A Comparative Analysis of Multi-Modal Transportation Network Resilience: Evaluating Stochastic Dynamic Traffic Assignment Algorithms

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Abstract. This study examines the resilience of multi-modal transportation networks through a comparative analysis of stochastic dynamic traffic assignment algorithms. By incorporating real-time data and predictive modeling, the research offers insights into optimizing traffic flow and enhancing network robustness. Findings indicate that advanced algorithms significantly improve transportation efficiency under varied conditions. The study contributes to the field by providing a framework for evaluating algorithm efficacy in complex urban environments.

Keywords: Multi-modal transportation, Traffic assignment algorithms, Network resilience, Stochastic modeling, Urban transportation systems, Dynamic traffic management

Introduction

The increasing complexity of urban transportation systems has underscored the critical need for resilient networks capable of withstanding various disruptions—from natural disasters to sudden traffic surges. In recent years, the focus on optimizing multi-modal transportation networks has intensified, driven in part by the growing urban populations and the consequent pressure on infrastructure. The integration of various transportation modes, including public transit, cycling, and pedestrian systems, requires sophisticated planning and dynamic management strategies to ensure seamless operation under fluctuating conditions. Stochastic dynamic traffic assignment (SDTA) algorithms have emerged as pivotal tools in addressing these challenges, offering a means to model and predict traffic patterns with unprecedented accuracy. These algorithms utilize real-time data inputs to simulate traffic flow and re-routing in response to network disruptions, thus enhancing overall system resilience. This paper delves into a comparative analysis of competing SDTA algorithms, evaluating their performance in optimizing traffic distribution and minimizing congestion across diverse transportation scenarios. The methodologies employed in this research include a comprehensive review of existing algorithm frameworks, empirical testing using simulated urban environments, and a multi-criteria evaluation approach to determine algorithm efficiency. The structure of this paper is organized as follows: Section II discusses the theoretical background and related works on SDTA algorithms. Section III outlines the research methodology employed in our comparative analysis. Section IV presents the detailed results and discussion, highlighting key findings and their implications for urban planning. Finally, Section V concludes with a summary of contributions and future research directions.

References

1. Yu Timkina, S., Stepanchuk, O. V., & Bieliatynskyi, A. A. (2019, December). The design of the length of the route transport stops' landing pad on streets of the city. In IOP Conference Series: Materials Science and Engineering (Vol. 708, No. 1, p. 012032). IOP Publishing.