

Quan Guo, PhD

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Summary

I am a versatile researcher specializing in physics simulations and AI-driven analysis, with expertise in numerical modeling, machine learning, and inference. My work focuses on leveraging advanced **deep learning models** to address challenges in **spatio-temporal modeling** and **geophysical inference**, aiming to bridge the gap between computational methods and real-world applications. My research spans several key areas:

- **Scientific Machine Learning:** Educating machine learning with physical knowledge to solve PDEs efficiently: physics informed neural networks, neural operators, etc.
- **Bayesian Optimization & Inference:** Utilizing Bayesian and random fields to conduct dimensionality reduction and optimization for large-dimensional inverse problems.
- **Domain Generalization:** Creating AI generative models to encode multiple distributions, supporting uncertainty quantification with broader prior assumptions.
- **Digital Twin:** Employing imaging and computer vision techniques to render invisible physical systems based on sensory data.

Through my interdisciplinary expertise, I aim to advance the integration of AI and geophysics, driving innovation in subsurface exploration and digital simulation technologies.

Education

PhD in Civil Engineering , Georgia Institute of Technology, Atlanta, GA	2019 - 2024
<ul style="list-style-type: none">• Dissertation: <i>Physics Informed Deep Learning Application in High-Dimensional Groundwater Inverse Modeling of Hydraulic Tomography</i>• Adviser: Prof. Jian Luo	
MS in Computer Engineering , Georgia Institute of Technology, Atlanta, GA	2017 - 2018
MS in Environmental Engineering , Georgia Institute of Technology, Atlanta, GA	2016 - 2017
BS in Ecology , Xiamen University, Xiamen, Fujian, China	2012 - 2016

Research Funding

Principal Investigator , ISTI FY25 Rapid Response, Los Alamos National Laboratory	2025
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Teaching

Hydraulic Engineering , CEE4200, Georgia Institute of Technology	2019, 2020
Big Data for Healthcare , CSE6250, Georgia Institute of Technology	2020 - 2024

Professional Experience

Postdoc , Los Alamos National Laboratory, Los Alamos, NM	2024 - Present
<ul style="list-style-type: none">• Authored a highly competitive research proposal as Principal Investigator, securing funding with a 13% acceptance rate within six months of joining.	

- Lead developer of *SimCCS*, an R&D 100 Award-winning software, enabling users to interactively simulate the diffusion of deformable plumes and assess well-drilling risks through integrated numerical and machine learning models.
- Collaborated with 50 scientists across 10+ institutions on the DOE SMART project to optimize ML-based history matching models, enhance software infrastructure and build demos to present tools to DOE sponsors.
- Published 3+ proceedings at top-tier conferences, including CCUS 2025 and GHGT-17.
- Delivered technical presentations to governmental sponsors and private-sector stakeholders, securing continued funding for cutting-edge research projects.

Research Assistant, Georgia Institute of Technology, Atlanta, GA 2019 – 2024

- Implemented Physics Informed Neural Networks (PINNs) for scalable inverse modeling and designed corresponding data fusion and training strategy, performing 10x faster on high-resolution PDE parameter estimation than the best numerical model.
- Created Fourier Neural Operator (FNO)-based surrogate models to enhance elliptic PDE solution performance, improving forward solution by 10x and backpropagation speed by 100x.
- Implemented GAN to encode non-linear random fields at low-dimensional space, enhancing computational efficiency by 50x for estimating the fields.
- Applied Bayesian optimization and random field analysis to reduce dimensionality in physical field variables by 99%, enabling efficient parameter estimation.
- Introduced upscaling methods to achieve up to 1000x faster Jacobian evaluations. Conducted error analysis on the numerical method and found the optimal upscaling rate for balance speed and accuracy.
- Published 5+ papers in leading journals, including *Water Resources Research* and *Journal of Hydrology*, contributing to machine and computational methods for geosciences.

Machine Learning Engineer, Schlumberger-Doll Research, Cambridge, MA 2023

- Reviewed cutting-edge AI methodologies and implemented generative AI for reservoir characterization, reducing analysis time from two days to five minutes.
- Built an ML infrastructure integrating Kubernetes, CUDA, Docker, and PyTorch on Azure DevOps, streamlining model training for geophysical applications and becoming the company's standard Python-based workflow.

