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Pattern Recognition Techniques:A Review

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Abstract

Pattern recognition is simply the recognition of patterns in this digital words. That is the reason that Pattern Recognition has attracted the attention of researchers in last few decades as a machine learning approach due to its widespread application areas. The application of pattern recognition has been observed in many areas like medicine, communications, automations, military Intelligence, Data mining, bioinformatics, Document classification, speech recognition and many others. Here in this review paper,we present various approaches of Pattern Recognition and their pros-cons, application specificparadigm.According to researchers, pattern recognition techniques can be categorized into six parts. They are Statistical Techniques, Structural Techniques, Template Matching, Neural Network Approach, Fuzzy Model and Hybrid Models.

***Index Terms**: Pattern Recognition, Statistical Pattern Recognition, Structural Pattern Recognition, Neural Networks and Fuzzy Sets.*

1. INTRODUCTION

Pattern is anything we see in our surrounding.We see many objects in the nature and it is trivial task for us to recognize them.But if we talk about them to implement artificially,it became very complex task for us.It helps to understand the solution of the problem related to speech recognition,speaker diarization, face recognition to classification of handwritten characters and medical diagnosis.We know that pattern recognition has applications in many fields like bioinformatics, character recognition,image analysis, datamining, industrial automation, biometric recognition, remote sensing, handwritten text analysis, medical diagnosis, speech recognition, GIS and many others.While dealing with the solutions of above all problems,first features are extracted and then analyzed with recognition followed by classification.There are mainly three processes take place in pattern recognition task:

I. Data Acquisition:

It is the process of converting data from one form (speech, character, pictures etc.) into another form which should be acceptable to the computing device for further processing.We generally perform data acquisition by sensors, digitizing machine and scanners. Second step is data analysis.

ii. Data Analysis:

It is the second step after data acquisition.During this step,the learning about the data takesplace and information is collected about the different events and pattern classes available in the data.The above information obtained from is used for further processing.

iii. Classification:

It is the process of keeping same category data in the same group.It is generally performed in supervised learning.Dataset in pattern recognition system is categorized into two sets:Training set and Testing set.Training set is used to train the classifier and testing set is used to check the efficiency of the system.Generally,90% of the data is used as training set and remaining 10% is used as testing set. We measure the performance of pattern recognition techniques mainly on three:i)Amount of data ii)technology used(method) iii)designer and the user.It is challenging job in pattern recognition is to develop systems with capability of handling large amounts of data.

2. PATTERN RECOGNITION MODELS

Models selected for pattern recognition can be divided into different categories depending upon the method used for data analysis and classification.Models are very important for pattern recognition which help in performing pattern recognition task.Models help in understanding the problems in real time. So model is the abstraction or blue print.Various models used for pattern recognition task are described follow:

A.Statistical Model

Statistical Model is also known as probabilistic model.In this model of pattern recognition,each pattern is described in terms of features.Here,the features are chosen in such a way that different patterns occupy non-overlapping feature space.It deals with the probabilistic nature both of the information we seek to process, and of the form in which we should express it.It works properly when the selected features lead to feature spaces which cluster in a recognizable manner.Decision boundary is determined after analyzing the probability distribution of a pattern belonging to a class.Pre-processing operations on patterns are done to to make them suitable for training purposes.Features are opted upon analyzing training patterns.Pattern recognition system learns and adapts itself for unknown patterns as shown in Fig. 1.Then after test patterns are applied to check suitability of system to recognize patterns.During testing,features measurement is done and these feature values is presented to learne system and in this way classification is performed.

We have two types of classification schemes:parametric classification schemes and nonparametric classification scheme.We use parametric classification schemes when conditional probability density distribution is known and otherwise we use non parametric classification schemes.We use various decision rules to determine decision boundary like,Bayes Decision Rule, Optimal Bayes Decision Rule, The
Maximum Likelihood Rule, Neyman-Pearson rule and MAP rule.As we know that feature spaces are partitioned so pattern recognition system becomes

noise insensitive, thus in case of noisy patterns, the choice of statistical model is a good solution.Statistical technique can be categorized into two categories depending on the method is supervised or unsupervised.They are Discriminant Analysis and Principal Component Analysis.

