

Amaldi 12 Abstract

Effective use of machine learning in commissioning and characterization

Nikhil Mukund

June 13, 2017

Abstract

We have been able to demonstrate the resourcefulness of machine learning (ML) for commissioning and characterization efforts at the gravitational wave observatories. The applications described below make use of ML techniques like clustering, classification, regression and natural language processing (NLP). (1) Increasing the IFO uptime helps in gathering more coincident data and improves the chance of detecting astrophysical events. Understanding why the detector was unable to maintain its lock is something that requires analysis thousands of auxiliary subsystem channels. The Lockloss-Monitor installed at LIGO Livingston tracks various subsystems and uses density based spatial clustering to identify the channels that show abnormal behavior seconds before the lock loss. This information helps the commissioners and on-site engineers to probe the issue further. (2) Earthquakes occurring around the globe can cause significant ground motion leading to lock loss. SEISMON, the earthquake warning system installed at the sites uses regression to predict the associated ground motion and provides the probability of staying in lock. (3) Accurate system identification and stable control design are necessary to bring the IFO under control. Constructing a digital filter that fit the measured transfer function is a time-consuming task when the measurements are noisy. We automate TF fitting via total variation denoising and carry out constrained multi-parameter optimization using a limited number of zeroes and poles. (4) Glitches or non-astrophysical transients often show up in GW strain data leading to false triggers in the various astrophysical signal search pipelines. The hybrid classifier we developed combines unsupervised clustering and supervised learning to achieve the desired level of accuracy needed for a morphology-based veto but is also flexible enough to handle new class of transients. (5) The advances in NLP can be utilized to efficiently retrieve information from unstructured logbook data maintained at the interferometers for over a decade. HeyLIGO, our NLP-based recommendation system, facilitates this knowledge discovery and provides the most relevant information pertaining to the given search query.