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Title: Quantum algorithms, tensor networks and quantum supremacy

Abstract:

Matrix product state algorithms and similar tools---called tensor network methods---form the backbone of modern numerical methods used to simulate many-body physics. Matrix product states have a further range of applications in machine learning. In this talk we (1) We present a quantum algorithm which returns a classical description of a k-rank matrix product state approximating an eigenvector given black-box access to a unitary matrix. Each iteration of the optimization requires $O(n\cdot k^2)$ quantum gates, yielding sufficient conditions for our quantum variational algorithm to terminate in polynomial-time---though in general, there's no guarantee that it will. (2) Developing methods based on tensor network theory, we derive a formula for the minimal number of nearest-neighbor gates on a 2D lattice required to possibly generate a quantum state possessing volumetric entanglement scaling in the number of qubits. Hence, we predict the minimum random circuit depth needed to generate the maximal bipartite entanglement correlations between all problem variables (qubits).

In conclusion, we forecast gate-depths for quantum supremacy.

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