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Applications of machine learning in the event reconstruction of Imaging Atmospheric Cherenkov Telescopes

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Very-high-energy gamma rays play a crucial role in the investigation of a wide range of extreme phenomena occurring in the environment of galactic and extragalactic sources, as well as in studying Dark Matter or the Lorentz invariance. They can be detected by Imaging Atmospheric Cherenkov Telescopes (IACT) at energies in the GeV-TeV range. These instruments observe the Cherenkov light produced in the interactions of gamma rays and cosmic rays with the Earth atmosphere, capturing the spatial, temporal, and calorimetric properties of the event.
One of the main challenges in the reduction of the observed signal is given by the precise reconstruction of energy and arrival direction of the primary particle and its classification (gamma-ray or hadron).
At the beginning of ground-based gamma-ray astronomy, the analysis methods used relied on the parametrization of the recorded images and the application of static cuts in such parameters, more complex methods were also developed like comparison models based on templates obtained with semi-analytical algorithms, however very demanding with computing resources. Currently, the standard analysis chain involves the use of classical machine learning algorithms, like Random Forests (RF), operating on the same parametrized images.
In recent years, the increasing interest in Deep Learning (DL) showed the potential of DL techniques in the reconstruction of this kind of events, given their excellent performances in a large variety of tasks such as image recognition.
This presentation will give a broad overview of the methods generally used in IACT event reconstruction, with particular regard to their advantages and limitations, together with the differences and innovative aspects introduced by the tested DL models.

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Session Classification: Future directions