International Journal of Electronics, Communication & Soft Computing Science and Engineering
ISSN: 2277-9477, Volume 4, Issue 2

Hybrid Soft Computing Methods of Pattern Recognition: A Review

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Abstract- **Pattern Recognition is the topic of intense research due to its applicability in diversified fields. The primary goal of pattern recognition is supervised or unsupervised classification. In spite of 50 years of research the general problem of recognizing complex patterns with arbitrary orientation, location, and scale remains unsolved. The traditional methods of pattern recognition have been presented and their pros and cons with respect to the modern soft computing techniques have been presented. This paper presents a survey of latest approaches for pattern recognition including soft computing based methods like artificial neural network, fuzzy logic, and genetic algorithms and the Hybrid Models. We propose to bring together a unified framework of traditional and soft computing techniques.**

Keywords- **Pattern Recognition, Statistical Pattern, Fuzzy logic, Neural Network, Genetic Algorithm, Fuzzy-Neural-Genetic**.

I. INTRODUCTION

Pattern recognition is the study of how machines can observe the environment, learn to distinguish patterns of interest from their background, and make sound and reasonable decisions about the categories of the patterns. In spite of almost 50 years of research, design of a general purpose machine pattern recognizer remains an elusive goal. The best pattern recognizers in most instances are humans, yet we do not understand how humans recognize patterns. Ross [1] emphasizes the work of Nobel Laureate Herbert Simon whose central finding was that pattern recognition is critical in most human decision making tasks: “The more relevant patterns at your disposal, the better your decisions will be. This is hopeful news to proponents of artificial intelligence, since computers can surely be taught to recognize patterns.

Traditional statistical classification procedures such as discriminant analysis are built on the Bayesian decision theory [3]. In these procedures, an underlying probability model must be assumed in order to calculate the posterior probability upon which the classification decision is made. One major limitation of the statistical models is that they work well only when the underlying assumptions are satisfied. Neural networks have emerged as an important tool for classification. Although significant progress has been made in classification related areas of neural networks, a number of issues in applying neural networks still remain and have not been solved successfully or completely.

Interest in the area of pattern recognition has been renewed recently due to emerging applications which are not only challenging but also computationally more demanding. The rapidly growing and available computing power, while enabling faster processing of huge data sets, has also facilitated the use of elaborate and diverse methods for data analysis and classification. At the same time, demands on automatic pattern recognition systems are rising enormously due to the availability of large databases and stringent performance requirements (speed, accuracy, mid cost). In many of the emerging applications, it is clear that no single approach for classification is "optimal" and that multiple methods and approaches have to be used. Consequently, combining several sensing modalities and classifiers is now used practice in pattern recognition.

Hybrid systems, could be considered those systems that have the properties of self-maintenance, adaptivity, information preservation, and increase in complexity, but use other means to achieve such objectives are found in [7] and [8].

Lately more and more researchers recognize and define as main components of computational intelligence, four areas of research that dominate the area of AI, namely, (1) fuzzy sets , (2) neural networks, (3) genetic algorithms and evolutionary computing and (4) machine learning and data mining. Below we attempt a reference to the basic concepts of the most popular intelligent components of hybrid intelligent architectures, and then a quick review of related research papers found in recent literature, is made.

Fuzzy logic [9] is a language, which uses syntax and local semantics where we can imprint any qualitative knowledge about the problem to be solved. The main attribute of fuzzy logic is the robustness of its interpolative reasoning mechanism. Neural networks were introduced by [10] and [11]. They are computational structures that can be trained to learn by examples. Using a supervised learning algorithm, such as the back-propagation [12], and a training set that samples the relation between input and output, we can perform fine local optimization. Genetic algorithms [13] provide a way to perform randomized global search in a solution space. Genetic programming, proposed by [14] is an extension to the original concept of genetic algorithms. The population in genetic programming is composed by variable length tree-like candidate solutions. Each of individual candidates, called program, may have functional nodes, enabling the solution to perform arbitrarily large actions. Therefore, in many cases, hybrid combinations are capable of describing an approximate reasoning for these domains. These hybrid systems are proved superior to each of their underlying computational intelligent components, thus providing us with better problem solving tools.

This paper presentsa survey on three methods based on so-called soft computing techniques such as fuzzy logic, genetic algorithm, neural network and the hybrid of them for pattern recognition. These methods tend to exploit the difference ofeach network to combine the networks. The first method is to combine the network outputs with the importance of each network, where the importance can be subjectively assigned from the spirit of fuzzy logic. The second method utilizes the weight parameters, which are determined by genetic algorithm, to obtain the combined output. The third method is to hybridize the two methods for achieving the optimal solution to combine neural networks.

There have been a lot of literature that integrate NN/Fuzzy, Fuzzy/GA, GA/NN, and NN/Fuzzy/GA [15], [16]. There are even some attempts to use fuzzy logic and/or genetic algorithms to search for ensemble members. However, there is no systematic work to propose the ensemble framework for multiple neural networks. Our novelty lies in proposing the unified framework to combine three soft computing techniques to optimize the way of how to combine the networks, even though the idea itself is not that complicated.

