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Noise-Resilient Variational Hybrid Quantum-Classical Optimization

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Variational hybrid quantum-classical optimization represents one of the most promising avenue to show the advantage of nowadays noisy intermediate-scale quantum computers in solving hard problems, such as finding the minimum-energy state of a Hamiltonian or solving some machine-learning tasks. In these devices noise is unavoidable and impossible to error-correct, yet its role in the optimization process is not much understood, especially from the theoretical viewpoint. Here we consider a minimization problem with respect to a variational state, iteratively obtained via a parametric quantum circuit, taking into account both the role of noise and the stochastic nature of quantum measurement outcomes. We show that the accuracy of the result obtained for a fixed number of iterations is bounded by a quantity related to the Quantum Fisher Information of the variational state. Using this bound, we study the convergence property of the quantum approximate optimization algorithm under realistic noise models, showing the robustness of the algorithm against different noise strengths.

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