SEMINAR: Unraveling waveform inversion with an eye on the near surface

by Tariq Alkhalifah

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URL: https://sites.google.com/a/kaust.edu.sa/tariq/home

Abstract

Fully simulating our seismic experiment with all its acquisition variables, medium properties and the physical behavior of waves to reproduce the observed seismic data is an ultimate objective we all seek to achieve. Not with standing the computational limitations and the physical approximations, inverting for the medium properties (i.e. seismic velocities) is at the heart of seismic inversion. Thus, full seismic waveform inversion (FWI) is fast becoming the premiere research focus in Geophysics, with many academic and industry labs devoting a lot of resources to the problem. Many of the current tools used to perform FWI were known since the 1980's, but only recently did our computational capability allow us to implement FWI with higher resolution and speed, albeit we are still focused on 2D acoustic media. Despite the recent advances, the remaining challenges are three fold: 1) The highly nonlinear nature of the objective (data misfit) function due to the sinusoidal nature of the wavefield and the complex Earth reflectivity, which renders gradient methods useless in some cases as we get trapped in local minima, or requiring a very accurate initial velocity model, 2) The acoustic, isotropic and 2D simplification of the medium, which unlike imaging, can cause tremendous problems to FWI, taking into account that the alternative can induce tremendous Null space into the problem, 3) Finally, the high computation cost of FWI as each iteration is equivalent to 3-5 imaging steps, and the iterations to go up to the hundreds.

Traveltime inversion focuses on the geometrical features of the waveform (traveltimes), which is generally smooth, and thus, tends to provide averaged (smoothed) information of the Earth. On other hand, general waveform inversion uses additional elements of the wavefield including amplitudes to extract higher resolution information, but this comes at the cost of introducing complex nonlinearity to the inversion operator, complicating the convergence process. The sources of nonlinearity in the inversion are the nature of our sinusoidal wavefield and the complex reflectivity of the Earth. Each one of these nonlinearity sources has a distinctive imprint on the objective function. These nonlinearities can, however, be unwrapped to obtain a more convex objective function. For the near surface where reflections, and thus, the reflectivity source of non linearity, is attenuated, we focus on refractions and contend with only the wavefield induced nonlinearity, which is easy to mitigate. Inversion results and examples complement these assertions and we end up with convergent inversions of the near surface.

In FWI a very simple, but important, fact holds: We can only estimate what the simulation assumptions and the acquired sinusoidal in nature data allow us to estimate, so we have to make sure that we take these restrictions into account. **This challenge, despite the many advances, will remain a topic of research for the industry and academia alike, including a topic attractive to graduate student's research and dissertation projects.**

!!! This seminar would be interesting for Geophysicist, Mathematicians, Physicist, Physical Engineers and Geologist !!!

Schedule

Date	Time	Location	Address
14 January - Monday	14:00- 15:00	Ankara, TURKEY	Ankara University Department of Geophysical Eng.
16 January - Wednesday	14:00- 15:00	İstanbul, TURKEY	İstanbul University Department of Geophysical Eng.
16 January - Wednesday	19:00- 20:00	İstanbul, TURKEY	CGET Istanbul Branch Offices,
17 January - Thursday	14:00- 15:00	İstanbul, TURKEY	İstanbul Technical University Department of Geophysical Eng.

Biography

Tariq A. Alkhalifah is a professor of geophysics in the division of Physical Sciences and Engineering at King Abdullah University for Science and Technology (KAUST). He assumed his duties there in June 2009. Prior to joining KAUST, Tariq was a research professor and director of the Oil and Gas Research Institute at King Abdulaziz City for Science & Technology (KACST). He has also been associate research professor, assistant research professor and research assistant at KACST. From 1996 to 1998, Tariq served as a postdoctoral researcher for the Stanford Exploration Project at Stanford University, USA.

He received the J. Clarence Karcher Award from the Society of Exploration Geophysicists (SEG) in 1998 and the Conrad Schlumberger Award from the European Association for Geoscientists and Engineers (EAGE) in 2003. He is a member of SEG and EAGE.

Tariq received his doctoral degree in geophysics (1997) and master's degree (1993) in geophysical engineering from the Colorado School of Mines, USA. He holds a bachelor's degree (1988) in geophysics from King Fahd University of Petroleum and Minerals, Saudi Arabia.

Tariq's research interests are in imaging and velocity model building for exploration seismic data with special emphasis on media that exhibit anisotropic behavior. of wave propagation. He is also interested in seismic acquisition and processing of near surface data for better near surface treatment.

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