

# Sam D. Buchanan

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## Professional Experience

- 2025– **Postdoctoral Scholar**  
University of California, Berkeley
- 2022–25 **Research Assistant Professor**  
Toyota Technological Institute at Chicago

## Education

- 2016–22 **PhD, Electrical Engineering**  
Columbia University in the City of New York  
ADVISOR: John Wright  
THESIS: [Deep Networks Through the Lens of Low-Dimensional Structure: Towards Mathematical and Computational Principles for Nonlinear Data](#)
- 2017 **MS, Electrical Engineering**  
Columbia University in the City of New York
- 2010–14 **BS, Electrical Engineering** (with distinction)  
University of Kansas

## Awards and Honors

- 2022 Eli Jury Award, Columbia University Electrical Engineering Department
- 2017 NDSEG Fellow, US Department of Defense (award rate:  $\approx 7\%$ )
- 2016 Tesla Scholar, Columbia University Electrical Engineering Department
- 2014 Foreign Language and Area Studies Fellowship, US Department of Education

## Publications

### Preprint

- 2022 S. Buchanan, J. Yan, E. Haber, and J. Wright, “Resource-efficient invariant networks: Exponential gains by unrolled optimization,” Mar. 2022. arXiv: [2203.05006 \[cs.CV\]](#).

## Book

- 2025 S. Buchanan\*, D. Pai\*, P. Wang, and Y. Ma, *Learning Deep Representations of Data Distributions*. Online, Aug. 2025, <https://ma-lab-berkeley.github.io/deep-representation-learning-book/>.

## Journal

- 2024 Y. Yu\*, S. Buchanan\*, D. Pai\*, T. Chu, Z. Wu, S. Tong, H. Bai, Y. Zhai, B. D. Haeffele, and Y. Ma, “White-box transformers via sparse rate reduction: Compression is all there is?” *Journal of Machine Learning Research*, vol. 25, pp. 1–129, Sep. 2024.

## Conference

- 2025 S. Buchanan\*, D. Pai\*, Y. Ma, and V. D. Bortoli, “On the edge of memorization in diffusion models,” in *Advances in Neural Information Processing Systems (NeurIPS)*, Dec. 2025.
- Z. Fang, M. Díaz, S. Buchanan, and J. Sulam, “Beyond scores: Proximal diffusion models,” in *Advances in Neural Information Processing Systems (NeurIPS)*, Dec. 2025.
- 2024 Z. Fang\*, S. Buchanan\*, and J. Sulam, “What’s in a prior? Learned proximal networks for inverse problems,” in *International Conference on Learning Representations*, May 2024.
- D. Pai, Z. Wu, S. Buchanan, Y. Yu, and Y. Ma, “Masked completion via structured diffusion with white-box transformers,” in *International Conference on Learning Representations*, May 2024.
- Y. Yu\*, T. Chu\*, S. Tong, Z. Wu, D. Pai, S. Buchanan, and Y. Ma, “Emergence of segmentation with minimalistic white-box transformers,” in *Conference on Parsimony and Learning (CPAL)*, Jan. 2024.
- 2023 Y. Yu, S. Buchanan, D. Pai, T. Chu, Z. Wu, S. Tong, B. D. Haeffele, and Y. Ma, “White-box transformers via sparse rate reduction,” in *Advances in Neural Information Processing Systems (NeurIPS)*, Dec. 2023.
- B. Yi, W. Zeng, S. Buchanan, and Y. Ma, “Canonical factors for hybrid neural fields,” in *International Conference on Computer Vision (ICCV)*, Oct. 2023.
- 2021 T. Wang, S. Buchanan, D. Gilboa, and J. Wright, “Deep networks provably classify data on curves,” in *Advances in Neural Information Processing Systems*, vol. 34, Curran Associates, Inc., Dec. 2021, pp. 28 940–28 953.
- S. Buchanan, D. Gilboa, and J. Wright, “Deep networks and the multiple manifold problem,” in *International Conference on Learning Representations*, Jan. 2021.
- 2019 D. Gilboa, S. Buchanan, and J. Wright, “Efficient dictionary learning with gradient descent,” in *Proceedings of the 36th International Conference on Machine Learning*, ser. Proceedings of Machine Learning Research, vol. 97, PMLR, 2019, pp. 2252–2259.

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\*denotes equal contribution

- 2018 S. Buchanan, T. Haque, P. Kinget, and J. Wright, “Efficient model-free learning to overcome hardware nonidealities in analog-to-information converters,” in *2018 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Apr. 2018, pp. 3574–3578.

