Available online at www.elixirpublishers.com (Elixir International Journal)

Computer Engineering

Elixir Comp. Engg. 106 (2017) 49823-49826

ISSN: 2229-712X

A Novel Method of Pattern Recognition and Classification based on Clustering Algorithm and Linear Decision

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ARTICLE INFO

Article history:
Received: 15 April 2017;
Received in revised form:
14 May 2017;
Accepted: 25 May 2017;

Keywords
Pattern recognition,
Classification,
Clustering Algorithm,
Linear Decision.

ABSTRACT
In this paper, the pattern recognition and classification based on clustering algorithm and linear decision is studied. The research method is used for an example of a car and a background in a picture. The experimental results show that the recognition effect is better than other traditional methods.

Introduction

The rapid development of computer hardware, computer applications continue to develop, urgently requires a computer to more effectively such as text, image, sound perception, temperature, vibration and other human development itself, the transformation of the environment information[1-3]. But in general sense, the current general computer can not directly perceive them, keyboard, mouse and other external devices, for such a wide variety of external world seems powerless. Even the TV camera, scanner, microphone and other equipment has solved the conversion of non electrical signals, and the computer online, but the recognition is not high, but failed to make the computer really know what information collection after. The low perception ability of the computer to the outside world has become the bottleneck of the development of computer application, and it also forms a strong contrast with its high computing ability. Therefore, it has been developing rapidly in order to broaden the application field of computer and improve its ability to perceive the external information. Pattern recognition artificial intelligence research is the use of computer instead of human beings or help human perception model, is a simulation of human perception function, is the study of computer pattern recognition system, which is a computer system with simulation of human through the senses to accept outside information, recognition and understanding of the surrounding environment perception.

2. Pattern Recognition System

A typical pattern recognition system, as shown in Figure1, consists of five parts: data acquisition, preprocessing, feature extraction, classification decision and classifier design. A typical pattern recognition system generally is divided into two parts.one part classifies unknown categories mode, the other part belongs to the designed training process by the classifier that can train samples and determine the specific parameters of the classifier and complete the design of the classifier.

The classification decision plays an important role in the recognition process, and the classification of the samples is made.

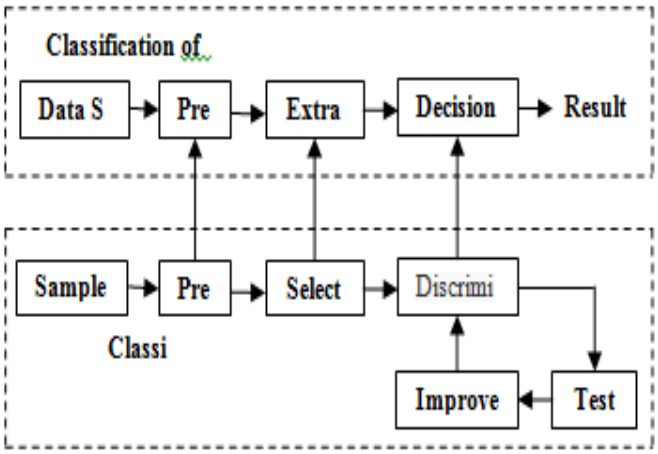

Figure 1.Pattern recognition system and recognition.

The function modules of the system are as follows.

(1)Data acquisition.The symbols that can be calculated by computer can be used to represent the objects studied. The general data types are two-dimensional image, one dimensional waveform, physical parameter and logical value.

(2)Pretreatment.The restoration of the input measurement instruments or other factors caused by the phenomenon of degradation, noise removal, extraction of useful information.

(3)Feature extraction and selection.The original data is transformed to get the best classification feature. The higher dimension measurement space (the space of the original data) is transformed into a lower dimensional feature space (the space for classification and recognition).

(4)Classification decision.In the feature space, the identified objects are classified into one category by pattern recognition method.

(5)classifier design.The basic method is to determine the discriminant function on the basis of sample training, improve the discriminant function and error test.

