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Abstract

Velocity field is an essential parameter in seismic imaging process. It is derived from the recorded seismic traveltime in velocity model building method such as normal moveout (NMO) velocity analysis, traveltime tomography and full waveform inversion (FWI). However, these conventional velocity model building methods are very time consuming and highly require human interaction. Recently, researchers are progressively giving effort and interest in the usage of artificial intelligence (AI) technology in velocity model building. It is an alternative to cope the time consumption and human interaction problems by the conventional methods. This study aims to use fully convolutional neural network deep learning in predicting velocity model on synthetic data (seismic shot records) that have complex subsurface structure.

The reliability of seismic traveltime calculation methods by ray tracing and finite difference are analyzed first. Since finite difference yield better traveltime calculation coverage, it then employed in the seismic forward modeling process, generating synthetic shot records with a good resolution. The training part of deep learning is done by feeding the network with huge amount of a pair of shot record (input) and its corresponding velocity model (label). In testing, different shot record (input) is given, and the network try to predict the velocity model (label).

Our findings shows that deep learning is relatively less time consuming with minimal human interaction, compared to NMO velocity analysis. In calculating travel time upon the complex geological structure (Bell Model), gridding scheme of finite difference method covers more area at all source location, unlike ray tracing, where its maximum coverage limited to near offset source location only. Finite difference also manages to outcome the disadvantage of ray tracing in solving the shadow zone area.

As an alternative to the conventional NMO velocity analysis, deep learning shows an excellent velocity model prediction outcome of the complex geological structure. Velocity model can be generated way faster than NMO velocity analysis once the deep learning network is well-trained.