Contribution ID: **157** Type: **Short Talk**

Dual-Parameterized Quantum Circuit GAN Model in High Energy Physics

Thursday, 20 May 2021 11:03 (13 minutes)

Generative Models, and Generative Adversarial Networks (GAN) in particular, are being studied as possible alternatives to Monte Carlo. Meanwhile, it has also been proposed that, in certain circumstances, simulation using GANs can itself be sped-up by using quantum GANs (qGANs).

Our work presents an advanced prototype of qGAN, that we call the dual-Parameterized Quantum Circuit (PQC) GAN, with a classical discriminator and two quantum generators which take the form of PQCs. The first PQC learns the probability distribution over the images of N pixels, while the second generates normalized pixel intensities of an individual image for each PQC input. The performance of the dual-PQC architecture has been evaluated through the application in HEP to imitate calorimeter outputs, translated into pixelated images. The results demonstrate that the model can reproduce a fixed number of images with a reduced size as well as their probability distribution and we anticipate it should allow us to scale up to real calorimeter outputs.

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Session Classification: Quantum Computing

Track Classification: Offline Computing