II. PATTERN RECOGNITION MODELS

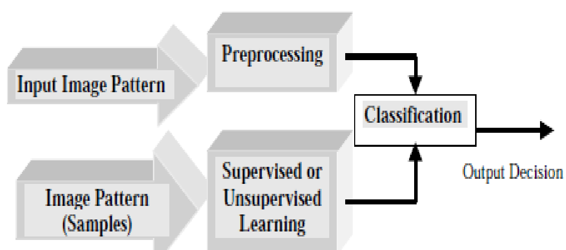

Fig.1: Block Diagram of decision-theoretical pattern recognition system

The block diagram of decision-theoretical pattern recognition shown in Fig.1 represented by three primary stages:
1. Preprocessing
2. Learning
3. Classification

Preprocessing is used to remove noise and eliminate irrelevant, visually unnecessary information. Learning stage involves either supervised or unsupervised learning. Classification stage classified the pattern, which is preprocessed in the first stage, by computing the output and considering the maximum output is the more similar image in database library to the unknown input pattern image.

The design of a pattern recognition system essentially involves the following three aspects: 1) data acquisition and preprocessing, 2) data representation, and 3) decision making. The traditional best known approaches for pattern recognition:

A. The Deterministic Approach to Pattern Classification:

Most of the procedures minimize or maximize a deterministic quantity that reflects separability of pattern classes. Many deterministic procedures have statistical interpretations when the sample size is large. The deterministic approaches can be divided into following subclasses:
1. Adaline and Madaline
2. Linear Discriminant Functions
3. Mathematical Programming Procedures
4. Mode-Seeking Procedures
5. Nearest Neighbor Procedure

B. The Statistical Approach to Pattern Classification:

In the statistical approach, each pattern is represented in terms of *d*features or measurements and is viewed as a point in a d-dimensional space. The goal is to choose those features that allow pattern vectors belonging to different categories to occupy compact and disjoint regions in a d-dimensional feature space. The effectiveness of the representation space (feature set) is determined by how well patterns from different classes can be separated. Given a set of training patterns from each class, the objective is to establish decision boundaries in the feature space which separate patterns belonging to different classes. In the statistical decision theoretic approach, the decision boundaries are determined by the probability distributions of the patterns belonging to each class, which must either be specified or learned.

The fundamental procedure in statistical approach is the Bayes procedure that minimizes the expected cost.Under the Bayes and minimax procedures two subclasses are considered:
1. Parametric Procedure
2. Distribution Free Procedure.

C. C. Syntactic Approach:

In many recognition problems involving complex patterns, it is more appropriate to adopt a hierarchical perspective where a pattern is viewed as being composed of simple sub patterns which are themselves built from yet simpler sub patterns. The simplest/elementary sub patterns to be recognized are called primitives and the given complex pattern is represented in terms of the interrelationships between these primitives. In syntactic pattern recognition, a formal analogy is drawn between the structure of patterns and the syntax of a language. Thus, a large collection of complex patterns can be describe by a small number of primitives and grammatical rules. Structural pattern recognition is intuitively appealingbecause, in addition to classification, this approach also provides adescription of howthe given pattern is constructed from the primitives. The implementation of a syntactic approach, however, leads to many difficulties which primarily have to do with the segmentation of noisy patterns (to detect the primitives) and the inference of the grammar from training data.

D. Template Matching:

One of the simplest and earliest approaches to pattern recognition is based on template matching. Matching is a generic operation in pattern recognition which is used to determine the similarity between two entities (points, curves, or shapes) of the same type. In template matching, a template (typically, a2Dshape) or a prototype of the pattern to be recognized is available. The pattern to be recognized is matched against the stored template while taking into account all allowable pose (translation and rotation) and scale changes. The similarity measure, often a correlation, may be optimized based on the available training set. Often, the template itself is learned from the training set. Template matching was computationally demanding, but the availability of faster processors has made this approach more feasible. The rigid template matching mentioned above, while effective in some application domains, has a number of disadvantages. For instance, it would fail if the patterns are distorted due to the imaging process, viewpoint change, or large intraclass variations among the patterns.

Attempts have also been made to combine one or two traditional approaches for better results, but the soft computing methods have proved more efficient. Combining one or more methods of soft computing methods for better accuracy and performance is the need of an hour. A brief review is presented below.

E. Fuzzy Logic in Pattern Recognition:

Dealing with uncertainties is a common problem in pattern recognition and the use of fuzzy set theory has given rise to a lot of new methods of pattern recognition. Fuzzy set theory plays a key in formalizing uncertainties Zadeh (1965), Bezdek (1981), Adlassing (1986), Sterimann (1997), Kuncheva (1999), Steimann (2001).

According to Nagalakshmi [30] the significance of fuzzy set theory in the realm of pattern recognition is adequately justified in

1. Representing linguistically phrased input features for processing.
2. Providing an estimate of missing information in terms of membership values.
3. Representing multiclass membership of ambiguous patterns and in generating rules and inferences in linguistic form.
4. Extracting ill-defined images regions, primitives and properties and describing relations among them as

A fuzzy set A represented as $A = \{\mu A(x_i)/x_i, i = 1, 2\ldots n\}$ where $\mu A(x_i)$ gives the degree of belonging of the element x_i to the set A.

The relevance of fuzzy sets theory in pattern recognition problems has adequately been addressed that the concept of fuzzy sets can be used at the feature level in representing an input pattern as an array of membership values denoting the degree of possession of certain properties and in representing linguistically phrased input features; at the classification level in representing multi-class membership of an ambiguous pattern, and in providing an estimate of missing information in terms of membership values. In other words, fuzzy set theory may be incorporated in handling uncertainties in various stages of pattern recognition system.

