Sam D. Buchanan

Research Assistant Professor
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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, S. Buchanan, Z. Wu, 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

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.

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*denotes equal contribution

Teaching

2024 **Tutorial**, Building White-Box Deep Neural Networks
ICASSP 2024 Tutorial, April 2024

2023 **Tutorial**, Learning Nonlinear and Deep Low-Dimensional Representations from High-Dimensional Data: From Theory to Practice
ICASSP 2023 Short Course, June 2023

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

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

2023 **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
TTIC, Chicago

Tutorial Chair, 3rd Workshop on Seeking Low-Dimensionality in Deep Neural Networks
MBZUAI, Abu Dhabi

Journal Reviewing

TMLR, TPAMI

Conference Reviewing

CVPR 19*, 21*; ICASSP 24; 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.)