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Automotive LLM Model

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OBJECTIVES

An AI solution for precise **POST-SESSION ANALYSIS** to enhance racing performance

A Large Language Model (LLM) that efficiently processes telemetry data for **RAPID INSIGHTS**

TIME-SAVING support for telemetrists with **EFFICIENT** data analysis





VALUE PROPOSITION



Anticipate the Unseen: **DETECT** anomalies in order to **PREDICT** future failures before they become setbacks.

Optimize Potential: **SIMULATE, SHAPE,** and **REFINE** the perfect lap by uncovering deeper insights to **COMPARE** and **EVOLVE** strategies for continuous improvement.



9 INDUSTRY, INNOVATION
AND INFRASTRUCTURE



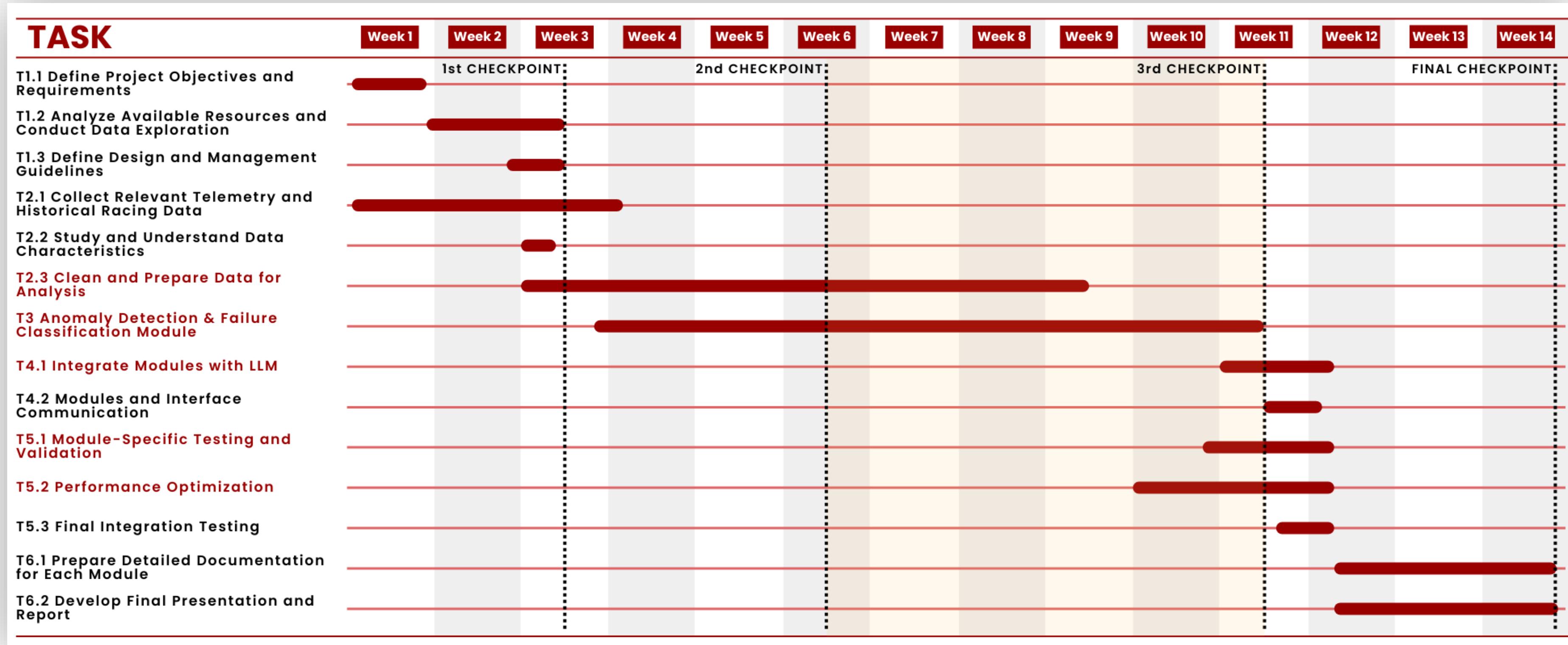
Our project aligns with **SDG 9** by leveraging advanced AI to drive innovation, improve efficiency, and support **SUSTAINABLE** practices in modernizing motorsport performance and infrastructure.





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GANNT





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DATASET





FASTF1

KEY FEATURES



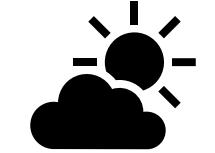
SESSION
DATA



TELEMETRY
AND CAR DATA



VISUALIZATION



TRACK & WEATHER
CONDITIONS



TABULAR DATA



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TARGET AUDIENCE



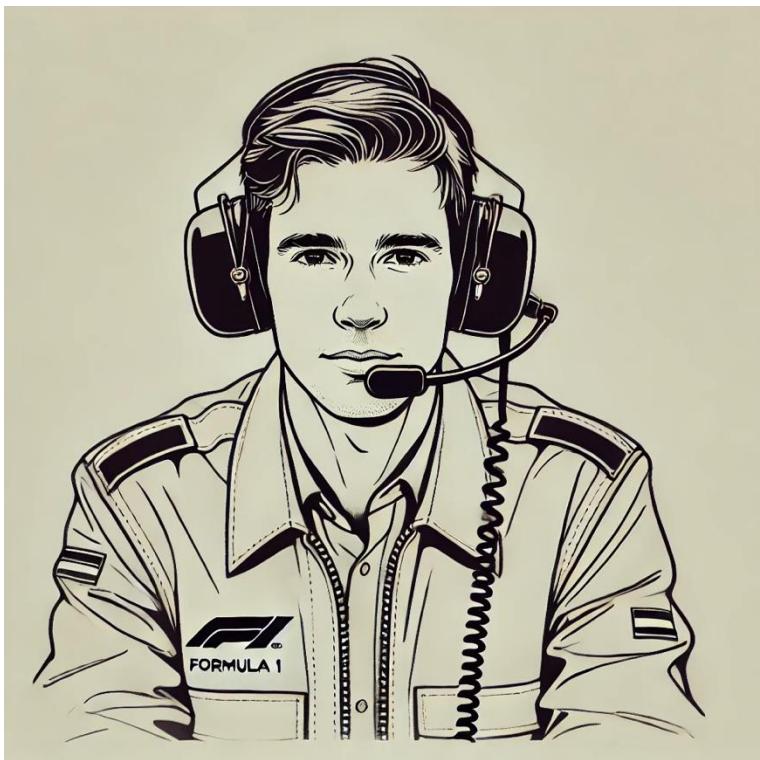
Alex
TELEMETRIST

*Overwhelmed by data volume,
making real-time issue
detection difficult.*



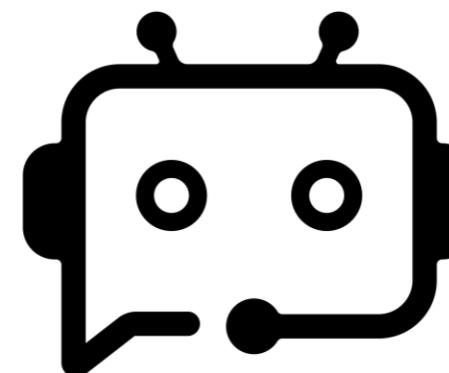
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SOLUTION



