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Study on Discrete Quantum Adiabatic Computation in Combinatorial Search Problems

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1. Introduction

The model of adiabatic quantum computation is a new paradigm for designing quantum algorithms. This model is based on the quantum adiabatic theorem, where a quantum computer evolves the quantum system slowly to switch gradually from an initial Hamiltonian to a final Hamiltonian . This dissertation presents an experimental study on the discrete quantum adiabatic algorithm in solving random instances of 3-SAT problems which are among difficult NP-Hard problems for the worst case.

We proposes a new monotonic variation method for the phase shift and mixing functions in the adiabatic quantum algorithm called the *Quadric variation method,* in order to speed up the algorithm search and decrease the overall resulting search cost. In addition, we present a better parameter configuration for the algorithm to be used with quadric variation as well as the previously proposed methods.

2. Results and Discussions

The search cost is defined to be the expected number of steps required to find a solution $C = j/Psoln$.The results are the average of solving 100 random instances. Figures 1, and 2 compares the search cost for different methods Annealing, Linear, Cubic, and the Quadric method we proposed. Fig 1 uses original △ values and Fig. 2 uses the improved △values. We can see from the comparison that the quadric variation methods improve in both cases over the other methods, that is due to the lower required number of steps to find the solution only as double of number bits n, whereas the other methods requires at least n^2 steps.

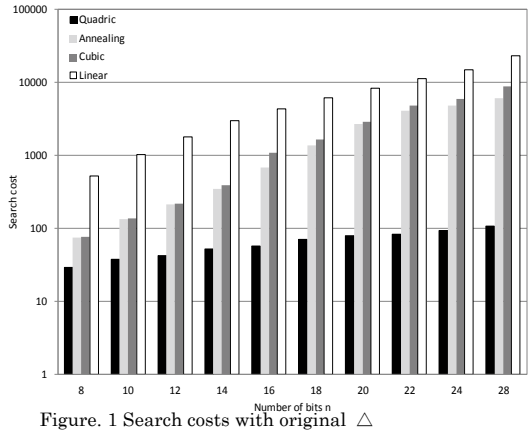

Figure. 1 Search costs with original △

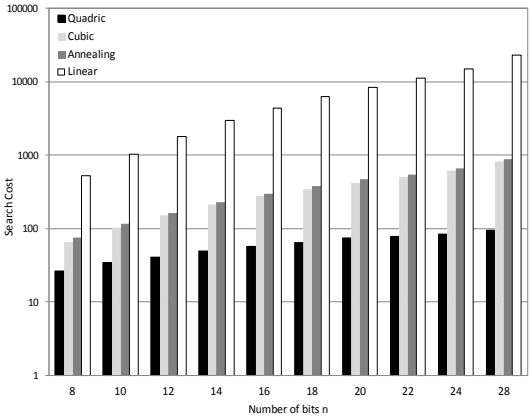

Figure. 2 Search costs with improved △

3. Conclusions

The quantum adiabatic algorithm offers new insights into the usefulness of quantum resources for computational tasks. The experiments have revealed that using the quadric variation method improves on the other variation methods, where it gave search cost of only $O(n)$. Also the improved values of the parameter Δ has strongly enhanced the search behavior