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Machine Learning Algorithm Generated Sales Prediction for Inventory Optimization in Cross-border E-Commerce

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ABSTRACT: With the continuous expansion of cross-border e-commerce enterprises' cross-border business activities and the rising operating costs of overseas warehousing, the cross-border e-commerce enterprise resource management system (ERP) is responsible for the management, coordination and optimization of global supply chain warehousing. On the cross-border e-commerce ERP platform, the product sales forecast and inventory optimization strategy realized by machine learning algorithm can effectively summarize the key factors, use the sales record big data, so that the forecast value, the expectations fit the actual value of the basic trend. The results show that the machine learning algorithm has good prediction effect and improved the best inventory equilibrium efficiency.

KEYWORDS: Cross-border E-commerce, Machine Learning Algorithm, Enterprise Resource Management System (ERP)

1. cross-border e-commerce ERP system inventory management module detailed design

The core modules of the cross-border e-commerce enterprise resource management system (ERP system) are: inventory management, product management, supplier management, logistics management detailed design, in the realization of the basic functions of the four modules can meet the needs of the primary stage of cross-border e-commerce enterprises ERP system, the main object of the database design.

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1.1Inventory management module design

Order management is the order management department of the enterprise to deal with customer demand, which is the key logistics activity of the enterprise, but also the core business process of the enterprise, from the beginning of the customer placed the order until the customer receives the goods, the change of order status and related products and information in the process is the main task of order management. Orders start through the order operation, into the logistics center, after input, verification and confirmation, inventory allocation and other processing, and finally produce shipping instructions, and then began to pick up, shipping and distribution finally through customer sign-off, withdrawal check-out and other circular operations, the entire order information processing work in the system can be completed, Relevant business data can become the historical data of the system. The system should ensure that the processing of orders on each node is carried out in accordance with normal procedures, and that the interface between the front and back nodes is accurate. Therefore, the system should be adjusted and corrected at any time for anomalies in order handling that cannot be avoided in actual operations to maintain the accuracy of the system and avoid the resulting losses.

1.2Inventory management module features

（1）Order import and query: the system will process the third-party order information and import it into the ERP system, this function should be started or stopped by the system management, when the function is started, the automatic acquisition processing and import tasks, the task interval of 1 hour. Depending on the role of the operator, the system allows the operator to query order information within his or her permissions and meets the status requirements.

（2）Match placed orders and modify order products: The salesperson performs matching tasks on imported orders, primarily checking whether the product ordered by the order exists in the ERP system, and if there is a status matching product to the order, the order can be executed. If a match failure indicates that the product may be a legacy product, the order add status match product fails, the order is processed by the salesperson, and if the salesperson is unable to update the product information, the order status is modified to be unprocessable, the order is canceled. The matching order function is automatically executed when the modification information is submitted to ensure that the added product exists in the ERP system, and that the status of the order can be modified after the match is successful, and the order can be

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executed.

（3）Check inventory function: After matching the order to ensure the validity of the order product, check whether the product is in stock, if there is inventory can be directly jumped to distribution, if there is no inventory to generate procurement information, by the purchaser to purchase the line, and submit the purchase information.

（4）Reporting the warehouse: In the inventory and daily out of the warehouse process, warehouse personnel found that the goods have damage, stains, flooding and other affect the quality of the product should be reported in time to update inventory data, to avoid affecting the operating efficiency of enterprises.

The entire order module uses the permissions of the order to complete the isolation of different stores of the order, uses the status of the order to complete the flow of orders, and uses this method to complete the implementation of the flow of work without the need for a heavy workflow engine, reducing the development workload.

1.3 Supplier Product Management Module Design

Due to internal and external reasons, cross-border e-commerce enterprises urgently need product management. Analysis from external reasons: market demand changes faster and faster, competition is more and more intense, technology is constantly updated, products, especially the core technology behind products become the key to enterprise success. Analysis from internal reasons: When an enterprise's product line grows to the point where the original functionally divided organizational structure is difficult to load, product management is needed.

