Machine learning model generates realistic seismic waveforms

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LOS ALAMOS, N.M., April 22, 2021—A new machine-learning model that generates realistic seismic waveforms will reduce manual labor and improve earthquake detection, according to a study published recently in *JGR Solid Earth*.

“To verify the e#cacy of our generative model, we applied it to seismic #eld data collected in Oklahoma,” said Youzuo Lin, a computational scientist in Los Alamos National Laboratory’s Geophysics group and principal investigator of the project. “Through a sequence of qualitative and quantitative tests and benchmarks, we saw that our model can generate high-quality synthetic waveforms and improve machine learning-based earthquake detection algorithms.”

Quickly and accurately detecting earthquakes can be a challenging task. Visual detection done by people has long been considered the gold standard, but requires intensive manual labor that scales poorly to large data sets. In recent years, automatic detection methods based on machine learning have improved the accuracy and efficiency of data collection; however, the accuracy of those methods relies on access to a large amount of high#quality, labeled training data, often tens of thousands of records or more.

To resolve this data dilemma, the research team developed SeismoGen based on a generative adversarial network (GAN), which is a type of deep generative model that can generate high#quality synthetic samples in multiple domains. In other words, deep generative models train machines to do things and create new data that could pass as real.

Once trained, the SeismoGen model is capable of producing realistic seismic waveforms of multiple labels. When applied to real Earth seismic datasets in Oklahoma, the team saw that data augmentation from SeismoGen#generated synthetic waveforms could be used to improve earthquake detection algorithms in instances when only small amounts of labeled training data are available.

Paper: SeismoGen: Seismic Waveform Synthesis Using GAN with Application to Seismic Data Augmentation, Tiantong Wang, Daniel Trugman, and Youzuo Lin. Published in JGR Solid Earth. April, Volume 126, Issue 4, e2020JB020077, 2021. DOI: 10.1029/2020JB020077

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