



APPLICATION OF SOFT COMPUTING TECHNIQUES OVER HARD COMPUTING TECHNIQUES: A SURVEY

Santanu Chakraborty*

*Department of Computer Application, Sikkim Manipal University, Gangtok, Sikkim, India

Ramesh Kumar Sharma², Pushpa Tewari³

^{2,3}Department of Computer Science, Gurunanak College, Dhanbad, Jharkhand, India

*email: ksantanu28@gmail.com

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Abstract. Soft computing is the fusion of different constituent elements. The main aim of this fusion to solve real-world problems, which are not solve by traditional approach that is hard computing. Actually, in our daily life maximum problem having uncertainty and vagueness information. So hard computing fail to solve this problems, because it give exact solution. To overcome this situation soft computing techniques plays a vital role, because it has capability to deal with uncertainty and vagueness and produce approximate result. This paper focuses on application of soft computing techniques over hard computing techniques.

Keyword. Hard computing; Soft computing; Hybrid computing; Industrial applications.

INTRODUCTION

In modern era, several types of problems are increases rapidly in the applications of science and engineering (e.g. computer science, electrical engineering, communication system, transportation, management etc.). These problems are unsolvable due to complex nature by the help of traditional approaches (i.e. hard computing) [1]. Because these problems are contain many uncertainty and vagueness information. So, it should be solve by theoretically or logically.

All hard computing approaches modelled with accurate solution which are achieved very quickly. Resultant solution having exactness and full truth. But when these problems comes with incomplete knowledge than its fails to achieve the goal. Thus, soft computing techniques are easily applied in this situation with its variety of components. The research community has investigated and explored this techniques over traditional techniques. However, recently, there have been numerous efforts toward making use of soft computing techniques as engineering problems and the optimization solver for science, based on their distinctive characteristics and appropriate use for imprecision, uncertainty, partial truth, and approximation scenarios to achieve practicability and robustness as a low-cost solution, e.g., evolutionary and swarm intelligence-based algorithms as well as bio-inspired computation, which are applicable for real-world scenarios.

MOTIVATION

Several surveys have been illustrated in last few decade. Each survey deal with individual area either soft computing technique or any one constituent component of soft computing. No one describe that what are relation between soft computing with hard computing. In which area hard computing is fails to achieve the goal and soft computing deal that goal. This paper highlight, some general concept of soft computing as well as hard computing and relation between them. This paper also discusses few situations and related works where hard computing is fail and soft computing is achieve this goal.

CONTRIBUTIONS

In this survey paper, we illustrate application of soft computing techniques over hard computing techniques. The key contributions of this paper are as follows:

- It gives general concept of soft computing as well as hard computing.
- It also gives basic components of soft computing and hard computing.
- It illustrates the situations where hard computing is fails to achieve the goal and soft computing take place.
- Some literature reviews are discussed to elaborate the concept of soft computing.

ORGANIZATION OF THE PAPER

The remainder of this paper is organized as follows. In Section 2, the literature reviews are presented. In Section 3 and Section 4, offers a general ideas of hard computing and soft computing technique respectively. Section 5



illustrates difference between hard computing and soft computing techniques. Section 6 illustrates several innovations in different areas based on soft computing techniques. Finally, conclusion and directions for future scope are outlined in Section 7.

LITERATURE REVIEW

In this section, there are two types proposals have been discussed: hard computing based proposal and soft computing based proposal. Short explanation of these proposals are given below:

HARD COMPUTING BASED PROPOSALS

Houssaini et al. [2] proposed an attack detection scheme using multivariate control chart which is currently exist in industrial management. The proposed scheme does not require any modification to the 802.11 standard. It easily helps to detect greedy nodes handled complicated situations due to reducing control chart.

K. Chaiyasarn [3] proposed a method to cracks detection in multi-temporal images. Basically, it involve two steps first is pre-processing step and second is crack identification step. In first preprocessing step, it usually applied to image processing techniques and in second identification step, it applying for crack modeling.

In ad-hoc network, many energy efficient and multicast routing schemes [4, 5] have been offered to achieve transmission between source and multicast groups. The main aim of this schemes, to minimize or maximize several network metrics.

