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Research on the effects of exercise on the improvement of happiness index among the aged based on BP neural network

Zhenjun Xu

Department of Physical Education, Changchun Institute of Technology, Changchun 130012, Jilin, (CHINA)

ABSTRACT

Recently, more and more attention has been paid to the life quality of the aged. Activities for them range from singing and playing chess to doing exercise. To some degree, the happiness index of the aged is a signal of the development of social productivity and the national living standard. As a result, experts and intellects have make comparison on the activities that influence the happiness index of the aged, and the conclusion is that exercise can contribute to the index. In this paper, we apply BP neural network to the research, and referring to scores of articles, satisfaction of life and health will be regarded as the features of the happiness index of the aged. After survey, we can the eigenvalues of the aged who do exercise and those who don't. On this basics, we can judge from the targets.

KEYWORDS

The aged; Happiness index; BP neural network; Life satisfaction; Health satisfaction.

INTRODUCTION

With the intensity of the aging population, the life quality of the aged has been a focus of the society. It's our common wish that the aged are in good condition. The rise of the happiness index of the aged is an indicator of the social improvement. And in recent years, people have found that doing exercise can heighten their happiness.

In 2010, Yin Zhihong, in the article *Doing Exercise can Help to Improve the Happiness Index of Senior Citizens*, has make study on the relationship between exercise and old people's happiness. It's proved that if they take exercise often, their happiness and smoothness will be enhanced, and reduce the mood of depression and anxiety. With some survey, the author found a positive correlation between the self-evaluation and subjective happiness of the old. The sense of happiness of those who always take exercise is largely higher than that of those we don't. And it's pointed out that to improvement their happiness, exercise coaching centers should be set up and more research and publicity about it should be made.

In 2012, Luo Hengyuan, in his article *Solid Evidence about Improving the Life Quality of Senior Citizens by Doing Exercise*, he make research on how to improve the life quality of the aged by doing sports with different methods on the example of life of old in Chongqing. Research has shown that exercise contributes to cardio-pulmonary function and physical health. And it also does good to sleep and remove the sense of loss. As to how it can improve life quality, he has given out some advice. The construction of laws on sports should be enhanced and more publicity should be made to call on doing exercise. The instructor team of sports for the old should be strongly supported and items that roll entertainment, fitness, and culture into one should be dug out. Last but not least, government should increase the financial support to senior citizens' sports items.

In 2013, Hu Hongwei and others, in the paper *Factors Influencing the Subjective Happiness of Senior Citizens and Methods to Improve it*, choose the life situation of the rural and urban old people as the target. They find that there is obvious relation between the subjective happiness and physical condition, incomes, relationship with their children, and accommodation. The author said that we should improve the subjective happiness old the old from service assurance, material assurance, and metal assurance. At the same time, senior citizens are the majority to enjoy social welfare and security. Their life quality and happiness index can reveal the level of social service.

In this paper, the focus is the effect of sports exercise to the happiness index of the aged. We will select two the influencing factors and by comparing the indexes of those who doing sports and those who do not, we can know how exercise will affect their happiness.

MODEL ESTABLISHMENT

With a lot of articles, we find that the life satisfaction and health satisfaction of the old can represent their happiness index to some degree. To get the proof of sport's effect on the index, we apply the method of field investigation to do research. And with BP neural network model, we can prove the differences between the indexes of those who do exercise and those who do not, and thus, we can judge it.

Data survey and process

Referring to many articles, the important factors to the happiness index of the aged are life satisfaction and health satisfaction. We get our samples from the aged who is over 65 and take exercise for over an hour a day in Beijing, Shanghai, Guangzhou, Shenzhen, and Tianjin. We choose 100 males and 100 females at random and let them mark their life satisfaction and health satisfaction. The full score is two marks. The average of their marks is the eigenvalue of the group who do exercise, in

TABLE 1. In these five cities, we also choose 100 males and 100 females who do exercise for less than an hour a day at random. And we can get their eigenvalue in the same way, seeing TABLE 2.

TABLE 1 : Eigenvalue of group who exercise

Life Satisfaction	Health Satisfaction
1.12	1.33
1.25	1.41
1.16	1.51
1.18	1.37
1.33	1.45
1.21	1.42
1.36	1.39
1, 21	1.50
1.19	1.36
1.26	1.42

TABLE 2 : Eigenvalue of group who do not exercise

Life Satisfaction	Health Satisfaction
0.99	1.21
1.01	1.13
1.13	1.24
1.03	1.11
1.08	1.17
1.11	1.22
1.10	1.15
1.04	1.19
1.05	1.20
1.07	1.16

The data of the judged subjects are in TABLE 3.

TABLE 3 : Data of judged subjects

No.	Life Satisfaction	Health Satisfaction
1	1.11	1.52
2	1.20	1.49
3	1.09	1.14
4	1.02	1.22
5	1.31	1.44

BP neural network model

Neural network comes from neurobiology. The calculating process is just similar to the reaction process of neuron in biology. Figure 1 shows it.