Alex
TELEMETRIST

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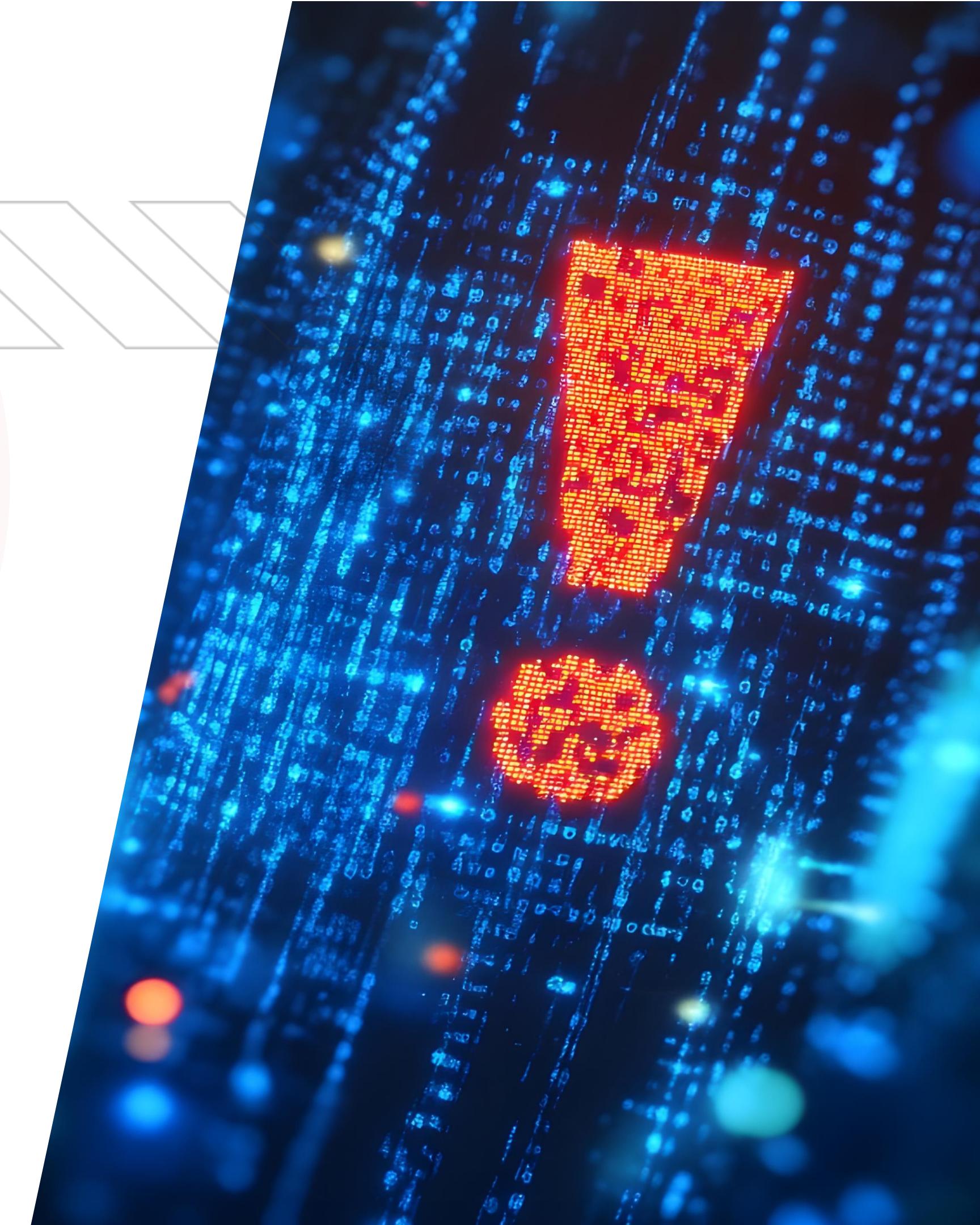
LLM

SIMPLE to use
USER FRIENDLY
RAPID results



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ANOMALY DETECTION & FAILURE CLASSIFICATION





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ANOMALY DETECTION DATA PREPROCESSING

TRAIN

TEST

SOURCE

DIFFERENT GRANULARITY → merge (telemetry, weather, laps)

SEASON

From 2019 to 2023

2024

FAILURE FILTER

Data WITHOUT FAILURES

Data WITH FAILURES

DATA CLEANING

Removal of NaN VALUES and DUPLICATE handling

PIT STOP LAPS

Data WITHOUT PIT STOP laps

Complete data WITH PIT STOP laps

NORMALIZATION

DATA TYPE handling to normalize (Min Max Scaler) only NUMERICAL and TEMPORAL values.
MAPPING of CATEGORICAL data