Cocks [6] defined a pairing-free Identity Based Encryption (IBE) using Quadratic Residues (QR) modulo a prime composite number. It was the first IBE (though long-size ciphertext) based on quadratic residue that reduced computation cost by eliminating the bilinear pairing [7].

The above mentioned proposals are based on mathematical approach. These approaches are not considered uncertainty related to information.

SOFT COMPUTING BASED PROPOSALS

S. K. Das and S. Tripathi [8] designed a protocol that chooses an energy competency route which minimizes energy expenses of MANET by using vague set. It is mainly employed for interval based membership function where all constraint of energy competency routing (i.e. energy and distance) is differentiated with true and false membership functions.

In ad-hoc network, various soft computing based technique based multicast and multipath routing protocols [9-11] have been proposed to established path between source and destinations. The main aim of these protocol to improve several network metrics as well as reduced interference among nodes.

Das et al. [12] proposed an energy efficient routing protocol in wireless sensor network. The purpose of this protocol is design an efficient path between source and destination node. This path should having short distance and high energy. It also reduced uncertainties related to route design in wireless sensor network.

Mishra et al. [13] proposed a fuzzy set theory in grinding process including several parameters such as cross sectional area, density, and speed. These parameter are not defined precisely. This approach solve by weighted compensatory operator to get precise output.

Murmu et al. [14] proposed a hard-facing or hard-surfacing process which is used for enhancing the service life of various machine parts. The hard-faced part contains rough, irregular and wavy surface. Hence machining process is applied on them to get smooth finishing. This approach predict the surface roughness and produce good result.

Kumar et al. [15] proposed a fuzzy based energy-saving approach. In this approach, ad-hoc node select most suitable route which has enough energy and short distance with minimum number of queue length packet. It also helps to enhance the network metrics.

The above mentioned proposals are based on soft computing technique. These approaches are considered uncertainty related to information.

HARD COMPUTING TECHNIQUE

Hard computing is a conventional method. It requires a precisely stated analytical model and often a lot computation complexity. Various analytical models are useful in many cases but maximum are invalid in the case of hesitate environment. In hard computing, first problem is defined, then based on the problem

mathematical model is designed and data are collected [16]. It solve the problem by using mathematical model and collect data to get final output. If output of the final solution is valid, then model implemented in real world otherwise modify the model by remodelling and re-collection of data. The overall operation of hard computing shown is Figure. 1. The several features of hard computing are given below:

- Real-time constraints.
- Need of accuracy and precision in calculations and outcomes.
- Useful in critical systems.

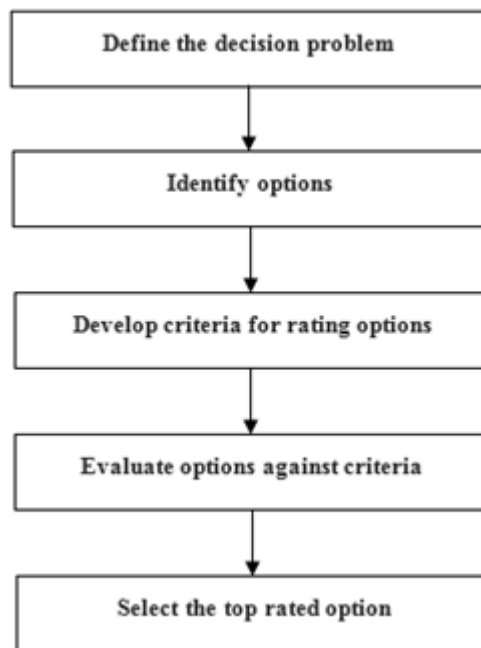


Figure 1. Overall operation of hard computing.

SOFT COMPUTING TECHNIQUE

Soft computing [17] is the fusion of some components that make possible to solve real world problems which are not modelled or too complex for mathematical modelling. Its ambition is to exploit the tolerance for some hazier elements given below.

Approximation: It indicates the features that are similar to the real ones but not the same.

Uncertainty: It indicates a situation which involves imperfect and/or unknown information.

Imprecision: It indicates the features that quantities are not same as real ones but close to them.

Partial truth: It indicates close to truth but not exact truth. Its value between true and false.

The controlling theory of soft computing is to use these tolerances to accomplish, robustness tractability and low solution cost. It based of natural as well as artificial ideas. It is referred as a computational intelligence was originally coined by Zadeh [18]. It gives low solution cost, and better understanding with reality.