G.Nagalakshmi [30] in her literature survey suggested that the indeterminacy in an image for classification is due to inherent vagueness rather than randomness. Incertitude in an image pattern may be explained in terms of 1.Grayness ambiguity means “indefiniteness” in deciding whether a pixel is white or black. 2. Spatial ambiguity means “indefiniteness” in the shape and geometry of a region within the image. 3. Both Grayness ambiguity and spatial ambiguity. These aspects are handled under the area fuzzy image processing that grew up almost in parallel with fuzzy pattern recognition. It is based on the very concept that the basic definitions of edge, boundary, region, and the relations between them, do not lend themselves to precise formulation. In fact, in 1970, Prewitt first mentioned that gray image segments should be fuzzy subsets of an image.

S.B.Cho [37] defined the fuzzy integral as a nonlinear function that is defined with respect to a fuzzy measure, especially g_λ- fuzzy measure introduced by Sugeno. The ability of the fuzzy integral to combine the results of multiple sources of information has been established in several previous works.

O.Mema Devi [29] stated the main reasons for the application of fuzzy set theory in pattern recognition: (i) its way of representation in linguistic approach with excellent formulation of input feature, (ii) representation of missing or incomplete knowledge as a degree of membership and (iii) its capability of drawing approximate inferences.

The use of pattern recognition methods for abstraction, indexing and retrieval of images is presented by Anatani (2002). Uncertainties also affect image analysis and the most challenging problem in image analysis and pattern recognition research is segmentation [Souza (2008), Hasanzadeh (2008), Yang (2009)].

In the fuzzy classification rule described by Ishibuchi[41], the partitioning is uniform, i.e., the regions continue to be split until a sufficiently high certainty of the rule, generated by each region, is achieved. Ishibuchi extended this work later [41] by using an idea of sequential partitioning of the feature space into fuzzy subspaces until a predetermined stopping criterion is satisfied and studied its application for solving various pattern classification problems.

F. Neural Network Based Approach:

Artificial neural networks (ANN’s) attempt to replicate the computational power (low-level arithmetic processing ability) of biological neural networks and, thereby, hopefully endow machines with some of the (higher-level) cognitive abilities that biological organisms possess (due in part, perhaps, to their low-level computational prowess). However, an impediment to a more widespread acceptance of ANN’s is the absence of a capability to explain to the user, in a human comprehensible form, how the network arrives at a particular decision. Fuzzy logic is capable of modeling vagueness, handling uncertainty, and supporting human-type reasoning. A neural network is widely regarded as a black box that reveals little about its predictions

Jayanta Kumar Basu [33] in their work stated that the main characteristics of neural networks are that they have the ability to learn complex nonlinear input-output relationships, use sequential training procedures, and adapt themselves to the data. The most commonly used family of neural networks for pattern classification tasks is the feed-forward network, which includes multilayer perceptron and Radial-Basis Function (RBF) networks. Another popular network is the Self-Organizing Map (SOM), or Kohonen-Network [3], which is mainly used for data clustering and feature mapping. The learning process involves updating network architecture and connection weights so that a network can efficiently perform a specific classification/clustering task.Artificial neural networks (ANNs) provide a new suite of nonlinear algorithms for feature extraction (using hidden layers) and classification (e.g., multilayer perceptron). In addition, existing feature extraction and classification algorithms can also be mapped on neural network architectures for efficient (hardware) implementation. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process.

Zhang [32] in his survey has studied the advantage of neural networks in the following theoretical aspects. First, neural networks are data driven self-adaptive methods in that they can adjust themselves to the data without any explicit specification of functional or distributional form for the underlying model. Second, they are universal functional approximators in that neural networks can approximate any function with arbitrary accuracy. Since any classification procedure seeks a functional relationship between the group membership and the attributes of the object, accurate identification of this underlying function is doubtlessly important. Third, neural networks are nonlinear models, which makes them flexible in modeling real world complex relationships. Finally, neural networks are able to estimate the posterior probabilities, which provides the basis for establishing classification rule and performing statistical analysis.

Raudys [32] presents a detailed analysis of nonlinear single layer perceptron (SLP). He shows that during the adaptive training process of SLP, by purposefully controlling the SLP classifier complexity through adjusting the target values, learning-steps, number of iterations and using regularization terms, the decision boundaries of SLP classifiers are equivalent or close to those of seven statistical classifiers.

Kanaya and Miyake and Miyake and Kanaya also illustrate theoretically and empirically the link between neural networks and the optimal Bayes rule in statistical decision problems.

Lee [39] used Hidden Markov Model (HMM) for gesture recognition using shape feature. Gesture state is determined after stabilizing the image component as open fingers in consecutive frames. He also used maxima and minima approach like Raheja for construction the hand image and FSM like Verma [39] for gesture finalization.

Wang [39] proposed an optical flow based powerful approach for human action recognition using learning models. It labels hidden parts in image also. This mas-margin based algorithm can be applied to gesture recognition. Kim [39] in his system used learning model for dynamic pattern recognition. Ng [39] used HMM and RNNs for pattern classification from the collected vectors of hand pose frames. Outputs of both classifiers were combined to get better results.

