"Tony" Runzhe Yang

Researcher | Princeton Ph.D. in CS & Neurosci.

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Research Interests

Reinforcement Learning, Natural Language Processing, Theoretical and Computational Neuroscience.

Industry Positions

Susquehanna International Group (SIG) ⟨2023 – Present⟩
Machine Learning Scientist & Quantitative Researcher

⟨**AI Startup**⟩ ⟨2023⟩
Co-Founder & Chief Scientist

Education

Princeton University, USA Sept. 2018 – Sept. 2023
Doctor of Philosophy (Ph.D.) in Computer Science & Neuroscience
Advisors: Prof. Sebastian Seung and Prof. Karthik Narasimhan

Shanghai Jiao Tong University, China Sept. 2014 – Jun. 2018
Honors Bachelor of Science (B.Sc. Hons) in Computer Science
Graduated from **ACM Class**, an elite CS program for top 5% of students.

Research Experience

Founder and Researcher at **x-Discovery**, a non-profit research org Jan. 2024 – Present

- Our goal is to apply modern computational methodologies to advance research across diverse domains, including neuroscience, psychology, economics, and social science.

Research Assistant at **Seung Lab**, Princeton University Sept. 2018 – Sept. 2023

- Mentored by Prof. Sebastian Seung on Computational Neuroscience and Machine Learning
- **I. Connectome Analysis**: (1) Analyzed the various topological properties of different neural networks reconstructed by 3D electron microscopy (EM), including mouse visual cortex, zebrafish oculomotor circuit, fly whore brain, with the tools from complex networks. (2) Modified semantic segmentation algorithms in computer vision to detect soma, dendrites and axons of neurons, as well as glia cells in EM images. **II. Cortex-Inspired Machine Learning:** (3) Designed unsupervised representation learning algorithms that satisfy biological constraints. (4) Analyzed the convergence and duality of correlation games and neural networks with Hebbian feedforward excitation and anti-Hebbian lateral inhibition.

Research Assistant at **Princeton NLP Group**, Princeton University Sept. 2018 – Sept. 2023

- Mentored by Prof. Karthik Narasimhan on Natural Language Processing and Reinforcement Learning.
- **I. Large Language Models (LLMs)**: (1) Proposed a multi-agent framework of LLMs for knowledge self-discovery; (2) Improved the inference throughput of neural networks with data multiplexing; (3) Created a systematic, extendable text generation benchmark for LLMs. **II. Reinforcement Learning (RL)**: (3) Developed one of the first deep multi-objective reinforcement learning algorithm that enables few-shot adaptation to new tasks; (4) Incorporated Theory of Mind from cognitive science to RL-based negotiation systems for strategic dialogue generation. (5) Designed an equilibrium-informed algorithm for generating optimal communication in multi-agent strategy games.

Summer Research Associate at **Flatiron Institute**, Simons Foundation Jun. 2022 – Aug. 2022

- Mentored by Prof. Dmitri "Mitya" Chklovskii on Neuro-Inspired Machine Learning.
- (1) Implemented a general framework of unsupervised learning with Hebbian and anti-Hebbian plasticity; (2) Designed a bio-plausible neural network algorithm for dynamical systems identification.

Research Intern at **Google Brain Team**, Google Research Jun. 2021 – Sept. 2021

- Mentored by Yuan Cao on Multi-Modal Large Language Models.
- (1) Analyzed visually grounded language models on natural language understanding (NLU) tasks; (2) Designed cognitive science inspired fine-tuning to improve model performance on GLUE benchmark.

Research Intern at **Institute for Computational Sustainability**, Cornell University Jun. 2017 – Feb. 2018

- Mentored by Prof. Carla Gomes on Artificial Intelligence and Computational Sustainability.
- (1) Established imitation refinement approach to improve imperfect data by mimicking; (2) Proposed a game-theoretic crowdsourcing framework for better crowd workers' reliability; (3) Developed a multi-armed bandit system to minimize expert annotation time for eelgrass wasting disease monitoring.

Undergraduate Researcher at **SJTU Speech Lab**, Shanghai Jiao Tong University Jul. 2016 – Jun. 2018

- Mentored by Prof. Kai Yu on Spoken Dialogue System and Reinforcement Learning.
- (1) Created the companion teaching framework for reinforcement learning based dialogue system to incorporate human teaching; (2) Quantitatively measured the safety and efficiency of the on-line dialogue policy learning; (3) Implemented natural language generation module and dialogue manager module; (4) Lead author of the research papers, accepted by EMNLP and EACL.

