Yuhang Song

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My interest is to decipher learning principles of biological neurons, so as to reverse-engineer them as algorithms or specialized hardware. Such a route would, on the one hand, bring us one step closer to ultra efficient machine intelligence (as our attempt in *Fractile*; on the other hand, improve our understanding of the most sophisticated part of our body, the brain (as our attempt in *the Nature Neuroscience paper*).

BIOGRAPHY

2024 – Now **CEO & Co-founder**, *Perturbation Ltd*.

2022 – 2024 **CTO & Co-founder**, *Fractile Ltd*.

2021 – 2022 **J.P. Morgan AI Research Fellow**, *University of Oxford*.

2018 – 2022 **Ph.D.**, *Department of Computer Science* & *Nuffield Department of Clinical Neurosciences*, *University of Oxford*.

2014 – 2018 **B.S.**, *Beihang University*.

Fellowships / Scholarships

2024 *Thomas Willis Early Career Researcher Prize, University of Oxford*

2024 *Ideas 2 Impact (I2I) Fellow, Saïd Business School, University of Oxford*

2022 *J.P. Morgan AI Research Fellowship* ***$100,000 | A total of 11 awardees worldwide***

2019 *Special Project Grant* @ *Somerville College* ***£2,000 | Top-tier***

2018 *Honorary China Oxford Award* | ***15 among 1,000*** ***£3,000 |1st Prize***

2017 *National Innovation Scholarship* | ***20 among 200,000+*** ***$12,000 | 1st Prize***

Awarded by the National Ministry of Industry and Information.

2016 Outstanding Science and Technology Scholarship | ***12 among 256*** ***$220 |1st Prize***

2015 *Airbus Academic Scholarship* | ***2 among 600+*** ***$1,200 |2nd Prize***

PUBLICATIONS

(∗: Corresponding Author. †: Co-first author.)

[1] Journal **Yuhang Song**∗, Beren Millidge, Tommaso Salvatori, Zhenghua Xu∗, Thomas Lukasiewicz∗, Rafal Bogacz∗. *Inferring Neural Activity Before Plasticity: A Foundation for Learning Beyond Backpropagation*. **Nature Neuroscience, IF: 28.77**. [Link]

[2] Journal Beren Millidge, **Yuhang Song**∗, Armin Lak, Mark E. Walton, Rafal Bogacz∗. *Reward-Bases: Dopaminergic Mechanisms for Adaptive Acquisition of Multiple Reward Types*. **PLOS Computational Biology**. [Link]

[3] Conference Tommaso Salvatori†, **Yuhang Song**∗†, Yordan Yordanov, Beren Millidge, Lei Sha, Cornelius Emde, Zhenghua Xu, Rafal Bogacz, Thomas Lukasiewicz. *A Stable, Fast, and Fully Automatic Learning Algorithm for Predictive Coding Networks*. **ICLR 2024**. [Link]

[4] Journal Mufeng Tang, Tommaso Salvatori, Beren Millidge, **Yuhang Song**, Thomas Lukasiewicz, Rafal Bogacz*. *Recurrent predictive coding models for associative memory employing covariance learning.* **PLOS Computational Biology**. [Link]

[5] Conference Tommaso Salvatori, Beren Millidge, **Yuhang Song**, Rafal Bogacz, Thomas Lukasiewicz. *Associative Memories in the Feature Space.* **ECAI 2023**. [Link]

[6] Conference Beren Millidge, **Yuhang Song***, Tommaso Salvatori, Thomas Lukasiewicz, Rafal Bogacz. *A Theoretical Framework for Inference and Learning in Predictive Coding Networks.* **ICLR 2023**. [Link]

[7] Conference Beren Millidge, **Yuhang Song***, Tommaso Salvatori, Thomas Lukasiewicz, Rafal Bogacz. *Backprop at the Weak-Feedback Limit of Energy-Based Models: Unifying Predictive Coding, Equilibrium Propagation, and Contrastive Hebbian Learning.* **ICLR 2023**. [Link]

[8] Conference Luca Pinchetti, Tommaso Salvatori, Yordan Yordanov, Beren Millidge, **Yuhang Song***, Thomas Lukasiewicz. *Predictive Coding beyond Gaussian Distributions.* **NeurIPS 2022**. [Link]

[9] Conference Tommaso Salvatori, Luca Pinchetti†, Beren Millidge, **Yuhang Song***, Tianyi Bao, Rafal Bogacz, Thomas Lukasiewicz. *Learning on Arbitrary Graph Topologies via Predictive Coding.* **NeurIPS 2022**. [Link]

[10] Conference Beren Millidge, Tommaso Salvatori, **Yuhang Song***, Thomas Lukasiewicz, Rafal Bogacz. *Universal Hopfield Networks: A General Framework for Single-Shot Associative Memory Models.* **ICML 2022**. [Link]

[11] Conference Beren Millidge†, Tommaso Salvatori†, **Yuhang Song***, Rafal Bogacz, Thomas Lukasiewicz. *Predictive Coding: Towards a Future of Deep Learning beyond Backpropagation?* **IJCAI 2022**. [Link]

[12] Conference Tommaso Salvatori, **Yuhang Song***, Zhenghua Xu, Thomas Lukasiewicz, Rafal Bogacz. *Reverse Differentiation via Predictive Coding.* **AAAI 2022**. [Link]

