Developing an Enhanced Fusion Model to Classify Biomedical data

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Abstract: Classification is the technique where we discover the h_{id}den class level of the unknown data. Multiple classifier fusion system needed to fuse the answers of several classifiers to enhance the accuracy. Here the proposed model will use each classifier for every $indiv_{id}ual$ data. In this paper, we have used principal component analysis to deal with issues of high dimensionality in biomedical classification. We have implemented three types of classification technique on micro array data after reduction. Eighty percent of data has been taken for the training and twenty percent for the testing. We have also implemented and compared three classification methods on the data like Multi Layer Perceptron, FLANN and PSO- FLANN and from the analysis; it has been observed that MLP has given better result. In this paper, we have also proposed a model for classifier fusion where the model will choose the relevant classifiers according to the different region of data set.

Keywords: Principal Component Analysis; Classification; Classifier fusion.

I. INTRODUCTION

Classification is the process of assigning unknown input patterns of data to some known classes based on their properties [1-2]. For a long time many research area in designing classifiers have focused improving efficiency, accuracy and reliability of classifier for a $w_{id}e$ range of application. Fusing output of more classifier is an alternative method to build more reliable classifier [3, 7]. It is well known that in many situations combining output of several classifier leads to improved classification result. This occurs because each classifier produces error on different area of input space. In other words, subset of input space that each classifier labels correctly will differ from one classification to another. This implies that by using information from more than one classifier, it is probable that the better overall accuracy can be obtained for a given problem. On the other hand, instead of picking of just one classifier a better approach would be to use more than one classifier while averaging there output. The new classifier might not be better then the single best classifier but it will distinguish or eliminate the risk of picking an inadequate single classifier. For any pattern classification, increase in data size, number of classes, and dimension of feature space and inter class. Separability effect the performance of any classifier. A single classifier is generally unable to handle $w_{id}e$ variability and scalability of data. In many problem domains most modern technique of pattern classification uses a combination of classifier and fused decision $prov_{id}ed$ by the some often using any selected set of appropriate features for the task. Combining classifier is a thrust research area based on both statistical pattern recognition and machine learning. It is also known as committee of learners, mixtures of experts, classifiers ensemble, multiple classifier system, consensus theory etc. By having a number of different classifier it is wise to use them in a combination in the hope of increasing the overall accuracy and efficiency.

II. RELATED WORK

Zhenyu Chen et al. [1] proposed a multiple kernel SVM based data mining system. Multiple tasks, including feature selection, data fusion, class prediction, decision rule extraction, associated rule extraction and sub class discover, are incorporated in an integrated framework. All-AML leukemia data set is used to demonstrate the performance of the system.

Esma Kilic et al. [2] investigate two kinds of classifier system which are capable of estimating how much to weight each base classifier dynamically, during the calculation of the overall output for a given test data instance: 1. In "referee: based system", a referee is associated with each classifier which learns the area of expertise of its associated classifier and weights it accordingly. 2. Each referee in referee base system learns a two class problem where as a getting system learns an L-class problem assigning the input to one of L base classifiers. The study shows that, by using well trained selection unit, we can get as high accuracy as using all the base classifiers with drastic decrease in the number of base classifiers used, and improve accuracy.

Each one being able to solve a multi class problem; the other task is the fusion of binary classifiers, with each one solving a different two-class problem to construct a multi-class classifier. The paper presents a study of the different class binarization methods for the various standards multi class classification problems.

Hui-Min Feng et al. [4] introduced a fuse model, which compare comprehensively four fuzzy integrals in multiple classifier fusions and hope to give the foundation for selecting choquet integral. According the theoretical and experimental analysis the paper gives the conclusion that choquet is the best suitable for classifier fusion.

Jiangtao huang et al. [5] proposed a new multiple classifier fusion method integrated classifier selection and classifier

combination. This paper based on interval-valued fuzzy permutation. Firstly, normalize all classifier posterior probabilities using the priory knowledge of corresponding classifier recognition rate. Secondly, convert decision matrix for multiple classifier system into interval-valued fuzzy decision matrix. Thirdly, determine the grade of possibility of each class for input sample for multiple classifier system. Finally, selects the best classifier in current pattern recognition task using interval valued fuzzy permutation. The experiments have shown that the new multiple classifier fusion approach using interval-valued fuzzy permutation can provide much better accuracy compare to independent classifier and some other fusion methods.

Hazem M. Ei-Bakry [6] proposed an efficient algorithm for pattern detection using combine classifier and data fusion. In this paper efficient neural network for face detection are presented. Such classifier are designed based on cross co-relation in the frequency domain between the input matrix and the input weight of neural network, this approach is developed to reduce the computation steps required by these ENN's for the searching process.

