SPGNA 2018 Q2 Meeting Agenda

June 30, 2018; 1-3 pm

Cinco Ranch Branch Library, Conference Room 2 (Second floor)

2620 Commercial Center Blvd. Katy TX 77494

Agenda

Start time	End time	Presenter	Title
1:00	1:15	Sanjay Sood / Samarjit Chakraborty	Introduction / SPGNA update
1:15	1:30	Debanjan Datta	A two-level checkpointing framework for RTM/FWI for GPUs in heterogeneous memory systems
1:30	1:45	Janaki Vamaraju	Numerical simulations of seismic wave propagation in fractured media and fracture parameter estimation
1:45	2:00	Reetam Biswas	2D Full-Waveform Inversion and Uncertainty Estimation using the Reversible Jump Hamiltonian Monte Carlo
2:00	2:15	Vishal Das	Simulation of coupled fluid-solid interaction in digital rock samples and Convolutional Neural Network for seismic impedance inversion
2:15	2:30	All	Discussion / Networking

A two-level checkpointing framework for RTM/FWI for GPUs in heterogeneous memory systems

Debanjan Datta, Graduate Research Assistant, Institute for Geophysics, The University of Texas at Austin

Reverse Time Migration (RTM) and Full Waveform Inversion (FWI) are some of the most critical and intensive algorithms in the processing workflow. They involve temporal cross-correlation of forward and adjoint states at the same time and, therefore require saving the forward states in memory. Checkpointing is implemented to trade memory usage with data movement and computations. The increased data movement is especially detrimental to the performance of Graphical Processing Units (GPU) where data transfers are much slower compared to compute. Moreover, limited GPU memory necessitates more frequent transfers and effective GPU utilization is lowered because GPU waits to finish data copy before resuming computing. This lowers their effective performance when solving adjoint problem and delays the time-to-solution of RTM/FWI workflows. We propose a two-level checkpoint formulation for GPUs using asynchronous compute and Non-Volatile Memory Express (NVMe) systems which hides all data movement overhead and enables continuous GPU usage without waiting for data transfer. The parameters of the check- pointing formulation are generalizable to multiple system and any RTM/FWI formulations using bandwidth and through-put values. Implementing optimized data transfer approaches leads to faster compute time with increased GPU utilization. I demonstrate the speed-up using an acoustic RTM formulation.

Numerical simulations of seismic wave propagation in fractured media and fracture parameter estimation

Janaki Vamaraju, Graduate Research Assistant, Institute for Geophysics, The University of Texas at Austin

Natural or induced fractures are frequently observed in rocks at all scales. Since they greatly influence the porosity and permeability of a reservoir, their characterization is critically important not only for drilling, well completion and reservoir management but also for hydrocarbon exploration. In this regard, my talk will be about:

a) Development of numerical methods such as enriched/hybrid finite elements to model seismic wave propagation in fractured elastic media at reduced computational costs (forward problem).

b) Modeling seismic wave propagation in fractured poroelastic media to examine the effects of fluid filled cracks and pores on scattering (forward problem).

c) Finally, to estimate fault networks (seismic migration) from synthetic seismic data by employing mean field Boltzmann machines (inverse problem)

2D Full-Waveform Inversion and Uncertainty Estimation using the Reversible Jump Hamiltonian Monte Carlo

Reetam Biswas, Graduate Research Assistant, Institute for Geophysics, The University of Texas at Austin

Seismic data are used to generate high resolution subsurface images, which require detailed velocity models. Full Waveform Inversion (FWI), has recently gathered immense popularity in inverting for the elastic wave velocities from the seismic data. FWI is a non-linear and non-unique inverse problem that uses complete time and amplitude information for estimating the elastic properties. Typically FWI is performed using local optimization methods in which the subsurface model is described by using a large number of grids. The number of model parameters is determined a priori. In addition, the convergence of the algorithm to the globally optimum answer is largely dictated by the choice of a starting model. Here, we apply a trans-dimensional approach, which is based on a Bayesian framework to solve the waveform inversion problem. In our approach, the number of model parameters is also treated as a variable, which we hope to estimate. We use Voronoi cells and represent our 2D velocity model using certain nuclei points and employ a recently developed method called the Reversible Jump Hamiltonian Monte Carlo (RJHMC). RJHMC is an effective tool for model exploration and uncertainty quantification. It combines the reversible jump MCMC with the gradient based Hamiltonian Monte Carlo (HMC). We solve our forward problem using time-domain finite difference method while ad-joint method is used to compute the gradient vector required at the HMC stage. We demonstrate our algorithm with noisy synthetic data for the well-known Marmousi model. Convergence of the chain is attained in about 3000 iterations; marginal posterior density plots of velocity models demonstrate uncertainty in the obtained velocity models.

Simulation of coupled fluid-solid interaction in digital rock samples and Convolutional Neural Network for seismic impedance inversion

Vishal Das, PhD Candidate, Geophysics Department, Stanford University

The first part of the talk will focus on the results from numerical simulation of coupled fluid-solid interaction in digital rock samples. Dynamic fluid effects when seismic waves pass through a rock sample is simulated using numerical methods. The second part of the talk is related to the application of convolutional neural networks for seismic impedance inversion. The work is focused on understanding the machine in machine-learning workflows using knowledge of physics and geology.