EXECUTIVE SUMMARY OF POWER UNIT HEALTH MONITOR

Introduction

This project is a practical exploration into using race telemetry data to estimate power unit (PU) health over a Formula 1 season. The goal was to simulate how engineers might monitor engine condition in real-time during races using available sensor data. The focus is on building a tool that calculates a simple health score based on how often key parameters exceed predefined safe thresholds. While simplified, this approach provides meaningful insights into engine wear and performance degradation.

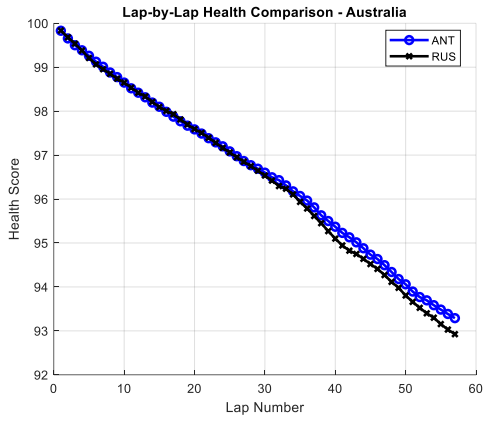
Approach

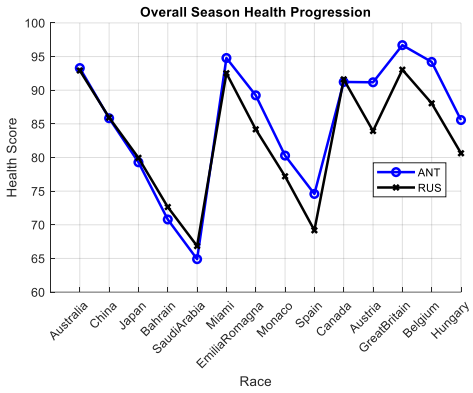
Data for two drivers across 14 races in the 2025 F1 season was gathered using FastF1, then processed to include synthetic values for oil and coolant temperature. When an engine is changed between races, the health score resets to 100. The results are visualized with lap-by-lap health for a selected race and overall season health progression for each driver. The MATLAB code analyses the data lap-by-lap for each race and deducts penalties from an initial health score of 100 when sensor readings exceed safety limits such as:

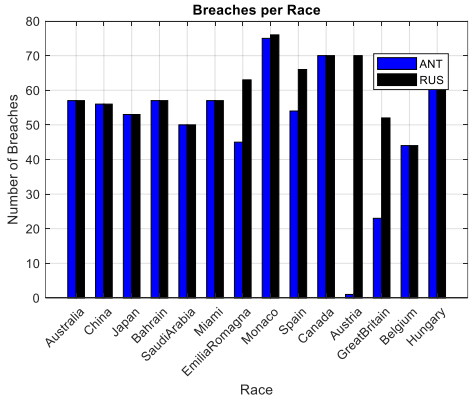
- RPM exceeding 15,000
- Throttle above 95% for more than 5 seconds
- Oil temperature exceeding 110°C for more than 1 second
- Coolant temperature exceeding 100°C for more than 1 second
- Rough gear shifts (±80% deviation from race average delta RPM during shifts)

Results

- The tool successfully computes continuous PU health metrics for each driver and race.
- Health scores decrease based on the number and duration of breaches in engine operating limits.
- Visualizations clearly show health trends across laps and races.
- Engine replacements correctly reset health scores, allowing for realistic season modelling.







Why It Matters

Keeping track of engine health is critical in motorsport to avoid breakdowns while pushing performance. This project shows how data can be turned into insights about engine condition during races. Can also be used to assess competitors' engine performance and reliability by analyzing publicly available race data.

Limitations & Future Work

- Synthetic temperature data is an approximation and should be replaced with real sensor data if available.
- More detailed event detection, such as lap-by-lap breach counts and early detection of component degradation to prevent complete failure, could improve analysis.
- Realistic degradation models for engine components, including turbocharger, battery, and MGU-K parameters, could enhance the health assessment and provide more accurate data to help teams decide when to change components.
- Packaging the tool into a user-friendly interface or automated reporting system would enhance practical usability.

Conclusion

This project demonstrates how raw race telemetry can be processed to provide actionable engine health insights, reflecting a simplified but effective model of real-world monitoring. It lays the foundation for deeper data-driven approaches in power unit performance and reliability management.