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Cosmology in the machine learning era

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Recent advances in deep learning are triggering a revolution across fields in science. In this talk I will show how these techniques can also benefit cosmology. I will present a new approach whose final goal is to extract every single bit of information from cosmological surveys, discussing all the complications involved on it. I will start showing the large amount of cosmological information that is embedded on small, non-linear, scales; information that cannot be retrieved using the traditional power spectrum. I will then show how neural networks can learn the optimal estimator needed to extract that information. I will discuss the role played by baryonic effects and point out how neural networks can automatically learn to marginalize over them even at the field level. From volumes covering Gigaparsec scales to individual galaxies, I will show how accurately the value of the cosmological parameters can be constrained. I will show how this approach requires combining machine learning techniques with numerical simulations. Along the talk, I will present the simulations we are using in this program: the Quijote and the CAMELS simulations. These two suites contain thousands of N-body and state-of-the-art (magneto-)hydrodynamic simulations covering a combined volume larger than the entire observable Universe (Quijote) and sampling the largest volume in parameter space for astrophysics models to-date (CAMELS).

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