The Research on the Application of Fuzzy Neural Network in Internet Addiction Decision

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Abstract:A model of the internet addiction decision is set up. The model uses fuzzy mathematics and BP neural network.Six judgement indexes are selected.The subordinate degree functions of quantitative indexes are structured. The qualitative indexes are fuzzified by expert scoring. The college students using network are selected to be samples randomly. The experiment shows that the method could carry out the internet addiction decision accurately and efficiently.

Keywords :internet addiction ; decision; fuzzy mathematics; BP neural network

Ⅰ. Introduction

Internet addiction has caught many attention of educational and psychological experts [1][2].Internet addiction was put forward by Ivan Goldberg, an alienist in New York[3],then K.S.Young,a psychological expert in the University of Pittsburgh confirmed the existence of internet addiction[4].The internet addiction is referred to those impulsive and wild behaviour of using internet.At present the questionnaire,which is based on internet addiction scale is used to evaluate people.But high accuracy can not be obtained[5].Fuzzy mathematic can raise the degree of accuracy,but it lacks the ability of self-learning[6].

Neural network simulates the basic functions of the human brain.It has been applied in pattern recognition and analytical prediction.Up till the present moment, the error back propagation neural network,namely BP neural network,is used far and wide. The BP neural network was given by P.Werbos of Harvard University in 1974[7].The arbitrary non-linear representation relationship between input and output can be realized without description in advance.The BP neural network has other merits,such as the fault-tolerant ability,the ability of classification,parallel processing and self-learning.The neural network was used in this paper,supplying the internet addiction decision with new method.

Ⅱ. The basic theory of neural network

The BP neural network consists of input layer,output layer and hidden layer.The neurons of one layer are connected to the neurons of the next layer.And weights show the connection relations.The structure of three layers BP neural network is described in figure 1. In fact, the network can have many hidden layers.A research had testified that three layer neural network can realize arbitrary complex representation relation. So this kind of three layer was selected in the model.

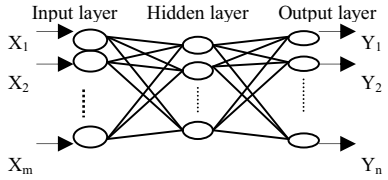

Fig 1 The structure of the BP neural network

The learning process of BP neural network consists of forward and back propagation.In the forward propagation process, the input model are transmitted from input layer to hidden layer and output layer.If the expected output is not attained in the output layer,then the error signal will be transmitted from output layer to input layer and the weights and thresholds will be adjusted to decrease the error.The process will loop until the error is less than a minor number.

Ⅲ. The design of the internet addiction decision model based on fuzzy neural network

The three layer fuzzy neural network was selected.Figure 2 depicts the model.

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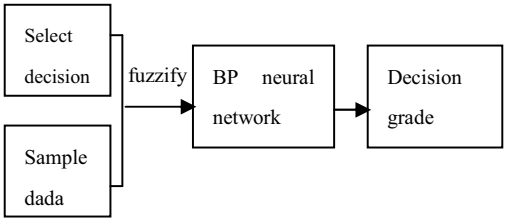

Fig 2 The model of internet addiction decision based on fuzzy neural network

A. Selects indexes

The educational method of parents is the main factor which can influence the internet addiction behaviour[8].According to the addiction evaluating indexes criterion[9], the purpose of using internet(Pu),the number of using times every week(Nu), the average duration of every time(Ad),the relationship with schoolmates(Rs), psychokinesis(Ps) and the relationship with parents(Rp) were selected as internet addiction evaluating indexes. These six indexes were grouped into three kinds, namely internal ,extrinsic and behaviour factor. This is shown in figure 3.Nu and Ad belong to quantitative indexes.Others belong to qualitative indexes.Ps was divided into firm,average and low-resolution.Pu was divided into collecting messages,collecting messages or making friends and making friends or playing games.Rs was divided into good,average and bad.Rp was divided into harmonious,average and odious.

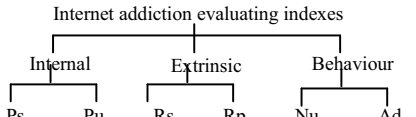

Fig 3 Internet addiction evaluating indexes

B Defines the subordinate degree functions and fuzzifies the indexes

The rank of the internet addiction evaluating is divided into independent, average and dependent,corresponding to grade 1,2 and 3 respectively.The quantitative indexes are transformed by lower semi-trapezoid distribution functions. For example, the subordinate degree(SD) functions of Ad shows as in:

$$U_1(x)=\begin{cases}1 & (x\le 2)\\ (6-x)/4 & (2<x\le 6)\\ 0 & (x>12)\end{cases} \quad (1)$$

$$U_2(x)=\begin{cases}0 & (x<2,x>12)\\ (x-2)/4 & (2<x\le 6)\\ (12-x)/6 & (6<x\le 12)\\ 1 & (x>12)\end{cases} \quad (2)$$

$$U_3(x)=\begin{cases}0 & (x<6)\\ (x-6)/6 & (6\le x<12)\\ 1 & (x\ge 12)\end{cases} \quad (3)$$

The qualitative indexes are transformed by experts grading method.The experts grades every index adopting 10 minutes systems.The grades are divided by 10.The quotients are the subordinate degree.Table 1 shows the SD of every indexes.

