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Techniques of Soft Computing For Agricultural Research

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Abstract

Soft computing analyzes and finds a solution to various complex problems. It provides complete, analytical and cost effective solutions. In last decades, it is used for engineering computing and scientific research. In biological and agriculture engineering various techniques like decision trees, artificial neural networks, fuzzy logic etc. are used for study of water and soil. This paper provides a review of various methods used in soft computing.

Keywords: PDP, ANN, FL, BI

1 Introduction

Soft computing is set of various methods of computing as Genetic Algorithm (GA), Artificial Neural Network (ANN) and Fuzzy Logic (FL). Unlike the various hard computing methods, this refers to huge set of conventional methods as statistical and stochastic methods. But these offers not an exact solution to complex problems through analysis with tolerance of approximation, uncertainty and imprecision. It is integration of computing techniques and biological structures. In an imprecise environment, FL develops non-numeric, multi-valued linguistic variables for modelling the human reasoning. Configurations are provided by ANN that are made of artificial neurons that are interconnected. GA finds a solution to a problem by mutation, selection and recombination. Soft computing achieves the robustness, tractability and is able to provide a solution with low-cost that comprises tolerance of approximation, partial truth, uncertainty and imprecision. So it is able to find a solution to various complex problems. First technique used in area of soft computing is FL [16] [17] [18]. Further, series of algorithms are published by Parallel Distributed Processing (PDP) [10]. The core methods considered are GAs, ANNs and FL. Also the list includes chaos theory, probabilistic reasoning and machine learning. The methodology is being advanced of soft computing for the new methods to be more robust, efficient and provide a reliable solution. One of the emerging linear classifier is SVM [1][2]. It provides higher classification accuracies and is emerging as a set of supervised generalized linear classifier. The another

advancement in soft computing is method fusion. It combines various methods of soft computing for improving the performance of system. The best example for fusion is Neuro-fuzzy systems [13] [6] [8] [7].

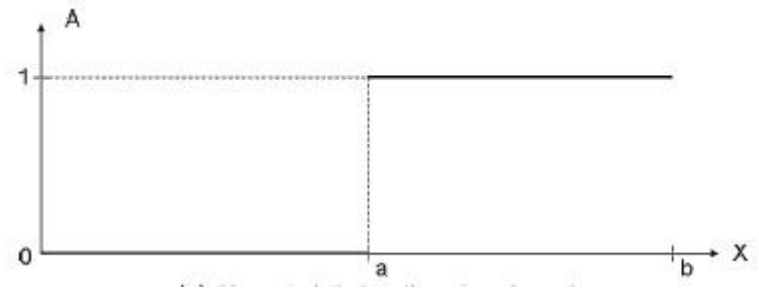

Figure 1: Crisp set characteristic functions

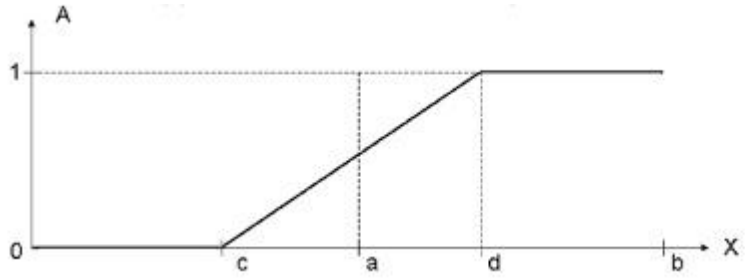

Figure 2: Fuzzy set characteristic functions

In biological and agriculture engineering, there are various applications and research in soft computing [14] [14]. Various methods of biological and agriculture engineering have been developed for SVMs, Decision Tree (DT), Bayesian Inference (BI), GAs, ANNs and FL. Various methods of soft computing are reviewed in this paper.

2 Methods of soft computing

In general, soft computing method includes the techniques of parts of learning theory, chaotic system, belief networks, evolutionary computing, neuro computing etc. In biological and agriculture engineering, primary techniques are DT, BI, GAs, ANNs and FL. The neuro computing learning algorithms and model architectures are ANNs. The evolutionary algorithm specific class is GA. The probabilistic computing is realized by BI. The data-sets are organised in soft computing by DT. All these have been used in last decade.

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The various methods are:

2.1 Fuzzy Logic

FL derived from fuzzy set theory is a multi-valued logic that works with approximate reasoning not with precise. It indicates the truth degree by specifying the values between 0 and 1 rather then specifying truth value o or 1. The fuzzy and crisp set difference is depicted in Figure 1 and Figure 2. This figures compares the characteristic functions [15].

2.2 Artificial Neural Networks(ANN)

ANN provides a solution for emulation of biological neuron for solving complex problems as human brain does. From recent decades, brain study interest and mechanism involved in brain is being worked on. So it is leading to development of new connectionist system or biological models that are based on biological background. On the basis of neuron model, capabilities and potential of several components interconnecting is being studied [3]. Further , the 'perceptron' was introduced. Also, non linear dynamic structure was applied for solving complex optimization problems [11]. Various algorithms were proposed using Parallel Distributed Approach (PDP).

