

Ali Siahkoohi

CURRICULUM VITAE

CONTACT INFORMATION

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RESEARCH INTERESTS

My research focuses on developing scalable deep learning methods to reliably solve computational problems in the physical and data sciences. This includes high-dimensional Bayesian inference for solving large-scale inverse problems governed by partial differential equations and unsupervised time series analysis with limited data.

Keywords: Generative Models, Variational Inference, Bayesian inference, Uncertainty Quantification, Signal Processing

ACADEMIC POSITIONS

Simons Postdoctoral Fellow August 2022 – present
Department of Computational Applied Mathematics & Operations Research
Rice University, Houston, TX, USA

EDUCATION

Georgia Institute of Technology, Atlanta, GA, USA August 2022
Ph.D., *Computational Science and Engineering*
University of Tehran, Tehran, Iran March 2016
M.Sc., *Geophysics*
Sharif University of Technology, Tehran, Iran August 2013
B.Sc., *Electrical Engineering*

PUBLICATIONS

Preprints

- P2. [A. Siahkoohi](#), R. Morel, R. Balestrieri, 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, 2023

Journal Publications

- J6. L. Luzzi, 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 Papers

- C32. S. Alemohammad, J. Casco-Rodriguez, L. Luzi, A. I. Humayun, H. Babaei, D. LeJeune, [A. Siahkoohi](#), and R. 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. Solna, 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 *Neural Information Processing Systems 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 *Neural Information Processing Systems 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, 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, 2020
- R1. A. Siahkoohi, M. Louboutin, and F. J. Herrmann. Neural network augmented wave-equation simulation. Technical Report arXiv:1910.00925, 2019

TALKS

-
- Unearthing InSights into Mars: Unsupervised source separation with limited data July 2023
- International Conference on Machine Learning
 - Poster presentation
- Refining amortized posterior approximations using gradient-based summary statistics July 2023
- Symposium on Advances in Approximate Bayesian Inference
 - Poster presentation
- Martian time-series unraveled: A multi-scale nested approach with factorial variational autoencoders May 2023
- Geo-Mathematical Imaging Group Partners Meeting, Rice University
 - Oral presentation
- Unearthing InSights into Mars: Unsupervised source separation with limited data May 2023
- Geo-Mathematical Imaging Group Partners Meeting, Rice University
 - Oral presentation
- Low-cost uncertainty quantification for large-scale inverse problems January 2023
- RhEoVOLUTION Group (Dr. Andréa Tommasi), CNRS & Université Montpellier
 - **Invited** virtual oral presentation
- Reliable amortized variational inference with conditional normalizing flows via physics-based latent distribution correction August 2022
- International Meeting for Applied Geoscience & Energy, Workshop on Subsurface Uncertainty Description and Estimation
 - **Invited** oral presentation
- Velocity continuation with Fourier neural operators for accelerated uncertainty quantification August 2022
- International Meeting for Applied Geoscience & Energy
 - Oral presentation
- Low-bitrate speech coding with Transformers December 2021
- Chrome Media Team, Google
 - Virtual oral presentation
- Multifidelity conditional normalizing flows for physics-guided Bayesian inference November 2021
- ML4SEISMIC Partners Meeting, Georgia Institute of Technology
 - Virtual oral presentation
- Uncertainty quantification in imaging and automatic horizon tracking—A Bayesian deep-prior based approach November 2021
- ML4SEISMIC Partners Meeting, Georgia Institute of Technology
 - Virtual oral presentation
- Learning by example: Fast reliability-aware seismic imaging with normalizing flows September 2021
- Society of Exploration Geophysicists International Exposition and Annual Meeting
 - Virtual oral presentation [\[Link to video\]](#)
- Fast and reliability-aware seismic imaging with conditional normalizing flows June 2021
- KAUST Virtual Workshop: Intelligent illumination of the Earth
 - **Invited** virtual oral presentation
- Preconditioned training of normalizing flows for variational inference in inverse problems January 2021
- Symposium on Advances in Approximate Bayesian Inference
 - Prerecorded short oral presentation [\[Link to video\]](#)

