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A Comprehensive Review on Soft Computing Framework

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Abstract. Soft computing exercises the use of imprecise elucidations to computationally hard tasks for which there is no established algorithm that can reckon an exact solution in polynomial time. Soft computing, as confronting to conventional computing compromise with relative standards and provides solutions to multifarious realistic predicaments. Clashing to hard computing, soft computing is liberal to imprecision, ambiguity, approximation as well as fractional truths. Moreover, soft computing is based on approaches like: artificial neural network, fuzzy logic, genetic algorithms, expert system, and machine learning etc. Owing to the wide spread adoration of soft computing, the various approaches of soft computing are currently being passed down flourishingly in numerous sedentary, industrial and profit-making purposes. This paper relinquishes an analysis of the prevalent state of soft computing approaches and collaborates the pros and cons of soft computing set side by side to conventional hard computing strategies. In addition, the current paper also discusses the various real life application domains corresponding to soft computing techniques.

Keywords: ***neural network, fuzzy system, genetic algorithm, evolutionary computing.***

I. Introduction

Soft Computing is basically a type of solecism, perplexity, fractional truth and likeliness or approximation that is purposeful to a system of solution where the solution lies between 0 to 1. It is basically a fusion of research involving neural network, fuzzy logic, genetic programming and evolutionary algorithms, etc. The maxim of soft computing involves: escapade the resilience for imprecision, fragmentary truth as well as approximation for attaining robustness, amenability, as well as lower solution cost while solving the basic problems concerned with recent technological peregrination.

The major constituents of soft computing include: Fuzzy Control Systems (FCS), Evolutionary Computations (EC), Neural Networks (NN), Genetic Algorithms (GA), Machine Learning (ML), Probabilistic Reasoning (PR) etc. Soft computing basically deals with the inexact solutions to intractable problems under consideration. Further, soft computing is receptive to uncertainty, imprecision as well as partial truth and is applicable for the real world practical problems where the ideal model is unavailable. Further, various problems solving technology are segregated fundamentally into hard computing and soft computing as portrayed in Fig. 1. The hard computing is based on precise model where as soft computing is based on approximate model. Further, the precise model is of two categories namely: traditional numeric modelling that deals with conventional modelling that is based on certain conventions or symbols. Similarly, approximate model is based on either randomized search or approximate reasoning. The randomized search explores the same space of parameters while the approximate reasoning is aimed for treating the uncertainty as well as imprecision.

The entire framework of soft computing is portrayed in Fig. 2. Among all, the fuzzy systems play a very crucial role in soft computing and this shoots from the fact that the reasoning conducted by human being is not crisp.

