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Optimization of Delivery Process Based on Machine Learning Support Vector Regression SVR Algorithm

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Abstract: In the current post-pandemic era, takeout delivery still plays an important role in our daily life. At the same time, the new challenge facing O2O takeout delivery is how to ensure the safe and efficient delivery of the order within the specified time in the process of delivery. This paper mainly studies the optimization of delivery process based on machine learning support vector regression SVR algorithm. This paper proposes a regional takeout order demand prediction model based on SVR algorithm. The model can effectively predict the order demand in each business area within the next hour, which provides a basis for the intelligent scheduling of the delivery system of the takeout platform. The order data of a delivery platform in Dalian area are used to verify the prediction model, and the prediction results are compared with BP neural network and GA algorithm. The experimental results show that the prediction results of SVR algorithm have better fitting effect, which can effectively predict the order demand of the delivery platform in the region.

1. Introduction

With the continuous development of the service industry, on the one hand, it changes the economic life on the other hand it also provides new content for the design industry. Research on design began to focus on user-oriented experience and service design. Service plays an increasingly important role in People's Daily life. As a part of the field of design, service design needs to benefit more users through design. An emerging generation of Internet consumers rose rapidly, creating a favorable environment for online takeaway delivery [1-2]. In its existing categories, takeout has expanded from delivering only catering food in the past to almost covering all commodities, and high-end, healthy and environmentally friendly takeout has become the mainstream of the current takeout industry. The delivery platform will also expand more diversified consumption scenarios to meet the needs of users in diversified scenarios [3]. Due to major network platform in order to retain users, to attract new users, to through the optimization of distribution logistics, constant compression about distribution network member to send a single time, through online delivery platform system architecture of the algorithm, in the invisible force take-out rider regardless of personal safety, speeding and running red lights on the road, have significant potential safety hazard, At the same time, some unwritten regulations for online delivery personnel also reduce the quality of delivery services [4-5].

Vehicle routing is put forward in the 1960s, usually said the movement track of vehicles, now with the development of logistics industry, in contact with the user in the process of vehicle distribution has their own needs, and the distribution center distribution of goods to customers, distribution in the process of the optimization route, if you know the customer's demand condition, the increase before optimization constraints, So as to achieve customer satisfaction [6]. The general constraints are: shortest path, lowest cost, highest satisfaction, etc. In route optimization, delivery path optimization is the focus of this paper. Now the takeaway industry is rising, and deliverers are also one of the key considerations in the takeaway industry [7]. Some scholars have discussed the issue of order distribution and path optimization in online and offline platforms of crowdsourced takeout, but they have not considered that the crowdsourced delivery personnel need to operate by hand in the case of order grabbing or delivery [8]. A scholar took into account the influence of environment and traffic, so as to construct different road network conditions at different periods and concretely describe practical problems [9]. At present, scholars at home and abroad have conducted a great deal of research on dynamic path, delivery path optimization and genetic algorithm [10]. Some scholars have studied the dynamic path problem, but few have studied the distribution problem in depth. Under the optimization of delivery path, time window has also been frequently mentioned, but the subject of delivery has not been systematically considered in the urban road network [11].

In this paper, based on the urban road network, the delivery of order grabbing takeout is considered through the time window combined with the dynamic path. In order to get more accurate results, the SVR algorithm of support vector regression is used to optimize the delivery process.

2. Delivery Path Optimization Based on SVR Algorithm

2.1. The Package Delivery

Crowdsourcing takeout delivery mode can be considered as the traditional crowdsourcing delivery mode. In this mode, the customer submits the delivery order through the crowdsourcing delivery platform, and then the crowdsourcing delivery platform releases the order submitted by the customer to the corresponding restaurant to inform the restaurant to start the meal preparation activities according to the order requirements. On the other hand, the order is put into a public order pool so that the crowdsourcing deliverers can obtain order information from the order pool. Crowdsourced deliverers typically obtain delivery tasks in order form from the order pool on a first-come, first-served basis. After obtaining the delivery task, the crowdsourced deliveryman needs to provide the restaurant in the delivery task with the pick-up service, obtain the delivery for the customer, and then deliver the takeaway to the customer to provide the delivery service for the customer, so as to complete the whole delivery service.

