Article

Pattern classification of human body's acupoints based on functional similarity in Traditional Chinese Medicine
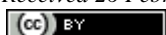
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Abstract

Based on previously constructed data tables of acupoint functions and meridians, we performed a pattern classification of acupoints based on functional similarity in this study. Unsupervised pattern classification methods include *k*-means clustering, hierarchical clustering, BP neural network, self-organizing feature map network; supervised pattern classification methods include BP neural network, and LVQ network. Supervised pattern classification helps to determine the correspondence between acupoint functions and meridians, and to further explore the meridian properties of acupoints. Among them, hierarchical clustering gives two categories of pattern classifications, that is, fixed number classes of pattern classification and cluster tree, and other methods give pattern classification of fixed number classes. The cluster tree of acupoints reflects hierarchical relationship of functional similarity between acupoints, which can determine the functional relationship between acupoints at different levels. In unsupervised pattern classification, *k*-means clustering gave the most reasonable pattern classification, followed by BP neural network, and the results of hierarchical clustering and self-organizing feature map network were poor. In supervised pattern classification, LVQ network is superior to BP neural network, and self-organizing feature map network is poor. Compared with 15 categories of meridians, the LVQ network divided 13 classes of acupoints, the BP neural network divided 6 classes of acupoints, and the self-organizing feature mapping network divided 83 classes of acupoints. The pattern classification results obtained have guiding significance for selection, collocation, diagnosis and treatment of acupoints, and can be used for further in-depth mining and analysis.

Keywords acupoints; functional similarity; pattern classification; artificial neural networks; *k*-means clustering; BP neural network; LVQ neural network; self-organizing feature map network.

1 Introduction

Acupoints in human body are nodes inside meridians. Meridians and acupoints constitute a biological network of matter, energy and information (Benias et al., 2018; Li et al., 2021; Zhang and Qi, 2023a-b). Not long ago,

we had developed an information system of acupoint diagnosis and treatmentin in Traditional Chinese Medicine (TCM). It includes information on acupoint indications and clinical applications (that is, acupoint functions), acupoints, twelve meridians, eight extra meridians, five elements and other TCM acupoint information. In further research, based on the web database of the system, we have constructed the data table of acupoint functions, and further constructed the acupoint network, and analyzed the network type and network topology.

In this study, based on previously constructed constructed data tables of acupoint functions and meridians, we performed a pattern classification of acupoints based on functional similarity. Through pattern classification, the functional similarity relationship between acupoints can be determined at different levels, which helps to determine the correspondence between acupoint functions and meridians, and further discover the meridian properties of acupoints. The stronger the functional similarity of two acupoints, the stronger the substitutability of one acupoint for the other. Therefore, the results of pattern classification of acupoints have guiding significance for selection, collocation, diagnosis and treatment of acupoints. The results obtained in this study can also be used for further in-depth analysis.

2 Materials and Methods

2.1 Data sources

The data used for pattern classification is the 311×651 data table of acupoint functions constructed earlier (Zhang and Qi, 2023a; acufunc). Among them, there are 311 acupoints and 651 functions (acupoint indications and clinical applications). Meridian data come from previous studies (Zhang and Qi, 2023b). There are 12 types of meridians, 2 types of extra meridians, and 1 type of non-meridian extra acupoints. There are 15 types of meridians (acumeri) in total.

2.2 Unsupervised pattern classification

In the unsupervised pattern classification, the data table of acupoint functions is used as the original data, with a total of 311 samples (acupoints) and 651 variables (acupoint functions). Unsupervised pattern classification was performed on 311 samples (acupoints).

2.2.1 k-means clustering

Assuming that the samples (acupoints) need to be divided into k classes, the procedures of k-means clustering is:

(1) Select k samples (acupoints) as coagulation points.

(2) According to the principle of proximity, agglomerate the remaining samples (acupoints) to the coagulation point to form k clusters.

(3) Calculate the center positions of the k classes, that is, the mean.

(4) According to the centers' position, return to (2) to re-cluster. This procedure is repeated until the location of the coagulation point converges.

Based on the 311×651 data table of acupoint functions, different number of k was selected, and the 311 acupoints were clustered by k-means clustering using SPSS software to obtain k classes.

2.2.2 Hierarchical clustering

Hierarchical clustering is also called systematic clustering (Zhang, 2017). In the hierarchical clustering, the inter-class distance uses the class average method.

Based on the 311×651 data table of acupoint functions, 311 acupoints were clustered hierarchically with SPSS software, and the distance between samples (acupoints) used squared with the Boolean Euclidean distance, finally we obtain a clustering tree of acupoints. The clustering tree is a hierarchical relationship of

functional similarity between acupoints, which can determine the relationship between acupoints at different levels.

Based on the 311×651 data table of acupoint functions, the maximum number of classes, k_{max}, was specified, and Matlab software was used to perform hierarchical clustering on 311 acupoints. The distance between samples (acupoints) was Euclidean distance, and maximally k_{max} classes were obtained. The Matlab codes for hierarchical clustering are as follows:

```
X=acufunc;
Y=pdist(X);
Z=linkage(Y,'average');
T=[(1:311)' cluster(Z,'maxclust',15)]      %kmax=15
```

2.2.3 BP neural network

BP (Back Propagation) neural network is a multi-layer forward network with one-way propagation, which is the most representative type of artificial neural network. Usually, the transfer function of neurons in the hidden layer of BP neural network is a sigmoid function, and the transfer function of neurons in the output layer is a linear function. There are two steps in the learning process: first, the forward propagation process, the input signal is passed layer by layer, and the actual output of each neuron is calculated; then the back propagation process is used to calculate the error between the actual output and the expected output layer by layer, and adjust weights according to error (Zhang, 2007c; Zhang, 2010, 2016; Zhang and Barrion, 2006; Zhang and Zhang, 2008).

The Matlab codes of BP neural network for unsupervised pattern classification are as follows:

```
SamplingData=[acufunc acuMeri]';
n=size(SamplingData,1)-1;
lastrow=SamplingData(n+1,:);
P=SamplingData(1:n,:);
m=max(lastrow);
net=newff(minmax(P),[5,5,m],{'tansig' 'tansig' 'purelin'},'trainlm','learngd','mse');
net.trainParam.epochs=1000;
net.trainParam.goal=0.001;
net=train(net,P);
recog=sim(net,P);
maxout=max(recog);
for i=1:size(P,2);
for j=1:m;
if (recog(j,i)==maxout(i)) recognized(1,i)=i; recognized(2,i)=j; break;
end
end
end
recognized
```

2.2.4 Self-Organizing Feature Map Network

The self-organizing feature map (SOFM) network tries to discover a certain mechanism from the input, and adjust the network according to the mechanism to generate the corresponding output (Hagan et al., 1996; MathWorks, 2002; Zhang, 2007c; Zhang, 2007a-b, 2010, 2016, 2018). The basic algorithm of self-organizing neural network for unsupervised pattern classification is to set $f(x)=(y_1,y_2,\ldots,y_m)^{\mathrm{T}}$, where f: $A^n \rightarrow B^m$, A^n is a compact set in R^n. $y_r=\max y_j$, if and only if $x \in C_r$. The set $\{C_1,C_2,\ldots,C_m\}$ is a partition of An, that is, $A^n = \cup\, C_j$, and $C_i \cap C_j = \varphi$, $i \neq j$.

In SOFM network, neurons in a layer represent different regions of the sample space by learning from samples, and adjacent neurons respond to similar samples by learning from samples. The network can not only learn the topology of the sample space, but also learn the distribution of samples.

The Matlab codes of the self-organizing feature map network are as follows:

```
P=acufunc';
net=newsom(minmax(P),[10,10]);
net.trainParam.epochs=1000;
net=init(net);
net=train(net,P);
w=net.iw{1,1};          % Network weight matrix
for i=1:size(P,2);
a=vec2ind(sim(net,P(:,i)));
outputclass(1,i)=i;
outputclass(2,i)=a;
end
outputclass
```

2.3 Supervised pattern classification

In the supervised pattern classification, the data table of acupoint functions and meridians are used as the original data, with a total of 311 samples (311 acupoints), 651 variables (651 acupoint functions), and 1 grouping variable (15 categories of meridians). Using supervised pattern classification, the 311 samples (acupoints) were classified according to the 15 types of meridians to which they belonged. Supervised pattern classification helps to determine the correspondence between acupoint functions and meridians, and to further explore the meridian properties of acupoints.

2.3.1 BP neural network

The BP neural network algorithm is as mentioned above. The Matlab codes of BP neural network for supervised pattern classification are as follows:

```
SamplingData=[acufunc acuMeri]';
n=size(SamplingData,1)-1;
samples=size(SamplingData,2);
RecSamples=SamplingData(1:651,:);
lastrow=SamplingData(n+1,:);
P=SamplingData(1:n,:);
C=ind2vec(lastrow);
m=max(lastrow);
% Load the file (RecSamples.*) for samples to be recognized. The same format with sampling data file.
```

```
Q=RecSamples;
net=newff(minmax(P),[5,5,m],{'tansig' 'tansig' 'purelin'},'trainlm','learngd','mse');
net.trainParam.epochs=1000;
net.trainParam.goal=0.001;
net=train(net,P,C);
% Make classification on trained quadrates
out=sim(net,P);
maxout=max(out);
for i=1:samples;
for j=1:m;
if (out(j,i)==maxout(i)) outputclass(1,i)=i; outputclass(2,i)=j;
break;
end
end
end
outputclass
% Make recognition on the samples with unknown classification
recog=sim(net,Q);
maxout=max(recog);
for i=1:size(Q,2);
for j=1:m;
if (recog(j,i)==maxout(i)) recognized(1,i)=i; recognized(2,i)=j; break;
end
end
end
recognized
```

2.3.2 LVQ network

LVQ (Learning Vector Quantization) network is used for supervised pattern classification. LVQ networks are a supervised extension of self-organizing feature map network. Even if the input vector is not linearly separable, the LVQ network can classify the input vector according to the given target. The LVQ network consists of two layers. The first layer is a competitive layer, and the second layer is a linear layer. The competition layer learns to classify from the input vectors using a competition transfer function. The linear layer has linear neurons that transform the classification information of the competing layer into defined classes. Weighted inputs and network outputs are computed through these neurons. The LVQ network uses hidden layer neurons to represent vector clusters, and output neurons group vector clusters to form desired classes (Zhang, 2007c; Zhang et al., 2008).

The Matlab codes of LVQ neural network for supervised pattern classification are as follows:

```
SamplingData=[acufunc acuMeri]';
varis=size(SamplingData,1)-1;
samples=size(SamplingData,2);
lastrow=SamplingData(varis+1,:);
P=SamplingData(1:varis,:);
C=ind2vec(lastrow);
```

```
for i=min(lastrow):m;
percentages(i)=0;
for j=1:samples;
if lastrow(j)==i percentages(i)=percentages(i)+1;
end
end
percentages(i)=percentages(i)/samples;
end
percentages
% Generate a LVQ neural network (newlvq) with 200 hidden neurons. Learning rate is 0.01. Learning function is learnlv1.
net=newlvq(minmax(P),200,percentages,0.01, 'learnlv1');
% Train the network. 1000 epochs.
net.trainParam.epochs=1000;
net=train(net,P,C);
w=net.iw{1,1};        % Network weight matrix
% Make classification on trained samples
outputclass=sim(net,P)
% Make recognition on the samples with unknown classification
outputclass=vec2ind(outputclass)'
```

3 Results

3.1 Cluster tree of acupoints generated from hierarchical clustering

The cluster tree of acupoints from hierarchical clustering are listed in Table 1. According to Table 1, the functional similarity relationship between acupoints can be determined at different levels. For example, the similarity relationship between the functions of the acupoints Yimen (BL51) and Weicang (BL50) is the closest, and the clustering is the earliest. It is followed by Kufang (ST14) and Yuzhong (KI26). The acupoints Binao (LI14) and Taixi (KI3) had the farthest functional similarity and the thus latest clustering.

