Ali Siahkoohi

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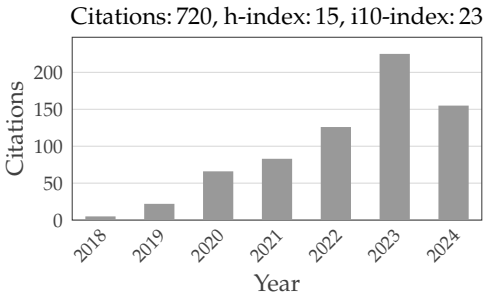
Research Interests and Highlights

My research in scientific machine learning aims to overcome barriers to fully unlocking AI's potential in computational science. I develop scalable, data-driven methods that integrate strengths from both fields to tackle challenging problems in computational science and engineering. Keywords defining my current research include: generative models, scientific machine learning, computational imaging, and uncertainty quantification.



Over the past years, I have published 38 peer-reviewed articles, including 17 first-author papers in high-impact journals and conference proceedings, such as NeurIPS, ICML, ICLR, Interspeech, MIDL, SPIE, TMLR, and Geophysics.

Academic Appointments

Rice University — August 2022 – Present
Simons Postdoctoral Fellow — Houston, TX, USA
Department of Computational Applied Mathematics & Operations Research
Jointly hosted by Maarten V. de Hoop and Richard G. Baraniuk

Education

Georgia Institute of Technology — August 2022
Ph.D. in Computational Science and Engineering (minor in Applied Math.) — Atlanta, GA, USA
Advised by Felix J. Herrmann

University of Tehran — March 2016
M.Sc. in Geophysics — Tehran, Iran

Sharif University of Technology — August 2013
B.Sc. in Electrical Engineering — Tehran, Iran

Publications

Google Scholar profile: `https://scholar.google.com/citations?user=sxRMqYIAAAAJ&h`

In Preparation & Under Review

P5. P. M. Mayer, L. Luzi, A. Siahkoohi, D. H. Johnson, and R. G. Baraniuk. Removing bias from maximum likelihood estimation with model autophagy. Preprint arXiv:2405.13977; under review by ***NeurIPS***, 2024

P4. L. Baldassari, A. Siahkoohi, J. Garnier, K. Sølna, and M. V. de Hoop. Taming score-based diffusion priors for infinite-dimensional nonlinear inverse problems. Preprint arXiv:2405.15676; under review by ***NeurIPS***, 2024

P3. R. Orozco, A. Siahkoohi, M. Louboutin, and F. J. Herrmann. ASPIRE: Iterative amortized posterior inference for Bayesian inverse problems. Preprint arXiv:2405.05398; under review by ***Inverse Problems***, 2024

P2. A. Siahkoohi, R. Morel, R. Balestriero, E. Allys, G. Sainton, T. Kawamura, and M. V. de Hoop. Martian time-series unraveled: A multi-scale nested approach with factorial variational autoencoders. Preprint arXiv:2305.16189, 2024

P1. R. Orozco, P. Witte, M. Louboutin, A. Siahkoohi, G. Rizzuti, B. Peters, and F. J. Herrmann. InvertibleNetworks.jl: A Julia package for scalable normalizing flows. Preprint arXiv:2312.13480; under review by ***Journal of Open Source Software***, 2023

Journal Publications

J6. L. Luzi, P. M. Mayer, J. Casco-Rodriguez, A. Siahkoohi, and R. G. Baraniuk. Boomerang: Local sampling on image manifolds using diffusion models. ***Transactions on Machine Learning Research***, 2024

J5. M. Louboutin, Z. Yin, R. Orozco, T. J. Grady II, A. Siahkoohi, G. Rizzuti, P. A. Witte, O. Møyner, G. J. Gorman, and F. J. Herrmann. Learned multiphysics inversion with differentiable programming and machine learning. ***The Leading Edge***, 42(7):474–486, 2023

J4. Y. Zhang, Z. Yin, O. López, A. Siahkoohi, M. Louboutin, R. Kumar, and F. J. Herrmann. Optimized time-lapse acquisition design via spectral gap ratio minimization. ***Geophysics***, 88(4):A19–A23, 2023