Fig 1.Statistical Pattern Recognition Model

Discriminant Analysis:

Discriminant Analysis is a supervised technique which is used for dimensionality reduction.In this technique,linear combination of features is utilized to perform the classification operation.A discriminant function is defined for each class and which is used to perform the classification function.There is no any specific rule regarding the form of discriminant function like minimum distance classifier uses one reference point for each class, and the discriminant function computes minimum distance from unknown vectors to these points whereas nearest neighbor classifier uses set of points for each class.There are many types of Discriminant Analysis methods which are used based upon the application and system requirement like:(i)Linear Discriminant Analysis (LDA), (ii)Null-LDA (N-LDA), (iii)Fisher Discriminant Analysis (FDA), (iv)Two Dimensional Linear Discriminant Analysis (2D-LDA), (v)Two Dimensional Fisher Discriminant Analysis (2D-FDA).

LDA: In this type of discriminant analysis method,feature set is obtained by linear combination of original features.Here,intra-class distance is minimized and inter-class distance is maximized to obtain the optimum results.One disadvantage is of LDA is that it suffers from small sample size (SSS) problem.

FDA: In this type of discriminant analysis,ratio of variance in inter-classes to variances in intra-classes defines the separation between classes.Here,inter-class scatter is maximized and intra-class scatter is minimized to get the optimum results.This approach is a combination of PCA and LDA.

2D-LDA: This discriminant analysis avoids the problem of LDA(small sample size (SSS) problem).In this type of discriminant analysis,matrices of input data are computed to form the feature vector.In 2D-LDA Trace of interclass scatter matrix is maximized whereas trace of intra-class scatter matrix is minimized to get the optimum results.In 2D-LDA,non-singular interclass and intra-class matrices are provided.

N-LDA:It is null space of intra-class scatter matrix which involves solving the Eigenvalue problem for a very large matrix.

Principal Component Analysis(PCA):

It is an unsupervised technique in which we approach for dimensionality reduction.Patterns are detected in the data and these patterns determine the similarity measure by using PCA.Here,Eigenvectors with largest Eigenvalues are computed to form the feature space.PCA is a multi-element closely related to Factor Analysis.It has application in graphically

unreliablepatterns.In terms of accuracy and time elapsed,discriminant Analysis is more efficient as compared to PCA.

B. Structural Model

In pattern recognition,all information can not be expressed in terms of the numerical values or features.In this scenario,structural model of pattern recognition is a good choice.In this model,complex patterns are expressed in terms of sub-patterns and we consider the grammatical rules with which these sub patterns are associated with each other.Here the model is concerned with structure and attempts to recognize a pattern from its general form.Pattern description language is a language that provides structural description of patterns in terms of pattern primitives and their composition.Complexity of syntax analysis system is increased by increasing descriptive power of a language.

Finite- state automata is used to recognize finite-state language.Context sensitive languages are explained by non-deterministic procedures.Thus,we can say that descriptive power of finite-state languages is weaker than that of context-sensitive languages.Primitives,the grammar's descriptive power and analysis efficiency play main role in selecting the type of grammar for pattern description.A number of languages have been suggested for description of patterns like as chromosome images, 2D-mathematics, chemical structures,spoken words, English characters and fingerprint patterns.Web grammars, tree grammars, graph grammars and shape grammars are high dimensional grammars. So they need high dimensional patterns for efficient description.