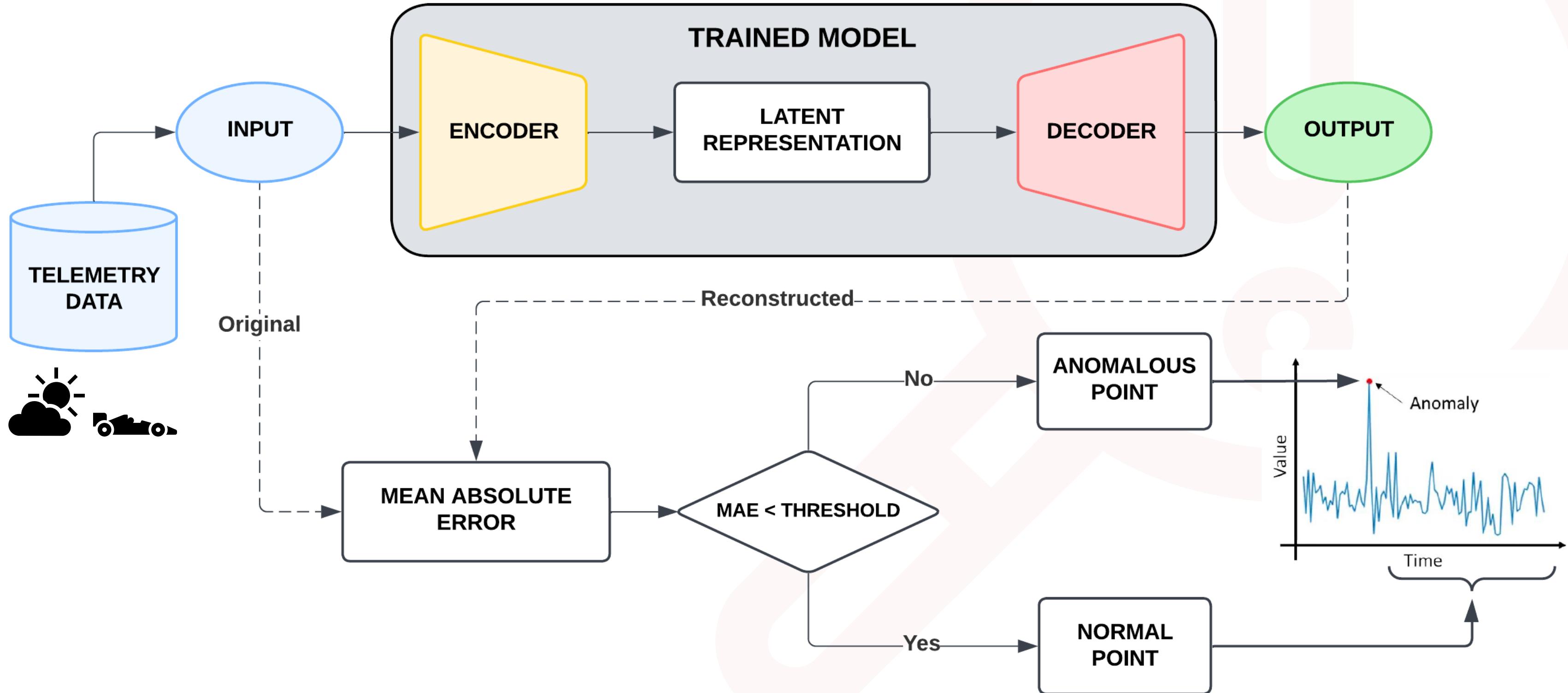
STORAGE

Data are stored in NPZ instead of CSV files in order to reduce the amount of STORAGE ON DISK and OPTIMIZE the data loading and management



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ANOMALY DETECTION AUTOENCODER





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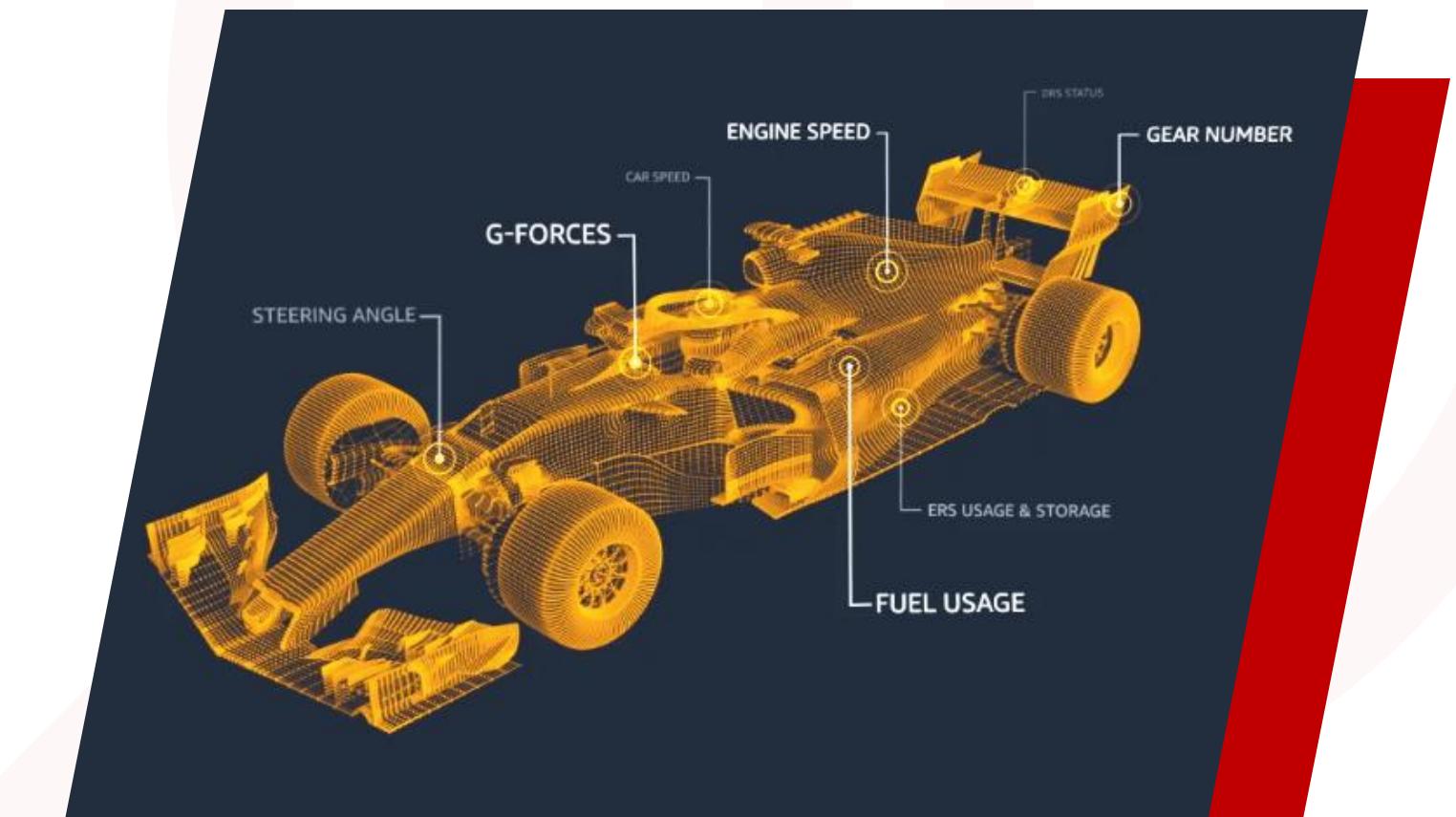
ANOMALY DETECTION TRAINING

SLIDING WINDOWS and different **BATCH SIZE** to reduce the load on RAM.

KFOLD CROSS VALIDATION to generalize the model and reduce the overfitting.

Different **LEARNING RATE** and **OPTIMIZER** to improve the model.

