

Classifying Anomalies THrough Outer Density Estimation (CATHODE)

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We propose Classifying Anomalies THrough Outer Density Estimation (CATHODE): A novel, completely data-driven and model-agnostic approach to search for resonant new physics with anomalous jet substructure at the LHC.

Training a conditional normalizing flow on kinematic and substructure variables in a sideband region, we acquire an approximation of their probability densities. We then interpolate our trained background model into the signal region and sample from it, which yields an estimation of the standard model background inside the signal region without relying on simulation. Finally, a classifier is trained to distinguish background and data events in the signal region to find anomalies.

We report an improvement of the nominal statistical significance in a specific example from $\sim 1\%$ to as much as $\sim 15\%$ using the LHC Olympics R&D dataset as benchmark. Thus, the CATHODE method is able to discover new physics that otherwise would be hidden in data.

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