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Information Security in the Market-Oriented Operation of The "Yixin Europe" China Europe Freight Train Based on Improved ESN Algorithm

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Abstract:

In order to improve the scientific of the market-oriented operation mechanism of "Yi-Xin-Europe" China-Europe train, this paper combines intelligent methods to analyze the market-oriented operation mechanism and implementation strategy of "Yi-Xin-Europe" China-Europe train. This paper presents the mathematical principles and algorithm flow of two online training algorithms, ESN-LMS and ESN-RLS. Moreover, this paper designs a set of experiments to verify the good nonlinear approximation ability of ESN, and uses the classical ridge regression algorithm and two online training algorithms to predict the Mackey-Glass nonlinear time series. In addition, this paper applies the improved algorithm to the market-oriented operation mechanism of "Yi-Xin-Europe" China-Europe train. Through experimental research, we can see that the market-oriented operation mechanism of "Yi-Xin-Europe" China-Europe train proposed in this paper has a good effect.

Key words: Internet; China-Europe train; marketization; operation mechanism; Information security

1 INTRODUCTION

Cross-border shipments go through a myriad of different countries. For example, "Yi-Xin-Europe" passed through Kazakhstan, Russia, Belarus, Poland, Germany, and France, and finally arrived in Madrid, Spain after 21 days. Since different countries have different customs and cultures, it is inevitable that there will be some conflicts due to different cultures and customs during transportation. The laws of different countries are different, so there may be some prohibited items caused by different cultures in the transportation of goods, which is not conducive to transportation. The geographical limitations of train transportation are too strong to reach any continent of the world like sea and air transportation. Although the transportation speed is relatively fast, it is still inferior to air transportation. For some goods that need fast transportation, train transportation is not a good choice, such as flower transportation [1]. Because the transportation time is too long, the requirements for preservation have risen sharply. Compared with air transportation, it costs more for preservation. Although its transportation speed is better than that of sea transportation, in terms of transportation volume, sea transportation is countless times more than train transportation. In transporting large quantities of goods, sea transportation is more cost-effective than train transportation. China is a big manufacturing country, and the daily transportation volume is huge. Train transportation is far from meeting this logistics demand. Therefore, for China, the value of sea transportation is more important than train transportation [2].

When passing through each country, the country has the right to carry out customs inspection of goods. This is for the sake of national security and national taxation, but cross-border transportation is racing against time, and repeated customs inspections undoubtedly hinder the speed of cross-border transportation. Under the premise of ensuring national security and tax revenue, the customs should reduce the steps of customs inspection as much as possible. For example, one inspection can be carried out when the goods are loaded, one inspection after getting off the car, and no inspection during transportation [3]. When goods pass through a country, the country has the right to collect transit taxes on the goods. Cross-border trains have to pass through countless countries along the way, which increases the cost of transportation a lot and hinders the reduction of the cost of cross-border transportation [4].

The train runs for a long time. The main factors that lead to the long running time of the train are: First, the transit and rail change (installation) affect the traffic efficiency. The train runs in the overseas section, and the whole journey requires three transitions and three rail changes (installation). The detention time of the trains at various ports accounts for about 30% of the entire running time, of which the detention for other reasons such as transport capacity connection accounts for 40%. Second, there are certain difficulties in transit and customs clearance. Due to the characteristics of small commodity trade, such as miscellaneous categories and LCL, it is difficult to make the packing list consistent with the customs declaration. As a result, when customs transit and customs clearance, it takes longer than traditional general trade goods to transit customs, and the inspection and release The risk is high, which affects the efficiency and stability of the train. The third is the slow running speed of the train [5]. The total length of the domestic section of the train is 4,645 kilometers, but the train takes four and a half days to run, and the average speed is only 43 kilometers per hour. The cost of train transportation is high. The main reasons for the still high freight rates of trains are as follows: First, the freight rates of overseas sections are relatively high. Since the normal operation of the train has not been realized, the operating cost per kilometer of the overseas section is 8.52 yuan, which is higher than the domestic 4.51 yuan. In addition, due to the different situations of cooperation with foreign railway transportation companies, the right to speak in freight rate negotiation is also different, and foreign freight rates have a certain room for reduction [6]. In addition, during the operation of the overseas section of the train, frequent rail changes (installation) and customs transfers also increase the logistics cost. Second, severe cold weather additionally increases operating costs. In the early stage, the train passed through Russia, Kazakhstan and other countries. It was in the freezing and low temperature season. The minimum temperature was -20 °C. High-performance thermal insulation facilities must be added to ensure that products such as glass bottled red wine and olive oil can pass through the cold zone smoothly. The organization of supply is to be standardized. The main factors affecting the organization of the source of goods are as follows: First, the non-normal operation of the trains and the collection of goods in different places affect the organization of the source of goods. Since the train has not really realized the "five determinations" (fixed station, fixed route, fixed number of trains, fixed time, fixed price), the opening time and operation duration are uncertain, and the operating cost of the train is relatively high, which has a great impact on the grouping of goods. . Second, the supply of goods for the return journey is relatively small. The development of logistics must realize two-way operation in order to effectively reduce logistics costs. However, the current Sino-European trade structure determines that the supply of return goods is relatively small, and it is urgent to strengthen the organization of return goods [7].

