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Using Machine Learning for Noise Resilient Optimization of Variational Quantum Eigensolvers

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Variational Quantum Eigensolvers (VQEs) are a powerful class of hybrid quantum-classical algorithms designed to approximate the ground state of a quantum system described by its Hamiltonian. VQEs hold promise for various applications, including lattice field theory and quantum chemistry.
However, the inherent noise present in Noisy Intermediate-Scale Quantum (NISQ) devices poses a significant challenge for running VQEs. These algorithms are particularly susceptible to noise, such as measurement shot noise and hardware noise.

In the talk by Kim Nicoli, it was proposed to enhance the classical optimization of VQEs with Gaussian Processes and Bayesian Optimization, as these machine learning techniques are well-suited for handling noisy data.
In this poster, we provide additional insights into this new algorithm and present further numerical experiments. First, we show results for more complex Hamiltonians using classical simulations of quantum hardware without hardware noise. Second, we examine the impact of hardware noise and error mitigation on the performance of the algorithm.
All numerical experiments demonstrate a significant outperformance of state-of-the-art baselines, laying the foundation for future studies of applying our machine learning techniques for VQEs to real quantum hardware and lattice field theory setups.

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