

Singularity of Farhi -Gutmann Analog Quantum Search

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(Received: 2003-7-28; Revised: 2003-10-8)

Abstract: We show that the Farhi -Gutmann analog quantum search is a singular algorithm in the following sense: when the original driving Hamiltonian is perturbed slightly such that it is made of projections to the starting state and to the target state with different energies, the maximum fidelity (transition probability) between the searching state and the target state is strictly less than 1 over the entire evolution period, and the first time to achieve this maximum fidelity is of order $\sqrt{N}/\sqrt{1+cN}$, whose behavior depends crucially on whether $c=0$ or not (here N is the total number of items, and the original Farhi -Gutmann case corresponds to $c=0$). Moreover, when $c \neq 0$ and N tends to infinity, the maximum fidelity tends to zero, and the first time to achieve the maximum fidelity tends to a positive constant! The condition for guaranteeing the algorithm's efficiency is determined explicitly.

PACS: 03.67.Lx

Key words: quantum search, Hamiltonian, perturbation, fidelity

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