経験的 GPS データに基づくオンライン配車の改善

Improvement on online ride-hailing based on empirical GPS data

学籍番号　47186832
氏　　名　**陳　瑾瑜**（Jinyu Chen）
指導教員　柴崎　亮介教授

Ride-hailing, as a popular shared-transportation method, has been operated in many areas all over the world. Researchers conducted various researches based on global cases. They argued on whether car-hailing is an effective travel mode for emission reduction and drew different conclusions. The detailed emission performance of ride-hailing system depends on the cases. Therefore, there is an urgent demand to reduce the overall picking up distance during the dispatch. Moreover, most of the cases only analyze the emission pattern of mature ride-hailing systems. None of them provide a change pattern of a developing one. Discovering the emission pattern during the development can help understand how number of users in the system affect the emission performance and furtherly provide guideline of controlling the number of users to keep the system at a high-performance level. In this study, we answer these two demands by proposing two frameworks. 1. A cross simulation model combined with Gibbs sampling for a comprehensive computation. The illustration of framework is shown as figure 1.

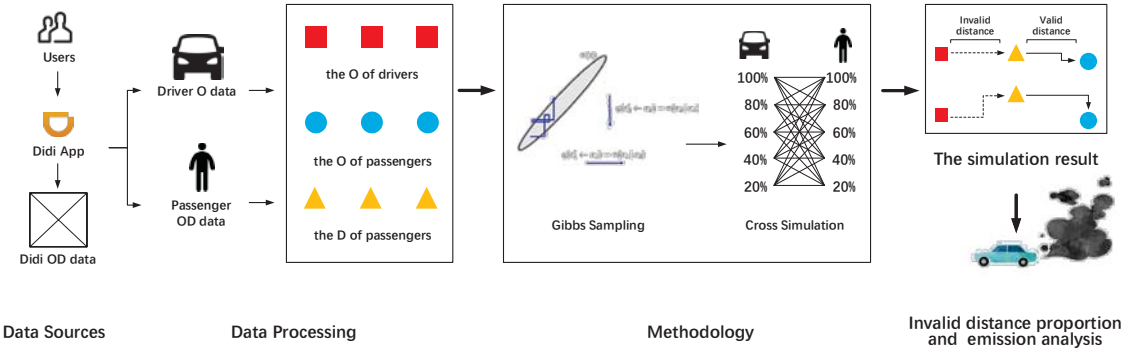


Figure 1. Flowchart of framework 1

We firstly preprocess the Didi OD ride-hailing record into driver O and passenger OD. Then we adopt Gibbs Sampling because it can generate different simulation samples and consider the issue of full sampling. Then sampled data will be fed to the reassignment algorithm for simulation. The simulation result is shown as figure 2. Based on the simulation results, we found a strong impact of user scale on the emission performance. The mean of void distance proportion varies from 3.69% to 31.75% under

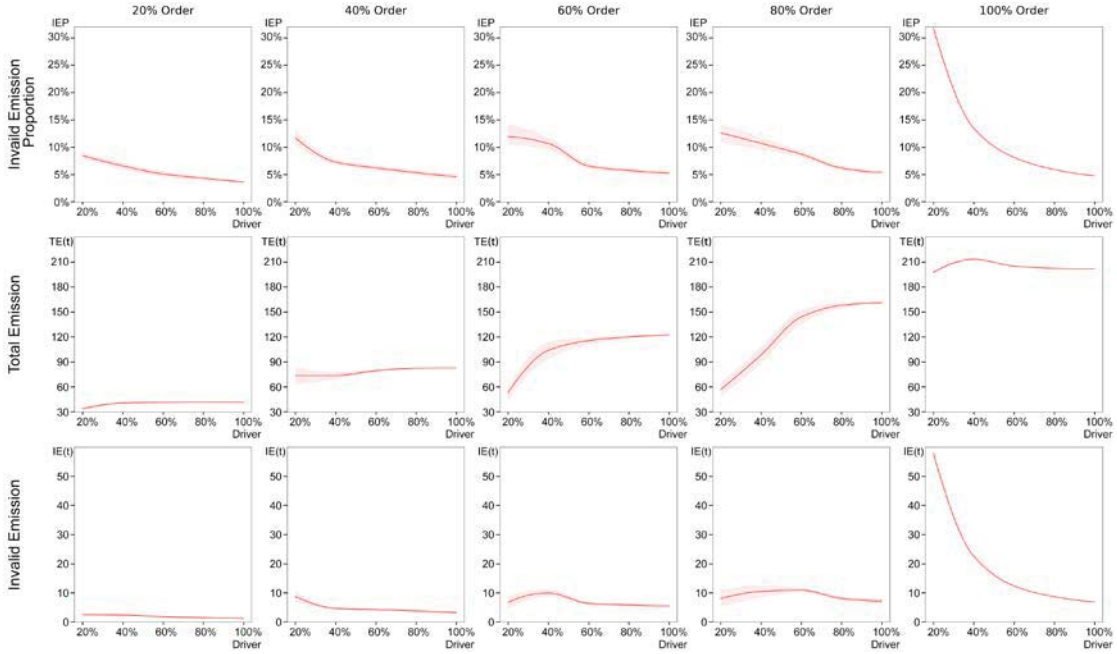


Figure 2. the emission of NOx under different proportion of users

all situation simulation. Finally, based on this relationship, we provided a guidance for the computation of approximate user scale if the emission and efficiency performance of car-hailing is expected to be better than a threshold. The illustration is shown as figure 3.

