Machine learning-infused cluster cosmology

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Abstract

Clusters of galaxies are powerful probes for testing our cosmological paradigm, especially dark energy models. However, a few obstacles prevent us from using clusters to their full potential, such as the accurate estimation of their total mass from observed proxies. In this work, we explore how modern machine-learning algorithms could be used to help with and improve upon each step of the cosmological exploitation of clusters of galaxies, from their detection to the determination of their characteristics.
On the detection side, we explored how the third iteration of the detection-oriented neural network "You Only Look Once" (YOLOv3, Redmon & Farhadi 2018) can be used to detect clusters of galaxies inside images of galaxy surveys, using for training the Sloan Digital Sky Survey (SDSS) and galaxy clusters previously identified by the redMaPPer algorithm (Rykoff et al. 2014)

On the characterization side, we use a novel type of neural network in order to work directly at the catalogue level, i.e. with lists of galaxies as inputs instead of images. The originality of the aforementioned networks – equipped with so-called Janossy layers – is their ability to work with sets of arbitrary size as inputs, while being insensitive to the ordering of members in said sets.

Our preliminary results indicate that our pipeline is able to perform at least as well as the redMaPPer algorithm when detecting clusters and deriving their properties, potentially outperforming it in the computation of cluster redshifts.

Slides: in PDF
Video: https://youtu.be/iTmj4f_0NXk

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