

# Sam D. Buchanan

*Research Assistant Professor*  
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## Professional Experience

- 2022– **Research Assistant Professor**  
Toyota Technological Institute at Chicago
- 2015–16 **Test Engineer (Radars and RF Components)**  
Honeywell FM&T, Kansas City, MO

## 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

## Publications

### Preprint

- 2023 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?,” Nov. 2023. arXiv: [2311.13110 \[cs.LG\]](#). (*Accepted with minor revision to JMLR*)

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

## Conference

- 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.
- 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”, 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.

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\*denotes equal contribution

*“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), 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

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, **Teaching Assistant**, Sparse Representation and High-Dimensional Geometry (ELEN  
2019 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, IMA-Information and Inference, JMLR, TMLR

### Conference ACing

NeurIPS 24

### Conference Reviewing

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

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