J3. A. Siahkoohi, G. Rizzuti, R. Orozco, and F. J. Herrmann. Reliable amortized variational inference with physics-based latent distribution correction. ***Geophysics***, 88(3):R297–R322, 2023

J2. A. Siahkoohi, G. Rizzuti, and F. J. Herrmann. Deep Bayesian inference for seismic imaging with tasks. ***Geophysics***, 87(5):S281–S302, 2022

J1. A. Siahkoohi, M. Louboutin, and F. J. Herrmann. The importance of transfer learning in seismic modeling and imaging. ***Geophysics***, 84(6):A47–A52, 2019

Peer-Reviewed Conference Proceedings

C32. S. Alemohammad, J. Casco-Rodriguez, L. Luzi, A. I. Humayun, H. Babaei, D. LeJeune, A. Siahkoohi, and R. G. Baraniuk. Self-consuming generative models go MAD. In *The Twelfth* ***International Conference on Learning Representations***, 2024

C31. L. Luzi, D. LeJeune, A. Siahkoohi, S. Alemohammad, V. Saragadam, H. Babaei, N. Liu, Z. Wang, and R. G. Baraniuk. Titan: Bringing the deep image prior to implicit representations. In ***IEEE International Conference on Acoustics, Speech and Signal Processing***, pages 6165–6169, 2024

C30. L. Baldassari, A. Siahkoohi, J. Garnier, K. Sølna, and M. V. de Hoop. Conditional score-based diffusion models for Bayesian inference in infinite dimensions. In ***Advances in Neural Information Processing Systems***, volume 36, pages 24262–24290, 2023

C29. A. Siahkoohi, R. Morel, M. V. de Hoop, E. Allys, G. Sainton, and T. Kawamura. Unearthing InSights into Mars: Unsupervised source separation with limited data. In ***Proceedings of the 40th International Conference on Machine Learning***, volume 202, pages 31754–31772, 2023

C28. R. Orozco, M. Louboutin, A. Siahkoohi, G. Rizzuti, T. van Leeuwen, and F. J. Herrmann. Amortized normalizing flows for transcranial ultrasound with uncertainty quantification. In ***Medical Imaging with Deep Learning***, volume 227, pages 332–349, 2023

C27. R. Orozco, A. Siahkoohi, M. Louboutin, and F. J. Herrmann. Refining amortized posterior approximations using gradient-based summary statistics. In ***5th Symposium on Advances in Approximate Bayesian Inference***, 2023

C26. R. Orozco, A. Siahkoohi, G. Rizzuti, T. van Leeuwen, and F. J. Herrmann. Adjoint operators enable fast and amortized machine learning based Bayesian uncertainty quantification. In ***Medical Imaging 2023: Image Processing***, volume 12464, page 124641L, 2023

C25. Y. Zhang, Z. Yin, O. Lopez, A. Siahkoohi, M. Louboutin, and F. J. Herrmann. 3D seismic survey design by maximizing the spectral gap. In ***Third International Meeting for Applied Geoscience & Energy***, 2023

C24. A. Siahkoohi, M. Chinen, T. Denton, W. B. Kleijn, and J. Skoglund. Ultra-low-bitrate speech coding with pretrained Transformers. In ***Proceedings of Interspeech***, pages 4421–4425, 2022

C23. A. Siahkoohi, M. Louboutin, and F. J. Herrmann. Velocity continuation with Fourier neural operators for accelerated uncertainty quantification. In ***Society of Exploration Geophysicists Technical Program Expanded Abstracts***, pages 1765–1769, 2022

C22. M. Louboutin, P. Witte, A. Siahkoohi, G. Rizzuti, Z. Yin, R. Orozco, and F. J. Herrmann. Accelerating innovation with software abstractions for scalable computational geophysics. In ***Society of Exploration Geophysicists Technical Program Expanded Abstracts***, pages 1482–1486, 2022

C21. Z. Yin, A. Siahkoohi, M. Louboutin, and F. J. Herrmann. Learned coupled inversion for carbon sequestration monitoring and forecasting with Fourier neural operators. In ***Society of Exploration Geophysicists Technical Program Expanded Abstracts***, pages 467–472, 2022