Mangai UG, et al. [7] has done a survey of decision fusion and feature training strategies for pattern classification. Most of this technique use the databases from the UCI repository, vistexture, speech and medical image for exhibiting their performance. The author also proposed a framework which uses decision and feature fusion for a better classification result. The result is presented using three benchmark dataset selected from the UCI repository.

Likuncheva et al. [8] proposed a simple rule for adapting the class combiner to the application. C decision templates are estimated with the same training set that is used for the set of classifier. These templates are then matched to the decision profile of new incoming objects by some similarity measure. The author compared eleven version of the proposed model with fourteen other techniques for classifier fusion on the Sitimage Phoneme data set from the database ELENA.

Matteore et al. [9] evaluated the performances of three basic ensembles to integrate six different sources of high dimension bio molecular data. They also studied the performances resulting from the application simple greedy classifier selection scheme.

Albert H.R.Ko et al. [10] proposed a pair-wise fusion matrix transformation, which produces reliable probabilities for the use of classifier combination and can be amalgamaped with most existent fusion function for combining classifier. The PFM pair wise fusion requires crisp class label outputs from classifiers, and is suitable for high-class problem, or problems with training samples. The experimental results suggest that the performance of a PFM can be a notch above that of simple majority voting rule, and a PFM can work on problem where a behavior-knowledge space might not be applicable.

III. PRELIMINARY

a. Principal component analysis: is a mathematical procedure that uses an orthogonal transformation to convert a set of observation of possibly co related variables into a set of values uncorrelated variables called principal components.

b. FLANN: is a mathematical model or computational model that is inspired by structural and/or functional aspects of biological neural networks [12]. It consist of an inter connected group of artificial neurons and it processes information using a model.

c. PSO: is a stochastic based search algorithm w_{id}ely used to find the optimum solution introduced by Kennedy and Eberthart [11] in 1995. PSO has used in this paper to update the weight of a FLANN model. PSO as an optimization tool provides a population-based search procedure in which individuals called particles change their position (state) with time.

The velocity V_{id} and X_{id} position of the ith particle are updated as follows:

$$V_{id}=V_{id}+c_1*rand1_{id}*(pbest_{id}-X_{id})+c_2*rand2_{id}*(gbest_{id}-X_{id}) \dots\dots\dots\dots\dots(1)$$

$$X_{id} = X_{id} + V_{id} \dots\dots\dots\dots\dots\dots\dots\dots\dots(2)$$

Where Xi is the position and Vi is the velocity of the particle. pbest is the best previous position yielding the best fitness value for the ith particle and gbest is the best position discovered by the whole population. c1 and c2 and are the acceleration constants reflecting the weighting of stochastic acceleration terms that pull each particle toward pbest and gbest positions respectively. $rand1_{id}$ and $rand2_{id}$ are two random numbers in range of (0,1)

d. MLP: MLP is a network of simple neurons called perceptrons. The basic concept of a single perceptron was introduced by Rosenblatt in 1958. The perceptron computes a single output from multiple real-valued inputs by forming a linear combination according to its input weights and then possibly putting the output through some nonlinear activation function. Mathematically this can be written as

$$y = \Psi \left(\sum_{i=1}^{n} w_i x_i + b \right) = \Psi \left(w^T x + b \right)$$

where **w** denotes the vector of weights, x is the vector of inputs; **b** is the bias and Ψ is the activation function.

e. Classification: is the process of assigning unknown input pattern of data to some known classes based on their properties. Data classification is two step processes, in training phase a classifier is build based upon predetermined set of data classes or concepts, in test phase the data are used to estimate the accuracy of the classification rules.

IV. PROPOSED MODEL

Feature extraction aims to reduce the computational cost of feature measurement, increase the classifier efficiency and allow greater classification accuracy based on the process of deriving new features from the original features. In the feature extraction the whole feature space

is projected into another dimensional space for a better analysis of the features. The dimension of a data set can be reduced by principal components analysis, linear discriminant analysis, factor analysis, independent component analysis, etc.

