Yuanhang Zhang

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Boosting AI with physics, and understanding physics with AI.

Research Interests

- Quantum Machine Learning
  - *Machine learning for quantum systems*: Development of machine learning algorithms to tackle previously intractable quantum problems.
  - *Quantum computing for machine learning*: Accelerating machine learning through quantum computing, and developing machine learning algorithms for quantum computers.
- Unconventional Computing
  - *MemComputing:* Leveraging long-range order in nonlinear dynamical systems for efficient computation.
  - *Neuromorphic computing:* Theoretical modeling and simulation of artificial neurons utilizing resistive switching materials.

Education

- Ph.D. Physics, University of California, San Diego — Jan 2020 - Jun 2024 (expected)
  GPA 3.93/4, Advisor: Prof. Massimiliano Di Ventra
- Postbaccalaureate Researcher, Tsinghua University — Aug 2019 - Dec 2019
  Advisor: Prof. Dong-Ling Deng
- B.Sc. Physics, University of Science and Technology of China — Sep 2015 - Jun 2019
  GPA 3.91/4.3, with minor in computer science, GPA 4.05/4.3

Publications

[1] **Zhang, Y. H.**, & Di Ventra, M. (2023). *Collective dynamics and long-range order in thermal neuristor networks.* arXiv preprint arXiv:2312.12899.

[2] Qiu, E., **Zhang, Y. H.**, Di Ventra, M., & Schuller, I. K. (2023). *Reconfigurable cascaded thermal neuristors for neuromorphic computing.* Advanced Materials, 2306818.

[3] **Zhang, Y. H.**, & Di Ventra, M. (2023). *Implementation of digital MemComputing using standard electronic components.* arXiv preprint arXiv:2309.12437.

[4] Primosch, D., **Zhang, Y. H.**, & Di Ventra, M. (2023). *Self-averaging of digital memcomputing machines.* Physical Review E, 108(3), 034306.

[5] Nguyen, D.C., **Zhang, Y. H.**, Di Ventra, M. & Pershin, Y.V. (2023). *Hardware implementation of digital memcomputing on small-size FPGAs.* arXiv preprint arXiv:2305.01061.

[6] **Zhang, Y. H.**, & Di Ventra, M. (2023). *Transformer quantum state: A multipurpose model for quantum many-body problems.* Physical Review B, 107(7), 075147.

[7] **Zhang, Y. H.**, & Di Ventra, M. (2022). *Efficient quantum state tomography with mode-assisted training.* Physical Review A, 106(4), 042420.

[8] **Zhang, Y. H.**, & Di Ventra, M. (2021). *Directed percolation and numerical stability of simulations of digital memcomputing machines.* Chaos: An Interdisciplinary Journal of Nonlinear Science, 31(6), 063127.
[9] **Zhang, Y. H.**, Zheng, P. L., Zhang, Y., & Deng, D. L. (2020). *Topological quantum compiling with reinforcement learning.* Physical Review Letters, 125(17), 170501.
[10] Zhao, J., **Zhang, Y. H.**, Shao, C. P., Wu, Y. C., Guo, G. C., & Guo, G. P. (2019). *Building quantum neural networks based on a swap test.* Physical Review A, 100(1), 012334.
[11] Jia, Z. A., **Zhang, Y. H.**, Wu, Y. C., Kong, L., Guo, G. C., & Guo, G. P. (2019). *Efficient machine-learning representations of a surface code with boundaries, defects, domain walls, and twists.* Physical Review A, 99(1), 012307.
[12] **Zhang, Y. H.**, Jia, Z. A., Wu, Y. C., & Guo, G. C. (2018). *An efficient algorithmic way to construct Boltzmann machine representations for arbitrary stabilizer code.* arXiv preprint arXiv:1809.08631.

Talks

[1] Collective dynamics and memory-induced long-range order in spiking oscillator arrays, APS March Meeting 2024
[2] Large language models: how they work and how to use them for science, seminar at USTC, 2024
[3] Neuromorphic computing with thermal interactions, invited talk at NIST and at Micius Forum, USTC, 2023
[4] Collective dynamics and memory-induced long-range order in spiking oscillator arrays, featured student talk, 2023 Annual Meeting of the APS Far West Section
[5] Towards a general-purpose model for quantum many-body problems, seminar at ByteDance, 2023
[6] Transformer Quantum State: A Multi-Purpose Model for Quantum Many-Body Problems, APS March Meeting 2023
[7] Self-Averaging of Digital MemComputing Machines, APS March Meeting 2023
[8] A brief introduction to MemComputing, seminar at Tsinghua University, 2022
[9] Towards a general-purpose model for quantum many-body problems, seminar at Tsinghua University, 2022
[10] Quantum State Tomography with Mode-assisted Training, APS March Meeting 2022
[11] Topological Quantum Compiling with Reinforcement Learning, seminar at University of Oxford, 2021
[12] Directed Percolation and Numerical Stability of Simulations of Digital MemComputing Machines, APS March Meeting 2021

Teaching

- Teaching assistant, Phys 1BL, Electricity & Magnetism Lab, UC San Diego, 2020

Skills

- Python and MATLAB programming
- Developing machine learning algorithms with PyTorch and JAX