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Searching for long lived particles with a neural-network-based displaced jet tagger

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We present a neural-network-based tagger that is trained to identify the presence of displaced jets arising from the decays of new long-lived particle (LLP) states in data recorded by the CMS detector at the CERN LHC. Information from individual particles and secondary vertices within jets are refined through the use of convolutional networks before being combined with high-level engineered variables via a dense network. The LLP lifetime is an input parameter of the network, which allows for hypothesis testing over several orders of magnitude in lifetime, from $c\tau$ = 10 μm to 10 m. We define a method based on truth information from Monte Carlo simulation to reliably label jets originating from an LLP decay, for the purposes of supervised training. The training is performed by streaming ROOT trees containing O(100M) jets directly into the TensorFlow queue and threading system. This custom workflow allows a flexible selection of input features and the asynchronous preprocessing of data, such as the resampling and shuffling of batches on the CPU, in parallel to training on the GPU. Domain adaptation is performed with control samples of pp collision data to ensure good agreement between data and Monte Carlo simulation. The tagger performance demonstrates only a moderate dependence on the new-physics model. The tagger is applied in a search for split supersymmetry in final states with jets and significant missing energy.

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