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ENHANCING URBAN TRAFFIC FLOW THROUGH INTEGRATED OPTIMIZATION AND STATISTICAL ANALYSIS

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Urban traffic congestion is a major problem that requires advanced mathematical models for effective traffic flow management. Traditionally, regression techniques have been used to fit empirical data into traffic flow models, but recent optimization methods promise more precise and reliable models. The main objective of this study was to discuss the importance of optimization techniques in estimating speed-density parameters. This study evaluated the Greenshields, Greenberg, and Underwood traffic flow models using both regression and optimization approaches. Previous studies used regression analysis and algorithms such as an Enumeration Algorithm to obtain model parameter estimates. In this study, mathematical optimization models were introduced, and Python's SciPy optimization module was used to solve these models, ensuring robust parameter estimation. Results showed that Greenberg's optimization model had poor alignment between predicted and observed values. However, Greenshields and Underwood optimization models have provided reliable speed-density estimates compared to other methods. The optimization models integrate constraints based on speed-flow models and flow-density relations, allowing model parameters to be shaped not only by the model equation and dataset but also by these constraints. The models become more precise by introducing constraints for road conditions and establishing jam density limits.

Keywords: Enumeration algorithm, Mathematical optimization, Regression analysis, Traffic flow models, Urban traffic