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Detecting the edges of galaxies with Deep Learning

Galaxy edges/truncations are Low Surface Brightness (LSB) features located in the galaxy outskirts that delimit the distance up to where the gas density enabled efficient star formation. Therefore, they constitute true galaxy edges. As such, they could be interpreted as a non-arbitrary means to determine the galaxy size, and this is also reinforced by the smaller scatter in the galaxy mass-size relation when comparing them with other size proxies. However there are several problems attached to this novel metric, namely the access to deep imaging and the need to contrast surface brightness, color and mass profiles to derive the edge position. While the first hurdle is already overcome by new ultra-deep galaxy observations, we hereby propose the use of Machine Learning algorithms in order to determine the position of these features for very large datasets. We compare the semantic segmentation by our Deep Learning models with the results obtained by humans for HST observations of a sample of massive disk galaxies at $z < 1$. In addition, the concept of astronomic augmentations is introduced to endow the inputs of the networks with physical meaning. Our findings (to appear in Fernández-Iglesias et al. 2023 in press) suggest that similar performances than humans could be routinely achieved, although in the majority of cases the best results are obtained by combining (with a pixel-by-pixel democratic vote) the output of several neural networks using ensemble learning. Specifically, the experiments show a great similarity between the semantic segmentation performed by the AI compared to the human model, with an average Dice of 0.8969 for the best model and an average Dice of 0.9104 for the best ensemble. This methodology will be profusely used in future datasets such as Euclid where our team has the expertise to create a LSB-compliant data reduction. We also offer to the community our Machine learning algorithms in the repository <https://github.com/jesusferigl>

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