

AIAD

AI-Powered Anomaly Detection for Tamping Operations



Sandro Lic¹, Jan Holzweber¹, Ouidane Guiza¹, Andreas Duthaler², Paul Grünbacher³, Alexander Egyed³

Pro2Future GmbH¹, Rhomberg Sersa Rail GmbH², JKU-ISSE (Institute for Software Systems Engineering)³

¹ Science Park 4, Altenberger Strasse 69, 4040 Linz

² Haidestraße 53, 4600 Wels

³ Altenberger Strasse 69, 4040 Linz



MOTIVATION & GOALS

- The **AIAD project** aims to **detect and analyze anomalies** during tamping operations to ensure **operational efficiency**, **minimize machine wear**, and **prevent potential infrastructure damage**.
- The targeted anomalies include **vehicle malfunctions**, **ballast obstacles**, and **infrastructure damage**.
- The approach combines **statistical analysis**, **machine learning paradigms**, and **end-to-end data pipelines** from acquisition to real-time inference.
- Key challenges include **multivariate data** complexity and the need for integrating **time-series** and various **contextual data**.

Project FactBox

Project Name AIAD
Project ID MFP O.2
Duration 48 Months

Area 2
Area Orchestration

Project Lead
DI Dr. Ouidane Guiza

APPROACH

- Exploring **statistical models** to capture normal operation behaviour using dynamic thresholds
- Leveraging **unsupervised clustering** of sub-group discovery to enhance data labelling
- Detecting outliers by calculating **statistical distance-based** anomaly scores, quantifying deviation from expected distributions
- Temporal and spatial modelling of multivariate data using **deep neural networks (DNN)**

CONTRIBUTION

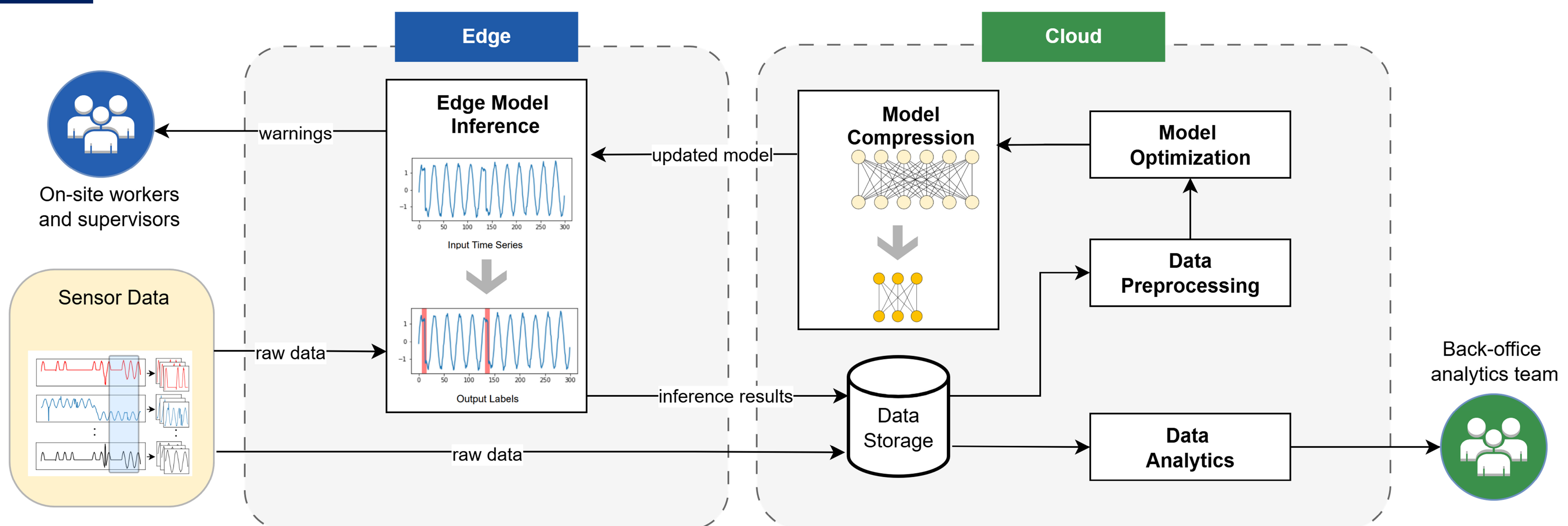
Scientific contribution

- Systematic mapping study of the use of different ML techniques for railway vehicle condition monitoring
- Application of unsupervised clustering techniques to vibration data for vehicle condition monitoring and detection of other anomalies

Economic contribution

- Condition monitoring of railway vehicles
- Early detection of anomalies related to railway tracks
- Reduce machine wear and down-time
- Prevent infrastructure damage

SYSTEM ARCHITECTURE



Contact: DI Dr. Ouidane Guiza, Pro2Future GmbH, ouidane.guiza@pro2future.at, +43 732 2468 - 9465

Acknowledgement: This work was supported by Pro2Future II (FFG, 911655).

