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Benchmarking Quantum Phase Recognition with a Novel Quantum Convolutional Neural Network

Recognizing quantum phases of matter is a central challenge in quantum many-body physics and quantum machine learning. In this work, we introduce a Novel Quantum Convolutional Neural Network (No-QCNN) architecture tailored for efficient quantum phase recognition and benchmark its performance on IBM's superconducting quantum hardware. The No-QCNN leverages translationally invariant circuit motifs and entangling layers inspired by classical convolutional networks, adapted to operate natively on near-term quantum devices. We implement and evaluate No-QCNN using quantum circuits composed of parameterized single- and two-qubit gates, trained variationally to distinguish between distinct quantum phases in prototypical spin models, including the transverse-field Ising model. Benchmarking is performed both in ideal simulation and on real IBM Quantum backends, highlighting the model's robustness against hardware noise and circuit depth constraints. Our results demonstrate that No-QCNN achieves high phase classification accuracy with reduced circuit overhead compared to standard quantum neural network baselines, making it a promising candidate for practical quantum machine learning applications in near-term quantum devices. We discuss implications for quantum phase transition detection, scalability, and future deployment in hybrid quantum-classical workflows.

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