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Using Generative AI to Explore the Limits of Jet Tagging

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The precise identification of jets originating from high-energy quarks and gluons is paramount for advancing our understanding of fundamental particles and forces. This study introduces a novel deep learning framework designed to probe the limits of jet classifier models by using generative AI. State-of-the-art generative models called diffusion neural networks are used to create synthetic jet data where we simultaneously estimate the probability density by solving a differential equation. The likelihood ratio built from the probability density is the theoretical optimal classifier. Our research goal is to explore how close state-of-the-art classifier models are to this bound. We find that a state of the art transformer model performs very well, noting increases in true positive rates and decreases in false positive rates, but there is still a gap with respect to the optimal classifier.

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