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Aerobics performance evaluation optimization model research based on bp neural network

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ABSTRACT

In recent years, aerobics have been rapidly developed in China; these achievements are also obvious to all. To further improve Chinese aerobics level, it is indispensible to make analysis of its result. Each item evaluation indicators which require being analyzed and defined exactly include many kinds of indicators; it shows each indicator performance and overall performance relations by establishing three layers' BP neural network which contains input and output layer as well as the hidden layer. The paper applies mass and athletes' two kind of people performances to make comprehensive evaluation for aerobics performance prediction, the result shows each sample value's actual value and predicted value are very approximate, the former error is less than 5%, and the later error is less than 0.1, which indicates BP neural network has very high and widely fitness to aerobics comprehensive evaluation after training.

KEYWORDS

Special performance;
Prediction model;
BP neural network;
Aerobics;
Performance evaluation.

INTRODUCTION

Aerobics is introduced to China around in 1980s, during more than 30 years, aerobics have been widely spread, well received by mass, and China has already arrived at international advanced level in some special events; As early as 1990s, China has established aerobics association in Beijing, while later also establishes aerobics management and commanding center. Due to aerobics is loved by people, country pays more attention to it, and so aerobics research has also made progress; aerobics players display their competitive capacities by physical quality, function and body shape, which is one of important parts in aerobics performance. Due to aerobics performance decides competition results, it is very necessary to make research on performance.

For aerobics performance evaluation, lots of people have made efforts, and got results, which provides impetus for sports and relative undertakings development. For example, Wang Fang[1] proposed aerobics players' special technical features and evaluation system, from which his weight was achieved by adopting experts and experience as well as other methods, which had stronger objectiveness; Wang Ni[2] established aerobics special performance evaluation model based on neural network, and applied multiple linear regression method predicting aerobics performance,

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besides she also provided correct plans for improving aerobics players' quality levels; Yin Hang[3] put forward different levels aerobics players' physical quality,body shape and technical research and analysis.

This paper on the basis of previous research results, applies BP neural network algorithm making comprehensive evaluation on aerobics performance. And to further prove the model rationality, it also introduces two relative examples to verify, which indicates the model has very widely application.

BP NEURAL NETWORK THEORY AND SPORTS PERFORMANCE HANDLING

It is well known that aerobics includes two parts that are respectively composed of exhibition score and motion completion score; in general, exhibition score is emotional, it puts emphasis on overall presentation, and motion completion performance is rational, it puts emphasis on details, but actually two performance tends to appear uneven status, and then it will need BP neural network model to explore their mutual relations, so that it forms into neural network mode[4]. After relative training, we only input motion completion score into the neural network model, the model itself will work out total