Extend and expand the train industry chain. Focus on the development of three businesses: First, export railway LCL (China-Europe) business. In accordance with the international professional LCL management standards, we have established a train LCL supervision warehouse, and implemented the mode of "declaration, warehouse inspection, and LCL release" for export goods to improve customs clearance efficiency. The second is the import and export railway express (Yi-Europe Express) business [8]. "Yixinou Overseas Warehouses" have been set up in Almaty, Moscow, Berlin, Paris, Madrid and other cities to provide warehousing and transportation services for international express mail. The third is international business services. Carry out Internet finance, offshore settlement, trade financing and other businesses closely related to Yixinou manifest financing and trade financing, and set up "Yixinou" commodity exhibition, procurement services, electronic payment, and marketing service centers to create a "Yixinou" product center. "A big data platform for business, logistics, customs clearance, payment, and authentication of the entire industry chain [9]. Increase import and export market cultivation. In the key cities of the countries along the route of the train, the Yiwu market distribution display center and distribution network will be established to transform from exporting commodities to exporting markets. At the same time, relying on the advantages of Yiwu market and bonded logistics center, cultivate and develop import and transit markets, and promote Yiwu to become a bridgehead and transit station connecting international and domestic markets[10].

Reference [11] pointed out that the main problems of the current China-Europe trains are the serious reliance on government subsidies, insufficient return goods, and empty boxes sold on the spot, and proposed measures to strengthen the benefits of countries to China-Europe trains and improve the construction of the information platform. Suggestions to improve efficiency. Literature [12] summarizes the existing problems mainly including insufficient capacity of port stations, inconsistent railway transportation rules in countries along the route, disordered price wars, and failure to achieve market-oriented operations, and proposes to assist countries along the route to do a good job in infrastructure construction, unified Standards, government organizations to maintain market order, and the establishment of intelligent information platforms, etc. Literature [13] believes that the main problems of China-Europe freight trains are insufficient supply of goods, shortage of port capacity, inconsistent transportation rules, chaotic management, and serious dependence on government subsidies. Combined transportation and other suggestions. Literature [14] pointed out that the information exchange on the foreign section of the China-Europe freight train is not timely, the transit time is long, and the level of equipment intelligence is not high. It is necessary to strengthen the exchange of talents and information, improve the establishment of facilities, and strengthen the construction of transit logistics. Reference [15] applied the SWOT analysis method and pointed out that the main problems of the current China-Europe trains are weak infrastructure, high logistics costs, heavy dependence on government subsidies, complicated customs clearance procedures, less return goods, and repeated routes. Literature [16] proposes that the three major factors restricting the development of China-Europe freight trains are insufficient supply of goods at the origin, high comprehensive cost, and heavy reliance on government subsidies. It is necessary to speed up the establishment of a comprehensive information platform, strengthen the government's macro-control and focus on improving the corresponding mechanism. building. Literature [17] pointed out that there are insufficient return goods, severe reliance on government subsidies, high logistics costs, complicated customs clearance procedures, and backward infrastructure in countries along the way. , optimize transportation routes, improve service quality, etc.

This paper combines the intelligent method to analyze the market-oriented operation mechanism and implementation strategy of the "Yi-Xin-Europe" China-Europe train, and promote the operation effect of the "Yi-Xin-Europe" China-Europe train.

2 INTELLIGENT TRAIN OPERATION OPTIMIZATION DATA PROCESSING ALGORITHM MODEL

In this paper, the echo state network model is mainly used for data processing in the research on the market-oriented operation process of China-Europe trains.

