Fuzzy Logic and Its Application with Soft Computing

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Abstract— In this paper we are presenting about fuzzy logic and its application with soft computing. Fuzzy logic is very important part of mathematics and soft computing. Fuzzy logic is very useful for computer science. We are survey on the theoretical developments of the fuzzy theory and soft computing. Soft computing replaces the traditional time consuming and complex technique of hard computing with more intelligent processing technique.

Keywords—Fuzzy Logic; Soft Computing; Application; Computer Science; Technique;

I. INTRODUCTION

The new wave of theoretical contributions and practical applications that followed the seminal works by Zadeh has had a remarkable inspirational on numerous disciplines. Activities in soft computing have increased since the field started. They do not only focus on theoretical descriptions, but also provide a collection of real-world problems and techniques that are used to solve them. Industry has bonneted from adopting these techniques to address a variety of problems that can be seen also by the diverse range of products developed. Lately, it has been noticed that publications tend to combine the different sub-fields which seems to indicate that there are much more applications to come. Basic results linked to the development of fuzzy logic date back to Zadeh (1973) and Mamdani and Assilian (1975). Introducing a concept he called ‘Approximate Reasoning’, Zadeh successfully showed that vague logical statements enable the formation of algorithms that can use vague data to derive vague inferences. Zadeh assumed his approach would be beneficial above all in the study of complex humanistic systems. What is a fuzzy logic system? Mendel (1995) explains the concept of a fuzzy logic system-a (FLS) as follows: ‘In general a FLS is a nonlinear mapping of an input data (feature) vector into a scalar output (the vector output case decomposes in to a collection of independent multi-input/ single-output systems)’. The first fuzzy chip was reported in 1986 at A T&T Bell Lab. Since then many different approaches have been suggested. Depending on the design techniques employed they are classified into two groups: digital and analog. The digital approach originated from Togai and Watanabe’s work and resulted in some useful chips. Generally a digital fuzzy system is either a fuzzy (co-)processor or a digital ASIC, which contains logic circuits to compute the fuzzy algorithm, memories to store fuzzy rules, and generators or look-up tables for membership functions of the input and output variables. Compared to its analog counterpart, the digital approach has greater flexibility, easier design automation, and good compatibility with other digital systems. However, most of the digital systems require A/D and D/A converters to communicate with sensors and/or actuators. Furthermore, the digital systems are more complex and need larger chip area, e.g. the synthesis of a 4-bit maximum operation in results in a CMOS unit of nearly 100 transistors.

II. WHY FUZZY LOGIC?

Fuzzy logic is an approach to computing based on "degrees of truth" rather than the usual "true or false" (1 or 0) Boolean logic on which the modern computer is based. Fuzzy logic deals with uncertainty in engineering by attaching degrees of certainty to the answer to a logical question. Why
should this be useful? The answer is commercial and practical. Commercially, fuzzy logic has been used with great success to control machines and consumer products. In the right applications fuzzy logic systems are simple to design, and can be understood and implemented by non-specialists in control theory. In most cases someone with a intermediate technical background can design a fuzzy logic controller. The control system will not be optimal but it can be acceptable. Control engineers also use it in applications where the on-board computing is very limited and adequate control is enough. Fuzzy logic is not the answer to all technical problems, but for control problems where simplicity and speed of implementation is important then fuzzy logic is a strong candidate.

Fuzzy logic seems closer to the way our brains work. We aggregate data and form a number of partial truths which we aggregate further into higher truths which in turn, when certain thresholds are exceeded, cause certain further results such as motor reaction. A similar kind of process is used in neural networks, expert systems and other artificial intelligence applications. Fuzzy logic is essential to the development of human-like capabilities for AI, sometimes referred to as artificial general intelligence: the representation of generalized human cognitive abilities in software so that, faced with an unfamiliar task, the AI system could find a solution.

III. FUZZY LOGIC APPLICATION

The new wave of theoretical contributions and practical applications that followed the seminal works by Zadeh has had a remarkable inspirational effect on numerous disciplines. Activities in soft computing have increased since the field started. They do not only focus on theoretical descriptions, but also provide a collection of real-world problems and techniques that are used to solve them. Industry has benefitted from adopting these techniques to address a variety of problems that can be seen also by the diverse range of products developed. Lately, it has been noticed that publications tend to combine the different sub-fields which seems to indicate that there are much more applications to come.

