The Difference between BP Neural Network and RBF Network Is Analyzed By Statistical Method

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Abstract— **Under the background of artificial intelligence, neural network develops rapidly, and different neural networks have different requirements for data characteristics. The author aims at the simulation experiment in the previous two published articles. Spearman correlation coefficient was used to analyze the correlation of experimental data, to explore the difference between BP neural network and RBF network on the requirements of data characteristics, and finally it was concluded that RBF network has more advantages in dealing with nonlinear data and battery related data**

Index Terms— **Spearman correlation coefficient BP neural network RBF network**

I. PREFACE

Under the background of artificial intelligence, neural network develops rapidly. It can process the information provided by the external environment through self-regulation, and can organize itself, so that the output value keeps approaching the expected value [1]. It has strong pattern recognition and prediction functions.

BP and RBF neural networks are widely used in modeling and prediction. For example, fu kangwei [2] et al used BP neural network algorithm to conduct prediction research on natural gas hydrate in muli area, and the results verified the effectiveness and feasibility of this algorithm in predicting natural gas hydrate in frozen soil area, which is conducive to future drilling and exploration work. Lai chunxiao et al [3] used BP neural network to construct the model of wheat cold resistance, and compared it with support vector machine and naive bayes, BP neural network was more accurate in the classification of wheat cold resistance than the latter two methods. Luo xirong et al [4] used RBF network to analyze the movement of human lower limbs, and established a knee gait prediction model, designed related gait capture experiments for verification, and concluded that RBF network has a good prediction effect. Chen yasong et al [5] studied the relationship between preparation process conditions and performance of PVDF separation membrane by using RBF radial basis network, established the corresponding relationship model, and applied the model to control and simulate the preparation conditions, providing certain theoretical guidance for the preparation of PVDF separation membrane.

What is the difference between BP neural network and RBF network in the requirement of data characteristics in prediction? The author studies the correlation of data by using spearman correlation coefficient in the simulation experiment in two published articles, and explores the difference between BP neural network and RBF network in the aspect of data correlation.

1. Spearman rank correlation coefficient

The correlation between 8 independent variables of lithium sulfur battery and the attenuation rate of specific capacity is analyzed. Explore the difference between BP neural network and RBF network in data processing. Spearman correlation coefficient studies the correlation between two variables, which has the characteristics of not requiring the whole variable to follow the normal distribution and the number of sample points of the variable.

1.1 spillman grade correlation coefficient calculation and test

Spearman correlation coefficient is a reaction indicator to describe whether there is the same or opposite convergence between two groups of variables. It is not necessary to assume that the experiment as a whole follows normal distribution, but only needs to be obtained from the level of each point (period) of the determined variable, so as to have good universality [6]. After data preprocessing, the formula is shown as follows:

$$r_{SP} = 1 - \frac{6\sum_{i=1}^{n} d_i^{\,2}}{n(n^{\,2}-1)}$$

d_i is the difference between the two groups of data, and n is the sample size.

The test of spearman's rank correlation coefficient is also very important. Similar to other test inference, when using sample data to infer the population, because the sample itself is random, there is no direct relationship between the correlation between the data and the population in small sample statistics. So it's a hypothetical test. Set null hypothesis H_0: there is no correlation ($p \neq 0$) among the populations studied; hypothesis H_1 is: there is close correlation ($p=0$) among the populations studied.

The sample estimator tested is the correlation coefficient r_{SP} of the sample. In the case of small sample detection, the r of its critical value can be obtained directly from the table; in the case of large sample detection, it can be obtained through transformation. The specific formula is:

$$t = r_{SP}\sqrt{\frac{n-2}{1-r_{SP}^{\,2}}}$$

T distribution subject to $t(n\text{-}2)$, using the t test. The following conditions are satisfied: $t \leq 0.05$ has significant correlation, and $t \leq 0.01$ has extremely significant correlation.

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II. ANALYSIS OF PREDICTION RESULTS

Through the simulation results of previous articles, it can be concluded that the prediction results of RBF network are more accurate than that of BP network. To explore the reasons why RBF network is more advantageous in processing data. Spearman rank correlation coefficient is applied to analyze the correlation between independent variable and dependent variable, and the results are shown in the following table:

Table 1 spearman correlation coefficients of variables

	x1	x2	x3	x4	x5	x6	x7	x8	y
x1	1.00000	-0.84397	-0.03724	-0.11293	0.16252	-0.18063	-0.05006	-0.00349	0.07589
		<.0001	0.5906	0.1019	0.0182	0.0085	0.4695	0.9598	0.2724
x2	-0.84397	1.00000	-0.23024	0.07705	-0.12295	0.13561	0.05067	-0.04852	-0.04151
	<.0001		0.0008	0.2652	0.0747	0.0491	0.4641	0.4833	0.5488
x3	-0.03724	-0.23024	1.00000	0.14931	0.09875	0.27351	0.10027	0.05746	-0.06362
	0.5906	0.0008		0.0302	0.1529	<.0001	0.1466	0.4063	0.3578
x4	-0.11293	0.07705	0.14931	1.00000	-0.05056	0.23582	0.06519	0.10932	-0.23543
	0.1019	0.2652	0.0302		0.4651	0.0006	0.3460	0.1134	0.0006
x5	0.16252	-0.12295	0.09875	-0.05056	1.00000	0.59365	0.01671	-0.18517	0.12027
	0.0182	0.0747	0.1529	0.4651		<.0001	0.8093	0.0070	0.0813
x6	-0.18063	0.13561	0.27351	0.23582	0.59365	1.00000	0.07791	-0.21938	0.00720
	0.0085	0.0491	<.0001	0.0006	<.0001		0.2599	0.0013	0.9171
x7	-0.05006	0.05067	0.10027	0.06519	0.01671	0.07791	1.00000	0.49661	-0.41698
	0.4695	0.4641	0.1466	0.3460	0.8093	0.2599		<.0001	<.0001
x8	-0.00349	-0.04852	0.05746	0.10932	-0.18517	-0.21938	0.49661	1.00000	-0.72558
	0.9598	0.4833	0.4063	0.1134	0.0070	0.0013	<.0001		<.0001
y	0.07589	-0.04151	-0.06362	-0.23543	0.12027	0.00720	-0.41698	-0.72558	1.00000
	0.2724	0.5488	0.3578	0.0006	0.0813	0.9171	<.0001	<.0001	

As can be seen from the above table, the dependent variable y is only extremely correlated with the significance of the independent variable x_4,x_7,x_8, while the correlation of x_1,x_2,x_3,x_5,x_6 is not significant, indicating that there is a nonlinear correlation between the dependent variable and the independent variable. Different independent variables also have different degrees of correlation.

According to the above analysis, when the experimental data have nonlinear correlation, RBF network is more advantageous than BP neural network for processing. Meanwhile, RBF network also has advantages in processing electrochemical experimental data.

THE CONCLUSION

Through the analysis of the correlation of experimental data, it is concluded that the dependent variable and independent variable are nonlinear correlation, so that RBF network has more advantages than BP neural network when dealing with practical problems with nonlinear correlation of data and more variables. Moreover, RBF network has advantages in processing battery related data.

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