Publications { Computer Science | Neuroscience }

C9 **COLLIE: Systematic construction of constrained text generation tasks.**.
- Shunyu Yao*, Howard Chen*, Austin W. Hanjie*, **Runzhe Yang*** (equal contribution), Karthik Narasimhan.
- In proceedings of the **ICLR 2024** conference. { **ArXiv** | **Bib** | **Code** }

J2 **Cyclic structure with cellular precision in a vertebrate sensorimotor neural circuit**.
- **Runzhe Yang**, Ashwin Vishwanathan, Jingpeng Wu, Nico Kemnitz, Dodam Ih, Nicholas Turner, Kisuk Lee, Ignacio Tartavull, William M. Silversmith, Chris S. Jordan, Celia David, Doug Bland, Amy Sterling, Mark S. Goldman, Emre R.F. Aksay, H. Sebastian Seung, the Eyewirers.
- **Current Biology** 2023. { **Paper** | **Bib**}

A3 **Neuronal Circuits for Robust Online Fixed-Point Detection**.
- **Runzhe Yang**, David Lipshutz, Tiberiu Tesileanu, Johannes Friedrich, Dmitri Chklovskii.
- In proceedings of the **COSYNE 2023** conference. { **Abstract** | **Poster** }

C8 **DataMUX: Data Multiplexing for Neural Networks**.
- Vishvak Murahari, Carlos Jimenez, **Runzhe Yang**, Karthik Narasimhan.
- In proceedings of the **NeurIPS 2022** conference. { **Paper** | **Bib** | **Code** }

J1 **Reconstruction of Neocortex: Organelles, Compartments, Cells, Circuits, and Activity**.
- Nicholas Turner*, Thomas Macrina*, Alexander Bae*, **Runzhe Yang***, Alyssa Wilson*, Casey Schneider-Mizell*, Kisuk Lee*, Ran Lu*, Jingpeng Wu*, Agnes Bodor*, Adam Bleckert*, Derrick Brittain*, Emmanouil Froudarakis*, Sven Dorkenwald*, Forrest Collman*, Nico Kemnitz* (equal contribution) ... Jacob Reimer, Andreas Tolias, Clay Reid, Nuno da Costa, Sebastian Seung
- **Cell**, 2022. { **Cell Paper** | **MICrONS Explore** }

A2 **Modularity, Graded Connectivity, and Recurrence in a Vertebrate Sensorimotor Neural Circuit**.
- **Runzhe Yang**, Ashwin Vishwanathan, Mark Goldman, Emre Aksay, and Sebastian Seung.
- Selected Poster at the **Neuronal Circuits 2022** conference. { **Abstract** | **Poster** }

C7 **Improving Dialog Systems for Negotiation with Personality Modeling**.
- **Runzhe Yang***, Jingxiao Chen* (equal contribution) and Karthik Narasimhan.
- Oral presentation, in proceedings of the **ACL 2021** conference. { **Paper** | **Bib** | **Code** }

A2 **Unsupervised Feature Discovery by Neural Networks with Disynaptic Recurrent Inhibition**.
- **Runzhe Yang**, Kyle Luther and H. Sebastian Seung.

- Selected talk in the **NAISys 2020** conference. { **Abstract** | **Slides** }

C6 **A Generalized Algorithm for Multi-Objective Reinforcement Learning and Policy Adaptation**.
- **Runzhe Yang**, Xingyuan Sun and Karthik Narasimhan.
- In proceedings of the **NeurIPS 2019** conference. { **Paper** | **Bib** | **Code** }

C5 **Unsupervised Learning by a "Softened" Correlation Game: Duality and Convergence**.
- **Runzhe Yang**, w/ Kyle Luther and Sebastian Seung (theoretical paper, invited).
- In proceedings of the **ACSSC 2019** conference. { **Paper** | **Bib** }

C4 **Imitation Refinement for X-Ray Diffraction Signal Processing**.
- Junwen Bai, Zihang Lai, **Runzhe Yang**, Yexiang Xue, John Gregoire and Carla Gomes.
- In proceedings of the **ICASSP 2019** conference. { **Paper** | **Bib** }

