WEISHUN ZHONG

www.weishunzhong.com
Cambridge, Massachusetts, 02138
wszhong@mit.edu

EDUCATION

Massachusetts Institute of Technology, Cambridge, MA *Sep.2017-May.2023(expected)*
Ph.D. Department of Physics
Advisors: Haim Sompolinsky (Harvard) and Mehran Kardar (MIT)

University of Chicago, Chicago, IL *Sep.2016-Jun.2017*
M.S., *Physical Sciences Division*, Physics GPA: 3.93/4.0

University of Michigan *Sep.2013-May.2016*
B.S., *highest distinction*, Physics and Mathematics GPA: 3.97/4.0

RESEARCH BACKGROUND

My research area lies in the intersection between statistical physics, neuroscience, and machine learning.

PUBLICATIONS

1. "A Theory of Weight Distribution-constrained Learning", **Weishun Zhong**, Ben Sorscher, Daniel D Lee, Haim Sompolinsky, *arXiv:2206.08933; accepted to NeurIPS 2022*
2. "Many-body Localized Hidden Born Machine", **Weishun Zhong**, Xun Gao, Susanne Yelin, Khadijeh Najafi, *arXiv: 2207.02346; under review*
3. "Quantifying Many-body Learning far from Equilibrium with Representation Learning", **Weishun Zhong***, Jacob M Gold*, Sarah Marzen, Jeremy L England, Nicole Yunger Halpern, *arXiv: 2001.03623; Scientific reports 11.1 (2021): 1-11*
4. "Learning about Learning by Many-body Systems", **Weishun Zhong***, Jacob M Gold*, Sarah Marzen, Jeremy L England, Nicole Yunger Halpern, *arXiv:2004.03604; ICML workshop ML Interpretability for Scientific Discovery (2020)*
5. "Non-equilibrium Statistical Mechanics of Continuous Attractors", **Weishun Zhong**, Zhiyue Lu, David J. Schwab, and Arvind Murugan, *arXiv: 1809.11167; Neural computation (2020) 32 (6)*
6. "A Closer Look at Disentangling in β-VAE", Harshvardhan Sikka*, **Weishun Zhong***, Jun Yin, Cengiz Pehlevan, *arXiv:1912.05127; 53rd Asilomar Conference on Signals, Systems, and Computers (2019)*
7. "Associative Pattern Recognition in Macro-Molecular Self-Assembly", **Weishun Zhong**, David J. Schwab, and Arvind Murugan, *arXiv: 1701.01769; J Stat Phys (2017) 167: 806*
8. "A Holographic c-Theorem for Schrödinger Spacetimes", James T. Liu and **Weishun Zhong**, *arXiv: 1510.06975; JHEP 1512 (2015) 179*

RESEARCH EXPERIENCE

Harvard University Cambridge, MA
Fellow in the Center for Brain Sciences

Project: Weight distribution-constrained learning

· Developed an theoretical framework for learning with weight distribution constraint
· Derived a learning algorithm from information geometry for weight distribution-constrained learning in neural networks
· Applied our theory and algorithm to study capacity and generalization in both feed-forward and recurrent neural networks

Project: Disentangling in β-VAE

· Established a theoretical trade-off between disentangling ability and Bayesian inference error in β-VAE
· Demonstrated the trade-offs on the rotated MNIST dataset
· Calculated optimal β for toy model β-VAEs

Massachusetts Institute of Technology Cambridge, MA
Graduate Researcher in Department of Physics

Project: Learning about learning by many-body systems

· Applied representation learning (VAEs) to study statistical mechanical learning by many-body systems
· Developed machine learning toolkits to measure classification ability, memory capacity, discrimination ability, and novelty detection in many-body system's learning
· Demonstrated machine learning approaches outperform traditional thermodynamic approaches in diagnosing many-body system's learning

Project: Non-equilibrium statistical mechanics of continuous attractors

· Found an analog of gravitational equivalence principle in neural networks
· Derived an absolute upper bound on how fast recurrent networks can track input signals
· Derived an analytical formula for capacity of non-equilibrium neural networks

IBM Research (Quantum) Cambridge, MA
Research Intern at IBM Quantum Computing Theory Group

Project: Many-body localized hidden Born machine

· Proposed a novel hidden architecture for the MBL Born machine
· Established a proof for the trainability and expressibility advantage of the hidden architecture
· Demonstrated the superiority of MBL hidden Born machine on both classical and quantum datasets

Project: Decoding quantum error-correcting codes with quantum neural networks

· Proved that logical decoding error in imperfect stabilizer codes are code distance-independent
· Proved an architecture-independent lower bound for QNNs decoding corrupted states
· Demonstrated QNNs outperform standard decoding procedure in imperfect stabilizer codes

AWARDS & HONORS

- NeurIPS Scholar Award, *Neural Information Processing Systems Foundation* 2022
- First-year Graduate Fellowship, *Massachusetts Institute of Technology* 2017
- Physical Sciences Division Tuition Award, *University of Chicago* 2016
- George Eugene Uhlenbeck Award, *University of Michigan* 2016
- Division of Particle and Fields Travel Award, *American Physical Society* 2016
- Division of Gravitational Physics Travel Award, *American Physical Society* 2016
- Otto Graf Scholarship, *University of Michigan* 2015
- James B. Angell Scholar, *University of Michigan* 2015

TEACHING EXPERIENCE

- Teaching assistant for MIT graduate physics course Statistical Physics in Biology (8.592) 2021
- Teaching assistant for various MIT undergraduate physics course (8.01-8.03) 2018-2020

SKILLS

Programming Python, Mathematica
Tools Quspin, Quskit, Tensorflow, High Performance Computing (Slurm), Numerical Methods