C20. Y. Zhang, M. Louboutin, A. Siahkoohi, Z. Yin, R. Kumar, and F. J. Herrmann. A simulation-free seismic survey design by maximizing the spectral gap. In ***Society of Exploration Geophysicists Technical Program Expanded Abstracts***, pages 15–20, 2022

C19. A. Siahkoohi, R. Orozco, G. Rizzuti, and F. J. Herrmann. Wave-equation based inversion with amortized variational Bayesian inference. In ***EAGE Deep learning for seismic processing: Investigating the foundations workshop***, 2022

C18. R. Orozco, A. Siahkoohi, G. Rizzuti, T. van Leeuwen, and F. J. Herrmann. Photoacoustic imaging with conditional priors from normalizing flows. In ***NeurIPS Workshop on Deep Learning and Inverse Problems***, 2021

C17. A. Siahkoohi, G. Rizzuti, M. Louboutin, P. Witte, and F. J. Herrmann. Preconditioned training of normalizing flows for variational inference in inverse problems. In ***3rd Symposium on Advances in Approximate Bayesian Inference***, 2021

C16. A. Siahkoohi and F. J. Herrmann. Learning by example: Fast reliability-aware seismic imaging with normalizing flows. In ***Society of Exploration Geophysicists Technical Program Expanded Abstracts***, pages 1580–1585, 2021

C15. R. Kumar, M. Kotsi, A. Siahkoohi, and A. Malcolm. Enabling uncertainty quantification for seismic data preprocessing using normalizing flows (NF)—An interpolation example. In ***Society of Exploration Geophysicists Technical Program Expanded Abstracts***, pages 1515–1519, 2021

C14. G. Rizzuti, A. Siahkoohi, P. A. Witte, and F. J. Herrmann. Parameterizing uncertainty by deep invertible networks, an application to reservoir characterization. In ***Society of Exploration Geophysicists Technical Program Expanded Abstracts***, pages 1541–1545, 2020

C13. M. Zhang, A. Siahkoohi, and F. J. Herrmann. Transfer learning in large-scale ocean bottom seismic wavefield reconstruction. In ***Society of Exploration Geophysicists Technical Program Expanded Abstracts***, pages 1666–1670, 2020

C12. A. Siahkoohi, G. Rizzuti, and F. J. Herrmann. Weak deep priors for seismic imaging. In ***Society of Exploration Geophysicists Technical Program Expanded Abstracts***, pages 2998–3002, 2020

C11. A. Siahkoohi, G. Rizzuti, and F. J. Herrmann. Uncertainty quantification in imaging and automatic horizon tracking—A Bayesian deep-prior based approach. In ***Society of Exploration Geophysicists Technical Program Expanded Abstracts***, pages 1636–1640, 2020

C10. A. Siahkoohi, G. Rizzuti, and F. J. Herrmann. A deep-learning based Bayesian approach to seismic imaging and uncertainty quantification. In ***European Association of Geoscientists & Engineers Conference and Exhibition Extended Abstracts***, 2020

C9. F. J. Herrmann, A. Siahkoohi, and G. Rizzuti. Learned imaging with constraints and uncertainty quantification. In ***NeurIPS Deep Inverse Workshop***, 2019

C8. A. Siahkoohi, R. Kumar, and F. J. Herrmann. Deep-learning based ocean bottom seismic wavefield recovery. In ***Society of Exploration Geophysicists Technical Program Expanded Abstracts***, pages 2232–2237, 2019

C7. A. Siahkoohi, D. J. Verschuur, and F. J. Herrmann. Surface-related multiple elimination with deep learning. In ***Society of Exploration Geophysicists Technical Program Expanded Abstracts***, pages 4629–4634, 2019

C6. G. Rizzuti, A. Siahkoohi, and F. J. Herrmann. Learned iterative solvers for the Helmholtz equation. In ***European Association of Geoscientists & Engineers Conference and Exhibition Extended Abstracts***, 2019

C5. A. Siahkoohi, M. Louboutin, R. Kumar, and F. J. Herrmann. Deep convolutional neural networks in prestack seismic—two exploratory examples. In ***Society of Exploration Geophysicists Technical Program Expanded Abstracts***, pages 2196–2200, 2018