[13] Conference Tommaso Salvatori, **Yuhang Song***, Yujian Hong, Lei Sha, Simon Frieder, Zhenghua Xu, Rafal Bogacz, Thomas Lukasiewicz. *Associative Memory via Predictive Coding.* **NeurIPS 2021**. [Link]

[14] Conference **Yuhang Song**, Thomas Lukasiewicz, Zhenghua Xu*, Rafal Bogacz. *Can the Brain Do Backpropagation? –Exact Implementation of Backpropagation in Predictive Coding Networks.* **NeurIPS 2020**. [Link]

[15] Conference **Yuhang Song**, Andrzej Wojcicki, Thomas Lukasiewicz, Jianyi Wang, Abi Aryan, Zhenghua Xu*, Mai Xu, Zihan Ding, Lianlong Wu. *Arena: A General Evaluation Platform and Building Toolkit for Multi-Agent Intelligence.* **AAAI 2020**. [Link]

[16] Conference **Yuhang Song**, Jianyi Wang, Thomas Lukasiewicz, Zhenghua Xu*, Shangtong Zhang, Andrzej Wojcicki, Mai Xu. *Mega-Reward: Achieving Human-Level Play without Extrinsic Rewards.* **AAAI 2020**. [Link]

[17] Conference **Yuhang Song**, Jianyi Wang†, Thomas Lukasiewicz, Zhenghua Xu*, Mai Xu. *Diversity-Driven Extensible Hierarchical Reinforcement Learning.* **AAAI 2019**. [Link]

[18] Journal Mai Xu*, **Yuhang Song**†, Jianyi Wang, Minglang Qiao, Liangyu Huo, Zulin Wang. *Predicting Head Movement in Panoramic Video: A Deep Reinforcement Learning Approach.* **TPAMI, IF: 17.861**. [Link]

[19] Conference **Yuhang Song**, Mai Xu*, Shengxi Li. *Watching Videos with Certain and Constant Quality: PID-based Quality Control Method.* **DCC 2017**. [Link]

[20] Conference Xin Deng, Hao Wang†, Mai Xu*, Yichen Guo, **Yuhang Song**, Li Yang. *LAU-Net: Latitude Adaptive Upscaling Network for Omnidirectional ImageSuper-resolution.* **CVPR 2021**. [Link]

[21] Conference Jianyi Wang, Xin Deng, Mai Xu*, Congyong Chen, **Yuhang Song**. *Multi-level Wavelet-based Generative Adversarial Network for Perceptual Quality Enhancement of Compressed Video.* **ECCV 2020**. [Link]

[22] Journal Jianyi Wang, Mai Xu*, Lai Jiang, **Yuhang Song**. *Attention-based Deep Reinforcement Learning for Virtual Cinematography of 360° Videos.* **IEEE Transactions on Multimedia, IF: 5.452**. [Link]

[23] Workshop **Yuhang Song**, Mai Xu*, Songyang Zhang, Liangyu Huo. *Generalization Tower Network: A Novel Deep Neural Network Architecture for Multi-Task Learning.* **Deep Reinforcement Learning Symposium at NeurIPS 2018**. [Link]

[24] Journal Liangyu Huo, Zulin Wang, Mai Xu*, **Yuhang Song**. *A Task-Agnostic Regularizer for Diverse Subpolicy Discovery in Hierarchical Reinforcement Learning.* **IEEE Transactions on Systems, Man, and Cybernetics: Systems, IF: 13.451**. [Link]

[25] Technical report **Yuhang Song**, Christopher Grimm, Xianming Wang, Michael Littman*. *Learning Approximate Stochastic Transition Models.* **2018**. [Link]

[26] Technical report Hao Sun, Ziping Xu, **Yuhang Song**, Meng Fang, Jiechao Xiong, Bo Dai, Zhengyou Zhang, Bolei Zhou. *Supervised Q-Learning for Continuous Control.* **2021**. [Link]

[27] Technical report Christopher Grimm, **Yuhang Song**, Michael Littman*. *Summable Reparameterizations of Wasserstein Critics in the One-Dimensional Setting.* **2018**. [Link]

Patents

[28,...,35] **Yuhang Song**, Xianglong Kong. *A Power / Joint / Servo / Connector Module Device in a Modular UAV System.* 4 Invention & 4 Utility Model Patents. ZL201620302692.X, ZL201620302142.8, ZL201620302048.2, ZL201620302137.7, 201610224780.7, 201610225217.1, 201610225216.7, 201610224853.2.

TEACHING

2019 **Advanced Machine Learning**, *Department of Computer Science*, *University of Oxford*.
- Role: Teaching Assistant & Tutor
- Lecturers:
  - *Prof. Yarin Gal*
  - *Prof. Thomas Lukasiewicz*

2019 **Imperative Programming 3**, *Department of Computer Science*, *University of Oxford*.
- Role: Teaching Assistant & Tutor
- Lecturers:
  - *Prof. Peter Jeavons*

2018 **Introduction to Machine Learning**, *Beihang University*.
- Role: Teaching Assistant & Tutor
- Lecturers:
  - *Prof. Mai Xu*