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3. Pattern Classification Method

Cluster analysis is a data classification into different classes or clusters, cluster analysis is an exploratory analysis, in the process of classification, people should not be given in advance a classification standard, clustering analysis can proceed from sample data, automatic classification. From the point of view of practical application, clustering analysis is one of the main tasks of data mining. Moreover, clustering can be used as an independent tool to obtain the distribution of data, to observe the characteristics of each cluster data, and to further analyze the specific clustering set. Clustering analysis can also be used as a preprocessing step for other algorithms such as classification and qualitative induction algorithms.

3.1 Hierarchical clustering

Before describing the basic idea, it is assumed that the one dimensional vector set. Hierarchical clustering algorithm generates a hierarchy of nested clusters. More specifically, these algorithms contain N steps, as much as the number of data vectors. In step T, a new cluster is generated on the basis of the previous T-1 steps. There are two different algorithms: merging and splitting algorithms.

In the merging algorithm, the initial cluster is composed of N clusters, each cluster contains only one element in X. The first step is to generate a cluster that contains N-1 sets, such as. This process is repeated until the last cluster is generated, which contains only a single set of clusters, the data set X. Thus the level of clustering is $\Re_0 \subset \Re_1 \subset \ldots \subset \Re_{N-1}$.

Split algorithm and the idea of merging algorithm is just the opposite. In this algorithm, the initial cluster includes only one set of X. The first step is to generate a cluster, which consists of a collection, such as. Repeat this process until the last cluster is generated, which contains N sets, each containing only one element in the X,In this case, $\Re_{N-1} \subset \Re_{N-2} \subset \ldots \subset \Re_0$ can be obtained.

3.2 Hierarchical clustering algorithm

N samples of the initial model from a class, that is, the establishment of N class, followed by the following steps:

Step1.Calculate the distance between all kinds of samples, and get a distance matrix D (0) with a dimension of N * N. "0" means the initial state.

Step2.Assuming that the distance matrix D (n) has been obtained, n is the number of successive cluster merging to find the smallest element in D (n), and the corresponding two classes are merged into one class. Thus a new classification: $G_1(n+1), G_2(n+1), \cdots$

Step3.Calculate the distance between the new categories obtained after merging, get D (n+1).

Step4.Jump to second steps, repeat calculation and merge.

When the condition is met, the calculation can be stopped: take the distance threshold T, when D (n) of the minimum component over a given value of T, the algorithm stops. The result of clustering is no threshold T, until all the samples into a class, the output of the hierarchical clustering tree.

3.3 C mean algorithm

The mean C algorithm first take a number of categories and C C clustering center selection of the C number of categories, according to the principle of minimum distance between each pattern assigned to the C class in a class, after constantly calculating the type of heart and adjust the model category, ultimately enable the model to the square of the minimum distance and the the corresponding sentence class center.

The C mean algorithm can initialize the cluster center and then execute the iteration process. The performance of the algorithm depends on the initial clustering center.

4. Linear Decision

In the feature space, different categories can get different discriminant functions by learning. The statistical pattern recognition method divides the feature space into the decision area to classify the patterns. A pattern corresponds to one or more decision areas. Each decision area corresponds to a discriminant function. For each feature vector x in the feature space, the discriminant function GI (x) corresponding to each decision region can be calculated, i=1,2,... C. Using discriminant function classification method is: if all of the I were GI (x) = GI (x), put the X into the J class, a R (x) =j.

Linear classifier is designed by using the minimum Euclidean distance criterion:

$$M_1 = \frac{1}{N_1} \sum_{X \in w_1} X$$

$$M_2 = \frac{1}{N_2} \sum_{X \in w_2} X$$

Discriminant function:

$$D_1(X) = X^T \bullet M_1 - \frac{1}{2} M_1{}^T \bullet M_1$$

$$D_2(X) = X^T \bullet M_2 - \frac{1}{2} M_2{}^T \bullet M_2$$

5. Simulation

An example of a car and a background in a picture. First of all, the sample is explained: there are 252 characteristics of each sample, the first of the 12 is the high frequency coefficient of the fourth layer, the middle of the 48 is the high frequency coefficient of the third layer, the latter is the second layer of high frequency coefficient. So it is possible to select different features from the 252 dimensional features, and analyze their respective classification results.

5.1 Simulation results based on linear classifier

Two kinds of vehicle and background data are distinguished by using the appropriate feature classifier, and the results are analyzed. The training samples and test samples are divided into two subsets, each of which has n/2 n samples. A subset of them is used as the training sample set to design the classifier, and then it is tested with another subset. Randomly selected, the average error rate is calculated as the performance index.