In the model (shown in figure 1) dimension of micro array data (MAD) has been reduced using principal component analysis (PCA), the data has classified using three classifier, functional link artificial neural network (FLANN), multi layer perceptron (MLP) and particle swarm optimization –functional link artificial neural network (PSO-FLANN), and the result of the three classification techniques has fused together using dynamic classifier fusion (DCF) to have the better accuracy of the model.
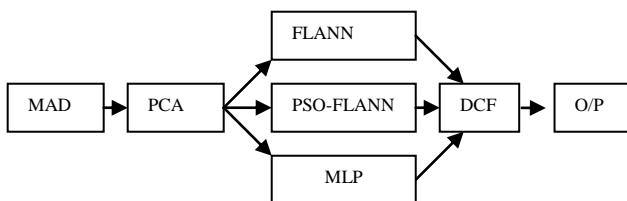

Figure1. Proposed model

V. EXPERIMENTAL EVALUATION

The original Breast Cancer data set of dimension 98 X 1,213. After implementing PCA the original data set has reduced to 98 X 97. The breast cancer data set contains three class level 1-11 features used for class level 1, 12-62 for class level 2 and rest are belong to class level level 3. The input vector for the classification contains 98 genes with 97 conditions. The mean square error graph is used as the cost function of the classification techniques. The learning of weights has been updated by LMS in FLANN, PSO is used in PSO-FLANN and back propagation algorithm used in MLP. The result of three classifier is fused together using dynamic classifier Fusion (DCF). DCF chooses the classifier according to the best class regions. In MLP classifier with hidden layer 4, $\eta=0.4$, $\alpha=0.7$ and umber of iteration 1000 gives confusion matrix table3. The mean square error graph is shown in figure2. In FLANN classifier $\mu=0.0009$ is taken and with 1000 iteration the confusion matrix is shown in table1. In PSO-FLANN with pnum=10, $\mu=0.001$,c1=0.4 and c2=0.3 with 1000 iteration gives confusion matrix as shown in table2. DCF as shown in table 4, is achieved by fusing the table 1,2,3. From the table4 it is noted that MLP gives better result as compared to FLANN and PSO-FLANN. Using DCF percentage accuracy rise to 78.787%.

Table1. Classification results obtained from testing using FLANN and PCA for Breast Cancer data set.

Classified observation	Cluster 1	Cluster 2	Cluster 3
Class 1	4	1	1
Class 2	4	10	3
Class 3	3	0	7
Cumulative	11	11	11

Table2. Classification result obtained from testing using PSO-FLANN and PCA for Breast Cancer data set.

Classified observation	Cluster 1	Cluster 2	Cluster 3
Class 1	3	1	0
Class 2	4	9	0
Class 3	3	1	11
Cumulative	11	11	11

Table3. Classification result obtained from testing using MLP and PCA for Breast Cancer data set.

Classified observation	Cluster 1	Cluster 2	Cluster 3
Class 1	5	0	0
Class 2	3	10	1
Class 3	3	1	10
Cumulative	11	11	11

Table4. DCF Result obtained from Fusion of FLANN, MLP and PSO-FLANN

Classified observation	Cluster 1	Cluster 2	Cluster 3
Class 1	5	0	0
Class 2	3	10	0
Class 3	3	1	11
Cumulative	11	11	11

Table5. Comparison of classification result

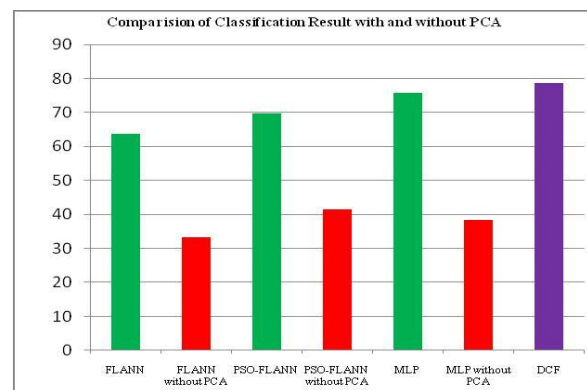| Name of data set	Percentage of accuracy			
	FLANN	PSO-FLANN	MLP	DCF
Breast Cancer	63.6364	69.696	75.757	78.787

Figure2. Convergence characteristics of MLP

VI. CONCLUSION AND FUTURE WORK

Ensemble learning or classifier fusion is an ever growing field, with a wide scope of inter disciplinary research over the fields of computer science, mathematics, statistics and machine learning. In the future, one can expect rich concepts from widely varying areas such as information theory, optimization theory, rough fuzzy sets, soft computing, evolutionary computation etc., to contribute

and enrich this problem domain in the field of pattern recognition. This paper processes an efficient dynamic classifier fusion. The input features are extracted using PCA technique. The classifiers are designed using simple LMS, Back propagation and PSO algorithms. MLP gives better performance compared to FLANN and PSO-FLANN, where as the dynamic classifier fusion enhance the accuracy of both the classifier. In future we can take diversify classifier to achieve more accuracy.

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