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Towards a Seismology Foundation Model

We introduce a SeismoGPT, a foundation model for seismology that leverages transformer-based architectures to model seismic waveforms. Inspired by natural language processing techniques. This approach tokenizes continuous seismograms by dividing them into fixed-length patches, where each patch represents a sequence of waveform samples. These patches serve as input tokens to the transformer model, enabling the application of self-attention mechanisms to learn temporal dependencies in seismic data. The model is trained in an autoregressive manner, predicting the next patch given previous ones, making it well-suited for forecasting seismic signals.

The architecture of SeismoGPT consists of a convolutional embedding that encodes raw seismic patches into a higher-dimensional representation, followed by positional embeddings to retain temporal order. A causal transformer processes these embeddings, utilizing self-attention to capture long-range dependencies in the seismic sequence. The final prediction head generates the next patch, allowing the model to reconstruct or extend seismic waveforms iteratively. This approach enables the efficient modeling of complex seismic patterns, offering potential applications in earthquake prediction, early warning systems, and seismic noise mitigation, which is particularly relevant for third-generation gravitational wave detectors such as the Einstein Telescope (ET). Accurately predicting seismic waveforms can help in reducing the impact of seismic noise on the detector's mirrors, thereby enhancing sensitivity to gravitational waves from sources such as supermassive black hole binaries.

AI keywords

Seismology, Gravitational Waves, Transformers, Einstein Telescope, Time series Forecasting

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Track Classification: Foundation Models