Prediction of ground-motion index using a deep neural network

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Kubo et al. (2017, SSJ) constructed a predictor of ground-motion index using a random forest method. In this study, we attempt to use a deep neural network to construct a predictor of ground-motion index utilizing “big” ground-motion data of K-NET and KiK-net of NIED.

For training data, we collect approximately 290,000 data of strong-motion indexes at K-NET and KiK-net stations for approximately 2200 events. The events satisfy the following conditions: (1) they occurred from 1998 to 2015, (2) their magnitudes range from 4.5 to 7.5, and (3) their depth is shallower than 200 km. For test data, we prepare approximately 30,000 data for 200 events that occurred in 2016. For source data, we refer to the moment tensor catalogue of F-net of NIED

The target variable in this study is seismic intensity. To predict the target variable, we prepare the following predictor variables: the epicentral distance, the moment magnitude, the source location (latitude, longitude, and depth), the station location (latitude and longitude), the engineering geomorphological classification code and the average S-wave velocity in upper 30m of ground (Vs30) included in site amplification factors of J-SHIS (Matsuoka and Wakamatsu 2008; Wakamatsu and Matsuoka 2013), and the top depth to each sediment layer in the deep subsurface structure model of J-SHIS (Fujiwara et al. 2009; Fujiwara et al. 2012).

Using the open-source software libraries for neural networks, TensorFlow and Keras, we construct a regression model of a neural network that consists of one input layer, more than four hidden layers, and one output layer. The evaluation functions of hidden and output layers are assumed to Hyperbolic Tangent and linear functions, respectively.

The preliminary results show that the prediction from the obtained predictor roughly follows the observed data, and that the use of the source and station location information leads to a few improvements of prediction accuracy.

Keywords: Ground-motion index, Deep neural network

