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Deep Learning for Full-Event Reconstruction in Imaging Atmospheric Cherenkov Telescopes: A Transfer Learning Approach with CTLearn

Arrays of imaging atmospheric Cherenkov telescopes (IACTs) are exceptional instruments for probing the very-high-energy gamma-ray sky. These telescopes focus Cherenkov light, emitted from air showers initiated by very-high-energy gamma rays and cosmic rays, onto the camera plane. A high-speed camera then digitizes the longitudinal development of the air shower, capturing its spatial, temporal, and calorimetric information. From these images, the properties of the primary very-high-energy particle that initiated the air shower can be inferred: the primary particle can be classified as either a gamma ray or a cosmic ray, and its energy and incoming direction can be estimated. This process, known as full-event reconstruction, is essential for the array's sensitivity to gamma rays and can be enhanced using machine learning techniques. We present a deep-learning-driven full-event reconstruction approach applied to IACT events, where transfer learning is explored as a strategy to reduce the computational demands inherent to the technique. For this purpose, we use simulated data from the Large-Sized Telescope 1 of the Cherenkov Telescope Array Observatory and CTLearn. CTLearn is an open-source Python package that provides a backend for training deep-learning models for the reconstruction of IACT events using TensorFlow.

AI keywords

event reconstruction, image recognition, convolutional neural networks

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Track Classification: Patterns & Anomalies