A STUDY ON SOFT COMPUTING AND APPLICATIONS

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Abstract : Soft computing is a growing set of approaches that strive to provide resilience, tractability, and cheap cost by leveraging tolerance for imprecision uncertainty and partial truth. It may appear to be a highly appealing alternative to a totally digital system, but there are several traps in store for researchers attempting to implement this new and intriguing technology. Software computing offers an appealing way to represent ambiguity in human thought with real-world uncertainty. The main approaches of soft computing include fuzzy logic, neural networks, and evolutionary computation. Both neural networks and fuzzy systems can be utilised for nonlinear processing.

Index Terms—(Soft computing, Fuzzy Logic, genetic algorithms, neural networks, expert systems)

I. INTRODUCTION

One of the issues with traditional control systems is that complex plants are difficult to regulate using present approaches since they cannot be effectively described by mathematical models. Soft computing, on the other hand, solves difficult problems using partial truth, uncertainty, and approximation. "The guiding idea of soft computing is to utilise the tolerance for imprecision, ambiguity, and partial truth to achieve tractability, resilience, cheap solution cost, and improved rapport with reality," said Dr. Zadeh1, a pioneer of fuzzy logic. Intelligent control, nonlinear programming, optimization, and decision-making are some of its characteristics.

Traditional approaches, for example, cannot easily regulate and stabilise numerous nonlinear and time-variant plants with considerable time delays. The lack of a realistic model that describes the plant is one of the causes behind this challenge. Soft computing is proving to be a cost-effective method of controlling such sophisticated machines. Soft computing is a branch of computer science characterised by the employment of approximate solutions to computationally difficult issues, such as the solution of NP-complete problems, for which a precise solution cannot be found in polynomial time. Soft computing, unlike hard computing, accepts imprecision, uncertainty, partial truth, and approximations. In effect, the human mind serves as a role model for soft computing. Fuzzy logic, genetic algorithms, artificial neural networks, machine learning, and expert systems are examples of soft computing techniques. Although soft computing theory and techniques were initially introduced in the 1980s, they have since grown in importance as a research and study topic in automatic control engineering. Soft computing techniques are currently successfully applied in a wide range of home, commercial, and industrial applications. With the introduction of low-cost, high-performance digital processors and the lower cost of memory chips, it is apparent that soft computing techniques and application areas will continue to grow. This paper provides an overview of the present status of soft computing approaches, as well as the benefits and drawbacks of soft computing, as well as their significance. Soft computing (SC) solutions are unpredictably unreliable, and range from 0 to 1. In the early 1990s, Soft Computing became a recognised field of study in Computer Science. Only relatively simple systems could be modelled and precisely analysed using previous computer methodologies. Machine learning techniques are used in more sophisticated systems appearing in biology, medicine, the humanities, management sciences, and other domains. Evolutionary and swarm intelligence-based algorithms, as well as bio-inspired computation, have become popular in recent years. Between soft computing and possibility, there are significant contrasts. When we don't have enough knowledge to solve a problem, we use possibility, but when we don't have enough information about the problem itself, we use soft computing.

Fig 1.1

II. WHAT IS SOFT COMPUTING?

Soft computing varies from traditional (hard) computing in that it tolerates imprecision, uncertainty, partial truth, and approximation, whereas hard computing does not. In effect, the human mind serves as a role model for soft computing. To achieve tractability, resilience, and cheap solution cost, soft computing relies on the tolerance for imprecision, uncertainty, partial truth, and approximation. Many earlier influences may be found in the core ideas underlying soft computing in its current form, including Zadeh's 1965 study on fuzzy sets, the 1973 paper on the analysis of complex systems and decision processes, and the 1979 report (1981 paper) on possibility theory and soft data analysis. Soft computing was eventually expanded to include neural computing and genetic computing.

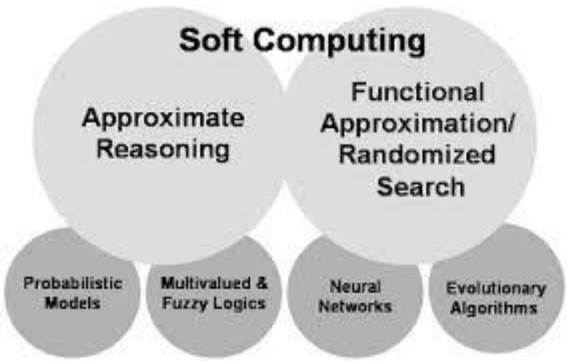

Fig 1.2

Premises of soft computing:

- The real world problems are pervasively imprecise and uncertain
- Precision and certainty carry a cost

Principles of soft computing:

Exploit the tolerance for imprecision, uncertainty, partial truth, and approximation to achieve tractability, robustness and low solution cost.

Implications of soft computing:

● Soft computing employs NN, SVM, FL etc , in a complementary rather than a competitive way.

● What has become known as "neuro fuzzy systems" is an example of a particularly effective combination.

