

Fuzzy Logic, Neural Networks, and Soft Computing

LOTFI A. ZADEH

In retrospect, the year 1990 may well be viewed as the beginning of a new trend in the design of household appliances, consumer electronics, cameras, and other types of widely used consumer products. The trend in question relates to a marked increase in what might be called the Machine Intelligence Quotient (MIQ) of such products compared to what it was before 1990. Today, we have microwave ovens and washing machines that can figure out on their own what settings to use to perform their tasks optimally; cameras that come close to professional photographers in picture-taking ability; and many other products that manifest an impressive capability to reason, make intelligent decisions, and learn from experience.

There are many factors that underlie the marked increase in MIQ. It is the author's opinion that the most important factor is the use of what might be referred to as *soft computing*—and, in particular, fuzzy logic—to mimic the ability of the human mind to effectively employ modes of reasoning that are approximate rather than exact.

In traditional—hard—computing, the prime desiderata are precision, certainty, and rigor. By contrast, the point of departure in soft computing is the thesis that precision and certainty carry a cost and that computation, reasoning, and decision making should exploit—wherever possible—the tolerance for imprecision and uncertainty.

A case in point is the problem of parking an automobile. Most people are able to park an automobile quite easily because the final position of the vehicle and its orientation are not specified precisely. If they were, the

difficulty of parking would grow geometrically with the increase in precision and eventually would become unmanageable for humans. What is important to observe is that the problem of parking is easy for humans when it is formulated imprecisely and difficult to solve by traditional methods because such methods do not exploit the tolerance for imprecision.

The exploitation of the tolerance for imprecision and uncertainty underlies the remarkable human ability to understand distorted speech, decipher sloppy handwriting, comprehend nuances of natural language, summarize text, recognize and classify images, drive a vehicle in dense traffic and, more generally, make rational decisions in an environment of uncertainty and imprecision. In effect, in raising the banner of "Exploit the tolerance for imprecision and uncertainty," soft computing uses the human mind as a role model and, at the same time, aims at a formalization

of the cognitive processes humans employ so effectively in the performance of daily tasks.

As was observed earlier, the year 1990 may be viewed as a turning point in the evolution of the MIQ of consumer products. The basis for this observation are the following facts.

The industrial applications of fuzzy logic starting in the early 1980s—of which the prime examples are the F.L. Smith cement kiln and the Sendai subway system designed by Hitachi—laid the groundwork for the use of fuzzy logic in the design and production of high-MIQ consumer products. The first such product—a fuzzy-logic-controlled shower head—was announced by Matsushita in 1987. This was followed by the first fuzzy-logic-based washing machine—also designed by Matsushita—in 1989.

In 1990, high-MIQ consumer products employing fuzzy logic began to grow in number and visibil-

