Ali Siahkoohi

CONTACT

Office: 2037 Duncan Hall
6100 Main Street
Houston, TX 77005

Email: alisk@rice.edu

RESEARCH INTERESTS

I conduct multidisciplinary research that focuses on developing deep learning methods to reliably solve scientific computing problems pertaining to inverse problems, uncertainty quantification, and signal processing.

Keywords: Deep Learning, Generative Models, Variational Inference, Inverse Problems, Uncertainty Quantification, Signal Processing

EMPLOYMENT

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

Research Assistant, February 2018–July 2022
School of Computational Science and Engineering
Georgia Institute of Technology, Atlanta, GA, USA

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

Research Assistant, August 2016–January 2018
Department of Earth, Ocean and Atmospheric Sciences
University of British Columbia, Vancouver, BC, Canada

PROFESSIONAL PREPARATION

Georgia Institute of Technology, Atlanta, GA, USA
Ph.D., 2022, Computational Science and Engineering

University of Tehran, Tehran, Iran
M.Sc., 2016, Geophysics

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

PUBLICATION

◇ **Preprints**

Baldassari, Lorenzo, Ali Siahkoohi, Josselin Garnier, Knut Sølna, and Maarten V. de Hoop. "Conditional score-based diffusion models for Bayesian inference in infinite dimensions". May 2023. DOI: 10.48550/arXiv.2305.19147. URL: https://arxiv.org/abs/2305.19147.

Orozco, Rafael, Ali Siahkoohi, Mathias Louboutin, and Felix J. Herrmann. "Refining amortized posterior approximations using gradient-based summary statistics". May 2023. DOI: 10.48550/arXiv.2305.08733. URL: https://arxiv.org/abs/2305.08733.

Siahkoohi, Ali, Rudy Morel, Randall Balestriero, Erwan Allys, Grégory Sainton, Taichi Kawamura, and Maarten V. de Hoop. "Martian time-series unraveled: A multi-scale nested approach with factorial variational autoencoders". May 2023. DOI: 10.48550/arXiv.2305.16189. URL: https://arxiv.org/abs/2305.16189.

◇ **Journal Publications**

Louboutin, Mathias, Ziyi Yin, Rafael Orozco, Thomas J. Grady II, Ali Siahkoohi, Gabrio Rizzuti, Philipp A. Witte, Olav Møyner, Gerard J. Gorman, and Felix J. Herrmann. "Learned multiphysics inversion with differentiable programming and machine learning". In: *The Leading Edge* (May 2023). In print. URL: https://arxiv.org/abs/2304.05592.

Siahkoohi, Ali, Gabrio Rizzuti, Rafael Orozco, and Felix J. Herrmann. "Reliable amortized variational inference with physics-based latent distribution correction". In: *Geophysics* 88.3 (Feb. 2023). DOI: 10.1190/geo2022-0472.1. URL: https://arxiv.org/abs/2207.11640.

Zhang, Yijun, Ziyi Yin, Oscar Lopez, Ali Siahkoohi, Mathias Louboutin, Rajiv Kumar, and Felix J. Herrmann. "Optimized time-lapse acquisition design via spectral gap ratio minimization". In: *Geophysics* 88.4 (Apr. 2023). DOI: 10.1190/geo2023-0024.1. URL: https://arxiv.org/abs/2302.01534.

Siahkoohi, Ali, Gabrio Rizzuti, and Felix J. Herrmann. "Deep Bayesian inference for seismic imaging with tasks". In: *Geophysics* 87.5 (Sept. 2022), S281–S302. DOI: 10.1190/geo2021-0666.1. URL: https://arxiv.org/abs/2110.04825.

Siahkoohi, Ali, Mathias Louboutin, and Felix J. Herrmann. "The importance of transfer learning in seismic modeling and imaging". In: *Geophysics* 84.6 (Nov. 2019), A47–A52. DOI: 10.1190/geo2019-0056.1.

◇ **Conference Papers**

Louboutin, Mathias, Rafael Orozco, Ali Siahkoohi, and Felix J. Herrmann. "Learned one-shot imaging". In: *3rd International Meeting for Applied Geoscience & Energy*. Society of Exploration Geophysicists. May 2023. URL: https://slimgroup.github.io/IMAGE2023/OneShot/abstract.html.

