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Astronomical source separation with variational autoencoders

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Upcoming surveys such as the Large Survey of Space and Time (LSST) and Euclid will observe the sky with unprecedented depth and area of coverage. As these surveys will detect fainter objects, the increase in object density will lead to an increased number of overlapping sources. For example, in LSST we expect around 60% of the objects to be blended. In order to better constrain Dark Energy parameters, mapping the matter content of our Universe with weak gravitational lensing is one of the main probes for the upcoming large cosmological surveys, and for these analyses, the blending effect is expected to be one of the major systematics to face. Classical methods for solving the inverse problem of source separation, so-called "deblending", either fail to capture the diverse morphologies of galaxies or are too slow to analyze billions of galaxies. To overcome these challenges, we propose a deep learning-based approach to deal with the size and complexity of the data.

In the context of the Dark Energy Science Collaboration (DESC), we have developed a Python package called DebVader, which uses a modified version of Variational Autoencoders (VAEs) for deblending. First, isolated galaxies are used to train a VAE to learn their latent space representations which are then used as a prior for deblending galaxies from a blended scene.

We have tested the performance of our algorithm using realistic simulations generated by the blending-task force of the LSST-DESC collaboration. With flux recovery as a metric, we observe that the errors are comparable to the state-of-the-art while still being fast and scalable. In this context, I will be demonstrating the performance of DebVader for deblending galaxy fields for Rubin and how we expect to shift from simulations to real data which is expected within the next few years.

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