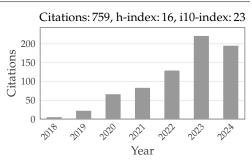
## Ali Siahkoohi

Simons Postdoctoral Fellow Dept. of Comp. Applied Math. & Operations Research Rice University alisk@rice.edu alisiahkoohi.github.io Last updated: August 13, 2024

### **Research Interests and Highlights**

My research in *scientific machine learning*, under the mentorship of Maarten V. de Hoop and Richard G. Baraniuk, lies at the intersection of computational science and artificial intelligence, focusing on developing scalable, data-driven methods that leverage the strengths of both fields to address challenging, large-scale problems in computational science and engineering. Keywords defining my current research interests include: computational science, deep learning, generative models, and uncertainty quantification.



Over the past years, I have published 39 peer-reviewed articles, including 17 first-author papers in high-impact journals and conference proceedings, such as NeurIPS, ICML, ICLR, Interspeech, MIDL, SPIE, TMLR, and Geophysics.

## **Academic Appointments**

Rice UniversityAugust 2022 – PresentSimons Postdoctoral FellowHouston, TX, USA

Department of Computational Applied Mathematics & Operations Research Jointly hosted by Maarten V. de Hoop and Richard G. Baraniuk

#### Education

# Georgia Institute of Technology Ph.D. in Computational Science and Engineering (minor in Applied Math.) Atlanta, GA, USA

Ph.D. in Computational Science and Engineering (minor in Applied Math.) Advised by Felix J. Herrmann

University of TehranMarch 2016M.Sc. in GeophysicsTehran, Iran

Sharif University of TechnologyAugust 2013B.Sc. in Electrical EngineeringTehran, Iran

#### **Awards**

#### George R. Brown School of Engineering, Rice University

Future Faculty Fellows Award

June 2024 Houston, TX, USA

#### The University of British Columbia

Faculty of Science PhD Tuition Award

August 2016 – August 2017 Vancouver, BC, Canada

#### **Publications**

Google Scholar profile: https://scholar.google.com/citations?user=sxRMqYIAAAAJ&h

#### In Preparation & Under Review

- P4. <u>A. Siahkoohi</u>, 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; under review by *IEEE Transactions on Neural Networks and Learning Systems*, 2024
- P3. P. M. Mayer, L. Luzi, <u>A. Siahkoohi</u>, D. H. Johnson, and R. G. Baraniuk. Removing bias from maximum likelihood estimation with model autophagy. Preprint arXiv:2405.13977; under review by *NeurIPS*, 2024
- P2. L. Baldassari, <u>A. Siahkoohi</u>, J. Garnier, K. Sølna, and M. V. de Hoop. Taming score-based diffusion priors for infinite-dimensional nonlinear inverse problems. Preprint arXiv:2405.15676; under review by *NeurIPS*, 2024
- P1. R. Orozco, <u>A. Siahkoohi</u>, M. Louboutin, and F. J. Herrmann. ASPIRE: Iterative amortized posterior inference for Bayesian inverse problems. Preprint arXiv:2405.05398; under review by *Inverse Problems*, 2024

#### **Journal Publications**

- J7. R. Orozco, P. Witte, M. Louboutin, <u>A. Siahkoohi</u>, G. Rizzuti, B. Peters, and F. J. Herrmann. InvertibleNetworks.jl: A Julia package for scalable normalizing flows. *Journal of Open Source Software*, 9(99):6554, 2024
- J6. L. Luzi, P. M. Mayer, J. Casco-Rodriguez, <u>A. Siahkoohi</u>, 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, <u>A. Siahkoohi</u>, 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, <u>A. Siahkoohi</u>, 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. <u>A. Siahkoohi</u>, 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. <u>A. Siahkoohi</u>, G. Rizzuti, and F. J. Herrmann. Deep Bayesian inference for seismic imaging with tasks. *Geophysics*, 87(5):S281–S302, 2022
- J1. <u>A. Siahkoohi</u>, 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 Proceedings**