2.1 Topology of echo state networks

The topology of the standard ESN is shown in Figure 1. The network consists of three parts: the input layer, the dynamic reserve pool and the output layer. The dynamic reserve pool in the middle imitates the thinking mechanism of the animal brain, and is formed by a large number of neurons sparsely connected to form a network. It realizes short-term memory function by dynamically updating the internal state of the reserve pool, and can show good nonlinear approximation ability. The output layer contains the feedback connection from the output to the reserve pool (shown by the dotted line in the figure), which can also be ignored in order to simplify the network structure.

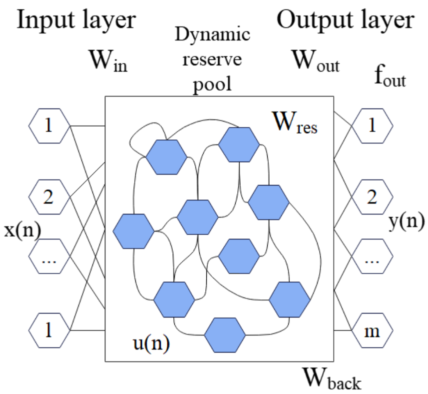


Figure 1 Topology of echo state network

The expressions for the pool state update and network output are as follows:

$$u(n) = f\left(W_{res}u(n-1) + W_{in}x(n) + W_{back}y(n-1)\right) \quad (1)$$

$$y(n) = f_{out}\left(W_{out}u(n)\right) \quad (2)$$

$f(\cdot)$、$f_{out}(\cdot)$ is the activation function of the neurons in the reserve pool and the readout function of the output layer, respectively, among which, $f(\cdot)$ usually uses a nonlinear function (such as the tanh function, the sigmoid function and other "S" type functions). $f_{out}(\cdot)$ performs nonlinear readout on the output nodes of the network, and it can also perform linear function readout, such as $f_{out}(\cdot)=1$.

Through the dynamic analysis of the RNN structure shown in Figure 1, it is found that when the state of the reserve pool is under certain conditions, the influence of the current state $u(n)$ and the current input $x(n)$ on the future state $u(n+k)$ will gradually disappear over time. In this case, the dynamic reserve pool is more inclined to reflect the latest input data, and the network has echo characteristics.

ESN has a dynamic reserve pool sparsely connected by a large number of neurons, which can map input data from low-dimensional nonlinear space to high-dimensional space. In the process of ESN learning, firstly, the input weight W_{in} and the reserve pool state weight W_{res} need to be randomly initialized and kept fixed, and then only the output weight W_{out} is adjusted when training the neural network.

The training sample $\left(x(n),y_t(n)\right),y_t(n)\in £^{m\times 1}$ is the target output when the network input is $x(n)$. The training process of ESN is as follows:

(1) Network initialization:

Each weight matrix of ESN is initialized, where W_m, W_{res} and W_{back} are randomly generated and remain unchanged during the dynamic update process of the network. In order to ensure the echo characteristics of the network, W_{res} needs to choose an appropriate spectral radius. In order to simplify the calculation, W_{back} is set to 0, that is, the feedback of the output layer to the reserve pool is ignored.

(2) Collect the state of the reserve pool and the target output matrix:

At time $n(n=1,2,\ldots,L)$, the input data $x(n)$ is input into the reserve pool of ESN, and the state of the reserve pool is updated according to equation (1) to obtain a new state matrix $u(n)$. The new state matrix is collected. Due to the dynamic characteristics of the reserve pool, the network is more sensitive to the input initial data, so the reserve pool is usually "idle" first. If it is assumed that the reserve pool state matrix $u(n)$ and the target output matrix are collected from time t_0, when n=L, the reserve pool matrix $U=\left[u(t_0),u(t_0+1),\ldots,u(L)\right]^T$ with dimension $N\times\left(L-t_0+1\right)$ and the target output matrix $T=\left[y_t(t_0),y_t(t_0+1),\ldots,y_t(L)\right]$ with dimension $m\times\left(L-t_0+1\right)$ can be obtained.