Table1 The SD of the qualitative indexes

Indexes / SD	Grade 1	Grade 2	Grade 3
	0.80	0.30	0.15
Ps	0.30	0.70	0.40
	0.01	0.20	0.90
	0.75	0.10	0.02
Pu	0.20	0.70	0.45
	0.10	0.3	0.86
	0.80	0.30	0.02
Rs	0.25	0.60	0.25
	0.10	0.20	0.70
	0.90	0.30	0.01
Rp	0.30	0.70	0.25
	0.20	0.30	0.90

C The structure of the neural network

The BP neural network consists of 18 input nodes and 3 output nodes.18 input nodes correspond to the SD of the six evaluating indexes.The SD of the quantitative indexes are obtained by calculating the test value through lower semi-trapezoid distribution functions.For example, the Ad is about 3 hours,3 is substituted into formula 1,2 and 3,then the SD *(0.75,0.25,0)* will be obtained. The SD of the qualitative indexes are obtained by reference to table 1.For example,one student's Ps is evaluated firm,then the SD *(0.80,0.30,0.01)* will be obtained.3 output nodes correspond to the expected output value *（1,0,0）*,*(0,1,0）* and *(0,0,1)*.

The number of the hidden layer nodes can be selected by the "2N+1" method,which was put forward by Hecht-Nielsen.As far as the learning time of the

neural network was concerned,the number of the hidden layer nodes is 12.

D The training of the neural network

The number of the samples is Q.The input vector of every sample is $X=[x_{q1},x_{q2},\ldots,x_{qm}]$.The expected output vector is $Y=[y_{q1},y_{q2},\ldots,y_{qn}]$.The input vector of the hidden layer is $S_1=[s_{q11},s_{q12},\ldots,s_{q1k}]$,the output vector of this layer is $S_2=[s_{q21},s_{q22},\ldots,s_{q2k}]$.The input of the output layer is $C_1=[c_{q11},c_{q12},\ldots,c_{q1n}]$,the output of this layer is $C_2=[c_{q21},c_{q22},\ldots,c_{q2n}]$.The weight of the NO$i$ neuron of the input layer to the NOt neuron of the hidden layer is W_{it}. The weight of the NOt neuron of the hidden layer to the NOj neuron of the output layer is V_{tj}.The threshold of the hidden layer nodes is θ_t,the output layer is σ_j. ($1\le q\le Q,1\le i\le m,1\le j\le n,1\le t\le k$)

For the first time,the first sample is input into the input layer ,the input value of the hidden layer is calculated in:

$$S_{q1t}=\sum_{i=1}^{m}W_{it}\times x_{qi}-\theta_t \qquad (4)$$

The output value of the hidden layer is got in:

$$S_{q2t}=f(S_{q1t}) \quad (f(x)=\frac{1}{1+e^{-x}}) \qquad (5)$$

The input value of the output layer is:

$$C_{q1j}=\sum_{t=1}^{k}V_{tj}\times S_{q2t}-\sigma_j \qquad (6)$$

The actual output value is:

$$C_{q2j}=f(C_{q1j}) \qquad (7)$$

After all of the samples are input,the total error will be got:

$$E=\frac{1}{2}\sum_{q=1}^{Q}\sum_{j=1}^{n}(y_{qj}-C_{q2j})^2 \qquad (8)$$

If the error is smaller than a given value or the learning circle number is bigger than a given number,the learning process will stop,otherwise the alignment errors of the output layer and hidden layer nodes will be calculated:

$$e_{qj}=(y_{qj}-C_{q2j})\times C_{q2j}\times(1-C_{q2j}) \qquad (9)$$

$$d_{qt}=\sum_{j=1}^{k}(e_{qj}\times V_{tj})\times S_{q2t}(1-S_{q2t}) \qquad (10)$$

The weights and the thresholds will be regulated for the next time:

$$V'_{tj}=V_{tj}+\alpha\times e_{qj}\times S_{q2t} \qquad (11)$$

$$\sigma'_j=\sigma_j+\alpha\times e_{qj} \qquad (12)$$

$$W'_{it}=W_{it}+\beta\times d_{qt}\times x_{qi} \qquad (13)$$

$$\theta'_t=\theta_t+\beta\times d_{qt} \qquad (14)$$

The second time learning process starts,it is as the same as above.The neural network toolbox of Matlab7 were used to train the weights and thresholds.100 students were selected randomly to complete the questionnaire,75 percent of those were training set,25 percent were testing set.At the training process,every student was a sample,a group of input and output value was got using the method mentioned above.The initial learning rate is 0.001,the error is smaller than 0.01.After 982 circled,the training process finished.Figure 4 shows the variation of the error convergence curve.

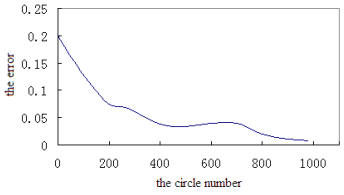

Fig 4 The error convergence curve

E The test of the model

The 25 samples were tested by the trained network.Table 2 shows the indexes of 5 participants.Table 3 shows the comparison of the actual situation and the decision result.The maximum membership degree law was used to determine the grade.The decision result conforms to the actual situation.

Table 3 The comparison of the actual situation and the decision result

sample	The actual grade	The dicision grade
1	dependent	（0.028,0.002,0.997）
2	dependent	(0.003,0.022,0.995)
3	average	(0.019,0.994,0.011)
4	independent	(0.996,0.009,0.026)
5	independent	(0.993,0.007,0.023)

Ⅳ. The conclusion

Fuzzy mathematics and BP neural network were combined in the internet addiction decision.In the training process,after all of the samples are input the total error will be transformed back,reducing the convergence time.This method can afford a credible evidence for the

psychological intervention of the internet addiction patients.

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Table 2 The indexes of 5 participants

index / sample	Ps	Pu	Rs	Rp	Nu	Ad
1	low-resolution	making friends or playing games	average	odious	10	7
2	low-resolution	collecting messages or making friends	good	average	8	6
3	firm	making friends or playing games	bad	average	6	3
4	low-resolution	making friends or playing games	good	harmonious	3	3
5	firm	collecting messages	good	harmonious	5	2