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Study of Shortcuts to Adiabaticity on QAOA

The Quantum Approximate Optimization Algorithm (QAOA) is a promising hybrid quantum-classical algorithm that can solve combinatorial optimization problems. The quantum part of the algorithm involves using parametric unitary operations on a quantum computer to prepare a trial solution state. The parametric QAOA angles are variationally optimized minimizing a cost function using classical methods. We study a generalized QAOA ansatz that includes corrections to the Trotter expansion at the first and second order based on the Baker-Campbell-Hausdorff (BCH) expansion, that we call QAOA-2CD. In our work, we have better performances of QAOA-2CD with respect to QAOA. In a regime in which QAOA is close to Quantum Annealing (QA), these new unitaries correspond to the countediabatic potential of Shortcuts to Adiabaticity. The latter assists the adiabatic evolution limiting excited state hoppings of the ground state and making the evolution time-independent. In our work, we reveal an expected connection between a property valid for QAOA-2CD and QA. A system with a huge minimal gap Δ_eg can be treated easily not only in QA but also in QAOA and QAOA-2CD.

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