(3) Train output weight W_{out}:

The algorithm trains the output weight W_{out} of the network according to the training sample $\left(x(n),y_t(n)\right)$ input at time n and the state $u(n)$ of the reserve pool. We assume that the state $u(n)$ of the reserve pool is linearly related to the output $y(n)$ of the network, that is, the readout function of the output layer is $f_{out}(\cdot)=1$. In order to make the actual output $y(n)$ of the network approximate the expected output $y_t(n)$ of the data sample, namely:

$$y_t(n)\approx y(n)=W_{out}(n)u(n) \quad (3)$$

That is, the expected output weight W_{out} of the network can minimize the mean square error of the system, namely:

$$W_{out} = arg\,min\left\|W_{out}U - T\right\|^2 \quad (4)$$

The output weight W_{out} of the network can be obtained by solving equation (4) by using the linear regression method.

$$W_{out} = U^{\bullet\&}T \quad (5)$$

The direct pseudo-inverse calculation has high numerical stability, but requires larger storage overhead for the reserve pool matrix with too high dimension, which limits the size of the reserve pool N or the number of training samples. This problem can be solved by solving the norm equation system, namely:

$$W_{out}UU^T = TU^T \quad (6)$$

The solution of the equation is obtained as:

$$W_{out} = TU^T\left(UU^T\right)^{-1} \quad (7)$$

It can be seen from equation (7) that $TU^T \in £^{m\times N}$ and $UU^T \in £^{N\times N}$ do not depend on the length $\left(L - t_0 + 1\right)$ of the training samples and can be calculated incrementally as the training data passes through the reservoir. Therefore, the solution of equation (7) is independent of $\left(L - t_0 + 1\right)$ in space or time complexity. Compared with the direct pseudo-inverse, the numerical stability obtained by this method is poor. In addition, the pseudo-inverse $\left(UU^T\right)^{\dagger}$ can also be used to replace the real inverse $\left(UU^T\right)^{-1}$, and a smaller computational complexity can also be obtained.

In addition, by adding a regular term to equation (4), W_{out} can be solved by ridge regression, namely:

$$W_{out} = arg\,min\left\|W_{out}U - T\right\|^2 + \lambda\left\|W_{out}\right\|^2 \quad (8)$$

Solving the above equation by least squares, we can get:

$$W_{out} = TU^T\left(UU^T + \lambda I\right)^{-1} \quad (9)$$

In addition to improving numerical stability, the regularization of W_{out} also reduces the sensitivity to noise and prevents overfitting.

2.2 Online training algorithm for echo state networks

The adjustment of the parameters of the LMS algorithm is based on the error correction learning rule, which is easy to implement and widely used. Therefore, the LMS algorithm can be used for ESN training with lower computational complexity than other learning methods.

The actual output of ESN is:

$$y(n) = W_{out}(n)u(n) \quad (10)$$

The error signal of ESN is:

$$e(n) = d(n) - y(n) \quad (11)$$

$d(n)$ is the expected output of ESN. By substituting equation (11) into equation (10), the error signal of ESN can be rewritten as:

$$e(n) = d(n) - W_{out}(n)u(n) \quad (12)$$

The mean square error of ESN is defined as the cost function, namely:

$$J(n) = E\left[|e(n)|^2\right] = E\left[\left|d(n) - W_{out}(n)u(n)\right|^2\right] \quad (13)$$

In order to minimize the cost function, the weight vector W_{out} of the ESN output layer is adaptively adjusted by the steepest descent method, namely:

$$W_{out}(n+1) = W_{out}(n) + \mu(-\nabla(n)) \quad (14)$$

Equation (14) searches for the minimum value of the surface along the negative gradient direction of the performance surface.

The mean square error in equation (13) is replaced by the square error, and the instantaneous estimated value of the gradient vector is:

$$\nabla(n) \approx \hat{\nabla}(n) = \frac{\partial J(n)}{\partial W_{out}(n)} = \frac{\partial e^2(n)}{\partial W_{out}(n)} \quad (15)$$

We can get:

$$\hat{\nabla}(n) = 2e(n)\frac{\partial e(n)}{\partial W_{out}(n)} = 2e(n)u(n) \quad (16)$$

Finally, the iterative formula of the ESN output weight W_{out} based on the minimum mean square error is obtained:

$$W_{out}(n+1) = W_{out}(n) + 2\mu e(n)u(n) \quad (17)$$

It can be shown that: $\hat{\nabla}(n)$ is an unbiased estimate of $\nabla(n)$. That is, if multiple observations of $u(n)$ are obtained before W_{out} is updated, and W_{out} is adaptively adjusted according to the statistical average value $E[\hat{\nabla}(n)]$ of the gradient, the converged iterative result must be consistent with the ideal output weight.

Recursive least squares (RLS) is an algorithm based on least mean square error (LMS). RLS is the most important fast convergence algorithm in linear signal processing, and it is a recursive online estimation method of weight vector. Using the RLS algorithm to train the output weights of the ESN online has a faster convergence rate than the LMS algorithm.

The process of online training of ESN using the recursive least squares (RLS) algorithm is as follows.

