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Reducing Barren Plateaus in Quantum Algorithm Protocols

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Quantum machine learning has emerged as a promising utilization of near-term quantum computation devices. However, algorithmic classes such as variational quantum algorithms have been shown to suffer from barren plateaus due to vanishing gradients in their parameters spaces. We present an approach to quantum algorithm optimization that is based on trainable Fourier coefficients of Hamiltonian system parameters. Our ansatz applies to the extension of discrete quantum variational algorithms to analogue quantum optimal control schemes and is non-local in time. We demonstrate the viability of our ansatz on the objectives of compiling the quantum Fourier transform and preparing ground states of random problem Hamiltonians using quantum natural gradient descent. In comparison to the temporally local discretization ansätze in quantum optimal control and parametrized circuits, our ansatz exhibits faster and more consistent convergence without suffering from vanishing gradients. We uniformly sample objective gradients across the parameter space and find that in our ansatz the variance decays at a decreasing rate with the number of qubits, which indicates the absence of barren plateaus. We propose our ansatz as a viable candidate for near-term quantum machine learning.

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