

RAHUL PARHI

PERSONAL INFORMATION

Department of Electrical and Computer Engineering
University of California, San Diego
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9500 Gilman Drive, MC 0407
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ACADEMIC EMPLOYMENT

University of California, San Diego, La Jolla, California, USA 2024 – present
Assistant Professor
Department of Electrical and Computer Engineering

École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland 2022 – 2024
Postdoctoral Researcher
[Biomedical Imaging Group](#)
Institute of Electrical and Micro Engineering
Supervisor: [Michael Unser](#)

EDUCATION

University of Wisconsin–Madison, Madison, Wisconsin, USA 2018 – 2022
Ph.D., Electrical Engineering
M.S., Electrical Engineering (2019)
Minor in Mathematics
Supervisor: [Robert D. Nowak](#)

University of Minnesota–Twin Cities, Minneapolis, Minnesota, USA 2015 – 2018
B.S., Mathematics
B.S., Computer Science
Minor in Physics
Graduated *magna cum laude*

PAPERS

[Manuscripts Under Review](#)

- [M3] **Rahul Parhi**, Pakshal Bohra, Ayoub El Biari, Mehrsa Pourya, and Michael Unser. “Random ReLU Neural Networks as Non-Gaussian Processes”. May 2024. arXiv: [2405.10229 \[stat.ML\]](#).
- [M2] **Rahul Parhi** and Michael Unser. “Function-Space Optimality of Neural Architectures with Multivariate Nonlinearities”. Oct. 2023. arXiv: [2310.03696 \[stat.ML\]](#).
- [M1] Ronald DeVore, Robert D. Nowak, **Rahul Parhi**, and Jonathan W. Siegel. “Weighted Variation Spaces and Approximation by Shallow ReLU Networks”. July 2023. arXiv: [2307.15772 \[stat.ML\]](#).

[Journal Publications](#)

- [J8] **Rahul Parhi** and Michael Unser. “Distributional Extension and Invertibility of the k -Plane Transform and Its Dual”. In: *SIAM Journal on Mathematical Analysis* 56.4 (2024), pp. 4662–4686. DOI: [10.1137/23M1556721](#).
- [J7] Joseph Shenouda, **Rahul Parhi**, Kangwook Lee, and Robert D. Nowak. “Variation Spaces for Multi-Output Neural Networks: Insights on Multi-Task Learning and Network Compression”. In: *Journal of Machine Learning Research* 25.231 (2024), pp. 1–40. URL: <https://www.jmlr.org/papers/v25/23-0677.html>.
- [J6] **Rahul Parhi** and Robert D. Nowak. “Deep Learning Meets Sparse Regularization: A signal processing perspective”. In: *IEEE Signal Processing Magazine* 40.6 (Sept. 2023), pp. 63–74. DOI: [10.1109/MSP.2023.3286988](#).

- [J5] **Rahul Parhi** and Michael Unser. “The Sparsity of Cycle Spinning for Wavelet-Based Solutions of Linear Inverse Problems”. In: *IEEE Signal Processing Letters* 30 (May 2023), pp. 568–572. DOI: [10.1109/LSP.2023.3275916](https://doi.org/10.1109/LSP.2023.3275916).
- [J4] **Rahul Parhi** and Robert D. Nowak. “Near-Minimax Optimal Estimation With Shallow ReLU Neural Networks”. In: *IEEE Transactions on Information Theory* 69.2 (Feb. 2023), pp. 1125–1140. DOI: [10.1109/TIT.2022.3208653](https://doi.org/10.1109/TIT.2022.3208653).
- [J3] **Rahul Parhi** and Robert D. Nowak. “What Kinds of Functions Do Deep Neural Networks Learn? Insights from Variational Spline Theory”. In: *SIAM Journal on Mathematics of Data Science* 4.2 (2022), pp. 464–489. DOI: [10.1137/21M1418642](https://doi.org/10.1137/21M1418642).
- [J2] **Rahul Parhi** and Robert D. Nowak. “Banach Space Representer Theorems for Neural Networks and Ridge Splines”. In: *Journal of Machine Learning Research* 22.43 (2021), pp. 1–40. URL: <https://jmlr.org/papers/v22/20-583.html>.
- [J1] **Rahul Parhi** and Robert D. Nowak. “The Role of Neural Network Activation Functions”. In: *IEEE Signal Processing Letters* 27 (Sept. 2020), pp. 1779–1783. DOI: [10.1109/LSP.2020.3027517](https://doi.org/10.1109/LSP.2020.3027517).

Conference Publications.....