C4. A. Siahkoohi, R. Kumar, and F. J. Herrmann. Seismic data reconstruction with generative adversarial networks. In ***European Association of Geoscientists & Engineers Conference and Exhibition Extended Abstracts***, 2018

C3. A. Siahkoohi and A. Gholami. Sparsity promoting least squares migration for laterally inhomogeneous media. In ***7th EAGE Saint Petersburg International Conference and Exhibition***, 2016

C2. M. S. Ebrahimi, M. H. Daraei, J. Rezaei, and A. Siahkoohi. A novel utilization of wireless sensor networks as data acquisition system in smart grids. In ***Materials Science and Information Technology***, volume 433-440, pages 6725–6730, 2012

C1. A. Najafi, A. Siahkoohi, and M. B. Shamsollahi. A content-based digital image watermarking algorithm robust against JPEG compression. In ***IEEE International Symposium on Signal Processing and Information Technology***, pages 432–437, 2011

Theses

T2. A. Siahkoohi. *Deep generative models for solving geophysical inverse problems*. PhD thesis, **Georgia Institute of Technology**, 2022

T1. A. Siahkoohi. *Sparsity promoting least-squares migration for laterally inhomogeneous media*. Master's thesis, **University of Tehran**, 2016

Technical Reports

R3. M. Louboutin, A. Siahkoohi, R. Wang, and F. J. Herrmann. Low-memory stochastic backpropagation with multi-channel randomized trace estimation. Technical Report arXiv:2106.06998, Georgia Institute of Technology, 2021

R2. A. Siahkoohi, G. Rizzuti, P. A. Witte, and F. J. Herrmann. Faster uncertainty quantification for inverse problems with conditional normalizing flows. Technical Report arXiv:2007.07985, Georgia Institute of Technology, 2020

R1. A. Siahkoohi, M. Louboutin, and F. J. Herrmann. Neural network augmented wave-equation simulation. Technical Report arXiv:1910.00925, Georgia Institute of Technology, 2019

Talks

Invited Talks

T22. **CNRS, Université Montpellier** — January 2023
Low-cost uncertainty quantification for large-scale inverse problems — Virtual oral presentation
RhEoVOLUTION Group (Dr. Andréa Tommasi)

T21. **Workshop on Subsurface Uncertainty Description and Estimation** — August 2022
Reliable amortized variational inference with conditional normalizing flows via physics-based latent distribution correction — Oral presentation
International Meeting for Applied Geoscience & Energy

T20. **Intelligent illumination of the Earth Workshop** — June 2021
Fast and reliability-aware seismic imaging with conditional normalizing flows — Virtual oral presentation
King Abdullah University of Science and Technology

T19. **Advances in Seismic Imaging and Inversion Mini-symposium** — October 2020
Unsupervised data-guided uncertainty analysis in imaging and horizon tracking — Virtual oral presentation

Contributed Talks

T18. **International Conference on Machine Learning** — July 2023
Unearthing InSights into Mars: Unsupervised source separation with limited data — Poster presentation

T17. **Symposium on Advances in Approximate Bayesian Inference** — July 2023
Refining amortized posterior approximations using gradient-based summary statistics — Poster presentation

T16. **Geo-Mathematical Imaging Group Partners Meeting, Rice University** — May 2023
Martian time-series unraveled: A multi-scale nested approach with factorial variational autoencoders — Oral presentation

T15. **Geo-Mathematical Imaging Group Partners Meeting, Rice University** — May 2023
Unearthing InSights into Mars: Unsupervised source separation with limited data — Oral presentation

T14. **International Meeting for Applied Geoscience & Energy** — August 2022
Velocity continuation with Fourier neural operators for accelerated uncertainty quantification — Oral presentation

T13. **Chrome Media Team, Google** — December 2021
Low-bitrate speech coding with Transformers — Virtual oral presentation

T12. **ML4SEISMIC Partners Meeting, Georgia Institute of Technology** — November 2021
Multifidelity conditional normalizing flows for physics-guided Bayesian inference — Virtual oral presentation

T11. **ML4SEISMIC Partners Meeting, Georgia Institute of Technology** — November 2021
Uncertainty quantification in imaging and automatic horizon tracking—A Bayesian deep-prior based approach — Virtual oral presentation