Fuzzy Logic Neural Networks And Soft Computing

**Oscar Castillo, Patricia Melin, Oscar
Montiel Ross, Witold Pedrycz, Roberto
Sepúlveda Cruz**

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Fuzzy Logic Neural Networks and Soft Computing Patricia A. S Ralston, Thomas L Ward, 1993 **NEURAL NETWORKS, FUZZY LOGIC AND GENETIC ALGORITHM** S. RAJASEKARAN, G. A. VIJAYALAKSHMI PAI, 2003-01-01 This book provides comprehensive introduction to a consortium of technologies underlying soft computing an evolving branch of computational intelligence The constituent technologies discussed comprise neural networks fuzzy logic genetic algorithms and a number of hybrid systems which include classes such as neuro fuzzy fuzzy genetic and neuro genetic systems The hybridization of the technologies is demonstrated on architectures such as Fuzzy Back propagation Networks NN FL Simplified Fuzzy ARTMAP NN FL and Fuzzy Associative Memories The book also gives an exhaustive discussion of FL GA hybridization Every architecture has been discussed in detail through illustrative examples and applications The algorithms have been presented in pseudo code with a step by step illustration of the same in problems The applications demonstrative of the potential of the architectures have been chosen from diverse disciplines of science and engineering This book with a wealth of information that is clearly presented and illustrated by many examples and applications is designed for use as a text for courses in soft computing at both the senior undergraduate and first year post graduate engineering levels It should also be of interest to researchers and technologists desirous of applying soft computing technologies to their respective fields of work **Computational Intelligence: Soft Computing and Fuzzy-Neuro Integration with Applications** Okyay Kaynak, Lotfi A. Zadeh, Burhan Türksen, Imre J. Rudas, 1998-08-20 Soft computing is a consortium of computing methodologies that provide a foundation for the conception design and deployment of intelligent systems and aims to formalize the human ability to make rational decisions in an environment of uncertainty and imprecision This book is based on a NATO Advanced Study Institute held in 1996 on soft computing and its applications The distinguished contributors consider the principal constituents of soft computing namely fuzzy logic neurocomputing genetic computing and probabilistic reasoning the relations between them and their fusion in industrial applications Two areas emphasized in the book are how to achieve a synergistic combination of the main constituents of soft computing and how the combination can be used to achieve a high Machine Intelligence Quotient *Fuzzy Sets, Neural Networks, and Soft Computing* Ronald R. Yager, 1994 Brings together chapters by experts involved in a new area based on the confluence of genetic algorithms fuzzy systems and neural networks Papers cover the broad ground of fuzzy logic control neural fuzzy systems genetic fuzzy systems process control and adaptive systems Topics include the composition of heterogeneous control laws ellipsoidal learning and fuzzy throttle control for platoons of smart cars supervised and unsupervised learning and propagation and satisfaction of flexible constraints Annotation copyright by Book News Inc Portland OR **Soft Computing and Its Applications** Rafik Aziz ogly Aliev, R. R. Aliev, 2001 The concept of soft computing is still in its initial stages of crystallization Presently available books on soft computing are merely collections of chapters or articles about different aspects of the field This book is the first to provide a

systematic account of the major concepts and methodologies of soft computing presenting a unified framework that makes the subject more accessible to students and practitioners Particularly worthy of note is the inclusion of a wealth of information about neuro fuzzy neuro genetic fuzzy genetic and neuro fuzzy genetic systems with many illuminating applications and examples

Soft Computing Andrea Tettamanzi,Marco Tomassini,2013-04-17 Soft computing encompasses various computational methodologies which unlike conventional algorithms are tolerant of imprecision uncertainty and partial truth Soft computing technologies offer adaptability as a characteristic feature and thus permit the tracking of a problem through a changing environment Besides some recent developments in areas like rough sets and probabilistic networks fuzzy logic evolutionary algorithms and artificial neural networks are core ingredients of soft computing which are all bio inspired and can easily be combined synergetically This book presents a well balanced integration of fuzzy logic evolutionary computing and neural information processing The three constituents are introduced to the reader systematically and brought together in differentiated combinations step by step The text was developed from courses given by the authors and offers numerous illustrations as

Explainable Neural Networks Based on Fuzzy Logic and Multi-criteria Decision Tools József Dombi,Orsolya Csiszár,2021-06-03 The research presented in this book shows how combining deep neural networks with a special class of fuzzy logical rules and multi criteria decision tools can make deep neural networks more interpretable and even in many cases more efficient Fuzzy logic together with multi criteria decision making tools provides very powerful tools for modeling human thinking Based on their common theoretical basis we propose a consistent framework for modeling human thinking by using the tools of all three fields fuzzy logic multi criteria decision making and deep learning to help reduce the black box nature of neural models a challenge that is of vital importance to the whole research community