The purpose of supplier management is to provide enterprises with safe, reliable and cost-effective sources of materials, for cross-border e-commerce is a cheap and stable supply of manufacturers, supplier management is the core of the entire procurement system of cross-border e-commerce enterprises, in general, the main content of supplier management has to find qualified suppliers, inquiries and quotations, Existing suppliers' evaluation, termination of supply contracts, etc., wherein the supplier's evaluation should follow the "Q.C.D.S" principle, that is, the quality cost delivery and service principle, which is also the basis for the calculation of the supplier's preferred algorithm.

II Cross-border E-commerce Big Data and Machine learning Algorithms

Big data analytics is the product consumption trace left by consumers when

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implementing cross-border e-commerce activities in the cross-border e-commerce ERP environment, as in the form of time series, as in Table 1. Implementation target to achieve personalized product sales volume data quantitative qualitative prediction, in the network data search calculation, reliability, stability, prediction error, robustness and other aspects of better sales forecast efficiency and inventory optimization effect.

Table 1 Time series of consumption data

buy_date	buy_price	buy_cnt	buy_factor	buy_pos	expect_direction	sell_type_extra	sell_date	sell_type	ml_features	profit	result
2018/10/24	20141024	105.01	1904	usAAPL	call	1	AbuFactorPreAtrNStop:pre_atr=1.0	114.25	win	64	17592.96
2018/10/24	20141024	105.01	1904	usAAPL	call	1	AbuFactorPreAtrNStop:pre_atr=1.0	114.25	win	64	17592.96
2018/10/29	20141029	223.68	781	usBIDU	call	1	AbuFactorPreAtrNStop:pre_atr=1.0	235.81	win	67	9473.53
2018/10/29	20141029	16.01	9217	usNOAH	call	1	AbuFactorAtrNStop:stop_win=3.0	24.05	win	67	74104.68
2018/10/29	20141029	21.43	6095	usVIPS	call	1	AbuFactorPreAtrNStop:pre_atr=1.0	23.47	win	67	12433.8
2018/10/29	20141029	223.68	781	usBIDU	call	1	AbuFactorPreAtrNStop:pre_atr=1.0	235.81	win	67	9473.53
2018/11/3	20141103	23.364	5900	usVIPS	call	1	AbuFactorPreAtrNStop:pre_atr=1.0	23.47	win	70	625.4
2018/11/11	20141111	16.99	9491	usNOAH	call	1	AbuFactorCloseAtrNStop:close_atr_n=1.5	20.145	win	76	29944.1
2018/11/12	20141112	43.25	2945	usWUBA	call	1	AbuFactorPreAtrNStop:pre_atr=1.0	42.6425	loss	77	-1789.09
2018/11/26	20141126	47.1	3262	usWUBA	call	1	AbuFactorAtrNStop:stop_loss=0.5	42.6425	loss	87	-14540.36

The empirical sample data of this paper is mainly through the major network search engines, according to the cross-border e-commerce ERP system export product history trace mining 200 days ago to attract consumer attention, interest, arouse desire, leave memories, the implementation of purchase actions such as business advertising words, exquisite catalogs, product-related pictures, product details, product details, Keyword search index that affects cross-border e-commerce sales in foreign trade, such as utility level strands and trends. Database table design sp. Figure 2:

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Figure 2 Sample database table design

The database used in this ERP system is MySQL, which is a relational database, which is an associated database that stores data in different labels rather than putting all the data in a large warehouse, thus increasing the speed of the system and increasing the flexibility of the database. It is an ideal experimental data source for product sales prediction, and its forecast data is presented in Figure 3.

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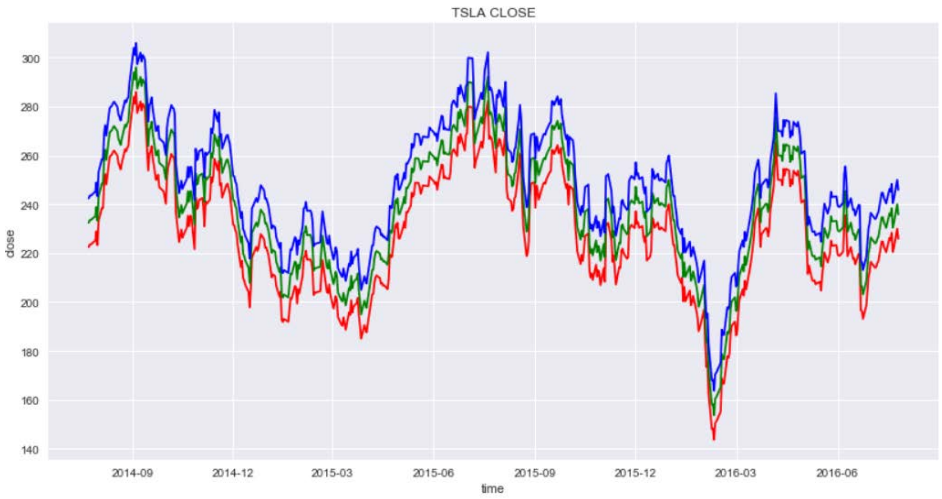

