A New Parking Space Allocation System based on a Distributed Constraint Optimization Approach

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Abstract: This paper develops and evaluates a new decentralized mechanism for the allocation of parking slots in downtown, using a distributed constraints optimization approach (DCOP). Our mechanism works with the multi-parking/multi-zone model, where vehicles are connected and can exchange information with the distributed allocation system. This mechanism can reach the minimal allocation costs where vehicles are assigned to the parking lots with the best possible aggregated user costs. The cost is calculated based on driver's aggregated preferences over slots. We empirically evaluated the performance of our approach with randomly generated costs and tested on three different configurations. The evaluation shows the performance of each configuration in terms of runtime and volume of exchanged data.

1 INTRODUCTION

Parking demand is determined by the attractiveness of the destination, with city centers being the most attractive areas. These areas are experiencing a growing shortage of parking places, and drivers generally need to spend a significant amount of time circling the blocks around their destination searching and waiting for available parking spaces. In this problem, the difficulty lies in the fact that the requirements and the destinations of the drivers vary from one driver to another. Many works have been carried on to deal with this last issue. For instance, (Zeenat et al., 2018) proposed a multiple criteria based parking space reservation algorithm that can be used to reserve a space for users, and to deal with their requirements in a fair way by using the normalized weighting of each criteria score for all options relating to each user's profile. In (Boudali and Ouada, 2017), the authors proposed a system that handles user's preferences by ensuring an online space allocation based on real-time information and by optimizing driver's preferences with respect to a set of operational constraints, such as, the bound on parking fees, bounds on distances, time interval that have to be satisfied for each reservation, etc. In (Ayala et al., 2011), the authors proposed to allocate parking slots via negotiations. This work uses a game theoretic approach to allocate the suitable place for the suitable vehicle, or the shortest way to the suitable spot via a routing algorithms (Hedderich et al., 2017), or via smart reservation system as in (Kazi et al., 2018). All these works, each in its own way, claim to reduce the traffic in urban areas, and to alleviate its negative related effects, from the reduction of air pollution, the reduction of fuel consumption, to the reduction of cursing time, social anxiety, etc. Besides, with the advent of IoT technology, the proliferation of smart-phones, and on-board navigation systems, it is already possible for a user to be linked in a real-time with parking space allocation applications that lead their users to the best possible spot to park. In this paper, we study the setting up of a parking management system to respond without a centralized control to parking requests in downtown parking areas, with the aim of limiting both the time of response and the cost of communication. Indeed, commercial fleet management solutions that require real-time data collections and exploitation, especially in the Cloud like parking allocation, carpooling, become rapidly costly depending on the rate of the data collections and the volume of data to be processed (Picard et al., 2018). We thus focus on finding efficient solutions for the allocation of parking slots. To that end, we formulate the problem as a distributed

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