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Quantum-assisted deep generative calorimeter surrogate

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As we approach the beginning of the High Luminosity Large Hadron Collider (HL-LHC) by the decade's end, the computational demands of traditional collision simulations have become untenably high. Current methods, relying heavily on Monte Carlo simulations for event showers in calorimeters, are projected to require millions of CPU-years annually, a demand far beyond current capabilities. This bottleneck presents a unique opportunity for breakthroughs in computational physics through the integration of generative AI with quantum computing technologies. We propose a Quantum-Assisted deep generative model that combines a variational autoencoder (VAE) with a Restricted Boltzmann Machine (RBM) embedded in its latent space. The RBM in latent space provides further expresiveness to the model. By designing RBM nodes and connections to leverage qubits and couplers available in D-Wave's Pegasus Quantum Annealer, our model is able to combine classical and quantum computing. We will make some initial comments on the infrastructure needed for deployment at scale.

Keyword-1

Calorimeter surrogate

Keyword-2

deep generative models

Keyword-3

quantum annealers

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