G. Genetic Algorithm Based Approach:

Basic Genetic Algorithm

Mukhopadhyay [34] in their review stated the basic structure of a genetic algorithm as given here under:

Algorithm
t: = 0;
Compute initial population B0;
WHILE stopping condition not fulfilled DO
BEGIN
Select individuals for reproduction;
Create offspring's by crossing individuals;
Eventually mutate some individuals;
Compute new generation
END

As obvious from the above algorithm, the transition from one generation to the next consists of four basic components:

1. Selection: Mechanism for selecting individuals (strings) for reproduction according to their fitness (objective function value).
2. Crossover: Method of merging the genetic information of two individuals; if the coding is chosen properly, two good parents produce good children.
3. Mutation: In real evolution, the genetic material can by changed randomly by erroneous reproduction or other deformations of genes, e.g. by gamma radiation. In genetic algorithms, mutation can be realized as a random deformation of the strings with a certain probability. The positive effect is preservation of genetic diversity and, as an effect, that local maxima can be avoided.
4. Sampling: Procedure which computes a new generation from the previous one and it's off springs.

Mukhopadhyay [34] compared GA with traditional continuous optimization methods, such as Newton or gradient descent methods, they have stated the following significant differences:

1. GAs manipulate coded versions of the problem parameters instead of the parameters themselves, i.e. the search space is S instead of X itself.
2. While almost all conventional methods search from a single point, GAs always operates on a whole population of points (strings). This contributes much to the robustness of genetic algorithms. It improves the chance of reaching the globaloptimum and, vice versa, reduces the risk of becoming trapped in a local stationarypoint.
3. Normal genetic algorithms do not use any auxiliary information about the objective function value such as derivatives. Therefore, they can be applied to any kind of continuous or discrete optimization problem. The only thing to be done is to specify a meaningful decoding function.
4. GAs use probabilistic transition operators while conventional methods for continuous optimization apply deterministic transition operators.

The best part of GA is that it work parallel on different points for faster computation.

A GA operates through a simple cycle of stages:

1. Creation of a population of real-valued strings,
2. Evaluation of each string with recognition rate on training data,
3. Selection of good strings, and
4. Genetic manipulation to create the new population of strings.

(a) one-point crossover with probability 0.6.

(b) Standard mutation with probability 0.01.

The cycle stops when the recognition rate gets better no longer. Notice that we replace all the members of old population with the new ones, and preserve the best possible solution obtained so far by elitist strategy.

Fig.2 shows these four stages using the biologically inspired terminology.

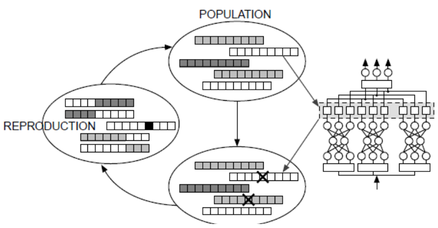

Fig:2. Overall procedure of the genetic algorithm based method.

H. Hybrid Systems and Combinations:

Hybrid approach aims to exploit the tolerance for imprecision, uncertainty, approximate reasoning, and partial truth in order to achieve tractability, robustness, and low-cost solutions. The guiding principle is to devise methods of computation that lead to an acceptable solution at low cost by seeking for an approximate solution to an imprecisely/precisely formulated problem.

The neuro–fuzzy approach, which provides flexible information processing capability by devising methodologies and algorithms on a massively parallel system for representation and recognition of real-life ambiguous situations forms, at this juncture, a key component of soft computing.

We can have approaches that exploit the benefits of all three soft computation tools, *viz*. fuzzy logic, ANN's and genetic algorithms (GA's), for pattern classification. In the area of ANN's, they have been used in determining the optimal set of connection weights as well as the optimal topology of layered neural networks. A fuzzy reasoning system can be implemented using a multilayer network, where the free parameters of the system can be learned using GA's. Similarly, the parameters of an FNN can also be learned using GA's. Such systems are termed neuro–fuzzy-genetic.

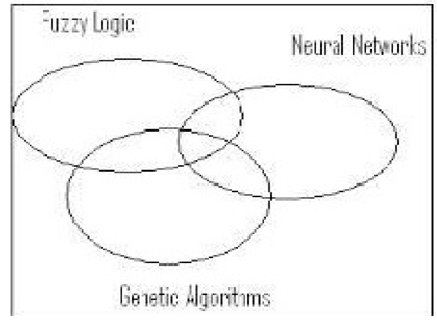

Fig 3. Hybrid Approach

Below we approach the concept of hybrid computational intelligence system by presenting evidence found in literature, concerning effective combinations of two, either competitive or, complementary intelligent approaches to pattern classification.

a. Neural Networks and Fuzzy Logic:

S.Mitra [36] in their work have presented a survey of Neuro-Fuzzy soft computing technique and have stated that Neuro-Fuzzy computing is a judicious integration of the merits of neural and fuzzy approaches, enables one to build more intelligent decision-making systems. This incorporates the generic advantages of artificial neural networks like massive parallelism, robustness, and learning in data-rich environments into the system. The modeling of imprecise and qualitative knowledge as well as the transmission of uncertainty are possible through the use of fuzzy logic. Besides these generic advantages, the neuro–fuzzy approach also provides the corresponding application specific merits.

