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Title: First order phase transition in the Quantum Adiabatic Algorithm

Abstract;

We investigate the complexity of the Quantum Adiabatic Algorithm using quantum Monte Carlo simulations, incorporating parallel tempering to speed up equilibration, for sizes up to N = 256. For a particular model, known as Exact Cover, we find that an increasing fraction of instances have a first order (discontinuous) quantum phase transition during the evolution of the algorithm. This implies a very small gap (probably exponential) and hence a very long running time for the algorithm to succeed. We have also investigated the effect of making the "costs" (the extra energy if a clause is not satisfied) and the transverse fields random. We find that this does not reduce the trend to a first order transition at large sizes.

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