- C32. S. Alemohammad, J. Casco-Rodriguez, L. Luzi, A. I. Humayun, H. Babaei, D. LeJeune, <u>A. Siahkoohi</u>, and R. G. Baraniuk. Self-consuming generative models go MAD. In *The Twelfth International Conference on Learning Representations*, 2024
- C31. L. Luzi, D. LeJeune, <u>A. Siahkoohi</u>, 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, <u>A. Siahkoohi</u>, 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, pages 24262–24290, 2023
- C29. <u>A. Siahkoohi</u>, 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, <u>A. Siahkoohi</u>, 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, <u>A. Siahkoohi</u>, 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, <u>A. Siahkoohi</u>, 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. <u>A. Siahkoohi</u>, 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. <u>A. Siahkoohi</u>, 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, <u>A. Siahkoohi</u>, 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, <u>A. Siahkoohi</u>, 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, <u>A. Siahkoohi</u>, 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. <u>A. Siahkoohi</u>, 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, <u>A. Siahkoohi</u>, G. Rizzuti, T. van Leeuwen, and F. J. Herrmann. Photoacoustic imaging with conditional priors from normalizing flows. In *NeurIPS Workshop on Deep Learning and Inverse Problems*, 2021
- C17. <u>A. Siahkoohi</u>, 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. <u>A. Siahkoohi</u> 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, <u>A. Siahkoohi</u>, 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, <u>A. Siahkoohi</u>, 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, <u>A. Siahkoohi</u>, 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. <u>A. Siahkoohi</u>, 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. <u>A. Siahkoohi</u>, 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. <u>A. Siahkoohi</u>, 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, <u>A. Siahkoohi</u>, and G. Rizzuti. Learned imaging with constraints and uncertainty quantification. In *NeurIPS Deep Inverse Workshop*, 2019
- C8. <u>A. Siahkoohi</u>, 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. <u>A. Siahkoohi</u>, 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, <u>A. Siahkoohi</u>, and F. J. Herrmann. Learned iterative solvers for the Helmholtz equation. In *European Association of Geoscientists & Engineers Conference and Exhibition Extended Abstracts*, 2019
- C5. <u>A. Siahkoohi</u>, 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. <u>A. Siahkoohi</u>, 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. <u>A. Siahkoohi</u> 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 <u>A. Siahkoohi</u>. 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, <u>A. Siahkoohi</u>, 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. <u>A. Siahkoohi</u>. *Deep generative models for solving geophysical inverse problems*. PhD thesis, **Georgia Institute of Technology**, 2022
- T1. <u>A. Siahkoohi</u>. *Sparsity promoting least-squares migration for laterally inhomogeneous media*. Master's thesis, University of Tehran, 2016

#### **Technical Reports**

- R3. M. Louboutin, <u>A. Siahkoohi</u>, R. Wang, and F. J. Herrmann. Low-memory stochastic backpropagation with multi-channel randomized trace estimation. Technical Report arXiv:2106.06998, Georgia Institute of Technology, 2021
- R2. <u>A. Siahkoohi</u>, G. Rizzuti, P. A. Witte, and F. J. Herrmann. Faster uncertainty quantification for inverse problems with conditional normalizing flows. Technical Report arXiv:2007.07985, Georgia Institute of Technology, 2020
- R1. <u>A. Siahkoohi</u>, M. Louboutin, and F. J. Herrmann. Neural network augmented wave-equation simulation. Technical Report arXiv:1910.00925, Georgia Institute of Technology, 2019

