Adaptive Neural Network Strategies for Optimizing Traffic Flow in Smart Cities: An AI-Driven Approach

Skyler Hernandez
PhD
Technische Universität München
Arcisstraße 21, 80333 München, Germany

Robin Clark
Associate Professor
Massachusetts Institute of Technology
77 Massachusetts Ave, Cambridge, MA 02139, USA

Ashley Young
Professor
University of Toronto
27 King's College Cir, Toronto, ON M5S, Canada

Casey White
Dr. Sc
KTH Royal Institute of Technology
Brinellvägen 8, 100 44 Stockholm, Sweden

Abstract. The increasing global urbanization and subsequent traffic congestion pose significant challenges to modern cities. This paper addresses these challenges by proposing adaptive neural network strategies that leverage real-time traffic data to optimize traffic flow within smart city environments. We employ a combination of deep learning techniques and reinforcement learning to develop a model that dynamically adjusts traffic signal timings based on real-time vehicular patterns. Our results indicate a notable reduction in average vehicle delay and overall congestion, demonstrating the potential of AI-driven solutions to enhance urban mobility. The findings underscore the importance of integrating advanced machine learning approaches to address complex urban traffic issues effectively.

Keywords: Artificial Intelligence, Neural Networks, Traffic Optimization, Smart Cities, Real-time Data Analytics, Urban Mobility, Machine Learning, Reinforcement Learning

Introduction

As urban populations soar worldwide, cities face unprecedented challenges in managing traffic congestion and ensuring efficient transportation systems. Current estimates suggest that by 2026, urban areas will house nearly 68% of the global population, exacerbating issues such as increased commute times, air pollution, and reduced quality of life.

Traditional traffic management systems, which often rely on fixed signal timings and periodic manual adjustments, are proving inadequate in adapting to the complexities of modern urban mobility patterns. The rise of smart cities offers a promising avenue for utilizing artificial intelligence (AI) to address these pressing issues effectively. This paper aims to present a novel approach utilizing adaptive neural networks for optimizing traffic flow in smart cities. By integrating real-time data analytics and machine learning techniques, we propose a dynamic traffic management system capable of understanding and responding to fluctuating traffic conditions. The innovative aspect of our approach lies in its incorporation of deep reinforcement learning, allowing the model to learn from real-world usage patterns and continually improve its performance over time. The paper is structured as follows: we begin with a review of the existing literature on traffic optimization techniques and AI applications in urban planning. Subsequently, we detail the methodologies employed in developing our adaptive neural network model, including data collection, processing, and the learning algorithms utilized. We then present our results, analyzing the effectiveness of our model against traditional traffic management systems. Finally, we discuss the implications of our findings for urban planning and potential future work in this area. This research contributes to the ongoing discourse on smart city development and highlights the transformative role of AI in creating sustainable urban environments.

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