LOW final LOSS value reached

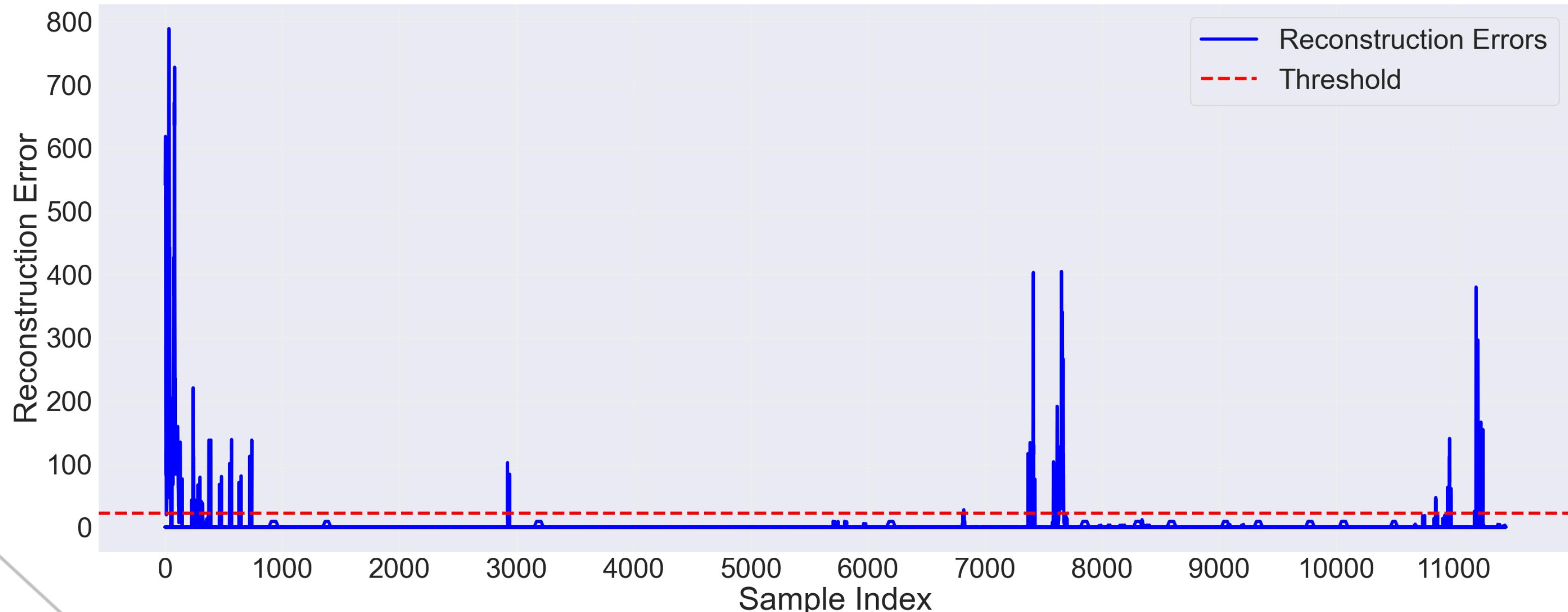




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ANOMALY DETECTION RESULTS

The model find **TELEMETRY IRREGULARITIES** on new unknown data complete of failures
The user analyze the output anomalies and give the anomaly span to the classifier

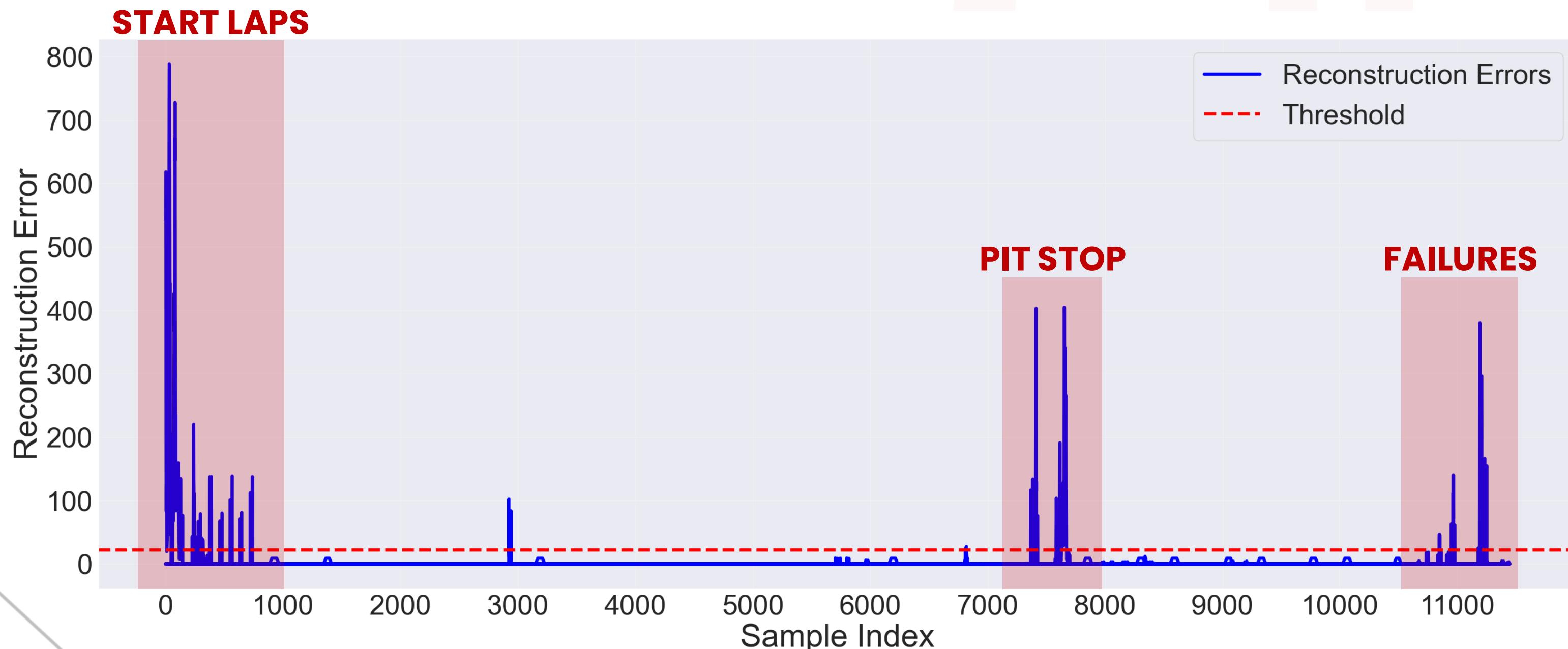




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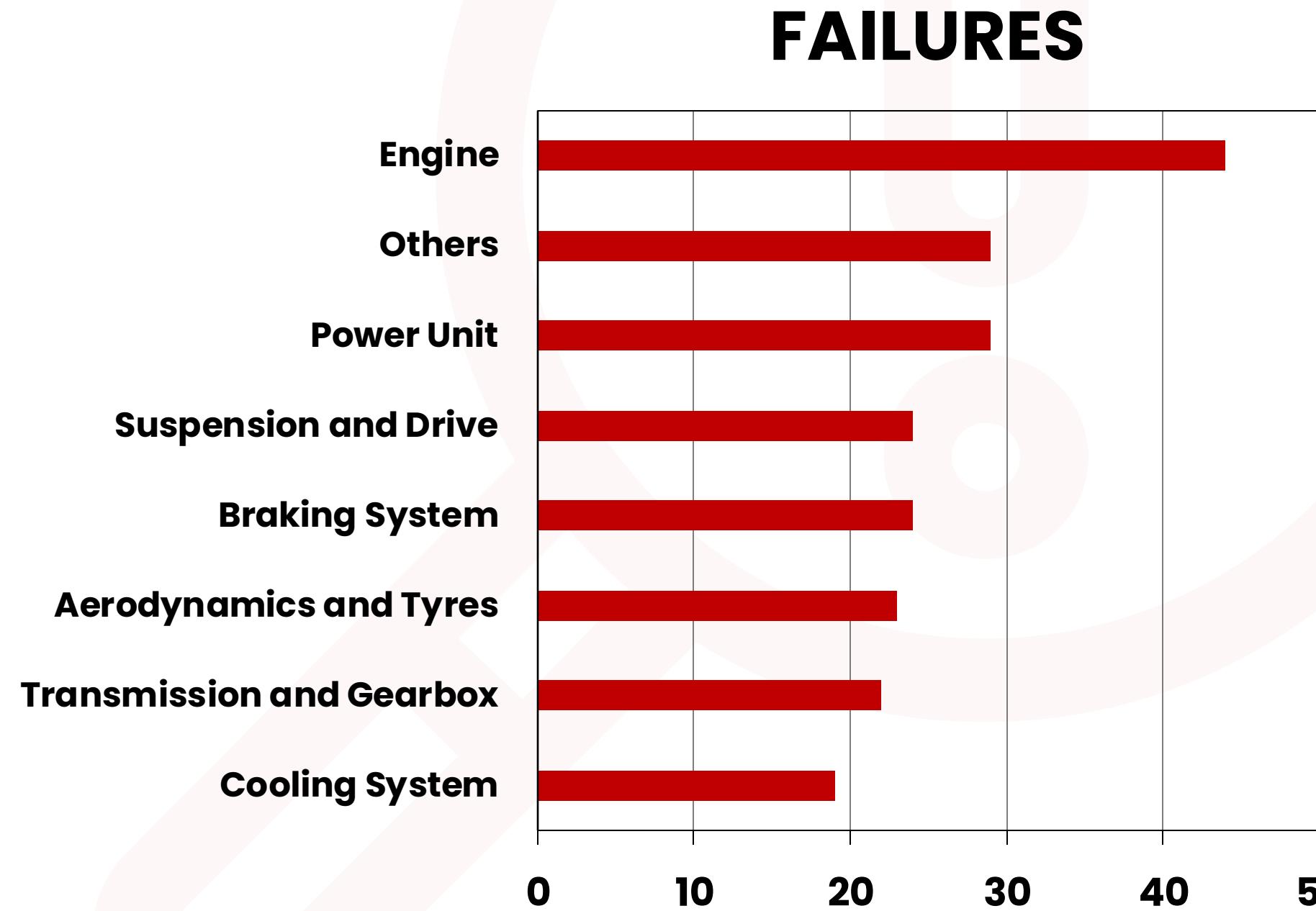


