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PINNflation solving the dynamics of Inflation using Physics Informed Neural Nets

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Cosmic inflation is a process in the early Universe responsible for the generation of cosmic structures. The dynamics of the scalar field driving inflation is determined by its self-interaction potential and is coupled to the gravitational dynamics of the FLRW-background. In addition, perturbations of the inflaton field can be computed by numerical solution of the so-called mode equations. They have straightforward solutions for slowly evolving fields, but get significantly more complex in the case of realistic inflaton dynamics. Physics-informed neural networks are well able to emulate this particular dynamical system, allowing very fast predictions of fluctuation spectra for given inflationary potentials. PINNs open the possibility of reconstructing these potentials on the basis of e.g. cosmic microwave background observations. Formulating the dynamics of the complex-valued perturbations in terms of the Madelung-picture yields significant numerical advantages and allowed us to find a new constant of motion. Cosmic inference and reconstruction of potentials with associated errors require an extension to Bayesian networks, which we currently investigate.

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