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Simulation-based inference with optical diagnostics

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Inferring physics parameters from experimental data is a key analysis need for physicists. Often it is desired for this inference process to have grounding in detailed models contained in simulation. Simulation-based inference (SBI) are techniques which utilize simulations in the forward model, create approximate posteriors which are faithful to the simulation. Recently neural networks have been leveraged in SBI to flexibly represent the underlying Bayesian inference process. The approximate posteriors generated can be sampled from quickly, which is attractive for fast between shot-analysis. Here we show ongoing work in applying SBI to experimental fusion diagnostics, focusing on optical diagnostics. We create a synthetic diagnostic for the Lyman-alpha diagnostic (LLAMA) at the DIII-D tokamak, using the CHERAB code for spectroscopic diagnostics, and the KN1D neutral transport code for relatively fast neutral density transport. By generating may thousands of samples of synthetic plasma input profiles, and obtaining output of the forward model, we can then leverage SBI for creating an approximate posterior. Here we use neural networks representing normalizing flow for accurate replication of the data distribution. This creates a neural network which can be sampled from quickly to create a posterior of the neutral density given the measured LLAMA line-integrated radiance.

Speaker's Affiliation

PPPL

Member State or IGO/NGO

US Department of Energy

Primary authors: CHURCHILL, Randy (Princeton Plasma Physics Laboratory); Mr KHARE, Tejas (Georgia Tech)

Presenter: CHURCHILL, Randy (Princeton Plasma Physics Laboratory)

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