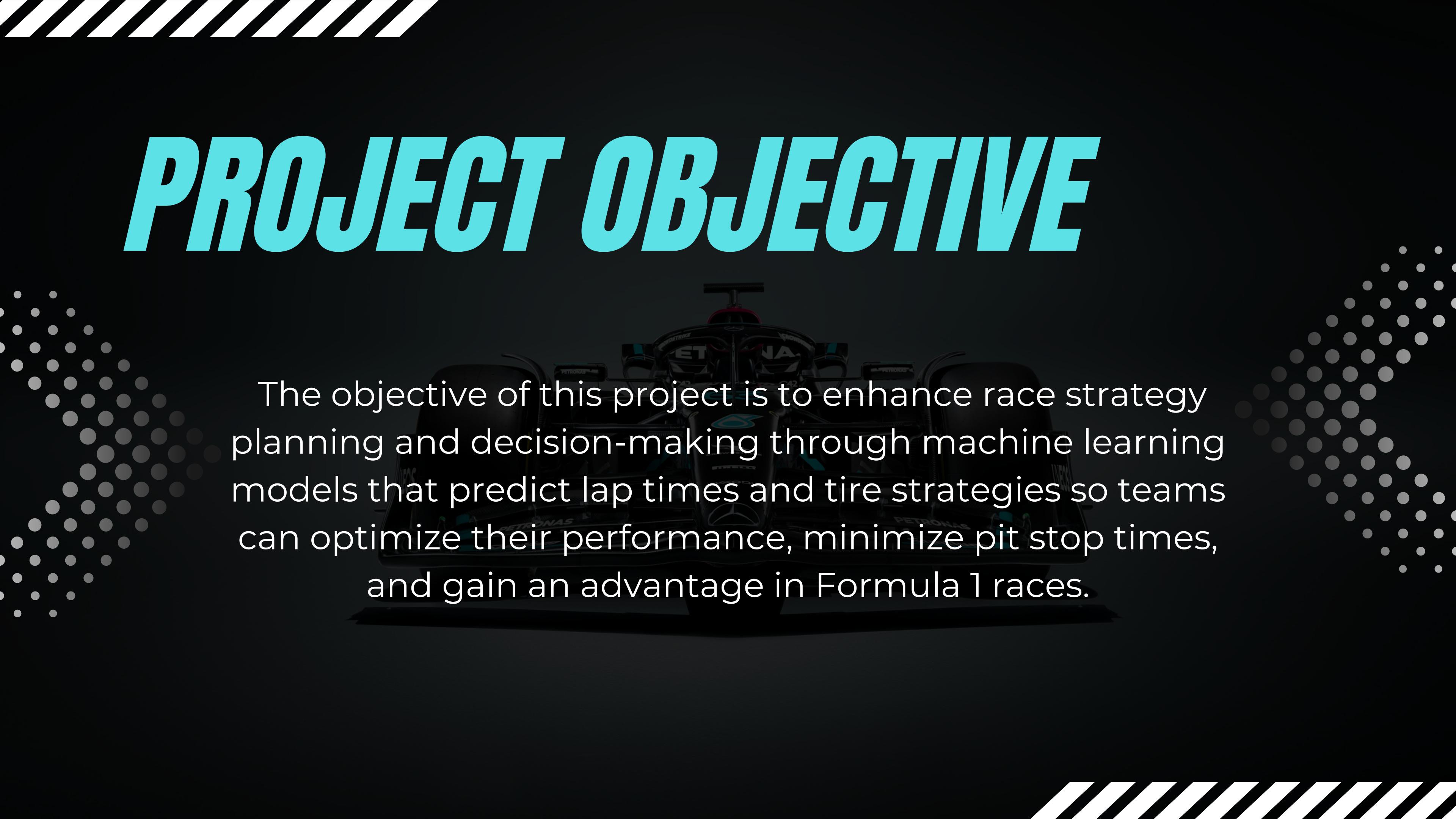


BY: KARINA & ABHI

FORMULA 1 RACE ANALYSIS



PROJECT OBJECTIVE



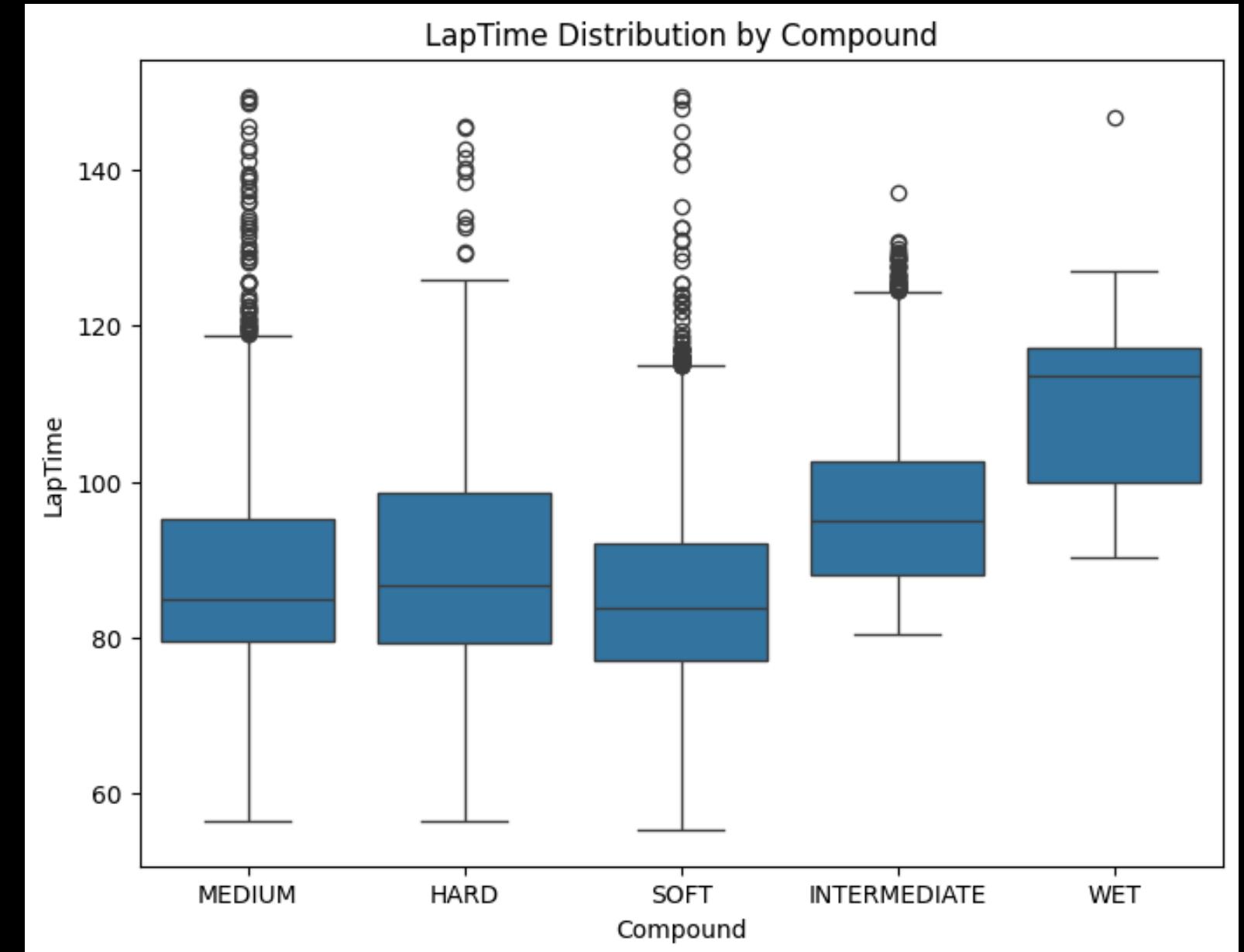
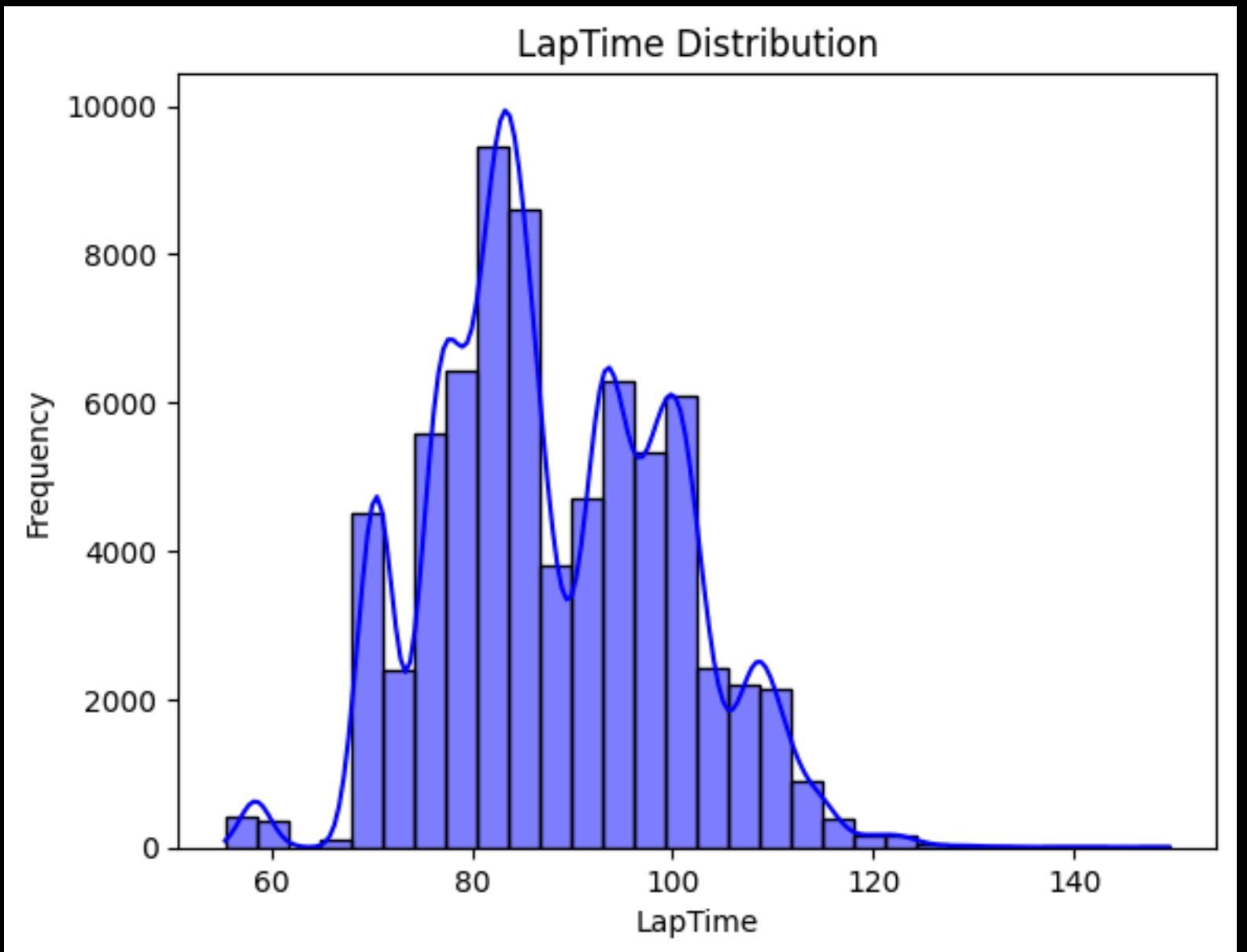
The objective of this project is to enhance race strategy planning and decision-making through machine learning models that predict lap times and tire strategies so teams can optimize their performance, minimize pit stop times, and gain an advantage in Formula 1 races.

