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Estimating the entangling power of a two-qubit gate from measurement data: artificial neural networks versus standard tomography methods

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Quantum logic gates are the building blocks of quantum circuits and algorithms, where the generation of entanglement is essential to perform quantum computations. The amount of entanglement that a unitary quantum gate can produce from product states can be quantified by the so-called entangling power, which is a function of the gate's unitary or Choi matrix representation. In this work, I introduce an efficient approach to the practical problem of estimating the entangling power of an unknown two-qubit gate from measurement data. The approach uses a deep neural network trained with noisy data simulating the outcomes of prepare-and-measure experiments on random gates. The training data is restricted to 48 measurement settings, which is significantly less than the 256 dimensions of the ambient space of 16×16 Choi matrices and very close to the minimum number of settings that guarantees the recovery of a two-qubit unitary gate using the compressed sensing technique at an acceptable error rate. This method does not make any prior assumptions about the quantum gate, and it also avoids the need for standard reconstruction tools based on full quantum tomography, which is prone to systematic errors.

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