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Estimating Spectra with the Dortmund Spectrum Estimation Algorithm

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Obtaining the energy spectrum of an astrophysical source is crucial for our understanding of the source properties and the underlying physical principles, e.g. the acceleration of cosmic rays. In Imaging Air Cherenkov Astronomy and neutrino astronomy, however, the reconstruction of spectra is hindered by the fact, that the energy of the primary particle cannot be accessed experimentally, but has to be inferred from secondary particles. Mathematically this task corresponds to an inverse problem, generally described by the Fredholm integral equation of the first kind. Solving the Fredholm integral equation is generally referred to as unfolding or deconvolution. In our talk, we present the Dortmund Spectrum Estimation Algorithm (DSEA), which is capable of solving inverse problems by utilizing state-of-the-art machine learning techniques. DSEA translates the unfolding in a multinominal classification task, which is then solved by an – at least in principle – arbitrary classification algorithm. The reconstruction quality of DSEA is comparable to the performance achieved using other state-of-the-art unfolding algorithms, but in contrast those, DSEA fully retains the information on the individual examples. This unique property allows researchers to study spectra as a function of other variable, e.g. time or zenith angle. Although the reconstruction of spectra is equally important in Imaging Cherenkov- and neutrino astronomy, we will focus on results obtained using simulated events from the Cherenkov telescopes FACT and MAGIC. DSEA is part of an open source software package development in project C3 of the Collborative Research Center 876.

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