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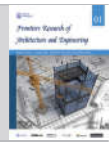

ARTICLE

Factors Affecting Road Rating

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ABSTRACT

The decision of traffic congestion degree is an important research topic today. In severe traffic jams, the speed of the car is slow, and the speed estimate is very inaccurate.

This paper first uses the data collected by Google Maps to reclassify road levels by using analytic hierarchy process. The vehicle speed, road length, normal travel time, traffic volume, and road level are selected as the input features of the limit learning machine, and the delay coefficient is selected. As the limit learning machine as the output value, 10-fold cross-validation is used. Compared with the traditional neural network, it is found that the training speed of the limit learning machine is 10 times that of the traditional neural network, and the mean square error is 0.8 times that of the traditional neural network. The stability of the model Significantly higher than traditional neural networks.

Finally, the delay coefficient predicted by the extreme learning machine and the normal travel time are combined with the knowledge of queuing theory to finally predict the delay time.

1. Background

In recent years, with the rapid economic growth and the acceleration of urbanization, urban population and vehicles have continued to increase, urban traffic issues have received widespread attention, traffic congestion has become increasingly serious, and urban traffic space has become increasingly saturated. Existing navigation software often obtains real-time GPS data through software installed in the vehicle to determine the current road congestion situation. However, under severe traffic jams, the speed of the car is slow, and the speed estimation is very inaccurate. As a result, the final predicted time is often much shorter than the actual time, or even one tenth of the actual time. Therefore, every driver hopes to be able to more accurately predict the time of vehicles passing through a congested road section, so as to avoid them entering the congested road section and reduce the waste of time.

Analysis of the model: Because the length and scale of the road sections and the location of the service target machine sections themselves are different, it is not easy to analyze traffic congestion.

2. Analysis of Road Congestion

The road congestion is related to the traffic condition of the road section, and the traffic condition of the road section is also related to the weather conditions of the day, the position and traffic status of the road section, the traffic volume during the road section time, and the road section. The overall length is related to many factors.

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Even the traffic conditions on different roads in the same section of the road are very different.

In order to simplify the model, distinguish between different sections, and explain the above definitions separately, these indicators have added relative reference data, taking into account relevant factors such as traffic flow, section length, geography, climate, and environment, making the evaluation indicators comparable. At the same time, the comparison between road indicators makes it practical.

Divide the road section. According to experience, the length of the road section should generally be (0.16km_16km), and different values can be taken according to different road conditions and speed conditions. Due to the good road conditions and high vehicle speed, the length of the road section can be appropriately extended; The traffic speeds of downtown and commercial areas are relatively low, and there is a large flow of people, and the road conditions are more complicated, so shorter lengths are preferable. And the road section can be set according to the location of the road. In this question, directly select the road section divided by Google Maps. Characteristic parameters of traffic flow:

According to experience, the traffic flow parameters are applied to quantify the traffic flow changes, indicating that the characteristics reflect the state of traffic congestion. In practical applications, traffic flow, speed, and traffic density are the three most widely used traffic parameters.

2.1 Traffic Flow

The number of vehicles passing a place on a road per unit time is called traffic flow.

$$Q = \frac{N}{T}$$

Among them: Q is the traffic flow;T is the length of the observation period; N is the number of vehicles passing through the observation point during the period.

Traffic flow will change with time and space. It is a dynamic parameter. Traffic flow can be used as a characteristic to measure urban traffic congestion, and its changing law can reflect road congestion to a certain extent. However, because different road congestion states may occur under the same traffic flow conditions, there is often a large error in judging road congestion traffic conditions only by applying traffic flow. In practical applications, we should even characterize with other traffic flows Parameters in combination.

