
THE BOOK TOPICS

The book deals with an emerging engineering discipline, viz, the Computational Intelligence that has rapidly found wide application in various branches of science and technology. The term Computational Intelligence is largely understood as a collection of intelligent computational methodologies, such as neuro-computing, fuzzy logic-based computing, and evolutionary computing that help in solving complex computational problems, not solvable or at least not easily solvable, using the conventional mathematical tools.

The research activity in combined application of different intelligent approaches to problem solving was initiated by Zadeh in 1994 [1] who has introduced the term soft computing with fuzzy logic, neuro-computing, and probabilistic reasoning as its principal constituents. Later, this term was extended to include the evolutionary computation and learning strategies. Also, the statistical version of evolutionary computation was developed relying on randomized global search paradigms suitable for finding the optimal solution of multi-dimensional problems. Thereafter, the basic search strategies have been widely extended and diversified to include the novel search strategies, such as genetic algorithms, genetic programming, evolutionary strategies, evolutionary programming, differential evolution, etc.

However, the most decisive step in formulating the term Computational Intelligence was made during the 1994 IEEE World Congress on Computational Intelligence (WCCI) [2]. At that time, R. J. Marks, in his Editorial Note to the IEEE Transactions on Neural Networks [3], pointed out that, although seeking similar goals, computational intelligence has emerged as a sovereign field distinct from artificial intelligence. Since that time the WCCI has become a regular event. In addition, in 2006, the IEEE Magazine on Computational Intelligence was launched.

During the last decade, Computational Intelligence approaches have again and again proved their efficiency in solving complex scientific and engineering problems that are not easily solvable using conventional computational methods. This spans signal processing, multi-sensor data fusion, pattern recognition, performance monitoring, fault diagnosis, etc. Since the majority of such problems are based on experimental observations and on collection of experimental data, mainly structured and analysed in the form of time series, the book under review is mainly focussed on time series analysis and forecasting of experimental data in engineering.
Therefore, the book will be of use not only to the mathematicians dealing with the processing of some statistical data, but also to the experimental researchers and to the practising engineers dealing with the analysis, modelling, and control of dynamic systems.

THE BOOK CONTENTS

The entire book is made up of 10 chapters organized in 4 parts.

Part I of the book is introductory one. It contains Chapters 1 and 2. Chapter 1 gives an extensive chronological insight into the evolution of Computational Intelligence depicting the development of intelligent problem-solving methodologies that became the basic constituent parts of the contemporary Computational Intelligence. Chapter 2, again, is a comprehensive introduction to standard problems of time series analysis and forecasting. This makes the book largely self-contained for the reader. Here, the problems of time series modelling and the linear regression-based time series models, preferably used in time series forecasting (ARMA, ARIMA, CARIMA, etc.), as well as multi-variate, nonlinear, and chaotic time series models, along with the problems of model parameter estimation, model validation, and of model diagnostic check for its acceptance proof, are discussed.

Part II of the book, made up of Chapters 3–5, is devoted to the individual constituents of Computational Intelligence. In Chapter 3, the reader is introduced into neuro-technology, i.e. into the structure and functionality of most frequently used neural network configurations as well as into their training approaches that include the preparation of training data, determination of initial network architecture, training stopping and validation, etc. Finally, due attention is paid to the problem of nonlinear combination of and to the combined application of neural networks and the traditional approaches of time series forecasts. All this is described in comprehensive details that are seldom found in standard books on neural networks. This supports the user in the accelerated stepping down into the neural network practical implementation and application.

The problem of modelling of experimental data is also treated in the subsequent Chapter 4, from the fuzzy logic point of view. Here, the reader will find the methodologies to build the Mamdani, Takagi-Sugeno, relational, and singleton models using experimental data. Particular attention is paid to the related issues of optimal shaping of membership functions, to automatic rules generation, and to modelling and forecasting using chaotic experimental data. The advantage of nonlinear combination of forecasts is demonstrated on temperature prediction in a chemical reactor.

Part II closes with Chapter 5 of the book, devoted to the main approaches of evolutionary computation, such as genetic algorithms, genetic programming, evolutionary strategies, evolutionary programming, and the differential evolution approach. Particular attention is paid to pivotal issues of genetic algorithms, such as their real coding and optimal selection of initial population and of genetic operators.

