gaussian process regression has been drawing an attention due to the largeness of the functional class that can represent, in fact, it has recently been known that it has some relations with deep learning. With the use of gaussian process regression, not only the parameter of the distribution of the aftershocks and the detection function, but the credible interval of the parameters and the detection function can be also obtained. We have also proposed a Bayesian computational algorithm to compute the hyperparameters. Our proposed method is applied to the 2004 Chuetsu earthquake.

Keywords: Bayesian method, detection-rate function, gaussian process regression