## Invited Talks

- 2024 “*White-Box Transformers via Sparse Rate Reduction*”, Workshop on Privacy and Interpretability in Generative AI: Peering into the Black Box, November.  
 “*White-Box Transformers via Sparse Rate Reduction*”, Asilomar Special Session “Mathematics in Generative AI”, October.  
 “*White-Box Transformers via Sparse Rate Reduction*”, “Mathematics of Deep Learning” Workshop, Casa Matemática Oaxaca (CMO), June.  
 “*White-Box Architecture Design via Unrolled Optimization and Compression*”, “Mathematics of Deep Learning” Workshop, Casa Matemática Oaxaca (CMO), June.  
 “*White-Box Transformers via Sparse Rate Reduction*”, Toyota Technological Institute Research Center for Smart Information Technology Research Seminar, April.  
 “*White-Box Transformers via Sparse Rate Reduction*”, Redwood Seminar (UC Berkeley Neuroscience), February.
- 2023 “*Deep Networks and the Multiple Manifold Problem*”, KU Eichstätt-Ingolstadt MIDS Seminar, December.
- 2022 “*Deep Networks and the Multiple Manifold Problem*”, U Michigan CSP Seminar, December.  
 “*Deep Networks and the Multiple Manifold Problem*”, SIAM MDS 2022 Minisymposium “The Role of Data Geometry in High-Dimensional Learning”, September.  
 “*Deep Networks Through the Lens of Low-Dimensional Structure*”, Talks at TTIC, April.  
 “*Deep Networks Through the Lens of Low-Dimensional Structure*”, Johns Hopkins MINDS Seminar, March.

## Tutorials and Teaching

- 2025 **Tutorial**, [Learning Deep Low-dimensional Models from High-Dimensional Data: From Theory to Practice](#)  
*ICCV 2025 Tutorial*, October 2025 (forthcoming)  
**Guest Lecture**, Introduction to Unsupervised Learning (EECS 289A)  
 UC Davis; Instructor: Prof. Yubei Chen  
*Lecture*: White-Box Transformers via Sparse Rate Reduction  
**Tutorial**, [Deep Representation Learning: from Knowledge to Intelligence](#)  
*CPAL 2025 Tutorial*, March 2025
- 2024 **Tutorial**, [Learning Deep Low-Dimensional Models from High-Dimensional Data: From Theory to Practice](#)

*CVPR 2024 Tutorial*, June 2024

*Lecture*: White-Box Transformers via Sparse Rate Reduction

**Guest Lecture**, Optimization Methods for Signal and Image Processing and Machine Learning (EECS 559)

*University of Michigan*; Instructor: Prof. Qing Qu

*Lecture*: White-Box Transformers via Sparse Rate Reduction and Unrolled Optimization

**Tutorial**, [Building White-Box Deep Neural Networks](#)

*ICASSP 2024 Tutorial*, April 2024

**Tutorial**, [Learning Deep Low-dimensional Models from High-Dimensional Data: From Theory to Practice](#)

*CPAL 2024 Tutorial*, January 2024

*Lecture*: White-Box Transformers via Sparse Rate Reduction

2023 **Tutorial**, [Learning Nonlinear and Deep Low-Dimensional Representations from High-Dimensional Data: From Theory to Practice](#)

*ICASSP 2023 Short Course*, June 2023

*Lecture*: Deep Representation Learning from the Ground Up

**Tutorial**, [Learning Low-Dimensional Structure via Deep Networks](#)

*SLOWDNN Workshop 2023 Tutorial*, January 2023

2022 **Tutorial**, [Low-Dimensional Models for High-Dimensional Data: From Linear to Nonlinear, Convex to Nonconvex, and Shallow to Deep](#)

*ICASSP 2022 Short Course*, May 2022

*Lecture*: Learning Low-Dimensional Structures via Deep Networks

2018, 2019 **Teaching Assistant**, Sparse Representation and High-Dimensional Geometry (ELEN 6886)

*Columbia University*

Developed a suite of theoretical and computational exercises for the textbook [High-Dimensional Data Analysis with Low-Dimensional Models: Principles, Computation, and Applications](#).

## Professional Service

### Conference and Workshop Organization

2025 **Web Chair**, [Second Conference on Parsimony and Learning \(CPAL\)](#)

*Stanford University, CA*

2024 **Organizer**, [SIAM MDS 2024 Minisymposium “Mathematical Principles in Foundation Models”](#)

*Atlanta, GA*

**Organizer**, [Collaboration on the Theoretical Foundations of Deep Learning Annual Meeting](#)

*Halicioğlu Data Science Institute (UCSD), San Diego*

**Web Chair**, [Inaugural Conference on Parsimony and Learning \(CPAL\)](#)

*Hong Kong University, Hong Kong*

2023 **Organizer**, [Collaboration on the Theoretical Foundations of Deep Learning Annual Meeting](#)  
*TTIC, Chicago*  
**Tutorial Chair**, [3rd Workshop on Seeking Low-Dimensionality in Deep Neural Networks](#)  
*MBZUAI, Abu Dhabi*

## Academic Committee Work

2024 **Member**, Toyota Technological Institute at Chicago (TTIC) Diversity, Equity, and Inclusion Committee

## Journal Reviewing

IEEE-JSTSP, IEEE-TPAMI, IEEE-TIT, JMLR, MCSS, TMLR

## Conference ACing

NeurIPS 24, 25

## Conference Reviewing

CVPR 19\*, 21\*; ICLR 22\*, 23, 24; ICML 21\*, 22, 23; NeurIPS 20\*, 21, 22\*, 23

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\*denotes a designation of reviewer quality (“outstanding reviewer”, etc.)