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De-noising Graph Super-Resolution with Diffusion Models and Transformers

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Accurate reconstruction of particles from detector data forms the core problem in experimental particle physics. The spatial resolution of the detector, in particular the calorimeter granularity, is both influential in determining the quality of the reconstruction, and largely sets the upper limit for the algorithm's theoretical capabilities. To address these limitations, super-resolution techniques can offer a promising approach by enhancing low-resolution detector data to achieve higher resolution.

In addition to image generation, Diffusion models have demonstrated effectiveness in super-resolution tasks. Given its sparsity and non-homogeneity, calorimeter data can be most faithfully represented using graphs. Therefore, this study introduces a novel approach to graph super-resolution using diffusion and a transformer-based de-noising network. This work represents the first instance of applying graph super-resolution with diffusion. The low-resolution image, which corresponds 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.

Brainstorming idea [title]

Exploring the Unconventional Potential of ML Models in Particle Physics

Brainstorming idea [abstract]

ML models are increasingly being utilized in particle physics, particularly for "mainstream"applications. There are also more "esoteric"applications of these models that hold great potential for the field. For example, super-resolution with Diffusion can be viewed from a similar angle, as diffusion has primarily been used in particle physics for generative models. By approaching ML models from a different perspective, we can uncover unexpected domains where they can be effectively applied, even if the connection may not be immediately apparent. Essentially, the question is whether we can identify unconventional "nails" that can be effectively paired with the powerful ML "hammers" at our disposal.

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