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Weighted complex network analysis of the Beijing subway system: train and passenger flows

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Abstract. In recent years, complex network theory has become an important approach to the study of the structure and dynamics of traffic networks. However, because traffic data is difficult to collect, previous studies have usually focused on the physical topology of subway systems, whereas few studies have considered the characteristics of traffic flows through the network. Therefore, in this paper, we present a multi-layer model to analyze traffic flow patterns in subway networks, based on trip data and an operation timetable obtained from the Beijing Subway System. We characterize the patterns in terms of the spatiotemporal flow size distributions of both the train flow network and the passenger flow network. In addition, we describe the essential interactions between these two networks based on statistical analyses. The results of this study suggest that layered models of transportation systems can elucidate fundamental differences between the coexisting traffic flows and can also clarify the mechanism that causes these differences.

Keywords. Complex systems; Traffic flow patterns; Directed network; Weighted network; Subway

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1. Introduction

Complex network theory is a research field that is concerned with the connections and interactions among components in a system, and it has offered an important approach to study the structure and dynamics of traffic systems. Recently, significant efforts have been made to understand public transport systems because of their increasing importance to ever denser populations.

Among public transport systems, subway systems offer a solution to problems associated with urban traffic congestion, providing frequent safe journeys to a large number of passengers in a short period of time [1, 2]. Subway system networks comprise a set of routes

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