

Sam D. Buchanan

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Professional Experience

2022– **Research Assistant Professor**
Toyota Technological Institute at Chicago

Education

2022 **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

2014 **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 \[cs.LG\]](#).

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”, 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.

*denotes equal contribution

- 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.

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, 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

- 2024 **Web Chair**, [Inaugural Conference on Parsimony and Learning \(CPAL\)](#)
Hong Kong University, Hong Kong
- Organizer**, [Collaboration on the Theoretical Foundations of Deep Learning Annual Meeting](#)
Halicioğlu Data Science Institute (UCSD), San Diego
- 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.)