Explainable AI with EDA for V2I path loss prediction

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Abstract

Accurate pathloss (PL) prediction is essential for reliable Vehicle-to-Infrastructure (V2I) communication, particularly in dense urban environments characterized by mobility, multipath effects, and complex street geometries. Traditional empirical models often fail to capture these variations, while black-box machine learning (ML) methods lack transparency, limiting their suitability for safety-critical V2X applications. This paper proposes a fully explainable V2I PL prediction framework that integrates Exploratory Data Analysis (EDA), optimized Kalman filtering, and inherently interpretable ML models, including Explainable Boosting Machines (EBM), Generalized Additive Models (GAM), and Generalized Neural Additive Models (GNAM). The framework is validated using a large-scale dataset of 24 heterogeneous urban scenarios and evaluated through 5-fold cross-validation and multi-seed runs. Results show that interpretable models offer competitive accuracy compared to black-box approaches while providing robust global and local explanations of feature contributions. The study also discusses computational

considerations, real-time feasibility, and ethical aspects relevant to practical V2X deployment. The proposed framework demonstrates high potential for transparent and trustworthy PL prediction in future 5G/6G V2I systems. © The Author(s) 2026.

Author keywords

Channel modeling; Explainable AI (ExAI); Path loss prediction; V2I communications

Indexed keywords

EMTREE medical terms

adolescent; article; controlled study; cross validation; data analysis; explainable artificial intelligence; explainable machine learning; filtration; geometry; human; machine learning; male; prediction; urban area

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