The ensuing Part III of the book, consisting of Chapters 6–9, predominantly deals with the hybrid computational structures implemented by various combinations of two or more basic computational technologies jointly actuating in solving some more advanced problems. This is achieved through augmentation of computational features of individual components used and through the improved performance of the overall system. For example, the combination of neural and fuzzy logic technology, investigated in Chapter 6, could be alternatively implemented as neuro-fuzzy or as fuzzy-neuro computational structure and can successfully be applied in solving the problems of model building and intelligent nonlinear systems control. The true improvement of the capability and the performance of the hybrid system implemented by the two merged technologies is demonstrated on the real-life examples involving the backpropagation training and—alternatively—by the Levenberg–Marquardt training of a Takagi–Sugeno-type multi-input multi-output neuro-fuzzy network.

Two novel aspects related to the systems modelling issue are recently brought to the public attention: the model transparency and the interpretability of data-driven automated fuzzy

---

Copyright © 2007 John Wiley & Sons, Ltd.

Int. J. Robust Nonlinear Control 2007; 17:347–354
models. In the successive Chapter 7 of the book, strong accent is placed on making the reader familiar with the compact and transparent modelling schemes that include model structure selection, data clustering, similarity-based simplification, and model validation. In this way the system designer profits through the rule base simplification by removing irrelevant fuzzy sets and redundant inputs, and by merging the related rules.

Chapter 8 covers the synthesis of neural networks and fuzzy systems by joint use of the genetic algorithm and evolutionary programming. In the past decade, this new field of evolutionary computation was the subject of intensive research. In this chapter, two synthesis problems are treated in detail: optimal evolution of a problem-oriented neural network structure, along with the optimal selection of its connection weights, and optimal evolution of a fuzzy system by optimal selection of its rules and the optimal shaping of its membership functions.

Chapter 9, finally, considers the inverse problems by indicating how the fuzzy logic systems can be applied to the adaptation of a genetic algorithm by optimal selection and tuning of genetic operators and fitness functions. An additional adaptivity strategy uses the probabilistic control of genetic algorithm in order to prevent the premature convergence by corresponding control of present population size.

Part IV of the book, consisting only of Chapter 10, focuses on some most recent development trends in the field of several intelligent computational technologies, such as the support vector machines, wavelet networks, and fractal networks. In addition, the reader’s attention is focused on the new fuzzy clustering approaches based on entropy and Kohonen networks that become relevant for solving the time series forecasting problem, for instance, through the design of Takagi–Sugeno fuzzy model. In this final chapter of the book, it is also indicated that in the future Computational Intelligence will also profit from the future development of bioinformatics, swarm engineering, multi-agent systems, and from fuzzy logic-based data understanding.

Apart from the theoretical consideration of computational approaches presented, the distinctive feature of the book is that it also considers the application aspects of Computational Intelligence methodology in real-life situations. This is documented by the application examples such as: prediction of nonlinear time series and the nonlinear combination of forecasts using neural networks, prediction of chaotic time series and of output data for second-order nonlinear plant using fuzzy logic, Levenberg–Marquardt training of multi-input multi-output hybrid neuro-fuzzy networks, besides the application of evolutionary training of multi-input single-output hybrid neuro-fuzzy networks, short-term forecasting of electrical load and of output data for second-order nonlinear plant using neuro-fuzzy hybrid technology, and isolated use of fuzzy logic and neuro-fuzzy networks in the nonlinear combination of traditional forecasts of temperature series obtained from a pilot-scale chemical reactor with temporarily disconnected controller etc. along with many other engineering application examples using hybrid neuro-fuzzy networks.

The book also provides many references, appended to individual chapters to serve the reader as a guide through the subjects considered in the chapter, and recommends further readings relevant to the topics covered in the chapter. This is helpful in enabling the reader to pursue individual topics in increased depth than has been possible within the space limitations of the book. This is also facilitated by the index of all key topics and keywords in the book.

Although in the recent past several books on Computational Intelligence have been published, to the best of the reviewer’s knowledge, there are only a few books which give such a systematic and exhaustive exposition of the methodologies and technologies in this area, encompassing the process of their evolution, the present state of the art, and future trends. But still, some of them are remarkable [4–7].

AUDITORIUM

The book material is drawn from various courses and experimental studies carried out at the Institute of Automation Technology (IAT) of the University of Bremen, Germany,
and from the Control Engineering Laboratory of Delft University of Technology (TU Delft), The Netherlands, and also from numerous publications of book authors. Therefore, in the opinion of the reviewer, the book can be recommended to be used as a reference volume by professionals directly engaged in the area of theory and engineering application of computational intelligence, as well—at least chapterwise—as reference book for postgraduate courses at the university or for advanced training courses in the industry.

REFERENCES

PROF. DR AMITAVA GUPTA
Department of Power Engineering,
Jadavpur University,
Salt Lake Campus,
LB-8, Sector 3,
Salt Lake, Kolkata 700098,
India
E-mail: amitg@pe.jusl.ac.in

(DOI: 10.1002/rnc.1153)