#### **Talks**

#### **Invited Talks**

T22.	CNRS, Université Montpellier Low-cost uncertainty quantification for large-scale inverse problems RhEoVOLUTION Group (Dr. Andréa Tommasi)	January 2023 Virtual oral presentation
T21.	Workshop on Subsurface Uncertainty Description and Estimation Reliable amortized variational inference with conditional normalizing flows via physics-based latent distribution correction International Meeting for Applied Geoscience & Energy	August 2022 Oral presentation
T20.	Intelligent illumination of the Earth Workshop	June 2021 Virtual oral presentation
T19.	Advances in Seismic Imaging and Inversion Mini-symposium Unsupervised data-guided uncertainty analysis in imaging and horizon tracking The 3rd Annual Meeting of the SIAM Texas—Louisiana Section	October 2020 Virtual oral presentation
Co	ntributed Talks	
	International Conference on Machine Learning Unearthing InSights into Mars: Unsupervised source separation with limited dates	July 2023 ata Poster presentation
T17.	Symposium on Advances in Approximate Bayesian Inference Refining amortized posterior approximations using gradient-based summary statistics	July 2023 Poster presentation
T16.	<b>Geo-Mathematical Imaging Group Partners Meeting, Rice University</b> Martian time-series unraveled: A multi-scale nested approach with factorial variational autoencoders	May 2023 Oral presentation
T15.	<b>Geo-Mathematical Imaging Group Partners Meeting, Rice University</b> Unearthing InSights into Mars: Unsupervised source separation with limited data.	May 2023 ata Oral presentation
T14.	International Meeting for Applied Geoscience & Energy Velocity continuation with Fourier neural operators for accelerated uncertainty quantification	August 2022 Oral presentation
T13.	Chrome Media Team, Google Low-bitrate speech coding with Transformers	December 2021 Virtual oral presentation
T12.	ML4SEISMIC Partners Meeting, Georgia Institute of Technology Multifidelity conditional normalizing flows for physics-guided Bayesian inference	November 2021 Virtual oral presentation
T11.	ML4SEISMIC Partners Meeting, Georgia Institute of Technology Uncertainty quantification in imaging and automatic horizon tracking—A Bayesian deep-prior based approach	November 2021 Virtual oral presentation
T10.	Society of Exploration Geophysicists International Exposition and Annual M Learning by example: Fast reliability-aware seismic imaging with normalizing flows [Link to video]	<b>leeting</b> September 2021 Virtual oral presentation
T9.	Symposium on Advances in Approximate Bayesian Inference Preconditioned training of normalizing flows for variational inference in inverse problems [Link to video]	January 2021 ed short oral presentation
T8.	European Association of Geoscientists & Engineers Annual Conference & Exhibit A deep-learning based Bayesian approach to seismic imaging and uncertainty quantification	<b>ibition</b> December 2020 Virtual oral presentation
T7.	Society of Exploration Geophysicists International Exposition and Annual M Uncertainty quantification in imaging and automatic horizon tracking—A Bayesian deep-prior based approach [Link to video]	<b>leeting</b> October 2020 Virtual oral presentation
T6.	Society of Exploration Geophysicists International Exposition and Annual M	<b>Ceeting</b> October 2020

Virtual oral presentation

Weak deep priors for seismic imaging [Link to video]

T5.	Society of Exploration Geophysicists Student Chapter, Georgia Tech A deep-learning based Bayesian approach to seismic imaging and uncertainty quantification	February 2020 Oral presentation
T4.	HotCSE Seminar, CSE Department, Georgia Institute of Technology	November 2019
TT 0	Learned imaging with constraints and uncertainty quantification	Oral presentation
13.	Society of Exploration Geophysicists International Exposition & Annual Meeting Deep-learning based ocean bottom seismic wavefield recovery	September 2019 Oral presentation
Т2	Society of Exploration Geophysicists International Exposition & Annual Meeting	September 2019
14.	Surface-related multiple elimination with deep learning	Oral presentation
T1.	Society of Exploration Geophysicists International Exposition & Annual Meeting	October 2018
	Deep convolutional neural networks in prestack seismic—two exploratory examples	Poster presentation
Pr	ofessional Service	
Ed	itorial Service	
<b>&gt;</b>	Acta Geophysica	2024 – Present
	Associate Editor	
	Applied Geophysics section	2022 P
•	Journal of Mathematics Guest Editor	2023 – Present
	Special issue on Applied Mathematics in Inverse Problems and Uncertainty Quantific	cation
Co	onference Organization	
•	Annual AAAI Conference on Artificial Intelligence	2025
•	Program Chair  International Meeting for Applied Geoscience & Energy Session Chair	2022
Te	chnical Program Committee Member and Reviewer	
•	International Conference on Learning Representations (ICLR)	2024 - 2025
•	Neural Information Processing Systems (NeurIPS)	2023 - 2024
•	Advances in Approximate Bayesian Inference (AABI)	2023 - 2024
•	Structured Probabilistic Inference & Generative Modeling (ICML workshop)	2023 - 2024
•	International Conference on Machine Learning (ICML)	2024
•	Artificial Intelligence and Statistics Conference (AISTATS)	2024
•	International Speech Communication Association (Interspeech)	2023
•	Deep Generative Models for Health (NeurIPS workshop)	2023
•	International Meeting for Applied Geoscience & Energy	2023
Jou	arnal Reviewer	
<b>&gt;</b>	IEEE Transactions on Neural Networks and Learning Systems	
	IEEE Geoscience and Remote Sensing Letters	
<b>&gt;</b>	IEEE Transactions on Geoscience and Remote Sensing	
<b>&gt;</b>	Notices of the American Mathematical Society (AMS)	
<b>&gt;</b>	Remote Sensing	
<b>•</b>	Journal of Geophysical Research – Solid Earth	

► Geophysical Prospecting

► Geophysics

- ▶ Geosciences
- ► Entropy

## **Teaching Experience**

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

# Internship

Linear Algebra

Teaching Assistant

Google Research Intern (cf. publication C24) Chrome Media Team August 2021 – December 2021 San Francisco, CA, USA

Tehran, Iran