

WEISHUN ZHONG

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EMPLOYMENT

Institute for Advanced Study, Princeton, NJ

Sep.2023-

Member, Simons Center for Systems Biology, School of Natural Sciences

EDUCATION

Massachusetts Institute of Technology, Cambridge, MA

Sep.2017-June.2023

Ph.D. Department of Physics

Advisors: Haim Sompolinsky (Harvard) and Mehran Kardar (MIT)

Thesis: Non-equilibrium Physics: from Spin Glasses to Machine and Neural Learning

University of Chicago, Chicago, IL

Sep.2016-Jun.2017

M.S., *Physical Sciences Division*, Physics

GPA: 3.93/4.0

Advisors: Arvind Murugan and David J. Schwab

University of Michigan

Sep.2013-May.2016

B.S., *highest distinction*, Physics and Mathematics

GPA: 3.97/4.0

Advisor: James T. Liu

PUBLICATIONS

1. “Advantage of Quantum Neural Networks as Quantum Information Decoders”, **Weishun Zhong**, Oles Shtanko, Ramis Movassagh, *arXiv:2401.06300*
2. “A Theory of Weight Distribution-constrained Learning”, **Weishun Zhong**, Ben Sorscher, Daniel D Lee, Haim Sompolinsky, *arXiv:2206.08933; NeurIPS 2022*
3. “Many-body Localized Hidden Born Machine”, **Weishun Zhong**, Xun Gao, Susanne Yelin, Khadijeh Najafi, *arXiv: 2207.02346; under review*
4. “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*
5. “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)*
6. “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)*
7. “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)*
8. “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*
9. “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
Graduate Researcher in Department of Physics

Cambridge, MA

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)
Research Intern at IBM Quantum Computing Theory Group

Cambridge, MA

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