Georgios Dounias [38] in his work has stated that neuro-fuzzy systems have shown a high rate of success when applied in complex domains of application, either when fuzzy set theory is the heart of such a system, or when the neural mechanism is the dominant component in the architecture. The main principle of this combination, as seen by a neural network expert, can be roughly described as the adoption of fuzzy functions in (mostly consisted of 3-layers) neural networks' nodes. On the other hand, a fuzzy systems' expert may realize a neural-like training (such as back-propagation) for the membership functions of a fuzzy system. However, combinations and approaches in these hybrid systems can be less obvious and descriptive, concerning different neural or fuzzy structures, such as self-organizing maps or, radial basis functions.An adaptive fuzzy-leader clustering (AFLC) algorithm was used in [38] for segmentation technique of magnetic resonance (MR) images of the brain.

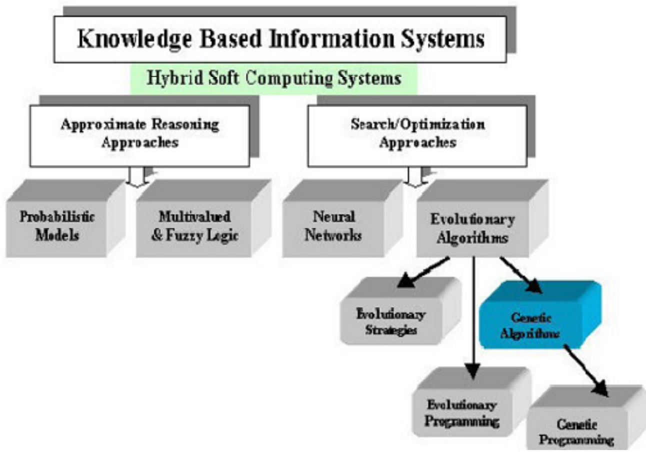

Fig.4. Hierarchy of Hybrid Soft Computing System

This approach through the definition of a proper quantitative measure proves of superior performance to other existing segmentation methods. In [39], a combination of fuzzy logic and neural networks is used to develop an adaptive control system for arterial blood pressure using the drug nitroprusside. The work presented in [39] uses fuzzy logic based adaptive neural networks, aiming to compensate for image degradation due to photon scattering and photon penetration through the collimated gamma camera to allow more accurate measurement of radiotracers in vivo.

Neuro-fuzzy systems with adaptive learning capabilities have been used in controlling selective stimulation for FES. Another neuro-fuzzy attempt can be found in [39], where chaos theory is used together with a neuro-fuzzy network, called FuNN, for building an adaptive, intelligent information system for time series analysis applied to the case of heart rare variability. In [39], for the pregnancy stages, has been developed a neural and fuzzy classifier to discriminate among normal and pathological fetal conditions during pregnancy. Results show very promising performance on the set of collected fetal heart rate signals. Another hybrid intelligent system based on a neuro-fuzzy approach can be found in [40]. The system comprises an adaptive fuzzy controller and a network-based predictor, which has been developed such for controlling the mean arterial blood pressure of seriously ill patients. The system has the ability to learn the control rules from off-line training process as well as to adjust the parameters during the control process.

b. Neural Networks and Genetic Algorithms:

Yas Abbas Alsultanny [35] in their paper have presented the idea behind the implementation of such hybrid systems is the adoption of an evolutionary algorithm for the determination of neural network's weights or the neural network's architecture, or both. In the first case, neural networks are tuned by evolutionary algorithms, rather than generated by, which is the case in the second approach. The third approach may contain both generation and tuning. A special case of tree-like neural networks may also be served by genetic programming training.

Yas Abbas Alsultanny [35] have proposed the learning algorithm using genetic algorithm with multilayer neural networks for pattern recognition is presented in Fig.5. It consists of two learning stages.

The first learning using genetic algorithm with the feed-forward step uses stage to accelerate the whole learning process. The genetic algorithm performs global search and seeks near optimal initial point (weight vector) for the second stage. Where, each chromosome is used to encode the weights of neural network. The fitness (objective) function for genetic algorithm is defined as the total sum squared system error (TSSE) of the corresponding neural network. Therefore, it becomes an unconstrained optimization problem to find a set of decision variables by minimizing the objective function. The best fitness function value in a population is defined as smallest value of the objective in the current population

Ishibuchi[41] select a small number of significant fuzzy IF–THEN rules to construct a compact and efficient fuzzy classification system. GA's are used to solve this combinatorial optimization problem, with an objective function for simultaneously maximizing the number of correctly classified patterns and minimizing the number of fuzzy rules.

c.Fuzzy Logic and Genetic Algorithms

S.Mitra *et al.* [36] have presented a survey and stated that a fuzzy model, containing a large number of IF–THEN rules, is liable to encounter the risk of over fitting and, hence, poor generalization. The strong searching capacity of GA's been utilized in fuzzy–genetic hybridization to circumvent this problem by 1) determining membership functions with a fixed number of fuzzy rules ;2) finding fuzzy rules with known membership functions ;and 3) finding both membership functions and fuzzy rules simultaneously.

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Genetic algorithms and fuzzy logic have been used in the past collaboratively for various control engineering applications and complex optimization problems. Both, fuzzy logic driven genetic approaches and genetic driven fuzzy logic based schemes have been proved effective in modern AI literature, as described in the following paragraphs. The fuzzy logic driven genetic approaches primarily concern the use of fuzzy logic, either for genetic parameters' tuning, or for fuzzy encoding of the chromosomes. The genetic driven fuzzy logic based schemes usually consist of fuzzy rule-based systems, using a genetic approach for the determination of the rule base. On the other hand, the prime theoretical aspects of implementing complex structures such as the fuzzy systemsinto genetic programming trees can be found in literature.

