ID de Contribution: **11** Code de contribution: **Confirmed** Type: **Talk (submitted)**

Simulation-based Inference for exoplanet characterization

mercredi 20 avril 2022 16:00 (15 minutes)

With the advent of new ground and space-based instruments that image exoplanets and record their spectra across a broader wavelength range and at higher spectral resolutions, complex atmospheric models are becoming crucial for a thorough characterization. This includes a detailed description of the clouds and their physics. However, since the microphysics of the clouds is not observable, this makes characterization challenging due to the presence of latent parameters which makes the likelihood intractable and restricts characterization to either simplistic models of clouds, or time consuming approximations of the likelihood function. As the parameter space expands, this framework is bound to reach its limits. Hence in this work, we suggest leveraging a novel deep learning approach called Neural Posterior Estimation (NPE). NPE is a simulation based inference (SBI) algorithm that directly estimates the posterior, hence sidestepping the need to compute the likelihood. Once trained, the network provides an estimate for the posterior distribution of any given observation. The key factor in this approach is that the density estimator is amortized, meaning that, once trained, the inference itself does not require simulations and can be repeated several times with different observations, hence saving a lot of time.

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Classification de Session: Talks