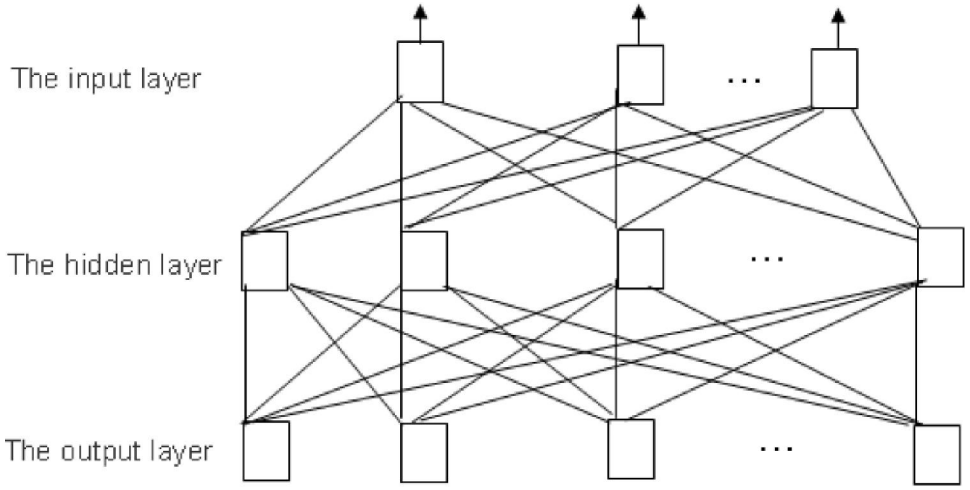

Figure 1 : Neural network theory process

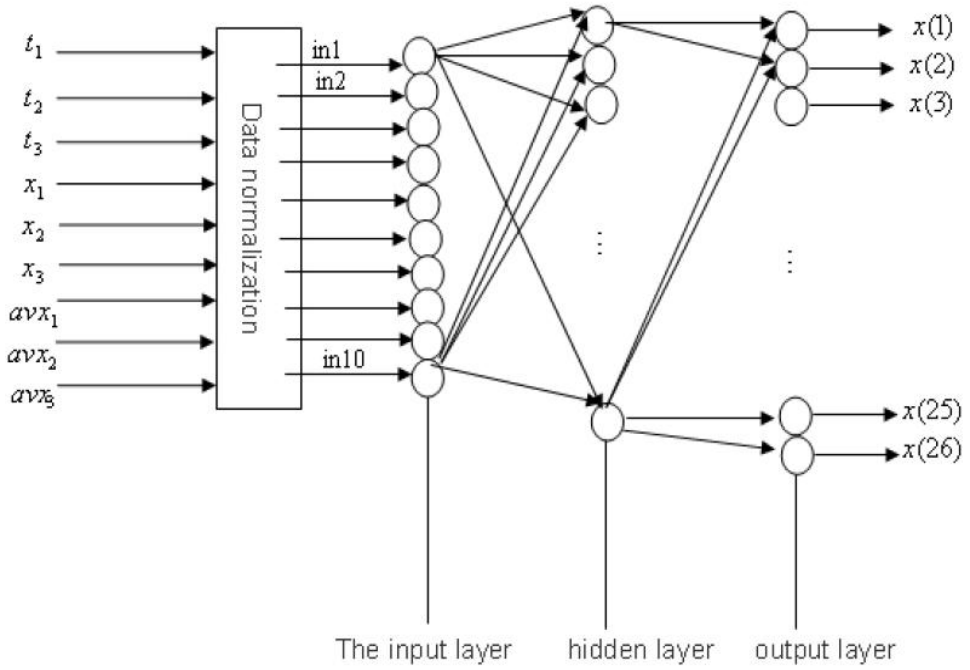

Figure 2 : BP neural network nerve cell structure

TABLE 1 : Competition rule

Music matching	Pace	Body posture
Health: Completely sets of music shows active ,natural dynamic and other metal outlook	Accuracy: Pace shows gymnastic exercise motion position accuracy.	Coordination: Participating athletes' trunk and limbs simultaneously motion completion ability.
Uniformity: Music rhythm and steps changes natural perfect combination.	Regularity: All participating athletes' simultaneously motion paces completion consistency degree	Stability: Participating athletes' limbs governing body continuity
Harmony: Whole set of exercise style and music rhythm ups and downs changes perfect combination	Elasticity: Participating athletes' motions completion process presented light and deft paces	Control force: Participating athletes governing and adjusting body capacities in completing one motion process

