PROJECT 1

Goal: Hybrid machine learning and inverse modeling for gas leakage detection based on observational data

- Characterizing gas source strength (q_s), properties (v, D) and locations
- Reconstructing gas concentration profile in time and space

Results: Reduced the cost of monitoring and number of detectors

Partnership: Australian National Low Emissions Coal Research & Development, Canberra, Australia

Methods: Machine learning, Inverse Modeling, K-means and genetic algorithm clustering, Web scraping, Non-negative matrix factorization, Non-linear least square minimization, Analytical solution

(1) $$\frac{\partial C}{\partial t} + v\frac{\partial C}{\partial z} = D\frac{\partial^2 C}{\partial z^2}$$

(2.a) $$W_s = q_s$$

(2.b) $$H_s(t) = \frac{C_0}{2}\left[erfc\left(\frac{z-vt}{2\sqrt{Dt}}\right) + exp\left(\frac{vz}{D}\right) erfc\left(\frac{z+vt}{2\sqrt{Dt}}\right)\right]$$

(3) $$O = \sum_{n=1}^{N}\sum_{t=1}^{T}\left(V_n(t) - \sum_{s=1}^{N_s} W_s H_s(t)\right)^2$$

$V_n(t)$: Observational data
N_s: Number of sources
N: Number of detectors

A non-linear least square procedure, Levenberg–Marquardt algorithm, is used for minimization of cost function O which gives the optimal properties for the gas source. Python and Matlab were used.

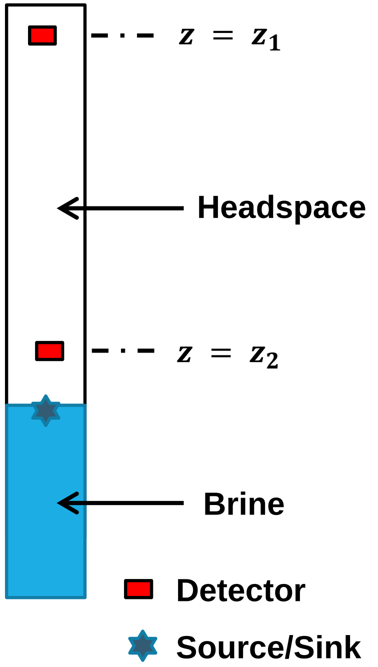


Fig 1. Test setup representing detectors and source in headspace of a monitoring well.

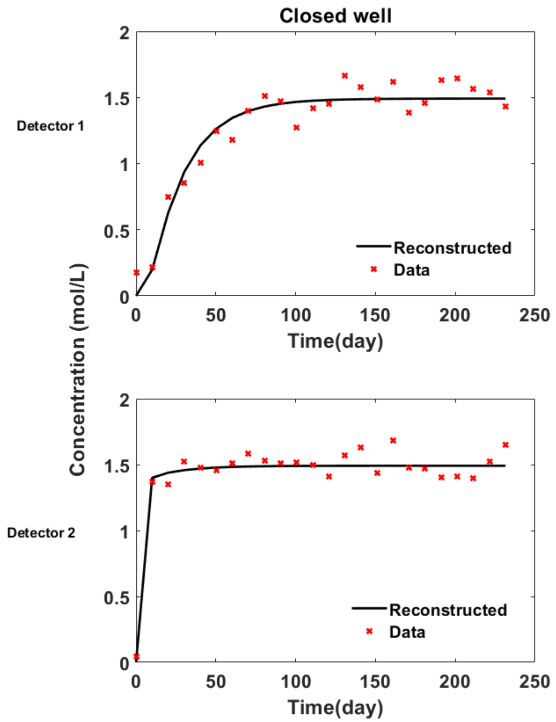


Fig 2. Comparison between concentration profiles using my approach (solid lines) for two detectors and observational data (red markers).

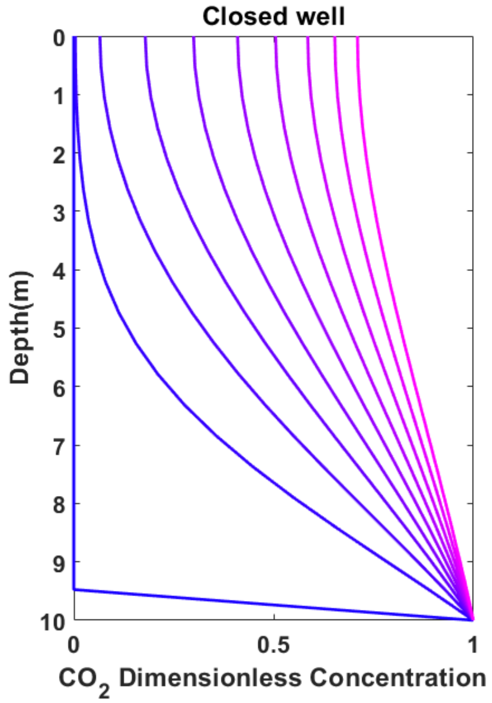


Fig 3. Time evolution of gas concentration profiles. Time increases from blue (t=0 s) to pink (t= 8000000 s).