Orozco, Rafael, Mathias Louboutin, Ali Siahkoohi, Gabrio Rizzuti, Tristan van Leeuwen, and Felix J. Herrmann. "Amortized Normalizing Flows for Transcranial Ultrasound with Uncertainty Quantification". In: *Medical Imaging with Deep Learning (MIDL) Conference*. Mar. 2023. URL: https://openreview.net/forum?id=LoJG-lUIlk.

Orozco, Rafael, Ali Siahkoohi, Gabrio Rizzuti, Tristan van Leeuwen, and Felix J. Herrmann. "Adjoint operators enable fast and amortized machine learning based Bayesian uncertainty quantification". In: *Medical Imaging 2023: Image Processing*. Vol. 12464. International Society for Optics and Photonics. SPIE, 2023, p. 124641L. DOI: 10.1117/12.2651691. URL: https://slim.gatech.edu/Publications/Public/Conferences/SPIE/2023/orozco2022SPIEadjoint/SPIE_2022_adjoint.pdf.

Siahkoohi, Ali, Rudy Morel, Maarten V. de Hoop, Erwan Allys, Grégory Sainton, and Taichi Kawamura. "Unearthing InSights into Mars: Unsupervised source separation with limited data". In: *Proceedings of the 40th International Conference on Machine Learning (ICML)*. Aug. 2023. URL: https://arxiv.org/abs/2301.11981.

Louboutin, Mathias, Philipp Witte, Ali Siahkoohi, Gabrio Rizzuti, Ziyi Yin, Rafael Orozco, and Felix J. Herrmann. "Accelerating innovation with software abstractions for scalable computational geophysics". In: *2nd International Meeting for Applied Geoscience & Energy*. Society of Exploration Geophysicists. Aug. 2022, pp. 1482–1486. DOI: 10.1190/image2022-3750561.1. URL: https://arxiv.org/abs/2203.15038.

Siahkoohi, Ali, Michael Chinen, Tom Denton, W. Bastiaan Kleijn, and Jan Skoglund. "Ultra-Low-Bitrate Speech Coding with Pretrained Transformers". In: *Proceedings of Interspeech 2022*. Sept. 2022, pp. 4421–4425. DOI: 10.21437/Interspeech.2022-10988. URL: https://arxiv.org/abs/2207.02262.

Siahkoohi, Ali, Mathias Louboutin, and Felix J. Herrmann. "Velocity continuation with Fourier neural operators for accelerated uncertainty quantification". In: *2nd International Meeting for Applied Geoscience & Energy*. Society of Exploration Geophysicists. Aug. 2022, pp. 1765–1769. DOI: 10.1190/image2022-3750475.1. URL: https://arxiv.org/abs/2203.14386.

Siahkoohi, Ali, Rafael Orozco, Gabrio Rizzuti, and Felix J. Herrmann. "Wave-equation based inversion with amortized variational Bayesian inference". In: *EAGE Deep learning for seismic processing: Investigating the foundations workshop*. June 2022. URL: https://arxiv.org/abs/2203.15881.

Yin, Ziyi, Ali Siahkoohi, Mathias Louboutin, and Felix J. Herrmann. "Learned coupled inversion for carbon sequestration monitoring and forecasting with Fourier neural operators". In: *2nd International Meeting for Applied Geoscience & Energy*. Society of Exploration Geophysicists. Aug. 2022, pp. 467–472. DOI: 10.1190/image2022-3722848.1. URL: https://arxiv.org/abs/2203.14396.

Zhang, Yijun, Mathias Louboutin, Ali Siahkoohi, Ziyi Yin, Rajiv Kumar, and Felix J. Herrmann. "A simulation-free seismic survey design by maximizing the spectral gap". In: *2nd International Meeting for Applied Geoscience & Energy*. Society of Exploration Geophysicists. Aug. 2022, pp. 15–20. DOI: 10.1190/image2022-3751690.1. URL: https://arxiv.org/abs/2204.02801.

Kumar, Rajiv, Maria Kotsi, Ali Siahkoohi, and Alison Malcolm. "Enabling uncertainty quantification for seismic data preprocessing using normalizing flows (NF)—An interpolation example". In: *First International Meeting for Applied Geoscience & Energy*. Society of Exploration Geophysicists. Expanded Abstracts, 2021, pp. 1515–1519. DOI: 10.1190/segam2021-3583705.1.

Orozco, Rafael, Ali Siahkoohi, Gabrio Rizzuti, Tristan van Leeuwen, and Felix J. Herrmann. "Photoacoustic imaging with conditional priors from normalizing flows". In: *NeurIPS 2021 Workshop on Deep Learning and Inverse Problems*. Dec. 2021. URL: https://openreview.net/forum?id=woi1OTvROO1.

