HARVARD UNIVERSITY
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Mathematical Picture Language Seminar

Tuesday, October 4

9:30 a.m. Boston time

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The Quantum Wasserstein Distance of Order 1

Abstract: We propose a generalization of the Wasserstein distance of order 1 to the quantum states of n qudits. This recovers the Hamming distance for vectors of canonical basis and the classical Wasserstein distance for quantum states diagonal in canonical basis. We prove a continuity bound for von Neumann entropy with respect to proposed distance, which significantly strengthens the best continuity bound with respect to trace distance. We also propose a generalization of the Lipschitz constant to quantum observables. The notion of quantum Lipschitz constant allows us to compute proposed distance with a semidefinite program. We prove a Gaussian concentration inequality for the spectrum of quantum Lipschitz observables and a quadratic concentration inequality for quantum Lipschitz observables measured on product states. We apply such inequalities to obtain extremely tight limitation bounds for standard NISQ proposals in both noisy and noiseless regimes. In the noisy regime with local depolarizing noise p, we prove that at depth O(p^-1) it is exponentially unlikely that the outcome of a noisy quantum circuit outperforms efficient classical algorithms for combinatorial optimization problems like Max-Cut.

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