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Data-driven self-calibration of quantum circuits

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Any circuit is in one-to-one correspondence with a logical table that specifies, upon any given input state, what the output state of the ideal circuit should be. Since classical states are perfectly distinguishable in principle, at least at a fundamental level the calibration of classical circuits does not therefore present any difficulty. This is in stark contrast with the quantum case where, due to the existence of superposition of states, neither input nor output states can in general be jointly distinguished perfectly, thus rendering the calibration of quantum circuits a problem in principle.

Here, we address this fundamental issue by adopting a Bayesian approach to the calibration of quantum circuits that is data-driven, i.e. it avoids any assumption on the quantum description of the states input and output of the circuit, and solely relies on correlations between their classical labels, thus de facto representing a self-calibration of the circuit. In particular, our approach automatically inherits from Bayes theorem an Occam's razor-like minimality criterion that favors the simplest inference that is consistent with the observations. We show that data-driven self-calibration is equivalent to a particular clustering problem in the correlation space that can be solved adopting John's theory on minimum volume enclosing ellipsoids.

This presentation is based on:

[1] M. Dall'Arno, On the role of designs in the data-driven approach to quantum statistical inference, arXiv:2304.13258.
[2] M. Dall'Arno, F. Buscemi, A. Bisio, and A. Tosini, Data-Driven Inference, Reconstruction, and Observational Completeness of Quantum Devices, Phys. Rev. A 102, 062407 (2020).
[3] M. Dall'Arno and F. Buscemi, Data-Driven Inference of Physical Devices: Theory and Implementation, New J. Phys. 21, 113029 (2019).
[4] M. Dall'Arno, S. Brandsen, F. Buscemi, and V. Vedral, Device-independent tests of quantum measurements, Phys. Rev. Lett. 118, 250501 (2017).

Abstract category

Other

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