The applications range from the purely theoretical ones, those which develop new lines in abstract mathematics or logic, passing across the areas of multi-media, preference modeling, information retrieval, hybrid intelligent systems, image processing, etc., to practical applications domains such as robotics and manufacturing, actuarial science, nuclear or medical engineering.
Fuzzy logic application is used in the following areas:

- Business
- Defense
- Electronics
- Finance
- Manufacturing
- Marine
- Medical
- Securities
- Transportation
- Psychology
- Aerospace
- Automotive

Fuzzy logic is extremely useful for many people involved in research and development including engineers (electrical, mechanical, civil, chemical, aerospace, agricultural, biomedical, computer, environmental, geological, industrial, and mechatronics), mathematicians, computer software developers and researchers, natural scientists (biology, chemistry, earth science, and physics), medical researchers, social scientists (economics, management, political science, and psychology), public policy analysts, business analysts, and jurists.

IV. SOFT COMPUTING

Most of the attempts for defining the evolving term Soft Computing coincide in that it is a collection of techniques which uses the human mind as a model and aims at formalizing our cognitive processes. These methods are meant to operate in an environment that is subject to uncertainty and imprecision. The objective is to study, model and analyze complex phenomena for which more conventional methods have not yielded low cost, analytic, and complete solutions. According to Zadeh the guiding principle of soft computing is to exploit the tolerance for imprecision and uncertainty to achieve tractability, robustness, and low solution cost. The notion soft computing is to computational intelligence as traditional hard computing is to artificial intelligence, and usually is viewed as a foundation component for the emerging field of conceptual intelligence.

The theory of fuzzy logic of soft computing is based on the notion of relative graded membership, as inspired by the processes of human perception and cognition. Lotfi A. Zadeh published his first famous research paper on fuzzy sets in 1965. Fuzzy logic can deal with information arising from computational perception and cognition, that is, uncertain, imprecise, vague, partially true, or without sharp boundaries. Fuzzy logic allows for the inclusion of vague human assessments in computing problems. Also, it provides an effective means for conflict resolution of multiple criteria and better assessment of options. New computing methods based on fuzzy logic can be used in the development of intelligent systems for decision making, identification, pattern recognition, optimization, and control.

It is widely accepted that the main components of Soft Computing are Fuzzy Logic, Probabilistic Reasoning, Neural Computing and Genetic Algorithms. This four constituents share common features and they are considered complementary instead of competitive. The mentioned technologies can be combined in models which exploit their best characteristics. As an important consequence, some real problems can be solved most effectively by using hybrid systems what is increasing the interest on them. The rest and probably the most successful hybrid approach till now are the so-called neurofuzzy systems, although some other hybridations are being developed with great success.
as, for instance, the genetic fuzzy systems. Soft computing is an emerging collection of methodologies, which aim to exploit tolerance for imprecision, uncertainty, and partial truth to achieve robustness, tractability and total low cost. Soft computing methodologies have been advantageous in many applications. In contrast to analytical methods, soft computing methodologies mimic consciousness and cognition in several important respects: they can learn from experience; they can universalize into domains where direct experience is absent; and, through parallel computer architectures that simulate biological processes, they can perform mapping from inputs to the outputs faster than inherently serial analytical representations. The trade off, however, is a decrease in accuracy. If a tendency towards imprecision could be tolerated, then it should be possible to extend the scope of the applications even to those problems where the analytical and mathematical representations are readily available.

V. CONCLUSION

In this paper we have brief recalled the basics of fuzzy logic, soft computing and its application. We are survey on the theoretical of the fuzzy theory and soft computing. The theory of fuzzy logic of soft computing is based on the notion of relative graded membership, as inspired by the processes of human perception and cognition. Soft computing methodologies have been advantageous in many applications. The applications range from the purely theoretical ones, those which develop new lines in abstract mathematics or logic, passing across the areas of multimedia, preference modeling, information retrieval, hybrid intelligent systems, image processing, etc.

REFERENCES