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APPLICATIONS OF SOFT COMPUTING IN VARIOUS AREAS

Menal Dahiya
Department of Computer Science, Maharaja Surajmal Institute,
C-4, Janakpuri, Delhi

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ABSTRACT

Soft Computing is the study of science of reasoning, thinking, analyzing and detecting that correlates the real world problems to the biological inspired methods. Soft Computing is the big motivation behind the idea of conceptual intelligence in machines. As such, it is an extension of heuristics and solve complex problems that too difficult to model mathematically. Soft Computing is tolerant of impression; uncertainty and approximation which is differ from hand computing. Soft Computing enumerates techniques like ANN, Evolutionary computing, Fuzzy Logic and statistics, they are advantageous and separately applied techniques but when used together solve complex problems very easily. This paper highlights various soft computing techniques and emerging fields of soft computing where they successfully applied.

KEYWORDS: Artificial Neural Network; Evolutionary Computing; Fuzzy Logic; Soft Computing.

INTRODUCTION

There are numerous problems in the real world that we have to deal daily and tried to solve logically & theoretically but failed in solving due to their requirements of huge resources and computation time. These problems work very systematically and coherently when solved by naturally method, a near optimal solution is sometimes enough in most practical situations. So these types of situations could be handled by biologically inspired methods called soft computing.

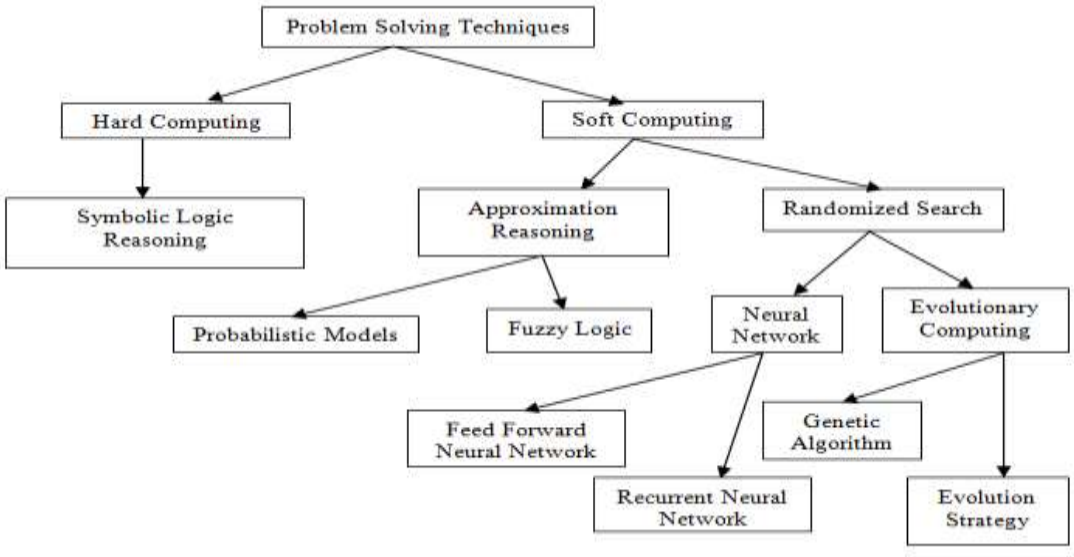

Fig.1: Overview of Problem Solving Techniques.

Soft computing is a series of techniques that could be dealt with in the same way as humans deal with them. The idea of soft computing is first coined by Professor Lotfi Zadeh [1], who developed the concept of Fuzzy Logic. Soft computing is based on knowledge, common sense, and reasoning and on natural as well as artificial ideas.

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The main coverage of Soft Computing is Genetic Algorithm, Fuzzy Logic, and Artificial Neural Network. These disciplines are applied on the problem individually or as hybrids of techniques. Soft computing comes under the family of collection of computing techniques or computational intelligence. Two types of problem solving technologies are Hard Computing and Soft Computing. Hard computing deals with the precise model where exact and accurate solutions are obtained [2]. Soft computing is based on approximate models. It is different from hard computing i.e. conventional computing which involves symbolic logic reasoning and totally passed on numerical modeling and search. Figure 1 shows both problem solving techniques with types [3]. On the other side soft computing is purely constructing on human mind. It is a tolerance of uncertainty, unpredictability, fuzziness approximation, low solution cost and better rapport with reality. It refers to collection of many computing techniques like in engineering areas such as Aircraft, mobile, robots, cooling and heating, power electronics etc [4].