A1 **Mitochondrial Size Gradients in Cortical Neurons Suggested by 3D Electron Microscopy**.
- Nicholas L. Turner, **Runzhe Yang**, Agata Foryciarz, Kisuk Lee, William Silversmith, William Wong, Jingpeng Wu, Sven Dorkenwald, T. L. Lewis, Yusuke Hirabayashi, Franck Polleux, Nuno da Costa, R. Clay Reid, H. Sebastian Seung
- Poster in the **SfN 2018** conference. { **Abstract** | **Poster** }

C3 **Affordable On-line Dialogue Policy Learning**.
- **Runzhe Yang***, Cheng Chang* (equal authorship), Lu Chen, Xiang Zhou and Kai Yu.
- In proceedings of the **EMNLP 2017** conference. { **Paper** | **Bib** | **Appendix** }

C2 **Agent-Aware Dropout DQN for Safe and Efficient On-line Dialogue Policy Learning**.
- Lu Chen, Xiang Zhou, Cheng Chang, **Runzhe Yang** and Kai Yu.
- In proceedings of the **EMNLP 2017** conference. { **Paper** | **Bib** | **Appendix** }

C1 **On-line Dialogue Policy Learning with Companion Teaching**.
- Lu Chen, **Runzhe Yang**, Cheng Chang, Zihao Ye, Xiang Zhou and Kai Yu.
- In proceedings of the **EACL 2017** conference. { **Paper** | **Bib** | **Poster** }

Selected Manuscripts { Computer Science | Neuroscience }

M13 **Network statistics of the whole-brain connectome of *Drosophila***. (2023, submitted to *Nature*)
- Albert Lin*, **Runzhe Yang*** (equal contribution), et al. { **bioRxiv** | **Bib** | **DataExplorer** }

M12 **Neuronal wiring diagram of an adult brain**. (2023, submitted to *Nature*)
- Dorkenwald et al. { **bioRxiv** | **Bib** | **DataExplorer** }

M10 **The Socratic Method for Self-Discovery in Large Language Models**. (2023)
- **Runzhe Yang** and Karthik Narasimhan. { **Blog** }

M8 **Functional connectomics spanning multiple areas of mouse visual cortex**. (2023, submitted to *Nature*)
- MICrONS Consortium et al. { **bioRxiv** | **Bib** | **News** }

M7 **Predicting modular functions and neural coding of behavior from a synaptic wiring diagram**. (2022, submitted to *Nature Neuroscience*)
- Vishwanathan, et al. { **bioRxiv** | **Bib** }

M3 **Imitation Refinement**. (2018) { **ArXiv** | **Bib** | **Code** }
- **Runzhe Yang***, Junwen Bai* (equal authorship), Yexiang Xue, John Gregoire and Carla Gomes.

M1 **Pedagogical Value-Aligned Crowdsourcing: Inspiring the Wisdom of Crowds via Interactive Teaching**.
- **Runzhe Yang**, Yexiang Xue and Carla Gomes. (2017) { **Manuscript** | **Appendix** | **Code** }

Selected Talks { Computer Science | Neuroscience }

T7 **Modularity and Cyclic Structure in a Vertebrate Sensorimotor Neural Circuit**. (2022) { **Slides**}
- Invited talk at **ICERM Workshop**: Topological and Dynamical Analysis of Brain Connectomes.

T6 **Improving Dialog Systems for Negotiation with Personality Modeling**. (2021) { **Slides**}
- Oral presentation at **ACL-IJCNLP 2021**.

T5 **Unsupervised Feature Discovery by Neural Networks with Disynaptic Recurrent Inhibition**. (2020)
- Selected talk at **NAISys 2020**. { **Slides**}

T4 **Multiscale and Multimodal Reconstruction of Cortical Structure and Function** (2020) { **Slides**}
- Invited talk at **Center for Computational Neuroscience, Flatiron Institute**.

T3 **Generating Strategic Dialogue for Negotiation with Theory of Mind** (2020) { **Slides**}
- Invited talk at Amazon Research Seminar

T2 **Multi-Objective Reinforcement Learning** (2020) { **Slides**}
- Open talk for general exam at **Computer Science Department, Princeton University**

T1 **Bridging the Duality Gap between Neural Networks with Hebbian/Anti-Hebbian Plasticity and the Correlation Game Principle** (2019)
- Invited presentation at **Asilomar 2019**: Neuroscience-Inspired ML Session.