Takeout delivery activities are different from the same distribution activities and have the characteristics of daily periodicity. Usually, takeout delivery tasks are the most during the two periods of 10:30-13:00 and 17:30-19:45 every day. Therefore, it is necessary for the delivery platform to allocate enough deliverers to guarantee the delivery service during peak periods [12]. At the same time, the existence of daily periodicity will inevitably lead to excess distribution resources in some periods, and the delivery platform must pay fixed salaries to the deliverers, which will affect the efficiency of the delivery platform [13]. But in the package delivery platform, all part of distribution is acquired through the package to the society, crowdsourcing platform without having to bear the shipping agent's compensation and employee benefits such as cost, just in the peak day depends on the package delivery to ensure delivery and distribution services, in the spare time and don't have to pay more money for crowdsourcing distribution member, thus greatly reduce the operation cost of crowdsourcing platform [14]. At the same time, crowdsourced delivery personnel are the idle transportation force from the society. They have no fixed position and are mostly scattered around the city. Therefore, compared with other delivery methods, crowdsourced delivery can provide a wider distribution range and a broader operation time [15].

Although crowdsourced food delivery has the advantages of low cost, wide distribution scope, wide operation time and abundant transportation resources, it also has some shortcomings. The low cost of crowdsourced food delivery is due to the fact that the platform does not need to provide fixed salaries and benefits to the deliverers, which increases the burden of the deliverers in disguise. At the same time, in the crowdsourcing take-out delivery mode, the crowdsourcing deliverers can only obtain the delivery task by the way of order acquisition, and the delivery task is the direct and only economic source for them. Therefore, the crowdsourcing deliverers blindly grab orders to increase their own economic income, so as to win by quantity [16]. However, there is little correlation between the delivery tasks obtained through order grabbing, which may lead to the deliveryman's inability to complete the delivery tasks within the prescribed time, affecting the delivery service effect. In addition, in the crowdsourcing take-out delivery mode, the choice of delivery task lies with the crowdsourcing deliverer. Therefore, some delivery tasks with long delivery distance, demanding time requirements and many additional tasks will have the phenomenon of unmanned delivery, which will greatly affect the service quality of the crowdsourcing delivery platform [17]. In addition, because the package delivery platform by rob one link and the package only contact marki, the management level is low, and crowdsourcing marki are usually not received formal training, plus the lack of a reasonable management system, crowdsourcing marki leak, wrong sheet, distribution events are occurring not in time, this will not only greatly affect the delivery and distribution services, Moreover, the losses are mostly borne by the crowdsourced deliverers, which increases the burden of the crowdsourced deliverers [18].

2.2. Establishment of Takeaway Prediction Model Based on SVR

There are many prediction algorithms for delivery time and their prediction results are excellent. However, the takeout industry has more strict requirements on the timeliness of delivery, which makes the prediction algorithm have the ability to correct errors caused by accidents while ensuring the prediction accuracy. In this paper, according to the characteristics of delivery and the advantages and disadvantages of existing algorithms, the delivery time prediction model is established.

In order to accurately predict the vehicle travel time under different driving conditions, machine learning models can be used to predict the vehicle travel time under different driving conditions. This kind of model relies on a large number of historical data training, so the time prediction accuracy of normal driving vehicles is good. However, urban traffic is a complex and changeable system. When a vehicle meets an accident on the way, such as a car accident in the middle of the road and road congestion ahead, the travel time will increase. The model for these sudden, random conditions, lack of prediction ability, for the resulting prediction error can not be corrected.

Unlike traditional regression models, SVR can allow a certain deviation between f (x) and y, which is assumed to be ε. The error loss is calculated by SVR only when the absolute value of the error between f (x) and y is greater than ε.