Table 1 Cluster tree of human body's acupoints based on functional similarity from hierarchical clustering.

Stage	Acupoint (A)	Acupoint (B)	Coefficient	Stage Cluster First Appears	Stage Cluster First Appears	Next stage
1	肓门穴 (BL51)	胃仓穴 (BL50)	0	0	0	28
2	库房穴 (ST14)	彧中穴 (KI26)	2	0	0	18
3	颅息穴 (SJ19)	率谷穴 (GB8)	2	0	0	63
4	府舍穴 (SP13)	居髎穴 (GB29)	2	0	0	8
5	大横穴 (SP15)	腹哀穴 (SP16)	2	0	0	50
6	水突穴 (ST10)	中泉穴 (EX-UE3)	3	0	0	12
7	臑俞穴 (SI10)	中魁穴 (EX-UE4)	3	0	0	14
8	府舍穴 (SP13)	筑宾穴 (KI09)	3	4	0	15
9	灵墟穴 (KI24)	紫宫穴 (RN19)	3	0	0	13
10	天宗穴 (SI11)	云门穴 (LU2)	3	0	0	36
11	肩髎穴 (SJ14)	髋骨穴 (EX-LE1)	3	0	0	38
12	定喘穴 (EX-B1)	水突穴 (ST10)	3.5	0	6	24
13	灵墟穴 (KI24)	神藏穴 (KI25)	3.5	9	0	48

14	承扶穴 (BL36)	臑俞穴 (SI10)	3.5	0	7	23
15	府舍穴 (SP13)	横骨穴 (KI11)	3.667	8	0	23
16	清冷渊 (SJ11)	正营穴 (GB17)	4	0	0	26
17	神堂穴 (BL44)	俞府穴 (KI27)	4	0	0	24
18	库房穴 (ST14)	璇玑穴 (RN21)	4	2	0	48
19	眉冲穴 (BL3)	五处穴 (BL5)	4	0	0	73
20	曲差穴 (BL4)	瞳子髎 (GB1)	4	0	0	47
21	脾俞穴 (BL20)	上脘穴 (RN13)	4	0	0	33
22	犊鼻穴 (ST35)	伏兔穴 (ST32)	4	0	0	53
23	承扶穴 (BL36)	府舍穴 (SP13)	4.417	14	15	31
24	定喘穴 (EX-B1)	神堂穴 (BL44)	4.667	12	17	40
25	带脉穴 (GB26)	子宫穴 (EX-CA1)	5	0	0	74
26	清冷渊 (SJ11)	至阴穴 (BL67)	5	16	0	30
27	外丘穴 (GB36)	小海穴 (SI8)	5	0	0	53
28	肓门穴 (BL51)	胃脘下俞 (EX-B3)	5	1	0	33
29	外踝尖 (Ex-LE9)	委阳穴 (BL39)	5	0	0	51
30	清冷渊 (SJ11)	青灵穴 (HT2)	5	26	0	41
31	承扶穴 (BL36)	箕门穴 (SP11)	5	23	0	34
32	会阳穴 (BL35)	魂门穴 (BL47)	5	0	0	49
33	肓门穴 (BL51)	脾俞穴 (BL20)	5.333	28	21	66
34	承扶穴 (BL36)	膝眼穴 (EX-LE5)	5.375	31	0	35
35	承扶穴 (BL36)	天髎穴 (SJ15)	5.444	34	0	37
36	秉风穴 (SI12)	天宗穴 (SI11)	5.5	0	10	54
37	承扶穴 (BL36)	气端穴 (EX-LE12)	5.5	35	0	39
38	肩髎穴 (SJ14)	肩井穴 (GB21)	5.5	11	0	90
39	承扶穴 (BL36)	梁丘穴 (ST34)	5.545	37	0	49
40	定喘穴 (EX-B1)	神封穴 (KI23)	5.6	24	0	52
41	风门穴 (BL12)	清冷渊 (SJ11)	5.75	0	30	42
42	风门穴 (BL12)	夹脊穴 (EX-B2)	5.8	41	0	72
43	身柱穴 (DU12)	侠白穴 (LU4)	6	0	0	52
44	日月穴 (GB24)	腕骨穴 (SI4)	6	0	0	108
45	会宗穴 (SJ7)	天窗穴 (SI16)	6	0	0	65
46	扶突穴 (LI18)	人迎穴 (ST9)	6	0	0	80
47	巨髎穴 (ST3)	曲差穴 (BL4)	6	0	20	69
48	库房穴 (ST14)	灵墟穴 (KI24)	6	18	13	103
49	承扶穴 (BL36)	会阳穴 (BL35)	6	39	32	51
50	大横穴 (SP15)	关门穴 (ST22)	6	5	0	68
51	承扶穴 (BL36)	外踝尖 (Ex-LE9)	6.214	49	29	55
52	定喘穴 (EX-B1)	身柱穴 (DU12)	6.333	40	43	54
53	犊鼻穴 (ST35)	外丘穴 (GB36)	6.5	22	27	83
54	秉风穴 (SI12)	定喘穴 (EX-B1)	6.75	36	52	67
55	承扶穴 (BL36)	神道穴 (DU11)	6.813	51	0	56
56	承扶穴 (BL36)	二白穴 (Ex-UE2)	6.882	55	0	66
57	风市穴 (GB31)	中渎穴 (GB32)	7	0	0	128
58	肩中俞 (SI15)	中府穴 (LU1)	7	0	0	71
59	通里穴 (HT5)	心俞穴 (Bl15)	7	0	0	85
60	巨阙穴 (RN14)	太渊穴 (LU9)	7	0	0	87
61	当阳穴 (EX-HN2)	申脉穴 (BL62)	7	0	0	86
62	强间穴 (DU18)	束骨穴 (BL65)	7	0	0	124
63	金门穴 (BL63)	颅息穴 (SJ19)	7	0	3	104

64	臂臑穴 (LI14)	肩前穴 (Ex-UE12)	7	0	0	107
65	耳门穴 (SJ21)	会宗穴 (SJ7)	7	0	45	89
66	承扶穴 (BL36)	肓门穴 (BL51)	7.122	56	33	68
67	秉风穴 (SI12)	颈百劳 (Ex-HN23)	7.273	54	0	71
68	承扶穴 (BL36)	大横穴 (SP15)	7.391	66	50	70
69	巨髎穴 (ST3)	阳白穴 (GB14)	7.667	47	0	125
70	承扶穴 (BL36)	急脉穴 (LR12)	7.692	68	0	74
71	秉风穴 (SI12)	肩中俞 (SI15)	7.75	67	58	103
72	风门穴 (BL12)	足通谷 (BL66)	7.833	42	0	73
73	风门穴 (BL12)	眉冲穴 (BL3)	7.857	72	19	84
74	承扶穴 (BL36)	带脉穴 (GB26)	7.907	70	25	83
75	耳尖穴 (EX-HN6)	小骨空 (EX-UE6)	8	0	0	100
76	条口穴 (ST38)	膝阳关 (GB33)	8	0	0	116
77	巨骨穴 (LI16)	三间穴 (LI3)	8	0	0	110
78	大陵穴 (PC7)	曲泽穴 (PC3)	8	0	0	120
79	地仓穴 (ST4)	颧髎穴 (SI18)	8	0	0	125
80	扶突穴 (LI18)	气舍穴 (ST11)	8	46	0	91
81	次髎穴 (BL32)	漏谷穴 (SP7)	8	0	0	112
82	大骨空 (EX-UE5)	浮郄穴 (BL38)	8	0	0	144
83	承扶穴 (BL36)	犊鼻穴 (ST35)	8.147	74	53	88
84	风门穴 (BL12)	玉枕穴 (BL9)	8.222	73	0	92
85	后顶穴 (DU19)	通里穴 (HT5)	8.5	0	59	123
86	当阳穴 (EX-HN2)	神庭穴 (DU24)	8.5	61	0	163
87	腹通谷穴 (KI20)	巨阙穴 (RN14)	8.5	0	60	137
88	承扶穴 (BL36)	膈关穴 (BL46)	8.545	83	0	90
89	耳门穴 (SJ21)	阳池穴 (SJ4)	8.667	65	0	106
90	承扶穴 (BL36)	肩髎穴 (SJ14)	8.667	88	38	105
91	扶突穴 (LI18)	华盖穴 (RN20)	8.667	80	0	105
92	风门穴 (BL12)	京骨穴 (BL64)	8.8	84	0	104
93	悬厘穴 (GB6)	支沟穴 (SJ6)	9	0	0	140
94	关元俞 (BL26)	小肠俞 (BL27)	9	0	0	142
95	角孙穴 (SJ20)	完骨穴 (GB12)	9	0	0	210
96	大迎穴 (ST5)	温溜穴 (LI7)	9	0	0	141
97	灵道穴 (HT4)	天鼎穴 (LI17)	9	0	0	134
98	气海穴 (RN6)	石门穴 (RN5)	9	0	0	158
99	归来穴 (ST29)	上髎穴 (BL31)	9	0	0	175
100	耳尖穴 (EX-HN6)	前顶穴 (DU21)	9	75	0	119
101	髀关穴 (ST31)	阑尾穴 (EX-LE7)	9	0	0	116
102	承满穴 (ST20)	梁门穴 (ST21)	9	0	0	126
103	秉风穴 (SI12)	库房穴 (ST14)	9.19	71	48	121
104	风门穴 (BL12)	金门穴 (BL63)	9.242	92	63	109
105	承扶穴 (BL36)	扶突穴 (LI18)	9.257	90	91	108
106	耳门穴 (SJ21)	听宫穴 (SI19)	9.5	89	0	138
107	臂臑穴 (LI14)	肩贞穴 (SI9)	9.5	64	0	180
108	承扶穴 (BL36)	日月穴 (GB24)	9.878	105	44	110
109	风门穴 (BL12)	解溪穴 (ST41)	9.929	104	0	122
110	承扶穴 (BL36)	巨骨穴 (LI16)	9.977	108	77	122
111	侠溪穴 (GB43)	液门穴 (SJ2)	10	0	0	202
112	次髎穴 (BL32)	腰阳关 (DU3)	10	81	0	142
113	承筋穴 (BL56)	腰俞穴 (DU2)	10	0	0	174