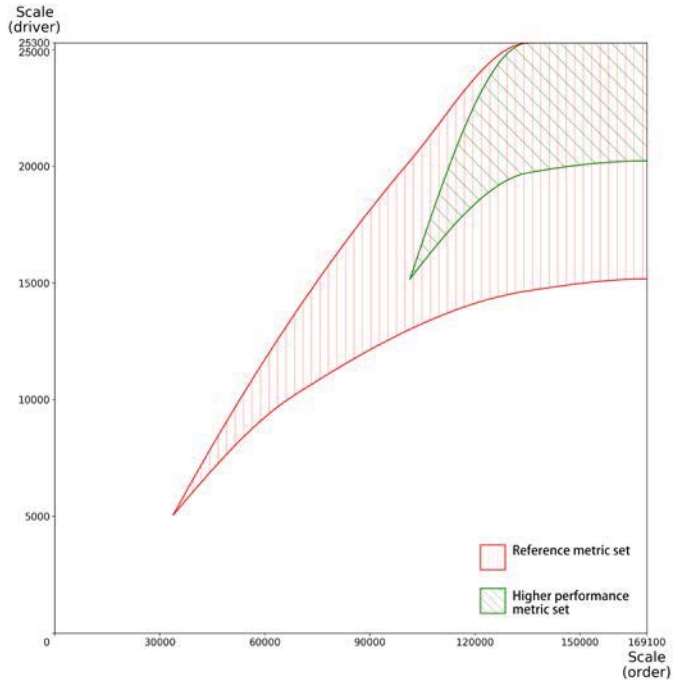


Figure 3. The area of scale of driver and order under two metric set

We believe this part can strengthen ride-hailing service provider's understanding on how to control the number of users in the system to improve the energy efficiency.

In the second part, we propose an optimization method combined with prediction model to minimize the global pick-up distance. The research framework of this part is shown as figure 4.

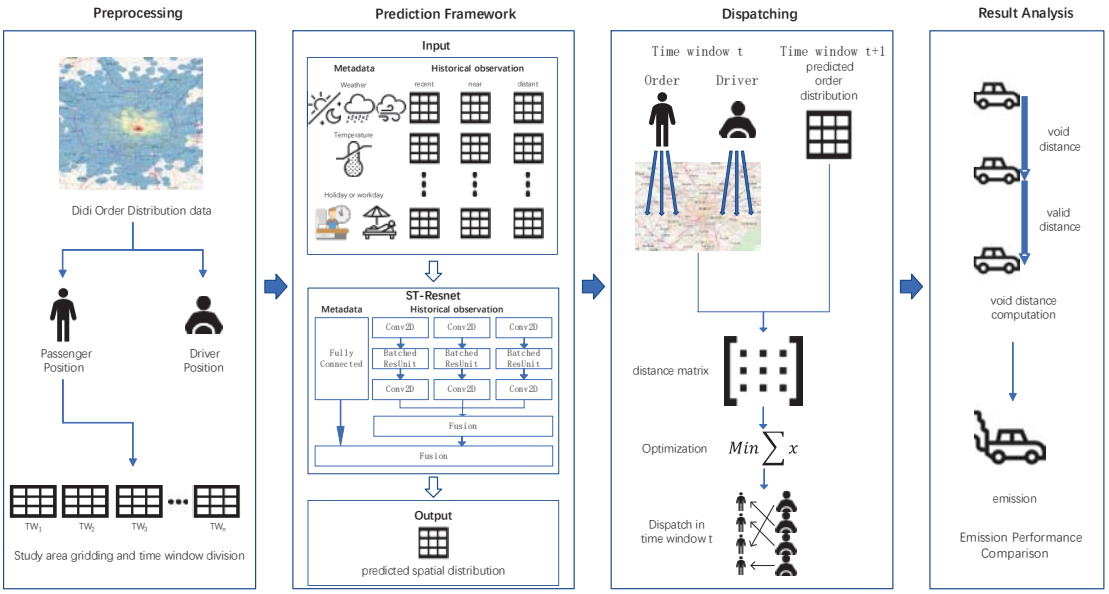
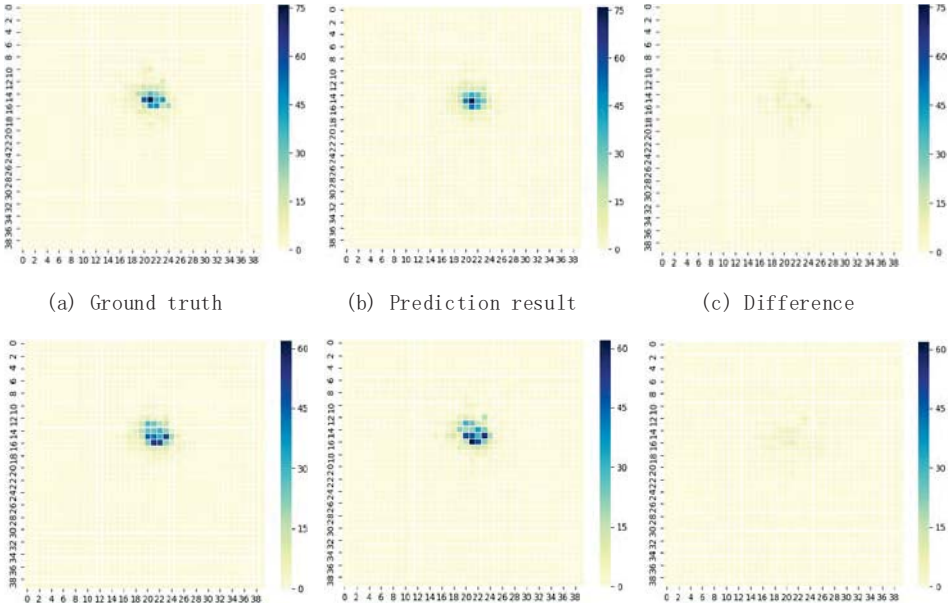


