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End-to-End Optimization of Generative AI for Robust Background Estimation

As searches at the LHC probe increasingly rare signals against an overwhelming background of Standard Model events, progressively tighter selection criteria are applied to enhance signal-rich regions. Simulated background samples serve as the basis for hypothesis testing, enabling comparisons between observed data and expected Standard Model backgrounds. However, this approach becomes challenging when the available background statistics are insufficient. This talk presents an end-to-end framework for estimating background models endowed with uncertainties. We train a generative model, explore different approaches to attribute a shape uncertainty and check its compatibility with the underlying ground truth using NPLM, a machine learning-based goodness-of-fit test. This procedure allows us to assess to which extent generative AI models are safe for sampling. By incorporating well-defined uncertainties, we ensure the framework can perform effectively even in data-limited scenarios to provide robust and reliable anomaly detection.

AI keywords

generative AI uncertainty estimation, oversampling, anomaly detection

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Track Classification: Patterns & Anomalies