Acerta

AI-Powered Machine Analytics

DETECTION OF MISFIRES IN ENGINE USING END-OF-LINE DATA

Acerta Case Study

OBJECTIVES

- Locate any anomalies while lacking information about tested system
- Prove data received is sufficient for malfunction detection

CHALLENGE

- Client provided only 194 MB of data
- Training data from only 12 engines
- Real-time analysis

RESULTS

- Negligible adjustments to algorithm required
- Achieved 91% detection accuracy
- Precisely identified the 0.612% anomalous data

CONTACT ACERTA

info@acerta.ca

+1 (519) 729-5543

www.acerta.ca

@AcertaAnalytics

Acerta Analytics Solutions

151 Charles Street,
Waterloo, ON, Canada

BACKGROUND

Engine misfires carry heavy ramifications on vehicle health. When a cylinder fails to provide power to the engine, raw fuel might reach the catalytic converter. If not detected or treated in time, misfires cause severe cumulative damage to the vehicle, costing thousands of dollars in repairs per vehicle. Identifying misfires early-on helps avoid serious damage, prolong vehicle lifetime, and reduce repair expenses.

THE PROBLEM

A leading Tier 1 manufacturer was facing a difficult task of detecting anomalies in its engines. Since sensor data from engine tests tend to include numerous spikes, detecting true anomalies is an unusually difficult task. The company hired Acerta to analyze data recorded during some of its dynamometer test runs. Given a limited data set of 194MB to train our algorithm, we were asked to determine variations between different engines as well as variations within a single test cycle.

SOLUTION PROCESS

Spikes in gas levels are very common, as they are often the consequence of the dynamic nature of driver actions and environmental conditions. Therefore, unlike with other parameters, defining set thresholds for gas level values isn't useful for determining anomalies. For that reason our technology is effective since it analyzes the correlations between various parameters in order to identify true anomalies.

Acerta's platform analyzed the data files received from the client and learned the normal correlations between the different gas levels and engine parameters. It then applied an ensemble of our machine learning algorithms, tuned to best fit the input parameters, and identified anomalous parts of the data. We then used reinforcement learning to further improve the classification accuracy.

In the example shown in figure 1, several spikes are clearly visible, particularly in A/F, CO and NOx, but our platform correctly identified them as normal. In both major instances the spike was caused due to a substantial drop in demand for engine RPM, and was not a result of a misfire. In another case, our platform correctly classified an unusually high concentration of CO, CO2, NOx, H2 as normal. It determined that since the value for engine temperature at the same time was low, the correlation between the different values was indicative of engine warm-up, and not a misfire.

True misfires are harder to detect but they can occur in scenarios where the correlation between different values behaves unexpectedly. Acerta's platform was able to understand the different conditions and significantly minimize the false positives generated, when compared to existing solutions. The example shown in figure 2 shows the values for the A/F ratio vs engine speed where the platform detected an anomaly around 3,500 RPM. Since the correlation between the different values was abnormal, the platform flagged this as an anomaly, indicating a lean misfire.

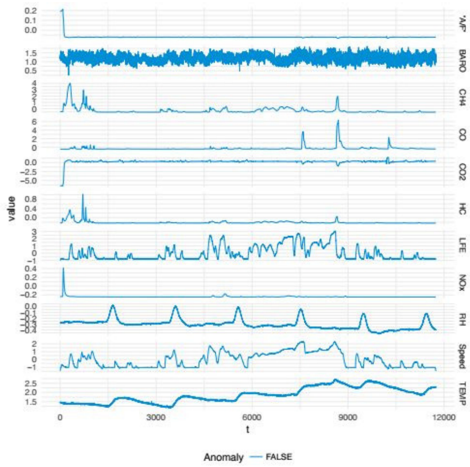

Figure 1: No anomalies detected despite data exhibiting seemingly random spikes

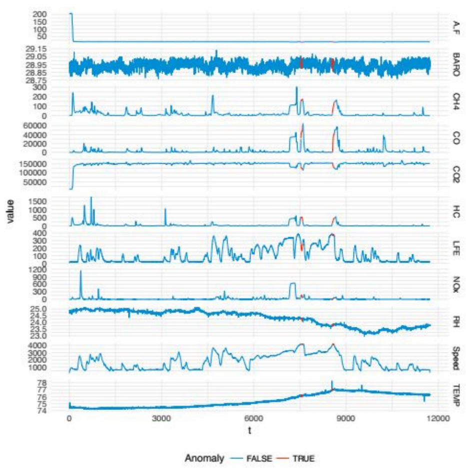

Figure 2: Anomalies identified where data exhibited unusual correlations

RESULTS

By learning what is considered normal behavior and how to identify different types of misfires, Acerta's platform automatically detected true misfires in real time. Acerta's models are dynamic in such a way that with minimal configuration, they quickly adjust to variations in input type or value. This allowed for the misfire detection with a True Positive Rate of 91% while maintaining an extremely low false-positive rate of 8.33%, which was critical in preventing unnecessary expenses.

Our platform determined that the relationship between the values of gases provided the most important insight into engine performance and is a key indicator of its health. It automatically produced a model to represent engine behavior, provided an alert on potential misfires, and generated actionable insight which assisted with root cause analysis.