T10. **Society of Exploration Geophysicists International Exposition and Annual Meeting** — September 2021
Learning by example: Fast reliability-aware seismic imaging with normalizing flows [Link to video] — Virtual oral presentation

T9. **Symposium on Advances in Approximate Bayesian Inference** — January 2021
Preconditioned training of normalizing flows for variational inference in inverse problems [Link to video] — Prerecorded short oral presentation

T8. **European Association of Geoscientists & Engineers Annual Conference & Exhibition** — December 2020
A deep-learning based Bayesian approach to seismic imaging and uncertainty quantification — Virtual oral presentation

T7. **Society of Exploration Geophysicists International Exposition and Annual Meeting** — October 2020
Uncertainty quantification in imaging and automatic horizon tracking—A Bayesian deep-prior based approach [Link to video] — Virtual oral presentation

T6. **Society of Exploration Geophysicists International Exposition and Annual Meeting** — October 2020
Weak deep priors for seismic imaging [Link to video] — Virtual oral presentation

T5. **Society of Exploration Geophysicists Student Chapter, Georgia Tech** — February 2020
A deep-learning based Bayesian approach to seismic imaging and uncertainty quantification — Oral presentation

T4. **HotCSE Seminar, CSE Department, Georgia Institute of Technology** — November 2019
Learned imaging with constraints and uncertainty quantification — Oral presentation

T3. **Society of Exploration Geophysicists International Exposition & Annual Meeting** — September 2019
Deep-learning based ocean bottom seismic wavefield recovery — Oral presentation

T2. **Society of Exploration Geophysicists International Exposition & Annual Meeting** — September 2019
Surface-related multiple elimination with deep learning — Oral presentation

T1. **Society of Exploration Geophysicists International Exposition & Annual Meeting** — October 2018
Deep convolutional neural networks in prestack seismic—two exploratory examples — Poster presentation

Professional Service

Editorial Service

- **Journal of Mathematics** 2023 – Present
  Guest Editor
  Special issue on Applied Mathematics in Inverse Problems and Uncertainty Quantification

Conference Organization

- **Deep Learning and Inverse Problems Workshop (NeurIPS)** 2024
  Workshop Organizer
- **International Meeting for Applied Geoscience & Energy** 2022
  Session Chair

Technical Program Committee Member and Reviewer

- Neural Information Processing Systems (NeurIPS) 2023 – 2024
- Advances in Approximate Bayesian Inference (AABI) 2023 – 2024
- Structured Probabilistic Inference & Generative Modeling (ICML workshop) 2023 – 2024
- International Conference on Machine Learning (ICML) 2024
- International Conference on Learning Representations (ICLR) 2024
- Artificial Intelligence and Statistics Conference (AISTATS) 2024
- International Speech Communication Association (Interspeech) 2023
- Deep Generative Models for Health (NeurIPS workshop) 2023
- International Meeting for Applied Geoscience & Energy 2023

Journal Reviewer

- IEEE Transactions on Neural Networks and Learning Systems
- IEEE Geoscience and Remote Sensing Letters
- IEEE Transactions on Geoscience and Remote Sensing
- Notices of the American Mathematical Society (AMS)
- Remote Sensing
- Journal of Geophysical Research – Solid Earth
- Geophysical Prospecting
- Geophysics
- Geosciences
- Entropy

Teaching Experience

Rice University Fall 2022
Instructor for 18 lectures Houston, TX, USA
Numerical Analysis I

Georgia Institute of Technology Spring 2022
Teaching Assistant Atlanta, GA, USA
Computational Foundations of Machine Learning

Georgia Institute of Technology Fall 2019
Teaching Assistant Atlanta, GA, USA
Imaging with Data-Driven Models

Georgia Institute of Technology Fall 2018
Teaching Assistant Atlanta, GA, USA
Numerical Analysis I

Sharif University of Technology Spring 2011
Teaching Assistant Tehran, Iran
Digital Signal Processing

Sharif University of Technology Spring 2011
Teaching Assistant Tehran, Iran
Signals and Systems

Sharif University of Technology Spring 2010
Teaching Assistant Tehran, Iran
Linear Algebra

Internship

Google August 2021 – December 2021
Research Intern (cf. publication C24) San Francisco, CA, USA
Chrome Media Team