Patents

P3 **Methods for Data Multiplexing in Neural Networks.**
- Inventors: Karthik Narasimhan, Vishvak Murahari, Carlos Jimenez, **Runzhe Yang**, Ameet Deshpande, Yushan Su, Kai Li.
- Assignee: Princeton Univ. **[WO2023154558A1 | Patents]**

P2 **Online Dialogue Strategy Optimization with Multitask Learning.**
- Inventors: Kai Yu, Cheng Chang, **Runzhe Yang**, Lu Chen, Xiang Zhou
- Assignee: SJTU, AISpeech Co., Ltd. **[CN107357838A | Patents]**

P1 **The Cold Starting System and Method for Dialog Strategy Optimization**.
- Inventors: Kai Yu, Lu Chen, Xiang Zhou, Cheng Chang, **Runzhe Yang**.
- Assignee: SJTU, AISpeech Co., Ltd. **[CN107342078A | Patents]**

Voluntary Service

Active reviewer for AI/ML journals and conferences: JAIR, JMLR, JAMMAS, NeurIPS, ICLR, ICML, etc.

Served as a voluntary columnist at **Neurealiy**, an NPO for popular AI and neuroscience.
- Columnist, co-hosted the Neuromancer podcast on topics in neuroscience and ML.

Participated in Deep Learning and Reinforcement Learning text books translation:
- Yoshua Bengio, **Learning Deep Architecture for AI**, Chinese edition published [a]
- Sutton, R. S., Barto, A. G, **Reinforcement Learning: An Introduction**, Chinese edition published [a]

Contributed to the chess opening book for **Yixin**, the strongest Gomoku/Renju AI in the world.

Leadership

President of Association of Chinese Students and Scholars, Princeton	May 2020 – May 2022
General Secretary of Association of Chinese Students and Scholars, Princeton	June 2019 – May 2020
President of Zhiyuan Association for Science and Technology, SJTU.	June 2015 – Jun. 2018
Chairperson of ACM Honors Class of 2018, SJTU.	Sept. 2016 – Jun. 2018
Co-organizer of the 8th ACM-Class Student Academic Festival (ASAF2017).	June 2017
Co-organizer of the 2nd and 3rd INS-ZY Student Conference on Natural Science.	June 2015, Apr. 2016

Teaching Experience

Teaching Assistant of COS485 @ Princeton: Neural Networks. Feb. 2020 – June 2020
Teaching Assistant of COS484 @ Princeton: Natural Language Processing. Sept. 2019 – Jan. 2020
Teaching Assistant of CS389 @ SJTU: Mathematics for the Information Age. May 2018 – June 2018
Teaching Assistant of CS120 @ SJTU: Introduction to Computer Science. Sept. 2016 – Jan. 2017

Programming Skills

Programming Languages: Python, Mathematica, C/C++, Java, Lua, Verilog, Matlab

Deep Learning Toolkits: PyTorch, Torch, MXNet, Tensorflow, Theano

Others: Unix/Linux, LaTeX, Markdown, Jupyter notebook

Honors and Awards

Bell Labs Prize 2022 (2nd place) { **News** } Nov. 2022
SEAS Award for Excellence of Princeton University { **News** } Nov. 2021
Excellent Graduate Award of Shanghai (**the highest award for graduates, top 1%**) May. 2018
Excellent Bachelor Thesis of Shanghai Jiao Tong University (**top 1%**) Jun. 2018
Zhiyuan Outstanding Student Scholarship of Shanghai Jiao Tong University Jun. 2018
Academic Excellence Scholarship of Shanghai Jiao Tong University (**A-level, top 1%**) Oct. 2015, 2017
Arawana Scholarship (gpa ranking is in **top 1%**, awarded to 2 students out of 300+) Oct. 2017
1st prize in "Hsue-shen Tsien Cup" Collegiate Science and Technology Contest Apr. 2017
Sunny Leadership Scholarship (**A-level**, awarded to **high leadership potential** students) Dec. 2016
Leo KoGuan Scholarship (**top 4%**, awarded to **high scientific research potential** students) Nov. 2016
United-Water Scholarship (gpa & integrated ranking are both in **top 4%**) Nov. 2015
1st prize in China Undergraduate Mathematical Contest in Modeling (Shanghai Division) Oct. 2015