Applying Deep Neural Network to dark matter halo catalogues to constrain the dark energy equation-of-state parameters

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Abstract

Future cosmological surveys will flood the scientists with a huge volume of data, and exploiting new methodologies such as Deep Neural Networks (DNN) for automation and handling this "Big-Data" seems necessary.
On the other hand, there are plenty of cosmological models, specifically in the Dark Energy field, which have to be tested and explored. The latter would be essential to analyse the data provided by Euclid satellite which will be launched soon.

Standard cosmological analyses based on abundances, two-point and higher-order statistics of specific extra-galactic tracer populations – such as e.g. galaxies, galaxy clusters, voids - have been widely used up to now to investigate the properties of the Cosmic Web. However, these statistics can only exploit a sub-set of the whole information content available.

Along these lines, we propose the application of the DNN in distinguishing different cosmological models by training the network on diverse mock dark matter halo and galaxy catalogs.

We have been using Pinocchio and Quijote simulation as our halo catalog reference for different cosmological models for this project.

In this work, we make use of only direct information provided by halo catalogs, such as coordinates and mass of the halo. In this way, we assure that any feature of the Cosmic Web is not lost due to the compression of information, for example in the form of two-point statistics.

By applying the DNN architecture on various constructed halo catalogs, we provide independent constraints on the dark energy equation of state parameters (w_0 and w_a) to test different dark energy models in the literature.

Slides: in PDF
Videos: https://youtu.be/999KIXhq85Q

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