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Novel use of generative AI for heavy ion experiments

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Generative AI that is data-driven and self-supervising has shown significant potential to transform both science and industry. In this talk, we present two novel applications of generative AI in heavy ion experiments.

1. The first application involves full-detector, whole-event simulation of heavy ion collisions using denoising diffusion probabilistic models (DDPMs). Our studies [in submission] demonstrate that DDPMs significantly outperform a popular rival, generative adversarial networks (GANs), offering much faster generation times compared to Geant4 simulations, with a speedup on the order of 100.

2. The second application is a new approach to jet background subtraction using unpaired image-to-image translation models. Specifically, our work with UVCGAN [arXiv:2303.16280, arXiv:2304.12858], an optimized CycleGAN model, shows excellent performance in separating jets in the calorimeter tower grid from the combinatorial background in heavy ion collisions.

For both applications, we examine the limitations and potential biases of AI models as scientific tools and discuss optimizations to enhance their accuracy and reliability.

Category

Experiment

Collaboration

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