A deep-learning based Bayesian approach to seismic imaging and uncertainty quantification	December 2020
<ul style="list-style-type: none"> ▶ European Association of Geoscientists and Engineers Annual Conference & Exhibition ▶ Virtual oral presentation 	
Unsupervised data-guided uncertainty analysis in imaging and horizon tracking	October 2020
<ul style="list-style-type: none"> ▶ The 3rd Annual Meeting of the SIAM Texas–Louisiana Section ▶ Invited virtual oral presentation 	
Uncertainty quantification in imaging and automatic horizon tracking—A Bayesian deep-prior based approach	October 2020
<ul style="list-style-type: none"> ▶ Society of Exploration Geophysicists International Exposition and Annual Meeting ▶ Virtual oral presentation [Link to video] 	
Weak deep priors for seismic imaging	October 2020
<ul style="list-style-type: none"> ▶ Society of Exploration Geophysicists International Exposition and Annual Meeting ▶ Virtual oral presentation [Link to video] 	
A deep-learning based Bayesian approach to seismic imaging and uncertainty quantification	February 2020
<ul style="list-style-type: none"> ▶ Society of Exploration Geophysicists Student Chapter, Georgia Institute of Technology ▶ Oral presentation 	
Learned imaging with constraints and uncertainty quantification	November 2019
<ul style="list-style-type: none"> ▶ HotCSE Seminar, CSE Department, Georgia Institute of Technology ▶ Oral presentation 	
Deep-learning based ocean bottom seismic wavefield recovery	September 2019
<ul style="list-style-type: none"> ▶ Society of Exploration Geophysicists International Exposition and Annual Meeting ▶ Oral presentation 	
Surface-related multiple elimination with deep learning	September 2019
<ul style="list-style-type: none"> ▶ Society of Exploration Geophysicists International Exposition and Annual Meeting ▶ Oral presentation 	
Deep convolutional neural networks in prestack seismic—two exploratory examples	October 2018
<ul style="list-style-type: none"> ▶ Society of Exploration Geophysicists International Exposition and Annual Meeting ▶ Poster presentation 	

PROFESSIONAL SERVICE

Editorial Service

[Special issue](#) on Applied Mathematics in Inverse Problems and Uncertainty Quantification

- ▶ Journal of Mathematics, 2023
- ▶ Guest Editor

Journal Reviewer

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

Technical Program Committee Member and Reviewer

- ▶ International Speech Communication Association (Interspeech 2023)
- ▶ Structured Probabilistic Inference & Generative Modeling (ICML 2023 workshop)
- ▶ Neural Information Processing Systems (NeurIPS 2023)
- ▶ Deep Generative Models for Health (NeurIPS 2023 workshop)

- ▶ International Meeting for Applied Geoscience & Energy (IMAGE 2023)
- ▶ Advances in Approximate Bayesian Inference (AABI 2023–2024)
- ▶ Artificial Intelligence and Statistics Conference (AISTATS 2024)
- ▶ International Conference on Learning Representations (ICLR 2024)
- ▶ International Conference on Machine Learning (ICML 2024)

Conference Organization

- ▶ Session Chair, International Meeting for Applied Geoscience & Energy (IMAGE 2022)

TEACHING EXPERIENCE

Numerical Analysis I	Fall 2022
Rice University, Houston, TX, USA	
Instructor for 18 lectures	
Computational Foundations of Machine Learning	Spring 2022
Georgia Institute of Technology, Atlanta, GA, USA	
Teaching Assistant	
Imaging with Data-Driven Models	Fall 2019
Georgia Institute of Technology, Atlanta, GA, USA	
Teaching Assistant	
Numerical Analysis I	Fall 2018
Georgia Institute of Technology, Atlanta, GA, USA	
Teaching Assistant	
Digital Signal Processing	Spring 2011
Sharif University of Technology, Tehran, Iran	
Teaching Assistant	
Signals and Systems	Spring 2011
Sharif University of Technology, Tehran, Iran	
Teaching Assistant	
Linear Algebra	Spring 2010
Sharif University of Technology, Tehran, Iran	
Teaching Assistant	

INTERNSHIP

Research Intern	August 2021 – December 2021
Chrome Media Team	
Google, San Francisco, CA, USA	