TABLE 2 : Aerobics grading result

Sample	Coordination	Stability	Control force	Health	Uniformity	Harmony	Accuracy	Regularity	Elasticity	Total score
1										
8.2	9.1	8.2	8.5	8.2	9.2	9	9.2	8.2	8.7	
2	9	9.8	8.2	9	9.3	9.8	9.8	8.2	9.5	9.1
3	8.8	8.5	8.8	9.2	9.5	9.4	9.3	8.5	8.5	8.6
4	8.4	9.3	8.5	8.2	8.6	8.2	8.2	9.1	8.5	8.5
5	7.9	8.1	7.8	7.8	7.7	7.6	7.9	7.8	6.9	7.7
6	9	8.5	8.5	8.6	8.5	8.2	8.8	9	8.6	8.6
7	8.6	9.1	8.5	8.2	8.3	9.3	8.5	8.2	8.5	8.6
8	8.7	8.8	8.9	8.9	9.1	9.2	8.9	9	8.8	8.9
9	9.5	9.6	9.2	9.8	9.5	9.8	9.6	9.8	9.5	9.6
10	9.3	9.2	9.5	9.8	8.9	9.4	8.9	9.1	8.2	9.1
11	8.5	8.7	8.5	8.3	9	8.6	8.5	8.9	9	8.7
12	8.6	8.8	8.6	8.2	8.5	9	8.5	9	8.8	8.7
13	8.7	9	8.7	8.9	8.5	9	8.6	8.9	8.4	8.7
14	9.5	9.8	9.3	9.8	9.5	9.8	9.6	9.6	9.5	9.6
15	7.9	7.8	7.6	7.8	7.8	7.3	7.6	7.8	7.9	7.7
16	9.8	9.5	9.5	9.3	9.6	9.6	9.2	9.5	9.4	9.5
17	8.5	8.2	8.7	8.5	8.5	8.9	8.8	8.8	8.8	8.6
18	8.3	8.8	8.5	8.6	8.5	8.8	8.5	8.9	8.9	8.6
19	6.8	6.5	6.8	6.7	6.5	6.8	6.8	6.9	6.8	6.7
20	9.5	9.2	9.2	9.5	9.2	9.5	9.5	9.5	9.6	9.4
21	8.9	9	9	9.3	9.2	9.3	8.9	9.2	9.2	9.1
22	8.5	8.8	8.8	8.1	8	8.6	8.5	8.8	8.8	8.2
23	9.6	9.4	9.4	9.5	9.6	9.4	9.2	9	9	9.3
24	9.2	8.9	8.9	9.1	9	8.9	8.8	9.1	9.5	8.9
25	8.2	8.8	9	8.8	9	8.6	9	9	8.5	8.8
26	8.5	8.5	8.8	8.6	8.9	9.1	8.8	8.6	8.5	8.7
27	6.8	7	6.8	6.9	6.8	7.5	6.9	6.8	7	6.9
28	8.2	8.5	8.6	8.2	8.2	8.5	9.1	8.8	8.5	8.4
29	9	8.9	8.2	8.8	8.9	8.6	8.8	8.5	8.8	8.7
30	8.9	8.6	9	8.8	8.9	8.1	8.9	8.8	8.9	8.8

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TABLE 3 : Aerobics grading analysis result

Sample No.	Predicted value	Actual value	Percentage error%
1	9.116	8.7	4.17
2	9.37	9.1	2.7
3	8.284	8.6	-3.16
4	8.893	8.5	3.94
5	7.508	7.7	-1.92
6	9.098	8.6	4.98
7	8.894	8.6	2.95
8	8.819	8.9	-0.81
9	9.682	9.6	0.82
10	9.323	9.1	-2.23
11	8.583	8.7	-1.17
12	8.933	8.7	2.33
13	9.12	8.7	4.2
14	9.373	9.6	-2.27
15	7.507	7.7	-1.93
16	9.724	9.5	2.24
17	8.997	8.6	3.97
18	8.782	8.6	1.82
19	6.927	6.7	2.27
20	9.115	9.4	-2.85
21	9.089	9.1	-0.12
22	7.866	8.2	-3.34
23	9.256	9.3	-0.44
24	8.842	8.9	-0.58
25	9.161	8.8	3.61
26	8.67	8.7	-0.3
27	7.361	6.9	4.61
28	8.876	8.4	4.76
29	9.116	8.7	4.16
30	9.235	8.8	4.35

performance, so that it can improve the competition total performance accuracy.

Aerobics performance prediction model neural network theory

Hierarchical neural network is one kind of neural network two connection ways, it is a feedforward multiple layer network model, neurophysiology and connectionism structure basic handling units ratio tends to be called as nerve cell, as following Figure 1 show:

One nerve cell k is expressed by following formula:

$$\mathbf{u_k = \sum_{t=1}^{m} w_{ik} x_t} \quad \mathbf{(1)}$$

$$\mathbf{y_k = f(u_k + b_k)} \quad \mathbf{(2)}$$

In above formula, b_k refers to nerve cell unit threshold value, u_k is input signal linear combinations' output, y_k refers to output signal, w_{ik} is k protruded weight, x_k is input signal, and $F()$ is an activated function, corresponding function formula is as following:

$$\mathbf{f(v) = \frac{1}{1+e^{-v}}} \quad \mathbf{(3)}$$

At first establish top layer: input layer, medium layer; hidden layer, bottom layer; output layer such three layers' BP neural network model structure. Meanwhile, though no any connections among them, their nerve cells are mutual correlated[5]. The algorithm learning process is composed of two directions that are respectively forward direction process and reverse two propagation processes, from which, the process from input layer to hidden layer and then transfer to output layer is information forward direction propagation, but once end cannot get corresponding output result, it will automatically turn to reverse propagation, and the model weight values defining and adjustment are adopting reverse propagation learning algorithm[6]. The algorithm can thoroughly reflect their inner features, therefore he overcomes grey model and multiple regression seriously shortcomings. We know BP neural network nerve cell does not change; corresponding model is as following Figure 2:

