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Deep Learning Phase Picking of Large-N experiments

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The popularisation of the use of large-N arrays of seismometers has resulted in a significant increase of the size of the datasets recorded during these experiments. Therefore, new challenges have arisen on how to process all these data efficiently, and in an automated fashion. This is particularly true in the case of induced seismicity monitoring, where often a large number of number of events are recorded at high frequency sampling rates.

Several methods of automatic picking have been developed during recent years, from triggering algorithms (e.g. STA/LTA) to higher order statistics or waveform similarity. Latest development in computational power and the popularization of GPUs have made possible to apply machine learning methods to several problems, from arrival picking and phase detection to earthquake location.

We have developed a deep neural network to detect the arrivals of seismic body waves, using an architecture based on convolutional layers. This type of models are widely used in computer vision applications, which is the most similar case to the phase picking by an operator. Trained with the data of the Southern California Seismic Network, this network is able to differentiate P and S waves from background noise with a precision higher than 98%.

We have applied this neural network to other large-N experiments in other regions (Europe and Asia) and found that the network localizes the events with a precision comparable or superior to an human operator, even in the case of low signal-noise ratio and superposition of earthquakes. (This research has been funded by MICINN Project CGL2017-88864-R)