연구논문/작품 제안서

2020년도 제 2학기

논문/작품	○논문(v) ○작품( ) ※ 해당란에 체크
제목	Factors guaranteeing QoS in shared bus scheduling
GitHub URL	https://github.com/jwl317/2020thesis
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1. Abstract

If one is working or studying in a field of smart cities, Public Vehicle (PV) system is one of the topics that he/she cannot miss. Unlike any other transportation system, PV system, such as a shared bus, can serve groups of passengers from different pick-up locations to drop-off locations. Meanwhile, shared bus scheduling comes to an issue. Previous research papers tried to provide algorithms for the most efficient and fastest path from source to destination with minimum travel time, travel distance and energy cost. However, Quality of Service (QoS) cannot be guaranteed. In this paper, factors that can guarantee QoS are investigated and a simulation model is created on OMNeT++ with Veins and SUMO.

2. Introduction

Shared bus scheduling problem is an evolutionary problem that solves for the most efficient path that serves many passengers from different origins to different destinations.

Shared buses are different from existing ride-sharing systems. Firstly, shared buses have a centralized system, while existing ride-sharing systems like Uber have a distributed system. Secondly, shared buses depend on a cloud for the most efficient scheduling, while existing ride-sharing systems usually depend on drivers. Thirdly, shared buses can cooperate in a network to enhance traffic efficiency, whereas existing ride-sharing systems hardly does it due to personal greed for more profit.

Travel time, travel distance and energy cost are main factors in measuring the performance of any proposed scheduling algorithms. Previous research papers have been scaled too much into computational efficiency and possibly ruled out QoS. For example, QoS factors can include number of buses, maximum number of shared persons and waiting time for request [4]. Shared bus scheduling is currently an open field. Therefore, it is meaningful to find a relationship between passenger QoS factors and shared bus system profits by creating models and running simulations on OMNeT++ with Veins and SUMO.

3. Related work

In such mobility-on-demand field, solving for the shared bus scheduling problem is challenging because it is a NP-hard problem. Existing strategies usually follow pruning and selecting scheme. For instance, like *Figure 1*, road network space is divided into cells. Buses can be located at any cells and their locations are dynamically recorded. If there is a request for a pick-up, buses nearby cells of source location will be first ones to be examined. In the pruning stage, buses that cannot satisfy the constraints of requests will be filtered out. Then most ideal buses are selected, and requests are added to their path. Xu *et al.* [3] propose more advanced algorithm *GeoPrune* that specifically focuses on "finding vehicles that satisfy the service constraints of trip requests rather than any particular optimization goal."

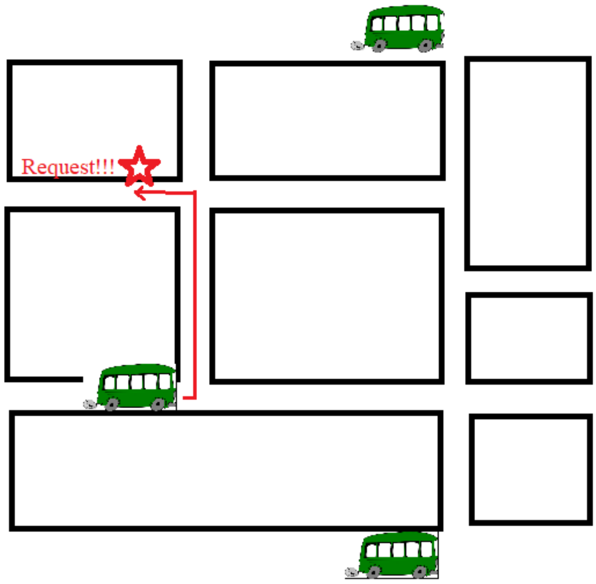

Figure 1. Self-drawn simple illustration showing shared buses driving in a road network space and nearest bus to the request source location being assigned.

Some papers are restricted to high-capacity ride sharing on large road networks. Zuo *et al.* [5] propose a "clustering-based multi-request matching and route planning algorithm *Roo*" without computing distances between nodes in advance. In particular, Mahin and Hashem [2] *propose an Activity-aware Ridesharing Group Trip Planning (ARGTP)* query on large road networks, but multiple point-of-interests (POIs) are pre-defined and used. However, all the above strategies cannot be applied in the real-world scenario where distances and points can be changed in any given time, for instance, due to road repairing.

Less research works focus on QoS. To reduce the total cost, Liu *et al.* [1] propose *Cooperative Intelligent Transport Systems (C-ITS)* to minimize the total cost of PV utilization on long distances. *C-ITS* consists of path generation methods using simple near optimal method and reset near optimal method. *C-ITS* also involves greedy based path scheduling method. On the other hand, Zhu *et al.* [4] suggest short waiting time and less detour can be factors that provide high QoS. Additionally, few PVs in a network can save travel distance at traffic peak time, but that means more passengers have to share PVs in limited space. Therefore, the number of PVs in the network can affect the level of QoS.

In summary, majority of heuristic solutions for shared bus scheduling problem are scaled to reduce the computational complexity and the total cost of PV utilization rather than enhancing QoS. Indeed, multiples of requests and allocations of shared buses are complicated. However, better solution is required that can guarantee certain level of QoS on passengers, so that more passengers can choose shared buses for transportation.

4. Plan

Here are general steps. Firstly, the basic concepts of shared bus scheduling problem will be stated. Secondly, the baselines will be selected to be used for comparing performance analysis. Thirdly, the problem formulation will take place. Conditions and constraints are defined. Fourthly, based on a hypothesis from the previous stage, a simulation model will be built on OMNeT++ with Veins and SUMO. A data set and further research are required. Fifthly, results of the simulation will be recorded and analyzed. Performance evaluation measures need to be decided and defined.

5. Expectation

Choosing an appropriate level of difficulty is quite a challenge. Previously mentioned research works will affect major parts of proposed algorithm. It is recommended to come up with many hypotheses as possible and run on simulations with some help from graduate students in CPS laboratory.

6. References

[1] Liu, Ji, et al. "Two-Phase Scheduling for Efficient Vehicle Sharing." *IEEE Transactions on Intelligent Transportation Systems* (2020).

[2] Mahin, Mehnaz Tabassum, and Tanzima Hashem. "Activity-aware Ridesharing Group Trip Planning Queries for Flexible POIs." *ACM Transactions on Spatial Algorithms and Systems (TSAS)* 5.3 (2019): 1-41.

[3] Xu, Yixin, et al. "GeoPrune: Efficiently Matching Trips in Ride-sharing Through Geometric Properties." *32nd International Conference on Scientific and Statistical Database Management*. 2020.

[4] Zhu, Ming, Xiao-Yang Liu, and Xiaodong Wang. "An online ride-sharing path-planning strategy for public vehicle systems." *IEEE Transactions on Intelligent Transportation Systems* 20.2 (2018): 616-627.

[5] Zuo, H., Cao, B., Zhao, Y. et al. High-capacity ride-sharing via shortest path clustering on large road networks. J Supercomput (2020). https://doi.org/10.1007/s11227-020-03424-6