Predictive dynamic relocations in carsharing systems implementing complete journey reservations

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Abstract

We study the operation of station-based one-way carsharing systems that enforce a complete journey reservation policy. Under such regulation, users are required to reserve both a vehicle at the origin station and a parking spot at the destination station during the booking time. Reservations can be made up to one hour in advance and users are not required to specify in advance the exact pick-up and drop-off times. These rental conditions are attractive to customers as they guarantee the availability of vehicles and parking spots at the start and end of the customers' journeys. Nevertheless, this policy may also result with inefficient use of resources due to long vehicle/parking spot reservation durations. From the operator's point of view, vehicle/parking spot reservations provide information about parking spots/vehicles that are about to become available. Integrating such information in the relocation decision process may improve the performance of the system significantly. In this work, we develop a single-station Markovian model that incorporates journey reservation information in the state representation and utilizes historical data to estimate expected near future demand loss at every station. The output of the model is integrated in a new proactive dynamic staff-based relocation algorithm that makes real-time relocation decisions. A collaboration with the Grenoble carsharing system has allowed us to test in field the proposed algorithm and compare it to other dynamic and static relocation approaches. The efficiency of the algorithm is further demonstrated through an extensive simulation experiment based on real transaction data obtained from the Grenoble system.

Keywords: simulation, Markov chain, carsharing

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