Editorial Experience

Editor

- Guest Editor, *Hydrology* 2024 - Present
Special Issue: Advancing Hydrological Science through Artificial Intelligence: Innovations and Applications

Reviewer

- Water Resources Research
- Journal of Hydrology
- ARMA
- SPE Journal
- Journal of Petroleum Science and Engineering

Collaborators and Co-Authors

- Jian Luo, Georgia Institute of Technology
- Minjae Kim, Georgia Institute of Technology
- Yu He, Sichuan University
- Chunhui Lu, Hohai University

- Bailian Chen, Los Alamos National Laboratory
- Yue Zhao, Meta Platforms, Inc.
- Martin Ma, Los Alamos National Laboratory
- Ming Liu, Meta Platforms, Inc.

Professional Affiliations

Member, AGU 2023 – 2024

Services and Volunteer

GUIDE Member, EES Division at Los Alamos National Laboratory 2024 – Present

DEI Association Member, CEE at Georgia Institute of Technology 2023 – 2024

President of Student Association, CEE at Xiamen University 2014 – 2015

Skills

Numerical: Numerical Linear Algebra, FEM Solver, Random Field Analysis, Bayesian Inference

Machine Learning: PINNs, Neural Operators, GANs, TensorFlow, PyTorch, Scikit-learn

Data Engineering: Python, SQL, Azure, AWS, Docker, Kubernetes, Spark, Hadoop

High-Performance Computing: CUDA, Parallel Computing Frameworks

Communication: Scientific Writing, Presentations, Teaching

Publications

Peer-reviewed journals

- Guo, Q., He, Y., Liu, M., Zhao, Y., Liu, Y., & Luo, J. (2024), Reduced Geostatistical Approach With a Fourier Neural Operator Surrogate Model for Inverse Modeling of Hydraulic Tomography, *Water Resources Research*, 60(6), e2023WR034939, doi: <https://doi.org/10.1029/2023WR034939>.
- 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 Resources Research*, 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>.
- Liu, Y., He, Y., Guo, Q., Kim, M., Rathore, S., & Luo, J. (2024), Impact of Boundary Conditions on Modeling Seawater Intrusion in Stratified Coastal Aquifers Under Sea Level Rise, doi: <http://dx.doi.org/10.2139/ssrn.4912526>.
- 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>.
- Zhao, Y., Guo, Q., Lu, C., & Luo, J. (2022). High-dimensional groundwater flow inverse modeling by upscaled effective model on principal components. *Water Resources Research*, 58(7), e2022WR032610. doi: <https://doi.org/10.1029/2022WR032610>.

Conference Proceedings

- Chen, B., Ma, Z., Ahmmed, B., Guo, Q., Li, W., Mehana, M., Meng, M., & Pawar, R. (2024), Unified SimCCS Platform for Decision-Making in Carbon Capture, Transport, and Storage Infrastructure, paper presented at Proceedings of the 17th Greenhouse Gas Control Technologies Conference (GHGT-17), 20-24 October 2024, doi: <http://dx.doi.org/10.2139/ssrn.5030859>.

- Ma, Z., Guo, Q., Viswanathan, H., Pawar, R., & Chen, B. (2024), Deep Learning Assisted History Matching and Forecasting: Applied to the Illinois Basin – Decatur Project (IBDP), paper presented at Proceedings of the 17th Greenhouse Gas Control Technologies Conference (GHGT-17), 20-24 October 2024, doi: <http://dx.doi.org/10.2139/ssrn.5019810>.

Conference and Workshop Presentations

- [Poster] Guo, Q., Ma, Z., & Chen, B. An Innovative Method to Evaluate Cost of CO₂ Shipping, In: CCUS 2025, Houston, TX, March 2025
- [Poster] Guo, Q., Ma, Z., & Chen, B. Unified SimCCS Platform for Decision-Making in Carbon Capture, Transport, and Storage, In: CESAM 2024, Socorro, NM, November 2024
- [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.