Quan Guo, Ph.D

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LinkedIn | GitHub | Publications

Objectives

I am a passionate **cross-disciplinary** researcher in **geophysics** and **machine learning**, dedicated to utilizing AI to solve civil engineering 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

• Georgia Institute of Technology	Ph.D	Civil Engineering	January 2019 – May 2024
• Georgia Institute of Technology	MS	Computer Engineering	August 2017 – December 2018
• Georgia Institute of Technology	MS	Environmental Engineering	August 2016 – December 2017
• Xiamen University	BS	Ecology	September 2012 – May 2016

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, which is further combined **PCA** for subsurface reservoir inference based on well-log data, achieving 30x faster than numerical model.
- Developed **GAN** and **DNN** as the first AI inverse model to estimate the subsurface fractures based on hydraulic data, the model can provide real-time conditional estimation on oil & gas discovery.
- Combined **PCA** and **geostatistical approach** to develop efficient numerical inverse model for groundwater modeling and uncertainty quantification, shortening the modeling time from 18 days to 1 hour.
- Applied upscaling method to develop high-speed numerical PDE solvers based on Finite Element Method**,** enhancing the groundwater 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 – August 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 as the first generative AI model providing real-time uncertainty identification of CO_2 storage in underground reservoirs.
- Leveraged **Kubernetes, Docker** and **Azure DevOps** to automate the AI model deployment on clusters. And automatically monitor the model train process with **Comet-ML**.

- Built up **GeoAI platform** on **Azure** with integrating hierarchical neural network modules, hyperparameter configurations, and automatic delivery for users to customize a **ML pipeline** with one-line code.

Skills

- **Programming**: Python, Java, C/C++, MATLAB, R, Julia.
- **ML/DL/AI**: Pytorch, Tensorflow, Scikit-learn, Jax, Keras, CUDA, Julia.
- **Big Data**: PySpark, Hadoop, MapReduce, Scala, Hive, Pig, Hbase.
- **Cloud Computing:** AWS, Azure, GCP, LAMBDA
- **Data Analysis and Visulization:** MySQL, Numpy, Pandas, Matplotlib, Plotly, Grafana.
- **CI/CD:** Git, Docker, Azure DevOps, Google Container Registry, Bitbucket, Gitlab

Publications

Peer-reviewed journals

- 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.
- He, Y., Guo, Q., Liu, Y., Huang, H., Hou, D., & Luo, J. (2024). Multiphysics Modeling Investigation of Wellbore Storage Effect and Non-Darcy Flow. Water Resources Research, 60(1), e2023WR035453. doi: https://doi.org/10.1029/2023WR035453.
- 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]

Conferences

- [Presentation] Guo, Q., Luo, J. Large-scale Inverse Modeling of Hydraulic Tomography by Physics Informed Neural Network, In: AGU 2022 Fall Meeting, Chicago, IL, December 2022

Invited Talks and Seminars

- Scalable high-dimensional inverse modeling of hydraulic tomography by physics informed neural network (HT-PINN). In: National Environmental Conference for Doctoral Students, Beijing, China, January 2023.
- Physics informed neural network in groundwater inverse modeling. In: Water Resource Engineering Seminar, Georgia Institute of Technology, Atlanta, GA, March 2022.

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