Yuanhang Zhang

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Research Interests

- **AI for Physics**
  - AI for quantum systems: Utilizing large language models to model a diverse family of quantum states.
  - AI for dynamical systems: Designing and optimizing dynamical systems using machine learning for enhanced computational performance.
- **The Physics of Computing**
  - Investigating how long-range order enhances computational efficiency.
  - Exploring memory-induced long-range order beyond critical phenomena.
- **Computing with Physics**
  - MemComputing: Utilizing long-range order in nonlinear dynamical systems to develop efficient computational methods.
  - Neuromorphic computing: Leveraging artificial spiking neurons based on novel materials to improve the energy efficiency of machine learning.

Education

- Ph.D. in Physics, University of California San Diego — Jan 2020 - Aug 2024
  Thesis: The physics of computing with memory — Advisor: Prof. Massimiliano Di Ventra
- B.Sc. Physics with minor in Computer Science, University of Science and Technology of China — Sep 2015 - Jul 2019

Experiences

- Postdoctoral Researcher, UC San Diego — Sep 2024 – Now
  Advisor: Prof. Massimiliano Di Ventra
- Teaching assistant, Electricity & Magnetism Lab, UC San Diego — Jan 2020 – Mar 2020
- Postbaccalaureate Researcher, Tsinghua University — Aug 2019 – Dec 2019
  Advisor: Prof. Dong-Ling Deng

Publications

[1] Sun, J., Sipling, C., **Zhang, Y. H.**, & Di Ventra, M. (2024). Memory in neural activity: long-range order without criticality. *arXiv preprint arXiv:2409.16394.*

[2] **Zhang, Y. H.**, Sipling, C., Qiu, E., Schuller, I. K., & Di Ventra, M. (2024). Collective dynamics and long-range order in thermal neuristor networks. ***Nature Communications**, 15(1), 6986.*

[3] **Zhang, Y. H.**, & Di Ventra, M. (2024). Implementation of digital MemComputing using standard electronic components. *International Journal of Circuit Theory and Applications*.

[4] Sipling, C., **Zhang, Y. H.**, & Di Ventra, M. (2024). Memory-induced long-range order in dynamical systems. *arXiv preprint arXiv:2405.06834.*

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

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

[7] Nguyen, D.C., **Zhang, Y. H.**, Di Ventra, M. & Pershin, Y.V. (2023). Hardware implementation of digital memcomputing on small-size FPGAs. *2023 IEEE 66th International Midwest Symposium on Circuits and Systems.*

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

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

[10] **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.*

[11] **Zhang, Y. H.**, Zheng, P. L., Zhang, Y., & Deng, D. L. (2020). Topological quantum compiling with reinforcement learning. ***Physical Review Letters**, 125(17), 170501.*

[12] 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.*

[13] 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.*

[14] **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.*

Selected Talks

[1] Computing with long-range order: from AI to combinatorial optimization, invited seminar at USTC, 2024

[2] Collective dynamics and memory-induced long-range order in spiking oscillator arrays, APS March Meeting 2024 and featured student talk at APS Far West Section 2023

[3] Neuromorphic computing with thermal interactions, invited talk at NIST, 2023

[4] Transformer Quantum State: A Multi-Purpose Model for Quantum Many-Body Problems, APS March Meeting 2023

[5] Self-Averaging of Digital MemComputing Machines, APS March Meeting 2023

[6] A brief introduction to MemComputing, seminar at Tsinghua University, 2022

[7] Towards a general-purpose model for quantum many-body problems, seminar at Tsinghua University, 2022

[8] Quantum State Tomography with Mode-assisted Training, APS March Meeting 2022

[9] Topological Quantum Compiling with Reinforcement Learning, seminar at University of Oxford, 2021

[10] Directed Percolation and Numerical Stability of Simulations of Digital MemComputing Machines, APS March Meeting 2021

Skills

- **Programming Languages**: Python, MATLAB, C, C++
- **Machine Learning**: Expertise in developing algorithms using PyTorch
- **High-Performance Computing**: Proficient in parallel computing and GPU programming