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Benchmarking Quantum Advantage in Boltzmann and Born Machines

In the advent of an era where quantum controllable systems are large enough to be not-completely-trivial but small enough to forbid quantum error correction protocols, the quantum advantage question arises naturally: can we make an algorithm that is significantly better than its classical counterpart for some task using current quantum technologies? Quantum Machine Learning is a blend of quantum-classical minimization methods in quantum digital or analog platforms. It can be generic enough to train their systems into any quantum state, with fidelities that increase with the depth of the platform's circuit or analog evolution up to a limit imposed by its decoherence. As such, it is a logical candidate for any task where we want to benchmark the gain of using arbitrary quantum states. Quantum Boltzmann Machines (QBMs) [2] tune Hamiltonian parameters so that measurements of its associated Boltzmann equilibrium resemble a desired probability distribution. Quantum Circuit Born Machines (QCBMs) [2] tune quantum circuit parameters so that measurements of the output resemble a desired probability distribution. In our work, we compare Quantum Boltzmann and Born Machines with their classical counterparts -and against each other-, and propose a nonlocal measurement scheme where the quantum advantage of QCBMs is exploited in the task of compressing classical information.

References:
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[2] Cheng, S., Chen, J., & Wang, L. (2018). Information perspective to probabilistic modeling: Boltzmann machines versus born machines. Entropy, 20(8), 583.