Steered quantum annealing: improving time efficiency with partial information

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Abstract

On the computational model of quantum annealing it is desirable to keep the gap between the ground and first excited states as large as possible during the annealing process, since it allows the computation to remain under the protection of the adiabatic theorem while staying efficient. We propose steered quantum annealing as a new method to enlarge the gap throughout the process, in the case of diagonal final Hamiltonians, based on the exploitation of some assumptions we can make about the particular problem instance. In order to introduce this knowledge, we propose beginning the anneal from a biased Hamiltonian that incorporates reliable assumptions about the final ground state. This is done by taking a locally rotated version of the standard initial Hamiltonian for annealing according to the guessed assignment by an angle Θ, which allows us to control the degree of confidence we have on such assignment. The approach is significantly flexible, since it allows to account for partial information about the solution and the expected quality of this information, as well as the possibility to bias against a certain subsubspace.

References

[1] Tameem Albash and Daniel A. Lidar, Rev. Mod. Phys. 90 (2018) 015002.

Figures

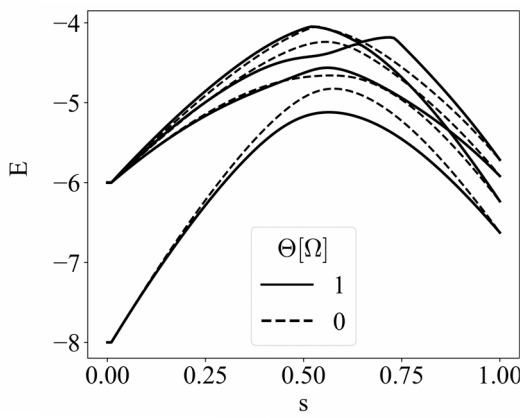

Figure 1: Comparison between spectra along the annealing process for the standard (dashed lines) and steered (solid lines) annealing process for a particular instance of a random Ising model in the spin glassy regime.

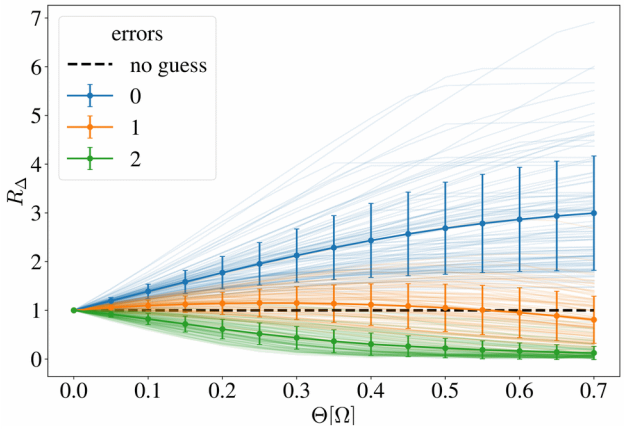

Figure 2: Comparison of the performance of the protocol for different accuracies of the initially provided information with respect to a standard anneal (dashed line). R_Δ is the ratio between the minimum gap of the steered process and that of the standard process, and Θ is normalised between 0 (no confidence on the assignment) and 1 (absolute confidence on the assignment).