Application of Deep Learning Techniques for Glitch Classification and Parameter Estimation for LIGO Data

Aprameya Muralidhara Yelanduru, Nithyashree S, Krishna Narasimha Rao

Team Dhruva, RVCE

Although LIGO and Virgo observatories can detect gravitational waves far smaller than a proton's width, this sensitivity also makes them susceptible to noise-causing glitches that can hide or mimic real signals. Therefore, it is important to minimize and classify these glitches to extract true astrophysical events from detector artifacts. In this paper, Convolutional Neural Networks (CNN) are trained on Gravity Spy spectrograms to learn patterns that classify glitches with high accuracy, aided by multi-headed attention mechanisms. The predictions from models trained on four different views of the same trigger (glitch or merger) are stacked to improve the model's accuracy. Since CNN models struggle with efficient classification of unknown or uncategorized glitches, autoencoders (AEs) and variational autoencoders (VAEs) are utilized. Celestial events involving binary neutron star and black hole-neutron star mergers have a poor signal-to-noise ratio. Machine Learning and Deep Learning concepts can be applied to data analysis to improve source parameter estimation. By combining supervised and unsupervised learning techniques, this work aims to develop tools that enhance gravitational-wave discoveries, making them more precise and comprehensive.