Contribution ID: **59** Type: **Poster contribution**

Classical shadows with Brownian quantum circuits

Tuesday, 7 May 2024 17:30 (1h 30m)

Classical shadows are a powerful method for learning many properties of quantum states in a sample-efficient manner, by making use of randomized measurements. Random local Pauli measurements [1] and shallow shadows [2–4] provide optimal protocols for estimating expectation values of local observables.
On the contrary, the Clifford global-twirling protocol [1] is optimal for estimating global quantities such as pure-state fidelity or the system's purity. However, this protocol may be difficult to implement in practice, due to the need to apply a global random unitary U.
In this work, we are interested in classical shadow protocols based on Brownian quantum circuits [5], which may be implemented using two-qubit gates only. We put forward a very simple approximate estimation scheme which, for a deep enough circuit, performs similarly to the global-twirling protocol, without the need to apply global unitary operators. We support this scheme with a systematic numerical study of its validity and performance.

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Abstract category

Quantum Simulations

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Session Classification: Poster session