Robust Techniques based soft computing model for real time prediction models

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Abstract

Soft computing offers a group of computational methodologies motivated by intrinsic vagueness, awareness, perception and intelligence of human beings and real life ambiguity. On other hand conventional computing techniques depends on exact solutions. Always soft computing seeks at exploiting given tolerance of imprecision and uncertain nature of the problem to give way an approximate solution to a problem in quick time. Soft Computing being a multi-disciplinary field employs various statistical, probabilistic and optimization tools. Some of the familiar computational methodologies are Neural Networks, Learning, Fuzzy Systems, Machine learning, Evolutionary Computation and Probabilistic Reasoning. In the midst of the various Soft Computing methods Neural Networks, Genetic Algorithms and Fuzzy Logic plays the major role in real life applications. Genetic Algorithms (GA) signify a stochastic search and optimization based computational tool which utilizes evolutionary theories of natural genetics. Artificial Neural Networks (ANN) stimulated by learning ability of the human brain which are capable to subtle relationships between neurons whose interactions are unknown, non-linear and too complex to represent. Fuzzy Logic (FL) assists in resolving real life problems with ambiguity and uncertainty. Consequently soft computing techniques yields the robust and low cost solutions.

Key Terms: Soft computing, Fuzzy logic, Neural network, Genetic Algorithm

1. INTRODUCTION

Soft computing (SC) solutions are unpredictable, uncertain and between 0 and 1. Soft Computing became a formal area of study in Computer Science in the early 1990s. Earlier computational approaches could model and precisely analyze only relatively simple systems. More complex systems arising in biology, medicine, the humanities, management sciences, and similar fields often remained intractable to conventional mathematical and analytical methods. However, it should be pointed out that simplicity and complexity of systems are relative, and many conventional mathematical models have been both challenging and very productive. Soft computing deals with imprecision, uncertainty, partial truth, and approximation to achieve practicability, robustness and low solution cost. As such it forms the basis of a considerable amount of machine learning techniques. Recent trends tend to involve evolutionary and swarm intelligence based algorithms and bio-inspired computation.

At this moment, the principal constituents of Soft Computing (SC) are Fuzzy Logic (FL), Neural Computing (NC), Evolutionary Computation (EC) Machine Learning (ML) and Probabilistic Reasoning (PR), with the latter subsuming belief networks, chaos theory and parts of learning theory. Each one contributes a distinct methodology for addressing problems in its domain. In this perspective, the principal constituent methodologies in soft computing are complementary rather than competitive.

Soft computing (SC) is a branch, in which, it is tried to build intelligent and wiser machines. Intelligence provides the power to derive the answer and not simply arrive to the answer. The applications of Soft Computing have proved two main advantages.

- First, it made solving nonlinear problems, in which mathematical models are not available/possible.
- Second, it introduced the human knowledge such as cognition, recognition, understanding, learning, and others into the fields of computing. This resulted in the possibility of constructing intelligent systems such as autonomous selftuning systems, and automated designed systems.

The employment of soft computing techniques leads to systems which have high machine intelligence quotient (MIQ). It is the high MIQ of SC based systems that accounts for the rapid growth in the number and variety of applications of soft computing. One of the important features of SC is acquisition of knowledge or information from inaccurate and uncertain data. It is expected that combination or fusion of the elemental technologies will help to overcome the limitations of individual elements. Soft Computing is defined as a collection of techniques spanning many fields that fall under various categories in computational intelligence. Soft Computing has three main branches: Fuzzy Systems, Evolutionary Computation, Artificial Neural Computing.

2. REVIEW OF RELATED WORK DONE

For the sake of clarity in the handwriting recognition field, in this section a brief review of the research work that is already available is presented. A number of review papers on off-line handwriting recognition have been published [1, 2, 3, 4].In this review, Steinherz, et al. [4] categorize off-line handwriting recognition systems into three categories: segmentation-free methods, segmentation-based methods, and perception-oriented approaches, in which the authors include as methods that perform similarly to human-reading machines using features located throughout the word.

Systems for recognizing machine printed text originated in the late 1950s and have been in widespread use on desktop computers since the early 1990s. In [5], historical review of off-line character recognition research and development is mentioned. In the early 1990s, image processing and pattern recognition are efficiently and effectively combined with artificial intelligence and statistical technique (HMM) [6, 7].