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FAILURE CLASSIFICATION DATA PREPROCESSING

Propose a **FAILURE CATEGORY**
that can be identified and
CLASSIFIED based on the
anomalies **DETECTED** in the data

45 different anomalies → **8** failure groups

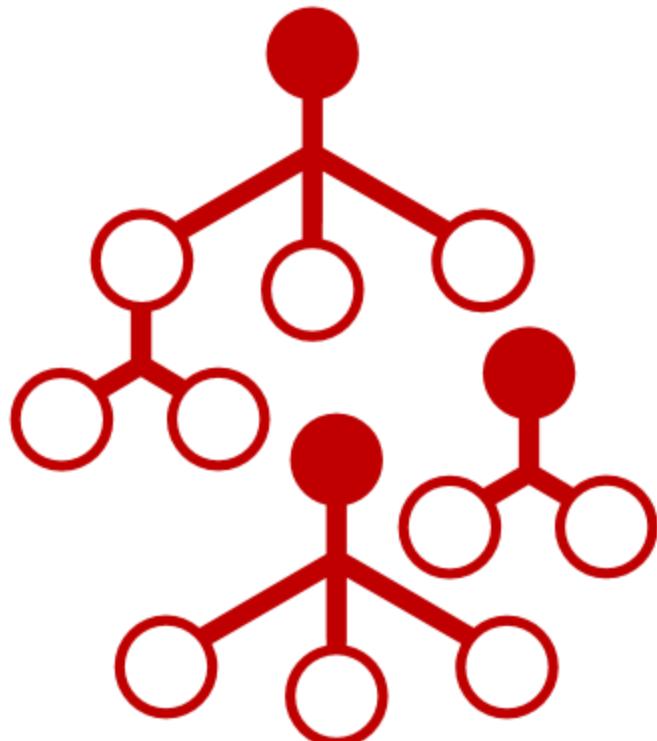




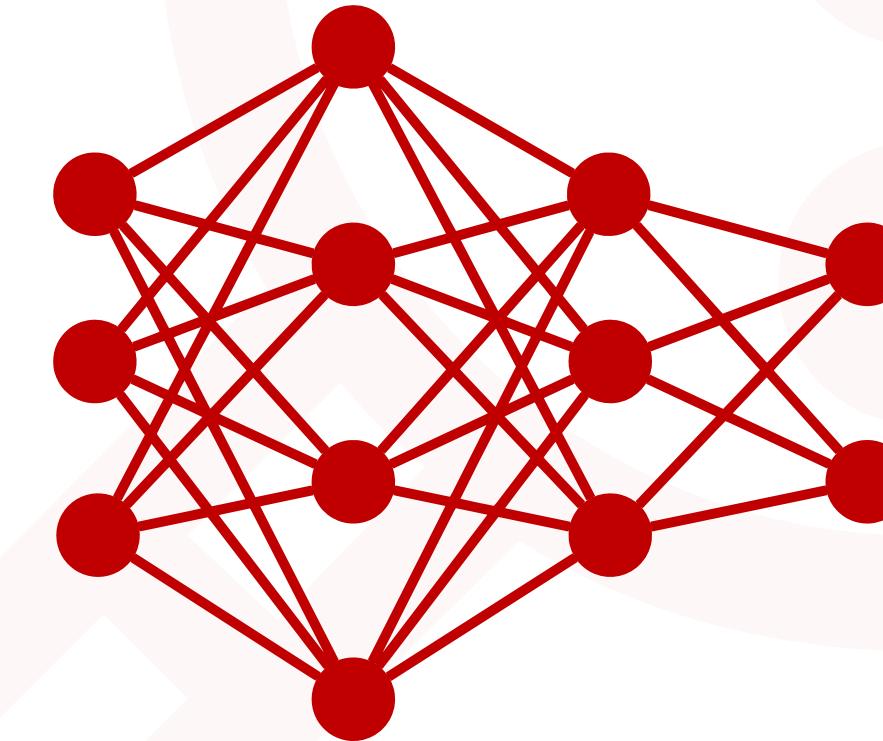
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FAILURE CLASSIFICATION TRAINING

RANDOM FOREST



NEURAL NETWORK

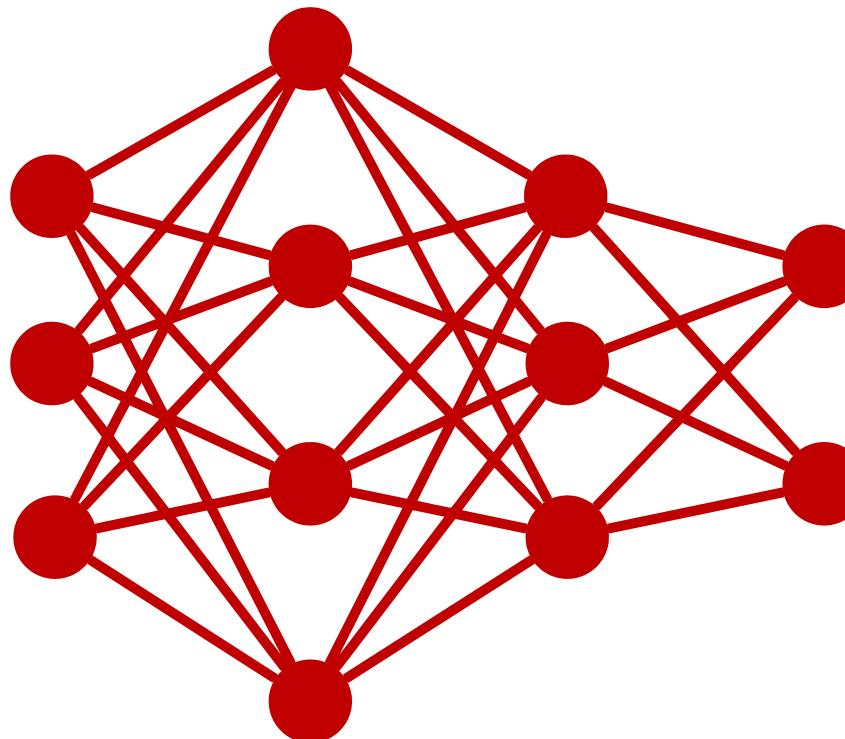




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FAILURE CLASSIFICATION TRAINING