Figure 4. The framework used in part 2

The basic idea is to consider the current dispatch problem combining the future knowledge of travel demand distribution. Firstly, we train a prediction model to predict the future spatial distribution of travel demand in the study area. The method we use is We use is ST-Resnet. The sample of prediction result is shown as figure 5. We can see from the result that the prediction is accurate and can be used into dispatch simulation.



(a) Ground truth (b) Prediction result (c) Difference

Figure 5. Visualization of prediction result

Didi ride-hailing data on one day for simulation. The dispatch algorithm is optimization. According to the simulation result, we found that our method can reduce the picking-up distance by 8.60% compared with baseline greedy algorithm. The proposed algorithm additionally makes the average waiting time of passenger more than 10 minutes shorter. The performance comparison is shown is table 1.

Table 1. Comparison of different algorithms by metric

Algorithm / Metric	Baseline: Greedy algorithm	Optimization without optional constraint	Optimization with optional constraint
Average waiting time of passenger	654.36 s	219.23 s	217.02 s
Average void cruising distance proportion	12.31%	3.83%	3.70%
Proportion of cancelled orders	48.35%	0.00149%	0.00%

The statistical results, which is shown as figure 6, also show that the performance of our method is stable. Almost the metric in all cases can be kept in a low interval.

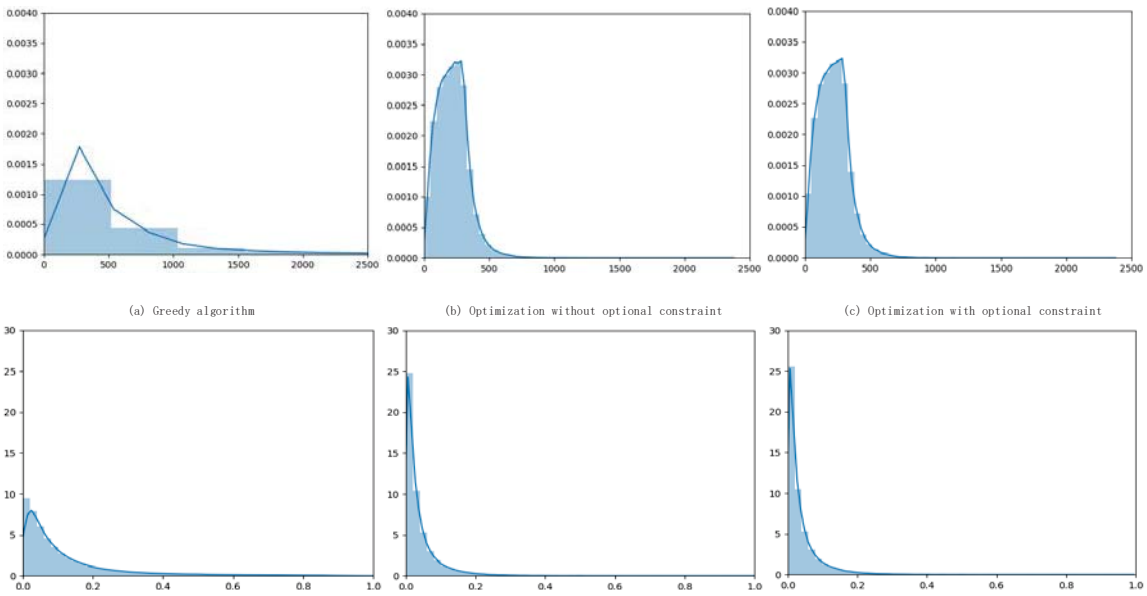


Figure 6. The statistic result of metrics

We believe our findings can improve deeper insight into the mechanism of ride-hailing system and contribute to further studies.