Figure 3

2 Product Sales Forecasting and Inventory Optimization Strategies

2.1 Sales forecasting strategies and methods

According to the results of big data mining of product sales, design the product sales forecasting algorithm of cross-border e-commerce big data.

The steps are as follows.

Step 1:

By using the multiplier level analysis and support vector machine clustering method, the "potential, initial, frequent, frequent, loyal" five levels of consumer level collection XFD is divided offline, mining the classification relationship between data such as trend characteristics of data series, external environment information and internal business information $LS_{i,j}$. By establishing an expert evaluation preference matrix to calculate the five levels of consumer's classified confidence fZX_i, the impact weight of the si, and the overall satisfaction of ZMD_i, the impact of each factor on the five levels of customer yXY_i.

Step 2: Roulette selection using distributed quantitative prediction strategy extracts product content features NAT, structural feature GAT, topological feature TAT, timing feature SAT, user reply relationship UHR, and other meta-information features from an online database to form a collection of QYAT = { GAT_i, TAT_i, SAT_i , UHR_i }

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Step 3: A comprehensive empowerment approach using a centralized qualitative forecasting strategy extracts key factors from QYAT and analyzes online search data using customizable, highly scalable consumer information index XXI_i, sentiment index XQI_i, confidence index XII_i, job search index GSI_i, and retail information index LXI_i WSXL (x) is the correlation between data and product sales. According to formula (1), smooth adjustment of exponential coefficient or learning cumulative probability, so that the function WSXL (x) stacked multiple times, so that the correlation evolutionary relationship adjustment amount to the specified convergence

Step 4: Using multi-nonlinear regression analysis method to establish conditional set attribute SJS, decision set property on JCS, adaptability SMD and corresponding affiliate function LSH (x), establish the dependence RR (x,y) between real predictors or attribute functions in the interval interval, resulting in problem identification, information search, evaluation selection, decision purchase, The rule knowledge set GZS for post-purchase evaluation, as well as structural characteristics linked density and average density and unexpected rules, are designed as parallel consolidated sales valueregression prediction target functions as shown in Equation (1):

$$ZXLY(x)=\frac{HSI_i \cdot TJS \cdot JCS \cdot SMD \cdot RR(x,y)}{\prod_{x}^{|GZS|} LSH(x) \cdot \langle NAT_i,\ GAT_i, TAT_i, SAT_i, UHR_i \rangle !} \quad (1)$$

According to Equation (1), the number of consumers may be expected to buy on a moving average and in a slot period, using the maximum-decline method under the Euclid model, thereby predicting future product sales based on different density attributes.

2.2 Inventory optimization strategy and method product sales forecast based on sales forecast results are the key factors affecting inventory.

According to the sales forecast strategy, method and regression prediction function, collect the ERP system saving supply and demand information, assuming that the total demand of the forecasted product is GRN, the production and manufacturing, the cost of sales is MP and SP, the logistics cost is WP, the equilibrium inventory is JHK, the purchase unit price is PRICE, the purchase cost is fixed to COST, The warehouse

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rate is RATE and the total cost of inventory is TOTAL. First, make ZXLY (x) a monotony function, obtain the raw data of sales forecast (order data and its processing cost data, warehouse and supplier geographic data, logistics and distribution data) online, and use cross-operators to calculate all the extreme values and minimum points within the time interval. Calculate the COST and RATE values.

