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Synthesis of optimal unitary transformations for the study of quantum complexity

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A quantum system perturbed by the environment is prone to errors. The existence of the environment itself implies that any given eigenstate of a pure Hamiltonian rapidly decays, hampering the information storage and processing in quantum computers. We wish to minimize errors by performing the most efficient synthesis of a given evolution. An important concept to achieve this goal is *quantum complexity*, understood as a metric of how hard it is to synthesize a given evolution. In general, the quantum complexity of a system is the amount of gates, from a given set of universal gates, needed to produce some unitary transformation. We make use, however, of differential geometry, and the definition of complexity changes to the length of the geodesic linking the identity of the system to the unitary evolution of interest. (1) To this date, some authors (2-3) have shown the possibility of implementing some recurrent neural network architectures capable of predicting the sequences of controls in order to synthesize the desired unitary. We aim to improve on said references by adding noise to the steered Hamiltonian. In order to do so, we model noise as a non-controllable drift Hamiltonian, purifying the system by adding one ancillary qubit for each other qubit of interest. We hope that, once this is clear, we may be able to compare these results with the usual dynamical decoupling methods. We speculate that the control of our method has a smooth evolution over time, whereas the dynamical decoupling method needs rapid manipulation of instantaneous pulses.

Palavras-chave: Quantum complexity. Quantum control theory. Machine learning.

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