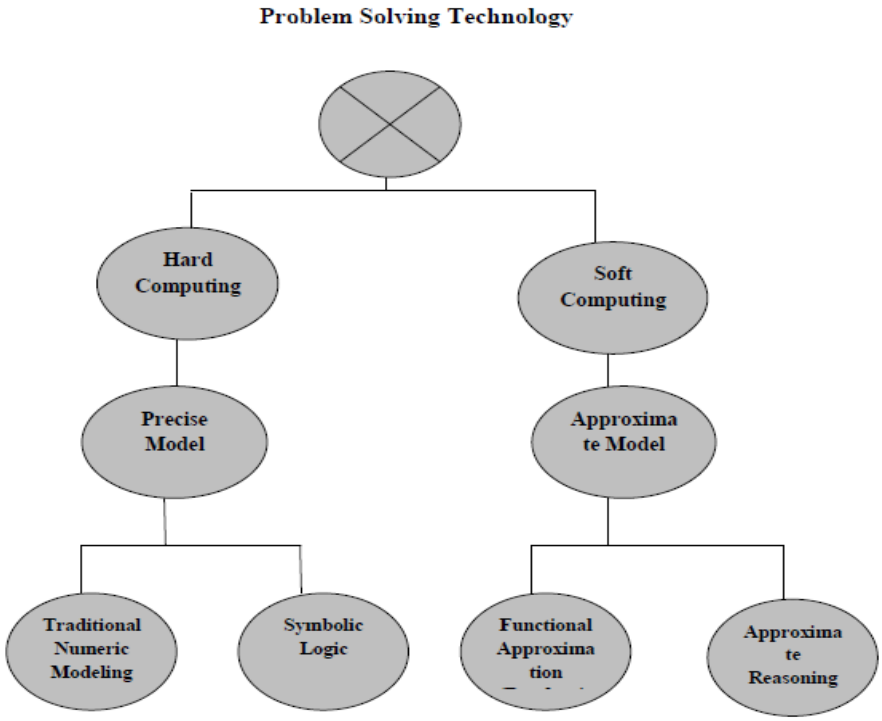

Fig. 1. Classification of Problem Solving Technology

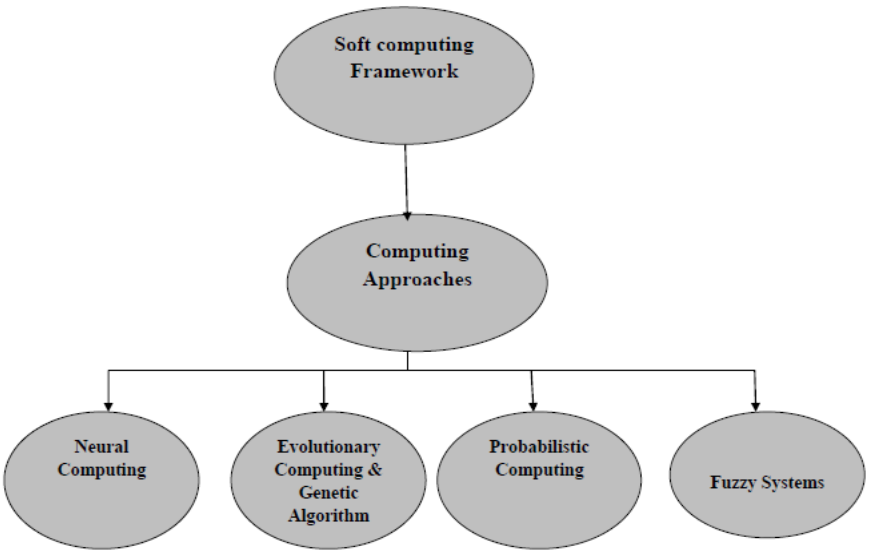

Fig. 2. Soft Computing Framework

II. Soft Computing Applications

Soft computing enjoys wide ranges of applications in various domains as follows:

a. Paper Enterprises: The use of neural network made it feasible to develop a model for paper making process by few experts [2]. The proposed framework generated data in planar stochastic fibrous configuration.

b. Artificial Neural Networks (ANNs): ANNs represent the computing systems exhilarated by biological neural network which comprises of zoological brains. Such structures gradually enhance the effectiveness of assignments by taking into account various illustrations commonly leaving out milestone-specific computing. This in conjunction with their capability for deriving from conversant data.

c. Support Vector Machine (SVM): SVM represents a novel supervised learning approach for interpreting classification problem along with high dimensional feature space and smaller training data set. Despite the fundamental method has been realized for the purpose of binary analysis; various approaches for single as well as multi-class problems have been advocated. Being a supervised approach, it consists of two stages namely: training phase and evaluation phase. At the time of training, the algorithm attains data about the concerned classes by examining the training set that depicts them.

d. Decision Tree: Decision trees are very effective contrivances for collocation as well as forecasting. A decision tree comprises of three major constituents such as: nodes, arcs and leaves. Every node is designated with a feature value and every leaf is designated with a class or category. Further, a decision tree can be passed down for classifying a data point by initiating at the root of the corresponding tree and gripping through it till a leaf node is arrived. The leaf node thereafter affords the allotment of data points.

e. Fuzzy Logic: Fuzzy logic represents a modelling of ambiguity of "natural language" and builds extended patterns for intrusion disclosure. Two major active research directions in fuzzy logic involve: (a) approaches with learning and robust competence with the aim of framing fuzzy rules, (b) to figure out the readability of few machine learning strategies like Support Vector Machine (SVM) or Hidden Markov Model (HMM). The adoption of fuzzy logic prepares it apparent the abrupt estrangement of regularity and irregularity.

f. Artificial Immune System (AIS): AIS has sapped compelling intentness as a strong source of exaltation for new strategies for solving convoluted computational problems. AIS has peculiarities like: highly adaptive, distributed,

and self-organizing. AIS needs both engineering and immunology for learning from each other by functioning in interdisciplinary way.

g. **Soft Computing in Malware Detection:** Soft computing strategies are popularly employed in malware detection. These methods have the capability of learning from previous incidences and segregate the normal as well as abnormal features. Basically, soft computing is used for anomaly detection, misuse detection, as well hybrid detection. F-sign is framed for automatic extraction of signature from malware files.

