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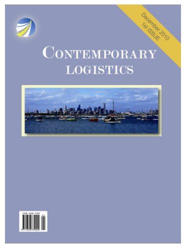

The Forecast of Logistics Cost of Coal Enterprises Based On PSO-BP

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KEYWORDS

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Neural network,
PSO-BP network

ABSTRACT

The forecast of logistics cost is the premise and basis of the management, planning and decision of the logistics cost of coal enterprises, in this paper, we analyze the cost of logistics in coal enterprises and its influencing factors, the PSO-BP and BP network are respectively used to forecast the logistics cost of coal enterprise, the result show that the PSO-BP network's convergence speed and prediction accuracy is obvious better than BP network.

1 PSO-BP Neural Network

1.1 The principle of BP neural network

BP network is a kind of multi-layer back propagation neuron network, The BP algorithm is made up of two parts: the before propagation of information and the back propagation of error. During the before propagation of information, the information inputted is calculated step by step from the input layer and propagate for output layer. If we haven't get the ideal result in the output layer, the network will calculate the variation of error and then propagate back. The network will transmit the error along the former route back and will not correct the weight until get the satisfied result.

Although BP network has been widely used, but it has serious flaws such as slow convergence, prone to local minima and poor generalization.

1.2 The principle of particle swarm optimization

Particle swarm optimization algorithm (PSO) is a randomly optimal algorithm based on swarm intelligence. The algorithm can be used to solve optimization problems and it is brought forward through the inspiration of the biology model of bird seeking foods. In the algorithm, the solution for each optimization problem can be considered as seeking a flying bird in the sky, and each bird is a "particle". Each particle has an adaptive value determined by the optimized function; the velocity of each particle will determine its direction and distance. then, the particles will follow the optimal particle searching in the solution space.

PSO can be stated as initializing a team of random particles and finding the optimal solutions by iterations. Each particle will update itself by two optimal values (one is found out by one particle, which is single extremum—pbest, another is found out by whole particles, which is global extremum—gbest).

The status of one particle on the searching space can be characterized by two factors: its position and velocity, which are updated by the following equations:

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$$v_{id} = \omega_{id} + c_1 r_1 (p_{id} - x_{id}) + c_2 r_2 (p_{gd} - x_{id}) \qquad (1)$$

$$x_{id} = x_{id} + v_{id} \qquad (2)$$

Where, the search space is D-dimensional; v_{id} is the velocity of particle i, x_{id} is the position of particle ; p_{id} is the best previous position of particle i ; p_{gd} is the best position among all particles in the population; r_1 and r_2 are two independently and uniformly distributed random variables with the range of [0,1]; c_1 and c_2 are positive constant parameters called accelerated coefficients, which control the maximum step size; ω is called the inertia mass that controls the impact of the previous velocity of the particle on its current.

This process is repeated until its fitness value has meet the Fitting function's requirements or it has reached the maximum number of iterations.

1.3 The BP neural network forecasting model based on PSO

To avoid the local infinitesimal defect and slow constringency in pure BP algorithm, we combine the particle swarm optimization (PSO) algorithm with the BP rapid training algorithm, and then, a kind of new neural network (NN) called PSO-BP NN is established. With the advantages of global optimization ability and the rapid constringency of the BP rapid training algorithm, the new algorithm not only can improve the convergence speed of neural networks, but also can enhance the generalization ability of neural networks.

1.3.1 The algorithm's design

The algorithm's design of PSO-BP neural network is as follows: each dimension of the particle corresponds to a neural network connection weight, these connection weights are encoded, then randomly generate the initial population formed by a number of individuals, repeating in accordance with the algorithm's steps until a stopping criterion is satisfied. in all finally particles, the particle whose fitness function is the smallest is the set of best BP network weights and thresholds.

1.3.2 The algorithm's steps

1) Select the particle dimension ,population size, fitting function, maximum times of iteration.

2) Initialize all the particles, setting the initial position and velocity of particles, each particle's initial position is pbest, the best value of these pbest is the gbest.

3) Start to iterate.

4) Calculate the fitness value of each particle.

5) For each particle, if its fitness is better than its pbest in his history, this particle will be the new pbest. if its fitness is better than gbest among the population, this particle will be the new gbest.

6) Repeating until its fitness value has meet the Fitting function's requirements or it has reached the maximum number of iterations.

7) Use the optimized particle's values as the initial weights and the threshold values of BP network, to train the neural network.

2 Logistics Cost and Its Influencing Factors of Coal Enterprises

2.1 Definition of logistics cost of coal enterprises

Logistics cost is currency expression of various activities of labor and materialized labor in products movement in space or possession in time. Specifically, it is the total sum of expenses of human, material and financial resources in the various activities, such as packaging, loading and unloading, transport, storage and distribution processing. etc, happening in the process of product physical movement.

