

IEA-GAN: Intra-Event Aware GAN for the Fast Simulation of PXD Background at Belle II

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A realistic detector simulation is extremely important in particle physics. However, the current methods are very inefficient computationally since large amounts of resources are required for the readout, storage and distribution of simulation data. Deep generative models allow for more effective fast simulation of this information. Nevertheless, generating detector responses is a highly non-trivial task as they carry fine-grained information and have correlated mutual properties within an “event”, a single readout window after the collision of particles. Thus, we propose the Intra-Event Aware GAN (IEA-GAN), in order to generate sensor-dependent images for the pixel vertex detector (PXD) which is the most sensitive sub-detector at the Belle II Experiment. First, we show that using the domain-specific relational inductive bias by introducing a Relational Reasoning Module, one can approximate the concept of an “event” in the detector simulation. Second, we incorporate a Uniformity loss in order to maximize the information entropy of the discriminator’s knowledge. Lastly, we develop the IEA-loss for the generator in order to imitate the class-to-class knowledge of the discriminator. As a result we show that the IEA-GAN not only captures fine-grained semantic and statistical similarity among the images but also it leads to a significant enhancement in the image fidelity and diversity in comparison to previous state of the art models.

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