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Dark Matter Extraction Using Neural Networks

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About the Study

Since its discovery in 1964, the Cosmic Microwave Background (CMB) has been of great interest to cosmologists and has played an important role in the well-established understanding and study of the early universe. By analyzing CMB data, we can estimate the density of dark matter in the universe. We already have a large amount of astronomical data, and more data will be added in the future. Machine learning techniques can offer a variety of benefits in the study of astrophysics and cosmology. Here we are investigating the use of deep learning to estimate the density of dark matter. For this task, we used a convolutional neural network.

Using the simulated CMB temperature map as a dataset, we trained the neural network to correlate the dark matter density from the power spectrum of the corresponding simulated CMB temperature map. Cosmic microwave background (CMB) is electromagnetic radiation within the microwave range of the electromagnetic spectrum. When the universe was young, it consisted of dense, hot, opaque hydrogen plasma. This era is known as the era of recombination when the universe fell below 3000 K and formed the first neutral atom about 380,000 years ago. Shortly thereafter, photons were free to move in space. These early photons have been propagating since then and we receive them as cosmic microwave background radiation. The CMB map shows the temperature fluctuations of these early photons, which follow a nearly random Gaussian distribution.

The pixel intensities of these CMB maps also follow a random Gaussian distribution. Given that CMB maps are considered random Gaussian fields and there is no particular inconsistency between CMB maps, it is tempting to see how closely machine learning models correlate Gaussian maps with cosmological parameters. It's work. My job is to create a convolutional neural network (CNN) model to predict the dark matter density of a particular CMB map. We have demonstrated the function of a machine learning model that predicts baryon density. We have shown the ability of the CNN model to extract useful information from CMB data using the density of dark matter as a parameter. CAMB uses several parameters to generate a FITS file containing angular power spectral data.

CAMB physical input parameters include CMB temperature (2.7255K), Hubble's constant, baryon density (0.0226), cold dark matter density (0.112), helium content (0.24), etc. (LAMBDA Tools, NASA 2015). The lens method uses reionization and a curve correlation function. With the help of a convolutional neural network (CNN), we were able to estimate the density of dark matter from the CMB map with sufficient accuracy. We used deep learning techniques to validate the results associated with cosmic microwave background (CMB). Extracting features from the map has been a complex problem for neural network models because the CMB has a Gaussian distribution. The limited computing power and higher resolution of the CMB card is due to the reduced accuracy. This shows that deep learning is applied to cosmological problems. My future plan is to apply CNNs and other deep learning models to Planks data and observe how neural network models work with Planks data.

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