Ren, Yuxiao, Philipp A. Witte, Ali Siahkoohi, Mathias Louboutin, and Felix J. Herrmann. "Seismic Velocity Inversion and Uncertainty Quantification Using Conditional Normalizing Flows". In: *American Geophysical Union (AGU) Fall Meeting*. Dec. 2021. URL: https://agu.confex.com/agu/fm21/meetingapp.cgi/Paper/815883.

Siahkoohi, Ali and Felix J. Herrmann. "Learning by example: Fast reliability-aware seismic imaging with normalizing flows". In: *First International Meeting for Applied Geoscience & Energy*. Society of Exploration Geophysicists. Expanded Abstracts, 2021, pp. 1580–1585. DOI: 10.1190/segam2021-3581836.1. URL: https://arxiv.org/abs/2104.06255.

Siahkoohi, Ali, Gabrio Rizzuti, Mathias Louboutin, Philipp Witte, and Felix J. Herrmann. "Preconditioned training of normalizing flows for variational inference in inverse problems". In: *3rd Symposium on Advances in Approximate Bayesian Inference*. Jan. 2021. URL: https://openreview.net/pdf?id=P9m1sMaNQ8T.

Rizzuti, Gabrio, Ali Siahkoohi, Philipp A. Witte, and Felix J. Herrmann. "Parameterizing uncertainty by deep invertible networks, an application to reservoir characterization". In: *90th Annual International Meeting*. Society of Exploration Geophysicists. Expanded Abstracts, Sept. 2020, pp. 1541–1545. DOI: 10.1190/segam2020-3428150.1. URL: https://arxiv.org/abs/2004.07871.

Siahkoohi, Ali, Gabrio Rizzuti, and Felix J. Herrmann. "A deep-learning based Bayesian approach to seismic imaging and uncertainty quantification". In: *82nd EAGE Conference and Exhibition*. Extended Abstracts, 2020. DOI: 10.3997/2214-4609.202010770.

Siahkoohi, Ali, Gabrio Rizzuti, and Felix J. Herrmann. "Uncertainty quantification in imaging and automatic horizon tracking—a Bayesian deep-prior based approach". In: *90th Annual International Meeting*. Society of Exploration Geophysicists. Expanded Abstracts, Sept. 2020, pp. 1636–1640. DOI: 10.1190/segam2020-3417560.1. URL: https://arxiv.org/abs/2004.00227.

Siahkoohi, Ali, Gabrio Rizzuti, and Felix J. Herrmann. "Weak deep priors for seismic imaging". In: *90th Annual International Meeting*. Society of Exploration Geophysicists. Expanded Abstracts, Sept. 2020, pp. 2998–3002. DOI: 10.1190/segam2020-3417568.1. URL: https://arxiv.org/abs/2004.06835.

Zhang, Mi, Ali Siahkoohi, and Felix J. Herrmann. "Transfer learning in large-scale ocean bottom seismic wavefield reconstruction". In: *90th Annual International Meeting*. Society of Exploration Geophysicists. Expanded Abstracts, Sept. 2020, pp. 1666–1670. DOI: 10.1190/segam2020-3427882.1. URL: https://arxiv.org/abs/2004.07388.

Herrmann, Felix J., Ali Siahkoohi, and Gabrio Rizzuti. "Learned imaging with constraints and uncertainty quantification". In: *Neural Information Processing Systems (NeurIPS) 2019 Deep Inverse Workshop*. Dec. 2019. URL: https://arxiv.org/pdf/1909.06473.pdf.

Rizzuti, Gabrio, Ali Siahkoohi, and Felix J. Herrmann. "Learned iterative solvers for the Helmholtz equation". In: *81st EAGE Conference and Exhibition*. Extended Abstracts, June 2019. DOI: 10.3997/2214-4609.201901542.

Siahkoohi, Ali, Rajiv Kumar, and Felix J. Herrmann. "Deep-learning based ocean bottom seismic wavefield recovery". In: *89th Annual International Meeting*. Society of Exploration Geophysicists. Expanded Abstracts, Aug. 2019, pp. 2232–2237. DOI: 10.1190/segam2019-3216632.1.

Siahkoohi, Ali, Dirk J. Verschuur, and Felix J. Herrmann. "Surface-related multiple elimination with deep learning". In: *89th Annual International Meeting*. Society of Exploration Geophysicists. Expanded Abstracts, Aug. 2019, pp. 4629–4634. DOI: 10.1190/segam2019-3216723.1.