G. Pirlo and D. Impedovo [8] presented a new class of membership functions, which are called Fuzzy-membership functions (FMFs), for zoning-based classification. These FMFs can be easily adapted to the specific characteristics of a classification problem in order to maximize classification performance. In this research, a real-coded genetic algorithm is presented to find, in a single optimization procedure, the optimal FMF, together with the optimal zoning described by Voronoi tessellation. The experimental results, which are carried out in the field of handwritten digit and character recognition, indicate that optimal FMF performs better than other

membership functions based on abstract level, ranked-level, and measurement-level weighting models, which can be found in the literature.

M. Hanmandlu, O.V. Ramana Murthy[9] have presented in their study the recognition of handwritten Hindi and English numerals by representing them in the form of exponential membership functions which serve as a fuzzy model. Velappa Ganapathy, and Kok Leong Liew [10], they proposed a method in which first multiscale neural training with modifications in the input training vectors is adopted to acquire its advantage in training higher resolution character images and then selective thresholding using minimum distance technique is proposed to increase the level of accuracy of character recognition. Saurabh Shrivastava and Manu Pratap Singh [11] describe the performance evaluation for the feed forward neural network with three

different soft computing techniques to recognition of hand written English alphabets.

Yoshimasa Kimura presented [12] a work on how to select features for Character Recognition Using Genetic Algorithm. The author proposes a novel method of feature selection for character recognition using genetic algorithms (GA). The proposed method selects only the genes for which the recognition rate of training samples exceeds than the predetermined threshold as a candidate of the parent gene and adopts a reduction ratio in the number of features used for recognition as the fitness value.

The handwriting recognition field has evolved in last decades and comes out to be new impetus to new researcher as the technology advances. Now a day, this field can have become a large business for many of industrial applications.

3.IMPORTANCE OF SOFT COMPUTING

The complementarity of FL, NC, GC, and PR has an important consequence: in many cases a problem can be solved most effectively by using FL, NC, GC and PR in combination rather than exclusively. A striking example of a particularly effective combination is what has come to be known as "neurofuzzy systems." Such systems are becoming increasingly visible as consumer products ranging from air conditioners and washing machines to photocopiers and camcorders. Less visible but perhaps even more important are neurofuzzy systems in industrial applications. What is particularly significant is that in both consumer products and industrial systems, the employment of soft computing techniques leads to systems which have high MIQ (Machine Intelligence Quotient). In large measure, it is the high MIQ of SC-based systems that accounts for the rapid growth in the number and variety of applications of soft computing.

3.1 Fuzzy Logic

Fuzzy logic provides an easiest way to get an accurate conclusion based upon fuzzy, ambiguous, imprecise, noisy or missing information of inputs. So the fuzzy expert system is designed which uses a collection of fuzzy membership functions and rules to reason about data.

The rules in a fuzzy expert system are usually similar to ordinary if rule as the following: if a is low and b is high then c = medium where a and b are input variables and c is an output variable. The states represented as low, high and medium are values of fuzzy variables defined by membership functions defined on a, b, c respectively. The antecedent part represents the rule's premise which describes to what degree the rule applies while the conclusion part is the rule’s consequent which assigns a membership function to one or more output variables. The group of rules in a fuzzy system is known as the rule base or knowledge base. Some of the basic operations of fuzzy reasoning are listed as

1. Comparison of input variables with the membership functions on the premise part to obtain the membership values of each linguistic label
2. Combining the membership values on the premise part to get firing strength of each rule,
3. Generating the qualified consequent each rule depending on the firing strength and
4. Aggregating the qualified consequents to produce a crisp output.

3.2 Genetic algorithm (GA)

Genetic algorithm is most popular evolutionary algorithm. It is a popular method for solving optimization problems based on selection, crossover and mutation process which drives biological based genetic evolution. Genetic algorithm can be applied to find the solutions for variety of optimization problems

which have their objective function as non differentiable, discontinuous, stochastic or with highly nonlinear. As working action of genetic algorithm, first it selects randomly each individual from the current population. These individuals are then considered as parents and use them to reproduce their children for the next generation. On successive generations the population moves toward an optimal solution. Based on genetic revolution, the genetic algorithm modifies a population of individual solutions repeatedly. The three basic operations of the genetic algorithm are selection, crossover and mutation. The selection operation selects the individuals as parents and they contribute to the population at the next generation. Crossover combines two parents to produce children for the next generation. Mutation creates modification to the individual parents randomly to form children.

