For favour of Posting

THE HONG KONG UNIVERSITY OF SCIENCE & TECHNOLOGY

Department of Mathematics

SEMINAR ON APPLIED MATHEMATICS

Two numeric methods for wavefield reconstruction towards efficient and memory-frugal seismic imaging

By

Dr. Pengliang YANG

Harbin Institute of Technology

Abstract

Reverse time migration (RTM) and full waveform inversion (FWI) are the state-of-the-art seismic imaging techniques routinely used for geophysical exploration. The computation of RTM imaging condition and FWI gradient requires simultaneously accessing the incident source field and adjoint receiver field at all time steps. This is a mathematically simple operation, but is extremely challenging for computer implementation in 3D large-scale applications due to the opposite direction of adjoint simulation compared to forward modelling. Storing 3D wavefield volumes for tens of thousands of time steps in memory or disk is impractical due to prohibitively large memory bandwidth and slow IO traffic.

We propose two numeric methods to improve the computational efficiency while reducing the memory overhead for time-domain RTM and FWI. The first method reconstructs the incident source field backwards in time by interpolating the decimated boundaries stored during forward modelling. The key idea is to view the wavefield evolution at each gridpoint as a continuous time series, so that its reconstruction is governed by Nyquist theorem rather than CFL stability condition. It reduces the memory consumption of wavefield reconstruction down to 20-50 times smaller.

The first method is optimal in non-dissipative medium, but breaks down in viscous medium. In the presence of seismic attenuation, a checkpointing-assisted reverse-forward simulation (CARFS) algorithm has been designed as the 2nd recipe to gain even better computational efficiency than optimal checkpointing strategy, thanks to the control of the instability using boundary value reconstruction. The above methods are applicable to acoustic and general anisotropic elastic medium. Numerical examples are presented to demonstrate the practical applications of these methods for 3D industrial-scale problems.

Bio: *Dr. Pengliang Yang holds an associate professor position in Harbin Institute of Technology since December, 2020. He obtained his PhD from Xi'an Jiaotong University majoring in EE. During his PhD, he did one year visiting research at The University of Texas at Austin, US. Between 2015 and 2018, he did his postdoctoral research on 3D viscoelastic full waveform inversion in anisotropic complex medium in University Grenoble, France (in the frame of SEISCOPE consortium). After that, he gained two years of industrial experience as a Scientist on controlled-source electromagnetics (CSEM) in Electromagnetic Geo-services ASA, Norway. His main research interests focus on seismic and electromagnetic modelling and inversion, with practical applications in oil and gas industry.*

Date : 12 November 2024 (Tuesday)

Time : 10:30a.m. – 11:30a.m.

Venue : Room 4502 (near Lift 25/26)

All are Welcome!