For BP nerve cell, its input end is :

$$\mathbf{net = x_1 w_1 + x_2 w_2 + \cdots + x_n w_n} \quad \mathbf{(4)}$$

In above formula, connection weight value: $w_1, w_2, \cdots, w_n$

Input value: $x_1, x_2, \cdots, x_n$

These nerve cells all activated function all use S type function, the function not only is continuous but also can derive.

Original data standardization process

Define that between 0 and 1 is BP neural network node value, if input information hasn't arrived at hidden

TABLE 4 : Women's group normalization result

Sample No.	Evaluation indicator (p) normalization result						Evaluation objective
	p_1	p_2	p_3	p_4	p_5	p_6	(T)
1	0.25	1.00	0.46	0.18	0.68	0.44	1.000
2	0.25	1.00	0.15	0.41	1.00	0.57	0.384
3	0.13	0.77	0.08	0.00	0.77	0.93	0.418
4	0.00	0.07	0.00	0.06	1.00	0.74	0.268
5	0.38	0.42	0.15	1.00	0.77	0.00	0.284
6	0.25	0.90	0.31	0.82	0.77	0.67	0.276
7	0.25	0.42	0.69	0.06	0.82	1.00	0.303
8	0.63	0.00	0.69	0.41	0.55	0.03	0.328
9	0.25	1.00	0.46	0.18	0.68	0.44	0.071
10	0.25	1.00	0.15	0.41	1.00	0.57	0.00
11	0.13	0.77	0.08	0.00	0.77	0.93	0.325

TABLE 5 : Men's group normalization result

Sample No.	Evaluation indicator (p) normalization result						Evaluation objective
	p_1	p_2	p_3	p_4	p_5	p_6	(T)
12	0.11	0.62	0.35	0.00	1.00	0.72	0.063
13	1.00	0.40	1.00	0.90	0.76	0.52	0.003
14	1.00	0.00	0.82	1.00	0.94	0.71	0.355
15	0.44	0.60	0.24	0.48	0.12	0.90	0.767
16	0.44	1.00	0.00	0.52	0.06	0.00	0.066
17	0.78	0.00	0.88	0.60	0.65	1.00	1.000
18	0.00	1.00	0.47	0.50	0.65	0.80	0.153
19	0.67	0.00	0.65	0.46	0.00	0.52	0.901
20	0.44	0.50	0.47	0.36	0.06	0.43	0.296
21	0.33	0.38	0.53	0.34	0.76	0.86	0.007
12	0.11	0.62	0.35	0.00	1.00	0.72	0.063

layer, then the node is 0, therefore to avoid the fault status, we adopt standardization handling with these original data, adopt:

$$1 = \sqrt{m = n} + a \quad (5)$$

Hidden point initial number values can be defined by formula (2), that is:

$$1 = \sqrt{0.43nm + 0.12n^2 + 2.54m + 0.77n + 0.35 + 0.51} \quad (6)$$

Among them, in above two formulas, a is a constant, and is a number between 1and 10, n, m are the number of output and input nodes. We work out a initial value by formula (1), and then solve it gradually[7].

Define error

Assume when outputs network, error value is :

$$E_K = \frac{1}{2}\sum_J (y_{jk} - o_{jk})^2 \quad (7)$$

If $E = \sum E_K$ is the sum of whole process generated output errors, from which in above formula, o_{jlk} is actual output value, y_{jk} is ideal output value.

Weight value adjustment[8,9]

Known:

$$\Delta_k \omega_{ji} = \eta \delta_k o_{ik}, \eta \succ 0 \quad (8)$$

The formula is weight value adjustment formula, from which : η is step length, $\Delta_k \omega_{ji}$ is ω_{ji} adjusted value, j is output nerve cell.

