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Towards emulating simulation of the reionization epoch in a few minutes with deep learning

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Room A304

I will present a deep learning model trained to emulate post-processed radiative transfer simulation during the epoch of cosmological reionization on top of pure hydro-simulation. CRADLE (Cosmological Reionization And Deep LEarning) is an autoencoder convolutional neural network that uses two-dimensional maps of the star number density and the gas density field at z=6 as inputs and that predicts 3D maps of the times of reionization as outputs. These predicted single fields are sufficient to describe the global reionization history of the intergalactic medium in a given simulation. We trained the model on a given simulation and tested the predictions on another simulation with the same parameters but with different initial conditions. The model is successful at predicting times of reionization maps that are in good agreement with the test simulation. Such predictions are done about 100 times faster compared to the full radiative transfer simulation at the same resolution. While the current model is already well-suited to get average estimates about the reionization history, we expect it can be further improved with larger samples for the training, better data pre-processing and finer tuning of hyper-parameters. Emulators of this kind could be systematically used to rapidly obtain the evolving HII regions associated with hydro-only simulations and could be seen as precursors of fully emulated physics solvers for future generations of simulations.