114	肺俞穴 (BL13)	阴郄穴 (HT6)	10	0	0	182
115	气冲穴 (ST30)	阴谷穴 (KI10)	10	0	0	150
116	髀关穴 (ST31)	条口穴 (ST38)	10	101	76	146
117	聚泉穴 (EX-HN10)	廉泉穴 (RN23)	10	0	0	203
118	地机穴 (SP8)	交信穴 (KI8)	10	0	0	158
119	耳尖穴 (EX-HN6)	睛明穴 (BL1)	10	100	0	163
120	大陵穴 (PC7)	滑肉门穴 (ST24)	10	78	0	152
121	秉风穴 (SI12)	步廊穴 (KI22)	10.15	103	0	127
122	承扶穴 (BL36)	风门穴 (BL12)	10.219	110	109	128
123	后顶穴 (DU19)	少冲穴 (HT9)	10.333	85	0	135
124	风府穴 (DU16)	强间穴 (DU18)	10.5	0	62	159
125	地仓穴 (ST4)	巨髎穴 (ST3)	10.5	79	69	129
126	不容穴 (ST19)	承满穴 (ST20)	10.5	0	102	195
127	秉风穴 (SI12)	天府穴 (LU3)	10.714	121	0	136
128	承扶穴 (BL36)	风市穴 (GB31)	10.8	122	57	134
129	地仓穴 (ST4)	迎香穴 (LI20)	10.833	125	0	155
130	大赫穴 (KI12)	照海穴 (KI6)	11	0	0	154
131	公孙穴 (SP4)	太白穴 (SP3)	11	0	0	176
132	附分穴 (BL41)	肩外俞 (SI14)	11	0	0	188
133	八邪穴 (EX-UE9)	八风穴 (EX-LE10)	11	0	0	159
134	承扶穴 (BL36)	灵道穴 (HT4)	11.065	128	97	135
135	承扶穴 (BL36)	后顶穴 (DU19)	11.297	134	123	139
136	秉风穴 (SI12)	膏肓穴 (BL43)	11.318	127	0	156
137	腹通谷穴 (KI20)	少府穴 (HT8)	11.333	87	0	160
138	耳门穴 (SJ21)	浮白穴 (GB10)	11.4	106	0	172
139	承扶穴 (BL36)	腹结穴 (SP14)	11.456	135	0	143
140	外关穴 (SJ5)	悬厘穴 (GB6)	11.5	0	93	217
141	大迎穴 (ST5)	口禾髎 (LI19)	11.5	96	0	155
142	次髎穴 (BL32)	关元俞 (BL26)	11.5	112	94	157
143	承扶穴 (BL36)	鹤顶穴 (EX-LE2)	11.667	139	0	144
144	承扶穴 (BL36)	大骨空 (EX-UE5)	11.743	143	82	145
145	承扶穴 (BL36)	内踝尖 (EX-LE8)	11.847	144	0	146
146	髀关穴 (ST31)	承扶穴 (BL36)	11.921	116	145	154
147	建里穴 (RN11)	胃俞穴 (BL21)	12	0	0	240
148	肓俞穴 (KI16)	外陵穴 (ST26)	12	0	0	185
149	灵台穴 (DU10)	陶道穴 (DU13)	12	0	0	227
150	气冲穴 (ST30)	水泉穴 (KI5)	12	115	0	161
151	二间穴 (LI2)	厉兑穴 (ST45)	12	0	0	206
152	大陵穴 (PC7)	鸠尾穴 (RN15)	12	120	0	177
153	耳和髎 (SJ22)	跗阳穴 (BL59)	12	0	0	187
154	髀关穴 (ST31)	大赫穴 (KI12)	12.331	146	130	157
155	地仓穴 (ST4)	大迎穴 (ST5)	12.333	129	141	184
156	秉风穴 (SI12)	天泉穴 (PC2)	12.348	136	0	162
157	髀关穴 (ST31)	次髎穴 (BL32)	12.359	154	142	160
158	地机穴 (SP8)	气海穴 (RN6)	12.5	118	98	228
159	八邪穴 (EX-UE9)	风府穴 (DU16)	12.5	133	124	173
160	髀关穴 (ST31)	腹通谷穴 (KI20)	12.577	157	137	162
161	独阴穴 (EX-LE11)	气冲穴 (ST30)	12.667	0	150	178
162	髀关穴 (ST31)	秉风穴 (SI12)	12.765	160	156	174
163	当阳穴 (EX-HN2)	耳尖穴 (EX-HN6)	12.833	86	119	194

164	脊中穴 (DU6)	中枢穴 (DU7)	13	0	0	244
165	陷谷穴 (ST43)	意舍穴 (BL49)	13	0	0	219
166	光明穴 (GB37)	阳辅穴 (GB38)	13	0	0	220
167	承灵穴 (GB18)	素髎穴 (DU25)	13	0	0	212
168	肩髃穴 (LI15)	上廉穴 (LI9)	13	0	0	207
169	京门穴 (GB25)	三焦俞 (BL22)	13	0	0	228
170	经渠穴 (LU8)	缺盆穴 (ST12)	13	0	0	234
171	胞肓穴 (BL53)	膀胱俞 (BL28)	13	0	0	211
172	瘈脉穴 (SJ18)	耳门穴 (SJ21)	13.167	0	138	183
173	八邪穴 (EX-UE9)	昆仑穴 (BL60)	13.4	159	0	192
174	髀关穴 (ST31)	承筋穴 (BL56)	13.446	162	113	178
175	归来穴 (ST29)	阴包穴 (LR9)	13.5	99	0	191
176	公孙穴 (SP4)	内庭穴 (ST44)	13.5	131	0	209
177	大陵穴 (PC7)	厥阴俞 (BL14)	13.5	152	0	204
178	髀关穴 (ST31)	独阴穴 (EX-LE11)	13.557	174	161	179
179	髀关穴 (ST31)	腰眼穴 (EX-B7)	13.644	178	0	181
180	臂臑穴 (LI14)	飞扬穴 (BL58)	13.667	107	0	189
181	髀关穴 (ST31)	四缝穴 (Ex-UE10)	13.681	179	0	182
182	髀关穴 (ST31)	肺俞穴 (BL13)	13.683	181	114	188
183	瘈脉穴 (SJ18)	地五会 (GB42)	13.714	172	0	193
184	地仓穴 (ST4)	颊车穴 (ST6)	13.9	155	0	190
185	肓俞穴 (KI16)	上巨虚 (S37)	14	148	0	233
186	冲门穴 (SP12)	蠡沟穴 (LR5)	14	0	0	239
187	耳和髎 (SJ22)	颔厌穴 (GB4)	14	153	0	208
188	髀关穴 (ST31)	附分穴 (BL41)	14	182	132	189
189	臂臑穴 (LI14)	髀关穴 (ST31)	14.27	180	188	191
190	地仓穴 (ST4)	兑端穴 (DU27)	14.273	184	0	205
191	臂臑穴 (LI14)	归来穴 (ST29)	14.448	189	175	194
192	八邪穴 (EX-UE9)	支正穴 (SI7)	14.5	173	0	197
193	瘈脉穴 (SJ18)	阳谷穴 (SI5)	14.5	183	0	202
194	臂臑穴 (LI14)	当阳穴 (EX-HN2)	14.738	191	163	195
195	臂臑穴 (LI14)	不容穴 (ST19)	14.949	194	126	204
196	大包穴 (SP21)	周荣穴 (SP20)	15	0	0	219
197	八邪穴 (EX-UE9)	哑门穴 (DU15)	15	192	0	210
198	环跳穴 (GB30)	殷门穴 (BL37)	15	0	0	230
199	胆俞穴 (BL19)	阳陵泉 (GB34)	15	0	0	221
200	合阳穴 (BL55)	阴市穴 (ST33)	15	0	0	216
201	孔最穴 (LU6)	鱼际穴 (LU10)	15	0	0	256
202	瘈脉穴 (SJ18)	侠溪穴 (GB43)	15	193	111	217
203	金津玉液穴 (EX-HN12)	聚泉穴 (EX-HN10)	15	0	117	232
204	臂臑穴 (LI14)	大陵穴 (PC7)	15.007	195	177	205
205	臂臑穴 (LI14)	地仓穴 (ST4)	15.326	204	190	206
206	臂臑穴 (LI14)	二间穴 (LI2)	15.449	205	151	211
207	肩髃穴 (LI15)	养老穴 (SI6)	15.5	168	0	231
208	耳和髎 (SJ22)	阳溪穴 (LI5)	15.667	187	0	224
209	大都穴 (SP2)	公孙穴 (SP4)	15.667	0	176	241
210	八邪穴 (EX-UE9)	角孙穴 (SJ20)	15.75	197	95	215
211	臂臑穴 (LI14)	胞肓穴 (BL53)	15.769	206	171	212
212	臂臑穴 (LI14)	承灵穴 (GB18)	15.938	211	167	216

213	落枕穴 (EX-UE8)	天牖穴 (SJ16)	16	0	0	218
214	命门穴 (DU4)	肾俞穴 (BL23)	16	0	0	237
215	本神穴 (BG13)	八邪穴 (EX-UE9)	16	0	210	222
216	臂臑穴 (LI14)	合阳穴 (BL55)	16.012	212	200	218
217	瘈脉穴 (SJ18)	外关穴 (SJ5)	16.091	202	140	225
218	臂臑穴 (LI14)	落枕穴 (EX-UE8)	16.422	216	213	222
219	大包穴 (SP21)	陷谷穴 (ST43)	16.5	196	165	234
220	光明穴 (GB37)	少泽穴 (SI1)	16.5	166	0	223
221	胆俞穴 (BL19)	筋缩穴 (DU8)	16.5	199	0	229
222	臂臑穴 (LI14)	本神穴 (BG13)	16.59	218	215	223
223	臂臑穴 (LI14)	光明穴 (GB37)	16.747	222	220	225
224	承光穴 (BL6)	耳和髎 (SJ22)	16.75	0	208	245
225	臂臑穴 (LI14)	瘈脉穴 (SJ18)	16.989	223	217	230
226	百会穴 (DU20)	印堂穴 (DU29)	17	0	0	261
227	后溪穴 (SI3)	灵台穴 (DU10)	17	0	149	243
228	地机穴 (SP8)	京门穴 (GB25)	17.25	158	169	252
229	胆俞穴 (BL19)	至阳穴 (DU9)	17.333	221	0	235
230	臂臑穴 (LI14)	环跳穴 (GB30)	17.347	225	198	231
231	臂臑穴 (LI14)	肩髃穴 (LI15)	17.463	230	207	232
232	臂臑穴 (LI14)	金津玉液穴 (EX-HN12)	17.663	231	203	235
233	肓俞穴 (KI16)	神阙穴 (RN8)	17.667	185	0	250
234	大包穴 (SP21)	经渠穴 (LU8)	17.75	219	170	242
235	臂臑穴 (LI14)	胆俞穴 (BL19)	17.963	232	229	240
236	少商穴 (LU11)	中冲穴 (PC9)	18	0	0	279
237	会阴穴 (RN1)	命门穴 (DU4)	18	0	214	251
238	百虫窝 (EX-LE3)	督俞穴 (BL16)	18	0	0	253
239	冲门穴 (SP12)	大敦穴 (LR1)	18	186	0	249
240	臂臑穴 (LI14)	建里穴 (RN11)	18.01	235	147	241
241	臂臑穴 (LI14)	大都穴 (SP2)	18.095	240	209	243
242	大包穴 (SP21)	手五里 (LI13)	18.167	234	0	247
243	臂臑穴 (LI14)	后溪穴 (SI3)	18.483	241	227	244
244	臂臑穴 (LI14)	脊中穴 (DU6)	18.606	243	164	245
245	臂臑穴 (LI14)	承光穴 (BL6)	18.774	244	224	246
246	臂臑穴 (LI14)	丰隆穴 (ST40)	18.911	245	0	247
247	臂臑穴 (LI14)	大包穴 (SP21)	18.999	246	242	249
248	十宣穴 (EX-UE11)	委中穴 (BL40)	19	0	0	259
249	臂臑穴 (LI14)	冲门穴 (SP12)	19.233	247	239	250
250	臂臑穴 (LI14)	肓俞穴 (KI16)	19.303	249	233	252
251	会阴穴 (RN1)	三阴交 (SP6)	19.333	237	0	255
252	臂臑穴 (LI14)	地机穴 (SP8)	19.805	250	228	253
253	臂臑穴 (LI14)	百虫窝 (EX-LE3)	19.98	252	238	255
254	大肠俞 (BL25)	天枢穴 (ST25)	20	0	0	266
255	臂臑穴 (LI14)	会阴穴 (RN1)	20.093	253	251	257
256	大杼穴 (BL11)	孔最穴 (LU6)	20.5	0	201	264
257	臂臑穴 (LI14)	隐白穴 (SP1)	20.769	255	0	258
258	臂臑穴 (LI14)	神门穴 (HT7)	20.853	257	0	259
259	臂臑穴 (LI14)	十宣穴 (EX-UE11)	21.219	258	248	260
260	臂臑穴 (LI14)	冲阳穴 (ST42)	21.306	259	0	261
261	臂臑穴 (LI14)	百会穴 (DU20)	21.453	260	226	262