- [C5] **Rahul Parhi** and Michael Unser. “Modulation Spaces and the Curse of Dimensionality”. In: *International Conference on Sampling Theory and Applications (SampTA)*. July 2023, pp. 1–5. DOI: [10.1109/SampTA59647.2023.10301395](https://doi.org/10.1109/SampTA59647.2023.10301395).
- [C4] Joseph Shenouda, **Rahul Parhi**, and Robert D. Nowak. “A Continuous Transform for Localized Ridgelets”. In: *International Conference on Sampling Theory and Applications (SampTA)*. July 2023, pp. 1–5. DOI: [10.1109/SampTA59647.2023.10301398](https://doi.org/10.1109/SampTA59647.2023.10301398).
- [C3] **Rahul Parhi** and Robert D. Nowak. “On Continuous-Domain Inverse Problems with Sparse Superpositions of Decaying Sinusoids as Solutions”. In: *IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*. 2022, pp. 5603–5607. DOI: [10.1109/ICASSP43922.2022.9746165](https://doi.org/10.1109/ICASSP43922.2022.9746165).
- [C2] **Rahul Parhi**, Michael Schliep, and Nicholas Hopper. “MP3: A More Efficient Private Presence Protocol”. In: *Financial Cryptography and Data Security*. 2018, pp. 38–57. DOI: [10.1007/978-3-662-58387-6_3](https://doi.org/10.1007/978-3-662-58387-6_3).
- [C1] **Rahul Parhi**, Chris H. Kim, and Keshab K. Parhi. “Fault-Tolerant Ripple-Carry Binary Adder Using Partial Triple Modular Redundancy (PTMR)”. In: *IEEE International Symposium on Circuits and Systems (ISCAS)*. 2015, pp. 41–44. DOI: [10.1109/ISCAS.2015.7168565](https://doi.org/10.1109/ISCAS.2015.7168565).

STUDENT SUPERVISION

École Polytechnique Fédérale de Lausanne Supervised Master’s Projects/Theses	Lausanne, Switzerland
▶ Ayoub El Biari – <i>Characterizing Random Neural Networks as Stochastic Processes</i>	2023
▶ Bassam El Rawas – <i>Approximation Theory with Exponential Splines</i>	2023

INVITED SEMINARS AND COLLOQUIA

Deep Learning Meets Sparse Regularization Electrical Engineering and Computer Science (EECS) Seminar Massachusetts Institute of Technology (MIT)	March 2024 Cambridge, Massachusetts, USA
Deep Learning Meets Sparse Regularization Electrical and Computer Engineering (ECE) Seminar University of California, San Diego (UCSD)	February 2024 San Diego, California, USA
Deep Learning Meets Sparse Regularization Applied Mathematics Seminar University of Colorado, Boulder (CU Boulder)	February 2024 Boulder, Colorado, USA
Deep Learning Meets Sparse Regularization Computing Science Seminar University of Alberta	February 2024 Edmonton, Alberta, Canada

Deep Learning Meets Sparse Regularization Mathematics Seminar Rutgers University	January 2024 New Brunswick, New Jersey, USA
Deep Learning Meets Sparse Regularization School of Science and Engineering Seminar The Chinese University of Hong Kong, Shenzhen (CUHK–Shenzhen)	January 2024 Shenzhen, Guangdong, China
Deep Learning Meets Sparse Regularization Electrical and Systems Engineering + Statistics and Data Science Seminar Washington University in St. Louis	December 2023 St. Louis, Missouri, USA
Deep Learning Meets Sparse Regularization Mathematical Information Science (MINS) Seminar Eidgenössische Technische Hochschule (ETH) Zürich	December 2023 Zürich, Switzerland
Deep Learning Meets Sparse Regularization Statistics Seminar Université Catholique de Louvain	November 2023 Louvain-la-Neuve, Belgium
Deep Learning Meets Sparse Regularization Math Machine Learning Seminar Max Planck Institute for Mathematics in the Sciences (MPI MiS) + University of California Los Angeles (UCLA)	September 2023 Online (via Zoom)
Regularizing Neural Networks via Radon-Domain Total Variation Mathematical Institute for Data Science (MINDS) Seminar Johns Hopkins University	November 2022 Baltimore, Maryland, USA
What Kinds of Functions Do Neural Networks Learn? Working Group on Mean Field Neural Networks Seminar Simons Institute for the Theory of Computing	November 2021 Online (via Zoom)
On BV Spaces, Splines, and Neural Networks Analysis Seminar Department of Mathematics, University of Wisconsin–Madison	November 2021 Madison, Wisconsin, USA
A Representer Theorem for Single-Hidden Layer Neural Networks Institute for Foundations of Data Science (IFDS) Seminar University of Wisconsin–Madison	July 2020 Online (via WebEx)
Neural Networks Learn Splines Human, Animal, and Machine Learning: Experiment and Theory (HAMLET) Seminar University of Wisconsin–Madison	October 2019 Madison, Wisconsin, USA
Minimum “Norm” Neural Networks and Splines Institute for Foundations of Data Science (IFDS) Seminar University of Wisconsin–Madison	September 2019 Madison, Wisconsin, USA

INVITED CONFERENCE TALKS

A Banach-Space View of Neural Network Training Nonsmooth and Hierarchical Optimization in Machine Learning Session 2024 International Symposium on Mathematical Programming (ISMP)	July 2024 Montréal, Québec, Canada
On the Sparsity-Promoting Effect of Weight Decay in Deep Learning Rising Stars Session 2024 Conference on Parsimony and Learning (CPAL)	January 2024 Pok Fu Lam, Hong Kong
A Banach Space Representer Theorem for Single-Hidden Layer Neural Networks Young Researchers Spotlight Session 2020 Workshop on Seeking Low-Dimensionality in Deep Neural Networks (SLOWDNN)	November 2020 Online (via Zoom)

OTHER EXPERIENCE

Industry.....

