Quan Guo

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Objectives

I am a passionate **cross-disciplinary** researcher in **physics** and **machine learning**, dedicated to utilizing AI and machine learning to solve scientific problems and construct digital twins. My current research focuses on several key areas:

- **Physics-Informed Neural Networks**: Developing neural networks with combining physics-based knowledge to enhance predictive robustness.
- **Neural Operators and Surrogate Forward Models**: Exploring the use of neural operators to efficiently simulate complex physical processes.
- **AI Generative Modeling**: Implementing AI generative model for encoding complicated subsurface structures. Combine AI generative model and traditional sampling and optimization of inverse estimation.
- **Bayesian Analysis and Random Fields**: Employing Bayesian analysis and random fields to model uncertainty and variability in geospatial data.
- **High-Performance Computing**: Utilizing high-performance computing resources to expedite data processing and model training.

Education

- B.S. in Ecology, Xiamen University, 2012 - 2016
- M.S. in Environmental Engineering, Georgia Institute of Technology, 2016 – 2017
- M.S. in Environmental Engineering, Georgia Institute of Technology, 2017 – 2018
- Ph.D in Water Resource Engineering, Georgia Institute of Technology, 2019 – Now

Teaching

Georgia Institute of Technology

- Head Teaching Assistant of CSE 6250 Big Data for Healthcare — Since 2020
- Lab Instructor CEE 4200 Hydraulic Engineering — Spring 2019, Spring 2020

Research Projects

- Assimilated multi-source IoT data from well-logs with **Physics Informed Neural Network** for reservoir inference, achieving equal accuracy as the best numerical model but 10x faster.
- Developed **Fourier Neural Operator (FNO)** as surrogate geophysical model and combined FNO and **PCA** for subsurface inverse modeling with borehole hydraulic data, model is 30x faster than numerical model.
- Developed **GAN** and **DNN** inference model of 2D reservoir with **Tensorflow** to estimate the subsurface fracture based on well test data for discovery, making the first deep learning model for this task.
- Combined **PCA** and **geostatistical approach** to develop efficient numerical inverse model for groundwater modeling and uncertainty quantification with pumping test data, shortening the modeling time from 18 days to 1 hours.
- Applied upscaling method to develop high-speed numerical PDE solvers and geophysical simulation models with **MATLAB,** enhancing the simulation speed by 16x with approximation error <3%.
- Combined **snesim** based on **multiple-point statistics** and Monte Carlo sampling to generate subsurface fractured realizations conditioning on borehole data. Provided estimation of the CO_2 storage capacity.

Work Experiences

Schlumberger-Doll Research — Cambridge, MA

Research Intern as Machine Learning Engineer — May 2023 – Aug 2023

Find end-to-end AI solution for carbon capture and sequestration in 3D subsurface environment.

- Developed "GeoGPT" software with the StyleGAN-V at backend, providing real-time uncertainty identification of CO_2 storage in reservoirs. Users can make quotes and obtain prompt responses.
- Built an AI/ML pipeline on Azure DevOps to automate the data loading and model training.

- Designed and encapsulated the state-of-art neural network modules that users, with or without AI background, can customize an AI model within one-line code and leverage CUDA and DL pipeline to train.

Ping An Insurance Co. Beijing, China
Machine learning engineering May 2018 – July 2018
Develop machine learning models for disease prediction.

- Detected risks of diabetes by conducting quantitative analysis on time series data of daily body checks.
- Performed A/B tests and analysis of significant difference to assess the impact of a diabetes treatment.

Skills

Programming: Python, Java, C/C++, MATLAB
Big Data: PySpark, Hadoop, Scala, Hive, Pig, Hbase
Cloud Computing: AWS, Azure, Google Cloud Platform, LAMBDA
Data Analysis: R, MySQL, Numpy, Pandas
ML/DL/AI: CUDA, Pytorch, Tensorflow, Scikit-learn, Comet-ML
CI/CD: Git, Docker, Azure DevOps, Google Container Registry, Bitbucket, Gitlab

Publications

Multiple papers and presentations at Water Resources Research, Journal of Hydrology, and AGU conference.

- Guo, Q., Liu, M., & Luo, J. (2023), Predictive Deep Learning for High-Dimensional Inverse Modeling of Hydraulic Tomography in Gaussian and Non-Gaussian Fields, *Water Resour. Res.,* 59(10), e2023WR035408, doi: https://doi.org/10.1029/2023WR035408.
- Guo, Q., Zhao, Y., Lu, C., & Luo, J. (2023). High-dimensional inverse modeling of hydraulic tomography by physics informed neural network (HT-PINN). *Journal of Hydrology*, 616, 128828, doi: https://doi.org/10.1016/j.jhydrol.2022.128828.
- Zhao, Y., Guo, Q., Lu, C., & Luo, J. (2022). High-dimensional groundwater flow inverse modeling by upscaled effective model on principal components. *Water Resour. Res.*, 58(7), e2022WR032610. doi: https://doi.org/10.1029/2022WR032610.
- Guo, Q., Large-scale Inverse Modeling of Hydraulic Tomography by Physics Informed Neural Network, AGU Fall Meeting, Chicago, IL, December 2022
- Guo, Q., , He, Y., Liu, M., Zhao, Y., Liu, Y., & Luo, J. Fourier neural operator for deep learning surrogate model of subsurface flow. [under review]
- He, Y., Guo, Q., Liu, Y., Huang, H., Hou, D., & Luo, J. Multiphysics modeling investigation of wellbore storage effect and non-Darcy flow.[under review]

Service and leadership

- Currently served as reviewer for Water Resources Research, Journal of Hydrology, etc.
- President of Student Association, College of Environment and Ecology, Xiamen University