Quantum Generative Modelling with Conservation Law based Pretraining

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Abstract:

The Quantum Circuit Born Machine (QCBM) is an implicit generative model inspired by quantum physics, well-suited for reproducing known target distributions. It showcases potential advantage due to its high complexity relative to supervised machine learning tasks. This makes them a suitable candidate for leveraging the potential of near-term quantum computers [1,2].

Our study incorporates the idea of conservation laws into quantum algorithms to provide more efficient and accurate quantum simulations. Precisely, this study leverages particle number distribution based pre-training and system Hamiltonian within QCBM to model target distributions, that is crucial for systems that adhere to physical conservation laws.

Our analysis of pre-training QCBM this way showcases the impact on the convergence and accuracy of the model obtained using the Kullback-Leibler (KL) divergence especially when using Ising-type entangling gates compared to non-pretrained models.

This approach points to significant improvements in the fidelity of generated quantum states and offers a pathway towards more realistic quantum simulations.

[1] : M. Benedetti et al Quantum Sci. Technol. 4 043001 (2019)

[2] : J. Liu, L. Wang Phys. Rev. A 98, 062324 (2018)