Research Result Report ICRR Inter-University Research Program 2023

Research Subject:
Low-Latency Localization and Parameter Estimation of Gravitational Waves Using
Probabilistic Deep Learning
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Summary of Research Result :

In this fiscal year, we tried to build a probabilistic deep learning model to rapidly predict the gravitational wave source locations, using the strain data from different detectors.

Instead of the Bayesian neural network we described in the proposal, we adopt the normalizing flow method to obtain more interpretable probabilistic distribution. The normalizing flow uses a series of invertible mappings to transform a Gaussian distribution into a complex posterior distribution, with some conditional inputs.

Assuming the data has been denoised, we used one-second whitened waveforms sampled at 4096 Hz as inputs. The waveforms are projected to Hanford, Livingston, and Virgo detector with random RA and dec at a fixed time respectively. We first input the data into a resnet-18 model to extract features, and use these features as the conditional input for the normalizing flow.

Unfortunately, so far, we cannot make the model converge in the training stage. A possible reason is that we use too lengthy data so that the model cannot affectively extract useful features. Also, using time series data along may have the degeneracy on source locations. In the future we plan to incorporate time delays between each detector and the detector antenna response maps to improve the model convergence.

The funding of this year is used for traveling and purchasing computer parts. We appreciate the support from ICRR.

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