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Classifying Waveform MAGIC Telescope Data Using Graph Neural Networks

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Graph Neural Networks (GNNs) have emerged as a robust architectural choice for deep learning across scientific disciplines, and are particularly suited for datasets with irregular topology. The MAGIC Telescope, comprising a pair of 17 m Imaging Atmospheric Cherenkov Telescopes (IACTs) located at Roque de Los Muchachos Observatory in La Palma, Spain, is designed to detect gamma rays from around 50 GeV to over 50 TeV. Arrays of IACTs rely on a complex pipeline in which each particle registered by the detectors generates a temporal stereo signal that must be calibrated, flattened into an image, cleaned, parameterized, and ultimately reconstructed by multiple machine learning algorithms. In recent years, Convolutional Neural Networks (CNNs) have shown great promise in performing full event reconstruction.

In contrast, this study leverages the calibrated waveform data, consisting of a 30 ns signal in each pixel of the camera. Due to the unconventional geometry of the MAGIC cameras and asynchronous clocks between pixels, we represent MAGIC data as a point cloud graph and employ GNNs as a classification algorithm for the first time in an IACT. Our preliminary trials indicate that GNNs not only represent a robust method for reconstructing raw MAGIC data, but also show potential for fast online inference or even direct telescope triggering.

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