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Deep Learning Applied to Cherenkov Telescope Array Images

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Gamma-ray astronomy is a field of physics that studies astrophysics sources of high-energy photons. These uncharged particles travel in straight lines and are not deviated by magnetic fields along their journey to Earth, making possible the track of their origins. Once they interact with the atmosphere, they produce particle showers, emitting lights through the so-called Cherenkov process, which will be captured by the optical telescopes called Imaging Atmospheric Cherenkov Telescopes (IACT). Their analysis consists in solving an inverse problem : the determination of the energy and the direction of arrival of the incoming photons given the telescope images. Through these studies, scientists may understand for instance the star birth process, the nature of dark matter, or even the evolution of galaxies. But this is a complicated task because other cosmic particles produce the same kind of showers, and photons are highly underrepresented. Fortunately, deep learning has been a great tool in solving many computer vision tasks. As a result, the GammaLearn project is born and aims to integrate deep learning approaches in the context of gamma-ray astronomy. However, the training procedure in our case implies the need of labelled data, which is unobtainable. Therefore, Monte Carlo simulations are used for the training, but the performance is degraded when applied on real data due to domain shifts between the two distributions. Fortunately, domain adaptation technic can be applied to this specific problem to improve the learning transfer from simulated data to observed data. In more details, two methods have currently been integrated into the GammaLearn workflow and preliminary results have shown encouraging ameliorations.

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