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Quantum and classical methods for ground state optimisation in quantum many-body problems

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We currently find ourselves in the era of noisy intermediate-scale quantum (NISQ) computing, where quantum computing applications are limited yet promising. In this work I will overview two algorithms for computing the ground state and dynamics of the transverse field Ising model as a testbed for more complex models. The Variational Quantum Eigensolver (VQE) algorithm leverages quantum circuits to offload the task of exploring an exponentially large Hilbert space to a quantum system (that naturally lives in this space). Conversely, I will show how a classical algorithm, Variational Monte Carlo (VMC), can achieve similar results by modeling the wavefunction as a Restricted Boltzmann Machine (RBM), without the need for quantum computing resources. To conclude, further work will be presented to explore, benchmark and leverage both quantum and classical machine-learned representation of quantum states.

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