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# COSMOPOWER: fully-differentiable Bayesian cosmology with neural emulators

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COSMOPOWER is a state-of-the-art Machine Learning framework adopted by all major Large-Scale Structure (LSS) and Cosmic Microwave Background (CMB) international collaborations for acceleration of their cosmological inference pipelines. It achieves orders-of-magnitude acceleration by replacing the expensive computation of cosmological power spectra, traditionally performed with a Boltzmann code, with neural emulators.

I will present recent additions to COSMOPOWER which render it into a fully-differentiable library for cosmological inference. I will demonstrate how it is possible to use its differentiable emulators to enable scalable and efficient statistical inference by means of hierarchical modelling and simulation-based inference. Leveraging the benefits of automatic differentiation, XLA optimisation, and the ability to run on GPUs and TPUs, COSMOPOWER allows for efficient sampling through gradient-based methods and significantly enhances the performance of neural density estimation for simulation-based inference, augmenting it with the simulator gradients. Additionally, I will show how COSMOPOWER allows the user to create end-to-end pipelines that achieve unparalleled accuracy in the final cosmological constraints, due to their ability to efficiently sample an unprecedentedly large number of nuisance parameters for the modelling of systematic effects.

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