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Recovering the CMB signal with neural networks

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Artificial neural networks are powerful machine learning models that can be trained to learn non-linear behaviors from data. In this talk, we present a new promising methodology for separating the CMB signal from foregrounds in Planck realistic simulations in temperature and polarization (formed by the CMB, Synchrotron and dust Galactic emissions, PS and thermal SZ extragalactic emissions and instrumental noise), using a fully convolutional neural network on patches of the sky.
Our methodology involves a set of convolutional blocks that make inference over microwave sky patches at three HFI Planck channels, and a set of deconvolutional blocks that output a single patch with the CMB signal. Once trained, the network is validated against new, similar data not used for training.
We compute the TT, EE and BB average power spectra of all the recovered patches and compared the results against the true CMB maps and of the residual patches. In temperature, we reach a difference between input and recovered signal less than 50+- ⊠⊠2 for multipoles up to ⊠ = 4000. Residuals are two orders of magnitude in the extragalactic region and one order below the input signal in the Galactic plane. In polarization, we recover E and B modes at sub-degree scales (up to ⊠ = 800): the E-mode is recovered with a difference between true and recovered CMB of 0.1+-0.3 ⊠⊠2, while the B mode is recovered with a difference of 0.002+-0.02 ⊠⊠2. Residuals are two orders of magnitude below the input E signal and one order below the B one, although noise levels start to dominate the signal along the B-mode. Moreover, we show that training without noise allows us to recover the signal at ⊠ = 1500 and that training with a proper foreground model is crucial for recovering the signal.

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