SOFT COMPUTING

Soft computing is a term, entering general circulation in 1994. According to L. A. Zadeh, the objective of soft computing is tolerant of uncertainty, lack of accuracy, approximation and partial truth to achieve low solution cost with better result [1]. Soft computing primary goal is to follow the human mind or match up the reasoning and thinking behavior of human mind as closely as possible. Soft computing combines different techniques together to form hybrid technology in fact, would inherit all the advantages, features of single soft computing components.

Fuzy Logic (FL)

It is organized method that deals with imprecise data and these data are known as fuzzy sets. The concept of fuzzy logic was coined by Lotfi Zadeh, Professor at the University of California at Berkeley. Fuzzy logic processes data by allowing partial set membership rather than non-membership. Earlier systems were designed only to input precise and accurate data. Therefore Zadeh designed systems that can be performed even with imprecise data and noisy data [5]. Fuzzy logic models the human mind using fuzzy controller for providing an approximate but effective mechanisms. Fuzzy logic is a superset of conventional Boolean Logic (BL). Fuzzy logic is similar to Boolean logic when all fuzzy memberships are restricted to 0 and 1. Fuzzy logic is differing from BL as it is more likely based on human thinking. As there is no standard method to develop the knowledge base for making rules, a mapping function is described i.e. membership function which minimize the output error. Expert systems are common use of fuzzy logic [6]. They are used in many fields like Pattern recognition, Data analysis, Operation research, Linear & non-linear control etc.

Evolutionary Computing

Evolutionary computing is also known as genetic algorithm as the evolutionary behavior of living creatures. It is an optimization and computer based search methodology that uses computational models of evolutionary process such as natural selection, reproduction and survival of the fittest. This method is very effective in finding optimal solution to a wide variety of problems [7]. It simply implies generate-and-test technique that can identify and exploit regularities in the environment. Genetic algorithm can optimize both discrete and continuous variable and it doesn't require derivative information. Genetic algorithms are implemented iteratively on the set of coded solution with three general operators: reproduction, crossover, mutation [8]. For every iteration, they use objective function and probabilities transition rules.

Artificial Neural Network

ANNs are non-algorithmic approach for processing which inspired by biological neurons systems. An ANN is composed of large number of interconnected processing elements called neurons, that works together to solve particular problem. ANN is designed for specific application such as pattern recognition through learning process like people learn by example. Components of neuron processing elements called nodes, which are associated with a weight, which controls the behavior of trained ANN [9]. Neural network have ability to derive meaning data from imprecise data, could be applied to extract patterns and predict trends that are too difficult for humans. Neural network are organized in layers and layers made up of number of interconnected nodes which contain "activation functions". Most of ANNs apply learning rule which helps in modifying the weights accordingly to input patterns [3].

APPLICATION AREAS OF SOFT COMPUTING

Soft computing is a promising tool that can provide problem resolution methods, optimization approximation methods including search methods. Soft computing techniques are used in different fields such as Wireless

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Communication, Data Mining, Communication System, Transportation, Healthcare, Robotics, Consumer Appliances etc.

Wireless Communication

Applications of soft computing in wireless communication covers broad area of resource allocation, Handoffs, networking optimization, power control, prediction etc. Artificial Neural Network and Fuzzy Logic methods of soft computing involves in resource allocation i.e. by using ANN technique, bandwidth allocation schemes utilization for mobile networks maximizes and minimizes bandwidth allocation for individuals [10]. An algorithm based system can be used to achieve fast and reliable solutions for dynamic resource allocation. Evolutionary Computing method of Soft Computing uses a soft computing algorithm to achieve power control in WWAN. The algorithm helps in reducing mobile terminal power consumption and increasing the cellular network capacity. Security in WLAN is also enhanced by using Artificial Neural Network and Fuzzy Logic methods. DoS and MITM attacks are common in wireless local area network [11]. A Soft Computing is designed to minimize the authentication frauds and detection delays.

