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(I) Enhancing Machine Learning and Combinatorial Optimization with Quantum Generative Models

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Generating high-quality data (e.g. images or video) is one of the most exciting and challenging frontiers in unsupervised machine learning. Utilizing quantum computers in such tasks to potentially enhance conventional machine learning algorithms has emerged as a promising application, but poses big challenges due to the limited number of qubits and the level of gate noise in available devices. In this talk, we provide the first practical and experimental implementation of a quantum-classical generative algorithm capable of generating high-resolution images of handwritten digits with state-of-the-art gate-based quantum computers. In the second part of my talk, we focus on combinatorial optimization; another key candidate in the race for practical quantum advantage. Here we introduce a new family of quantum-enhanced optimizers and demonstrate how quantum generative models can find lower minima than those found by means of stand-alone state-of-the-art classical solvers. We illustrate our findings in the context of the portfolio optimization problem by constructing instances from the S&P 500 stock market index. We show that our quantum-inspired generative models based on tensor networks generalize to unseen candidates with lower cost function values than any of the candidates seen by the classical solvers. This is the first demonstration of the generalization capabilities of quantum generative models that brings real value in the context of an industrial-scale application.

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