Genetic Algorithms And Fuzzy Logic Systems Soft Computing Perspectives Elie Sanchez,Takanori Shibata,Lotfi A Zadeh,1997-03-15 Ever since fuzzy logic was introduced by Lotfi Zadeh in the mid sixties and genetic algorithms by John Holland in the early seventies these two fields widely been subjects of academic research the world over During the last few years they have been experiencing extremely rapid growth in the industrial world where they have been shown to be very effective in solving real world problems These two substantial fields together with neurocomputing techniques are recognized as major parts of soft computing a set of computing technologies already riding the waves of the next century to produce the human centered intelligent systems of tomorrow the collection of papers presented in this book shows the way The book also contains an extensive bibliography on fuzzy logic and genetic algorithms

Knowledge-Based Neurocomputing: A Fuzzy Logic Approach Eyal Kolman,Michael Margaliot,2008-10-18 In this monograph the authors introduce a novel fuzzy rule base referred to as the Fuzzy All permutations Rule Base FARB They show that inferring the FARB using standard tools from fuzzy logic theory yields an input output map that is mathematically equivalent to that of an artificial neural network Conversely every standard artificial neural network has an equivalent FARB The FARB ANN

equivalence integrates the merits of symbolic fuzzy rule bases and sub symbolic artificial neural networks and yields a new approach for knowledge based neurocomputing in artificial neural networks

Theoretical Advances and Applications of Fuzzy Logic and Soft Computing Oscar Castillo, Patricia Melin, Oscar Montiel Ross, Witold Pedrycz, Roberto Sepúlveda Cruz, 2007-06-08 This book comprises a selection of papers on theoretical advances and applications of fuzzy logic and soft computing from the IFSA 2007 World Congress held in Cancun Mexico June 2007 These papers constitute an important contribution to the theory and applications of fuzzy logic and soft computing methodologies

Learning and Soft Computing Vojislav Kecman, 2001 This textbook provides a thorough introduction to the field of learning from experimental data and soft computing Support vector machines SVM and neural networks NN are the mathematical structures or models that underlie learning while fuzzy logic systems FLS enable us to embed structured human knowledge into workable algorithms The book assumes that it is not only useful but necessary to treat SVM NN and FLS as parts of a connected whole Throughout the theory and algorithms are illustrated by practical examples as well as by problem sets and simulated experiments This approach enables the reader to develop SVM NN and FLS in addition to understanding them The book also presents three case studies on NN based control financial time series analysis and computer graphics A solutions manual and all of the MATLAB programs needed for the simulated experiments are available

International Conference on Fuzzy Logic, Neural Nets, and Soft Computing, 1995 **Fuzzy Systems and Soft Computing in Nuclear Engineering** Da Ruan, 2000-01-14 This book is an organized edited collection of twenty one contributed chapters covering nuclear engineering applications of fuzzy systems neural networks genetic algorithms and other soft computing techniques All chapters are either updated review or original contributions by leading researchers written exclusively for this volume The volume highlights the advantages of applying fuzzy systems and soft computing in nuclear engineering which can be viewed as complementary to traditional methods As a result fuzzy sets and soft computing provide a powerful tool for solving intricate problems pertaining in nuclear engineering Each chapter of the book is self contained and also indicates the future research direction on this topic of applications of fuzzy systems and soft computing in nuclear engineering

Fuzzy Logic and Soft Computing Bernadette Bouchon-Meunier, Ronald R. Yager, Lotfi Asker Zadeh, 1995 Soft computing is a new emerging discipline rooted in a group of technologies that aim to exploit the tolerance for imprecision and uncertainty in achieving solutions to complex problems The principal components of soft computing are fuzzy logic neurocomputing genetic algorithms and probabilistic reasoning This volume is a collection of up to date articles giving a snapshot of the current state of the field It covers the whole expanse from theoretical foundations to applications The contributors are among the world leaders in the field

