DETECTION OF AIR LEAK IN EXHAUST SYSTEM USING ON-THE-ROAD DATA

Acerta AutoPulse™ Case Study

Acerta
AI-Powered Machine Analytics

OBJECTIVES

- Provide vehicle failure prediction using a small amount of training data
- Identify trends indicative of future system failures

CHALLENGE

- No examples to train the models on
- More than 350 input parameters
- Real-time analysis

RESULTS

- Provided algorithm for real-time on-the-road failure prediction
- Allowed for identification of previously undetected failure
- Reduced root-cause analysis time from *~2 weeks* to *1 hour*

CONTACT ACERTA

info@acerta.ca
+1 (416) 992-6731
https://acerta.ca
@AcertaAnalytics
Acerta Analytics Solutions
30 Duke Street West, Kitchener, ON, Canada

BACKGROUND

Malfunction detection is currently performed using control limits for various signals, which are determined using simulation data and adjusted using statistical process control. When a signal exceeds its threshold, a test failure is triggered and engineers perform a manual root-cause analysis. However, malfunctions are not the only cause for changes in signal behavior - it might also change as a result of the driver's actions or various environmental factors. Therefore, it is necessary to analyze not only the signals themselves but also the relationships between them (for example, acceptable engine starting time is dependent on ambient temperature). This makes the process of setting up thresholds very engineering-intensive and time-consuming. When analyzing hundreds of recorded signals, machine learning algorithms allow for significant acceleration of the process while improving the accuracy of results.

THE PROBLEM

A leading automotive manufacturer requested that Acerta analyze data collected during an on-the-road qualification test for one of its vehicles. As the test driver was operating the vehicle, he noticed excessive engine roughness which kept worsening until he ultimately had to shut down the vehicle. The client provided 250MB of data recorded from 350 sensors during 80 hours of driving. The objective was to identify any abnormality in vehicle subsystem that may have caused the issue, using only the data provided. Acerta was given no information regarding the type or model of the vehicle, nor regarding the nature of the anomaly or if one existed in the data.

SOLUTION PROCESS

Acerta's team analyzed the data and configured the most suitable machine learning algorithm for the type of data provided. Since no data from normal vehicle operation was provided, the first half of the datalog was used as a baseline for the models, from which any deterioration would be detected as an anomaly.

Acerta's platform automatically selected the best combination of models to be used in the algorithm for the specific use case. Once trained, the algorithm scanned the entire dataset, and identified an anomalous trend in the data generated by 8 out of 350 sensors installed in the car, including the signals representing the oxygen level in the exhaust system, the fuel banks, the engine speed, and the cylinder pressure.

RESULTS

The results were reported to the client who confirmed that the algorithm had correctly detected over 98% of the anomalous data. Using the information provided by the algorithm, a combustion engine expert was able to identify the root cause of the problem within an hour. In comparison, prior to contacting Acerta, the client's engineers required 2 weeks to diagnose the problem.

Based on Acerta's input, it was determined that the fault originated in an air leak in the exhaust system, which caused the oxygen sensors to spike. This caused the engine control system to increase fuel delivery to the engine to in an attempt to maintain the constant air-fuel ratio needed for correct engine operation. The complex relationships between these signals made it difficult to manually identify the cause.

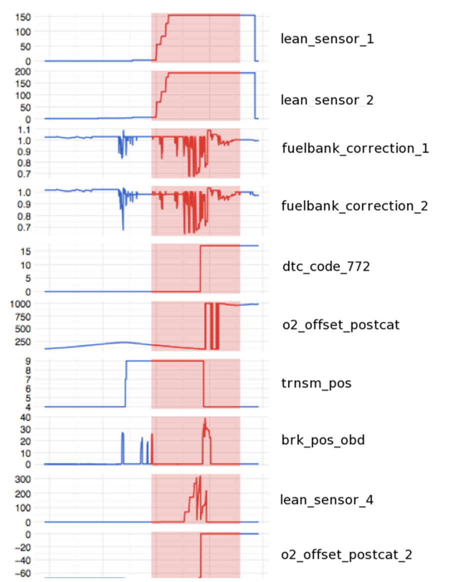

Figure: the portions of the signals which were classified by the algorithm as anomalous (marked in red)