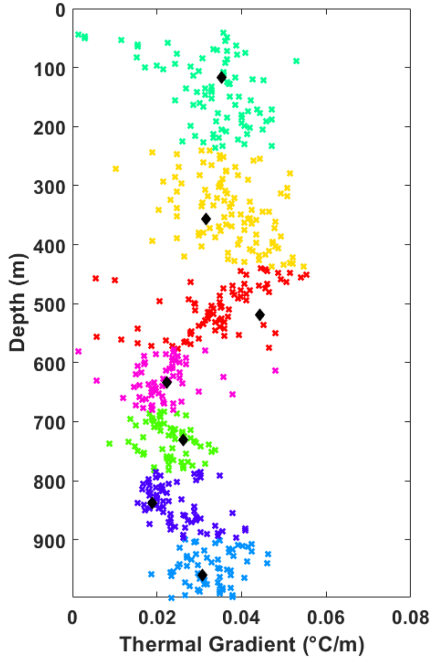


Fig 4. Temperature gradient profile in 1000 m of a monitoring well and different clusters derived from K-means and genetic algorithm.

PROJECT 2

Goal: Reservoir monitoring data management

Results: Draw meaningful insights from 370 **Gb** of data.

- ➢Reduced the time and cost of data processing.
- ➢Fully interactive visualizations and reservoir surveillance based on the real-time data

Partnership: Hilcorp Energy Company

Methods: C++ source code was developed to process temporal variance of the data, Data-quality management, Data cleansing, Data sampling, streaming and visualization

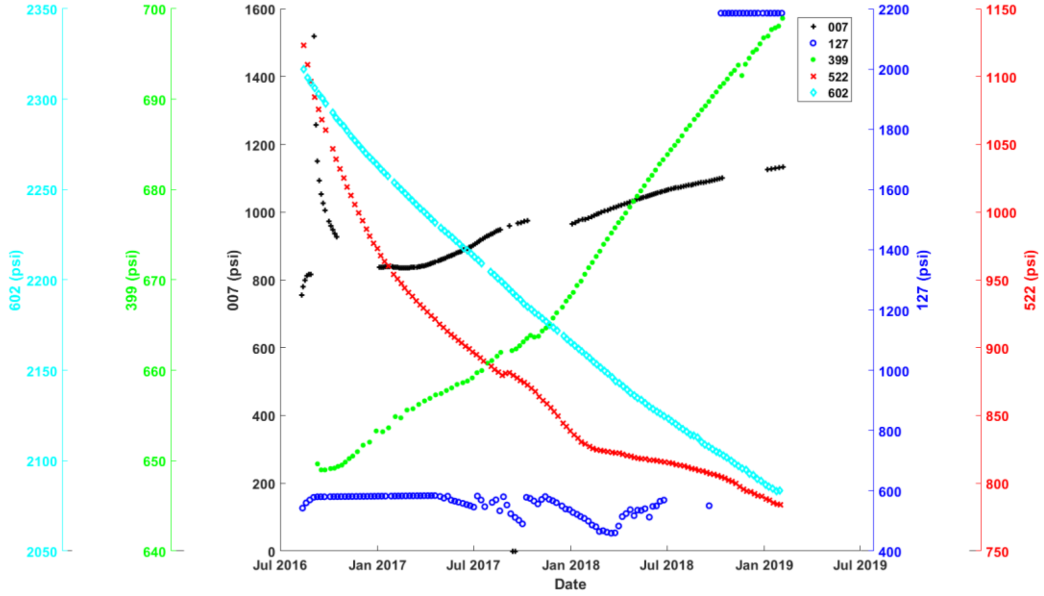


Fig 1. Pressure evolution in five wells.

PROJECT 3

Goal: Detection of salt precipitation based on time-lapse well log data in injection and monitoring wells.

Results: A novel approach was developed based on cross-wavelet transformation

Partnership: U.S. Department of Energy

Methods: Fractal analysis, Cross-wavelet transformation, Monte Carlo simulation, Exploratory data analysis, Petrophysical data interpretation, Matlab toolboxes