262	臂臑穴 (LI14)	列缺穴 (LU7)	21.868	261	0	263
263	臂臑穴 (LI14)	然谷穴 (KI2)	21.919	262	0	264
264	臂臑穴 (LI14)	大杼穴 (BL11)	21.973	263	256	268
265	少海穴 (HT3)	足窍阴 (GB44)	22	0	0	283
266	大肠俞 (BL25)	阴陵泉 (SP9)	22	254	0	277
267	攒竹穴 (BL2)	承泣穴 (ST1)	22	0	0	285
268	臂臑穴 (LI14)	志室穴 (BL52)	22.091	264	0	269
269	臂臑穴 (LI14)	天柱穴 (BL10)	22.121	268	0	270
270	臂臑穴 (LI14)	白环俞 (BL30)	22.355	269	0	271
271	臂臑穴 (LI14)	中渚穴 (SJ3)	22.398	270	0	272
272	臂臑穴 (LI14)	长强穴 (DU1)	22.622	271	0	273
273	臂臑穴 (LI14)	手三里 (LI10)	22.672	272	0	274
274	臂臑穴 (LI14)	大钟穴 (KI4)	22.974	273	0	275
275	臂臑穴 (LI14)	水沟穴 (DU26)	23.23	274	0	276
276	臂臑穴 (LI14)	血海穴 (SP10)	23.432	275	0	277
277	臂臑穴 (LI14)	大肠俞 (BL25)	23.493	276	266	278
278	臂臑穴 (LI14)	间使穴 (PC5)	23.767	277	0	279
279	臂臑穴 (LI14)	少商穴 (LU11)	23.935	278	236	280
280	臂臑穴 (LI14)	膻中穴 (RN17)	24.129	279	0	281
281	臂臑穴 (LI14)	承浆穴 (RN24)	24.358	280	0	282
282	臂臑穴 (LI14)	中脘穴 (RN12)	24.586	281	0	283
283	臂臑穴 (LI14)	少海穴 (HT3)	24.868	282	265	284
284	臂臑穴 (LI14)	悬钟穴 (GB39)	25.297	283	0	285
285	臂臑穴 (LI14)	攒竹穴 (BL2)	25.908	284	267	286
286	臂臑穴 (LI14)	内关穴 (PC6)	25.99	285	0	288
287	合谷穴 (LI4)	足临泣 (GB41)	26	0	0	292
288	臂臑穴 (LI14)	翳风穴 (SJ17)	26.077	286	0	289
289	臂臑穴 (LI14)	大巨穴 (ST27)	26.667	288	0	290
290	臂臑穴 (LI14)	期门穴 (LR14)	26.768	289	0	291
291	臂臑穴 (LI14)	曲泉穴 (LR8)	26.814	290	0	292
292	臂臑穴 (LI14)	合谷穴 (LI4)	27.289	291	287	293
293	臂臑穴 (LI14)	曲池穴 (LI11)	27.392	292	0	294
294	臂臑穴 (LI14)	尺泽穴 (LU5)	27.694	293	0	295
295	臂臑穴 (LI14)	章门穴 (LR13)	27.939	294	0	296
296	臂臑穴 (LI14)	承山穴 (BL57)	28.378	295	0	297
297	臂臑穴 (LI14)	极泉穴 (HT1)	28.694	296	0	298
298	臂臑穴 (LI14)	复溜穴 (KI7)	28.973	297	0	299
299	臂臑穴 (LI14)	天突穴 (RN22)	29.425	298	0	300
300	臂臑穴 (LI14)	丘墟穴 (GB40)	30.387	299	0	301
301	臂臑穴 (LI14)	大椎穴 (DU14)	30.445	300	0	302
302	臂臑穴 (LI14)	风池穴 (GB20)	31.152	301	0	303
303	臂臑穴 (LI14)	足三里 (ST36)	31.716	302	0	304
304	臂臑穴 (LI14)	肝俞穴 (BL18)	32.638	303	0	305
305	臂臑穴 (LI14)	膈俞穴 (BL17)	33.695	304	0	306
306	臂臑穴 (LI14)	关冲穴 (SJ1)	35.964	305	0	307
307	臂臑穴 (LI14)	关元穴 (RN4)	39.094	306	0	308
308	臂臑穴 (LI14)	涌泉穴 (KI1)	42.344	307	0	309
309	臂臑穴 (LI14)	太冲穴 (LR3)	46.382	308	0	310
310	臂臑穴 (LI14)	太溪穴 (KI3)	47.006	309	0	0

3.2 Pattern classification of acupoints with a fixed number of classes

The pattern classifications of acupoints with a fixed number of classes based on functional similarity are listed in Table 3. According to Table 3, it is possible to analyze the functional similarity relationship between acupoints at a given level, determine the corresponding relationship between acupoint functions and meridians, and further explore the meridian properties of acupoints. At the same time, the classe-acupoint data in Table 3 was counted to obtain the summary results in Table 4.

Obviously, in unsupervised pattern classification, k-means clustering gives the most reasonable pattern classification of acupoints, followed by BP neural network, and the results of hierarchical clustering and self-organizing feature map network are poor.

In supervised pattern classification (class IDs from 1 and 15 and their meanings of meridians, extra meridians and non-meridian extra acupoints in Tables 3 and 4 are listed in Table 2), the classification of acupoints by the LVQ network is superior to that of the BP neural network, and the result of the pattern classification of acupoints by the self-organizing feature map network is poor (Fig. 1-3). Compared with 15 categories of meridians, the LVQ network divided 13 classes of acupoints, the BP neural network divided 6 classes of acupoints, and the self-organizing feature mapping network divided 83 classes of acupoints. In the supervised pattern classification with BP neural network, no acupoints were classified into categories 1-8 (Lung Meridian of Hand-Taiyin (Lung Meridian), Pericardium Meridian of Hand-Jueyin (Pericardium Meridian), Heart Meridian of Hand-shaoyin (Heart Meridian), Large Intestine Meridian (Large Intestine Meridian), Sanjiao Meridian of Hand-shaoyang (Triple Energizer Meridian), Small Instestine Meridian of Hand-Taiyang (Small Intestine Meridian), Spleen Meridian of Foot-Taiyin (Spleen Meridian), Liver Meridian of Foot-Jueyin (Liver Meridian) and 13 (Conception Vessel). In the supervised pattern classification by the LVQ network, no acupoints were classified into classes 2 (Pericardium Meridian of Hand-Jueyin (Pericardium Meridian)) and 6 (Small Instestine Meridian of Hand-Taiyang (Small Intestine Meridian)).

Table 2 IDs (i.e., class IDs for supervised pattern classification in Tables 3 and 4) and their meanings of meridians, extra meridians and non-meridian extra acupoints.

