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CICADA: Anomaly Detection for New Physics Searches at the CMS Level-1 Trigger

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BSM physics has yet to be discovered at the LHC. Three possibilities remain: new physics cannot be produced given the current center-of-mass energy, more data need to be collected, or the physics may be present but we are looking in the wrong places and making the wrong event selections. The first round of event selection at CMS occurs at the Level-1 trigger, and machine learning (ML) can be used to search for new physics while minimizing human bias. CICADA (Calorimeter Image Convolutional Anomaly Detection Algorithm) is a novel ML-based trigger algorithm that uses anomaly detection technique to search for new physics in a model-agnostic way as close to the raw collision data as possible, i.e. the CMS Level-1 trigger. The model is an autoencoder that takes the low-level calorimeter energy deposits at the trigger-tower level as inputs and is trained unsupervisedly on the raw collision data to learn input reconstruction. This allows the model to detect a wide range of rare SM and BSM processes as anomalies whenever they are differently distributed from the majority of the collision data, namely the soft QCD processes. CICADA is developed and ready for the Run 3 deployment and will serve as a baseline for the preparation for the HL-LHC.

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