User-based relocation strategies in free-floating car-sharing systems

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Abstract

Free-floating car-sharing (FFCS) systems provide a promising way to reduce the traffic volume in cities sustainably. However, the efficiency of FFCS systems, measured by the daily operation time of the vehicles, is still very low. This is mainly due to a spatial (and temporal) mismatch of demand and available vehicles. For FFCS systems, active relocation derogates the operators profit significantly and causes additional traffic and emissions. In this course, environmentally friendly and cost efficient relocation strategies for FFCS systems are still missing. In this context, matching demand and supply by slightly changing the drop-off point of cars by incentivizing user behavior seems to be a promising option. Against this background, we introduce the Car-Sharing Relocation Problem with flexible drop-offs (CSRP-FDO) that accounts for relocating vehicles in FFCS fleets by utilizing the price sensitivity of users to change their drop-offs in a spatial or a temporal fashion. The CSRP-FDO is used to find an optimal relocation strategy for a given fleet with vehicle requests, using user price sensitivity most beneficially. We model the CSRP-FDO as a k-shortest disjoint paths problem and employ the Suurballe algorithm to solve large sized instances. We present new benchmark instances for the CSRP-FDO to assess the competitiveness of our algorithm. Furthermore, we present a case study based on real world data to derive managerial insights on user-based relocation strategies. In this context, we highlight the benefit of different modes of user-based relocation focusing on the reduction of both, temporal and spatial mismatches.

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