CONSTITUENT ELEMENTS OF SOFT COMPUTING

The basic components of soft computing are Fuzzy Logic (FL), Genetic Algorithm (GA), Artificial Neural Network (ANN) and its inherent component (e.g. FL-GA, FL-ANN, ANN-GA) shown in Figure. 2. The inherent component mark by red circle in Figure. 2. Each and every element has features shown in Figure. 3. Some of the components described below.

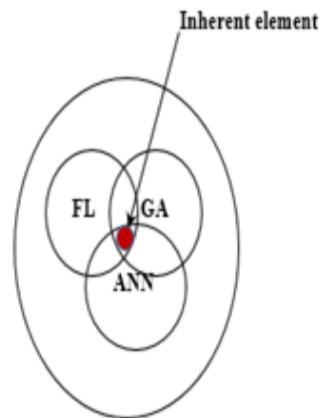


Figure 2. Basic components of soft computing.

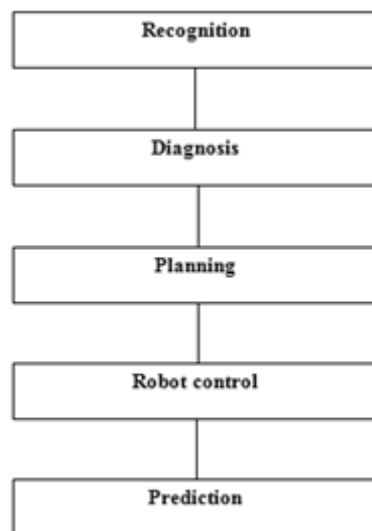


Figure 3. Features of soft computing.

FUZZY LOGIC

Fuzzy logic [19, 20] is a part of soft computing; which became mathematical discipline to express human reasoning in rigorous mathematical notation. It is a multi-valued logic that allows intermediate values to be defined between conventional evaluations like true/false, yes/no, high/low, small/big, short/long etc. Notions like rather long or very long, small or very small can be formulated processed by mathematically. It provides a simple way to arrive at definite conclusion based upon vague, ambiguous, imprecise, noisy, or missing input information.

NEURAL NETWORK

Neural network is a collection of simple processing units which communicate by sending signals to each other over a large number of weighted connections network based on biological neurons.

GENETIC ALGORITHM

Genetic algorithm is a heuristic search and optimization technique that imitate the process of natural evolution. It simulating evolution of species by the helps of natural selection and select best element and discard the rest part.

MACHINE LEARNING

Machine learning indicates to the changes in systems that perform tasks associated with artificial intelligence techniques. It consists some phases shown in Figure. 4. The changes might be either in existing system or newly designed system.

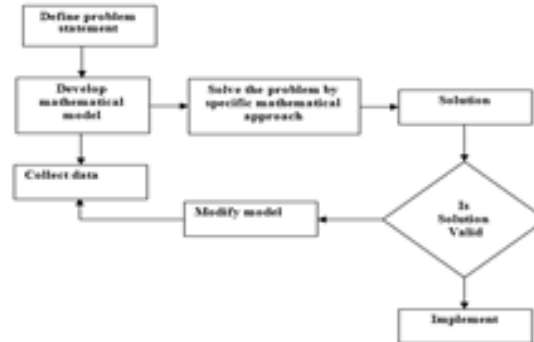


Figure 4. Some phases of machine learning.

DIFFERENCE BETWEEN HARD COMPUTING AND SOFT COMPUTING TECHNIQUES

Hard computing based on precision and accuracy whereas soft computing based on approximation. In hard computing, imprecision and uncertainty are undesirable properties, but in soft computing the tolerance for imprecision and uncertainty is exploited to achieve tractability, lower cost solution. There are various dissimilarities between them due to contradiction natures. But some solutions are depend on the traditional approach (i.e. hard computing technique) approach as well as modern (soft computing technique) approach. So, in this situation hybrid computing play vial role. Figure. 5 depict relation between hard computing and soft computing techniques and Table 1 illustrates the differences between them.