ID	Name	Intl Code	English Name
1	手太阴肺经	LU	Lung Meridian of Hand-Taiyin (Lung Meridian)
2	手厥阴心包经	PC	Pericardium Meridian of Hand-Jueyin (Pericardium Meridian)
3	手少阴心经	HT	Heart Meridian of Hand-shaoyin (Heart Meridian)
4	手阳明大肠经	LI	Large Intestine Meridian (Large Intestine Meridian)
5	手少阳三焦经	SJ	Sanjiao Meridian of Hand-shaoyang (Triple Energizer Meridian)
6	手太阳小肠经	SI	Small Instestine Meridian of Hand-Taiyang (Small Intestine Meridian)
7	足太阴脾经	SP	Spleen Meridian of Foot-Taiyin (Spleen Meridian)
8	足厥阴肝经	LR	Liver Meridian of Foot-Jueyin (Liver Meridian)
9	足少阴肾经	KI	Kidney Channel of Foot-Shaoyin (Kidney Meridian)
10	足阳明胃经	ST	Stomach Meridian of Foot-Yangming (Stomach Meridian)
11	足少阳胆经	GB	Gallbladder Meridian of Foot-Shaoyang (Gallbladder Meridian)
12	足太阳膀胱经	BL	Bladder Meridian of Foot-Taiyang (Bladder Meridian)
13	任脉	CV	Conception Vessel
14	督脉	GV	Governor Vessel
15	经外奇穴	EX	Non-meridian extra acupoint
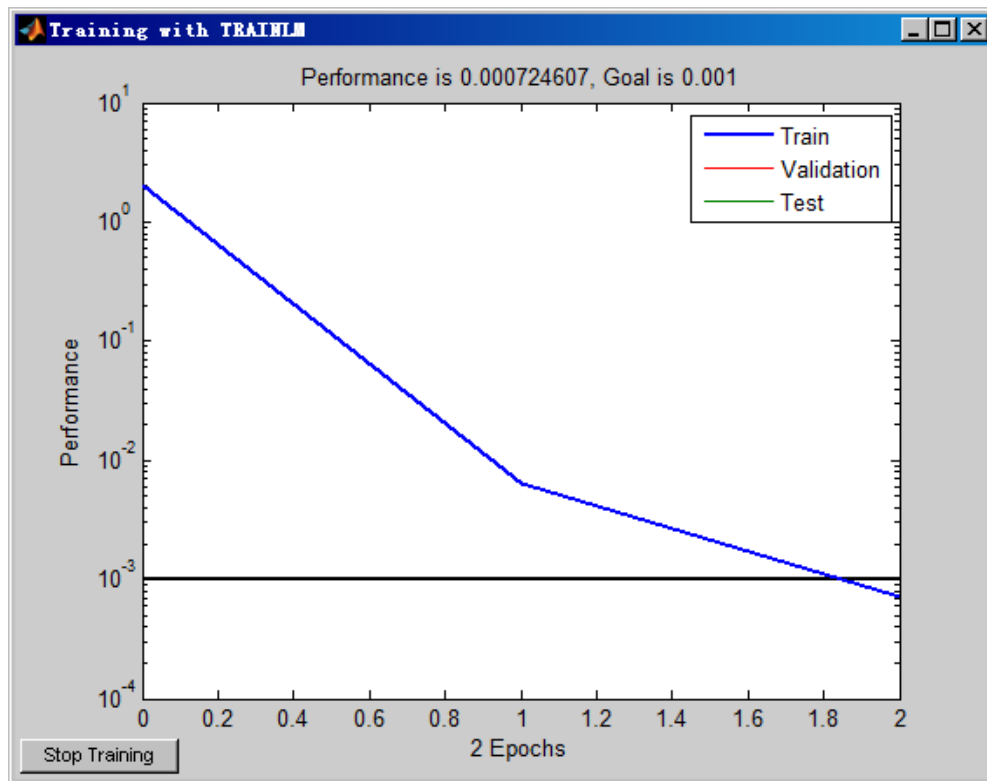
Fig. 1 Training and learning of unsupervised pattern classification with BP neural netowork.
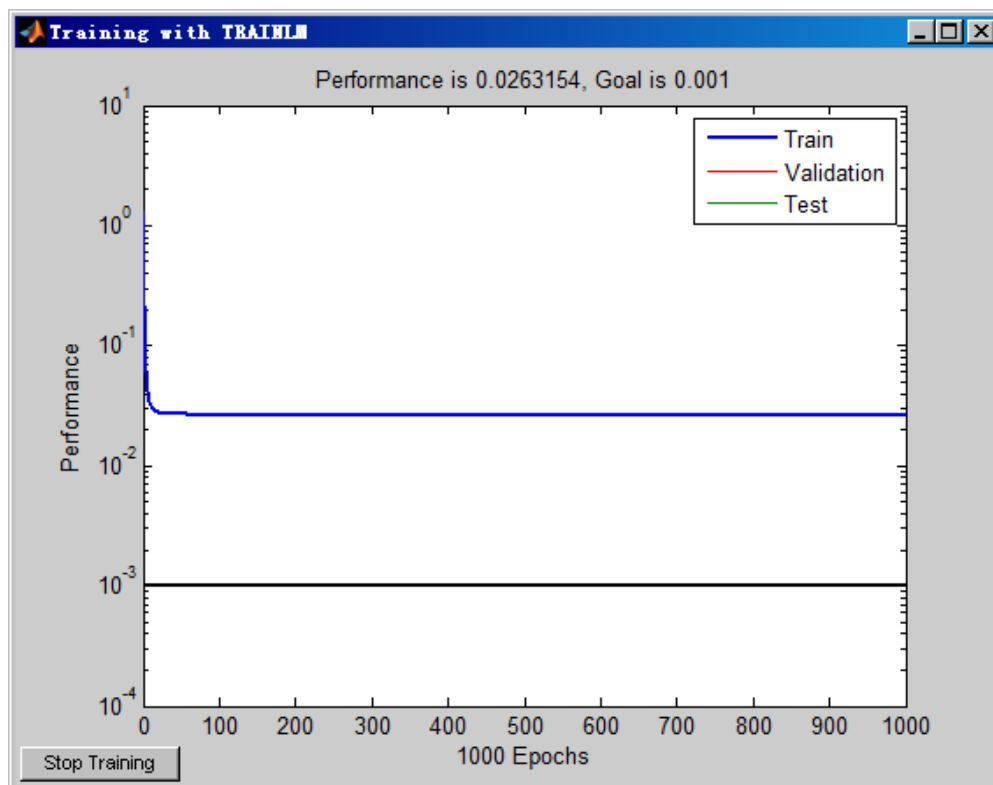
Fig. 2 Training and learning of supervised pattern classification with BP neural netowork.
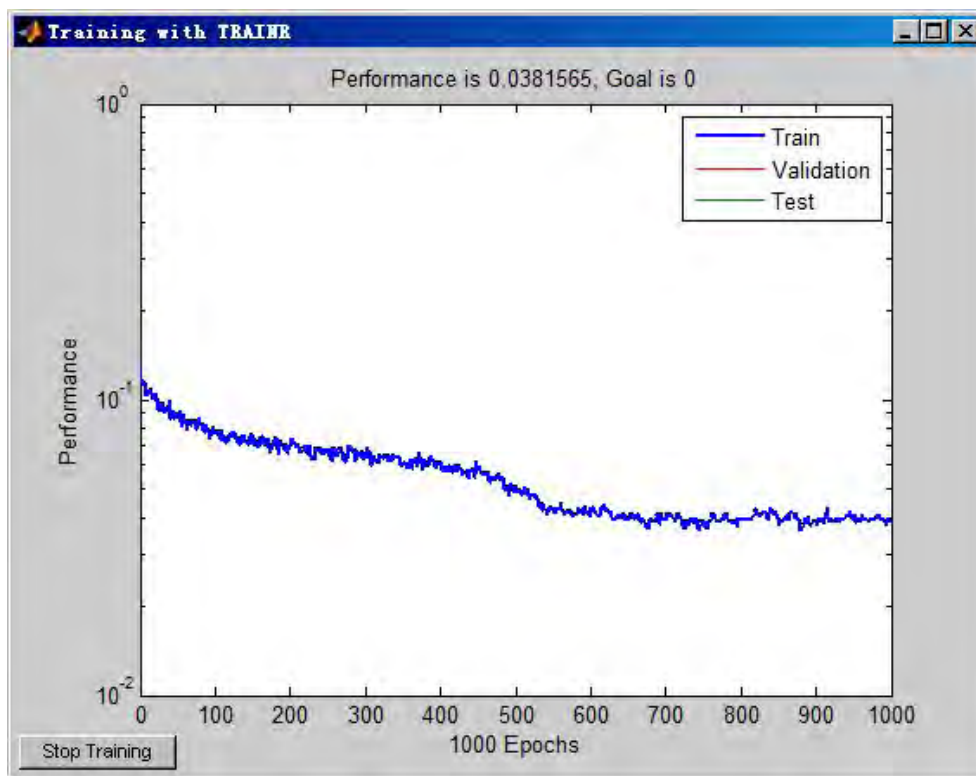
Fig. 3 Training and learning of supervised pattern classification with LVQ netowork.

Table 3 Pattern classfications of human body's acupoints based on functional similarity with fixed number of classes.

	Unsupervised Pattern Classification										Supervised Pattern Classification			
Acupoint	k-means clustering				Hierarchical clustering				BP NN	SOFM NN	Acupoint	Actual meridians	BP NN	LVQ NN
	k=15	k=6	k=3	k=2	k_{max} =15	k_{max} =6	k_{max} =3	k_{max} =2						
臂臑穴（LI14）	13	6	1	2	2	2	2	2	13	97	臂臑穴（LI14）	4	9	4
不容穴（ST19）	4	2	1	1	2	2	2	2	13	91	不容穴（ST19）	10	10	10
髀关穴（ST31）	1	2	1	1	2	2	2	2	11	5	髀关穴（ST31）	10	10	10
百会穴（DU20）	13	4	1	2	2	2	2	2	6	89	百会穴（DU20）	14	14	14
百虫窝（EX-LE3）	1	2	1	1	2	2	2	2	13	74	百虫窝（EX-LE3）	15	15	15
秉风穴（SI12）	6	2	1	1	2	2	2	2	13	18	秉风穴（SI12）	6	9	12
步廊穴（KI22）	6	2	1	1	2	2	2	2	13	19	步廊穴（KI22）	9	9	9
本神穴（BG13）	13	6	1	2	2	2	2	2	6	88	本神穴（BG13）	11	11	11
白环俞（BL30）	1	1	1	1	2	2	2	2	6	41	白环俞（BL30）	12	12	12
胞肓穴（BL53）	4	1	1	1	2	2	2	2	6	81	胞肓穴（BL53）	12	12	12
八邪穴（EX-UE9）	13	6	1	2	2	2	2	2	6	97	八邪穴（EX-UE9）	15	15	15
八风穴（EX-LE10）	13	6	1	2	2	2	2	2	5	97	八风穴（EX-LE10）	15	15	15
尺泽穴（LU5）	7	2	1	1	2	2	2	2	13	30	尺泽穴（LU5）	1	9	1
攒竹穴（BL2）	13	6	1	2	2	2	2	2	13	69	攒竹穴（BL2）	12	12	12
次髎穴（BL32）	1	1	1	1	2	2	2	2	11	21	次髎穴（BL32）	12	12	7
承浆穴（RN24）	12	2	1	1	2	2	2	2	13	3	承浆穴（RN24）	13	9	13

承泣穴（ST1）	12	2	1	1	2	2	2	2	13	3	承泣穴（ST1）	10	10	10
承扶穴（BL36）	1	2	1	1	2	2	2	2	13	64	承扶穴（BL36）	12	12	12
承满穴（ST20）	4	2	1	1	2	2	2	2	13	83	承满穴（ST20）	10	10	10
承筋穴（BL56）	1	2	1	1	2	2	2	2	13	44	承筋穴（BL56）	12	12	12
承山穴（BL57）	1	2	1	1	2	2	2	2	13	44	承山穴（BL57）	12	12	12
冲门穴（SP12）	1	1	1	1	2	2	2	2	13	31	冲门穴（SP12）	7	14	7
冲阳穴（ST42）	12	2	1	1	2	2	2	2	13	3	冲阳穴（ST42）	10	10	10
长强穴（DU1）	1	1	1	1	2	2	2	2	5	44	长强穴（DU1）	14	14	14
承光穴（BL6）	12	6	1	2	2	2	2	2	11	99	承光穴（BL6）	12	12	12
承灵穴（GB18）	1	2	1	1	2	2	2	2	6	16	承灵穴（GB18）	11	11	11
瘈脉穴（SJ18）	13	6	1	2	2	2	2	2	11	80	瘈脉穴（SJ18）	5	9	5
地仓穴（ST4）	12	2	1	1	2	2	2	2	13	3	地仓穴（ST4）	10	10	10
地机穴（SP8）	4	1	1	1	2	2	2	2	6	21	地机穴（SP8）	7	14	7
大巨穴（ST27）	4	1	1	1	2	2	2	2	6	81	大巨穴（ST27）	10	10	10
大都穴（SP2）	3	2	1	1	2	2	2	2	6	93	大都穴（SP2）	7	14	7
大迎穴（ST5）	12	2	1	1	2	2	2	2	13	4	大迎穴（ST5）	10	10	10
大横穴（SP15）	4	1	1	1	2	2	2	2	13	71	大横穴（SP15）	7	14	7
大包穴（SP21）	7	2	1	1	2	2	2	2	6	40	大包穴（SP21）	7	14	9
大椎穴（DU14）	3	2	1	1	6	2	2	2	6	94	大椎穴（DU14）	14	14	14
大赫穴（KI12）	4	1	1	1	2	2	2	2	11	11	大赫穴（KI12）	9	9	9
大肠俞（BL25）	4	1	1	1	2	2	2	2	13	71	大肠俞（BL25）	12	12	12
大杼穴（BL11）	6	6	1	2	2	2	2	2	5	10	大杼穴（BL11）	12	12	12
大陵穴（PC7）	3	2	1	1	2	2	2	2	13	63	大陵穴（PC7）	2	9	10
大钟穴（KI4）	1	2	1	1	2	2	2	2	5	53	大钟穴（KI4）	9	9	9
大敦穴（LR1）	1	1	1	1	2	2	2	2	13	41	大敦穴（LR1）	8	9	8
兑端穴（DU27）	12	2	1	1	2	2	2	2	13	4	兑端穴（DU27）	14	14	14
犊鼻穴（ST35）	1	2	1	1	2	2	2	2	6	5	犊鼻穴（ST35）	10	10	10
膻中穴（RN17）	3	2	1	1	2	2	2	2	13	65	膻中穴（RN17）	13	9	13
督俞穴（BL16）	1	2	1	1	2	2	2	2	13	27	督俞穴（BL16）	12	12	12
定喘穴（EX-B1）	6	2	1	1	2	2	2	2	13	10	定喘穴（EX-B1）	15	15	15
带脉穴（GB26）	1	2	1	1	2	2	2	2	13	23	带脉穴（GB26）	11	11	15
胆俞穴（BL19）	15	2	1	1	2	2	2	2	6	46	胆俞穴（BL19）	12	12	12
地五会（GB42）	1	2	1	1	2	2	2	2	5	37	地五会（GB42）	11	11	15
当阳穴（EX-HN2）	13	6	1	2	2	2	2	2	13	69	当阳穴（EX-HN2）	15	15	14
大骨空（EX-UE5）	1	2	1	1	2	2	2	2	6	26	大骨空（EX-UE5）	15	15	15
独阴穴（EX-LE11）	1	2	1	1	2	2	2	2	13	63	独阴穴（EX-LE11）	15	15	12
二间穴（LI2）	1	2	1	1	2	2	2	2	5	15	二间穴（LI2）	4	14	4
耳门穴（SJ21）	1	2	1	1	2	2	2	2	13	80	耳门穴（SJ21）	5	9	5
耳尖穴（EX-HN6）	13	6	1	2	2	2	2	2	13	59	耳尖穴（EX-HN6）	15	15	12
二白穴（Ex-UE2）	1	2	1	1	2	2	2	2	6	44	二白穴（Ex-UE2）	15	15	15
耳和髎（SJ22）	12	6	1	2	2	2	2	2	11	100	耳和髎（SJ22）	5	9	5
扶突穴（LI18）	3	2	1	1	2	2	2	2	13	65	扶突穴（LI18）	4	9	12
丰隆穴（ST40）	13	6	1	2	2	2	2	2	5	98	丰隆穴（ST40）	10	10	12
府舍穴（SP13）	1	2	1	1	2	2	2	2	13	42	府舍穴（SP13）	7	14	15
风门穴（BL12）	13	6	1	2	2	2	2	2	13	96	风门穴（BL12）	12	12	12
风府穴（DU16）	13	6	1	2	2	2	2	2	13	95	风府穴（DU16）	14	14	14