The linear regression equation of SVR is:

$$\min_{\omega,b} \frac{1}{2} \| \omega^2 \| + C \sum_{i=1}^{m} l_\varepsilon (f(x_i) - y_i) \tag{1}$$

In real problems, many training samples are nonlinear regression, so linear SVR cannot predict. For such nonlinear training samples, the samples need to be mapped to the feature space of higher dimensions. In this way, the samples of nonlinear regression become linear regression in the feature space of higher dimensions, and the description of hyperplane becomes:

$$f(x) = \sum_{i=l}^{m} (\hat{\alpha}_i - \alpha_i) \phi(x_i)^T \phi(x_j) + b \tag{2}$$

Where Φ(x) is the mapping function of sample x.

The inner product Φ(xi)TΦ(x) of the mapping function is replaced by the kernel function k(x I, xj) to obtain the equation of the kernel function SVR:

$$f(x) = \sum_{i=l}^{m} (\hat{\alpha}_i - \alpha_i) k(x_i, x_j) + b \tag{3}$$

The complexity and generalization ability of SVR model depend on the selection of model parameters. Radial basis kernel function is a better choice for nonlinear regression problems. The parameters to be optimized for radial basis SVR include: regularization coefficient C and kernel function parameter gamma.

Particle swarm optimization algorithm has the advantages of simple operation, fast convergence speed and high optimization accuracy, so it is widely used in practical problems. However, the algorithm is easy to fall into the local optimal point during optimization, and the convergence accuracy is low and not easy to converge. Considering the advantages and disadvantages of grid search and particle swarm optimization, this paper uses the combination of grid search and particle swarm optimization to optimize parameters. Firstly, the parameter combinations of different orders of magnitude were searched by grid, and the parameter values were determined to be in the correct order of magnitude. Then, the parameters of the optimal interval were optimized by particle swarm optimization, and the parameter combinations with higher accuracy were obtained.

3. SVR Algorithm Model Takeout Order Demand Experiment

3.1. Experimental Environment and Data Sets

The hardware environment of the regional takeout order demand prediction experiment in this paper is shown in Table 1.

The data set used in this paper is the regional takeout order data set after data preprocessing. Each data includes 15 attributes, such as year, month, date, temperature, humidity, wind speed, wind direction, weather condition, business district, whether it is a holiday attribute, and the total number of orders per unit hour. sklearn's train_test_split () method was used to randomly split the dataset, with 80% of the data being the training set and 20% of the data being the test set.

Table 1. Hardware environment

Project	Configuration
CPU	Intel Core i5-12400
GPU	NVIDIA RTX 3060
Memory	32G

The software environment of the experiment is shown in Table 2:

Table 2. Software environment

Project	Software version	Use instructions
Operating system	Windows 10	Operating system
Python	3.7	Programming language
Scikit-learn	0.22.2	Partitioning data sets and feature selection

3.2. Model Evaluation Index

Model evaluation is an important step in the modeling process. In machine learning, the evaluation indexes of classification problems and regression problems are not the same, because it is easy to overfit by only looking at the performance of the model on the training set. There are usually two ways to evaluate regression models, one is to look at the results of validation/cross-validation, and the other is to modify the performance results on the training set.

Common Performance Evaluation metrics for evaluating the prediction performance of regression models are as follows:

Mean Squared Error (MSE) is the mean square of the difference between the actual value y and the predicted value yˆ. Compared with the mean absolute error, MSE is more sensitive to outliers.

Root Mean Squared Error (RMSE): the square root of mean square error, which can be used to measure the prediction effect of the prediction model in unit metric.

The smaller the value of the above two validation errors or cross-validation errors, the better the performance of the prediction model.

R2_score: a measure of the fitting degree between the prediction results of the prediction model and the real value. It is a proportion formula. The closer it is to 1, the higher the fitting degree of the prediction model is.

4. Analysis of Experimental Results

In order to analyze the prediction effect of the model on regional takeout order demand, under the same experimental conditions, a business area is randomly selected to predict the takeout order demand of this business area on a certain day.