First, the algorithm weights the square of the error at all times of the ESN, namely:

$$J(n) = \sum_{k=0}^{n} \lambda^{n-k} \| e(k) \|^2 \quad (18)$$

In order to better track the signal in the non-stationary state, the time forgetting factor is introduced to modify the cost function. When $\lambda = 1$, this expression agrees with the standard squared error.

The gradient of the weighted sum of squares function (18) is:

$$\nabla J(n)=\mathrm{R}(n)\mathrm{W}_{out}(n)-\mathrm{r}(n) \quad (19)$$

According to the optimal solution of the least squares optimization problem given by $\nabla J(n)=0$, we can get:

$$\mathrm{W}_{out}(n)=\mathrm{R}^{-1}(n)\mathrm{r}(n) \quad (20)$$

Equation (20) is solved in a time-recursive manner. Considering the time recursion of the network output weight $\mathrm{W}_{out}(n)$, the autocorrelation matrix $\mathrm{R}(n)$ and the cross-correlation matrix $\mathrm{r}(n)$ are estimated recursively, namely:

$$\mathrm{R}(n)=\lambda\mathrm{R}(n-1)+\mathrm{u}(n)\mathrm{u}^{H}(n) \quad (21)$$

$$\mathrm{r}(n)=\lambda\mathrm{r}(n-1)+\mathrm{u}(n)\mathrm{d}(n) \quad (22)$$

Using the matrix inversion lemma, the recursive formula of the inverse $\mathrm{P}(n)=\mathrm{R}^{-1}(n)$ of the autocorrelation matrix $\mathrm{R}(n)$ in equation (21) can be obtained as follows:

$$\begin{aligned}\mathrm{P}(n)&=\frac{1}{\lambda}\left[\mathrm{P}(n-1)-\frac{\mathrm{P}(n-1)\mathrm{u}(n)\mathrm{u}^{H}(n)\mathrm{P}(n-1)}{\lambda+\mathrm{u}^{H}(n)\mathrm{P}(n-1)\mathrm{u}(n)}\right]\\&=\frac{1}{\lambda}\left[\mathrm{P}(n-1)-\mathrm{k}(n)\mathrm{u}^{H}(n)\mathrm{P}(n-1)\right]\end{aligned} \quad (23)$$

Among them, $\mathrm{k}(n)$ is the Kalman gain, which is expressed as:

$$\mathrm{k}(n)=\frac{\mathrm{P}(n-1)\mathrm{u}(n)}{\lambda+\mathrm{u}^{H}(n)\mathrm{P}(n-1)\mathrm{u}(n)} \quad (24)$$

By substituting equations (21) and (22) into equation (20), we get:

$$\begin{aligned}\mathrm{W}_{out}(n)=\mathrm{P}(n-1)\mathrm{r}(n)+\frac{1}{\lambda}\mathrm{d}(n)\left[\mathrm{P}(n-1)\mathrm{u}(n)-\mathrm{k}(n)\mathrm{u}^{H}(n)\right]\\-\mathrm{k}(n)\mathrm{u}^{H}(n)\mathrm{P}(n-1)\mathrm{r}(n-1)\end{aligned} \quad (25)$$

By substituting Equation (26) into Equation (25), the iterative formula of the output weight $\mathrm{W}_{out}(n)$ of ESN can be obtained:

$$\mathrm{W}_{out}(n)=\mathrm{W}_{out}(n-1)+\mathrm{k}(n)\mathrm{e}^{*}(n) \quad (26)$$

Among them,

$$\mathrm{e}(n)=\mathrm{d}(n)-\mathrm{W}_{out}(n-1)\mathrm{u}(n) \quad (27)$$

$\mathrm{e}(n)$ is the prior estimation error, and $\mathrm{P}(0)=\mathrm{R}^{-1}(0)$ needs to be initialized in the ESN. Due to the forgetting effect of the forgetting factor λ in the summation process, $\mathrm{R}(0)$ plays a small role in the recursive calculation of the autocorrelation matrix. Therefore, a small identity matrix can be used to approximate the autocorrelation matrix $\mathrm{R}(0)$, that is, $\mathrm{R}(0)=\delta\mathrm{I},\delta$ is a small positive number. Therefore, the inverse of the autocorrelation matrix can be initialized as $\mathrm{P}(0)=\delta^{-1}\mathrm{I}$.

