# Bayesian Inference Acceleration: a Deep Learning Approach

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**Abstract**

In the next decade, forthcoming galaxy surveys will provide the cosmological community with a wealth of data. The standard methods used to analyze such data and infer cosmological parameters, based on MonteCarlo Markov Chains, require the execution of codes known as Boltzmann solvers. Although the astrophysical community has optimized these codes and their speed, a typical MCMC analysis takes from 10ˆ4 to 10ˆ6 Boltzmann solver executions, usually requiring clusters or dedicated workstations to perform parameter inference in an acceptable time.

In order to overcome this issue we have developed an emulator, based on a feed-forward neural network, which can evaluate the angular correlation coefficients of a 3 × 2 pt analysis, combining cosmic shear, 2D galaxy clustering, and tangential shear for a Stage IV galaxy survey. Our neural network is fast (evaluation of angular correlation coefficients is order of magnitudes faster compared to standard Boltzmann solvers), accurate (a detailed analysis shows that we recover the constraints of the standard method with differences smaller than sampling noise), does not require dedicated hardware (the entire inference pipeline runs on a single computer), and handles a large parameter space (including both cosmological and nuisance parameters).

Furthermore, the differentiability of the Neural Network lends itself to gradient-based methods, such as the Hamiltonian MonteCarlo, resulting in an efficient sampling of high dimensional parameter space, where standard MCMC techniques fail. We show that this method, due to its features in sampling the parameter space, can further accelerate the inference.

**Keywords:** Cosmology, Large, Scale Structure, Neural, Networks, Differentiable Emulators, Bayesian Methods

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