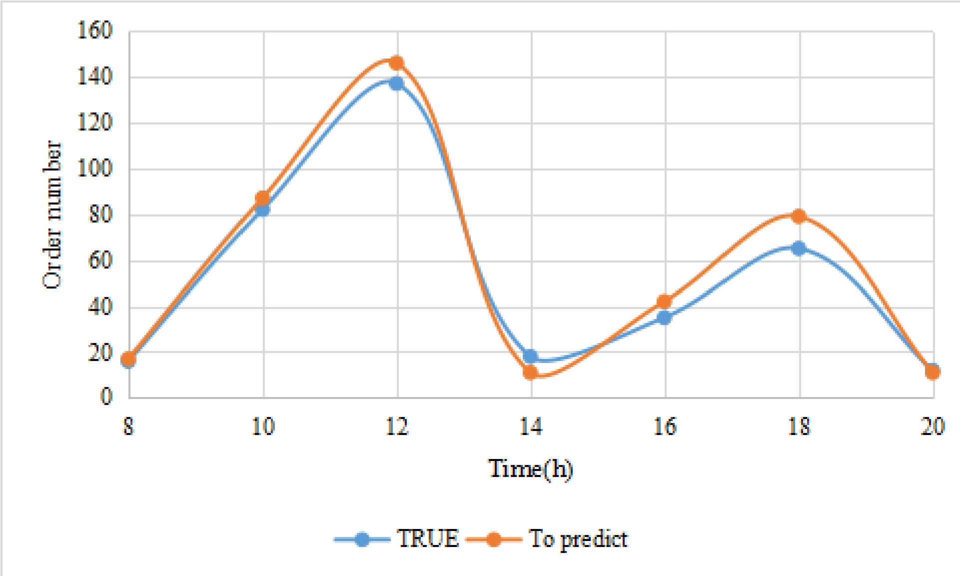

Figure 1. Prediction results of SVR model

As shown in Figure 1, the change of the prediction result of SVR algorithm is consistent with the actual situation. Although it cannot accurately predict the change of order quantity in all time periods, the overall gap between the predicted value and the real value is relatively small.

In this paper, RMSE and R2_score are used to evaluate the prediction performance of the model, which is compared with BP neural network model and GA algorithm model which are more used in demand prediction research at present. The performance of each algorithm in the training set and the test set was compared respectively, and the advantages and disadvantages of the prediction model in the regional takeout order demand prediction scenario were evaluated by comparing the scores of the evaluation indexes of the prediction results of each algorithm.

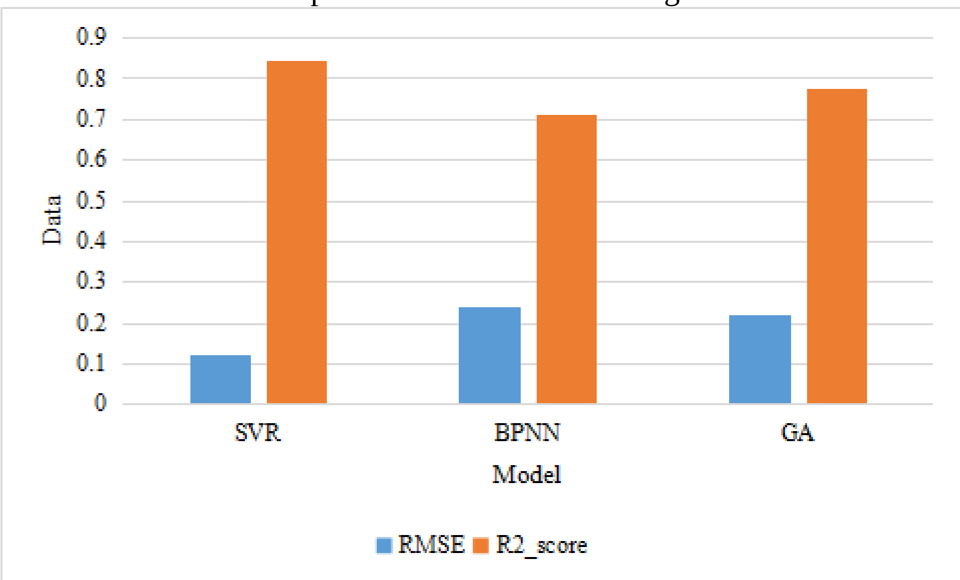

Figure 2. Comparison of experimental results in training sets

Figure 2 shows the prediction performance of each prediction algorithm in the training data set.

