Abstract

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Motivated by the ability of measurement-based quantum computing (MBQC) schemes to rapidly spread entanglement, we explore the possibility of utilizing MBQC in conjunction with current efficient variational protocols to simulate non-trivial quantum states in sublinear circuit depth scaling. In particular, we are interested in combining MBQC with the quantum approximate optimization algorithm (QAOA) to simulate the critical ground state of the N-spin-1/2 1D Ising model on a ring with sublinear circuit depth. To this end, we aim to explore the strengths and limitations of MBQC and QAOA, how they interact with each other, and how one might implement both schemes together. So far, we have (1) shown that QAOA can be implemented entirely with a MBQC scheme, (2) simulated the GHZ state, a non-trivial quantum state, in the MBQC scheme with a single layer of measurements, and (3) tested some conjectures regarding the robustness of QAOA. Our next goal is to show how one might implement both MBQC and QAOA in the same protocol, and whether this combination (which consists only of local unitaries and measurements) can, in principle, provide a speed up over the current linear-depth QAOA.