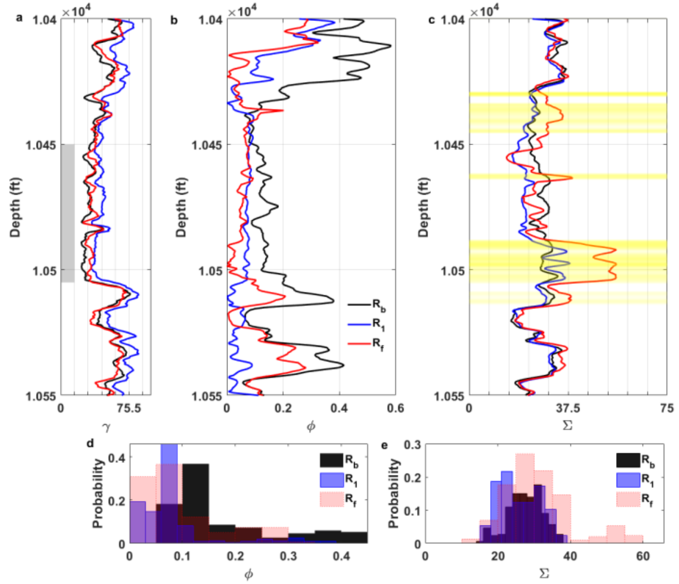


Fig 2. Time-lapse petrophysical data. a) Gamma (γ) ray log, b) Porosity (ϕ), c) Sigma (Σ), d) Probability distribution of porosity and e) Sigma. Injection interval is shown in gray on gamma log. Yellow color indicates the intervals with salt buildup.

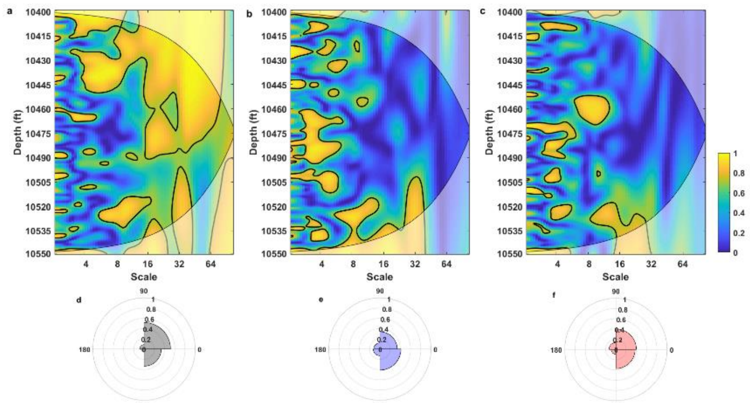


Fig 3. Time-lapse cross-wavelet coherence between porosity and Sigma. Top: The connections between ϕ and Σ for 2009 (a), 2010 (b) and 2014 (c). The thick black contours encloses the 5% significance level against red noise which indicates the notable coherence regions between ϕ and Σ. Bottom: Phase-angle histograms between ϕ and Σ at regions enclosed by thick black counters.

PROJECT 4

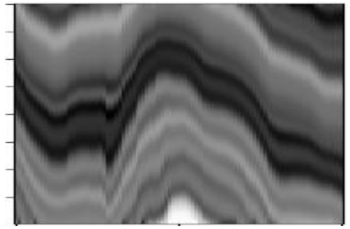
Goal: Stochastic Seismic Inversion Using Tensorflow

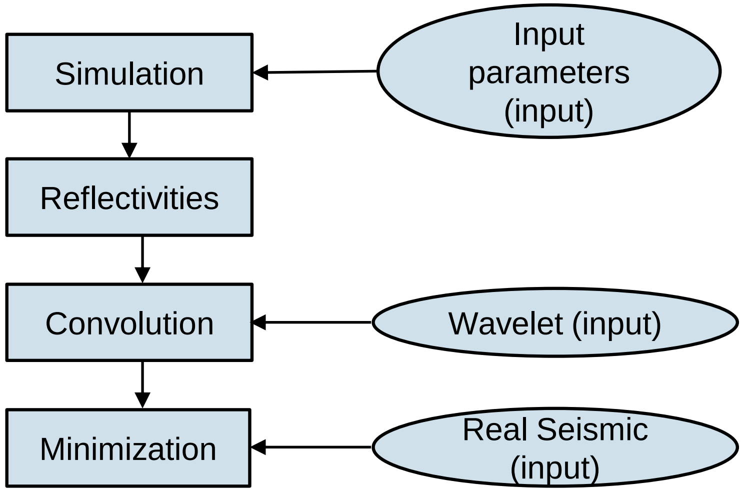
Results: A fast, GPU-based stochastic seismic inversion tool

Method: Tensorflow-gpu, python, Texas advanced computing center (and AWS)

I am presenting this work in 2019 Rice Oil & Gas HPC Conference

http://rice2019oghpc.rice.edu/program/





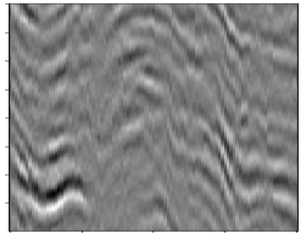


Fig 1. Algorithm for stochastic seismic inversion.

PHD RESEARCH

Seismic data denoising using curvelet transformation

Analyzing petrophysical data using wavelet transformation

GPU-based pore-scale simulation of evaporation, salt precipitation and reaction in porous media

Molecular dynamic simulation of nucleation of salt crystals in clay minerals

Personal projects:

My personal website hosted by AWS (Html, CSS, Java, D3.js, JSON):

http://www.hdashtian.com

PhD research:

http://hdashtian.com/research.html

Some cool data visualization:

http://hdashtian.com/levyflight.html

http://hdashtian.com/realnetwork.html