穴位											穴位			
风市穴 (GB31)	15	2	1	1	2	2	2	2	6	76	风市穴 (GB31)	11	11	11
风池穴 (GB20)	15	6	1	2	7	2	2	2	13	78	风池穴 (GB20)	11	11	11
飞扬穴 (BL58)	13	6	1	2	2	2	2	2	6	98	飞扬穴 (BL58)	12	12	12
腹结穴 (SP14)	4	2	1	1	2	2	2	2	13	82	腹结穴 (SP14)	7	14	7
腹通谷穴 (KI20)	3	2	1	1	2	2	2	2	13	63	腹通谷穴 (KI20)	9	9	9
腹哀穴 (SP16)	4	1	1	1	2	2	2	2	13	71	腹哀穴 (SP16)	7	14	7
复溜穴 (KI7)	4	1	1	1	3	2	2	2	11	1	复溜穴 (KI7)	9	9	9
肺俞穴 (BL13)	3	2	1	1	2	2	2	2	13	65	肺俞穴 (BL13)	12	12	12
伏兔穴 (ST32)	1	2	1	1	2	2	2	2	13	5	伏兔穴 (ST32)	10	10	11
浮白穴 (GB10)	13	6	1	2	2	2	2	2	13	80	浮白穴 (GB10)	11	11	11
浮郄穴 (BL38)	1	2	1	1	2	2	2	2	13	34	浮郄穴 (BL38)	12	12	12
附分穴 (BL41)	1	2	1	1	2	2	2	2	13	6	附分穴 (BL41)	12	12	12
跗阳穴 (BL59)	12	6	1	2	2	2	2	2	11	99	跗阳穴 (BL59)	12	12	12
肝俞穴 (BL18)	10	6	1	2	9	2	2	2	13	46	肝俞穴 (BL18)	12	12	12
归来穴 (ST29)	1	1	1	1	2	2	2	2	6	22	归来穴 (ST29)	10	10	10
公孙穴 (SP4)	4	2	1	1	2	2	2	2	13	92	公孙穴 (SP4)	7	14	7
关冲穴 (SJ1)	8	6	1	2	11	1	2	2	11	68	关冲穴 (SJ1)	5	9	5
关元穴 (RN4)	9	1	1	1	12	3	2	2	5	81	关元穴 (RN4)	13	14	13
关门穴 (ST22)	4	1	1	1	2	2	2	2	13	71	关门穴 (ST22)	10	10	10
关元俞 (BL26)	1	1	1	1	2	2	2	2	13	61	关元俞 (BL26)	12	12	12
光明穴 (GB37)	13	6	1	2	2	2	2	2	13	97	光明穴 (GB37)	11	11	11
膈俞穴 (BL17)	7	2	1	1	10	2	2	2	11	30	膈俞穴 (BL17)	12	12	12
膏肓穴 (BL43)	6	2	1	1	2	2	2	2	13	10	膏肓穴 (BL43)	12	12	12
膈关穴 (BL46)	1	2	1	1	2	2	2	2	6	84	膈关穴 (BL46)	12	12	12
合谷穴 (LI4)	15	6	1	2	2	2	2	2	13	60	合谷穴 (LI4)	4	14	11
合阳穴 (BL55)	14	2	1	1	2	2	2	2	11	23	合阳穴 (BL55)	12	12	12
后顶穴 (DU19)	1	2	1	1	2	2	2	2	13	7	后顶穴 (DU19)	14	14	14
后溪穴 (SI3)	3	2	1	1	2	2	2	2	13	58	后溪穴 (SI3)	6	9	12
横骨穴 (KI11)	1	1	1	1	2	2	2	2	13	41	横骨穴 (KI11)	9	9	12
会阴穴 (RN1)	1	1	1	1	2	2	2	2	11	41	会阴穴 (RN1)	13	14	12
会宗穴 (SJ7)	1	2	1	1	2	2	2	2	13	80	会宗穴 (SJ7)	5	9	5
鹤顶穴 (EX-LE2)	14	2	1	1	2	2	2	2	6	15	鹤顶穴 (EX-LE2)	15	15	15
华盖穴 (RN20)	3	2	1	1	2	2	2	2	13	65	华盖穴 (RN20)	13	9	12
滑肉门穴 (ST24)	3	2	1	1	2	2	2	2	13	73	滑肉门穴 (ST24)	10	10	10
颔厌穴 (GB4)	12	6	1	2	2	2	2	2	13	100	颔厌穴 (GB4)	11	11	11
环跳穴 (GB30)	14	2	1	1	2	2	2	2	6	5	环跳穴 (GB30)	11	11	11
会阳穴 (BL35)	1	2	1	1	2	2	2	2	13	64	会阳穴 (BL35)	12	12	12
肓俞穴 (KI16)	4	1	1	1	2	2	2	2	13	71	肓俞穴 (KI16)	9	9	9
魂门穴 (BL47)	1	2	1	1	2	2	2	2	13	73	魂门穴 (BL47)	12	12	12
肓门穴 (BL51)	1	2	1	1	2	2	2	2	13	82	肓门穴 (BL51)	12	12	12
经渠穴 (LU8)	6	2	1	1	2	2	2	2	13	18	经渠穴 (LU8)	1	9	1
金津玉液穴 (EX-HN12)	3	2	1	1	2	2	2	2	6	76	金津玉液穴 (EX-HN12)	15	15	15
金门穴 (BL63)	13	6	1	2	2	2	2	2	11	98	金门穴 (BL63)	12	12	12
京门穴 (GB25)	4	1	1	1	2	2	2	2	6	83	京门穴 (GB25)	11	11	10
京骨穴 (BL64)	13	6	1	2	2	2	2	2	5	98	京骨穴 (BL64)	12	12	12
睛明穴 (BL1)	1	2	1	1	2	2	2	2	13	58	睛明穴 (BL1)	12	12	12

极泉穴 (HT1)	14	2	1	1	1	2	2	2	13	7	极泉穴 (HT1)	3	9	3
间使穴 (PC5)	14	2	1	1	2	2	2	2	13	7	间使穴 (PC5)	2	14	12
解溪穴 (ST41)	13	6	1	2	2	2	2	2	13	98	解溪穴 (ST41)	10	10	12
箕门穴 (SP11)	1	2	1	1	2	2	2	2	13	51	箕门穴 (SP11)	7	14	12
厥阴俞 (BL14)	14	2	1	1	2	2	2	2	13	63	厥阴俞 (BL14)	12	12	9
交信穴 (KI8)	4	1	1	1	2	2	2	2	6	21	交信穴 (KI8)	9	9	9
肩贞穴 (SI9)	13	6	1	2	2	2	2	2	11	80	肩贞穴 (SI9)	6	9	5
肩髎穴 (SJ14)	15	2	1	1	2	2	2	2	13	76	肩髎穴 (SJ14)	5	9	15
肩前穴 (Ex-UE12)	1	2	1	1	2	2	2	2	13	24	肩前穴 (Ex-UE12)	15	15	15
肩髃穴 (LI15)	14	2	1	1	2	2	2	2	6	15	肩髃穴 (LI15)	4	9	4
肩中俞 (SI15)	6	2	1	1	2	2	2	2	13	18	肩中俞 (SI15)	6	9	1
肩外俞 (SI14)	7	2	1	1	2	2	2	2	6	40	肩外俞 (SI14)	6	9	11
肩井穴 (GB21)	1	2	1	1	2	2	2	2	13	76	肩井穴 (GB21)	11	11	11
脊中穴 (DU6)	1	2	1	1	2	2	2	2	13	35	脊中穴 (DU6)	14	14	14
角孙穴 (SJ20)	13	6	1	2	2	2	2	2	5	96	角孙穴 (SJ20)	5	9	11
居髎穴 (GB29)	1	2	1	1	2	2	2	2	13	42	居髎穴 (GB29)	11	11	12
巨阙穴 (RN14)	3	2	1	1	2	2	2	2	13	65	巨阙穴 (RN14)	13	9	13
巨骨穴 (LI16)	1	2	1	1	2	2	2	2	13	24	巨骨穴 (LI16)	4	9	15
夹脊穴 (EX-B2)	13	6	1	2	2	2	2	2	6	87	夹脊穴 (EX-B2)	15	15	15
颊车穴 (ST6)	12	2	1	1	2	2	2	2	13	4	颊车穴 (ST6)	10	10	10
急脉穴 (LR12)	1	2	1	1	2	2	2	2	13	31	急脉穴 (LR12)	8	9	15
巨髎穴 (ST3)	12	2	1	1	2	2	2	2	6	4	巨髎穴 (ST3)	10	10	4
筋缩穴 (DU8)	10	2	1	1	2	2	2	2	13	46	筋缩穴 (DU8)	14	14	14
建里穴 (RN11)	4	2	1	1	2	2	2	2	13	91	建里穴 (RN11)	13	9	9
鸠尾穴 (RN15)	3	2	1	1	2	2	2	2	13	65	鸠尾穴 (RN15)	13	9	13
颈百劳 (Ex-HN23)	6	2	1	1	2	2	2	2	13	10	颈百劳 (Ex-HN23)	15	15	15
聚泉穴 (EX-HN10)	1	2	1	1	2	2	2	2	13	76	聚泉穴 (EX-HN10)	15	15	15
孔最穴 (LU6)	6	6	1	2	2	2	2	2	13	10	孔最穴 (LU6)	1	9	1
昆仑穴 (BL60)	13	6	1	2	2	2	2	2	13	88	昆仑穴 (BL60)	12	12	12
库房穴 (ST14)	7	2	1	1	2	2	2	2	13	20	库房穴 (ST14)	10	10	9
口禾髎 (LI19)	12	2	1	1	2	2	2	2	6	4	口禾髎 (LI19)	4	9	4
髋骨穴 (EX-LE1)	15	2	1	1	2	2	2	2	13	76	髋骨穴 (EX-LE1)	15	15	15
列缺穴 (LU7)	13	6	1	2	2	2	2	2	5	96	列缺穴 (LU7)	1	9	12
梁门穴 (ST21)	4	2	1	1	2	2	2	2	13	91	梁门穴 (ST21)	10	10	10
梁丘穴 (ST34)	1	2	1	1	2	2	2	2	13	73	梁丘穴 (ST34)	10	10	10
灵墟穴 (KI24)	7	2	1	1	2	2	2	2	13	30	灵墟穴 (KI24)	9	9	9
灵道穴 (HT4)	14	2	1	1	2	2	2	2	13	6	灵道穴 (HT4)	3	9	15
廉泉穴 (RN23)	3	2	1	1	2	2	2	2	13	76	廉泉穴 (RN23)	13	14	13
蠡沟穴 (LR5)	1	1	1	1	2	2	2	2	13	21	蠡沟穴 (LR5)	8	9	8
落枕穴 (EX-UE8)	1	2	1	1	2	2	2	2	6	54	落枕穴 (EX-UE8)	15	15	15
阑尾穴 (EX-LE7)	1	2	1	1	2	2	2	2	13	5	阑尾穴 (EX-LE7)	15	15	15
漏谷穴 (SP7)	1	1	1	1	2	2	2	2	13	61	漏谷穴 (SP7)	7	14	7
厉兑穴 (ST45)	1	2	1	1	2	2	2	2	13	84	厉兑穴 (ST45)	10	10	10
颅息穴 (SJ19)	13	6	1	2	2	2	2	2	11	80	颅息穴 (SJ19)	5	9	5
灵台穴 (DU10)	3	2	1	1	2	2	2	2	5	65	灵台穴 (DU10)	14	14	14
眉冲穴 (BL3)	13	6	1	2	2	2	2	2	13	99	眉冲穴 (BL3)	12	12	12