Neuro-fuzzy and Soft Computing Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, 1997 Neuro Fuzzy and Soft Computing provides the first comprehensive treatment of the constituent methodologies underlying neuro fuzzy and soft computing an evolving branch of computational intelligence The constituent methodologies include fuzzy set

theory neural networks data clustering techniques and several stochastic optimization methods that do not require gradient information In particular the authors put equal emphasis on theoretical aspects of covered methodologies as well as empirical observations and verifications of various applications in practice The book is well suited for use as a text for courses on computational intelligence and as a single reference source for this emerging field To help readers understand the material the presentation includes more than 50 examples more than 150 exercises over 300 illustrations and more than 150 Matlab scripts In addition Matlab is utilized to visualize the processes of fuzzy reasoning neural network learning neuro fuzzy integration and training and gradient free optimization such as genetic algorithms simulated annealing random search and downhill Simplex method The presentation also makes use of SIMULINK for neuro fuzzy control system simulations All Matlab scripts used in the book are available on the free companion software disk that may be ordered by using the enclosed reply card The book also contains an Internet Resource Page to point the reader to on line neuro fuzzy and soft computing home pages publications public domain software research institutes news groups etc All the HTTP and FTP addresses are available as a bookmark file on the companion software disk

Type-2 Fuzzy Logic: Theory and Applications Oscar Castillo,Patricia Melin,2010-10-21 This book describes new methods for building intelligent systems using type 2 fuzzy logic and soft computing SC techniques The authors extend the use of fuzzy logic to a higher order which is called type 2 fuzzy logic Combining type 2 fuzzy logic with traditional SC techniques we can build powerful hybrid intelligent systems that can use the advantages that each technique offers This book is intended to be a major reference tool and can be used as a textbook

3rd International Conference on Fuzzy Logic, Neural Nets, and Soft Computing Hisao Ishibuchi,1995

Soft Computing Andrea G. B. Tettamanzi,Marco Tomassini,2014-03-12 Soft computing encompasses various computational methodologies which unlike conventional algorithms are tolerant of imprecision uncertainty and partial truth Soft computing technologies offer adaptability as a characteristic feature and thus permit the tracking of a problem through a changing environment Besides some recent developments in areas like rough sets and probabilistic networks fuzzy logic evolutionary algorithms and artificial neural networks are core ingredients of soft computing which are all bio inspired and can easily be combined synergetically This book presents a well balanced integration of fuzzy logic evolutionary computing and neural information processing The three constituents are introduced to the reader systematically and brought together in differentiated combinations step by step The text was developed from courses given by the authors and offers numerous illustrations as

New Horizons for Fuzzy Logic, Neural Networks and Metaheuristics Oscar Castillo,Patricia Melin,2024-05-21 This book contains a collection of papers focused on hybrid intelligent systems based on soft computing techniques In this book new horizons on the theoretical developments of fuzzy logic neural networks and optimization algorithms are envisioned In addition the abovementioned methods are discussed in application areas such as control and robotics pattern recognition medical diagnosis decision making prediction and optimization of complex problems There are a

group of papers with the main theme of type 1 type 2 and type 3 fuzzy systems which basically consists of papers that propose new concepts and algorithms based on type 1 type 2 and type 3 fuzzy logic and their applications There is also a group of papers that offer theoretical concepts and applications of meta heuristics in different areas Another group of papers outlines diverse applications of hybrid intelligent systems in real problems There are also a group papers that present theory and practice of neural networks in different applications Finally there are papers that offer theory and practice of optimization and evolutionary algorithms in different application areas

Fuzzy Neural Network Theory And Application
Puyin Liu,Hong-xing Li,2004-06-07 This book systematically synthesizes research achievements in the field of fuzzy neural networks in recent years It also provides a comprehensive presentation of the developments in fuzzy neural networks with regard to theory as well as their application to system modeling and image restoration Special emphasis is placed on the fundamental concepts and architecture analysis of fuzzy neural networks The book is unique in treating all kinds of fuzzy neural networks and their learning algorithms and universal approximations and employing simulation examples which are carefully designed to help the reader grasp the underlying theory This is a valuable reference for scientists and engineers working in mathematics computer science control or other fields related to information processing It can also be used as a textbook for graduate courses in applied mathematics computer science automatic control and electrical engineering

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