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CNN-Enhanced Zel'dovich Reconstruction for BAO analysis in Large-Scale Structure Surveys

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The Baryon Acoustic Oscillations (BAOs) scale in the 2-point galaxy correlation function serves as a standard ruler to trace the expansion history of the Universe and constrain the properties of the Dark Energy, as demonstrated by the recent results of the DESI survey. Precise measurements of the BAO scale rely on nonlinear transformation of the data commonly known as "reconstruction". The standard approach based on the Zel'dovich approximation can be improved in several ways which, however, are typically computationally demanding and, for this reason, difficult to apply to large datasets.
I present a novel approach, dubbed Enhanced Zeldovich Reconstruction (EZR) that leverages a Neural Network previously trained on a Zel'dovich-reconstructed density field to improve the quality of the reconstruction. This goal is to improve the matching between the model and the measured BAO peak and to increase the precision of the inferred cosmological parameters.
I have compared the performance of EZR to that of the standard Zel'dovich reconstruction using a large suite of simulated data. My results indicate that the BAO peak reconstruction performed with EZR is indeed more precise and consequently it provides tighter constraints on the cosmological parameters that determine the cosmic expansion history of the Universe.

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