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Air shower reconstruction with hexagonal convolutional neural networks

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Ground-based γ-ray astronomy relies on reconstructing primary particles' properties from the measurement of the induced air showers. Currently, template fitting is the state-of-the-art method to reconstruct air showers. CNNs represent promising means to improve on this method in both, accuracy and computational cost. Promoted by the availability of inexpensive hardware and open-source deep learning frameworks (DLFs) the applicability of CNNs for air shower reconstruction is in focus of recent and on-going studies. Thereby, the hexagonal sampling of data, which is common for Cherenkov telescopes but does not fit the input format of DLFs, poses an obstacle. It has been addressed e.g by transforming the hexagonally sampled data to an approximate representation on a rectangular grid prior to the application of CNNs. Though this procedure was shown to yield promising results, it comes at the prize of increasing computational costs. The transformation can be omitted if convolutions are directly applied on the hexagonal grid. For this purpose a Python library, called HexagDLy, was written and made publicly available. In the present study, HexagDLy was used to build CNN models for the analysis of data from the High Energy Stereoscopic System. The performance of these models on classifying and reconstructing air-shower events will be shown and compared to alternative methods.

Primary authors: Mr STEPPA, Constantin (University of Potsdam); Mr HOLCH, Tim Lukas (Humboldt-University of Berlin)

Co-author: Dr EGBERTS, Kathrin (University of Potsdam)

Presenter: Mr STEPPA, Constantin (University of Potsdam)

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