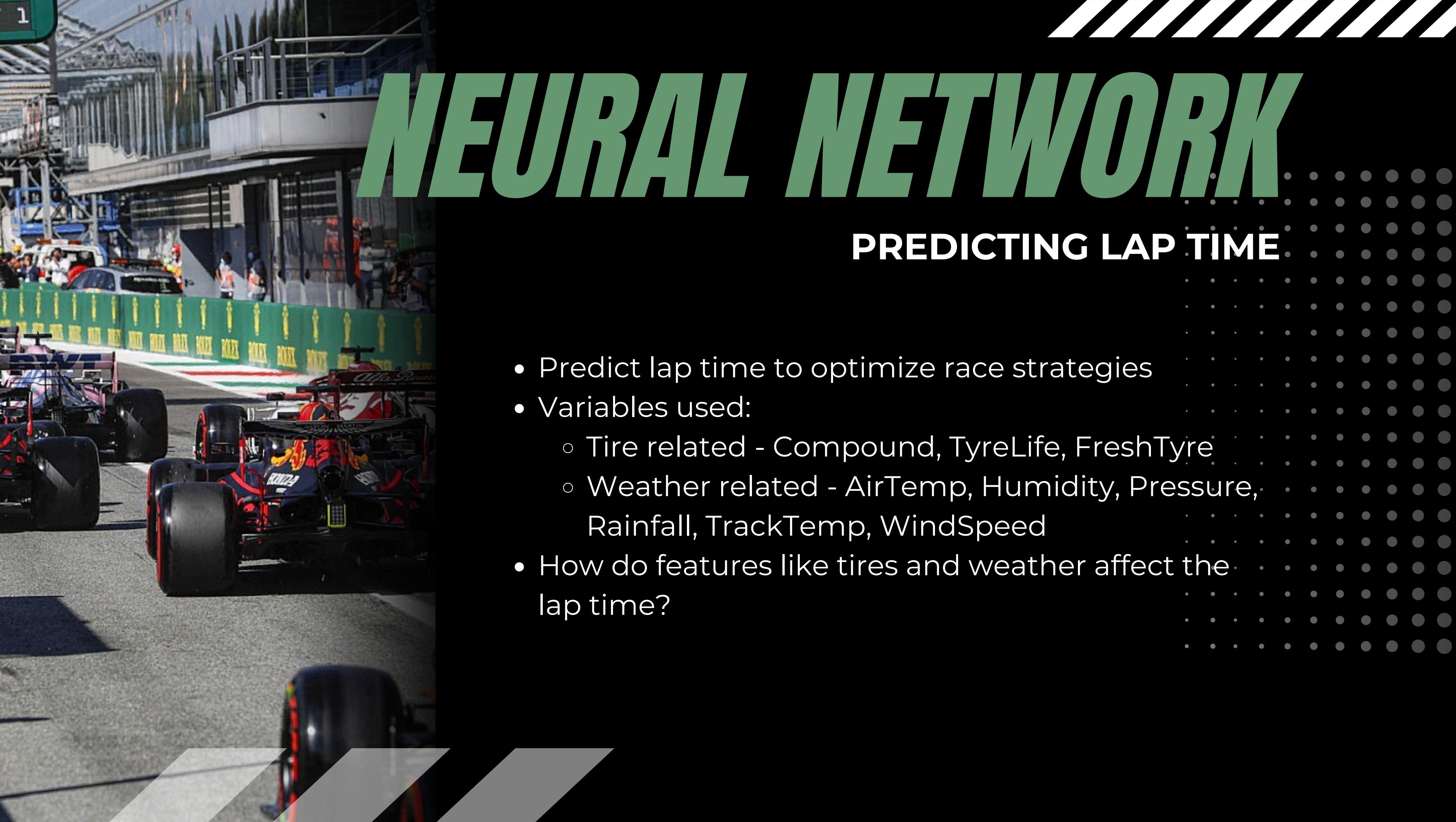
- FastF1 Library/API
 - Lap Data
 - Weather Data
- - Project-Specific Data Cleaning
 - Inconsistent Data Types
 - Domain Knowledge is useful!

