SPATIO TEMPORAL MAMBA DYNAMIC GRAPH CONVOLUTIONAL RECURRENT NETWORK FOR TRAFFIC PREDICTION

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Abstract

Accurate traffic prediction is a critical component of intelligent transportation systems and smart city infrastructure. Traffic flow exhibits complex spatio-temporal dependencies, where conditions at one location influence neighboring regions and evolve dynamically over time. Traditional statistical and machine learning approaches often fail to capture these nonlinear and graph-structured relationships effectively. Although recent deep learning models such as Graph Neural Networks (GNNs) and Transformer-based architectures have improved forecasting performance, many rely on static adjacency structures or incur high computational costs for long-sequence modeling. This paper proposes A Spatio-Temporal Mamba-Based Dynamic Graph Convolutional Recurrent Network for Traffic Prediction for multi-step traffic prediction. The model integrates dynamic graph learning, graph convolution, selective state-space temporal modeling, and recurrent forecasting into a unified architecture. The dynamic graph learner adaptively estimates time-varying adjacency matrices to capture evolving spatial dependencies between traffic sensors. The graph convolution module aggregates spatial information across nodes, while the Mamba-style selective state-space block efficiently models long-range temporal dependencies with linear computational complexity. A GRU-based forecasting head stabilizes multi-step prediction and generates future traffic speed estimates.The system is implemented using PyTorch and validated on synthetically generated multi-node traffic data that simulates congestion waves and spatial interactions. Experimental results demonstrate stable convergence, improved multi-horizon forecasting performance, and effective modeling of dynamic spatial-temporal relationships. Compared to traditional and static graph- based methods, the proposed framework offers enhanced adaptability, scalability, and computational efficiency.