SPGNA 2018 Q2 Meeting Minutes

The Society of Petroleum Geophysicists, India (North American Chapter) 2018 Q2 meeting was held at the Cinco Ranch Branch Library in Katy, Texas on June 30, 2018. Thanks to all who attended the meeting. Special thanks to Debanjan, Janaki, Reetam, and Vishal for sharing their research project. Following is a summary of the meeting.

Recognitions

- Sireesh Dadi for financial contributions to SPGNA

Attendees

1. Sireesh Dadi
2. Sanjay Sood
3. Dileep Tiwary
4. Janaki Vamaraju
5. Pradeep Mukhopadhyay
6. Dhananjay Kumar
7. Partha Routh
8. Debanjan Datta
9. Reetam Biswas
10. Ali Sayed
11. Vishal Das
12. Samarjit Chakraborty

Agenda, SPG-NA update by Samarjit Chakraborty and Sanjay Sood. Update on SPG-NA activities and financial status of the organization. SPG-NA provided interest-free student loan to Sanjukta Dhar who started her doctoral studies at Baylor University, Waco, Texas in Fall 2018. Sanjukta completed her Master's from NIT Rourkela, India and have worked as Project Scientific Assistant in Physical Research Laboratory, Ahmedabad and then as senior project associate at IIT Kanpur.

A two-level checkpointing framework for RTM/FWI for GPUs in heterogeneous memory systems by 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. Debanjan proposed 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

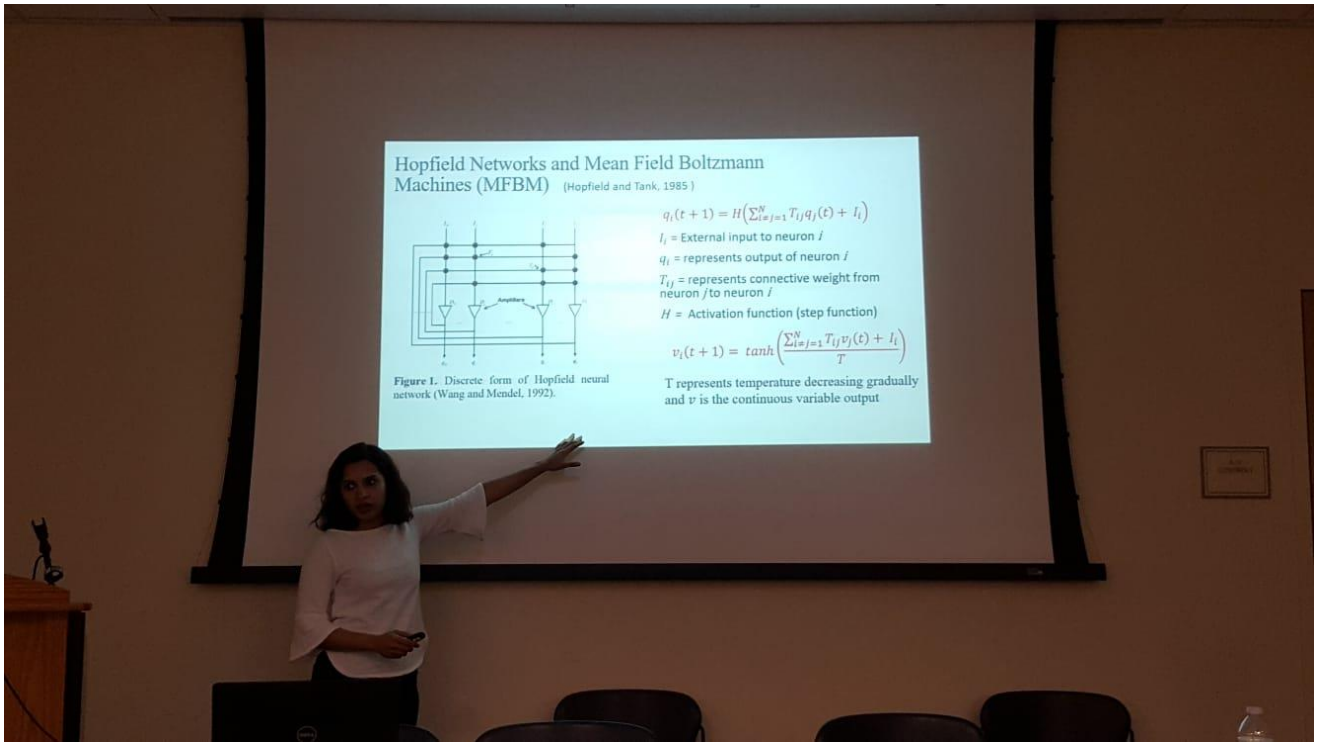
and through-put values. Implementing optimized data transfer approaches leads to faster compute time with increased GPU utilization. Optimal runtime parameters can be computed for any system configuration. Modular & Scalable methods applicable to other domains.