Siahkoohi, Ali, Rajiv Kumar, and Felix J. Herrmann. "Seismic Data Reconstruction with Generative Adversarial Networks". In: *80th EAGE Conference and Exhibition*. Extended Abstracts, June 2018. DOI: 10.3997/2214-4609.201801393.

Siahkoohi, Ali, Mathias Louboutin, Rajiv Kumar, and Felix J. Herrmann. "Deep convolutional neural networks in prestack seismic—two exploratory examples". In: *88th Annual International Meeting*. Society of Exploration Geophysicists. Expanded Abstracts, Oct. 2018, pp. 2196–2200. DOI: 10.1190/segam2018-2998599.1.

Siahkoohi, Ali and Ali Gholami. "Sparsity Promoting Least Squares Migration for Laterally Inhomogeneous Media". In: *7th EAGE Saint Petersburg International Conference and Exhibition*. Extended Abstracts, Apr. 2016. DOI: 10.3997/2214-4609.201600223.

Ebrahimi, Mohmmad Sadegh, Mohammad Hossein Daraei, Jamshid Rezaei, and Ali Siahkoohi. "A Novel Utilization of Wireless Sensor Networks as Data Acquisition System in Smart Grids". In: *Materials Science and Information Technology*. Vol. 433-440. Advanced Materials Research. Trans Tech Publications, Ltd., 2012, pp. 6725–6730. DOI: 10.4028/www.scientific.net/amr.433-440.6725.

Najafi, Amir, Ali Siahkoohi, and Mohammad B. Shamsollahi. "A content-based digital image watermarking algorithm robust against JPEG compression". In: *2011 IEEE International Symposium on Signal Processing and Information Technology (ISSPIT)*. IEEE. 2011, pp. 432–437. DOI: 10.1109/ISSPIT.2011.6151601.

◇ **Technical Reports**

Zhang, Yijun, Ziyi Yin, Oscar Lopez, Ali Siahkoohi, Mathias Louboutin, and Felix J. Herrmann. *3D seismic survey design by maximizing the spectral gap*. Tech. rep. TR-CSE-2023-1. Mar. 2023. URL: https://slimgroup.github.io/IMAGE2023/zhang2023IMAGEsg/abstract.html.

LeJeune, Daniel, Lorenzo Luzi, Ali Siahkoohi, Sina Alemohammad, Vishwanath Saragadam, Hossein Babaei, Naiming Liu, Zichao Wang, and Richard G. Baraniuk. *TITAN: Bringing The Deep Image Prior to Implicit Representations*. Tech. rep. Rice University, Nov. 2022. URL: https://arxiv.org/abs/2211.00219.

Luzi, Lorenzo, Ali Siahkoohi, Paul M Mayer, Josue Casco-Rodriguez, and Richard G. Baraniuk. *Boomerang: Local sampling on image manifolds using diffusion models*. Tech. rep. Rice University, Oct. 2022. URL: https://arxiv.org/abs/2210.12100.

Louboutin, Mathias, Ali Siahkoohi, Rongrong Wang, and Felix J. Herrmann. *Low-memory stochastic backpropagation with multi-channel randomized trace estimation*. Tech. rep. Georgia Institute of Technology, June 2021. URL: https://arxiv.org/abs/2106.06998.

Siahkoohi, Ali, Gabrio Rizzuti, Philipp A. Witte, and Felix J. Herrmann. *Faster Uncertainty Quantification for Inverse Problems with Conditional Normalizing Flows*. Tech. rep. Georgia Institute of Technology, July 2020. URL: https://arxiv.org/abs/2007.07985.

Siahkoohi, Ali, Mathias Louboutin, and Felix J. Herrmann. *Neural network augmented wave-equation simulation*. Tech. rep. Georgia Institute of Technology, Sept. 2019. URL: https://arxiv.org/abs/1910.00925.

Service

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

◇ Reviewed conference papers for
International Speech Communication Association (Interspeech)
Advances in Approximate Bayesian Inference (AABI, workshop)
Neural Information Processing Systems (NeurIPS)
Structured Probabilistic Inference & Generative Modeling (SPIGM, ICML workshop)
International Meeting for Applied Geoscience & Energy (IMAGE)

◇ Session chair for the International Meeting for Applied Geoscience & Energy (IMAGE 2022)

◇ Guest editor for a special issue in Mathematics journal
Applied Mathematics in Inverse Problems and Uncertainty Quantification

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

Ali Siahkoohi

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