

Exploring Quantum Generative Models from Quantum Communication Perspective

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One of the most important areas of quantum machine learning is quantum generative models. The generative models are considered as a leading strategy for unsupervised learning, which is a field dedicated to uncovering the hidden patterns within unlabeled data sets and further classifying them. The main goal of the generative models is to train the generator to produce data with high accuracy and substantial diversity from a vast amount of unlabeled data, which are associated with the quality. While the quantum generative models are expected to outperform their classical counterparts, a comprehensive understanding of the advantage of the quantum generative models with respect to the quality has remained an open problem.

This talk is based on our recent result [[arXiv: 2311.12163 \(2023\)](https://arxiv.org/abs/2311.12163)]. We will introduce a novel quality measure called quantum inception score, which can be defined by using Holevo information. This allows us to connect the physical interpretation of the quality of the quantum generative models to the amount of classical information transmitted through the quantum classifier channels. Also, the proposed metric leads us to demonstrate that the quantum advantage in the quality is attributed to the presence of the quantum coherences, and further that entanglement plays a significant role in achieving the best quality. Finally, we employ the quantum thermodynamics approach to elucidate that the decoherence is the primary reason for the quality degradation of the quantum generative models. Our results corroborate the significance of exploring the quantum foundation and communication approach to study the quantum machine learning protocols.