Rafael Orozco

rorozco@gatech.edu — *Cell:* 4707920316 —*Home:* Atlanta, GA
linkedin.com/in/rafael42 — Google scholar

Education

Georgia Institute of Technology
Advised by Prof. Felix J. Herrmann
PhD in Computational Science and Engineering *Expected graduation: 12/2024*

I research generative machine learning for uncertainty quantification of inverse problems. My main research contributions are in implementing and testing invertible networks that learn to sample from the Bayesian posterior of realistic inverse problems. I explore seismic imaging and medical imaging modalities (MRI, CT, Ultrasound, Photoacoustic) but generally focus on modalities governed by computationally expensive partial differential equations (PDEs). These modalities are best suited for physics hybrid frameworks that are accelerated by machine learning but informed by domain physics knowledge in the form of PDE simulations. I primarily consider myself an engineer since my passion is in bringing these novel techniques to real world applications.

Bucknell University
Bachelor of Science in Computer Science, Minor in Mathematics *Graduated 05/2019*

Work experience

NASA Langley Research Center, Hampton VA *Summer 2019*
Worked on the Program to Optimize Simulated Trajectories II (POST2) software used in trajectory planning for atmosphere entry and landing of rovers. I updated the continuous integration suite from the legacy workflow to a modern HDF5-based implementation. The update increased the ease of code maintenance and also took advantage of the HDF5 compression abilities to minimize memory usage.

Lawrence Berkeley National Laboratory, Berkeley CA *Summer 2018*
Proposed then implemented a statistics-based compression algorithm for multi-dimensional sensor data. We benchmarked against JPEG and found higher compression rates with comparable visual quality.
Paper: Multidimensional Compression with Pattern Matching. 2019 Data Compression Conference

National Renewable Energy National Laboratory, Golden CO *Summer 2017*
Used historical wind turbine sensor datasets to learn models for early diagnosis and warning of failures. Due to the large scale of the sensor data, I implemented the machine learning algorithm with big data software Hadoop and Spark.
Paper: Diagnostic models for wind turbine gearbox components using scada time series data. 2018 IEEE International Conference on Prognostics and Health Management (ICPHM)

Technical skills

- Python & Julia for scientific machine learning
- Generative AI: Normalizing flows & Diffusion
- Bayesian statistical inference
- Devito & JUDI for seismic inversion
- MRI, CT, Photoacoustic, Ultrasound
- HDF5, Spark and Hadoop for big data
- GIT, LaTeX
- Native English and Spanish

Software development

InvertibleNetworks.jl *Main developer since 05/2022*
Allows for memory efficient machine learning on GPUs. As main developer, I contributed physics-based and learned summary networks enabling high-resolution imaging in various seismic and medical inverse problems. Maintainence & testing is done with Github Actions for continuous integration.
Paper: A Julia package for scalable normalizing flows. (in review for JOSS)

PhotoAcoustic.jl *Main developer since 04/2023*
Derived adjoints of the photoacoustic PDE. Implemented the adjoint simulation with JUDI to accelerate algorithm development of photoacoustic image reconstruction.
Paper: Memory efficient invertible neural networks for 3D photoacoustic imaging.

Selected scientific publications

BEACON: Bayesian Experimental design Acceleration with Conditional Normalizing flows – a case study in optimal monitor well placement for CO2 sequestration *02/2024*
Rafael Orozco, Abhinav Gahlot, Felix J. Herrmann
Submited to IMAGE 2025

Normalizing Flows for Bayesian Experimental Design in Imaging Applications *02/2024*
Rafael Orozco, Abhinav Gahlot, Peng Chen , Mathias Louboutin, Felix J. Herrmann
SIAM Uncertainty Quantification

Inference of CO2 flow patterns–a feasibility study *02/2023*
Abhinav Gahlot, Tuna Erdinc, **Rafael Orozco**, Ziyi Yin, Felix J. Herrmann
NeurIPS 2023 Workshop on Tackling Climate Change with Machine Learning

Amortized Normalizing Flows for Transcranial Ultrasound with Uncertainty Quantification *06/2023*
Rafael Orozco, Mathias Louboutin, Gabrio Rizzuti, Tristan van Leeuwen, Felix J. Herrmann
PMLR Medical Imaging with Deep Learning

Adjoint operators enable fast and amortized Bayesian uncertainty quantification *04/2023*
Rafael Orozco, Ali Siahkoohi, Gabrio Rizzuti, Tristan van Leeuwen, Felix J. Herrmann
SPIE Medical Imaging Conference

Reliable variational inference with physics-based latent distribution correction *02/2023*
Ali Siahkoohi, Gabrio Rizzuti, **Rafael Orozco**, Felix J. Herrmann
Journal of Society of Exploration Geophysicists

Normalizing flows for regularization of 3D seismic inverse problems *11/2022*
Rafael Orozco, Mathias Louboutin, and Felix J. Herrmann
ML4Seismic Consortium Meeting

Wave-equation-based inversion with amortized variational Bayesian inference *04/2022*
Ali Siahkoohi, **Rafael Orozco**, Gabrio Rizzuti, Felix J. Herrmann
European Association of Geoscientists and Engineers (EAGE)

Photoacoustic imaging with conditional priors from normalizing flows *12/2021*
Rafael Orozco, Ali Siahkoohi, Gabrio Rizzuti, Tristan van Leeuwen, Felix J. Herrmann
NeurIPS - Deep Learning and Inverse Problems

Extended source imaging, a unifying framework for seismic & medical imaging *05/2020*
Ziyi Yin, **Rafael Orozco**, Philipp Witte, Mathias Louboutin, Gabrio Rizzuti, Felix J. Herrmann
Society of Exploration Geophysicists Annual Meeting