

Ali Siahkoohi

CONTACT	<p>Office: 2037 Duncan Hall 6100 Main Street Houston, TX 77005</p> <p>Email: alisk@rice.edu</p>
RESEARCH INTERESTS	<p>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.</p> <p><i>Keywords:</i> Deep Learning, Generative Models, Variational Inference, Inverse Problems, Uncertainty Quantification, Signal Processing</p>
EMPLOYMENT	<p>Simons Postdoctoral Fellow, August 2022–present Department of Computational Applied Mathematics & Operations Research Rice University, Houston, TX, USA</p> <p>Research Assistant, February 2018–July 2022 School of Computational Science and Engineering Georgia Institute of Technology, Atlanta, GA, USA</p> <p>Research Intern, August 2021–December 2021 Chrome Media Team Google, San Francisco, CA, USA</p> <p>Research Assistant, August 2016–January 2018 Department of Earth, Ocean and Atmospheric Sciences University of British Columbia, Vancouver, BC, Canada</p>
PROFESSIONAL PREPARATION	<p>Georgia Institute of Technology, Atlanta, GA, USA Ph.D., 2022, Computational Science and Engineering</p> <p>University of Tehran, Tehran, Iran M.Sc., 2016, Geophysics</p> <p>Sharif University of Technology, Tehran, Iran B.Sc., 2013, Electrical Engineering</p>
PUBLICATION	<p>◇ Preprints</p> <p>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,” Jul. 2023.</p> <p>L. Baldassari, A. Siahkoohi, J. Garnier, K. Sølna, and M. V. de Hoop, “Conditional score-based diffusion models for Bayesian inference in infinite dimensions,” May 2023.</p> <p>L. Luzi, P. M. Mayer, J. Casco-Rodriguez, A. Siahkoohi, and R. G. Baraniuk, “Boomerang: Local sampling on image manifolds using diffusion models,” Jun. 2023.</p> <p>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,” May 2023.</p> <p>◇ Journal Publications</p>

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*, vol. 42, no. 7, pp. 474–486, Jul. 2023.

A. Siahkoohi, G. Rizzuti, R. Orozco, and F. J. Herrmann, “Reliable amortized variational inference with physics-based latent distribution correction,” *Geophysics*, vol. 88, no. 3, R297–R322, Jan. 2023.

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*, vol. 88, no. 4, A19–A23, Apr. 2023.

A. Siahkoohi, G. Rizzuti, and F. J. Herrmann, “Deep Bayesian inference for seismic imaging with tasks,” *Geophysics*, vol. 87, no. 5, S281–S302, Sep. 2022.

A. Siahkoohi, M. Louboutin, and F. J. Herrmann, “The importance of transfer learning in seismic modeling and imaging,” *Geophysics*, vol. 84, no. 6, A47–A52, Nov. 2019.

◇ Conference Papers

M. Louboutin, R. Orozco, A. Siahkoohi, and F. J. Herrmann, “Learned one-shot imaging,” in *3rd International Meeting for Applied Geoscience & Energy*, Society of Exploration Geophysicists, May 2023.

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 (MIDL) Conference*, Mar. 2023.

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*, Jun. 2023.

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*, International Society for Optics and Photonics, vol. 12464, SPIE, 2023, p. 124641L.

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*, ser. Proceedings of Machine Learning Research, vol. 202, PMLR, Jul. 2023, pp. 31 754–31 772.

Y. Zhang, Z. Yin, O. Lopez, A. Siahkoohi, M. Louboutin, and F. J. Herrmann, “3D seismic survey design by maximizing the spectral gap,” in *3rd International Meeting for Applied Geoscience & Energy*, Society of Exploration Geophysicists, May 2023.

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 *2nd International Meeting for Applied Geoscience & Energy*, Society of Exploration Geophysicists, Aug. 2022, pp. 1482–1486.

A. Siahkoohi, M. Chinen, T. Denton, W. B. Kleijn, and J. Skoglund, “Ultra-Low-Bitrate Speech Coding with Pretrained Transformers,” in *Proceedings of Interspeech 2022*, Sep. 2022, pp. 4421–4425.

A. Siahkoohi, M. Louboutin, and F. 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.

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*, Jun. 2022.

