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quantum GAN for fast shower simulation

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High-energy physics relies on large and accurate samples of simulated events, but generating these samples with GEANT4 is CPU intensive. The ATLAS experiment has employed generative adversarial networks (GANs) for fast shower simulation, which is an important approach to solving the problem. Quantum GANs, leveraging the advantages of quantum computing, have the potential to outperform standard GANs.

Considering the limitations of the current quantum hardware, we conducted preliminary studies utilizing a hybrid quantum-classical GAN model to produce downsampled 1D(8 pixels) and 2D(64 pixels) calorimeter average shower shapes on quantum simulators. The impact of quantum noise is also investigated on the noisy simulator, and the performance is checked on the real quantum hardware.

After producing the average shower shape, we implemented a new generator model to produce the actual shower image with event fluctuation.

References

https://indico.ihep.ac.cn/event/19316/contributions/143669/

Experiment context, if any

no specific experiment.

Significance

Concerning the study of average shower shape generation, we have fixed the training instability shown in this study (https://ceur-ws.org/Vol-3041/363-368-paper-67.pdf).

Concerning the study of actual shower image generation, we have improved the pixel energy distribution compared to this study (https://doi.org/10.22323/1.449.0573).

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