命门穴 (DU4)	1	1	1	1	2	2	2	2	5	51	命门穴 (DU4)	14	14	12
内庭穴 (ST44)	4	2	1	1	2	2	2	2	6	92	内庭穴 (ST44)	10	10	7
内关穴 (PC6)	14	2	1	1	2	2	2	2	13	93	内关穴 (PC6)	2	9	10
臑俞穴 (SI10)	1	2	1	1	2	2	2	2	13	74	臑俞穴 (SI10)	6	9	15
内踝尖 (EX-LE8)	1	2	1	1	2	2	2	2	13	24	内踝尖 (EX-LE8)	15	15	15
脾俞穴 (BL20)	1	2	1	1	2	2	2	2	13	91	脾俞穴 (BL20)	12	12	12
气冲穴 (ST30)	1	1	1	1	2	2	2	2	13	22	气冲穴 (ST30)	10	10	10
气舍穴 (ST11)	3	2	1	1	2	2	2	2	13	65	气舍穴 (ST11)	10	10	10
气海穴 (RN6)	4	1	1	1	2	2	2	2	13	21	气海穴 (RN6)	13	9	8
颧髎穴 (SI18)	12	2	1	1	2	2	2	2	13	3	颧髎穴 (SI18)	6	9	10
清冷渊 (SJ11)	13	6	1	2	2	2	2	2	6	97	清冷渊 (SJ11)	5	9	12
强间穴 (DU18)	13	6	1	2	2	2	2	2	13	78	强间穴 (DU18)	14	14	14
气端穴 (EX-LE12)	1	2	1	1	2	2	2	2	6	15	气端穴 (EX-LE12)	15	15	15
曲差穴 (BL4)	12	2	1	1	2	2	2	2	6	4	曲差穴 (BL4)	12	12	12
前顶穴 (DU21)	1	2	1	1	2	2	2	2	13	59	前顶穴 (DU21)	14	14	12
曲池穴 (LI11)	14	2	1	1	2	2	2	2	13	27	曲池穴 (LI11)	4	9	4
曲泽穴 (PC3)	3	2	1	1	2	2	2	2	13	63	曲泽穴 (PC3)	2	9	10
曲泉穴 (LR8)	4	1	1	1	2	2	2	2	6	21	曲泉穴 (LR8)	8	9	8
丘墟穴 (GB40)	15	2	1	1	5	2	2	2	13	50	丘墟穴 (GB40)	11	11	11
期门穴 (LR14)	7	2	2	1	2	2	2	2	6	37	期门穴 (LR14)	8	9	8
青灵穴 (HT2)	13	6	1	2	2	2	2	2	5	97	青灵穴 (HT2)	3	9	12
膀胱俞 (BL28)	4	1	1	1	2	2	2	2	6	61	膀胱俞 (BL28)	12	12	12
缺盆穴 (ST12)	7	2	1	1	2	2	2	2	13	30	缺盆穴 (ST12)	10	10	10
人迎穴 (ST9)	1	2	1	1	2	2	2	2	6	74	人迎穴 (ST9)	10	10	10
日月穴 (GB24)	15	2	1	1	2	2	2	2	13	46	日月穴 (GB24)	11	11	14
然谷穴 (KI2)	1	1	1	1	2	2	2	2	11	22	然谷穴 (KI2)	9	9	9
少商穴 (LU11)	3	4	1	1	2	2	2	2	5	75	少商穴 (LU11)	1	9	14
少海穴 (HT3)	13	6	1	2	2	2	2	2	11	40	少海穴 (HT3)	3	9	11
少泽穴 (SI1)	13	6	1	2	2	2	2	2	5	97	少泽穴 (SI1)	6	9	4
少府穴 (HT8)	1	2	1	1	2	2	2	2	13	52	少府穴 (HT8)	3	9	11
少冲穴 (HT9)	14	2	1	1	2	2	2	2	13	7	少冲穴 (HT9)	3	9	12
三阴交 (SP6)	4	1	1	1	2	2	2	2	6	61	三阴交 (SP6)	7	14	7
三间穴 (LI3)	1	2	1	1	2	2	2	2	13	24	三间穴 (LI3)	4	9	4
三焦俞 (BL22)	4	2	1	1	2	2	2	2	6	82	三焦俞 (BL22)	12	12	7
十宣穴 (EX-UE11)	1	4	1	1	2	2	2	2	6	26	十宣穴 (EX-UE11)	15	15	15
手五里 (LI13)	7	2	1	1	2	2	2	2	13	39	手五里 (LI13)	4	9	4
手三里 (LI10)	12	2	1	1	2	2	2	2	6	2	手三里 (LI10)	4	14	4
四缝穴 (Ex-UE10)	3	2	1	1	2	2	2	2	13	65	四缝穴 (Ex-UE10)	15	15	15
神庭穴 (DU24)	13	6	1	2	2	2	2	2	6	89	神庭穴 (DU24)	14	14	14
神阙穴 (RN8)	4	1	1	1	2	2	2	2	5	92	神阙穴 (RN8)	13	9	10
神封穴 (KI23)	6	2	1	1	2	2	2	2	13	9	神封穴 (KI23)	9	9	9
神藏穴 (KI25)	7	2	1	1	2	2	2	2	13	30	神藏穴 (KI25)	9	9	9
水泉穴 (KI5)	1	2	1	1	2	2	2	2	13	52	水泉穴 (KI5)	9	9	9
水突穴 (ST10)	6	2	1	1	2	2	2	2	13	10	水突穴 (ST10)	10	10	1
神道穴 (DU11)	1	2	1	1	2	2	2	2	6	53	神道穴 (DU11)	14	14	15
水沟穴 (DU26)	3	2	1	1	2	2	2	2	13	14	水沟穴 (DU26)	14	14	14

穴位										穴位			
神堂穴 （BL44）	6	2	1	1	2	2	2	2	13	10	神堂穴 （BL44）	12	12	9
上巨虚 （S37）	4	1	1	1	2	2	2	2	13	1	上巨虚 （S37）	10	10	10
上廉穴 （LI9）	13	6	1	2	2	2	2	2	11	87	上廉穴 （LI9）	4	9	4
上髎穴 （BL31）	1	2	1	1	2	2	2	2	6	32	上髎穴 （BL31）	12	12	12
上脘穴 （RN13）	1	2	1	1	2	2	2	2	13	91	上脘穴 （RN13）	13	9	12
石门穴 （RN5）	4	1	1	1	2	2	2	2	6	21	石门穴 （RN5）	13	9	7
肾俞穴 （BL23）	1	1	1	1	2	2	2	2	11	51	肾俞穴 （BL23）	12	12	12
神门穴 （HT7）	3	2	1	1	2	2	2	2	6	85	神门穴 （HT7）	3	9	14
率谷穴 （GB8）	13	6	1	2	2	2	2	2	11	80	率谷穴 （GB8）	11	11	5
素髎穴 （DU25）	1	2	1	1	2	2	2	2	6	16	素髎穴 （DU25）	14	14	14
束骨穴 （BL65）	13	6	1	2	2	2	2	2	13	68	束骨穴 （BL65）	12	12	12
申脉穴 （BL62）	13	6	1	2	2	2	2	2	13	69	申脉穴 （BL62）	12	12	12
身柱穴 （DU12）	6	2	1	1	2	2	2	2	13	10	身柱穴 （DU12）	14	14	12
天府穴 （LU3）	6	2	1	1	2	2	2	2	13	18	天府穴 （LU3）	1	9	1
天突穴 （RN22）	6	2	1	1	4	2	2	2	11	10	天突穴 （RN22）	13	9	10
天泉穴 （PC2）	6	2	1	1	2	2	2	2	13	18	天泉穴 （PC2）	2	9	10
太冲穴 （LR3）	2	5	2	2	14	5	1	2	5	70	太冲穴 （LR3）	8	9	8
天柱穴 （BL10）	13	6	1	2	2	2	2	2	13	77	天柱穴 （BL10）	12	12	12
天鼎穴 （LI17）	1	2	1	1	2	2	2	2	13	14	天鼎穴 （LI17）	4	9	4
陶道穴 （DU13）	3	6	1	2	2	2	2	2	11	95	陶道穴 （DU13）	14	14	14
天髎穴 （SJ15）	1	2	1	1	2	2	2	2	5	54	天髎穴 （SJ15）	5	9	12
天牖穴 （SJ16）	13	6	1	2	2	2	2	2	5	98	天牖穴 （SJ16）	5	9	12
天宗穴 （SI11）	6	2	1	1	2	2	2	2	13	18	天宗穴 （SI11）	6	9	15
天窗穴 （SI16）	1	2	1	1	2	2	2	2	6	80	天窗穴 （SI16）	6	9	5
听宫穴 （SI19）	1	2	1	1	2	2	2	2	13	80	听宫穴 （SI19）	6	9	5
条口穴 （ST38）	1	2	1	1	2	2	2	2	13	25	条口穴 （ST38）	10	10	4
天枢穴 （ST25）	4	1	1	1	2	2	2	2	6	92	天枢穴 （ST25）	10	10	10
通里穴 （HT5）	1	2	1	1	2	2	2	2	6	7	通里穴 （HT5）	3	9	15
太渊穴 （LU9）	3	2	1	1	2	2	2	2	13	65	太渊穴 （LU9）	1	9	13
太溪穴 （KI3）	5	3	3	2	15	6	3	1	5	90	太溪穴 （KI3）	9	9	9
太白穴 （SP3）	4	2	1	1	2	2	2	2	13	92	太白穴 （SP3）	7	14	7
瞳子髎 （GB1）	12	2	1	1	2	2	2	2	6	4	瞳子髎 （GB1）	11	11	12
温溜穴 （LI7）	12	2	1	1	2	2	2	2	6	4	温溜穴 （LI7）	4	9	4
外关穴 （SJ5）	13	6	1	2	2	2	2	2	13	70	外关穴 （SJ5）	5	9	5
外陵穴 （ST26）	4	1	1	1	2	2	2	2	13	71	外陵穴 （ST26）	10	10	10
腕骨穴 （SI4）	1	2	1	1	2	2	2	2	13	47	腕骨穴 （SI4）	6	9	14
完骨穴 （GB12）	12	6	1	2	2	2	2	2	13	100	完骨穴 （GB12）	11	11	11
外踝尖 （Ex-LE9）	1	2	1	1	2	2	2	2	13	24	外踝尖 （Ex-LE9）	15	15	15
外丘穴 （GB36）	1	2	1	1	2	2	2	2	13	5	外丘穴 （GB36）	11	11	12
胃俞穴 （BL21）	4	2	1	1	2	2	2	2	13	91	胃俞穴 （BL21）	12	12	12
委中穴 （BL40）	1	1	1	1	2	2	2	2	13	51	委中穴 （BL40）	12	12	12
委阳穴 （BL39）	1	2	1	1	2	2	2	2	13	33	委阳穴 （BL39）	12	12	12
五处穴 （BL5）	1	2	1	1	2	2	2	2	13	24	五处穴 （BL5）	12	12	12
胃仓穴 （BL50）	1	2	1	1	2	2	2	2	13	82	胃仓穴 （BL50）	12	12	12
胃脘下俞 （EX-B3）	1	2	1	1	2	2	2	2	13	84	胃脘下俞 （EX-B3）	15	15	15
侠白穴 （LU4）	6	2	1	1	2	2	2	2	13	10	侠白穴 （LU4）	1	9	1