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TABLE 6 : Neural network input and output result

Sample No.	Input sample						Output sample	Prediction error
	p_1	p_2	p_3	p_4	p_5	p_6	p_1	p_2
1	0.25	1.00	0.46	0.18	0.68	0.44	0.976	0.024
2	0.25	1.00	0.15	0.41	1.00	0.57	0.438	-0.053
3	0.13	0.77	0.08	0.00	0.77	0.93	0.444	-0.025
4	0.00	0.07	0.00	0.06	1.00	0.74	0.132	0.136
5	0.38	0.42	0.15	1.00	0.77	0.00	0.395	-0.111
6	0.25	0.90	0.31	0.82	0.77	0.67	0.314	-0.038
7	0.25	0.42	0.69	0.06	0.82	1.00	0.298	0.005
8	0.63	0.00	0.69	0.41	0.55	0.03	0.305	0.023
9	0.63	0.28	0.31	0.53	0.45	0.06	0.085	-0.014
10	1.00	1.00	1.00	0.29	0.00	0.15	0.029	-0.029
11	0.13	0.77	0.85	0.00	0.50	0.71	0.352	0.027
12	0.11	0.62	0.35	0.00	1.00	0.72	0.126	0.063
13	1.00	0.40	1.00	0.90	0.76	0.52	0.008	0.005
14	1.00	0.00	0.82	1.00	0.94	0.71	0.342	-0.013
15	0.44	0.60	0.24	0.48	0.12	0.90	0.759	-0.008
16	0.44	1.00	0.00	0.52	0.06	0.00	0.071	0.005
17	0.78	0.00	0.88	0.60	0.65	1.00	0.963	-0.037
18	0.00	1.00	0.47	0.50	0.65	0.80	0.167	0.014
19	0.67	0.00	0.65	0.46	0.00	0.52	0.893	-0.008
20	0.44	0.50	0.47	0.36	0.06	0.43	0.303	0.007
21	0.33	0.38	0.53	0.34	0.76	0.86	0.014	0.007

BP NEURAL NETWORK PERFORMANCE ANALYSIS BASED ON AEROBICS

Indicator selection

We know that aerobics competition rule is compose of three major aspects' nine small indicators, as TABLE 1 show[10]:

Samples defining

Select five teachers from aerobics physical education class to respectively make judgment on 30 students' each score and total score, and take its average value as TABLE 2:

Model establishment

After inputting 9 pieces of nodes, adopt BP neural network and according to formula(3) selecting nerve cell, and then if output one node is 1, let it to be y, we let maximum training parameters to be 9000, pace value is 1.1-1.6, and calculated result is as TABLE 3 show:

From above TABLE 3, it is clear that all relative errors fluctuate around 5%, from sample 1 to sample 30, their relative error minimum value is No.21 sample that error is -0.12%, maximum error is No.28 sample that value is 4.76%, thereupon each sample error value is smaller than 5%, which proves aerobics competition performance and BP neural network are non-linear and also shows BP neural network input and output are also non-linear, it means network training is successful.

BP neural network performance analysis based on aerobics players

Make corresponding filtering on selected data that used for establishing a sample set. Let single arm push-up to be p_1, support to be p_2, 15s quick kick to be p_3, split to be p_4, 800m running to be p_5, standing long

jump to be p_6. Corresponding performance is T, and do normalization on it, its function is :

y = (x – min value) /(max value – min value) **(9)**

Men and women normalization results are respectively as TABLE 4 and TABLE 5 show :

In the following, we filter six kind of performance indicators as their corresponding results samples, input them into corresponding algorithm, input matrix p formula 6 columns 21rows matrix, and then corresponding output nerve cell is 1, it represent corresponding performance, subsequently it will output a 21 columns 1 rows matrix and further construct three layers' BP neural network, objective error is 0.15,maximum training times is 70000 times, realize its calculation by Matlab, after completing operation, it gets output and input layer data as TABLE 6:

From TABLE 6, it is clear that men and women athletes neural network model performance prediction are very ideal, their corresponding error range within 0.1, so the precise is higher, which shows the model is correct.

CONCLUSIONS

(1) According to aerobics performance, it establishes BP neural network algorithm model that predicts aerobics players' special performance.

(2) By mass performance evaluation and predicting its error less than 5% training, it gets aerobics players' evaluation and prediction as well as corresponding error values are less than 0.1, which fully shows the model rationality.

(3) By actual examples analyzing and explaining, it will have profound influences on future aerobics competitions prediction, evaluation and testing athletes' training effects.

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