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Deep learning denoising applied to regional distance seismic data in Utah

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Seismic waveform data are generally contaminated by noise from various sources. To date, the most common noise suppression methods have been based on frequency filtering. These methods, however, are less effective when the signal of interest and noise share similar frequency bands. We implemented a seismic denoising method that uses a trained deep convolutional neural network (CNN) model. In our approach, the CNN provides a signal mask and a noise mask for an input signal. The Short-Time Fourier Transform (STFT) of the estimated signal is obtained by multiplying the signal mask with the STFT of the input signal. To build and test the denoiser, we used compiled signal and noise datasets of seismograms recorded by the University of Utah Seismograph Stations network (United States). Results of test runs involving more than 9,000 constructed waveforms suggest that on average the denoiser improves the SNRs by ~5 dB and that most of the recovered waveforms have high similarity with respect to the target waveforms and suffer little distortion. Application to real data suggests that our denoiser achieves on average a factor of up to ~2-5 improvement in SNR over bandpass filtering and can suppress many types of noise that bandpass filtering cannot.

Promotional text

This study aligns with the SnT2021 goal of identifying methods for improving nuclear test monitoring and verification. In fact, the implemented deep learning denoiser could provide a valuable addition to the existing data processing pipelines.

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