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(G*) Variationally Scheduled Quantum Simulation

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Eigenstate preparation is ubiquitous in quantum computing, and a standard approach for generating the lowest-energy states of a given system is by employing adiabatic state preparation (ASP). In the present work, we investigate a variational method for determining the optimal scheduling procedure within the context of ASP. In the absence of quantum error correction, running a quantum device for any meaningful amount of time causes a system to become susceptible to the loss of relevant information. Therefore, if accurate quantum states are to be successfully generated, it is crucial to find techniques that shorten the time of individual runs during iterations of annealing. We demonstrate our variational method toward this end by investigating the hydrogen and P4 molecules, as well as the Ising model problem on a two-dimensional triangular lattice. In both cases, the time required for one iteration to produce accurate results is reduced by several orders of magnitude in comparison to what is achievable via standard ASP. The significant shortening of the required time is achieved by using excited states partially during ASP. As a result, the required quantum coherence time to perform such a calculation on a quantum device becomes much less stringent with the implementation of this algorithm. In addition, our variational method is found to exhibit resilience against control errors, which are commonly encountered within the realm of quantum computing.

Primary authors: BUCK, Samantha (University of Guelph); Dr MATSUURA, Shunji (1QBit)

Co-authors: Mr SENICOURT, Valentin (1QBit); Dr ZARIBAFIYAN, Arman (1QBit)

Presenter: BUCK, Samantha (University of Guelph)

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