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Machine Learning Gravitational Waves from Binary Black Hole Mergers with Higher Order Modes

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We develop a machine learning model to fast and accurately predict the time domain gravitational wave emission non-precessing binary black hole system. Our model incorporates the effect of higher order modes of the multipole expansion of the waveform.
Building on our previous work we decompose each mode by amplitude and phase and we reduce the dimensionality with Principal Component Analysis. We train an ensemble of Artificial Neural Networks to learn the relation between orbital parameters and the low dimensional representation of each mode.
We train our model, called mlgw-NN, on ˜ 10ˆ5 signals generated with the state-of-the-art approximant SEOBNRv4PHM and we find that mlgw-NN achieves a median faithfulness of 10ˆ{-4}, averaged across the parameter space.
We show that our model generates a single waveform two orders of magnitude faster than the training model, with the speed up increasing when waveforms are generated in batches.
Our framework is fully general and can be applied to any other time domain approximant.

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