3 Analysis model of market-oriented operation mechanism of "Yi-Xin-Europe" China-Europe train based on intelligent model

By summarizing transportation information, it is necessary to plan on the top-level design of information, open up the internal information exchange channel of China Railway Express, and help the internal information flow of China Railway Express. At the same time, it is necessary to use the platform to centrally and uniformly publish the return transportation information, and expand the channels for customers to obtain information about the return train service online, so that they can choose the transportation method after understanding the information, and place an order to reserve the train cabin. Figure 2 shows the overall plan for the final design of the return information marketing platform for China-Europe trains.

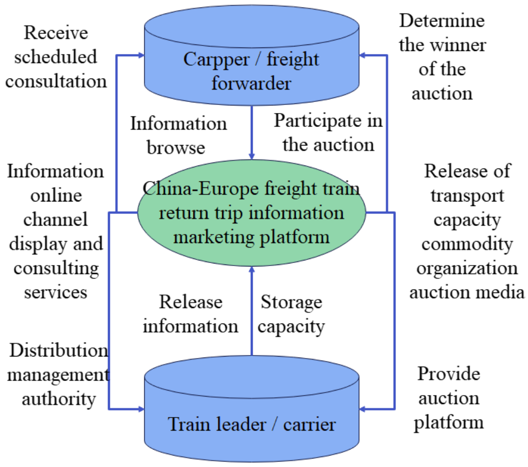


Figure 2 The overall plan of the China-Europe train return platform

Decentralized publishing refers to decentralizing the information publishing function to the smallest sub-department that can take responsibility. This kind of department is often on the field front line of the business and is the actual operation department of the business. The publishing authority is delegated through the enterprise internal network or other secure domain network, and the person in charge of the sub-department directly manages and publishes the demand information. In this way, the steps and time for information collection are reduced, the workload of the data administrator in the main center of the platform is reduced, and it is more conducive to efficient updating of operation and management information. The decentralized publishing mechanism is shown in Figure 3.

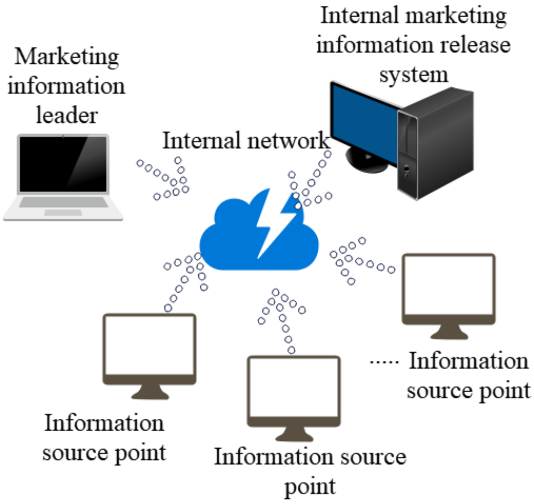


Figure 3 Decentralized collection and release mechanism

Based on the analysis of the main related external networks, data flow interfaces, and various server requirements, the network connection relationship between the internal network of the platform, the data transmission network of the management system, the user access network, and the internal network of the railway group and the enterprise network of the operating company is sorted out. The overall structure of the constructed network is shown in Figure 4.

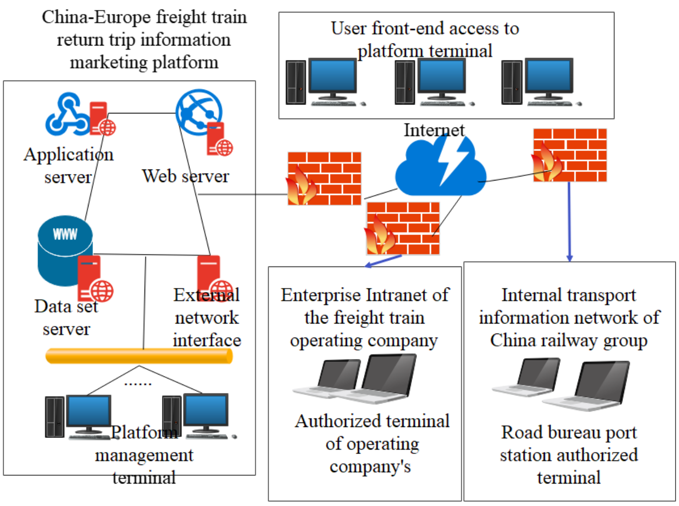


Figure 4 System network structure design

The data simulation verification is carried out in combination with the constructed model. The simulation experiment of time series prediction is carried out for the classical training algorithm of ESN, the ESN-LMS algorithm and the ESN-RLS algorithm. The performance difference of the algorithm is analyzed through the experimental results.