According to the above description of logistics cost, logistics cost of coal enterprises can be defined as follows:

logistics cost of coal enterprises is in the procurement and supply of raw materials, production, sales and other processes of the coal enterprises, the total cost direct and indirect that occurred in the warehousing, transportation, handling of raw materials and finished goods, waste recycling, and also information processing, order processing , interest, taxes, insurance, logistics facility planning and management, logistics administration and so on, which are related to logistics activities.

2.2 Influencing factors of logistics cost of coal enterprises

Enterprise logistics cost can be broadly divided into transportation cost ,inventory cost and logistics management cost. According to this, the influencing factors of coal enterprises' logistics cost can be broken down into:

The influencing factors of transportation cost of: transport mode, transport distance, freight volume, product features.

The influencing factors of inventory cost: warehouse numbers, stock amount, turn over of inventory, warehouse logistics capacity, loan rate.
Logistics Management cost equals the sum of transportation cost and inventory cost multiplied by a fixed coefficient.
In the above factors, these two factors, freight volume and warehouse logistics capacity, play the most important role in Logistics costs of coal enterprises.

3 Logistics Cost Forecast Model of Coal Enterprises Based on PSO-BP

3.1 Selection of variables

Select the independent variables based on the two criteria: 1) independent variables should be the factors which closely related to predict object; 2) the chosen independent variables can not have a strong linear relationship.
In this paper, we select the two greatest impact factors: freight volume and warehouse logistics capacity, as the input variables, select the corresponding Logistics cost as the output variable.

3.2 Selection of sample

In this paper, we select the historical logistics costs data in a coal mine in Shandong Province as the sample data, studying and modeling based on PSO-BP, and predicting the logistics cost of the mine, the primitive samples data are listed in Table1.

Table1 Primitive samples data

Serial number	Freight volume(Ton)	Warehouse logistics capacity(Ton)	Logistics cost(Million)
1	101876	82435	556.70
2	112220	91796	629.51
3	107253	88156	564.12
4	117850	95990	537.40
5	114680	92180	508.38
6	96695	75875	476.05
7	103779	81615	485.99
8	107760	83815	583.60
9	118885	93636	733.63
10	132325	88815	685.86
11	128278	89550	615.75
12	104270	90410	490.06
13	116969	93119	608.24
14	112860	79332	598.16
15	102395	81487	501.72
16	126972	83389	660.25
17	130328	85340	664.66
18	128395	79856	706.16
19	83258	50846	434.25
20	119680	83138	598.40
21	88220	78808	441.14
22	83538	75022	360.20
23	92865	82762	395.32
24	95628	82125	506.20
25	100226	85910	491.26
26	121360	88958	558.24

27	131051	96028	642.60
28	132066	94908	640.52
29	85358	75241	409.80
30	96852	80889	471.70

3.3 Data processing

To eliminate the deviation derived from different values, it is necessary to normalize the data using the arithmetic mean method. After normalizing the same factor, it has the minimum boundary 0 and the maxi-mal boundary 1. The mean value can be calculated by the following equation:

$$T = \frac{X - X_{max}}{X_{max} - X_{min}} \tag{3}$$

T indicates a group of data, which has been normalized. Where xi is defined as an initial group of data among the collected data groups. X_{min} and X_{max} express the minimum and maximum data group among the collected data groups, respectively, The normalized samples data are listed in Table2.

Table2 The normalized samples data

Serial number	Freight volume(Ton)	Warehouse logistics capacity(Ton)	Logistics cost(Million)
1	0.3794	0.6992	0.5262
2	0.5903	0.9063	0.7212
3	0.4890	0.8258	0.5461
4	0.7050	0.9992	0.4745
5	0.6404	0.9148	0.3968
6	0.2738	0.5540	0.3102
7	0.4182	0.6810	0.3369
8	0.4994	0.7297	0.5982
9	0.7261	0.9471	1.0000
10	1.0000	0.8404	0.8721
11	0.9175	0.8566	0.6843
12	0.4282	0.8757	0.3477
13	0.6870	0.9356	0.6642
14	0.6033	0.6305	0.6372
15	0.3900	0.6782	0.3790
16	0.8909	0.7203	0.8035
17	0.9593	0.7634	0.8153
18	0.9199	0.6421	0.9264
19	0	0	0.1983
20	0.7423	0.7147	0.6379
21	0.1011	0.6189	0.2167
22	0.0057	0.5351	0
23	0.1958	0.7064	0.0940
24	0.2521	0.6923	0.3910
25	0.3458	0.7761	0.3510

26	0.7765	0.8435	0.5303
27	0.9740	1.0000	0.7562
28	0.9947	0.9752	0.7507
29	0.0428	0.5399	0.1328
30	0.2770	0.6649	0.2986

3.4 The number of the neurons in hidden-layer

In this paper, the BP network has three layers (only one hidden-layer),The number of the neurons in hidden-layer affects the performance of neural networks. we can determine the number of neurons in hidden-layer through comparing the precision between different schemes. Firstly, experiential rules $n_1 = \sqrt{n+m} + a$ is used to calculate the approximate range, then compare the prediction accuracy of different number of neurons in the range, the number of neurons which has the most accurate prediction is the suitable number. in this paper, the suitable number of neurons is 10.

