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Estimation of site effect proxies from K-NET and KiK-net data using recurrent neural networks

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This study utilizes artificial neural networks to propose a novel method of evaluating site effects and seeks two main purposes. First, to construct an RNN model and enable it to extract information on site effects directly from coda wave timeseries. Second, to evaluate the similarity between coda waves and microtremor waves regarding the reflection of site effects in each of the two timeseries. Therefore, a parametric investigation is conducted to find suitable coda wave extraction parameters on one hand, and near optimal model parameters on the other hand.

A Long Short-Term Memory (LSTM) recurrent neural network is designed using Tensorflow 2 library in python language. A dataset consisting of about 150000 3-component strong motion records at 958 stations from Kyoshin Network (K-NET) in Japan is obtained. The prediction input in the training phase is coda wave timeseries of strong motion records and all 3 seismograph components EW, NS and UD are used as parallel features. Each sample input consists of 3 timeseries with 100 timestamps at a 20Hz sampling rate. The prediction target is defined as a vector of 3 site effect proxies namely, average shear-wave velocities for the upper 30-m depth (*vs30*) and the upper 10-m depth (*vs10*) and fundamental frequency (f_0). Assuming equipartition regime prevails, in the application phase, the coda timeseries of strong motion records are replaced by observed microtremor timeseries. Different parameter combinations are tested, and the best combination is selected based on the Mean Squared Error (MSE) and Standard Deviation (SD) of prediction errors for coda test dataset and microtremor dataset.

Overall, the method is successful at predicting site effect proxies from the coda test set. However, the prediction accuracy is poor when microtremor timeseries are used as input. This means the correlation between the selected coda waves and their microtremor counterparts are not straight forward and additional adjustments are required in order to achieve desirable interchangeability of coda and microtremor. That means ensuring the coda time windows are minimally affected by the S-wave, for example by extracting coda waves from strong motion records which have smaller Peak Ground Accelerations (PGA).

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