心俞穴（Bl15）	14	2	1	1	2	2	2	2	13	7	心俞穴（Bl15）	12	12	12
小肠俞（BL27）	4	1	1	1	2	2	2	2	6	61	小肠俞（BL27）	12	12	7
小海穴（SI8）	1	2	1	1	2	2	2	2	6	5	小海穴（SI8）	6	9	12
陷谷穴（ST43）	7	2	1	1	2	2	2	2	6	38	陷谷穴（ST43）	10	10	10
血海穴（SP10）	1	2	1	1	2	2	2	2	13	23	血海穴（SP10）	7	14	7
悬钟穴（GB39）	13	6	1	2	2	2	2	2	13	87	悬钟穴（GB39）	11	11	11
悬厘穴（GB6）	13	6	1	2	2	2	2	2	13	70	悬厘穴（GB6）	11	11	11
璇玑穴（RN21）	7	2	1	1	2	2	2	2	6	20	璇玑穴（RN21）	13	9	9
侠溪穴（GB43）	13	6	1	2	2	2	2	2	11	80	侠溪穴（GB43）	11	11	11
膝阳关（GB33）	1	2	1	1	2	2	2	2	6	5	膝阳关（GB33）	11	11	11
膝眼穴（EX-LE5）	1	2	1	1	2	2	2	2	13	24	膝眼穴（EX-LE5）	15	15	15
小骨空（EX-UE6）	1	2	1	1	2	2	2	2	13	59	小骨空（EX-UE6）	15	15	15
云门穴（LU2）	6	2	1	1	2	2	2	2	5	18	云门穴（LU2）	1	9	1
鱼际穴（LU10）	6	4	1	1	2	2	2	2	13	9	鱼际穴（LU10）	1	9	1
玉枕穴（BL9）	13	6	1	2	2	2	2	2	6	98	玉枕穴（BL9）	12	12	12
阴谷穴（KI10）	1	2	1	1	2	2	2	2	5	31	阴谷穴（KI10）	9	9	9
阴市穴（ST33）	14	2	1	1	2	2	2	2	5	15	阴市穴（ST33）	10	10	10
阴郄穴（HT6）	1	2	1	1	2	2	2	2	13	17	阴郄穴（HT6）	3	9	12
阴包穴（LR9）	1	1	1	1	2	2	2	2	13	23	阴包穴（LR9）	8	9	12
腰眼穴（EX-B7）	1	1	1	1	2	2	2	2	13	51	腰眼穴（EX-B7）	15	15	15
阴陵泉（SP9）	4	1	1	1	2	2	2	2	11	61	阴陵泉（SP9）	7	14	7
阳白穴（GB14）	12	2	1	1	2	2	2	2	6	4	阳白穴（GB14）	11	11	12
阳溪穴（LI5）	12	6	1	2	2	2	2	2	13	100	阳溪穴（LI5）	4	9	11
阳谷穴（SI5）	1	2	1	1	2	2	2	2	13	80	阳谷穴（SI5）	6	9	5
阳辅穴（GB38）	13	6	1	2	2	2	2	2	11	87	阳辅穴（GB38）	11	11	11
阳池穴（SJ4）	1	2	1	1	2	2	2	2	13	73	阳池穴（SJ4）	5	9	5
隐白穴（SP1）	1	2	1	1	2	2	2	2	13	53	隐白穴（SP1）	7	14	7
俞府穴（KI27）	6	2	1	1	2	2	2	2	13	10	俞府穴（KI27）	9	9	9
阳陵泉（GB34）	1	2	1	1	2	2	2	2	6	56	阳陵泉（GB34）	11	11	11
翳风穴（SJ17）	12	6	1	2	2	2	2	2	13	100	翳风穴（SJ17）	5	9	5
印堂穴（DU29）	13	6	1	2	2	2	2	2	6	89	印堂穴（DU29）	14	14	14
涌泉穴（KI1）	11	4	1	2	13	4	2	2	11	89	涌泉穴（KI1）	9	9	9
殷门穴（BL37）	1	2	1	1	2	2	2	2	13	44	殷门穴（BL37）	12	12	12
养老穴（SI6）	14	2	1	1	2	2	2	2	5	15	养老穴（SI6）	6	9	11
腰俞穴（DU2）	1	1	1	1	2	2	2	2	6	44	腰俞穴（DU2）	14	14	12
腰阳关（DU3）	1	1	1	1	2	2	2	2	6	11	腰阳关（DU3）	14	14	11
哑门穴（DU15）	3	6	1	2	2	2	2	2	13	95	哑门穴（DU15）	14	14	14
液门穴（SJ2）	13	6	1	2	2	2	2	2	11	80	液门穴（SJ2）	5	9	5
意舍穴（BL49）	7	2	1	1	2	2	2	2	6	40	意舍穴（BL49）	12	12	12
彧中穴（KI26）	7	2	1	1	2	2	2	2	6	20	彧中穴（KI26）	9	9	9
迎香穴（LI20）	12	2	1	1	2	2	2	2	6	3	迎香穴（LI20）	4	14	4
中府穴（LU1）	6	2	1	1	2	2	2	2	13	9	中府穴（LU1）	1	9	1
中冲穴（PC9）	3	4	1	1	2	2	2	2	6	76	中冲穴（PC9）	2	9	11
中渎穴（GB32）	15	2	1	1	2	2	2	2	6	56	中渎穴（GB32）	11	11	11
中渚穴（SJ3）	13	6	1	2	2	2	2	2	11	80	中渚穴（SJ3）	5	9	5
中脘穴（RN12）	4	2	1	1	2	2	2	2	13	72	中脘穴（RN12）	13	9	10

中枢穴 (DU7)	1	2	1	1	2	2	2	2	13	93	中枢穴 (DU7)	14	14	14
足临泣 (GB41)	13	6	1	2	2	2	2	2	13	60	足临泣 (GB41)	11	11	11
足三里 (ST36)	6	1	2	1	8	2	2	2	6	10	足三里 (ST36)	10	10	10
足窍阴 (GB44)	13	6	1	2	2	2	2	2	11	80	足窍阴 (GB44)	11	11	11
足通谷 (BL66)	13	6	1	2	2	2	2	2	13	98	足通谷 (BL66)	12	12	12
章门穴 (LR13)	4	1	1	1	2	2	2	2	13	71	章门穴 (LR13)	8	9	8
周荣穴 (SP20)	7	2	1	1	2	2	2	2	13	30	周荣穴 (SP20)	7	14	12
紫宫穴 (RN19)	7	2	1	1	2	2	2	2	13	30	紫宫穴 (RN19)	13	9	9
支沟穴 (SJ6)	13	6	1	2	2	2	2	2	13	70	支沟穴 (SJ6)	5	9	5
支正穴 (SI7)	13	6	1	2	2	2	2	2	13	78	支正穴 (SI7)	6	9	11
至阳穴 (DU9)	15	2	1	1	2	2	2	2	13	46	至阳穴 (DU9)	14	14	14
至阴穴 (BL67)	13	6	1	2	2	2	2	2	13	97	至阴穴 (BL67)	12	12	12
正营穴 (GB17)	13	6	1	2	2	2	2	2	13	97	正营穴 (GB17)	11	11	12
照海穴 (KI6)	1	2	1	1	2	2	2	2	6	33	照海穴 (KI6)	9	9	9
子宫穴 (EX-CA1)	1	1	1	1	2	2	2	2	6	22	子宫穴 (EX-CA1)	15	15	15
志室穴 (BL52)	1	1	1	1	2	2	2	2	5	33	志室穴 (BL52)	12	12	12
筑宾穴 (KI09)	1	2	1	1	2	2	2	2	6	32	筑宾穴 (KI09)	9	9	12
中魁穴 (EX-UE4)	1	2	1	1	2	2	2	2	13	74	中魁穴 (EX-UE4)	15	15	15
中泉穴 (EX-UE3)	6	2	1	1	2	2	2	2	13	10	中泉穴 (EX-UE3)	15	15	15

Under the same pattern classification, acupoints with the same class ID belong to the same class.

Table 4 Number of acupoints of each class in pattern classfications based on functional similarity with fixed number of classes.

Unsupervised Claification																			Supervised Claification			
Number of each class for k-means clustering								Number of each class for hierarchical clustering								Number of each class for BP NN		Noumber of each class for SOM NN	Number of each meridian		Number of each class for BP NN	Number of each class for LVQ NN
k=15		k=6		k=3		k=2		k_max=15		k_max=6		k_max=3		k_max=2								
Cla	No.	Cla	No.	Cla	No.	Cla	No.	Cla	No.	Cla	No.	Cla	No.	Cla	No.	Cla	No.	Cla No.	Cla	No.	No.	No.
1	104	1	188	1	307	1	240	1	297	1	306	1	309	1	310	1	183	83 Cla *	1	11	0	10
2	53	2	67	2	3	2	71	2	1	2	1	2	1	2	1	2	73		2	6	0	0
3	35	3	48	3	1			3	1	3	1	3	1			3	29		3	9	0	1
4	25	4	6					4	1	4	1					4	26		4	16	0	15
5	24	5	1					5	1	5	1								5	17	0	17
6	23	6	1					6	1	6	1								6	16	0	0
7	16							7	1										7	17	0	18
8	14							8	1										8	8	0	7
9	10							9	1										9	20	112	25
10	2							10	1										10	34	34	35
11	1							11	1										11	30	30	31
12	1							12	1										12	56	56	84
13	1							13	1										13	17	0	7
14	1							14	1										14	24	49	23
15	1							15	1										15	30	30	38

Cla: class. No.: number of acupoints in the class. The classes in the supervised pattern classification are the actual categories of meridians, see the supplementary material for details. The classes in unsupervised pattern classification have not been actually defined and will be determined by further analysis. *Indicates that there are too many classes, and the acupoints of each class are not listed, please refer to the supplementary material for details.

4 Discussion

The pattern classification of acupoints in this study is based on the similarity of acupoint functions. For acupoint A, if acupoint B has more of the same functions as acupoint A, the greater their similarity. The stronger the functional similarity of two acupoints, the stronger the substitutability of one acupoint for the other. Therefore, the results of pattern classification of acupoints have guiding significance for selection, collocation, diagnosis and treatment of acupoints. In the non-neural network methods, the results are different if the between-acupoint distances and classification methods are selected differently, and comprehensive consideration is required. In general, the pattern classification of acupoints by the k-means clustering is more effective. The neural network methods are not as effective as the k-means clustering because of fewer samples (311 acupoints), more variables (651 acupoint functions), and more given categories (15 meridian categories). Therefore, the acupoint relationship can be further mined and analyzed mainly based on the pattern classification of the k-means clustering and the cluster tree of the hierarchical clustering. For other detailed results, see:

http://www.iaees.org/publications/journals/nb/articles/2023-13(4)/e-suppl/Zhang-Supplementary-Material.rar

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