THE DATA



SUMMARY PLOTS





NEURAL NETWORK

PREDICTING LAP TIME

- Predict lap time to optimize race strategies
- Variables used:
 - Tire related - Compound, TyreLife, FreshTyre
 - Weather related - AirTemp, Humidity, Pressure, Rainfall, TrackTemp, WindSpeed
- How do features like tires and weather affect the lap time?

DATA CLEANING & PRE-PROCESSING

- Handled missing values
- One hot encoded categorical features
 - Type of tire ('Compound')
- Standardized continuous features
- Split data into training and testing sets (80/20)



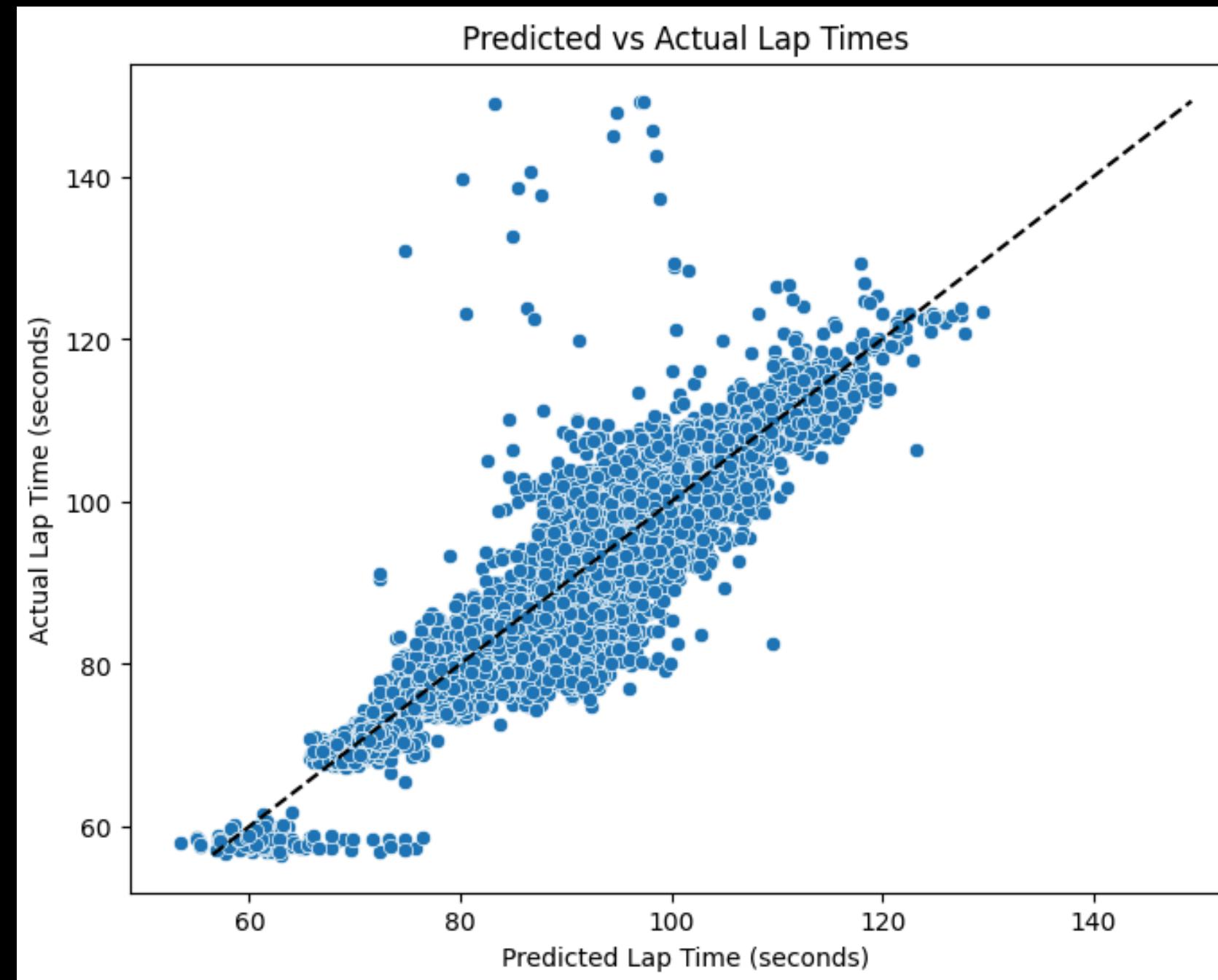
ARCHITECTURE OF

THE NEURAL NETWORK

- Feedforward Neural Network
 - good for tabular, structured data that does not have sequential dependencies
- Layers - 4 total to avoid overfitting but still capture complex non-linear relationships
 - 1 input layer
 - 3 hidden layers (128, 64, 32)
 - 1 output layer
- 100 epochs
 - when the model converged (loss decreased steadily)
- Optimizer
 - adam
 - learning rate: 0.0001 gave the model enough time to converge



