

Deep Learning Estimating of Epicentral Distance for Earthquake Early Warning Systems

*Shunta NODA¹

1. Railway Technical Research Institute

To enhance the performance of earthquake early warning (EEW) systems that aim to issue alerts as quickly as possible, it is crucial to improve the accuracy of the epicentral distance Δ estimated via the single-station method. While the conventional method estimates Δ from the slope of the initial P-wave envelope, this study applies deep-learning techniques that can extract a variety of information from the waveform data. By analyzing approximately 20,000 records observed at Kyoshin Network (K-NET) stations in Japan, the convolutional neural network (CNN) method achieved higher accuracy than the conventional method. Increasing the data length or the number of iterations of convolution, activation and pooling layers in the typical CNN model did not significantly improve the accuracy of Δ estimation. An automatic structure search (AutoSS) technique, in which model structure and hyperparameters are randomly varied, was employed to identify models that yield higher accuracy. A typical CNN model was used as the initial structure. The models obtained through this technique showed improved accuracy with increased data length or computational cost. The models that exhibited the highest accuracy among those generated using the AutoSS technique outperformed the typical CNN model in terms of accuracy, although their computational costs were comparable. The AutoSS technique offers a significant advantage in that it allows the selection of a model that matches the computational capabilities of the hardware used for its implementation, thereby ensuring optimal computational efficiency. This demonstrates that deep-learning technologies can be used to improve the performance of EEW systems.