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Study on impacts of quantum noises on qGAN training

In classical deep learning, a number of studies have proven that noise plays a crucial role in the training of neural networks. Artificial noises are often injected in order to make the model more robust, faster converging, and stable. Meanwhile, quantum computing, a completely new paradigm of computation, is characterized by statistical uncertainty from its probabilistic nature. Furthermore, near-term quantum hardware encounters the challenge to overcome the noise due to the gate errors, readout errors, and interactions with the environment. The presence of these intrinsic quantum noises suggests the possibility to replace the artificial noise in the context of classical machine learning with the noise of the quantum hardware. However, the influence of noise on quantum machine learning (QML) has never been investigated in depth.
In this work, we conduct the first thorough study on the performance of quantum Generative Adversarial Networks (qGAN) for a simplified High-Energy Physics use case in the presence of different errors, including readout and two-qubit gate errors. We explore the limit of different error levels that the algorithm can tolerate for producing reliable results by tuning the errors manually in the artificial noise model provided by IBM Qiskit. We also investigate the influence of the training hyperparameters and error mitigation methods to understand their impact on qGAN training, depending on the error rates. Finally, we conclude our study with the simulation of qGAN on IBM real quantum hardware. This work will ultimately provide a broad insight to unfold the hidden impact of noise in QML, which takes a critical role in the current noisy intermediate-scale quantum (NISQ) era.

Significance

References

Speaker time zone

Compatible with Europe

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