A Bike-sharing Optimization Framework Combining Dynamic Rebalancing and User Incentives

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Bike-sharing systems have become an established reality in cities all across the world and are a key component of the Smart City paradigm. However, the unbalanced traffic patterns during rush hours can completely empty some stations, while filling others, and the service becomes unavailable for further users. The traditional approach to solve this problem is to use rebalancing trucks, which take bikes from full stations and deposit them at empty ones, reducing the likelihood of system outages. Another paradigm that is gaining steam is gamification, i.e., incentivizing users to fix the system by influencing their behavior with rewards and prizes. In this work, we combine the two efforts and show that a joint optimization considering both rebalancing and incentives results in a higher service quality for a lower cost than using simple rebalancing. We use simulations based on the New York CitiBike usage data to validate our model and analyze several schemes to optimize the bike-sharing system.

CCS Concepts: • **Information systems** → **Location based services**; • **Networks** → *Location based services*; • **Theory of computation** → *Network flows*;

Additional Key Words and Phrases: Bike sharing, rebalancing, gamification

ACM Reference format:
Federico Chiariotti, Chiara Pielli, Andrea Zanella, and Michele Zorzi. 2020. A Bike-sharing Optimization Framework Combining Dynamic Rebalancing and User Incentives. *ACM Trans. Auton. Adapt. Syst.* 14, 3, Article 11 (February 2020), 30 pages.
https://doi.org/10.1145/3376923

1 INTRODUCTION

Bike sharing is a key component of the emerging Smart City paradigm [46]: Bike-sharing services offer more flexibility than standard public transportation, while reducing both vehicular traffic [45] and its impact on the environment [19] and improving public health [38]. Such services leverage technology to identify users, track the paths they cover, and provide real-time information on the current bike availability through, e.g., smartphone applications. Sensors embedded in the bikes and in the docking stations enable the collection of real-time data that can be used in the short term to dynamically adapt the service to the current needs of users and, in the long-term, to enhance the system by adding bikes or stations where they are more needed and plan new bike lanes to cover the most common routes [1].

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1556-4665/2020/02-ART11 $15.00
https://doi.org/10.1145/3376923