

Chapter 10

Explainable AI for Fuel and Energy Consumption: A Meta-Deep Learning Approach for Sustainable Vehicle Analytics



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Abstract The global surge in vehicle usage has amplified concerns surrounding fuel resource depletion, environmental pollution, and the need for vehicle performance optimization. With transportation accounting for a significant share of fuel and energy consumption, it is imperative to adopt intelligent solutions for enhancing fuel efficiency and predictive maintenance. This study proposes an AI-based framework that uses deep learning (DL) models like Long Short-Term Memory (LSTM) and Gated-Recurrent Unit (GRU) with ensemble methods like XG-Boost to predict vehicle fuel and energy consumption. Our approach emphasizes feature engineering to incorporate diverse parameters, including driving behavior, environmental conditions, and vehicle-specific attributes such as gradient, wind resistance, and fuel mode. To improve prediction robustness and accuracy, outputs from these models are brought together using a meta-model based on Linear Regression. Additionally, we employ Local Interpretable Model-agnostic Explanations (LIME) which helps improve the comprehensibility and transparency of models by offering clear and transparent explanations about the factors that affect predictions. Experimental results demonstrate that our unified approach effectively addresses the limitations of existing methods, offering a scalable, accurate, and interpretable solution for predicting fuel and energy consumption.

Keywords Artificial Intelligence · Fuel and energy efficiency · Meta-model · Feature engineering · Explainable AI · LIME

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