Deep Learning Classification of Transient Noises using LIGO's Auxiliary Channel Data

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We demonstrate that a deep learning classifier that only uses to gravitational wave (GW) detectors auxiliary channel data can distinguish various types of non-Gaussian noise transients (glitches) with significant accuracy, i.e., ~80%. The classifier is implemented using the multi-scale neural networks (MSNN) with PyTorch. The glitches appearing in the GW strain data have been one of the main obstacles that degrade the sensitivity of the gravitational detectors, consequently hindering the detection and parameterization of the GW signals. Numerous efforts have been devoted to tracking down their origins and to mitigating them. However, there remain many glitches of which origins are not unveiled. We apply the MSNN classifier to the auxiliary channel data corresponding to publicly available GravitySpy glitch samples of LIGO O1 run without using GW strain data. Investigation of the auxiliary channel data of the segments that coincide to the glitches in the GW strain channel is particularly useful for finding the noise sources, because they record physical and environmental conditions and the status of each part of the detector. By only using the auxiliary channel data, this classifier can provide us with the independent view on the data quality and potentially gives us hints to the origins of the glitches, when using the explainable AI technique such as Layer-wise Relevance Propagation (LRP) or GradCAM.

Fig 1. Captions should be written in Times New Roman, 12-point