CO.CO.MAT

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Efficient characterization of quasi-unitary quantum operations

Quantum technologies necessitate to assess how well a quantum device implements a desired quantum operation. The standard approach is based on quantum process tomography which scales exponentially in resources, quickly becoming impractical. Stochastic sampling can significantly reduce the required resources [1,2]. However, it still relies on the channel-state isomorphism, i.e., the representation of quantum channels as states on a larger Hilbert space which allows for applying the fidelity used for quantum states to quantum processes.

Here we take a different approach motivated by a problem that arises in the optimal control theory of open quantum systems. Instead of trying to characterize the full open system evolution, or evaluate how close it is to a desired quantum gate via the channel-state isomorphism, we ask how one can characterize the unitary part of the total evolution. This leads us to define a distance measure for unitaries whose evaluation requires significantly less resources than in any approach based on tomography. We discuss the connection to the standard fidelity and show that our distance measure provides the required information for quantum operations that are close to unitary.

[1] S. T. Flammia and Y.-K. Liu, Phys. Rev. Lett. 106, 230501 (2011)
[2] M. P. da Silva, O. Landon-Cardinal, and D. Poulin, Phys. Rev. Lett. 107, 210404 (2011)

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