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Precise Quantum Angle Generator Designed for Noisy Quantum Devices

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The Quantum Angle Generator (QAG) is a new quantum machine learning model designed to produce precise images on current Noise Intermediate Scale (NISQ) Quantum devices. The QAG model uses variational quantum circuits as its core, and multiple circuit architectures are evaluated.
This study explores the QAG model's noise robustness through an extensive quantum noise study. The results indicate that the model, when trained on a quantum device, can learn the hardware noise behavior and produce excellent outcomes. When simulated quantum hardware noise is included, the model's results remain stable until approximately 1.5% of noise during inference and almost 3% in training. However, running the noise-less trained model on real quantum hardware leads to a decrease in accuracy. If the model is trained on hardware, it can learn the underlying noise behavior, where the same precision is achieved by the noisy simulator. Additionally, the training showed that the model can recover precision even with significant hardware calibration changes during training with an increase of noise up to 8% for one qubit.
This work demonstrates the QAG model's ability to learn hardware noise behavior and deliver accurate results in the presence of realistic noise levels expected in real-world quantum hardware. The QAG model is utilized on simulated calorimeter shower images, which are employed in high-energy physics simulations to determine particle energies and to identify unknown particles at CERN's Large Hadron Collider.

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