

Towards Scalable Adiabatic Quantum Algorithms for MIS

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Recent advances in neutral-atom quantum computers enable scaling their computation power toward solving large combinatorial optimization problems (COPs) [1,2]. Hybrid algorithms, combining classical and quantum computing, offer a promising path forward. This talk presents two hybrid adiabatic quantum computation (AQC) approaches for solving prototypical COP – finding the Maximum Independent Set (MIS) of a graph – on neutral-atom quantum annealers, potentially extending the reach to problem sizes beyond current capabilities.

Our first algorithm utilizes mathematical graph properties to inflate the spectral gap of the Hamiltonian, which limits the complexity of traditional AQC. Even though finding the MIS of a graph requires, in principle, checking independent sets across the entire graph, we show that information regarding the local density of edges can be used to engineer the controls and accelerate the convergence towards the desired solution state. Secondly, we present a pulse optimization method for accelerating adiabatic control protocols [3]. Our method finds control pulses that keep the quantum system in its instantaneous ground state during the evolution. It is efficient, using gradient-free optimization, and robust, using analytic adiabatic solutions in the optimization cost function. To validate our results, we perform digitized adiabatic protocols on IBM's quantum cloud and run numerical simulations of Rydberg atom arrays.

References:

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