2020 MCM
Problem D: Online Car-Hailing Platform

Background

With the increase in urban population and people's income, taxis have become a competitive travel option in urban public transportation systems. However, in the real world, people who want to take a taxi are usually unable to find a taxi. In contrast, taxi drivers often spend a lot of time cruising to find passengers. In Beijing, 34% of passengers have to wait more than 20 minutes, while only 32.2% of passengers can hail a taxi within 10 minutes. At the same time, the no-load rate of taxis during the day exceeds 25%. In other words, passengers and empty cars know almost nothing about each other and cannot find each other effectively.

The development of the Internet and the sharing economy has promoted the emergence of online car-hailing platforms, such as DiDi and Uber. These online car-hailing platforms greatly alleviate the problem that passengers cannot find empty taxis by matching empty taxis with passengers. After several years of development, online car-hailing has profoundly changed people's travel habits and promoted the effective use of social resources. However, online car-hailing platforms still face many challenges. The platforms need to attract more taxi drivers and users to increase platform revenue; taxi drivers want to take more orders and earn more profits; passengers want to reduce waiting time, reduce travel costs, and improve travel experience. Besides, the safety of online car-hailing has also caused widespread concern.

To address these challenges, online car-hailing platform X hires your team to evaluate the existing platform's operating conditions and provide strategies for improving platform revenue. To help your team complete the task, the online car-hailing platform X provides trajectory data for taxi drivers on the platform of Chengdu in November 2016. The trajectory point collection interval is 2 to 4 seconds. The trajectory points have undergone the road binding process, ensuring that the data can correspond to the actual road information. The order information was encrypted, desensitized and anonymized. For more details, please refer to the sample files. (Notes: The sample files only show the parameters' formats, meanings, and a small amount of data. Teams choosing the problem D could contact 244-Yucen Gao for specific data.) Your team need to complete the following tasks:

1. Analyze the distribution and trend of orders and taxis, and evaluate the efficiency of the current online car-hailing platform.
2. Search and analyze the factors that affect the distribution and trend of taxis, and design a model based on the conclusion of task 1 to improve the efficiency of the online car-hailing platform (by designing efficient matching algorithms or providing personalized services such as carpooling). To simplify the problem, suppose you have known all orders and vehicles in advance.
3. Suppose you have known the total number of vehicles in advance, while you do not know the order information. Please modify the model according to the historical information of order to improve the efficiency of the online car-hailing platform.
4. In order to optimize the passengers' travel experience, please analyze whether the current vehicles are sufficient. If not enough, please analyze how many active taxi drivers need to be newly attracted, and explain the rationality of your conclusion.

5. Provide a one-page advertisement to publicize the advantages that your solution brings to online car-hailing platform X to attract more passengers.

Attachment: GPS and Order data from Didi chuxing (https://gaia.didichuxing.com)

Your submission should consist of:

· One-page Summary Sheet,
· One-page advertisement,
· Your solution of no more than 20 pages, for a maximum of 22 pages with your summary and advertisement.
· Note: Reference list and any appendices do not count toward the 22-page limit and should appear after your completed solution.