3.5 Selection of transfer function in network

In this paper, the network has only one hidden-layer and the number of the neurons in hidden-layer is 10,the neuron transfer function in hidden-layer is tansig, and in Output-layer is purelin, the training function is trainlm.

3.6 Parameters for PSO

The initial location and velocity of search point is randomly generated between [-1,1]; the maximum speed of particles is 0.5;the population size is 40;the maximum times of iteration is 200; the accelerated coefficients c1=2,c2=1.8; the inertia mass $\omega_{\max}$ =0.90, $\omega_{\min}$ =0.30; the particle dimension is 41(2*10+1*10+10+1=41).

4 Result Analysis of the Prediction Model

We use the first 25 groups of sample data as the training sample, use the remaining 25 groups of sample data as the test sample, in order to compare with PSO-BP algorithm, we also have used BP neural network to predict.

4.1 Comparison of convergence rate

The error evolution curves of the PSO-BP algorithm and BP algorithm are showed in Figure1 (the training error precision is 0.0001). (a) is the error evolution curve of the PSO-BP, it requires only 80 step iterations, (b) is the error evolution curve of the BP neural network, it requires 120 steps. From the figure can we see that the PSO-BP algorithm's iterations is far less than the BP algorithm's, it means that the PSO-BP algorithm's convergence rate is faster than the BP algorithm.

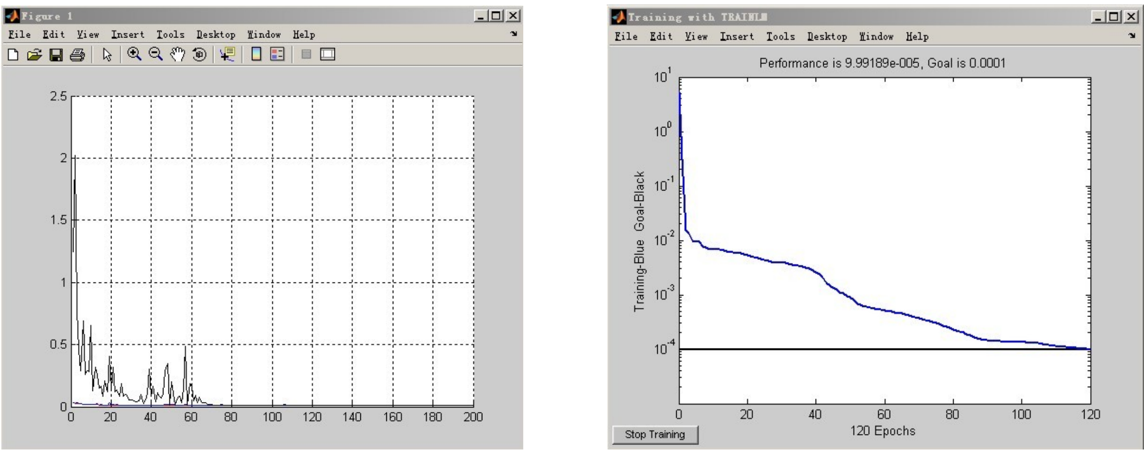

Fig1. Comparison of convergence rate of PSO-BP algorithm and BP algorithm

4.2 Comparison of prediction accuracy

The PSO-BP algorithm and BP algorithm's prediction value and the actual values are respectively compared in table3.And we have calculated the mean square error, from the table can we see that the prediction accuracy of PSO-BP algorithm is much higher than BP algorithm.

Table3 Comparison of models prediction error of PSO-BP algorithm and BP algorithm

Serial number	26	27	28	29	30	mse(err)
actual values	0.5303	0.7562	0.7507	0.1328	0.2986	
PSO-BP algorithm's prediction value	0.7189	0.8049	0.8189	0.0738	0.3135	0.0093
BP algorithm's prediction value	0.8070	1.4241	1.2604	0.3529	0.5458	0.1784

5 Conclusion

The forecast of logistics cost is the premise and basis of the management, planning and decision of the logistics cost of coal enterprises, in this paper, we analyze the cost of logistics in coal enterprises and its influencing factors, the PSO-BP and BP network are respectively used to forecast the logistics cost of coal enterprise, the result show that the PSO-BP network has a high convergence rate, a strong generalization ability, it's performance is better than BP network. The PSO-BP neural network has bright prospects for the forecast of logistics cost of coal enterprises.

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