Noisy and distorted patterns are described by Stochastic languages, approximation and transformational grammars.This model demands large training sets and very large computational efforts.So this model is time taking model.Sometimes dealing with noisy patterns,it is difficult to design grammar for the basic structure of the complex patterns and in that cases we feel too difficult to define the patterns then at that time,statistical model is a good option.We use this model in the area like in textured images, shape analysis of contours and image interpretation where patterns have a definite structure.We can predict our death with the help of this model.This can be done by studying our tissues and cells.This is the time taking process and very complex process.

C. Template Matching Model

This model is the simplest and most primitive among all pattern recognition models.It helpd to determine the similarity between two samples, pixels or curves.This model has stored templates and the patternto be recognized is matched with the stored templates while assuming that template can be gone through rotational or scalar changes.The stored templates determine the efficiency of this model.In this model,correlation function is taken asrecognitionfunction which is optimized depending on the available training set.This model does not work efficiently in the presence of distorted patterns.

D. Neural Network Based Model

Neural networks are parallel structures composed of "neuron" like subunits.This model provides efficient result in the field of classification.The amazing property of this model is that it can change its property iteratively which helps in recognition process.Perceptron is a primitive neuron model which has a twolayer structure.Perceptron solves classification problems as well as regression problems.When the output of the perceptron is step,it solves classification problems and if the output is linear,it solves regression problems.The feedforward networks like MLP and RBF networks are the most commonly used family ofneural networks for pattern classification.Depending upon our application,we use different types of neural networks.

Non-linear differentiable functions is implemented by Feed Forward Back-propagation Neural Network (FFBP-NN).Convergence time is inversely proportional to the learning rate in Back-propagation neural network.As general Regression neural network (GRNN) is a highly parallel structure so in GRNN learning is from input side to output side.The performance of GRNN on noisy data is better than Back-propagation.FFBP Neural Network does not perform accurately if available data is large Enough whereas the performance of GRNN becomes better when the size of the data increases. Kohnen Networks are the neural network model which are mainly used for data clustering and feature mapping. As the number of hidden layers increases up to a certain extent,the performance of the neural networks also increases.The performance of the system can be improved by increasing number of neurons in hidden layer.

E. Fuzzy Based Model

The significance of fuzzy sets in Pattern Recognition lies in modeling forms of uncertainty that cannot be fully understood by the use of probability theory.Many techniques of fuzzy pattern recognition has been defined by Kandel.We use syntactic techniques when the pattern sought is related to the formal structure of language and semantic techniques are used when fuzzy partitions of data sets are to be produced. A similarity measure which is based on weighted distance helps to obtain similarity degree between the fuzzy description of unknown shape and reference shape.

F. Hybrid Model

In many modern applications,it is difficult to get better performance by using single model so multiple models are combined to get better result which leads to hybrid model.It is very difficult totask identify a best classifier unless deep prior knowledge is available at hand.We can combine statistical model and structural model to solve hybrid problems.In such scenario,statistical model is utilized to recognize pattern primitives whereas syntactic approach is used for the recognition of sub-patterns and pattern itself.We can use a set of individual classifiers and combiner to enhance system performance.We can use multiple classifiers in several ways to enhance the system performance.We have to train each classifier in a different region of feature space or in other way and each classifier can provide probability estimate and decision can be made upon analyzing individual results.The methods which utilize combination

function design tend to find an optimal combination of decisions from a set of classifiers.

3. CONCLUSION

In this paper,a comparative view of all the models of pattern recognition has been shown which depicts that for various domains in this areas different models or combination of models can be used.While dealing with noisy patterns, choice of statistical model is a good solution.Practical importance of structural model is based on recognition of simple pattern primitives and their relationships represented by description language.We use structural model for complex patterns where each pattern is described by its components.The efficiency of recognition system depends on wise selection of pattern grammar.The utilization of pattern primitives and pattern grammar depends upon the application requirements.As modern digital computer is unable to solve the biological problems, a new model called neural network model has been introduced to overcome this problem.Fuzzy model is used to recognize unknown shapes.To enhance the performace of the system,multiple models are combined giving better result which is called as hybrid model.

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