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To the editors of PRX Quantum

March …, 2022

Dear Editors,

we would like to submit our manuscript "Adaptive Quantum State Tomography with Active Learning" to PRX Quantum.

In this work we present and implement an efficient scheme to reconstruct quantum states from very few measurements. It based on a combination of active learning and restricted Boltzmann machines. In contrast to existing quantum state tomography (QST) schemes, our scheme can request specific, highly informative measurements during the reconstruction process and is able to actively incorporate them into the reconstruction. We show that the quality of the reconstruction is improved significantly by this scheme. To this end, we examine the quality of the reconstruction of different multi-qubit states with varying degree of entanglement as well as ground states of a kinetically constrained spin chain.

The reconstruction of quantum states has become increasingly important in the recent years, since ever larger quantum systems are being investigated experimentally and quantum devices with more than 100 qubits are being built. To access these quantum states, tools for inferring the information about state from measurements are of high importance. However, most existing schemes have the downside that the number of samples needed for a good reconstruction scales exponentially and therefore they are limited to small systems. By learning the structure of the quantum states by means of neural networks it is possible to reduce the number of samples and access larger systems. However, the measurement configurations in which the state is being measured have a large impact on the reconstruction quality.

Our active learning QST scheme tackles this problem by selecting the configurations that maximize the information gain without any prior knowledge about the state. It paves the way for characterizing large quantum devices and probing quantum many-body systems, for example in quantum simulators.

We thank you for your time and consideration. Please do not hesitate to contact us if any questions occur.

Sincerely yours,

Hannah Lange
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…
Fabian Grusdt
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