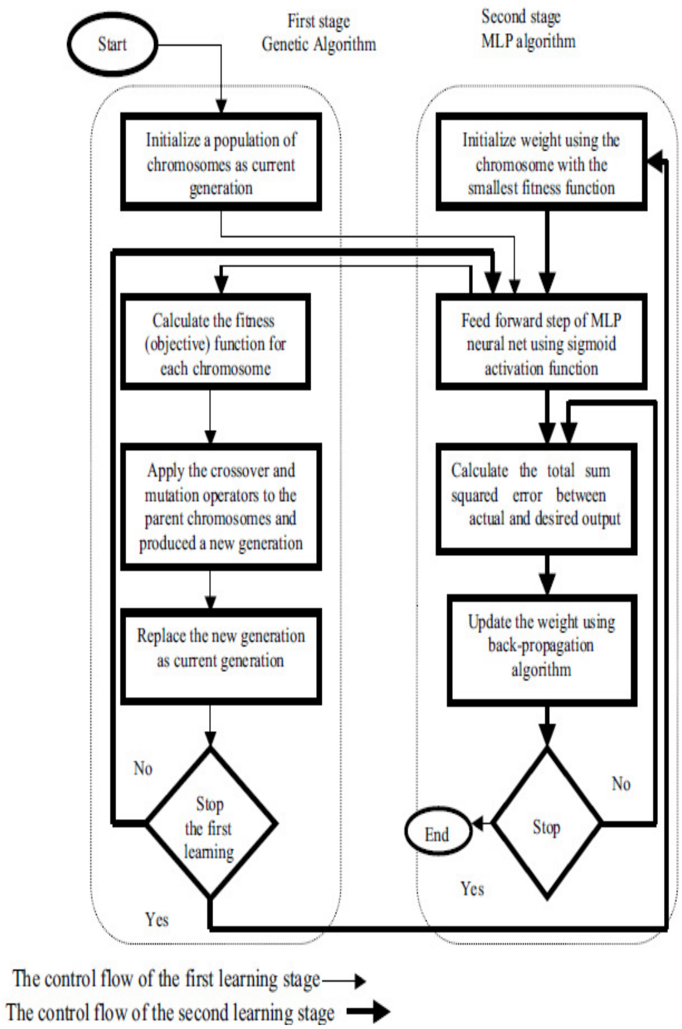

Fig.5. The Neural Genetic Learning Algorithm

d. Neural-Genetic-fuzzy hybrid method:

A neuro–fuzzy-genetichybridization has been reported by Yupu [36]. *A priori* knowledge from the designer is combined with the learning ability of the network to design an optimal fuzzy controller. This self-learning system uses the control performance index as the fitness function of the GA while searching for the network parameters.

Farag [36] present a neuro–fuzzy system capable of handling both quantitative and qualitative knowledge. The learning involves first finding the initial parameters of the membership functions of the fuzzy model with Kohonen's self-organizing feature map algorithm. This is followed by the extraction of linguistic fuzzy rules. A multi resolutional dynamic GA is then used for optimized tuning of membership functions.

Wang and Archer [36] have introduced ultra-fuzzysets for modeling decision-making under conflict, using a modified version of back propagation. In case of ultra-fuzzy sets, the membership function takes on fuzzy values.

Fuzzy logic and genetic algorithm are probably useful techniques that have been proposed for achieving some aspect of intelligent system. Their differences, however, have prompted a number of researchers to try combining them to produce more powerful systems. In this section we present a hybrid method of fuzzy logic and genetic algorithm to give an optimal solution to combine neural networks.

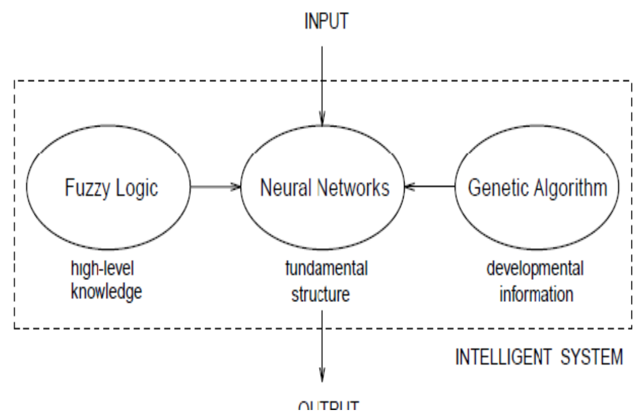

Fig.6. Schematic diagram of the hybrid framework based on neural networks, fuzzy logic and genetic algorithm

Fuzzy logic gives a possibility to utilize top-down knowledge from designer. Human operators can enhance the neural networks by incorporating their knowledge with fuzzy membership functions, which are modified through learning process as fine tuning. After the learning, the human operators may be able to understand the acquired rules. On the other hand, genetic algorithm is a powerful tool for structure optimization of fuzzy logic and neural networks which provide evaluation functions for genetic algorithm. Fig.6 shows a schematic diagram of the general framework based on the hybridization of them.