The basic architecture of ANN, learning/training is simplified version of activities and structure of human brain. In order to find a solution to a problem, brain of human uses web of interconnected neurons, processing units for processing the information. Each neuron is independent, autonomous and performs the work asynchronously. It is one the powerful tool for analysis and processing of data. The two hidden-layer feed forward network is represented in Figure 3.

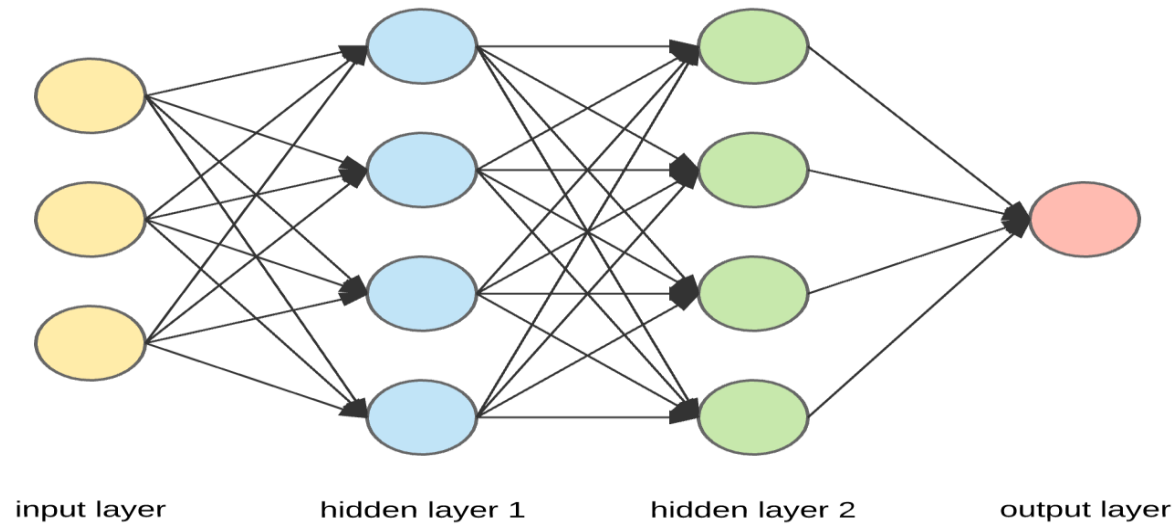

Figure 3: Network structure ANN

2.3 Genetic Algorithms (GA)

GA is one the evolutionary method in the area of artificial intelligence for solving the combinatorial optimization problems. It is further implemented in iteratively. The population growth is selected using the parallel processing method. Biological evolution processes inspires this technique as Darwin theory [12]. GA is one of the heuristic search and optimization method inspired by crossover, selection, mutation and inheritance. It works simultaneously on a set to find a solution to the problem. The algorithms starts with a solution set that represents chromosomes. The fitness value of the chromosome is evaluated for a certain performance criteria. Then alterations are performed by individuals as crossover and genetic mutation. The flowchart of GA algorithm is depicted in Figure 4. It can be used in various fields as machine learning , function optimization[19], scheduling.

2.4 Bayesian Inference

The method of soft computing i.e probabilistic computing performs probabilistic reasoning. The main goal is combining probability theory capacity for handling uncertainty in order to make inference with belief networks [5] . The various methods of Bayesian uses the Bayes's theorem in procedure of probabilistic computation. The models of classical inference does not allow prior knowledge in calculations. But, using the prior knowledge can be helpful in some cases. This technique incorporates both the prior probability distributions and prior knowledge. In BI procedure, observation or evidence updates the probability making the hypothesis true. It is one the powerful tool in decision making in various complex situations. They are probabilistic graphical models. The models classifies probabilistic independencies and variable set. It makes structural representation of cognitive process on the basis of node and link structure. The child and parent nodes are related using Conditional probability tables for predicting the relationship.

2.5 Decision Tree (DT)

One of the popular technique developed in 1960 for machine learning. It constitutes arrangement as a structure of a tree of different attributes set for evaluating and predicting the output. In DT process, recursive operation is performed to get the attribute with higher information gain. It identifies process for reaching the goal. It is one the descriptive mean for conditional probability calculation. It represents the decisions explicitly and visually for decision support. It is one the predictive model in data mining [4]. It gives description about the data and not the decisions. It reaches a conclusion from a map of attributes to the target values. Using the data decision tree is used by a machine earning method known as decision tree learning [9].

3 Future Scope and conclusion

Although various techniques of soft computing exist but each may have its own limitations. The combination of two or more techniques is one the major trend in various applications of soft computing. Various neuro and fuzzy systems represents the knowledge in explicit form. Also ANNs and FL are combined for inheriting the advantages of both techniques and avoiding their drawbacks. They can further be used in various applications. Whatever technique of soft computing is used, one of the powerful tool is adaptive learning.

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