It can be seen from the chart that in the training set, the RMSE score of SVR algorithm is 0.121, while that of BPNN is 0.238 and that of GA is 0.223. In R2_magician evaluation index, SVR still has the highest score. The prediction accuracy of SVR algorithm is better than BP neural network algorithm and GA algorithm in RMSE and R2_score two evaluation indexes.

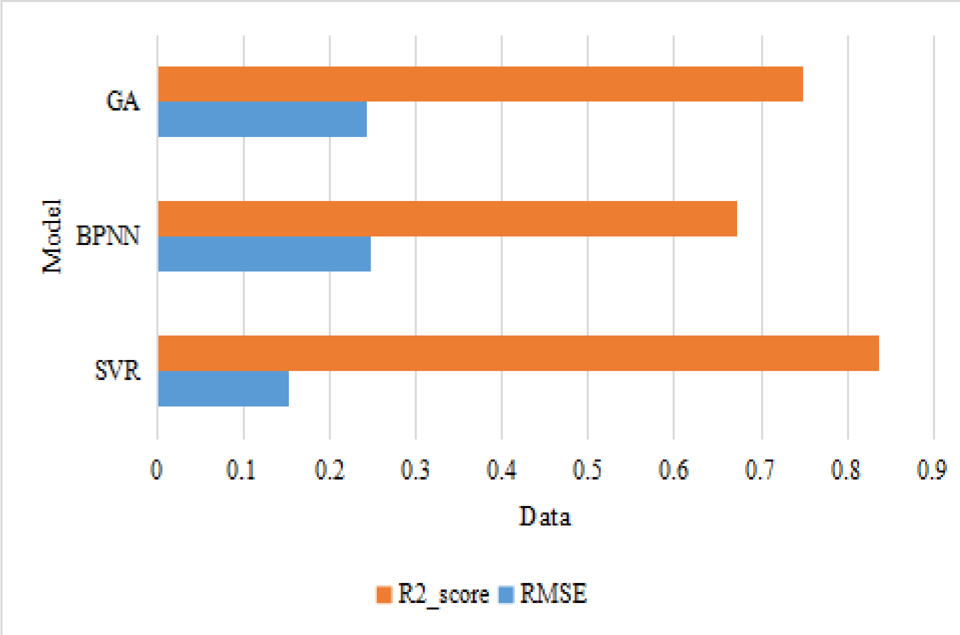

Figure 3. Comparison of test set experimental results

Figure 3 shows the prediction performance of each prediction algorithm on the test dataset. The RMSE value of SVR algorithm is 0.153. Although the prediction effect of SVR algorithm is slightly worse than that of the training set, the RMSE value is still lower than that of the other two algorithms. The RMSE and R2_score of SVR algorithm are better than BP neural network algorithm and GA algorithm when the test dataset is used to predict the regional takeout order demand.

5. Conclusion

This paper mainly studies the regional takeout order demand forecasting model based on SVR algorithm. The prediction model based on SVR algorithm proposed in this paper can better predict the demand of regional takeout orders. It can be said that the research in this paper has achieved certain practical results, but there are still many things that can be optimized: In this article, the business circle as a feature only participate in the training algorithm and prediction, if you can collect, sort out business circle of population density, per capita income levels and other related business circle attribute information, can the business circle features further cutting, such as the radiation scope of business circle, level and other properties, thereby enhancing prediction model is of universal applicability.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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