Quantum Machine Learning: From Near-Term to Fault-Tolerance

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Abstract
Quantum technologies, such as quantum computing, are poised to revolutionize next-generation digital technologies by leveraging the principles of quantum mechanics, and are widely regarded as some of the most significant technologies of our era. Quantum machine learning, which involves running machine learning algorithms on quantum devices, is seen as a flagship application in this field. In my talk, I will explore two aspects of quantum machine learning: near-term algorithms and fault-tolerant algorithms. For near-term applications, I will delve into the use of variational quantum circuits in machine learning problems and discuss the quantum neural tangent kernel theory as an analytical tool for understanding and optimizing quantum neural networks. Regarding fault-tolerant applications that incorporate quantum error correction, I will present an end-to-end application of the HHL algorithm. This algorithm offers a provable, generic, and efficient approach to a range of machine learning challenges.

Bio
Dr. Junyu Liu is a theoretical physicist affiliated with the University of Chicago and IBM. He earned his PhD in Physics from the California Institute of Technology in June 2021, where he gained experience at the Walter Burke Institute for Theoretical Physics and the Institute for Quantum Information and Matter. Dr. Liu has a keen interest in the combination of physics and computing, especially machine learning and other modern computing technologies. His work encompasses areas such as quantum machine learning, variational quantum circuits, quantum optimization, and quantum data centers. His research, published in leading journals and conferences like Physics Review Letters, Nature Communications, Physics Review X Quantum, ICLR, and IEEE, has garnered significant attention in both academia and industry. Dr. Liu has been honored with several awards, including the IEEE QCE 1st place best paper award in quantum algorithms (2023), the Kadanoff Fellowship at the University of Chicago (2021), and the Quantum Information Science Award from Fermilab (2020-2021).

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