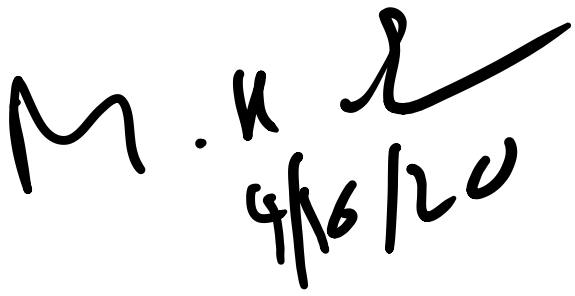
RESERVOIR PARAMETER ESTIMATION BY SEISMIC INVERSION AND MACHINE LEARNING

TOMSKI, Jackson, Jackson School of Geosciences – Institute for Geophysics, University of Texas at Austin, Austin, TX 78758, tomskija@utexas.edu

The goal of my research is to characterize the unconventional reservoir of the Bakken Formation, specifically within northwest North Dakota using 3D seismic and well log data. I employ seismic inversion followed by employing a Bayesian Neural Network (BNN) to predict total porosity across a seismic line given an estimated volume of P-impedance. The BNN utilizes Langevin Dynamics Markov Chain Monte Carlo in order to sample from the probability distribution, which can be used to estimate uncertainity.

During preprocessing, a pre-stack isotropic inversion is performed given pre-stack migrated common image gathers, four horizons, and two time-depth corrected wells. I carried out two different train-test cases to validate the effectiveness of the BNN: 1) well by well, and 2) sorted K-means clustering. Case #1 involves data training of one well and prediction of the other. Case #2 involves K-means clustering to form clusters by finding the nearest data point relative to another on combined well data. This is performed using a P-impedance and total porosity crossplot, where 60% of the data is sampled at random within each cluster, summed together, and then sorted based on cluster color to get the training dataset that resembles the total porosity log response across the Bakken reservoir. The remaining 40% of data is used for testing, and is derived the same way. BNN hyperparameters were tuned to allow for total porosity predictions away from the well locations without getting stuck within a low probability zone. A good R^2, low root mean squared error, and low standard deviation throughout sample iteration was achieved, giving good correlation between P-impedance and total porosity.

The results of this work show that there is a high correlation between P-impedance and total porosity, and that the BNN does a good job at predicting the expected total porosity log response across the Bakken reservoir. Integrating these techniques, a better understanding of the parameters useful for reservoir characterization is possible given a degree of uncertainity; thereby, improving oil/gas exploration and risk assessment.



Dr. Mrinal K. Sen 04/16/2020