- Z. Yin, A. Siahkoohi, M. Louboutin, and F. 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.
- 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 *2nd International Meeting for Applied Geoscience & Energy*, Society of Exploration Geophysicists, Aug. 2022, pp. 15–20.
- R. Kumar, M. Kotsi, A. Siahkoohi, and A. 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.
- R. Orozco, A. Siahkoohi, G. Rizzuti, T. van Leeuwen, and F. J. Herrmann, “Photoacoustic imaging with conditional priors from normalizing flows,” in *NeurIPS 2021 Workshop on Deep Learning and Inverse Problems*, Dec. 2021.
- Y. Ren, P. A. Witte, A. Siahkoohi, M. Louboutin, and F. J. Herrmann, “Seismic Velocity Inversion and Uncertainty Quantification Using Conditional Normalizing Flows,” in *American Geophysical Union (AGU) Fall Meeting*, Dec. 2021.
- A. Siahkoohi and F. 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.
- 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*, Jan. 2021.
- G. Rizzuti, A. Siahkoohi, P. A. Witte, and F. J. Herrmann, “Parameterizing uncertainty by deep invertible networks, an application to reservoir characterization,” in *90th Annual International Meeting*, Society of Exploration Geophysicists, Expanded Abstracts, Sep. 2020, pp. 1541–1545.
- A. Siahkoohi, G. Rizzuti, and F. J. Herrmann, “A deep-learning based bayesian approach to seismic imaging and uncertainty quantification,” in *82nd EAGE Conference and Exhibition*, Extended Abstracts, 2020.
- A. Siahkoohi, G. Rizzuti, and F. 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, Sep. 2020, pp. 1636–1640.
- A. Siahkoohi, G. Rizzuti, and F. J. Herrmann, “Weak deep priors for seismic imaging,” in *90th Annual International Meeting*, Society of Exploration Geophysicists, Expanded Abstracts, Sep. 2020, pp. 2998–3002.
- M. Zhang, A. Siahkoohi, and F. J. Herrmann, “Transfer learning in large-scale ocean bottom seismic wavefield reconstruction,” in *90th Annual International Meeting*, Society of Exploration Geophysicists, Expanded Abstracts, Sep. 2020, pp. 1666–1670.
- F. J. Herrmann, A. Siahkoohi, and G. Rizzuti, “Learned imaging with constraints and uncertainty quantification,” in *Neural Information Processing Systems (NeurIPS) 2019 Deep Inverse Workshop*, Dec. 2019.
- G. Rizzuti, A. Siahkoohi, and F. J. Herrmann, “Learned iterative solvers for the helmholtz equation,” in *81st EAGE Conference and Exhibition*, Extended Abstracts, Jun. 2019.

A. Siahkoohi, R. Kumar, and F. 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.

A. Siahkoohi, D. J. Verschuur, and F. 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.

A. Siahkoohi, R. Kumar, and F. J. Herrmann, “Seismic Data Reconstruction with Generative Adversarial Networks,” in *80th EAGE Conference and Exhibition*, Extended Abstracts, Jun. 2018.

A. Siahkoohi, M. Louboutin, R. Kumar, and F. 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.

A. Siahkoohi and A. Gholami, “Sparsity Promoting Least Squares Migration for Laterally Inhomogeneous Media,” in *7th EAGE Saint Petersburg International Conference and Exhibition*, Extended Abstracts, Apr. 2016.

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*, ser. Advanced Materials Research, vol. 433-440, Trans Tech Publications, Ltd., 2012, pp. 6725–6730.

A. Najafi, A. Siahkoohi, and M. 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.

◇ **Thesis**

A. Siahkoohi, “Deep generative models for solving geophysical inverse problems,” PhD Thesis, Georgia Institute of Technology, Jul. 2022.

◇ **Technical Reports**

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,” Rice University, Tech. Rep., Nov. 2022.

M. Louboutin, A. Siahkoohi, R. Wang, and F. J. Herrmann, “Low-memory stochastic backpropagation with multi-channel randomized trace estimation,” Georgia Institute of Technology, Tech. Rep., Jun. 2021.

A. Siahkoohi, G. Rizzuti, P. A. Witte, and F. J. Herrmann, “Faster uncertainty quantification for inverse problems with conditional normalizing flows,” Georgia Institute of Technology, Tech. Rep., Jul. 2020.

A. Siahkoohi, M. Louboutin, and F. J. Herrmann, “Neural network augmented wave-equation simulation,” Georgia Institute of Technology, Tech. Rep., Sep. 2019.

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

Linear Algebra, Spring 2010

Sharif University of Technology, Tehran, Iran

Teaching Assistant