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Massive Black Hole Binary parameter estimation using Masked Autoregressive Flows

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One of the sources which we expect to be detected by the Laser Interferometer Space Antenna (LISA) are Massive Black Hole Binaries (MBHBs). Detection for these sources should be relatively easy, since their signal to noise ratio (SNR) will be large.

Once a detection has been made, parameter estimation is typically done with Bayesian sampling methods, such as nested sampling or variations of Markov Chain Monte Carlo (MCMC). These can be reliable methods, but are also very slow and computationally expensive —for each of the many thousands of samples one wants to produce, one has to evaluate the likelihood function, which in turn involves making forward simulations.

We are looking at ways to speed up the inference process. Using Machine Learning techniques, one can incur the computational cost in the training process, done beforehand, then very quickly analyze the real data. The way we are doing this is by replacing our desired likelihood function with a Masked Autoregressive Flow (MAF), which bijectively maps it via a neural network with some masked weights to a very simple distribution. We can then sample this base distribution very quickly.

In this talk, I will explain how this method works, how we produced our training dataset of MBHB data to be as close as possible to the first LISA Data Challenge (LDC), and show some preliminary results.

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