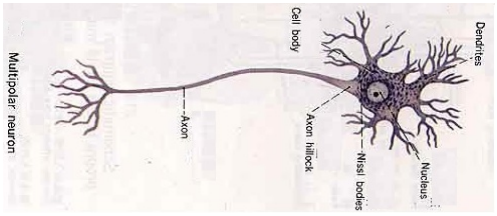

Figure 1 : The structure of neurons

In neural network, axon terminals of the neurons can enter the dendrons on the same neuron and form a number of cynapses. Neurotransmitters released by cynapses from different origins can influence the changes of membrane potential on the same neuron. From this, the comprehensive ability of neuron space, which means neurons on the dendrons, can comprehend the input information of different origins, showed in Figure 2, and the symbol description of Figure 2 is in TABLE 4.

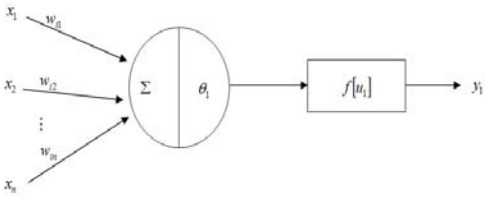

Figure 2 : The schematic of mathematical models of neurons

TABLE 4 : Symbol description in the mathematical model

Symbol	Meaning
$x_1, x_2, \cdots, x_n$	Input of neuron, message from the last level
θ_i	threshold value of neuron
y_i	Output of neuron
$f[u_1]$	excitation function

$f[u_1]$ decides the output form of reaching threshold θ_i under the combined action of the input of $x_1, x_2, \cdots, x_n$. Figure 3 shows the images of two excitation functions. In this text, the second excitation function is used.

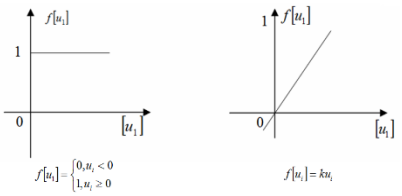

Figure 3 : Typical excitation functions

In which,

$$u_i = \sum_j w_{ij} x_i - \theta_i \quad \textbf{(1)}$$

Hence

$$y_i = f[u_i] = f\left(\sum_j w_{ij} - \theta_i\right) \quad \textbf{(2)}$$

Formula (2) is a complete expression of mathematical expression of a single neuron.

Calculation step of *BP* neural network model: *BP* neural network is a kind of multilayer forward network, calculated in minimum mean square error. When using back propagation algorithm on multilayer feed forward network, we use *Sigmoid* as excitation function and acquire w_{ij} (i.e. network weight system recursion) by the following steps. As every layer has n neuron(s), and as the i th neuron in k th layer, hence there is n weight coefficient, $w_{i1}, w_{i2}, \cdots, w_{jn}$. In addition, get another w_{jn+1} to express θ_i. When inputting sample x, we get $x = (x_1, x_2, \cdots, x_n, 1)$.

Evaluate w_{ij}. We evaluate w_{ij} in every layer in a relatively small nonzero random number, and at the same time $w_{jn+1} = -\theta_i$. Because this model is run in Matlab, the process of evaluation is random on computer, and also the same code may produce difference in different running process.

input sample value $x = (x_1, x_2, \cdots, x_n, 1)$, and corresponding expected output $y = (y_1, y_2, \cdots, y_n, 1)$。Calculate output in every layer. As to the i th neuron of the k th layer's output x_{ik}, there is

$$y_i^k = f\left[u_i^k\right] \quad \textbf{(3)}$$

More,

$$u_i^k = \sum_j w_{ij} x_j^{k-1} - \theta_i^k \quad \textbf{(4)}$$

In the equation, $x_{n+1}^{k-1} = 1$, $w_{i(n+1)} = -\theta$

4work out the errors of each layer d_i^k, to the output layer:

$$d_i^m = x_i^m (1 - x_i^m)(x_i^m - y_i^m) \quad \textbf{(5)}$$

To other layers:

$$d_i^k = x_i^k \left(1 - x_i^k\right)\left(\sum_j w_{ij} x_j^{k-1} - \theta_i^k\right) \quad \textbf{(6)}$$

5to correct w_{ij} and θ_i ,

$$w_{ij}(t+1) = w_{ij}(t) - \eta d_i^k x_j^{k-1} \quad \textbf{(7)}$$

6when we calculate the weight coefficients of each layers, we can tell whether it has met the requirement set. If not, go back to step 3. And if do, end up the calculation.