III. Neural Network

Neural Networks are basically the simplified representations of biological neurons. It is basically a parallel distributed framework consisting of neuro computing parts that are capable of attaining knowledge and performing needful action at the time of want. Similarly, Artificial Neural Network (ANN) comprises of processing entities known as artificial neurons that is mostly encouraged by structure of cerebral cortex of the biological brain. The biological brain contains highly interconnected network of neurons. Each biological neuron comprises of cell body known as Soma. Various axon terminals are present that are connected through synapses to dendrites of other neurons and these are basically the interface through which neurons interact with their neighbours. If the entire input signals coming to one neuron exceeds some particular threshold value, the neurons send an action potential at axon hillock and transfers the electrical signal along the axon. Basically, such biological networks motivated the conception of Artificial Neural Network (ANN). Further, the work depicted in [3] considers a Dynamic Bayesian Network (DBN) identification approach based on Minimum Description Length for identifying and locating various functional connections that are typical in Synthetic Biological Networks. Likewise, the work done in [4] discusses the Zeroing Neural Networks (ZNN) as a type of network that are dedicated finding the zeros of equation. Similarly, the work presented in [5] discusses a review of randomized algorithms for training of the neural networks. Similarly, the work presented in [6] proffers Neural Networks with Random Weights (NNRW), where the weights between the hidden layer and input layer are randomly determined while the weights between the output layer and hidden layer are attained mathematically. Moreover, the work done in [7] summarizes various applications of artificial intelligence strategies in different aspects of business administration.

IV. . Fuzzy Logic

Fuzzy logic is basically the type of logic where the truth values of variables lies between 0 to 1. I It basically deals with the concept of partial truth, where the true value ranges from completely true to completely false [8]. The work presented in [9] introduces fuzzy rough sets as a new-fangled solution to the problem of handling imprecise input information in the tasks of classification. The proposed method in [9] is proved as an indispensable way to non-singleton fuzzification approach. The work presented in [10] demonstrates a fuzzy topology as an instance of general fuzzification process for topological categories. Similarly, the work presented in [11] justifies that a set-valued dynamic system is sensitively dependent on initial conditions if its g-fuzzification is sensitively dependent on initial conditions under consideration. The work presented in [12] discusses elaboratively on one fuzzification of Choquet integral where the integration outcomes along with the integrand result in fuzzy numbers based on the principle of extension. The concept of fuzzy logic is based on the idea of relative graded membership that is inspired through the process of cognition and human perception [13] that is imprecise, vague, partially true as well as uncertain. Furthern fuzzy logic can be employed in the development of intelligent systems for identification, decision making, optimization and control. On the contrary, defuzzification is defined as a process of generating a quantifiable outcome in crisp logic [14], where fuzzy sets and the concerned membership degrees are given. Normally, defuzzification is employed in case of fuzzy control systems [14]. Particularly, defuzzification refers to the interpretation of the membership degrees of the fuzzy sets into a particular decision or a real value.

V. Genetic Algorithm

Genetic algorithm is basically a meta heuristic algorithm triggered by the phenomenon of natural selection pertaining to the larger class of Evolutionary Algorithms (EAs). Such algorithms are generally used for producing high quality solutions for optimization as well as searching problems [15]. The approach presented in [16] depicts a novel Generational Genetic Algorithm (GGA) which includes effective initialization strategies as well as search operators under the guidance of modularity. Fundamentally, genetic algorithms are inspired by Darwins's theory of evolution, It basically employs an evolutionary process. The algorithm initiates with a set of solutions indicated by chromosomes known as population. Further, the chromosomes from one populations are taken and employed for generating a new population that are normally better than the old ones. The solutions that are then

chosen to form new solutions are determined as per their fitness. The more suitable the solution is, the greater is the probability to reproduce. Such process gets repeated till some condition gets gratified.

VI. Evolutionary Computing

Evolutionary computing represents a family of algorithms for attaining global optimization triggered by biological evolution [18]. They represent a family of populations based on trial and error approach. In this context, an initial set of candidate solutions are generated and iteratively updated and every newly formed generation is produced by stochastically eliminating lesser intended solutions and demonstrating smaller random changes. Evolutionary computation strategies normally generate highly optimized solutions for wider range of problems. The work done in [19] reviews research papers concerning evolutionary computing methods concerned to analytical tasks under single and multi-objective optimization tasks. The work discussed in [20] exploits membrane computing for supporting the dual parallel computation. Further, an architecture is presented in the same paper that solves the virtual network embedding predicament through the evolutionary membrane computing.

VII. Conclusions

In current article, we have discussed about various aspects of soft computing involving neural network, fuzzy computing, evolutionary computing etc. Further, the various application domains of soft computing have been elaboratively discussed. In toto, the paper brings forward the comprehensive well-focussed reviews of soft computing paradigms while analysing various application prospects.

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