- Amazon.com, Inc.** Seattle, Washington, USA
- ▶ Software Development Engineering (SDE) Intern Summer 2018
 - ▶ Software Development Engineering (SDE) Intern Summer 2017

Teaching.....

- University of California, San Diego** La Jolla, California
Instructor

- ▶ ECE 251C: Filter Banks & Wavelets Fall 2024

- École Polytechnique Fédérale de Lausanne** Lausanne, Switzerland
Teaching Assistant

- ▶ MICRO 512: Image Processing II Spring 2024
- ▶ MICRO 511: Image Processing I Fall 2023
- ▶ MICRO 512: Image Processing II Spring 2023
- ▶ MICRO 511: Image Processing I Fall 2022

- University of Wisconsin–Madison** Madison, Wisconsin, USA
Teaching Assistant

- ▶ ECE/CS 761: Mathematical Foundations of Machine Learning Spring 2022
- ▶ ECE/CS/ME 532: Matrix Methods in Machine Learning Fall 2021
- ▶ ECE 901: Nonparametric Methods in Data Science Spring 2021
Helped develop and teach a new topics course covering variational/nonparametric methods in data science ranging from classical methods based on splines and wavelets to modern methods based on neural networks.
- ▶ ECE/CS/ME 532: Matrix Methods in Machine Learning Fall 2020
- ▶ ECE/CS 761: Mathematical Foundations of Machine Learning Spring 2020

- University of Minnesota–Twin Cities** Minneapolis, Minnesota, USA
Teaching Assistant

- ▶ MATH 5651: Basic Theory of Probability and Statistics Spring 2018
- ▶ CSCI 1933: Introduction to Algorithms and Data Structures Fall 2017
- ▶ CSCI 1933H: Honors Introduction to Algorithms and Data Structures Spring 2017
- ▶ CSCI 1933: Introduction to Algorithms and Data Structures Fall 2016
- ▶ CSCI 1933: Introduction to Algorithms and Data Structures Spring 2016

Professional Activities.....

Journal Reviewer:

- ▶ Annals of Statistics
- ▶ Applied and Computational Harmonic Analysis
- ▶ Biometrika
- ▶ IEEE Open Journal of Signal Processing
- ▶ IEEE Signal Processing Magazine
- ▶ Journal of Computational and Applied Mathematics
- ▶ Journal of Machine Learning Research
- ▶ Neural Networks
- ▶ SIAM Journal on Mathematics of Data Science

Conference Reviewer:

- ▶ 2020 Conference on Machine Learning and Systems (MLSys)
- ▶ 2023, 2024 IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)

Session Chair:

- ▶ International Symposium on Mathematical Programming (ISMP), Montréal, Québec, Canada July 2024

HONORS, AWARDS, & MISCELLANEOUS

- 2024 ▶ Conference on Parsimony and Learning (CPAL) Rising Stars Award
- 2023 ▶ Harold Peterson Outstanding Dissertation Award from the University of Wisconsin–Madison
- 2022 ▶ IEEE Signal Processing Society Travel Grant for ICASSP 2022
- 2022 ▶ University of Wisconsin–Madison ECE Dissertator Travel Award for ICASSP 2022
- 2020 ▶ NSF Graduate Research Fellowship (3 year award, only used 2)
*Awarded for the project titled *Bringing Approximation Theory to Data Science*.*
- 2018 ▶ NSF Research Traineeship (NRT) from NSF grant 1545481 (2 years)
- 2018 ▶ NSF Graduate Research Fellowship Program Honorable Mention
- 2017 ▶ Astronaut Scholarship
- 2017 ▶ Barry M. Goldwater Scholarship
- 2013 – 2015 ▶ Post-Secondary Enrollment Options (PSEO) Student at the University of Minnesota–Twin Cities
Enrolled full-time at the University of Minnesota–Twin Cities during 11th and 12th grades of high school through PSEO.
- 2008 – 2013 ▶ University of Minnesota Talented Youth Math Program (UMTYMP)
Completed differential and integral calculus, linear algebra, differential equations, set theory, methods of proof, and multivariable calculus at the University of Minnesota–Twin Cities at the end of 10th grade of high school through UMTYMP.