NEURAL NETWORK



PROS:

- Powerful for **COMPLEX PATTERNS**
- Adaptable to **HIGH-DIMENSIONAL** data
- Considers feature **INTERACTIONS**

CONS:

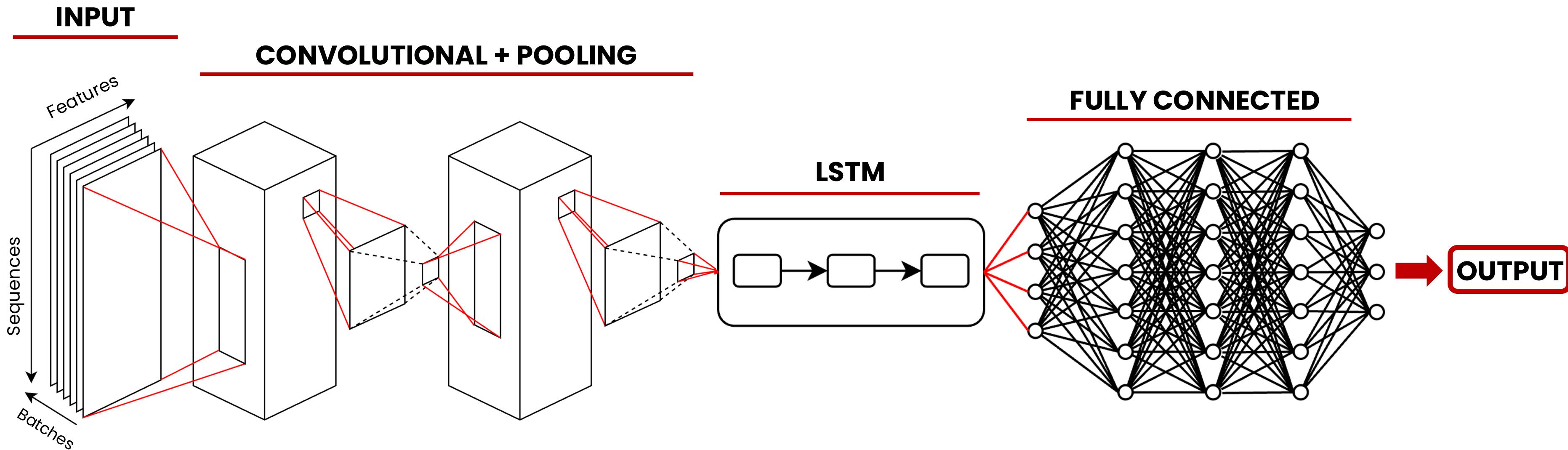
- Computationally **EXPENSIVE**
- **LESS INTERPRETABLE**
- **DIFFICULT** to tune



