

# Ali Siahkoohi

## CURRICULUM VITAE

### CONTACT INFORMATION

**Office** Duncan Hall, Room 2037  
6100 Main Street, Houston, TX 77005

**Email** [alisk@rice.edu](mailto:alisk@rice.edu)  
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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

### 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. 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 10.21105/joss.06103, 2023
- P1. [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, 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

- C33. 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 *International Conference on Learning Representations*, 2024

- C32. 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. In *IEEE International Conference on Acoustics, Speech and Signal Processing*, 2024. In print
- 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
<ul style="list-style-type: none"> <li>▶ International Conference on Machine Learning</li> <li>▶ Poster presentation</li> </ul>	
Refining amortized posterior approximations using gradient-based summary statistics	July 2023
<ul style="list-style-type: none"> <li>▶ Symposium on Advances in Approximate Bayesian Inference</li> <li>▶ Poster presentation</li> </ul>	
Martian time-series unraveled: A multi-scale nested approach with factorial variational autoencoders	May 2023
<ul style="list-style-type: none"> <li>▶ Geo-Mathematical Imaging Group Partners Meeting, Rice University</li> <li>▶ Oral presentation</li> </ul>	
Unearthing InSights into Mars: Unsupervised source separation with limited data	May 2023
<ul style="list-style-type: none"> <li>▶ Geo-Mathematical Imaging Group Partners Meeting, Rice University</li> <li>▶ Oral presentation</li> </ul>	
Low-cost uncertainty quantification for large-scale inverse problems	January 2023
<ul style="list-style-type: none"> <li>▶ RhEoVOLUTION Group (Dr. Andréa Tommasi), CNRS &amp; Université Montpellier</li> <li>▶ <b>Invited</b> virtual oral presentation</li> </ul>	
Reliable amortized variational inference with conditional normalizing flows via physics-based latent distribution correction	August 2022
<ul style="list-style-type: none"> <li>▶ International Meeting for Applied Geoscience &amp; Energy, Workshop on Subsurface Uncertainty Description and Estimation</li> <li>▶ <b>Invited</b> oral presentation</li> </ul>	
Velocity continuation with Fourier neural operators for accelerated uncertainty quantification	August 2022
<ul style="list-style-type: none"> <li>▶ International Meeting for Applied Geoscience &amp; Energy</li> <li>▶ Oral presentation</li> </ul>	
Low-bitrate speech coding with Transformers	December 2021
<ul style="list-style-type: none"> <li>▶ Chrome Media Team, Google</li> <li>▶ Virtual oral presentation</li> </ul>	
Multifidelity conditional normalizing flows for physics-guided Bayesian inference	November 2021
<ul style="list-style-type: none"> <li>▶ ML4SEISMIC Partners Meeting, Georgia Institute of Technology</li> <li>▶ Virtual oral presentation</li> </ul>	
Uncertainty quantification in imaging and automatic horizon tracking—A Bayesian deep-prior based approach	November 2021
<ul style="list-style-type: none"> <li>▶ ML4SEISMIC Partners Meeting, Georgia Institute of Technology</li> <li>▶ Virtual oral presentation</li> </ul>	
Learning by example: Fast reliability-aware seismic imaging with normalizing flows	September 2021
<ul style="list-style-type: none"> <li>▶ Society of Exploration Geophysicists International Exposition and Annual Meeting</li> <li>▶ Virtual oral presentation <a href="#">[Link to video]</a></li> </ul>	
Fast and reliability-aware seismic imaging with conditional normalizing flows	June 2021
<ul style="list-style-type: none"> <li>▶ KAUST Virtual Workshop: Intelligent illumination of the Earth</li> <li>▶ <b>Invited</b> virtual oral presentation</li> </ul>	
Preconditioned training of normalizing flows for variational inference in inverse problems	January 2021
<ul style="list-style-type: none"> <li>▶ Symposium on Advances in Approximate Bayesian Inference</li> <li>▶ Prerecorded short oral presentation <a href="#">[Link to video]</a></li> </ul>	
A deep-learning based Bayesian approach to seismic imaging and uncertainty quantification	December 2020

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

## 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

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

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#### INTERNSHIP

<b>Research Intern</b> Chrome Media Team Google, San Francisco, CA, USA	August 2021 – December 2021
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