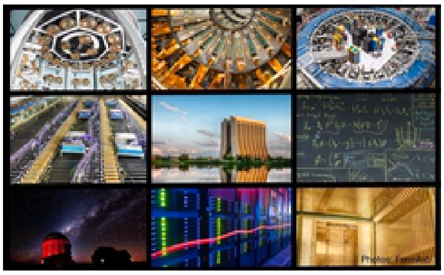

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Estimating Parameters of Gravitationally Lensed Quasars with Simulation-Based Inference and SplineCNNs

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The Hubble Tension is considered a crisis for the LCDM model in modern cosmology. Addressing this problem presents opportunities for identifying issues in data acquisition and processing pipelines or discovering new physics related to dark matter and dark energy. Time delays in the time-varying flux of gravitationally lensed quasars can be used to precisely measure the Hubble constant (H_0) and potentially address the aforementioned crisis. Gaussian Processes (GPs) are typically used to model and infer quasar light curves; unfortunately, the optimization of GPs incurs a bias in the time-evolution parameters. In this work, we introduce a machine learning approach for fast, unbiased inference of quasar light curve parameters. Our method is amortized, which makes it applicable to very large datasets from next-generation surveys, like LSST. Additionally, since it is unbiased, it will enable improved constraints on H_0. Our model uses Spline Convolutional VAE (SplineCVAE) to extract descriptive statistics from quasar light curves and a Sequential Neural Posterior Estimator (SNPE) to predict posteriors of Gaussian process parameters from these statistics. Our SplineCVAE reaches reconstruction loss RMSE=0.04 for data normalized in the range $[0, 1]$. SNPE predicts the order of magnitude of time-evolution parameters with an absolute error of less than 0.2.

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