IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Advances in Space-based Communication Systems and Services, Part 3 (4)

Author: Mr. Armando La Rocca
AIKO S.r.l., Italy

Mr. Gabriele Giordana
AIKO S.r.l., Italy
Mr. Alessandro Aquilano
AIKO S.r.l., Italy
Mr. Gianluca Maria Campagna
AIKO S.r.l., Italy

UNSUPERVISED ANOMALY DETECTION THROUGH MULTI-MODEL ENSEMBLE METHOD

Abstract

Anomaly detection in satellite telemetry management is the process of identifying unexpected or abnormal behavior in telemetry data that is transmitted from satellites which may include position, health, as well as data collected from on-board instruments and payloads. This technology can help ensure the success of satellite missions by identifying issues as soon as they occur and before they escalate into more serious problems, minimizing downtime and keeping the satellite operating at peak efficiency.

Currently, many anomaly detection systems are built upon shallow threshold-based rules, while a good number of on-board anomalies are detected after days, just after a manual examination. Here is where Artificial Intelligence (AI) can be of some use.

ATRIA is a Horizon 2020 project founded by the European Commission and involves partners with different expertise like GMV, AIKO, CTTC, Eutelsat, Skylogic, OHB and Fraunhofer. The goal of ATRIA project is to develop a software application endowed with AI models to support flexible payloads features and Very High Throughput Satellites, supporting operators in the assets monitoring and deciding the optimum configuration of the satellite resources.

The project mainly embraces telecommunications-related use cases and one of them is the development of an anomaly detection algorithm to automate the telemetry analysis of the satellites. The data available to the operator are time series reflecting the use of Internet services and thus include different types of parameters such as bandwidth or efficiency with a high variability making the system complex and heterogeneous. Also for this reason, few anomalous behaviors are documented. The different nature of the available data and the lack of known anomalies are two challenging aspects in the development of AI technology to detect potential anomalies given a set of relevant time series.

In this paper we propose a novel approach based on unsupervised Machine Learning methods to address anomaly detection in complex systems like the one described above. Our method is based on a multi-model AI techniques to address the different parameters and combine their outputs in ensemble layers. The method is able to discriminate the nominal variance in the time-series behavior and provides to the final user an overall vision of the system status measuring the anomaly severity. Our implementation proves that anomaly detection algorithms can tackle complex systems and recognize anomalies even in situations in which labeled data are not available.