Then, according to the "spatial clustering" idea, through the filter function filter filtering the maximum value, the minimum value of two endpoints pollution data and errors, calculated the inventory safety level KAL, the order lead period of demand changes in the standard variance BZFC, order lead time days N, so as to get the following online inventory efficiency optimal solution formula ZYJ:

$$ZYJ=\frac{\lim_{x\to N}(ZXLY(x)\cdot COST\cdot RATE\cdot BZFC\cdot KAL)}{GRN\cdot PRICE\cdot MP\cdot SP\cdot WP\cdot JHK\cdot TOTAL} \quad (2)$$

According to the formula (2), enter the relevant parameter values, you can quantitatively optimize inventory, inventory cost and balanced procurement number, realize cross-border e-commerce ERP system supplier selection, inventory inventory, full use of funds, suppliers, manufacturers and retailers according to the forecast model to obtain the forecast results, jointly develop inventory plan, Establish an online sales network management system and online inventory response system based on big data analysis, determine inventory optimization parameters, and feed demand and forecast results into inventory information system management department, so as to drive intelligent and efficient inventory balancing and transfer, improve inventory efficiency, upgrade inventory strategy and safety level, eliminate inventory crisis to ensure the smooth running of cross-border e-commerce enterprises. In order to provide data processing logic to machine learning algorithms, the product sales forecasting model and the optimal inventory solution function are expressed in Python language as follows:

‘’Multi-nonlinear regression analysis prediction function

def ZXLY(x=0.0,y=0.0,i=0):

val=HSI[i]*TJS*JCS*SMD*RR(x,y)/ConMulti(LSH(x))*ExcGroup(QYAT)

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```
)
    # multiple-factor accumulative multiplication
        return val

    ‘’Inventory optimal solution equation ZYJ
    def ZYJ(x=0.0,N=0):
        val=limitCalc(inv(x,N))
     # Find the limit of inventory function
        return val
```

3.Machine Learning Algorithms Processing Sales Volume Data

Through mathematical statistics, the content characteristics, structural characteristics, topological features, timing characteristics, trend characteristics, user response relationship and other meta-information characteristics, as well as consumer information index, sentiment index, confidence index, job search index, retail information index and inventory optimization keyword search data, the classification of consumers. Due to the different magnitude, residual, and space-time range slots of data, the raw data needs to be standardized through the Z-score standardized covariance matrix, with the first 150 sample sets of data selected as training data and the remaining 205 groups as test data. Using training regression means, we can verify the practicality of product sales forecasting and inventory optimization strategies, methods and comprehensive models. Here are the steps:

Step 1: In the process of simulation prediction, the noise of 150 sample data can be solved by exponential smoothing, the specific experimental results are calculated according to the equation (1) - (3), the weight coefficient of can be customized and highly extensibility is calculated, the relevant evolutionary relationship WSXL (x), and the forecast value is obtained by comprehensive empowerment based on the observation, expectation, actual value of the most recent <HSIi ,wsxl(x)>period. </HSIi>

Step 2: The demand and forecast results are fed back into the ERP inventory information system management module to improve inventory health. The empirical effect evaluation index is as follows:

Adaptability (trust interval of s.14 -18), overall variance (trust interval of .0- 0.

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12), coupling coefficient (trust interval is .20-26), tight attribution (confidence interval is .0. 88-1. 0), optimal inventory equilibrium (trust interval is .0. 9-1. 0). These indices are obtained by the following formula of mean square deviation:

$$ZFE(\mathrm{x}_j)=\frac{JSXS}{ZYJ^{n_i}}\sum_{x=1}^{n}(ZXLY(x)\cdot WSXL(x)) \quad (3)$$

Call the training set from the TensorFlow Machine Learning Library and implement machine learning algorithms to process data (Python) as follows:

```
#Import tensorFlow Machine Learning Library
…
#Import sales statistics and inventory data
…
#Rough division of sales and inventory training sets and test set data
X_test = sales[0:5].reshape(-1,1)
y_test = inventory[0:5]  X_train =sales[5:].reshape(-1,1)  y_train = inventory[5:]
W=tf.Variable(tf.zeros([1,1])) #Set slope (weight value) W variable
b=tf.Variable(tf.zeros([1])) #Set intercept (bias) b variable
y=tf.matmul(x,W)+b #Set the linear model y=Wx-b
y_=tf.placeholder(tf.float32,[None,1]) #Set placeholders to enter the actual y value
cost=tf.reduce_sum(tf.pow((y_-y),2)) #Set up cost function (minimum variance)
#Utilize gradient descent at the rate of 0.000001 to minimize cost function, in order to get the values of W and b
train_step=tf.train.GradientDescentOptimizer(0.000001).minimize(cost)
#Initialize variables before training
#Implementation Details
sess.run(init) #Use the model after session starts running
cost_history=[] #create a list to keep track of cost history
#train 100 times with the data set
# Implementation Details…
#Apply the model to perform prediction
 print ("Apply the model to perform prediction:")
print ( sess.run(y, feed_dict={x: [[99]]}) )
```

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```
# Use test data set to calculate MSE of the model
pred_y = sess.run(y, feed_dict={x: X_test})
mse = tf.reduce_mean(tf.square(pred_y - y_test))
print("MSE: %.4f" % sess.run(mse))
#Plot test product sales, prediction sales and its associated inventory
 """
fig, ax = plt.subplots()
ax.scatter(y_test, pred_y)
ax.plot([y_test.min(), y_test.max()], [y_test.min(), y_test.max()], 'k--', lw=1.5)
ax.set_xlabel('Measured')
ax.set_ylabel('Predicted')
plt.show()
"""
```

4.Cross-border E-commerce ERP System Integrated Inventory Optimization Module

Cross-border e-commerce ERP system can be divided into: the implementation of supplier evaluation system, logistics channel optimization algorithm, as well as supplier product management implementation, inventory management of the order interface, and other management functions module interface.

4.1upplier Product Management Implementation

System product management main interface, machine learning algorithm through the product SKU to search for products, the implementation of optimal inventory strategy, you can select the product off the shelf, can also be in accordance with the product upload template to organize the product's Excel file batch of products uploaded to MySQL database, The Details button in each product record can pop up to show all the information about the product and modify the product information. The home page on the mobile phone can notify the user of the cumulative number of orders for the current week, the current store's positive rating, and the number of messages that need to be answered and the number of orders that need to be shipped.

The comprehensive evaluation effect of machine learning algorithms is shown in Table 2.

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Table 2 Evaluation of the effectiveness of the composite model

Fitness	The overall variance	The coupling coefficient	Compact attribution	Optimal inventory equilibrium rate
16.3	0.1	25	0.91	0.95

From the evaluation effect analysis of Table 2, it can be seen that in the process of product sales prediction, some extreme point pollution data and deviations were eliminated, the model trained by the machine learning algorithm was fully fitted, the customizable coupling coefficient, adaptability, tight attribution, optimal inventory equilibrium rate was effectively improved, the overall variance, The error was effectively controlled. This shows that the most recent observation, expectation, and contribution of the product content, structure, topology, timing, trend, user response relationship, and keyword search features such as consumer information, mood, confidence, job search, retail information index and inventory optimization, etc., The basic trend of the actual value is synchronous, according to which the corresponding forecast value of the subsequent period skews with little deviation from the actual value, and filter the pollution data and errors of the maximum value and the minimum value, calculate the inventory safety level KAL, the standard variance of demand change slot during the order lead period, BZFC, the number of days in advance of the order, With the best inventory balancing efficiency.

Therefore, the experiment proves that in the environment of cross-border e-commerce ERP system, the strategy, method and comprehensive model based on the sales forecast and inventory optimization of big data products of cross-border e-commerce have certain advantages.

5. Conclusion

Product sales forecast is a key factor affecting inventory optimization. Mining and analyzing big data of product sales and forecasting future sales have become an important research area of cross-border e-commerce ERP system. In this paper, through the major Internet search engines, we mine the historical traces of products purchased by consumers on the cross-border e-commerce ERP platform, search index of keywords, classify consumers, and build a stable and reliable database of key

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factors, so as to design a sales volume prediction and inventory optimization strategy, method and comprehensive model based on machine learning algorithm in the cross-border e-commerce ERP system environment. The experiment shows that the relevant indexes are all more than other inventory optimization schemes.

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