Numerical simulations of seismic wave propagation in fractured media and fracture parameter estimation by 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, Janaki's talk was about 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), modeling seismic wave propagation in fractured poroelastic media to examine the effects of fluid filled cracks and pores on scattering (forward problem), and finally, estimation of 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 by 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). 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.

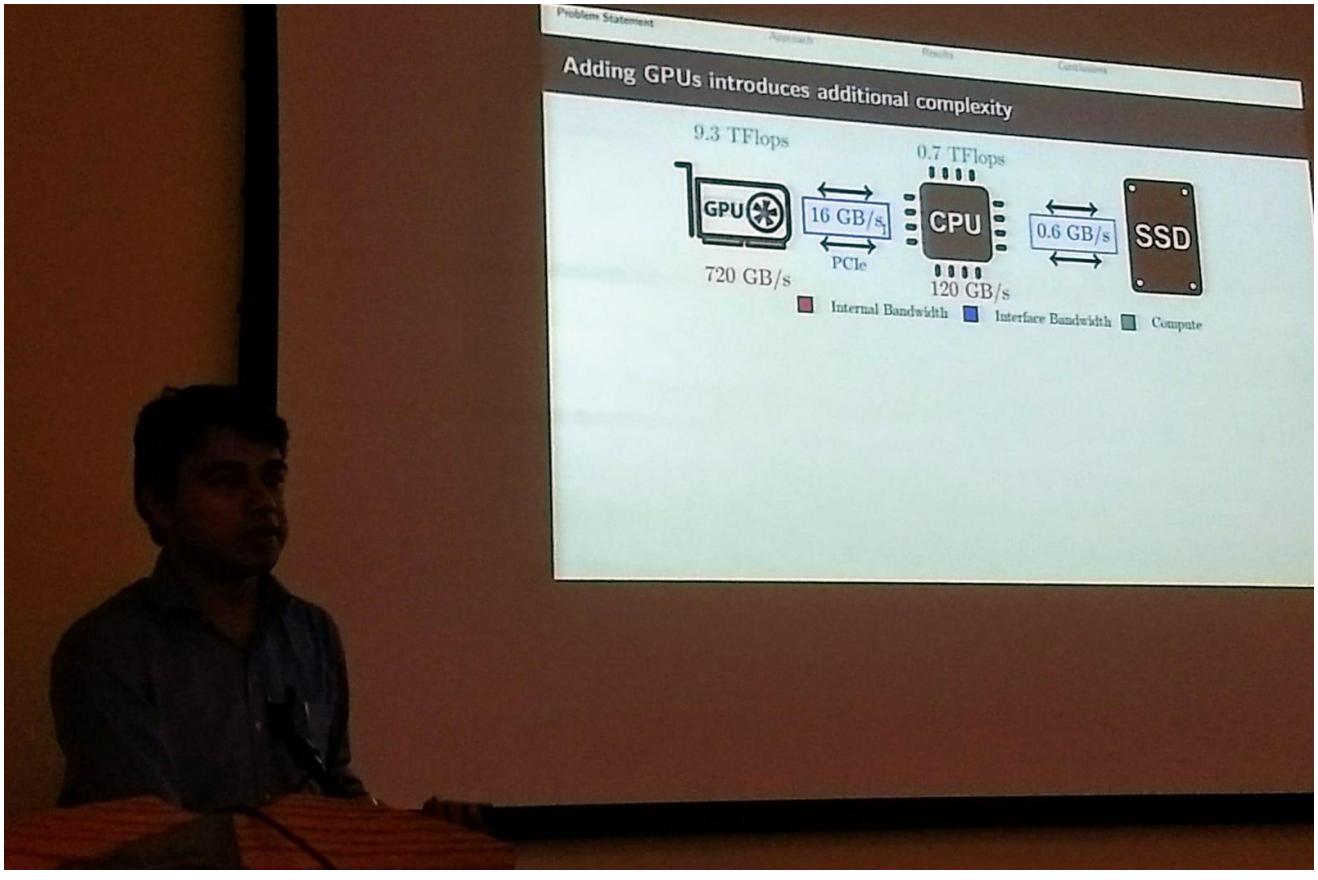
Simulation of coupled fluid-solid interaction in digital rock samples and Convolutional Neural Network for seismic impedance inversion by Vishal Das, PhD Candidate, Geophysics Department, Stanford University. The first part of the talk focused on the results from numerical simulation of coupled fluid-solid 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 was 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.

SPGNA 2018 Q2 meeting attendees.