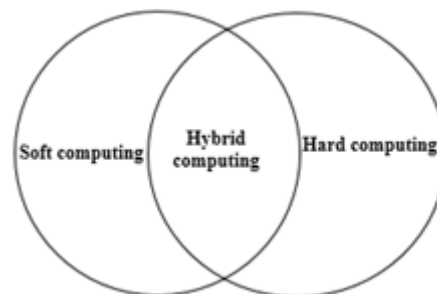


Figure 5. Relation between hard computing and soft computing.

Table 1. Difference between hard computing and soft computing

Sl. no.	Hard computing	Soft computing
1	Real time constraints	Artificial constraints
2	Need of accuracy and precision	Need of robustness rather than accuracy
3	It requires, programs to be written	It requires, its own programs
4	It follows two-valued logic	It follows multi-valued logic
5	It requires exact input data	It requires inexact input data
6	It is strictly sequential in computation	It is parallel in computations
7	It produce precise answers	It produce approximate answers
8	It is deterministic	It is non-deterministic

SEVERAL INNOVATIONS IN DIFFERENT AREAS BASED ON SOFT COMPUTING TECHNIQUES

Innovation is the development of new principles through explanations that meet new requirements, inarticulate needs, and market needs. This is accomplished through more effective products, processes, services, technologies, or ideas that are readily available to markets, governments, and society. In daily life, human directly or indirectly attached with different types e-commerce [21] services such as Consumer to Consumer (C2C), Consumer to Business (C2B), Business to Business (B2B), Business to Consumer (B2C) etc. and face different uncertainty problems. In last few decades, soft computing play key role of innovation in various areas. The fusion of soft computing techniques increases rapidly. It has been used considerably in human-related fields (e.g. aircraft, cloud computing, robotics, image processing, e-commerce etc.). In the last two years, several components of soft computing used in numerous applications to solve specific problem. Short descriptions given in Table 2. Some of the techniques are old and some of the techniques are new (e.g. Chaos theory, Honeybees, Semantic interoperability, Singular value decomposition, Lagrangian particle mode, Multi-step-ahead prediction etc.).

Table 2. Summary of applications of soft computing in different area

Sl. no.	Application areas	SC Components	References
1	Aircraft and air traffic Particle swarm optimization Lagrangian particle mode	Multi-objective optimization	[22], [23], [24]
2	Cloud computing Fuzzy logic Ant colony optimization	Intelligent system	[25], [26], [27]
3	Cooling and Heating Mixed-integer optimization	Fuzzy logic	[28], [29], [30], [31]
4	Data communications & Security in wireless	Fuzzy logic, Meta-heuristic Harmony search algorithm Ant Colony Optimization Swarm Intelligence Artificial Bee Colony Honeybees, Bio-inspired	[32], [33], [34], [35]
5	Fault Diagnosis	Fuzzy logic Multi-step-ahead prediction Nature-inspired optimization Artificial neural networks Wavelet packet decomposition Principal component analysis Singular value decomposition Machine learning method	[36], [37], [38], [39], [40]
6	Manufacturing Technologies	Computational intelligence Feature extraction Multi-agent system Bio-composite technique	[41], [42], [43], [44]
7	Robot	Fuzzy logic Genetic algorithm Particle swarm optimization Adaptive neuro fuzzy inference system Evolutionary algorithm	[45], [46], [47], [48]
8	Image processing	Feature extraction Chaos theory Artificial neural network Geometric parameters	[49], [50], [51]
9	Ontology	Semantics approach Fuzzy domain ontology Support vector machine Semantic interoperability	[52], [53], [54]



10	Spacecraft	Neuro-fuzzy network Fuzzy logic system Approximate based reasoning Multi-objective optimization	[55], [56], [57]
11	Unicast and Multicast	Fuzzy logic with Multi-value	[58], [59]

CONCLUSION AND FUTURE SCOPE

The effective applications of soft computing over hard computing suggest that it has important role in engineering and science. It represents a significant paradigm in modern era. It gives greater impact in present as well as future. Its integrated components inspires to deals with uncertainty and vagueness information. It can be extended with computing not only from human thinking aspects but also from artificial intelligence techniques. It is already a major area of academic research but nowadays it becomes academic as well as industrial. It much more effective in a real-world problems which are not evaluated by the helps of traditional hard computing techniques. It will gives greater impact in the coming years in the fields of science and engineering. Future scope include, to select any real world problem and solve with the help of soft computing techniques. Then implement it by the help of simulator and wish to compare the analytical results with simulation results.

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