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Quantum Assisted Calorimeter Simulation

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Numerical simulations of collision events within the ATLAS experiment have been instrumental in shaping the design of future experiments and analyzing ongoing ones. However, the accuracy achieved in describing Large Hadron Collider (LHC) collisions comes at a substantial computational cost, with projections estimating the requirement of millions of CPU-years annually during the High Luminosity LHC (HL-LHC) run. Notably, the full simulation of a single LHC event using Geant4 currently demands approximately 1000 CPU seconds, with calorimeter simulations dominating the computational burden. Deep generative models are being developed to act as surrogates of the calorimeter data generation pipeline, and can potentially decrease the overall time to simulate single events by orders of magnitude. We introduce a novel Quantum-Assisted deep generative model. Our model combines a variational autoencoder (VAE) on the exterior with a Restricted Boltzmann Machine (RBM) in the latent space, offering enhanced expressiveness compared to conventional VAEs. RBM nodes and connections are crafted to enable the use of qubits and couplers on a D-Wave quantum annealing processor.
We will make some initial comments on the infrastructure needed for deployment at scale.

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