Automatic Phase Picking of Seismograms by Deep Neural Network

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The identification of arrival times of P and S waves is often the first step of seismic data analyses. Cross-correlation-based methods, such as the matched filter method, are often used for identifying events and measuring relative arrival times. Those methods require template events and otherwise significant computational cost for taking cross-correlation of much seismic data. Especially in the case of campaign observations, the preparation of template events requires manual picking of many events, which is tough process.

I built an automatic phase picking system by a deep neural network with an inception module. I use seismograms from Hi-net for earthquakes in the northern Ibaraki prefecture and the Fukushima Hamadori areas, where the seismicity rate is high since the 2011 Tohoku-oki earthquake. The P and S arrivals are the manually picked ones in the JMA Unified Earthquake Catalog. I introduce the picking data as one-hot vectors.

The trained neural network gives P arrivals within 0.02 s from the JMA data for more than 70 % of seismograms. We empirically relate the output to the probability, which will give the accuracy of the arrival times given by the neural network.