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Accelerating Full Waveform Inversion By Transfer Learning

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Full waveform inversion (FWI) is a powerful tool to reconstruct the material distribution with damage such as a void or a crack based on sparsely measured wave propagation data. FWI can be utilized in health monitoring of infrastructure to determine the location and severity of the damage. However, the reconstruction of damage from sensor data is an ill-posed and computationally expensive problem. A computationally cheaper alternative is to use the framework of Neural Networks (NN) trained by supervised learning. The training of the NN is performed on sparsely measured wave propagation data measured in domains with known defects. However, such a purely supervised approach can lead to wrong predictions for signals outside the training data set. Alternatively, NNs may be combined with classical FWI. Therein, NNs are used as the discretization of the material field, utilizing the adjoint formulation inherent to FWI. This combination of NN with FWI yields reliable predictions, whose results are improved wr.t. classical FWI in terms of quality. To further improve NN-based FWI, we propose to combine Transfer Learning and FWI . The proposed technique utilizes supervised pretraining to provide a better NN weight initialization leading to faster convergence of FWI. The network is pretrained to predict the unknown material field using the gradient information from the first iteration of the conventional FWI. We demonstrate that the use of gradient information in transfer-learning based FWI provides reliable predictions also for data outside the training set and reduces the number of iterations required for convergence [3]. Even in case where the initial guess is not accurate, transfer learning FWI can still recover the damaged shape although requiring more epochs.

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