

Research Article

Multiagent Reinforcement Learning-Based Taxi Predispatching Model to Balance Taxi Supply and Demand

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With the improvement of people's living standards, people's demand of traveling by taxi is increasing, but the taxi service system is not perfect yet; taxi drivers usually rely on their operational experience or cruise randomly to find passengers. Without macroguidance, the role of the taxi system cannot be fully utilized. Many scholars have studied taxi behaviors to find better operational strategies for drivers, but their researches rely on local optimization methods to improve the profit of drivers, which will lead to imbalance between supply and demand in the city. To solve this problem, we propose a Multiagent Reinforcement Learning- (MARL-) based taxi predispatching model through analyzing the running data of 13,000 taxis. Different from other methods of scheduling taxis based on the real-time location of orders, our model first predicts the demand for taxis in different regions in the next period and then dispatches taxis in advance to meet the future requirement; thus, the number of taxis needed and available in different regions can be balanced. Besides, in order to reduce computational complexity, we propose several methods to reduce the state space and action space of reinforcement learning. Finally, we compare our method with another taxi dispatching method, and the results show that the proposed method has a significant improvement in vehicle utilization rate and passenger demand satisfaction rate.

1. Introduction

Smart city, an emerging technology, which aims to apply the new generation of information and communication technology to all walks of life in the city, is able to alleviate the "big city disease" [1], coordinate urban development, and improve the running efficiency of the city and the quality of citizens' life [2]. Intelligent transportation [3, 4], as an indispensable part of a smart city, aims at improving the operation efficiency of transportation systems, making full use of transportation resources, and ensuring traffic safety [5]. It plays a vital role in citizens' lives and the operation of the whole city. Nowadays, traffic congestion, frequent accidents, energy waste, air pollution, and other problems commonly exist in cities and they can be well solved by intelligent transportation [6, 7].

With the rapid development of wireless communication technology and the Internet of Things (IoT), collecting the trajectory records of mobile objects becomes simple and fast,

which makes intelligent transportation possible [5, 8]. Various devices embedded with GPS are ubiquitous in our lives, such as smartphones [9, 10], private cars [11, 12], and public transport [13]. Location information can be obtained more easily, and a large number of trajectory data are collected every day. Trajectory data has spatial attributes as well as temporal attributes; it becomes the main research object of spatiotemporal data mining technology. The application of trajectory data can not only provide location-based services for users, but also help urban planning and intelligent transportation. Gathering and analyzing these large-scale real-world digital traces have provided us with an unprecedented opportunity to grasp the city dynamics and understand the social and economic patterns better [14–16].

However, the corresponding operation strategy did not develop with the increase of the number of taxis, there are still many shortcomings, such as the difficulty in finding taxis in peak hours, uneven distribution of taxis, and the drivers' refusal of service [17]. Taxi drivers' strategies of