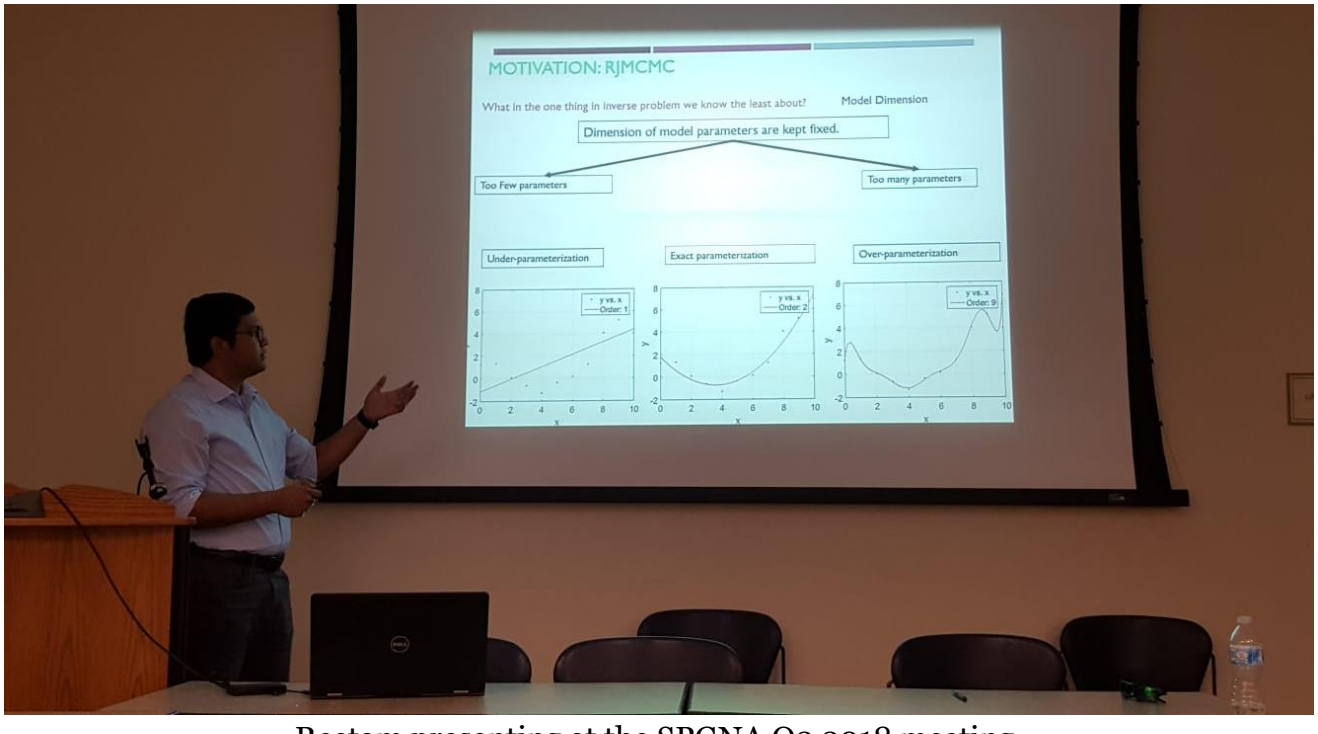


Janaki presenting at the SPGNA Q2 2018 meeting.

Vishal presenting at the SPGNA Q2 2018 meeting.



Debanjan presenting at the SPGNA Q2 2018 meeting.



Reetam presenting at the SPGNA Q2 2018 meeting.

PLEASE CONTRIBUTE TO SPGNA

SPGNA has a scholarship fund to help Indian geophysics students and faculty members for their research, training and attending international conferences. We need financial support from members and patrons. We are requesting you to contribute generously.

In 2011, SPGNA signed a Memorandum of Understanding (MOU) with GSH (Geophysical society of Houston) under which GSH has created a sub-account for SPGNA in their bank. You can contribute to SPGNA through GSH (tax free in USA). GSH is a nonprofit tax-exempt organization under 501(C)(3) of the IRS tax codes. There are three ways you can contribute to SPGNA.

1. Contribute with your company's give and match program: Most of the companies based in USA have some kind of sponsorship program, in which the company will match the employee's donation to a registered non-profit organization up to some amount. This way you automatically save income tax and the non-profit organization you choose to donate to gets more money with your contribution. When donating using your company's give and match program, please select Geophysical Society of Houston (EIN 742171855) as the organization name and put "for SPGNA" as program to make sure your contribution goes to SPGNA. Also send an email to spgnam@gmail.com.

2. Contribute with your personal check: You can also write a check as donation to SPGNA and still get tax benefit in USA. Write your check payable to "GSH" and mention "SPGNA" in memo to make sure it goes to the SPGNA fund. Please send your check to Sanjay Sood (Sanjay Sood, 2327 High Landing Ln, Katy, TX 77494). Please also send an email to spgnam@gmail.com.

3. Contribute by cash: Please give your cash donation to any SPGNA team member and send an email to spgnam@gmail.com.

There is no annual membership fee for SPGNA. Thank you for your support.

North American Chapter
Society of Petroleum Geophysicists