Physics-guided Learning-driven Computational Seismic Imaging: from Synthetic Practice to Field Applications

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LECTURE ABSTRACT

Computational seismic imaging is crucial for energy exploration, civil infrastructure, groundwater contamination and remediation, and so on. However, nearly all the earth's interior is inaccessible to direct observation. Inference of unknown subsurface properties, therefore, relies on indirect and limited geophysical measurements taken at or near the surface. The relevant data analysis capability for solving computational seismic imaging problems is inadequate, mainly due to the ill-posed nature of the problems and the high computational costs of solving them. Recently, machine learning (ML) based computational methods have been pursued in the context of scientific computational imaging problems. Some success has been attained when an abundance of simulations and labels are available. Nevertheless, ML models, trained using physical simulations, usually suffer from weak generalizability when applied in a moderately different real-world dataset. Moreover, obtaining corresponding training labels is typically prohibitively expensive due to the high demand for subject-matter expertise. On the other hand, different from imaging problems from a typical computer vision context, many scientific imaging problems are governed by underlying physical equations. For example, the wave equation, describing how a wave signal is propagated through a subsurface medium over time, is the governing physics for seismic imaging problems. To fully unleash the power and flexibility of ML for solving large-scale computational seismic imaging problems, we have developed new computational methods to bridge the technical gap by addressing the critical issues of generalizability and data scarcity. In this talk, I will go through the details of our recent R&D effort in leveraging both the power of machine learning and underlying physics. A series of numerical experiments are conducted using datasets from synthetic simulations to field applications to evaluate the effectiveness of our imaging methods.

SPEAKER BIOSKETCH

Dr. Youzuo Lin is a staff scientist and team leader in the Geophysics Group at Los Alamos National Laboratory. His research interests lie in computation and scientific machine learning methods and their applications in various geoscience problems. Youzuo received his Ph.D. in Applied and Computational Mathematics from Arizona State University in 2010. After completing his Ph.D., he was a postdoctoral fellow in the Geophysics Group at Los Alamos National Laboratory from 2010 to 2014, and then converted as a staff scientist.