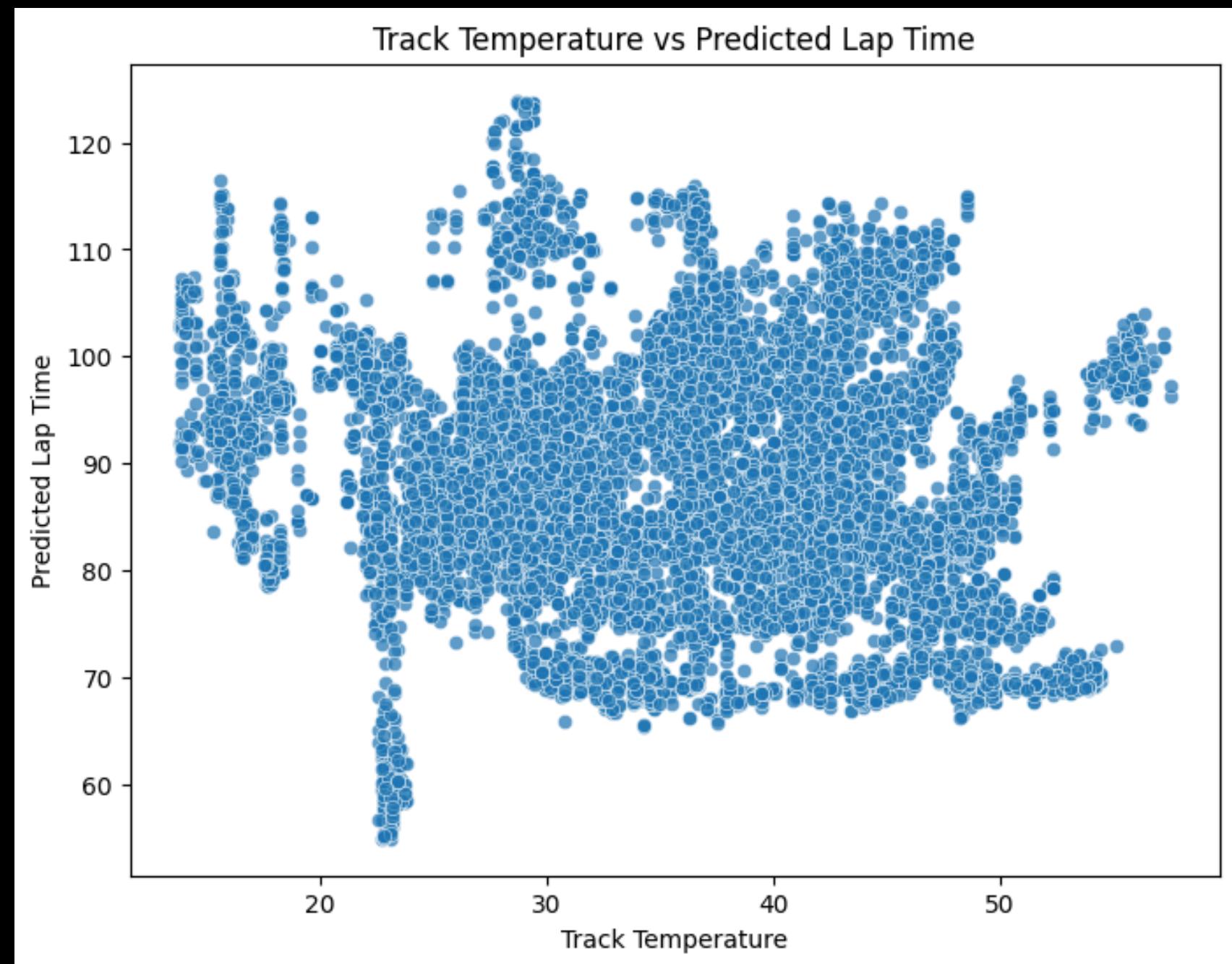
MODEL PERFORMANCE



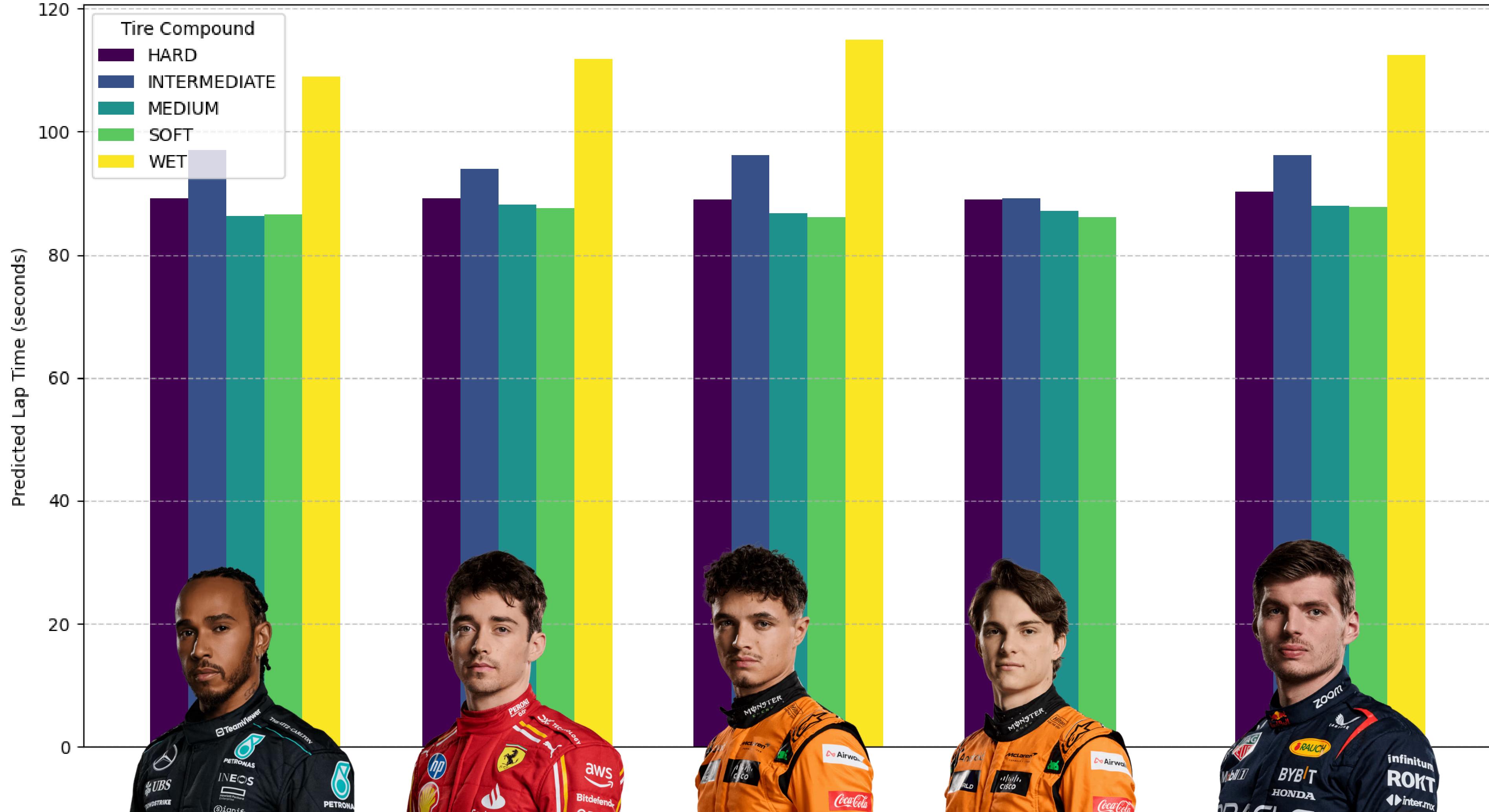
Both the training and testing MAE are ~2.6 seconds, meaning the model's predictions are off by about 2.6 seconds.

The average error in predicting the lap time is about 4.04 seconds (test RMSE)

