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Emulation of seismic-phase travel times using the Deep Learning Travel Time (DeLTTa) method

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Deep Learning Travel Time (DeLTTa) is a deep-learning method and computer code for emulating seismic-phase travel times that are based on a 3-dimensional (3D) Earth model. Greater accuracy of travel time predictions using a 3D Earth model are known to reduce the bias of event location estimates and improve the process of associating detections to events. However, practical use of 3D models is challenged by slow computational speed and the unwieldiness of pre-computed lookup tables. DeLTTa trains a deep-learning network using pre-computed travel times, resulting in a compact and computationally fast way to approximate travel times based on a 3D Earth model. DeLTTa is trained using approximately 850 million P-wave travel times based on the LLNL-G3D-JPS model from randomly sampled event locations to 10,393 global seismic stations. After training, the machine-learning computer code is approximately 10 Mbytes in size and travel times are computed in approximately ten micro-seconds on a single CPU. Currently achieved prediction accuracy is approximately ½ second at the 2-sigma level, which is similar to the inherent accuracy of the 3-D model. With additional development, DeLTTa will enable easy use of 3-D models in routine seismological processing and analysis.

Promotional text

3D Earth models can improve seismic travel-time prediction accuracy, which leads directly to more accurate event locations. Machine learning efficiently emulates travel-time calculations, opening the possibility of using state-of-the-art Earth models in the operational system.

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