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Conditional Set-to-Set Generation for Fast Simulation using Diffusion and Graph-to-Graph Translation

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Simulating particle physics data is a crucial yet computationally expensive aspect of analyzing data at the LHC. Typically, in fast simulation methods, we rely on a surrogate calorimeter model with a subsequent reconstruction algorithm to generate a set of reconstructed objects. This work demonstrates the potential to generate these reconstructed objects in one shot, effectively replacing both the calorimeter simulation and reconstruction steps. Our primary goal in this set-to-set generation is to accurately replicate the detector's resolution and the properties of the reconstructed objects.

Building on the success of our previous slot-attention-based model, we introduce two innovative approaches to improve this task and evaluate their performance using a realistic dataset. This dataset incorporates a realistic detector simulation and a machine learning-based reconstruction algorithm.

In the first approach, we enhance the slot-attention mechanism with a state-of-the-art graph diffusion model. This entails starting with a noisy graph and progressively eliminating noise conditioned on the truth particle set, ultimately generating the reconstructed objects.

The second approach involves graph refinement, directly converting the set of truth particles into the set of reconstructed objects. These approaches outperform our previous baseline regarding both accuracy and resolution of predicted particle properties.

Would you like to be considered for an oral presentation?

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