Detection of multiple earthquakes by using theoretical seismograms as training dataset of machine learning

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Earthquake Early Warning (EEW) is now routinely used for hazard mitigation purpose in various countries. One of the causes which results false alarm of EEW is earthquakes which happen concurrently in different location. On January 5th, 2018, two earthquakes with magnitude around 5, which separate about 400 km, happened concurrently in Japan and false EEW was issued by JMA. Here we combine numerically computed theoretical seismograms and deep machine learning to properly identify multiple earthquakes to avoid false alarm. We calculate theoretical seismograms for realistic three-dimensional Earth model and use these seismograms to create snapshots of seismic wave propagation images at the surface of the Earth. Then we use these snapshots as training dataset of convolutional neural network. We build neural networks to identify multiple earthquakes and found that this networks may identify multiple earthquakes with 99% accuracy. Advantage of using this approach to identify multiple earthquakes is that we may include any earthquakes in our training dataset and accuracy of hypocenter parameters can be increased by accumulating theoretical seismograms for various earthquake location and size as learning dataset of deep machine learning. We also apply this technique for determination of hypocentral parameters, such as epicenter, depth, origin time and magnitude. We have applied these networks to actual seismograms to show that this procedure works successfully to locate earthquake and determine magnitude.

Keywords: earthquake location, machine learning, synthetic seismograms