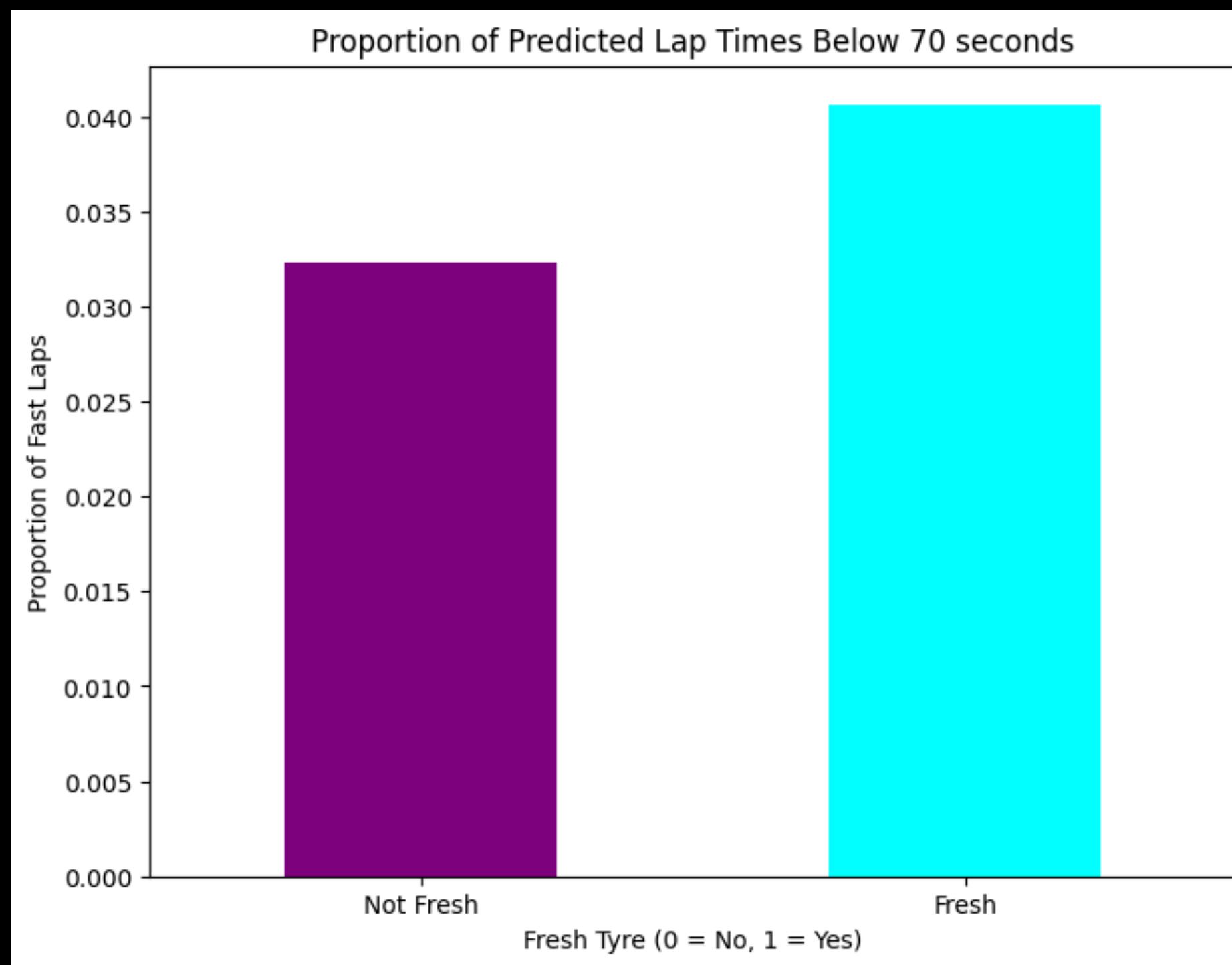
EXAMPLES OF USES



Comparison of Predicted Lap Times for Some Popular Drivers by Tire Compound



EXAMPLES OF USES



Overall, the model is decently accurate but has room for improvement.

Since different events vary in lap length by a bit, in the future, I could create multiple models for each event and then average those results. Additionally, I could train on one event to fine-tune the others that have less data.

FINAL THOUGHTS



LSTM

PREDICTING TIRE STRATEGY

- Predict Tire Compound for the next pit stop
 - Tire Data (Compound, Stint)
 - Telemetry Data (Speed, Lap Times etc.)
 - Weather Data (Track Temp, Air Temp etc.)
- What is the best tire for a certain track in a certain year?
 - Tire Degredation
 - Car-Specific Effects
 - Grid Specific Effects