In order to verify that ESN has good nonlinear approximation ability, three algorithms are used for the prediction of Mackey-Glass nonlinear time series. The Mackey-Glass equation is a nonlinear time-delay differential equation, which is expressed as follows:

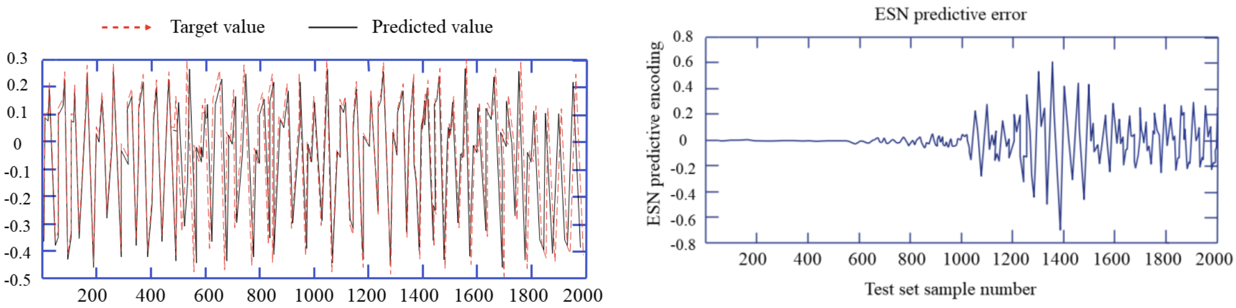
$$\frac{ds(t)}{dt}=\frac{0.2s(t-\tau)}{1+s^{10}(t-\tau)} \quad (28)$$

When τ is greater than 17, the Mackey-Glass equation is a chaotic system, and the Runge-Kutta method is used to generate 10,000 time series samples. Since the classic training algorithm of ESN is an offline training method, the samples are divided into training set and test set. The ESN-LMS and ESN-RLS algorithms directly use data samples for online training. The number of input nodes of ESN is l=1, the number of output nodes is m=1, the activation function of the neurons in the reserve pool is $f(\cdot)=tanh(\cdot)$, the readout function is $f_{out}(\cdot)=1$, the spectral radius of the reserve pool is $\rho\left(W_{res}\right)=0.9$, and the sparsity is $SD=0.2$. In this experiment, the mean square error (MSE) is used as the performance evaluation standard of the three algorithms, and the calculation formula is as follows:

$$MSE=\frac{1}{L}\sum_{n=1}^{L}(y(n)-d(n))^2 \quad (29)$$

Among them, L is the data length.

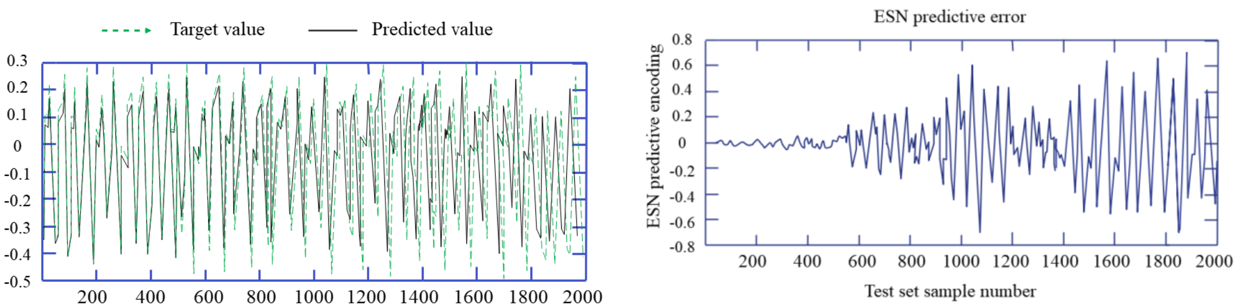
For the classic training algorithm of ESN, 5000 data samples are used as training samples, and the remaining data are used as test samples, and the output weights of ESN are trained by means of ridge regression, in which the regularization coefficient is $\lambda=10^{-8}$. Figure 5(a) and Figure 5(b) are the prediction results and prediction error curves (take the first 2000 predicted values) when the size of the ESN's reserve pool is N=400, respectively.