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FAILURE CLASSIFICATION

CNN + LSTM + FC





F1LM

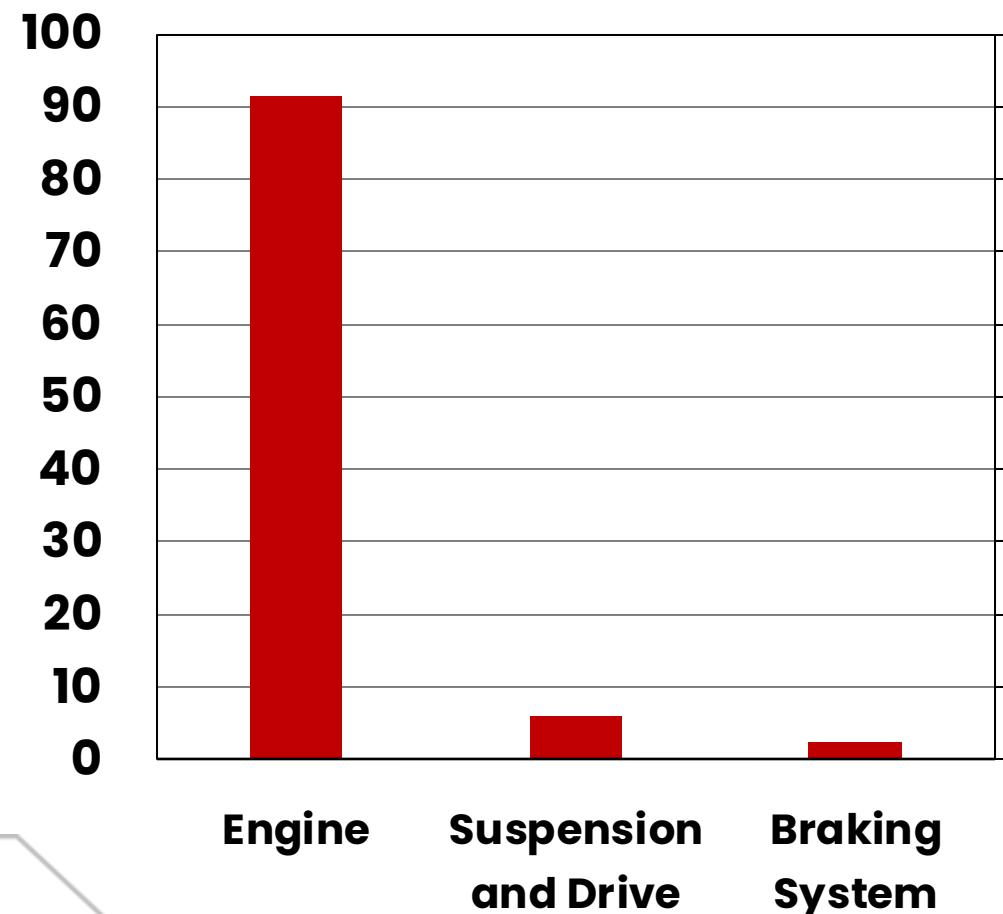
FAILURE CLASSIFICATION RESULTS

CANADIAN GRAND PRIX

Actual Anomaly
Engine

Predicted Anomaly
Engine

Charles LECLERC

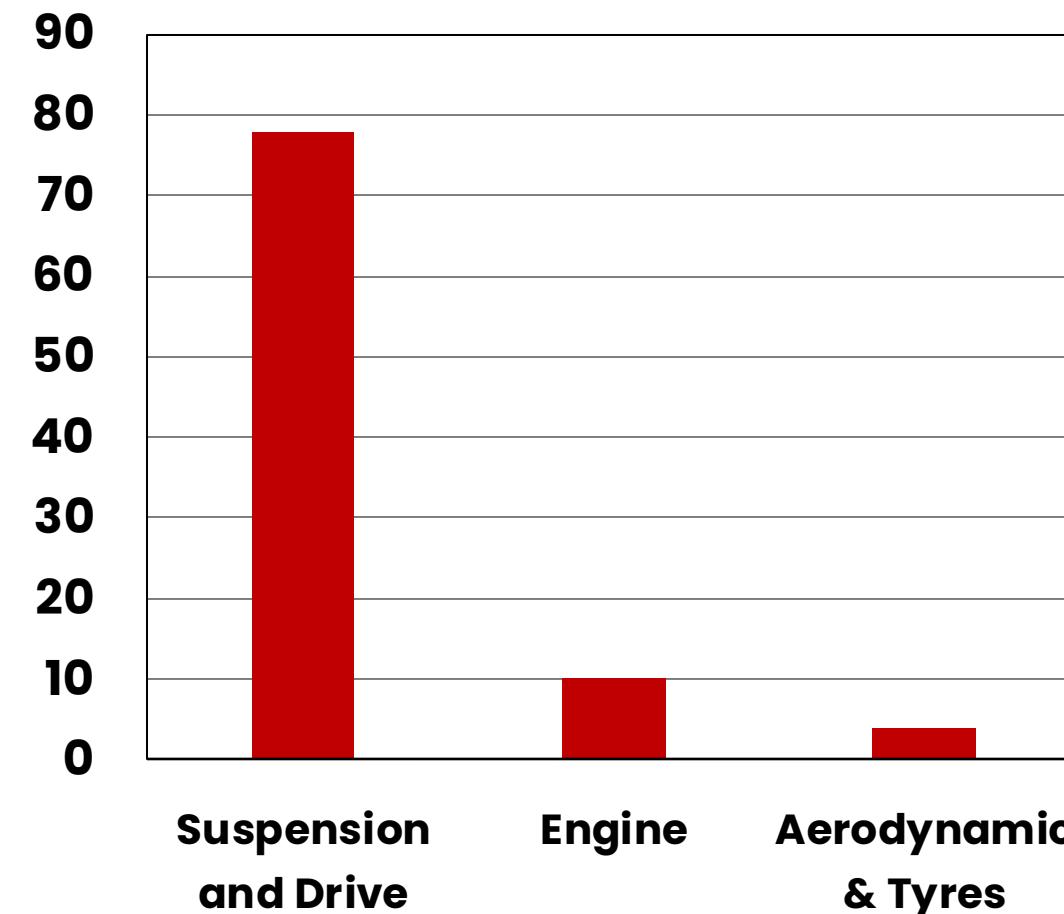


HUNGARIAN GRAND PRIX

Actual Anomaly
Suspension and Drive

Predicted Anomaly
Suspension and Drive

Pierre GASLY

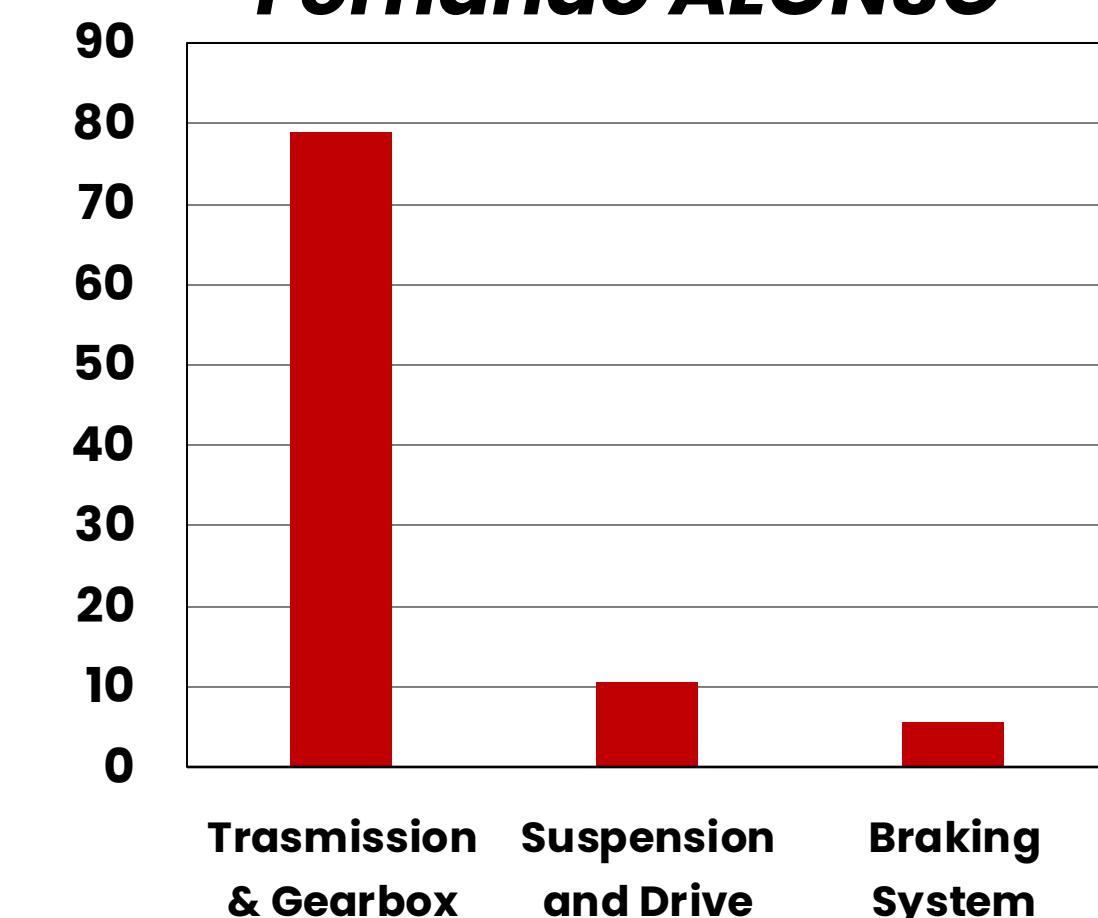


MEXICOCITY GRAND PRIX

Actual Anomaly
Braking System

Predicted Anomaly
Transmission and Gearbox

Fernando ALONSO