III. DISCUSSION AND FRONTIERS

In our attempt to comment on the most effective hybrid intelligent schemes for pattern recognition, neuro-fuzzy systems are definitely the most popular until now, due to the fact that they are fast and efficient as a methodology (i.e. accurate enough), and can be understood, designed and implemented easily.Neuro-fuzzy systems are usually superior to simple neural networks, due to the fact that a neural network "suffers" from noise, whereas the neuro-fuzzy system has the ability to "absorb" the noise with the use of the embedded membership functions. Fuzzy-genetic systems are preferable than simple fuzzy systems, due to the fact that fuzzy-genetic approaches do not have to define oneself the rule-base. For similar reasons, a neuro-fuzzy system is superior to a simple fuzzy system, as the neuro-fuzzy systems do not have to tune oneself the rule-base. Generally one should also have in mind that the nature, the reliability and the availability of the data under processing, consist sometimes also a crucial factor for the success or the failure of a specific hybrid intelligent methodology. Regarding the combination of neural networks and genetic algorithms, although there exists a sufficient number of (most theoretical) publications, the number of real-world applications remains relatively small as compared to the fuzzy-neural systems. However, the uniqueness in some of the fuzzy-evolutionary systems, which is the incorporation of fuzzy logic into an evolutionary algorithm makes these hybrid schemes to work effectively in a larger scale of application domains.

To date, there has been no detailed and integrated categorization of the various neuro–fuzzy-genetic models used for pattern classification. We have attempted to collect these under a unified soft computing framework. The need for the design of generalized hybrid architectures combining principles on how to choose theoretically the most suitable intelligent components, while taking into account at the same time, the special characteristics of the area of application under examination, is be the aim far ahead.

Choi [39] brings attention of researchers pointing out an old problem of the incrementing processing time of algorithm's complexity and say "the most important issue in field of the pattern recognition is the simplification of algorithm and the reduction of processing time". He used morphological operation to implement his system using the center points extracted from primitive elements by morphological shape decomposition. Lu [39], Gastaldi [39], Ozer [39] used parallel approach in the design and implementation of their system. Different threads are implemented in such way that they can run in parallel and can compute faster. Shin [39] presented a 3D system HGR system with the application in fruit fly chromosomes based on 2D slices of CT scan images. Lee [17] describes his system which he developed for remote control systems which worked for motion recognition also. He uses 3D systems with two or more cameras to detect command issued by hand. Morimoto [38] made interesting virtual system, in which he pushed virtual buttons using fingers in the air and recognized it using 3D sensors.

IV. Conclusion

An exhaustive survey of fuzzy, neural, genetic, neuro–genetic generation algorithms and neuro-fuzzy-genetic algorithm for pattern recognition is presented. This paper has presented three combining methods of neural-fuzzy-genetic networks for producing an improved performance on real-world classification problem, in particular pattern recognition. In case of noisy patterns, choice of statistical model is a good solution. Practical importance of structural model depends upon recognition of simple pattern primitives and their relationships represented by description language. As compared to statistical pattern recognition, structural pattern recognition is a newer area of research. For complex patterns and applications utilizing large number of pattern classes, it is beneficial to describe each pattern in terms of its components. A wise decision regarding the selection of Pattern grammar influences computations efficiency of recognition system. Pattern primitives and pattern grammar to be utilized depends upon the application requirements. Low dependence of neural networks on prior knowledge and availability of efficient learning algorithms have made the neural networks famous in the field of Patten Recognition. Although neural networks and statistical pattern recognition models have different principles most of the neural networks are similar to statistical pattern recognition models. To recognize unknown shapes fuzzy methods are good options. As each model has its own pros and cons, therefore to enhance system performance for complex applications it is beneficial to append two or more recognition models at various stages of recognition process. Furthermore, future efforts will concentrate on refining the feature extraction to capture more information, and testing the efficacy of the soft computing techniques on larger data sets. The complementary nature of fuzzy logic and genetic algorithm leads us to believe that a further refined genetic fuzzy neural system will significantly improve the state-of-the-art pattern recognizers.

Moreover, it has been observed that the highly increasing computing power and technology, could make possible the use of more complex intelligent architectures, taking advantage of more than one intelligent techniques, not in a competitive, but rather in a collaborative sense. This last fact corresponds to what is called a hybridcomputational intelligence system methodology throughout this paper

References

[1] P.E. Ross, "Flash of Genius", Forbes, pp. 98-104, Nov, 1998.

[2] The European Network on Intelligent Technologies for Smart Adaptive Systems: EUNITE Symposium, Proceedings, 16-17 March 2001,ELITE Foundation, Aachen, Germany.

[3] P. O. Duda and P. E. Hart, Pattern Classification and Scene Analysis New York: Wiley, 1973.

[4] J.A. Benediktsson and P.H. Swain, Consensus theoretic classification methods, *IEEE.Trans.Syst*. Man. Cyber. 22 (1992), 418–435.

[5] L. Xu, A. Krzyzak and C.Y. Suen, Methods of combining multiple classifiers and their applications to handwriting recognition, *IEEE Trans. Syst*. Man. Cyber. 22 (1992), 688–704.

[6] M.P. Perrone and L.N. Cooper, when networks disagree: Ensemble methods for hybrid neural networks, in: Neural Net.for Speech and Image Proc, R.J. Mammone, ed., Chapman- Hill, London, 1993.

[7] Chen Z., Computational Intelligence for Decision Support. CRC Press, 2000.

[8] Nilsson N., Artificial Intelligence: A New Synthesis. Morgan Kaufm., 1998.

