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Quantum Convolutional Neural Networks IRIS CONG, Harvard University, SOONWON CHOI, University of California, Berkeley, MIKHAIL LUKIN, Harvard University — We introduce and analyze a novel quantum machine learning model motivated by convolutional neural networks (CNN). Our quantum convolutional neural network (QCNN) makes use of only O(log(N)) variational parameters for input sizes of N qubits, allowing for its efficient training and implementation on realistic, near-term quantum devices. We show that QCNN circuits combine the multi-scale entanglement renormalization ansatz and quantum error correction to mimic renormalization-group flow, making them capable of recognizing different quantum phases and associated phase transitions. As an example, we illustrate the power of QCNNs in recognizing a 1D symmetry-protected topological phase, and demonstrate that a QCNN trained on a set of exactly solvable points can reproduce the phase diagram over the entire parameter regime. Finally, generalizations and possible applications of QCNN are discussed.

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