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FUTURE WORKS

- 1 LAP SIMULATION**
- 2 TELEMETRY COMPARISON**





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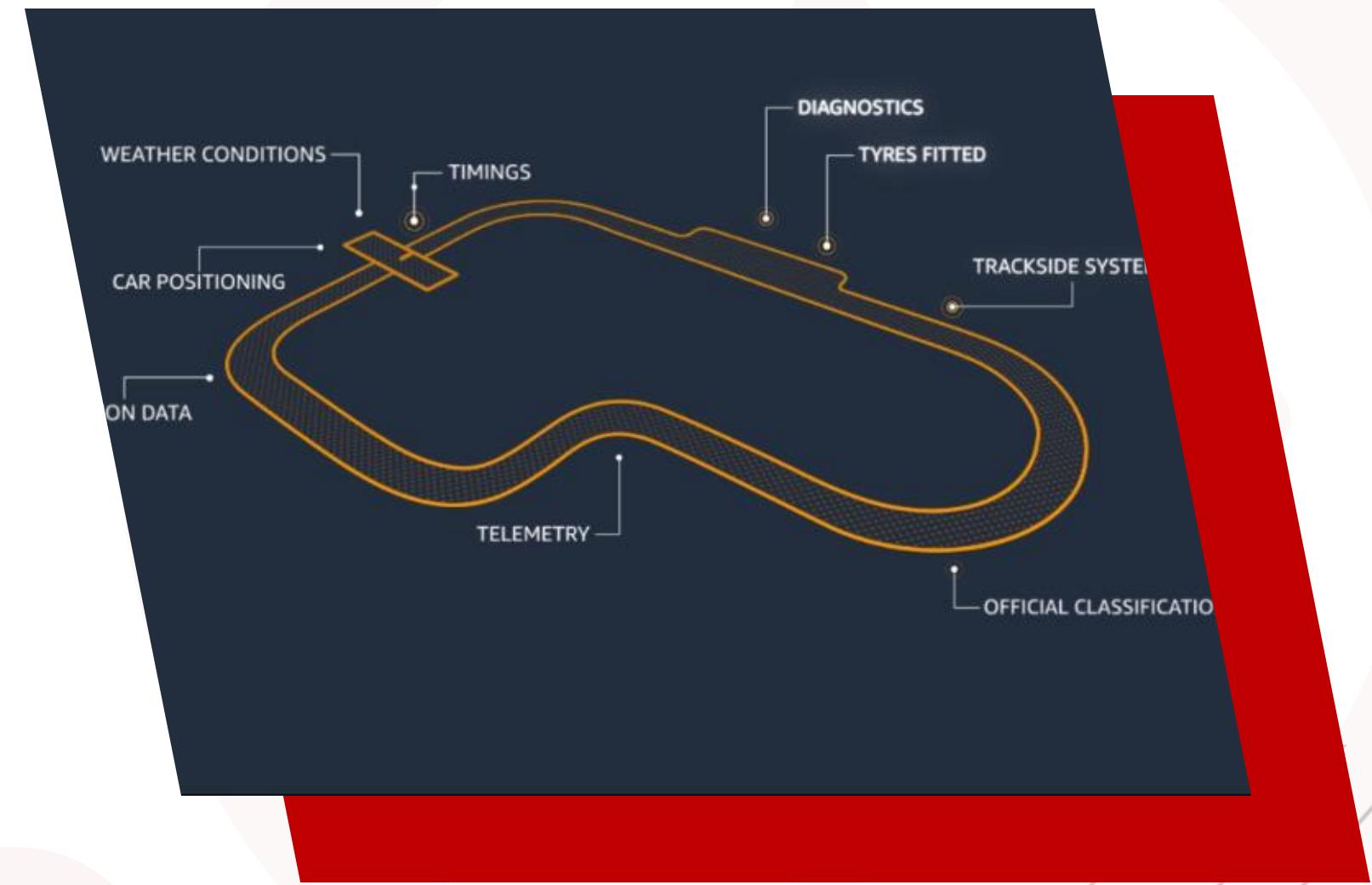
FUTURE WORKS

1 LAP SIMULATION

Analyzing historical qualifying data to predict **CAR PERFORMANCE**

2 TELEMETRY COMPARISON

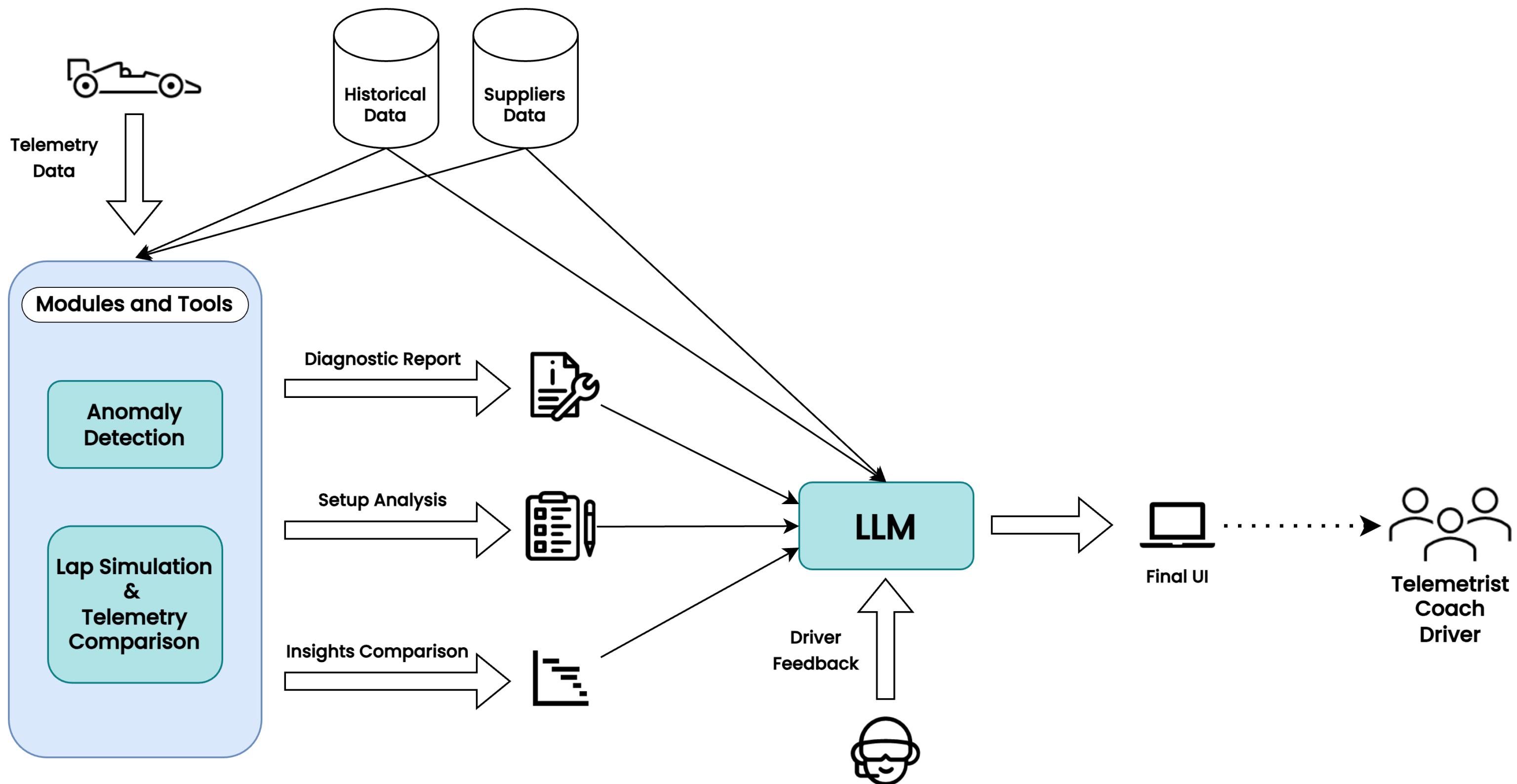
Evaluation through **TEAMMATE PERFORMANCE** analysis
Comparison with **FASTER DRIVERS**





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FUNCTIONAL DIAGRAM



THANK YOU

FOR YOUR ATTENTION



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