Quantum learning with noise and decoherence: a robust quantum neural network

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Abstract

Noise and decoherence are two major obstacles to the implementation of large-scale quantum computing. Because of the no-cloning theorem, which says we cannot make an exact copy of an arbitrary quantum state, simple redundancy will not work in a quantum context, and unwanted interactions with the environment can destroy coherence and thus the quantum nature of the computation. Because of the parallel and distributed nature of classical neural networks, they have long been successfully used to deal with incomplete or damaged data. In this work, we show that our model of a quantum neural network (QNN) is similarly robust to noise, and that, in addition, it is robust to decoherence. Moreover, robustness to noise and decoherence is not only maintained but improved as the size of the system is increased. Noise and decoherence may even be of advantage in training, as it helps correct for overfitting. We demonstrate the robustness using entanglement as a means for pattern storage in a qubit array. Our results provide evidence that machine learning approaches can obviate otherwise recalcitrant problems in quantum computing.

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