The program first calls the randQ to write your own way to distinguish between the training samples and test samples obtained by the relevant parameters, the design of the minimum Euclidean distance classifier, and then used to detect all the test samples, the error rate of each end respectively.Err_vg represents the car as the background of the misclassification error rate and Err_gv represents background misclassified as error rate during vehicle.

Due to the distribution of specific each time the error rate and the sample data, so to estimate the classification error rate, so the book set the cycle ten times sampling process is calculated by single sampling rate is different, the average error rate is obtained:err_VG and err_GV.

Variables - err_vg

err_VG | err_vg | err_gv

err_vg <1x10 double>

	1	2	3	4	5	6	7	8	9	10	11
1	0.0280	0.0360	0.0240	0.0400	0.0440	0.0400	0.0360	0.0200	0.0280	0.0280	
2											

Variables - err_gv

err_VG | err_vg | err_gv

err_gv <1x10 double>

	1	2	3	4	5	6	7	8	9	10	1
1	0.0640	0.0400	0.0440	0.0320	0.0520	0.0320	0.0480	0.0320	0.0560	0.0360	
2											
3											

Figure 2.Error rate.

Name	Value	Min	Max
M_bg	<1x252 double>	0.0176	0.3969
M_vec	<1x252 double>	0.0115	1.2160
ans	<250x252 double>	0	4.1650
background	<500x252 double>	0	4.1667
bg_test	<250x252 double>	0	4.1667
bg_tr	<250x252 double>	0	3.5958
d_bg	1.3489	1.3489	1.3489
d_vec	8.9612	8.9612	8.9612
dk_bg	4.1309	4.1309	4.1309
dk_vec	2.4272	2.4272	2.4272
err_GV	0.0360	0.0360	0.0360
err_VG	0.0448	0.0448	0.0448
err_gv	[0.0280, 0.0400, 0....	0.0240	0.0520
err_vg	[0.0320, 0.0520, 0....	0.0200	0.0680
flag_bg	<1x250 double>	0	1
flag_vec	<1x250 double>	0	1
i	10	10	10
j	10	10	10
k_d	252	252	252
k_s	1	1	1
s1_bg	239	239	239
s1_vec	233	233	233
vec_test	<250x252 double>	0	3.5184
vec_tr	<250x252 double>	0	3.1157
vehicle	<500x252 double>	0	3.5184

Figure3. Program variable value.

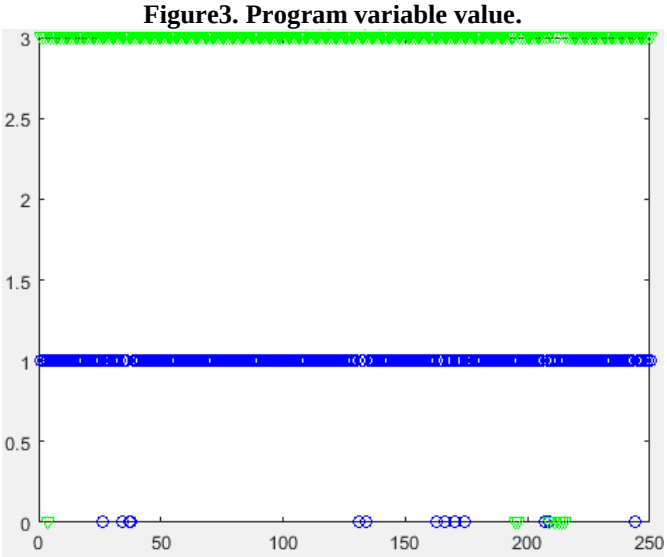

Figure 4. Simulation results based on linear classifier.

5.2 Simulation results based on hierarchical clustering

Firstly, the distance between object 22 is calculated by pdist function, and then the hierarchical tree is constructed by using linkage function. By comparing the classification results, we select the minimum square error algorithm in the class. Finally, the cluster function is called, the structure tree is clustered to determine the final category.

By clustering,the background error probability err_bg＝0.0420 is get when sample as the background, misjudged other.Auto error probability err_car = 0.0400 is get when sample for the car, misjudged other.Pedestrian error probability err_hm=0.002 is get when sample for pedestrians, misjudged other.

