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Entanglement detection in Noisy Intermediate-Scale Quantum devices

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With the recent advent of noisy intermediate-scale quantum devices implemented in various platforms, entanglement and quantum coherence detection are in the focus of interest. We propose an ordered set of experimentally accessible conditions for detecting entanglement in mixed states. The k-th condition involves comparing moments of the partially-transposed density operator up to order k. Our empirical studies highlight that the first four conditions already detect mixed state entanglement reliably in a variety of architectures. Exploiting symmetries can help to further improve their detection capabilities. We also show how to estimate moment inequalities based on local random measurements of single state copies (classical shadows). We illustrate the method by applying it to a variety of physical systems and to experimental data.

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