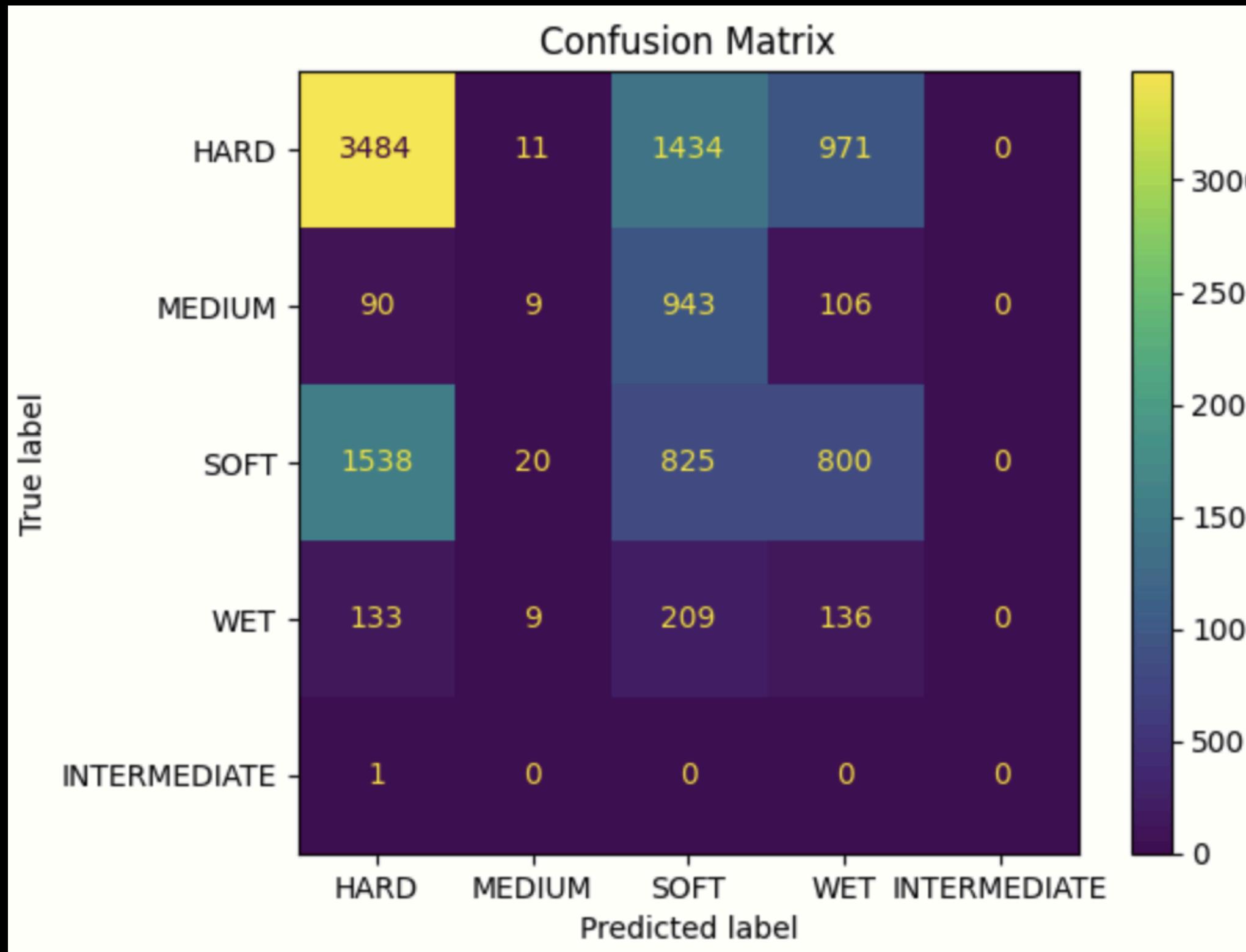


DATA CLEANING & PRE-PROCESSING

- OneHotEncoding
 - Tire Compound Types
- LabelEncoding
 - Driver/Event Pairs
- MinMaxScaling for continuous variables

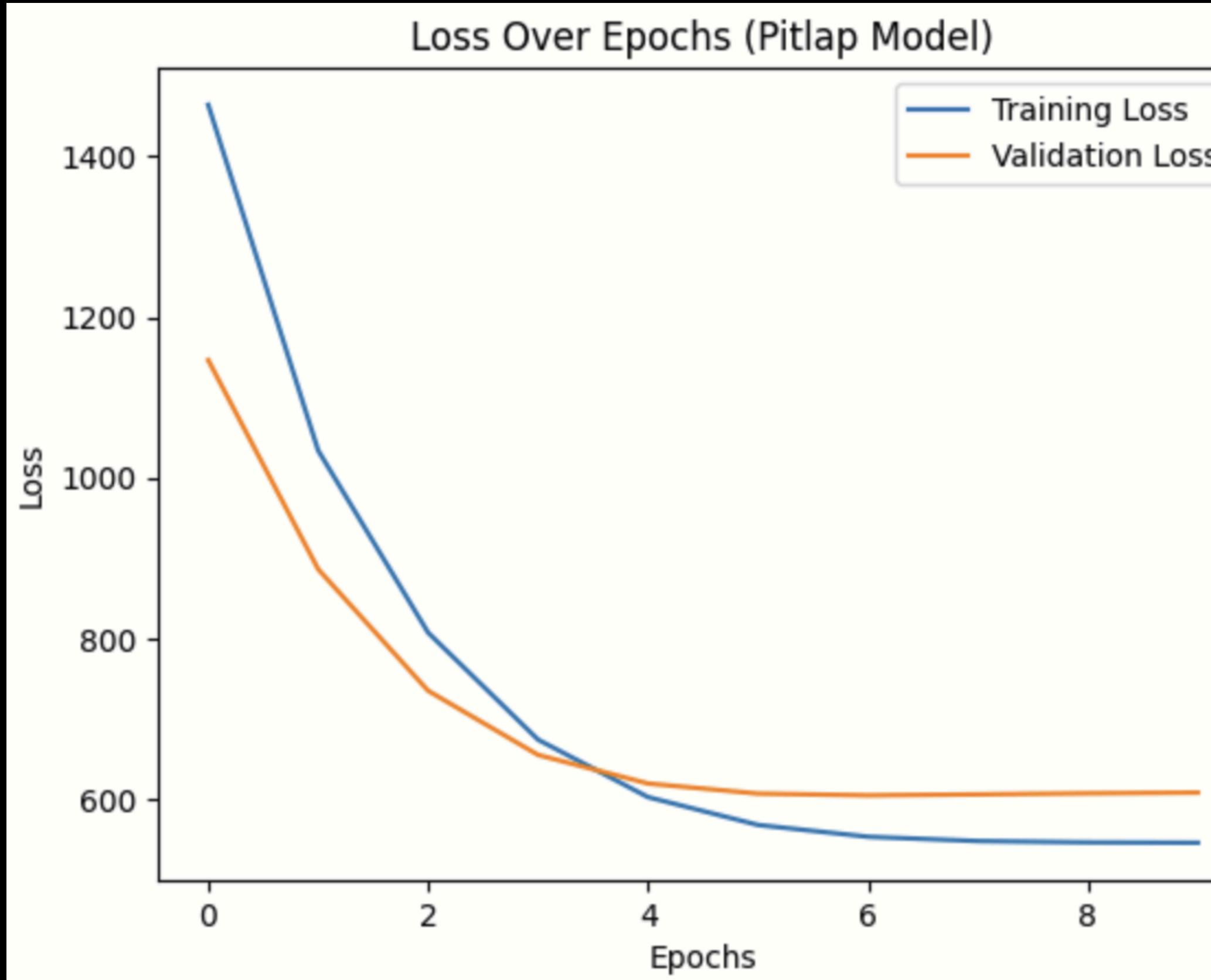


MODEL PERFORMANCE



- Model is amazing at recognizing Hard tires
- Model is awful at recognizing Medium Tires
- Lack of data for Inters/Wets

MODEL PERFORMANCE



- No over-fitting/under-fitting
- High Loss
- Difficult to use the model in real life
- Potential Fix
 - More focused dataset