Array class_1, class_2, class_3 each store the data corresponding to the sample in the total sample concentration of the subscript. From which we can get the correct classification of the samples, which are divided into different types of errors. Compared with the results obtained from the most remote clustering algorithm, the results obtained by this algorithm are very good, the error rate is relatively low, the maximum not more than 5%. That is to say 500 sample data, only 25 error data, the effect is good.

Editor - project3.m

class_1 | class_2 | class_3

479x3 double

	1	2	3
1	12	503	1
2	24	504	2
3	66	505	3
4	103	506	4
5	105	507	5
6	112	508	6
7	169	509	7
8	289	510	8
9	319	511	9
10	558	512	10
11	861	513	11
12	1001	514	13
13	1002	515	14
14	1003	516	15
15	1004	517	16
16	1005	518	17
17	1006	519	18
18	1007	520	19
19	1008	521	20
20	1009	522	21
21	1010	523	22
22	1011	524	23
23	1012	525	25
24	1013	526	26
25	1014	527	27
26	1015	528	28
27	1016	529	29
28	1017	530	30

Figure 5.classification results.

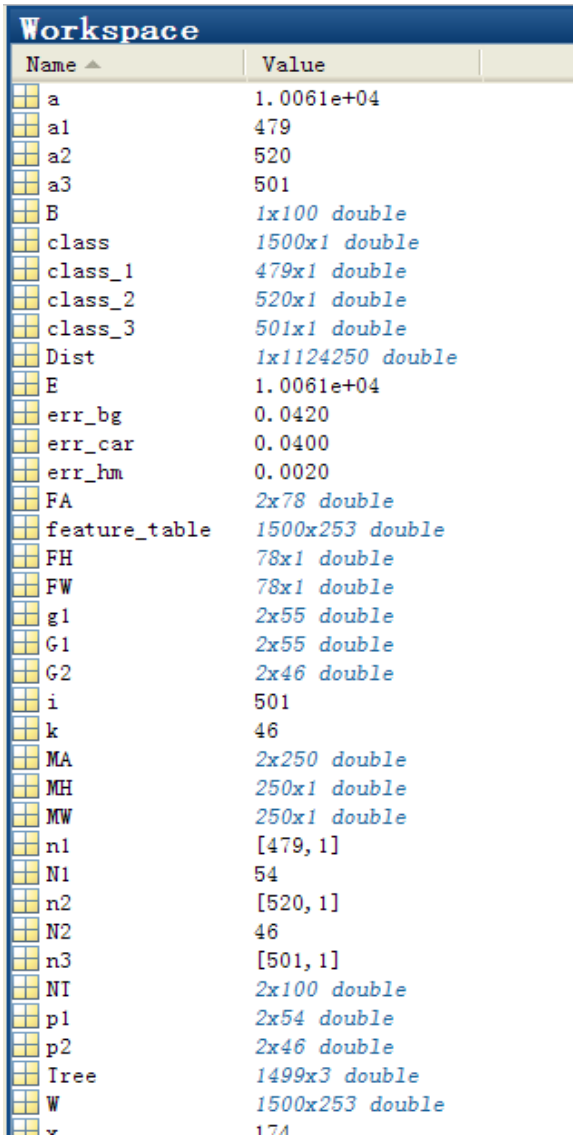

Figure 6. Program variable value

6. Conclusions

Through data analysis, linear classifier for minimum Euclidean distance criterion, when it selects different features for training, judgment, the error rate is still a relatively large difference, especially the fourth coefficients are only selected after wavelet transform, the error rate is relatively large, then the error rate of is the second layer, third layer. If the second and the combination of the characteristics of the combination of the third, the error rate is the smallest, even smaller than the selection of all the features of the dimension.

The randomly selected training samples and testing samples, and calculate the average error rate of the last, if the use of linear decision is based on the minimum Euclidean distance, the third and second layer wavelet coefficients as the feature selection is the change after the final judgment results.

No label hierarchical clustering algorithm: because no label learning, so there is no training process of direct clustering according to the position data of the samples in the feature space, so the selection of clustering algorithm for the sample distribution is very important, it determines the final classification result.

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