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 medical and geophysical inverse problems and unsupervised time series analysis with limited data.

Keywords: deep generative models, variational inference, inverse problems, uncertainty quantification, signal processing

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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

P3. D. LeJeune, L. Luzi, 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. Preprint: arXiv:2211.00219, 2023

P2. 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. Preprint: arXiv:2307.01850, 2023

P1. 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, 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*, 2023

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

C31. 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, 2023

C30. 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

C29. 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

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 Conference*, 2023

C27. 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

C26. M. Louboutin, R. Orozco, A. Siahkoohi, and F. J. Herrmann. Learned one-shot imaging. In *Third International Meeting for Applied Geoscience & Energy*, 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
- Virtual short oral presentation [Link to video]

A deep-learning based Bayesian approach to seismic imaging and uncertainty quantification — December 2020

- European Association of Geoscientists and Engineers Annual Conference & Exhibition
- Virtual oral presentation

Unsupervised data-guided uncertainty analysis in imaging and horizon tracking — October 2020
- 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
- Society of Exploration Geophysicists International Exposition and Annual Meeting
- Virtual oral presentation [Link to video]

Weak deep priors for seismic imaging — October 2020
- 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
- Society of Exploration Geophysicists Student Chapter, Georgia Institute of Technology
- Oral presentation

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

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

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

Deep convolutional neural networks in prestack seismic—two exploratory examples — October 2018
- 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)
- Advances in Approximate Bayesian Inference (AABI 2023)
- Neural Information Processing Systems (NeurIPS 2023)
- Deep Generative Models for Health (NeurIPS 2023 workshop)
- International Meeting for Applied Geoscience & Energy (IMAGE 2023)

- International Conference on Learning Representations (ICLR 2024)
- Artificial Intelligence and Statistics Conference (AISTATS 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