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Lockloss prediction for diagnostics and early intervention

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Ground-based interferometric gravitational wave detectors at LIGO are complex instruments that need to be in light resonance or 'locked' in order to take data and make astronomical observations. The 'lock' is maintained by a series of control loops which can be disturbed by systematic or environmental factors. Multiple detectors need to be simultaneously in lock to triangulate the sky location of a source and reacquiring a lost lock is time consuming. Since LIGO has a network of sensors deployed to monitor the instrument and its environment, it is worthwhile to study LIGO's 'lockloss' events and potentially build a data-driven, predictive model using machine learning to find lockloss witnesses which can aid in diagnostics and early intervention. In this work, we use an unsupervised anomaly detection technique called Isolation Forest to investigate whether data from a subset of length and angular degrees of freedom channels is an outlier prior to lockloss events compared to locked time data. The ultimate goal is to find witnesses to the lockloss events that help LIGO instrument experts to diagnose the causes of lockloss events and potentially mitigate them to improve the detector duty cycle and enable multi-messenger astronomy.

Primary author: GURAV, Rutuja (University of California Riverside)

Presenter: GURAV, Rutuja (University of California Riverside)

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