Based on this evolution process and logic of fittest survival, the genetic algorithm is widely considered as global optimization algorithm [10]. In some applications the mutation is done to change certain point by probability. Thus in general, it is important to choose suitable crossover and mutation probability suitably.
The pseudocode for general GA's is described as follows:

Step1: Generating initial GA population.
Step2: Evaluation of all individuals in the population.
Step3: Performing local search for each individual in the population and replacement with improved solution;
Step4: Creation of new population by applying standard genetic algorithm Operators.
Step5: This process ends on obtaining the optimal solution, otherwise the same Process is repeated from the step 2.

3.3 Artificial Neural Network (ANN)

Artificial Neurons are simple functioning bodies of complex structure and also tried to stimulate the brain. The study of networks consisting of nodes connected by adaptable weights and which store the knowledge of the experiments from the worked examples through a process of learning is called Neural network. Since the nodes of the brain are adaptable, they collect the knowledge through the updating of the node weight. The type on neural network is classified based on the following basis such as i) Activation function supplied to the neurons ii) Learning method of determining weights on the connection and iii)Based on the architecture of the network

This parallel organization of the system can give solutions to problems where multiple constraints have to be satisfied simultaneously. Neural Network is also tolerable with noise and easier to handle since it involves less human work than traditional statistical analysis. ANN has the ability to recover easily from distortions in the input data and their capability of learning. They solve very complex problems for conventional technologies.

Neural networks learn by example. They prone to fewer errors because they can always respond to anything and minor changes in the input normally do not affect its output. Apart from all these traditional techniques, the hybrid approach like neuro fuzzy or hybrid fuzzy-neural are also in practice because it gets the benefits of neural networks as well as fuzzy logic system.

- **HYBRID SOFT COMPUTING REAL TIME APPLICATIONS**

In the past few years there has been a tremendous inclination towards hybrid soft computing techniques for dealing with problems encountered in real life. The reason for this growth is attributed to the complementing nature of the distinct soft computing approaches. The hybridization of the techniques covers up the limitations of the individual ones and leads to development of robust computational methodologies. Srinivasulu and Jain (2006)[13] compared the back-propagation neural network ANN trained using real coded genetic algorithm (RGA) and self organizing map (SOM) classified input-output rainfall-runoff data. The study showed that ANN trained using a RGA provided better generalization of the complex and non-linear rainfall-runoff process. Nasseri *et al.* (2008)[14] presented hybridization of ANN with GA for short term rainfall forecasting, by harnessing the global search ability of GA for selection of suitable input parameters and optimal neural network architecture. The study showed that hybrid ANN outperformed the prediction ability of multi-layer perceptron (MLP) neural network.

Talei *et al.* (2010)[15] used Adaptive Network-based Fuzzy Inference System (ANFIS) for event-based rainfall runoff modelling. The results of the ANFIS were compared with an established physical-based model. The study showed that ANFIS is comparable to the physical model and is found to give a better peak flow estimation compared to the physical model. Dorum *et al.* (2010)[16] studied the rainfall-runoff data using ANN and ANIFS methods. A multi regression model was also used to compare the results obtained from ANN and ANIFS models with traditional methods. The study showed that ANN and ANIFS models can be used in determination of rainfall runoff relationships of Susurluk Basin except peak situations. Asadi *et al.* (2013)[17] used GA for evolving the weights of the neural network used for rainfall-runoff process modelling. The data were preprocessed by data transformation, input variable selection and data clustering for improving the prediction accuracy of the model. The study showed that by adopting this methodology, faster training, high degree of accuracy and good adaptation of nonlinear functional relationships between rainfall and runoff is achieved.

CONCLUSION

Soft Computing act as a backbone in many multi-disciplinary field which uses a variety of statistical and optimization approaches .tools The computational methodologies namely, Neural Networks, Evolutionary Computation, Fuzzy Systems, Machine Learning and Probabilistic Reasoning are applied recently dealing with the real life phenomenon associated with imprecise, noisy, complex and ambiguous nature of information.

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