Communication Systems

In Communication Systems Soft Computing can be effectively applied to obtain the solutions that have not been able to solve by Hard Computing. Artificial Neural Network and Fuzzy Logic combined together and give Neuro-Fuzzy approaches that used for data compression and for equalizer [12]. Various researchers proposed their views and implemented different Soft Computing techniques.

Consumer Appliances

The field of consumer appliances activities is associated to practical product development. There is a huge scope of fuzzy logic, neural networks which have already brought artificial intelligence in home appliances. More recently, evolutionary computation has also shown remarkable identity in this field. These techniques are used for various applications like washing machines, heaters, refrigerators, microwaves and many more.

Robotics

Robotics is an emerging field which is based on human thinking and behavior. Fuzzy Logic and Expert System techniques integrate in a way to develop useful real world applications. Also neuro-fuzzy system hybridization is the representation of fuzzy logic with learning capabilities. Neurofuzzy approach learns obstacle avoidance and wall-following behavior on a small size robot [13]. Present day intelligence is considered to be interactive information processing among humans and artificial objects. Intelligence is human like information processing and adaptation to environment by learning, evolution and prediction [14]. Soft Computing is widely used in this field.

Transportation

Soft Computing is applicable in constructing intelligent vehicles and provide efficient environment to each other i.e. to machines and drivers. Intelligent vehicle control requires recognition of the driving environment and planning of driving that is easily acceptable for drivers. The field of transportation deals with passengers, logistics operations, fault diagnosis etc. Fuzzy Logic and Evolutionary Computing are often used in elevator control systems.

Healthcare

Health care environment is very much reliant to on computer technology. With the advancement in computer technology, the use of Soft Computing methods provide better and advance aids that assists the physician in many cases, rapid identification of diseases and diagnosis in real time. Soft Computing techniques are used by various medical applications such as Medical Image Registration Using Genetic Algorithm, Machine Learning techniques to solve prognostic problems in medical domain, Artificial Neural Networks in diagnosing cancer and Fuzzy Logic in various diseases [15].

Data Mining

Data Mining is a form of knowledge discovery used for solving problems in a particular area. Data sets may be gathered and implemented collectively for purposes others that those for which they were originally created. The three basic methodologies of Soft Computing are widely applied in the data mining. Fuzzy Logic plays important role in modeling different functions of data mining.

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Clustering

Data Mining extracts information from large database in order to reveal useful information for decision making by a user. Fuzzy sets focused on a specified search and help to discover dependencies between the data in qualitative format. Various fuzzy clustering algorithms for mining telecommunications customer and business customer market share.

Association Rule

Association rules are the describing rules that associate relationship among different attributes. The use of fuzzy technique has been considered the key features of data mining systems. Neural Network contributes towards the data mining from rule extraction and clustering. Neural Network has also been used for a variety of classification and regression tasks [16]. In addition, combination of neural network and fuzzy logic is one of the most popular hybridization that integrates the merits of neural and fuzzy approaches.

CONCLUSION

The proliferation of soft computing techniques is remarkable in every field of physics, material sciences, computer chemistry, statistics, etc. This paper outlined various soft computing techniques and different applications areas where these techniques have been applied. The robustness, cost effectiveness, simplicity are the few characteristics of the soft computing. Fuzzy logic is very much suitable for tracking imprecision and uncertainty. Whereas ANN offers good prediction capabilities due to its generalization and learning features. On the other hand, Evolutionary computing techniques have been shown to be very much applicable in optimization problems. As the development of soft computing flourish day by day, the application areas will also be felt increasing in coming years. Soft computing based products are increasing day by day. Majority of such products uses any of the soft computing technique inside the sub systems which are not known to end user. The gist is that, soft computing techniques will become common to various applications and has ability to deal with imprecise problems.

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