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Exploring end-to-end deep learning solutions for event classification at CMS

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An essential part of new physics searches at the Large Hadron Collider at CERN involves event classification, or distinguishing signal decays from potentially many background sources. Traditional techniques have relied on reconstructing particle candidates and their physical attributes from raw sensor data. However, such reconstructed data are the result of a potentially lossy process of forcing raw data into progressively more physically intuitive kinematic quantities. However, powerful image-based machine learning algorithms have emerged that are able to directly digest raw data and output a prediction, so-called end-to-end deep learning classifiers. We explore the use of such algorithms to perform physics classification using raw sensory data from the CMS detector. As proof of concept, we classify photon versus electron identification using data from the CMS electromagnetic calorimeter. We show that for single particle shower images, we are able to exploit higher-order features in the shower to improve discrimination versus traditional shower shape variables. Furthermore, for full event classification, we show that these techniques are able to exploit correlations between different showers in the event to achieve strong discrimination.

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