(a) Prediction results of ESN time series (N=400)   (b) Forecast error of ESN time series (N=400)

Figure 5 Simulation of ESN time series (N=400)

Figure 6(a) and Figure 6(b) are the prediction results and prediction error curves (take the first 2000 predicted values) when the size of the reserve pool is N=200. Compared with the prediction results when N=400, it can be seen that when the size of the reserve pool is larger, the dynamic memory effect of the network is better, the echo characteristic of the reserve pool is stronger, and the prediction ability of time series is also stronger.



(a) Prediction results of ESN time series (N=200)   (b) Forecast error of ESN time series (N=200)

Figure 6 Simulation of ESN time series (N=200)

Figure 7 is a graph of MSE values of two online algorithms, ESN-LMS and ESN-RLS. It can be seen from the figure that ESN-RLS has a faster convergence rate than ESN-LMS algorithm. ESN-LMS algorithm needs 6000 iterations to converge, while ESN-RLS algorithm only needs 2000 iterations.

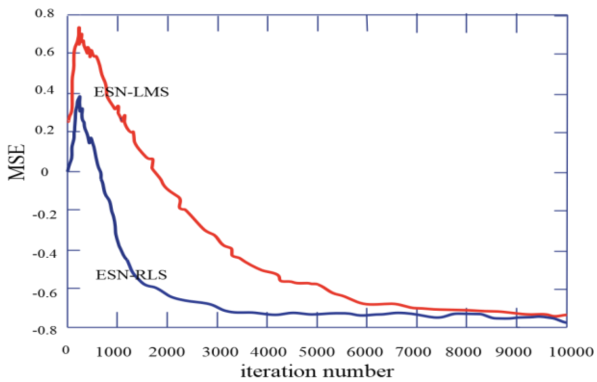


Figure 7 MSE value curves of two online algorithms

It can be shown that the convergence of the LMS algorithm strongly depends on the eigenvalue expansion of the covariance matrix, and singularity or near singularity of the state matrix of the reserve pool is common and thus may cause the convergence failure of the algorithm. In conclusion, the LMS algorithm is an online training method with low computational complexity but has a convergence problem. The algorithm has to adjust the iteration step size according to the eigenvalues of the covariance matrix, which is not known in the online environment. Even with the correct iteration step size, the convergence rate is slow (as shown in Figure 7).

However, the recursive least squares (RLS) algorithm computes the least squares solution before that step at each step and, in theory, provides a pseudo-inverse solution at the end of training.

On the basis of the above model, the effect of the market-oriented operation mechanism of the "Yi-Xin-Europe" China-Europe train proposed in this paper is evaluated, and the evaluation results shown in Table 1 are obtained.

Table 1 Evaluation results of the market-oriented operation mechanism of "Yi-Xin-Europe" China-Europe train

Num	Mechanism evaluation	Num	Mechanism evaluation	Num	Mechanism evaluation
1	81.07	18	85.03	35	86.27
2	84.60	19	81.11	36	83.80
3	88.28	20	85.75	37	83.29
4	86.03	21	86.25	38	88.70
5	83.96	22	85.31	39	81.34
6	85.46	23	83.81	40	88.14
7	87.53	24	81.48	41	84.49
8	83.02	25	82.73	42	85.71
9	88.59	26	84.13	43	88.03
10	87.60	27	83.77	44	82.40
11	81.21	28	88.70	45	83.93
12	86.39	29	87.78	46	81.99
13	81.04	30	88.46	47	80.14
14	83.13	31	85.56	48	87.95
15	83.54	32	81.08	49	80.74
16	87.97	33	88.96	50	81.77
17	80.41	34	82.36	51	84.39

It can be seen from the above research that the market-oriented operation mechanism of "Yi-Xin-Europe" China-Europe train proposed in this paper has a good effect.

4 CONCLUSION

In terms of railway logistics, "Yi-Xin-Europe" has the most abundant local supply of goods among the "X Xin Europe" in China. In addition, other Zhengzhou, Xi'an, Lanzhou and other places are all assembled from Yiwu. Compared with other modes of transportation, railway transportation is between air and sea transportation. The time to arrive at the port is about one-third shorter than that of sea transportation, and the transportation price is only about one-fifth of that of air transportation. Therefore, it is attractive to merchants with fast time requirements and affordable freight rates. This article analyzes the high cost of the "Yi-Xin-Europe" China-Europe train. It mainly includes the delay cost caused by the change of track, the transportation cost of insufficient supply of return goods, the cost of customs clearance, transit tax and quarantine, and the increase of subsidy cost caused by bidding. Through the experimental research, it can be seen that the market-oriented operation mechanism of "Yi-Xin-Europe" China-Europe train proposed in this paper has a good effect.

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