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Development of a background-estimation technique in regions of degree-scale gamma-ray emission for IACTs

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Identifying extended degree-scale γ-ray structures is a challenging task for imaging atmosperic cherenkov telescopes (IACTs). This is primarily due to their comparatively small field-of-view (FOV) of around 3.5° - 5°, and a large background induced by cosmic-rays. In order to estimate this background, many approaches depend on the existence of a γ-ray free region in each observation, from which the background rate, given the respective observation conditions, can be estimated. However, this is only possible in cases in which the extension of the γ-ray emission is significantly smaller than the FOV of the telescopes.

We develop a robust approach to estimate the background for use with open source tools combining a energy-dependent background model, created from archival observations, and estimating its normalisation from separate, matched observations of emission-free sky regions. As a result, no emission-free region is necassary in the FOV of the observation, while the background estimation is afflicted with relatively small statistical uncertainties compared to an estimation using a classical ON/OFF approach. To achieve this, we implement an algorithm that identifies observation pairs with the most similar observation conditions. The open-source analysis package \texttt{Gammapy} is then used to estimate the background rate, enabling easy adaptation of the framework to various γ-ray detection facilities. Public data from the H.E.S.S. array of IACTs is used to validate this method. We demonstrate that this approach provides a reliable way to estimate the background rate in complex sky regions where standard background estimation techniques can not be used.

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