● Consumer products ranging from air conditioners and washing machines to photocopiers, camcorders, and a variety of industrial applications are increasingly using such systems.

Unique Property of Soft Computing:

● Learning from experimental data

● Soft computing techniques derive their power of generalization from approximating or interpolating to produce outputs from previously unseen inputs by using outputs from previous learned inputs

● Generalization is usually done in a high dimensional space.

III. CONSTITUENTS OF SOFT COMPUTING

The principal constituents of Soft Computing (SC):

1. Fuzzy logic (FL)
2. Evolutionary computing (EC)
3. Neural Networks (NN)
4. Probabilistic Reasoning (PR),

1. Fuzzy Logic : L. Zadeh created fuzzy logic in 1965 as a multi-valued logic. Between the two standard evaluations, Fuzzy Logic allows for the definition of intermediate values. Fuzzy logic is a modification of traditional (Boolean) logic that has been extended to handle the concept of partial truth - truth values that fall between "totally true" and "absolutely false." Fuzzy logic is an inference process that allows knowledge-based systems to use approximate human reasoning capabilities.

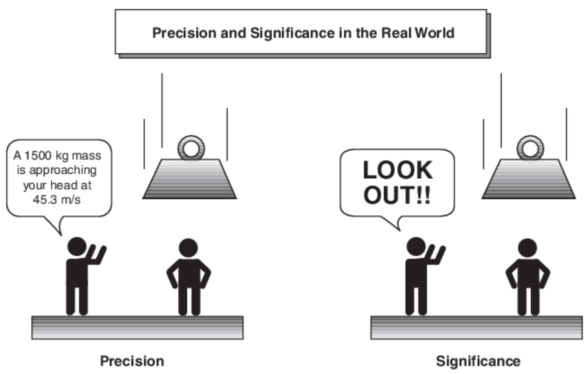

Fig 1.3

The use of fuzzy logic to translate an input space to an output space is quite convenient. The first step in any project is to map input to output. Think about the following scenarios:

- A fuzzy logic system can calculate the appropriate tip based on information about how wonderful your restaurant service was.
- With your specification of how hot you want the water, a fuzzy logic system can adjust the faucet valve to the right setting.
- A fuzzy logic system can focus the lens for you using information about how far away the subject of your shot is.
- With information about how fast the car is going and how hard the motor is working, a fuzzy logic system can shift gears for you.

2. Evaluationary computing : The term "evolutionary computing" refers to a group of problem-solving methodologies based on biological evolution principles such as natural selection and genetic inheritance. These methods are rapidly being used to solve a wide range of challenges, from practical applications in industry and commerce to cutting-edge scientific study.

3. Nerual Networks : A neural network is a massively parallel distributed processing system made up of densely interconnected neural computing pieces that have the ability to learn and so gain knowledge and make it available for use. It is a simplified model of a biological neuron system.

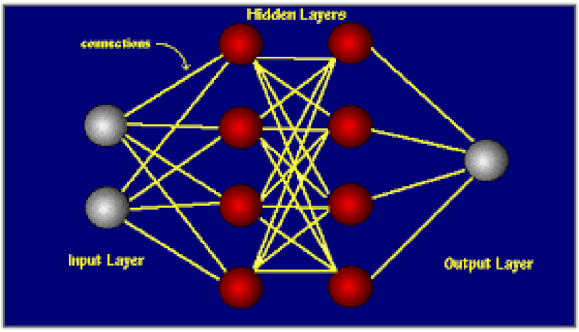

Fig 1.4

4. Probabilistics Reasoning :

The goal of probabilistic logic (also known as probability logic or probabilistic reasoning) is to combine probability theory's ability to handle uncertainty with deductive logic's ability to exploit structure. Probabilistic reasoning is similar to fuzzy reasoning in that it considers uncertainty rather than fuzziness as the idea of approximation that is applicable. The Bayesian method is widely utilised.

IV. DIFFERENCE BETWEEN SOFT COMPUTING AND HARD COMPUTING

- Hard computing, or traditional computing, necessitates a properly specified analytical model and, in many cases, a significant amount of processing time. Soft computing varies from traditional (hard) computing in that it tolerates imprecision, uncertainty, partial truth, and approximation, whereas hard computing does not. In effect, the human mind serves as a role model for soft computing.

Binary logic, crisp systems, numerical analysis, and crisp software are used in hard computing, whereas fuzzy logic, neural nets, and probabilistic reasoning are used in soft computing.

Hard computing is characterised by precision and categorization, while soft computing is characterised by approximation and dispositionality. Although imprecision and uncertainty are undesirable features in hard computing, tolerance for them is used in soft computing to promote tractability, cheaper costs, a high Machine Intelligence Quotient (MIQ), and communication economy.

- Hard computing requires programs to be written; soft computing can evolve its own programs
- Hard computing uses two-valued logic; soft computing can use multivalued or fuzzy logic
- Hard computing requires exact input data; soft computing can deal with ambiguous and noisy data
- Hard computing is strictly sequential; soft computing allows parallel computations
- Hard computing produces precise answers; soft computing can yield approximate answers.

