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Denoising Graph Super-Resolution with Diffusion Models and Transformers for Improved Particle Reconstruction

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Accurately reconstructing particles from detector data is a critical challenge in experimental particle physics. The detector's spatial resolution, specifically the calorimeter's granularity, plays a crucial role in determining the quality of the particle reconstruction. It also sets the upper limit for the algorithm's theoretical capabilities. Super-resolution techniques can be explored as a promising solution to address the limitations imposed by the detector's spatial resolution. Super-resolution refers to enhancing the resolution of low-resolution images to obtain higher-resolution versions. In the specific case of calorimeter data, which is characterized by sparsity and non-homogeneity, representing it using graphs provides the most faithful representation. Building upon this idea, we propose a diffusion model for graph super-resolution that uses a transformer-based de-noising network to enhance the resolution of calorimeter data. Notably, this study represents the first instance of applying graph super-resolution with diffusion. The low-resolution image, corresponding to recorded detector data, is also subject to noise from various sources. As an added benefit, the proposed model aims to remove these noise artifacts, further contributing to improved particle reconstruction.

Significance

Increasing resolutions of detector data with Diffusion powered graph super-resolution that can help improve reconstruction, and push the theoretical limits of reconstruction

References

1. Presentation at ML4Jets, Hamburg, Germany https://indico.cern.ch/event/1253794/contributions/5588579/

Experiment context, if any

LHC experiments in general

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