Attention-based neural networks for Quantum State Tomography

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Abstract

Resource-efficient quantum state tomography is one of the key ingredients of future quantum technologies. In this work, we propose a new tomography protocol combining standard quantum state reconstruction methods with an attention-based neural network architecture. We show how the proposed protocol is able to improve the averaged fidelity reconstruction over linear inversion and maximum-likelihood estimation in the finite-statistics regime, reducing at least by an order of magnitude the amount of necessary training data. We demonstrate the potential use of our protocol in physically relevant scenarios, in particular, to certify metrological resources in the form of many-body entanglement generated during the spin squeezing protocols. This could be implemented with the current quantum simulator platforms, such as trapped ions, and ultra-cold atoms in optical lattices.

References

[1] Adriano Macarone Palmieri, Guillem Müller-Rigat, Anubhav Kumar Srivastava, Maciej Lewenstein, Grzegorz Rajchel-Mieldzioć, Marcin Płodzień, arXiv:2309.10616

Figures

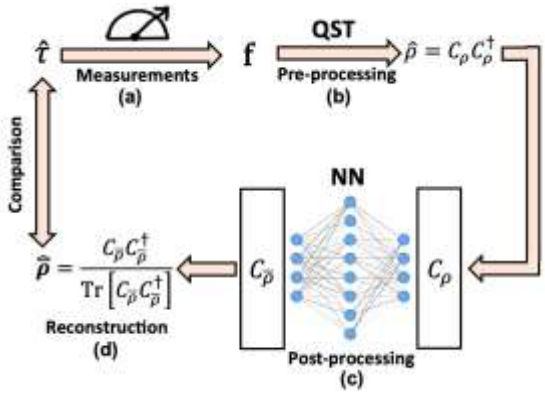

Figure 1. Schematic representation of the data pipeline of our QST hybrid protocol. Panel (a) shows data acquisition from a generic experimental set-up. Next, panel (b) presents standard density matrix reconstruction. Panel (c) depicts the matrix-to-matrix deep-learning strategy for Cholesky matrices reconstruction, and (d) depics density matrix reconstruction.