Taxi Pick-up at the Airport

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Abstract

In recent years, aircraft has become an important tool for people to travel. With more and more people flying, the long queue and waiting time wastes the potential passenger income. We study and analyze the factors that affect the taxi driver's income, consider the changing law of the number of airport passengers, and establish a taxi decision-making model. Through Posson distribution and cluster analysis and so on, we achieve our dream.

Keywords

Poisson distribution, Cluster analysis, Profit.

1. Introduction

We consider this problem from three perspectives: the number of taxis waiting in the car storage pool, the distribution density of urban population, and the number of passengers waiting in the waiting area. We investigate and analyze the number of passengers and get the distribution of the number of passengers at every moment of the day. We also need to look up data and research data to analyze the number of taxis at the airport every moment. Finally, we establish the income function, and take all the above into account. We compare every moment's revenue with the driver's revenue expectation to judge whether the driver will continue to wait at the airport or go back to the city to attract customers.

2. Model Analysis

2.1 Influencing factors of driver′s decision

In order to show the influencing factors of driver's decision more clearly, we will specify the influencing factors. Among them, the number of waiting vehicles in the car storage pool is the information that can be observed directly by the driver, and the density of urban population distribution and the number of passengers are judged by the driver's experience for many years. We will not consider other factors for the time being.

2.2 Data analysis and processing

Analyze any region, find out the population density distribution of the region, cluster analysis each region center, divide the region into m categories, each category represents different population distribution density($\mathrm{O_i}$ $\mathrm{i} = (1、2 \ldots . \mathrm{M})$)。The Euclidean distance from the residual centroid to the centroid is calculated

$$d(x,y) = [\textstyle\sum_{k=1}^{p} |x_k - y_k|^2] \tag{1}$$

From this, we can get the probability that passengers choose i destination $\mathrm{P_{2i}} = \frac{\mathrm{O_i}}{\mathrm{O_1+O_2+\cdots+O_i}}$, According to a large amount of information we have consulted, the probability distribution of the number of passengers (X) at every moment of the airport conforms to the Poisson distribution.

$$P(x = k) = \frac{e^{-\lambda}\lambda^k}{k!} \tag{2}$$

According to the GPS data of all taxis in the region, through our statistics and analysis of the data, we can get the number of taxis B at the airport every moment. It can be seen that the number of taxis B is a function of time t. The premise for taxi drivers to receive passengers is that there are more passengers than there are taxis. So we can figure out the probability that drivers can receive passengers in the normal queue P_1.

$$P_1 = P(X \geq B) = \sum_{j=B}^{\infty} \frac{e^{-\lambda}\lambda^j}{j!} \quad (3)$$

This probability is a function of B, and function B is a function of T, so we can derive it as a function of T. So we can get the comprehensive probability P_i'

$$P_i' = P_1 * P_{2i} \quad (4)$$

Distance conversion: the geographic coordinates of any point on the earth can be expressed as (U, V) with ordinal pairs, u as longitude and V as latitude. The three-dimensional rectangular coordinate system is established by taking the geocenter o as the coordinate origin, the equatorial plane as the xoy plane, and the 0 degree as the xoz plane through the plane where the coil is located, so

$$\begin{cases} x = R\ cosu\ cosv \\ y = R\ sinu\ cosv \\ Z = R\ sinv \end{cases} \quad (5)$$

Where R=6370is the radius of the earth， and the actual distance between any two points $A(u_A, v_A)$,$B(u_B, v_B)$ is

$$d = R * arccos(\frac{OA*OB}{|OA|*|OB|}) \quad (6)$$

Simplify and get：

$$d = R\ arccos[cos(u_A - u_B)\ cosv_A cos, v_B + sinv_A sin, v_B] \quad (7)$$

We also need to collect the taxi charge standard s in this area, so as to determine the charge S required for the above different clustering centers. In the process of waiting, drivers have to pay time to wait, which is also valuable, so we need to calculate the time cost T paid by drivers.

$$T = B * S * 30/60 * m \quad (8)$$

B is the number of vehicles in front of us. S is the waiting time (in minutes) of a car. Taxi is set at 30 km / h and M is the price per kilometer.

2.3 Establishment of decision mode

The driver's choice lies in profit. Therefore, the basis of our decision-making model is revenue. There are two kinds of revenue. The first is the revenue of waiting for the airport to pick up passengers. The second kind: the income of drivers returning to the city to pull passengers.

We build a model of drivers waiting for benefits：

$$E = R[\sum_{i=1}^{M} S_i * P_i' - T] \quad (9)$$

S_i is the money passengers should pay for going to class I center；P_i' is the product of the probability of the driver receiving the passenger（P_1）and the probability of the passenger's destination（P_2）；T is the cost of time;R is the influence coefficient caused by night, day and holidays.Put(2)(3)(4)into（9）We can get the driver's income.

Income model of drivers who do not receive passengers back to the city (assuming that drivers can receive people in the center of the airport area)：

$$E' = R[\sum_{i=1}^{M} S_i * P_i' - T' - K'] \quad (10)$$

T'is the cost of time without passengers($t' * 30/60 * m$)，K'is the cost of no passengers（No load cost per kilometer is 2 yuan）；R is the influence coefficient caused by night, day and holidays.When the first kind of income is greater than the second, the driver should choose to continue to queue up at the airport to meet the guests; otherwise, the driver should choose to empty back to the city to meet the guests.

3. Conclusion

The rationality of the model can be divided into two parts: model validation and validation. Model validation: under the same input conditions and operating environment, compare the consistency between the model and the actual system output, and evaluate the reliability or availability of the model. Model verification: determine whether the computer implementation of the model is correct. We compare the choice of our model and the driver's choice under the same input condition, and find that they are consistent. Therefore, our model is more reasonable in accordance with the reality. Because the final main influencing factor of our model is time, so it has a great correlation with time.

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