Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Optimizing Variational Quantum Algorithms using Pontryagin's Minimum Principle ZHI-CHENG YANG, Physics Department, Boston University, ARMIN RAHMANI, Department of Physics and Astronomy and Quantum Matter Institute, University of British Columbia, ALIREZA SHABANI, HARTMUT NEVEN, Google Inc., CLAUDIO CHAMON, Physics Department, Boston University — We use the Pontryagin's minimum principle to optimize variational quantum algorithms. We show that for a fixed computation time, the optimal evolution has a bang-bang (square pulse) form, both for closed and open quantum systems with Markovian decoherence. Our findings support the choice of evolution ansatz in the recently proposed Quantum Approximate Optimization Algorithm. Focusing on the Sherrington-Kirkpatrick spin glass as an example, we find a system-size independent distribution of the duration of pulses, with characteristic time scale set by the inverse of the coupling constants in the Hamiltonian. We numerically demonstrate that our optimal nonadiabatic bang-bang protocols can significantly outperform quantum annealing, favoring gate-model quantum computation for quantum enhanced optimization. Moreover, the fidelity of the final states following the bang-bang protocol remains high in the presence of weak additive white noise. The optimality of the bang-bang protocols and the characteristic time scale of the pulses inform the search for effective hybrid (classical and quantum) schemes for tackling combinatorial optimization problems.

Zhi-Cheng Yang
Physics Department, Boston University

Date submitted: 09 Nov 2016 Electronic form version 1.4