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Statistically Accurate Synthetic Data Generation for Enhanced Traffic Predictive Modeling Using Generative Adversarial Networks and Long Short-Term Memory

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Abstract : Effective traffic management and infrastructure planning are crucial for the development of smart cities and intelligent transportation systems. This study addresses the challenge of data scarcity by generating realistic synthetic traffic data using the PeMS-Bay dataset, improving the accuracy and reliability of predictive modeling. Advanced synthetic data generation techniques, including TimeGAN, GaussianCopula, and PAR Synthesizer, are employed to produce synthetic data that replicates the statistical and structural characteristics of real-world traffic. Future integration of Spatial-Temporal Generative Adversarial Networks (ST-GAN) is planned to capture both spatial and temporal correlations, further improving data quality and realism. The performance of each synthetic data generation model is evaluated against real-world data to identify the best models for accurately replicating traffic patterns. Long Short-Term Memory (LSTM) networks are utilized to model and predict complex temporal dependencies within traffic patterns. This comprehensive approach aims to pinpoint areas with low vehicle counts, uncover underlying traffic issues, and inform targeted infrastructure interventions. By combining GAN-based synthetic data generation with LSTM-based traffic modeling, this study supports data-driven decision-making that enhances urban mobility, safety, and the overall efficiency of city planning initiatives.

Keywords : GAN, long short-term memory, synthetic data generation, traffic management
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