Matlab calculation and the result

```
p=[1.12 1.25 1.16 1.18 1.33 1.21 1.36 1.21 1.19 1.26 0.99 1.01 1.13 1.03 1.08 1.11 1.10 1.04
1.05 1.07; 1.33 1.41 1.51 1.37 1.45 1.42 1.39 1.50 1.36 1.42 1.21 1.13 1.24 1.11 1.17 1.22 1.15 1.19
1.20 1.16];
%
t=[1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0];
plot(p(1, find(t>0.5)), p(2, find(t>0.5)), 'o');hold on;
plot(p(1, find(t<=0.5)), p(2, find(t<=0.5)), '*'); hold on;
net=newff(minmax(p), [2, 1], {'tansig', 'purelin'});
net.trainParam.show=50;
net.trainParam.epochs=300;
net.trainParam.goal=1e-2;
net=train(net, p, t);
pp=[1.11 1.20 1.09 1.02 1.31;1.52 1.49 1.14 1.22 1.44];
y=sim(net, pp);
plot(pp(1, find(y>0.5)), pp(2, find(y>0.5)), 'ro');hold on;
plot(pp(1, find(y<=0.5)), pp(2, find(y<=0.5)), 'r*');hold on;
plot([0.9 1.3], [1.40 1.1], 'k')
```

The above is the process of *Matlab*. And from it we can see that the training error 10^{-2} is regarded as the stop condition. As the data of life and health satisfaction belong to zero to two, the stop condition is proper. In the figure below, "*" means the happiness index of the non-exercise group while "o" means the exercise group.

As TABLE 1 and TABLE 2 have shown, we can get the distribution of the factors influencing happiness index like Figure 4. And Figure 5 is a diagram of the result.

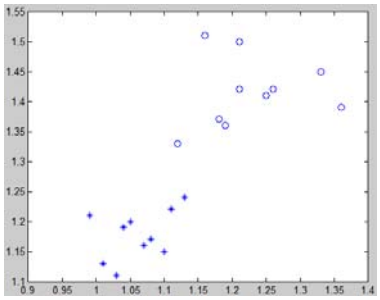

Figure 4 : Two types of elderly happiness index distribution

In Figure 4, there is a clear line between the distributions of the two indexes. Therefore, we can judge that the line is (0.9, 1.4)(1.3, 1.1).

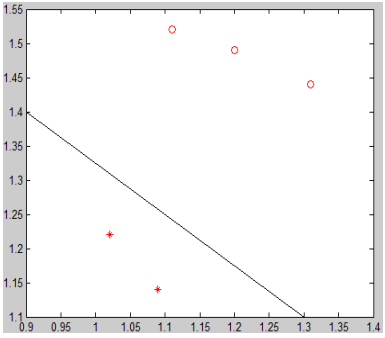

Figure 5 : The schematic of discrimination results

In Figure 5, No. 3 and 4 are the aged people in the non-exercise group, and no. 1, 2, and 5 are that in the exercise group. It's the real situation. And thus, the model is reasonable.

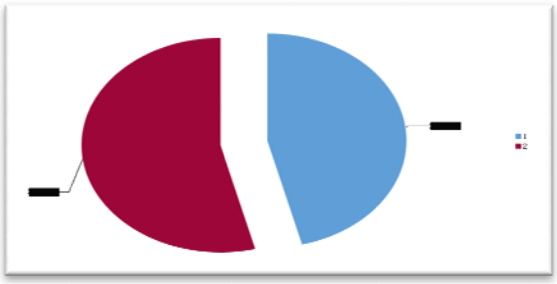

Figure 6 : Exercise group two factors allocation chart

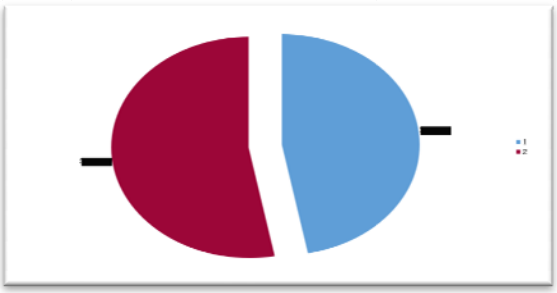

Figure 7 : Non-exercise group two factors allocation chart

Figure 6 is the distribution ratio of the life and health indexes of the exercise group, and Figure 7 is those of the non-exercise group. In the two figures, "1" means life satisfaction while "2" means health satisfaction. By comparison, we can easily find out that the ratio of the life and health satisfaction of the two groups are roughly consistent. Thus, the marks of the exercise group are higher than the other one in these two aspects.

CONCLUSION

BP neural network has realized the reaction process from input to output. It can deal with multiple information at the same time and simplify the operation and process of a complicated problem. However, if a large quantity of information has to be processed, the result may come out to be unreal because of the long process. Besides, the network must estimate the training error reasonably. If not, the result may be opposite to the actual situation.

In this paper, we apply BP neural network model to the empirical research of sport's effect to the improvement to happiness index of the aged. By model and calculation, we can find that there is a clear line between the happiness indexes of the exercise and non-exercise groups. On the basics of the model, we judge the subjects and figure out a result that is in accordance with the reality. And therefore we can prove the reasonability of the model.

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