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Crushing runtimes in adiabatic quantum computation with Energy Landscape Manipulation (ELM): Application to Quantum Factoring

NIKE DATTANI, Kyoto University, RICHARD TANBURN, OLIVER LUNT, Oxford University — We introduce two methods for speeding up adiabatic quantum computations by increasing the energy between the ground and first excited states. Our methods are even more general. They can be used to shift a Hamiltonian's density of states away from the ground state, so that fewer states occupy the low-lying energies near the minimum, hence allowing for faster adiabatic passages to find the ground state with less risk of getting caught in an undesired low-lying excited state during the passage. Even more generally, our methods can be used to transform a discrete optimization problem into a new one whose unique minimum still encodes the desired answer, but with the objective function's values forming a different landscape. Aspects of the landscape such as the objective function's range, or the values of certain coefficients, or how many different inputs lead to a given output value, can be decreased *or* increased. One of the many examples for which these methods are useful is in finding the ground state of a Hamiltonian using NMR. We apply our methods to an AQC algorithm for integer factorization, and the first method reduces the maximum runtime in our example by up to 754%, and the second method reduces the maximum runtime of another example by up to 250%.

Nike Dattani
Kyoto University

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