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Automatizing the search for mass resonances using BumpNet

The search for resonant mass bumps in invariant-mass histograms is a fundamental approach for uncovering Beyond the Standard Model (BSM) physics at the Large Hadron Collider (LHC). Traditional, model-dependent analyses that utilize this technique, such as those conducted using data from the ATLAS detector at CERN, often require substantial resources, which prevent many final states from being explored. Modern machine learning techniques, such as normalizing flows and autoencoders, have facilitated such analyses by providing various model-agnostic approaches; however many methods still depend on background and signal assumptions, thus decreasing their generalizability. We present *BumpNet*, a convolutional neural network (CNN) that predicts log-likelihood significance values in each bin of smoothly falling invariant-mass histograms, enhancing the search for resonant mass bumps. This technique enables a **model-independent search of many final states without the need for traditional background estimation**, making BumpNet a powerful tool for exploring the many unsearched areas of the phase space while saving analysis time. Trained on a dataset consisting of realistic smoothly-falling data and analytical functions, the network has produced encouraging results, such as predicting the correct significance of the Higgs boson discovery, agreement with a previous ATLAS dilepton resonance search, and success in realistic Beyond the SM (BSM) scenarios. We are now training and optimizing BumpNet using ATLAS Run 2 Monte Carlo data, with the ultimate goal of performing general searches on real ATLAS data. These encouraging results highlight the potential for BumpNet to accelerate the discovery of new physics.

AI keywords

Anomaly detection; Likelihood-based inference; Pattern recognition

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Track Classification: Patterns & Anomalies