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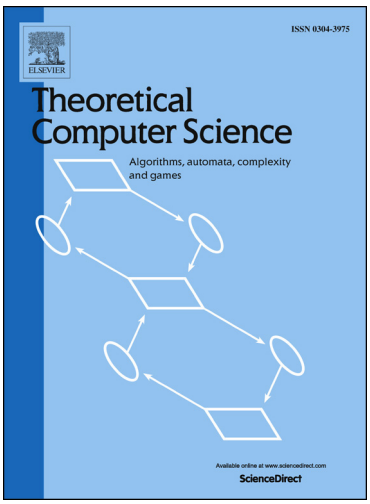

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Algorithmic Analysis for Ridesharing of Personal Vehicles [1]

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Abstract: The ridesharing problem is to share personal vehicles by individuals with similar itineraries. A trip in the ridesharing problem is an individual and his/her itinerary. To realize a trip is to deliver the individual to his/her destination by a vehicle satisfying the itinerary requirement. Major optimization goals in the ridesharing problem include minimizing the number of vehicles and minimizing the total travel distance of vehicles to realize all trips. There are many parameters in the minimization problems, making them complex and NP-hard. The problems can be simplified by considering only some of the parameters. We give an algorithmic analysis for the simplified minimization problems and explore a boundary between the NP-hard and polynomial time solvable cases. We prove that the simplified minimization problems, where only the source, destination, vehicle capacity, detour distance and preferred path parameters are considered, are still NP-hard. We show that the simplified problem of minimizing the the number of vehicles becomes polynomial time solvable if the considered parameters satisfy certain conditions. These suggest a boundary between the NP-hard and polynomial time solvable cases.

Key words: Ridesharing problem, algorithmic analysis, optimization algorithms

1 Introduction

The ridesharing problem is the shared use of personal vehicles by individuals who have similar itineraries. When a vehicle is selected to serve any individual, the owner of the vehicle is called a *driver* and an individual other than a driver is called a *passenger*. Ridesharing can save the total cost of all drivers and passengers, reduce traffic congestion, conserve fuel, and reduce air pollution [6, 14, 15]. Despite the advantages of ridesharing, according to [8], the share of personal vehicles has decreased by almost 10% in the past 30 years. The average occupancy rate of personal vehicles is 1.6 persons per vehicle mile based on reports published in 2011 [10, 16]. Currently, ridesharing coordination is not fully regulated and organized in the industry. Major obstacles that prevent ridesharing from being widely adopted include the lack of efficient and convenient methods to arrange vehicles for drivers and passengers, privacy, safety, social discomfort, and pricing. Some of these issues can be addressed by introducing reputation building system, profiling, or preferences [10]. With today's technology in GPS and smartphone, Internet-enabled mobile devices should

[1] A preliminary version of the paper appeared in the Proc. of the 10th Annual International Conference on Combinatorial Optimization and Applications (COCOA 2016) [11].