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A coherent approach to quantum-classical optimization

Hybrid quantum-classical optimization techniques, which incorporate the pre-optimization of Variational Quantum Algorithms (VQAs) using Tensor Networks (TNs), have been shown to allow for the reduction of quantum computational resources. In the particular case of large optimization problems, commonly found in real-world use cases, this strategy is almost mandatory to reduce the otherwise unfathomable execution costs and improve the quality of the results. We identify the coherence entropy as a crucial metric in determining the suitability of quantum states as effective initialization candidates. Our findings are validated through extensive numerical tests for the Quantum Approximate Optimization Algorithm (QAOA), in which we find that the optimal initialization states are pure Gibbs states. Further, these results are explained with the inclusion of a simple and yet novel notion of expressivity adapted to classical optimization problems. Based on this finding, we propose a quantum-classical optimization protocol that significantly improves on previous approaches for such tasks, with specific focus on its effectiveness.

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