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Explainable deep learning models for cosmological structure formation

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I will present an explainable deep learning framework for extracting new knowledge about the underlying physics of cosmological structure formation. I will focus on an application to dark matter halos, which form the building blocks of the cosmic large-scale structure and wherein galaxy formation takes place. The goal is to use an interpretable neural network to generate a compressed, “latent” representation of the data, which encodes all the relevant information about the final output of interest; the latent representation can then be interpreted using mutual information. I will show how such networks can be used to model final emergent properties of dark matter halos, such as their density profiles, and connect them to the physics that determines those properties. The results illustrate the potential for machine-assisted scientific discovery in cosmological structure formation and beyond.

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