V. APPLICATIONS OF SOFT COMPUTING

1.Vechicle Control : Fuzzy algorithms are being used to control braking and speed in a variety of subway systems, mainly in Japan and Europe. Tokyo Monorail, for example.

2.Image processing: Medical images are increasingly being employed in healthcare for diagnosis, treatment planning, and illness progression tracking. Soft computing techniques (e.g. fuzzy logic, neural networks, evolutionary algorithms), information fusion, and domain expertise are used to classify medical images.

Fig 1.5

3.Pattern Recognition : In general, pattern recognition aims to produce a reasonable answer for all potential inputs and conduct "most likely" matching of the inputs while accounting for statistical volatility. Many domains, including psychology, psychiatry, and ethology, as well as cognitive science, traffic flow, and computer science, study pattern recognition.

Fig 1.6

4. Home : In home soft computing is used in washing machine, AC and refrigerators.

5. Signal Processing: Signal processing is a branch of systems engineering, electrical engineering, and applied mathematics concerned with signal processing, signal analysis, and measurements of time-changing or spatially varying physical quantities. Sound, pictures, and sensor data, such as biological data like electrocardiograms, control system signals, telecommunication transmission signals, and many others, are examples of signals.

6. Process Control : Process control is a statistical and engineering subject that deals with the designs, methods, and algorithms for keeping a process' output within a certain range. It is widely employed in industry and allows for the mass production of continuous processes in industries such as oil refining, paper manufacture, chemicals, power plants, and a variety of others. Process control allows for automation, allowing a small team of operators to control a complex process from a central control room.

7. Computer Engineering : Computer engineering is a branch of electrical engineering and computer science that combines numerous domains to create computer systems. Instead of just software engineering or electronic engineering, computer engineers typically have expertise in electronic engineering, software design, and hardware-software integration. From the design of individual microprocessors, personal computers, and supercomputers to circuit design, computer engineers are involved in many hardware and software elements of computing. This branch of engineering is concerned not only with the operation of computer systems, but also with how they fit into the greater picture.

VI. GOALS OF SOFT COMPUTING

Soft computing's major goal is to create intelligent machines that can solve real-world issues that are either mathematically modelled or are too complex to model. Its goal is to use approximation tolerance, uncertainty tolerance, imprecision tolerance, and partial truth tolerance to attain close likeness to human decision making.

VII. IMPORTANCE OF SOFT COMPUTING

The complementarity of FL, NC, GC, and PR has a significant implication: in many circumstances, an issue can be solved more successfully by combining FL, NC, GC, and PR rather than employing them alone. What has become known as "neuro fuzzy systems" is a stunning example of a particularly powerful combination. Consumer products ranging from air conditioners and washing machines to photocopiers and camcorders are increasingly using such systems. Neuro fuzzy systems in industrial applications are less obvious but potentially more crucial. What's more, the use of soft computing approaches in both consumer and industrial systems results in systems with high MIQ (Machine Intelligence Quotient). The high MIQ of SC-based systems is largely responsible for the rapid development in the quantity and variety of soft computing applications.

VIII. ADVATAGES OF SOFT OCMPUTING

- A neural network can be an "expert" in analyzing the category of information given to it.
- Ability to learn how to do tasks basd on the data given for training or initial experience.
- Dealing with incomplete and uncertain knowledge
- Brain tumors can be detected using some soft computing tools.
- The structure of a rule-based experts system provides an effective separation of knowledge base from the interference engine.
- This allows multiple applications to be developed utilising the same expert system shell.
- Computation can be carried out in parallel.
- In some cases, it can be retained even after a major network damage.
- In future, it can also used to give spoken words an instructions for machine.

IX. FUTURE SCOPE OF SOFT COMPUTING

- Soft computing can be extended to include bio-informatics aspects.
- Fuzzy systems may be used to build more sophisticated intelligent industrial systems.
- Soft computing is very effective when it's applied to real world problems that are not able to solve by traditional hard computing.
- Soft computing enables industrial to be innovative due to the characteristics of soft computing, traceability, low cost and high machine intelligent quotient.

X. CONCLUSION

Soft computing is already a substantial topic of academic research. The notion, however, is continually growing, and new approaches, such as chaotic computing and immune networks, are now regarded to be part of SC. The number of successful soft computing-based products is growing at the same time as this methodological progress. SC is typically buried inside systems or subsystems, and the end user is unaware that soft computing technologies are utilised in control, diagnostics, pattern recognition, signal processing, and other applications. When SC is primarily used to improve the performance of traditional hard computing techniques, or perhaps to replace them, this is the situation. Soft computing, on the other hand, is particularly successful when applied to real-world situations that cannot be handled by standard hard computing. Soft computing is used in another type of goods to create unique intelligent and user-friendly features. Soft computing's essential qualities, such as tractability

(TR), high machine intelligence quotient (HMIQ), and cheap cost, enable industrial systems to be inventive (LC).

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