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Sequential simulation-based inference for cosmological initial conditions

Knowledge of the primordial matter density field from which the present non-linear observations formed is of fundamental importance for cosmology, as it contains an immense wealth of information about the physics, evolution, and initial conditions of the universe. Reconstructing this density field from galaxy survey data is a notoriously difficult task, requiring sophisticated statistical methods, advanced cosmological simulators, and exploration of a multi-million-dimensional parameter space. In this talk, I will discuss how sequential simulation-based inference allows us to tackle this problem and simultaneously obtain data-constrained realisations of the primordial dark matter density field together with constraints on the cosmological parameters in a simulation-efficient way for general non-differentiable simulators. In addition, I will describe our novel adaptive learning training strategy and how our results compare to those obtained with classical likelihood-based methods such as Hamiltonian Monte Carlo.

AI keywords

simulation-based inference, adaptive learning, uncertainty quantification, field-level inference

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Track Classification: Simulations & Generative Models