Contribution ID: **60** Type: **not specified**

TRANSIT your events into a new mass: Fast background interpolation for semi-supervised anomaly detection searches

Thursday 7 November 2024 11:30 (20 minutes)

We introduce TRANSIT, a conditional adversarial network for continuous interpolation of data. It is designed to construct a background data template for semi-supervised searches for new physics processes at the LHC, by smoothly transforming sideband events to match signal region mass distributions.

We demonstrate the performance of TRANSIT using the LHC Olympics R&D dataset. The method effectively captures non-linear mass correlations within given features and produces a template that offers competitive anomaly detection sensitivity compared to state-of-the-art (SotA) template generators. Additionally, the computational training time for TRANSIT is an order of magnitude lower than that of competing deep learning methods, making it particularly advantageous for analyses involving numerous signal regions and models.

Unlike most generative models, which must learn the full probability density distribution—i.e., the correlations between all variables—the proposed model only needs to learn a smooth conditional shift of the distribution. This simplifies the architecture and significantly enhances efficiency. The absence of an informational bottleneck and the use of a residual architecture facilitate mass-uncorrelated features to pass through the network unchanged, while mass-correlated features are adjusted accordingly.

The proposed approach is based on a variational approximation of mutual information via adversarial decomposition, further contributing to its robustness and flexibility.

Track

Anomaly detection

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Session Classification: Anomaly detection