[9] Zadeh L.A., Fuzzy Sets, Information Control 8, pp. 338-353, 1965.

[10] Rosenblatt F., Two theorems of statistical separability in the perceptron, Mechanization of Thought Processes, London HM Stat.Office, 421-456.

[11] Widrow B. and Hoff M.E., Adaptive switching circuits, IRE Western Electric Show and Convention Record - Part 4, pp. 96-104, 1960.

[12] Werbos P., Beyond regression: new tools for predictions and analysis in the behavioral science, PhD Thesis, Harvard University, 1974.

[13] Holland J.H., Adaptation in Natural and Artificial Systems, Cambridge, MA: MIT Press, 1975.

[14] Koza J. R. 1992. Genetic Programming – On the Programming of Computers by Means of Natural Selection, The MIT Press.

[15] T. Fukuda, Fuzzy-neuro-GA based intelligent robotics, in: Computational Intelligence: Imitating Life, J.M. Zurada, R.J. Marks II, C.J. Robinson, Eds, *IEEE* Press, 1994, pp. 252–263.

[16] H. Takagi, Fusion technology of neural networks and fuzzy systems: A chronicled progression from the laboratory to our daily lives, Int. Journal of AppliedMathematics and ComputerScience 10 (2000), 647–673.

[17] R.O. Duda and P.B.Hart, Pattern Classification, and Scene Analysis, New York John Wiley &Sons, 1973.

[18] Statistical Pattern Recognition: A Review, Anil K. Jain, *Fellow, IEEE,* Robert P.W. Duin, and Jianchang Mao, *Senior Member, IEEE.*
[19] K.Fukunaga, Introduction to Statistical Pattern Recognition, second ed., New York; Academic Press, 1990.
[20] P.A. Devijver and J. Kittler, Pattern Recognition: A Statistical Approach, London: Prentice Hall, 1982.
[21] L. Devroye, I. Gyorfi, and G. Lugosi, A Probabilistic Theory of Pattern Recognition, Berlin: Springer-Verlag, 1996.
[22] C.M.Bishop, Neural Network for Pattern Recognition, Oxford; Claredon Press, 1995.
[23] B.Ripley, Pattern Recognition and Neural Networks, Cambridge, Mass; Cambridge University Press 1996.
[24] J. Schurmann, *Pattern Classification: A Unified View of Statistical and Neural Approach,* New York: John Wiley & Sons. 1996.
[25] G.McLachlan, Discrimnant Analysis and Statistical Pattern Recognition. New York: John Wiley & Sons, 1992.
[26] G.Nagy,"State of the Art in Pattern Recognition,*"IEEE*, vol.56, pp.836-862, 1968.
[27] J.N.Kanal,"Patterns in Pattern Recognition: 1968-1974," *IEEE Trans. Information Theory,* vol 20, no.6, pp.697-722, 1974.
[28] Anil K. Jain, Fellow, *IEEE,* Robert P.W.Duin, and Jianchang Mao, *IEEE,"Statistical Pattern Recognition: A Review," Vol.22 No.1, Januar2000.*
[29] Shahin Ara Begum and O.Mema Devi,Fuzzy Algorithm for Pattern Recognition in Medical Diagnosis,Assam Univ. Journal,vol.7 No.II, 2011.
[30] G.Nagalakshmi, S.Jyothi,"A Survey on Pattern Recognition using Fuzzy Clustering Approaches", IRJES, vol.2, pp.24-31, 2013.
[31] Image Segmentation Using Clustering by Juraj Horvath.
[32] Guoqiang Peter Zhang,"Neural Networks for Classification: A Survey,"*IEEE Trans*. On System,vol.30,no. 4,2000.
[33] Jayanta Kumar Basu, Debnath Bhattacharyya, Tai-hoon Kim,"Use of Artificial Neural Network in Pattern Recognition, "International Journal of Software Engineering and its Application, vol.4, No.2, 2010.
[34] Deep Malya Mukhopadhyay, Maricel O. Balitanas, Alisherov Farkhood A.,"Genetic Algorithm: A Tutorial Review," Vol.2, No.3, 2009.
[35] Yas Abbas Alsultanny, Musban M.Aqel,"Pattern Recognition using multilayer neural-genetic algorithm,"Elsevier, 2003.
[36] Sushmita Mitra, YoichiHayashi,"Neuro-Fuzzy Rule Generation: Survey in Soft Computing Framework,"*IEEE Trans. On Neural Network,* vol.11, No.3, 2000.
[37] Sung-Bae Cho, Fusion of neural networks with fuzzy logic and genetic algorithm, IOS Press, 2002.
[38] Georgios Dounias,"Hybrid Computational Intelligence in Medicine,"Univ. of Aegean, 2002.
[39] Ankit Chaudhary, J.L.Raheja, Karen Das, Sonia Raheja,"Intelligent Approaches to interact with Machinesusing Hand Gesture Recognition in Natural Way: A Survey", Tezpur Univ. Assam, IJCSES, vol.2.No.1, 2011.
[40] S.Watanable, "Frontiers of Pattern Recognition, ed., NewYork: Academic Press, 1972.
[41] H.Ishibuchi, K. Kwon, and H. Tanaka, "A Learning algorithm of fuzzy Neural Networks with triangular fuzzy weights," *Fuzzy Sets Syst.,* vol.71, pp.277-293, 1995.