2.2 Speed

The distance a vehicle travels per unit time is called speed. Microscopically, the instantaneous speed of each vehicle is the speed at a certain moment. However, because traffic flow is a complex system composed of multiple vehicles, there are different concepts of speed. Common definitions include time average speed and space average speed through the length of a road segment over a period of time. The formula is as follows:

$$\bar{v}_i = \frac{1}{N}\sum_{i=1}^{N} v_i$$

$$\bar{v}_s = \frac{D}{\frac{1}{N}\sum_{i=1}^{N} t_i} = \frac{1}{\frac{1}{N}\sum_{i=1}^{N}\frac{1}{\bar{v}_i}}$$

The number of vehicles N is used to indicate the speed of the i-th vehicle passing through the observation point. In the following formula: is the time it takes for the first vehicle to pass the length of the road section, and the average speed of the first car to pass the road section.

$$\bar{v}_i = \frac{D}{t_i}$$

2.3 Traffic Density

The definition of traffic density is the number of vehicles appearing on a road unit length at a certain moment. The calculation formula is as follows:

$$\rho = \frac{N}{D}$$

ρ represents the traffic density; N the number of vehicles; D the length of the observation section.

Under normal circumstances, the traffic density is directly proportional to the traffic flow, that is, the greater the traffic flow, the greater the traffic density. However, when there is severe traffic congestion on the road, the vehicle will be in a stagnant state. At this time, the road traffic flow is very close to zero, but the traffic density is close to the maximum.

In practical applications, the above data is difficult to obtain, and the lane time occupancy can be directly obtained through detection, so in general, time occupancy is often used instead of traffic density. Occupancy is defined as the ratio between the sum of the time it takes a vehicle to pass an observation point and the observation time within a certain period, as shown in the formula:

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$$oc = \frac{1}{T}\sum_{i=1}^{N} t_i$$

Among them: T is the observation time; t_i is the time when the first car passes.

When the traffic flow is small, the vehicle speed will be relatively high, and the road time occupancy will be low; when the traffic flow increases, the vehicle speed will decrease, and the road availability rate will increase significantly; when the traffic congestion occurs on the road, the traffic The flow will be reduced to a certain extent, and the number of vehicles passing through the observation point will be reduced. However, due to road congestion, the speed will decrease significantly. At this time, we worry that the road time will be at a higher value. Therefore, road time occupancy can better reflect road traffic conditions.

2.4 Road Grade

Classification of road grades using AHP:

Roads can be divided into multiple levels, with different levels of traffic capacity and ease of congestion. According to national standards, divided by the width of the main road and road restrictions, the speedway levels are mainly divided into four levels, respectively as shown in the following table:

The division of the road is too one-sided. In order to consider that the location of the road and the actual transportation capacity do not meet the requirements of this question, we re-select the indicators in this question and classify the roads:

Item level	Design Speed (km / h)	Number of one-way lanes	Road width (m)	Total road width (m)	Divider settings
First level	60~80	No less than 4	3.75	40~70	(Required)
Secondary	40~60	No less than 4	3.5	30~60	(Should be set)
Third grade	30~40	No less than 2	3.5	20~40	(Can be set)
Fourth grade	Below 30 km	No less than 2	3.5	16~30	(Not set)

After consulting the literature, the following four indicators were selected:

The location of the road C1 (in the core business area, transportation hub area, and general area). The road functions are different according to the location of the road. To simplify the model, the road location is selected.

Traffic density C2 (relatively large, medium and small)

Road width C3 (number of one-way lanes)

The number of densely-concentrated areas in the road section C4 (such as large and medium-sized hospitals, schools with a lot of people, shopping malls, and entertainment venues)

Quantify the small indicators corresponding to each indicator to get the scores of each road segment, sort them separately, and define them hierarchically. We define the road segments as six indicators.

The situation of different roads at the same moment is collected here, as shown in the following table:

Table 1. situation of different roads at the same moment

Road name	position	Number of concentration areas	Section width
P1	Core business district	4	4
P2	Transportation hub area	6	4
P3	Ordinary area	3	2
P4	Ordinary area	9	3

Pick the first four roads and analyze them hierarchically

Compare the four elements of the base layer pair by pair to establish a judgment matrix (also called a pairwise comparison matrix), as shown below:

$$\begin{pmatrix} 0 & C1 & C2 & C3 & C4 \\ C1 & 1 & 1 & 1/2 & 1/2 \\ C2 & 1 & 1 & 1/3 & 1/2 \\ C3 & 2 & 3 & 1 & 3 \\ C4 & 2 & 2 & 1/3 & 1 \end{pmatrix}$$

Similarly, we can construct a judgment matrix as follows:

Road position C1-P1

$$\begin{pmatrix} C1 & P1 & P2 & P3 & P4 \\ P1 & 1 & 2 & 6 & 6 \\ P2 & 1/2 & 1 & 3 & 3 \\ P3 & 1/6 & 1/3 & 1 & 1 \\ P4 & 1/6 & 1/3 & 1 & 1 \end{pmatrix}$$

$$\begin{pmatrix} C2 & P1 & P2 & P3 & P4 \\ P1 & 1 & 2 & 7 & 7 \\ P2 & 1/2 & 1 & 5 & 5 \\ P3 & 1/7 & 1/5 & 1 & 1 \\ P4 & 1/7 & 1/5 & 1 & 1 \end{pmatrix}$$

$$\begin{pmatrix} C3 & P1 & P2 & P3 & P4 \\ P1 & 1 & 1/2 & 2 & 1/5 \\ P2 & 2 & 1 & 3 & 1/2 \\ P3 & 1/2 & 1/3 & 1 & 1/4 \\ P4 & 5 & 2 & 4 & 1 \end{pmatrix}$$

$$\begin{pmatrix} C4 & P1 & P2 & P3 & P4 \\ P1 & 1 & 1 & 3 & 2 \\ P2 & 1 & 1 & 3 & 2 \\ P3 & 1/3 & 1/3 & 1 & 1/2 \\ P4 & 1/2 & 1/2 & 2 & 1 \end{pmatrix}$$

Similarly, we can construct the following judgment matrix: road position C1-P1, where CI is the consistency index, and its calculation formula is as follows:

$$CI = \frac{\lambda_{\max} - n}{n-1},$$

RI is the average fixed consistency index, which is a fixed parameter, which can be obtained by checking the table.CI<1.0, The consistency of the judgment matrix is considered acceptable.

The consistency indicators of the above four judgment matrices are shown in the following table.

Table 2. consistency indicators

Target layer	Pairwise comparison	C1	C2	C3	C4
Consistency ratio *CR*	0.0039	1.66	0.006	0.027	0.0039

The consistency ratios all meet the requirements, and the weights are calculated by the arithmetic average method as shown in the following table.

Table 3

	Index Weight	1	2	3	4
position	0.15	0.54	0.27	0.09	0.09
density	0.13	0.53	0.32	0.07	0.07
Number of zones	0.46	0.13	0.26	0.09	0.57
width	0.23	0.35	0.35	0.10	0.18

Therefore, the influencing factors of the evaluation levels of the four roads are:

In this way, the collected data is scored, and it is hierarchically selected and defined to obtain five levels.

3. Analysis of the Relationship Between Traffic Flow Parameters and Traffic Congestion

Road traffic conditions are complex, mixed, and random, while neural networks have the characteristics of learning complex non-linear systems.

Therefore, neural networks are highly matched to road traffic conditions and are applicable to the field of traffic prediction. Although at present, many neural network-based computer sciences have been used for traffic prediction and have achieved fruitful results. The neural network models currently applied in the field of traffic prediction are: multilayer feedback neural network [9], radial basis RBF neural network [10], BP neural network [11], recurrent neural network [12-13], time delay neural Network model [14] and so on. However, when using traditional neural networks to solve complex non-linear problems such as traffic prediction, there are disadvantages such as large amount of input data, slow training speed, complex model, easy to fall into local optimum, and difficult to converge. There are shortcomings, so that neural networks have not been applied on a large scale in traffic prediction, and their role in solving traffic congestion and congestion is very limited. In order to solve this problem more accurately, this paper uses Extreme Learning Machine (ELM) to solve this problem more accurately.

Extreme learning machine (ELM) is a single hidden layer feedforward neural network proposed by Huang et al. [5] for the problems of slow training of traditional neural networks and easy to fall into local minima.The connection weights between the hidden layer and the hidden layer and the hidden layer neuron threshold are randomly generated networks. During the training process, only the number of hidden layer neurons can be set to obtain the unique optimal solution and traditional nerves.Compared with the network, it has the advantages of fast learning speed and good generalization performance.Therefore, it is widely used in regression fitting and classification recognition.

Therefore, the over-limit learning machine algorithm is very suitable for use in complex and variable traffic prediction models with large amounts of data.

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