Abstract Submitted
for the MAR05 Meeting of
The American Physical Society

Quantum Adiabatic Evolution Algorithm via combinatorial landscapes VADIM SMELYANSKIY, SERGEY KNYSH, ROBIN MORRIS, NASA Ames Research Center — We analyze the performance of the Quantum Adiabatic Evolution algorithm (QAEA) on a variant of Satisfiability problem for an ensemble of random graphs parametrized by the ratio of clauses to variables, $g = M/N$. We introduce a set of macroscopic parameters (landscapes) and put forward an ansatz of universality for random bit flips. We then formulate the problem of finding the smallest eigenvalue and the excitation gap as a statistical mechanics problem. We use the so-called annealing approximation with a refinement that a finite set of macroscopic variables (versus only energy) is used, and are able to show the existence of a dynamic threshold $g = g_d$, beyond which QAEA should take an exponentially long time to find a solution. We compare the results for extended and simplified sets of landscapes and provide numerical evidence in support of our universality ansatz. We have been able to map the ensemble of random graphs onto another ensemble with fluctuations significantly reduced. This enabled us to obtain tight upper bounds on satisfiability transition and to recompute the dynamical transition using the extended set of landscapes.

Vadim Smelyanskiy
NASA Ames Research Center

Date submitted: 07 Dec 2004 Electronic form version 1.4