Soft Computing in Communications

Lipo Wang

(ed.)

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Editor

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Soft Computing in Communications

This book is dedicated to recent novel applications of soft computing in communications. It presents the methodologies of neural networks, evolutionary computation, fuzzy logic and neurofuzzy systems, and kernel methods. Applications to the wide field of communications are demonstrated, such as to multi-service access multiplexers, hierarchical cellular systems, multicast routing, optimal channel assignment to cellular mobile communications, transporting voice over a wireless LAN, or the design of communication antennas.

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Preface

Soft computing, as opposed to conventional "hard" computing, tolerates imprecision and uncertainty, in a way very much similar to the human mind. Soft computing techniques include neural networks, evolutionary computation, fuzzy logic, and chaos. The recent years have witnessed tremendous success of these powerful methods in virtually all areas of science and technology, as evidenced by the large numbers of research results published in a variety of journals, conferences, as well as many excellent books in this book series on Studies in Fuzziness and Soft Computing.

This volume is dedicated to recent novel applications of soft computing in communications. The book is organized in four Parts, i.e., (1) neural networks, (2) evolutionary computation, (3) fuzzy logic and neurofuzzy systems, and (4) kernel methods.

Artificial neural networks consist of simple processing elements called neurons, which are connected by weights that may be adjusted during learning. Part 1 of the book has seven chapters, demonstrating some of the capabilities of two major types of neural networks, i.e., multiplayer perceptron (MLP) neural networks and Hopfield-type neural networks.

MLPs can be trained to respond with desired output when presented with certain input to arbitrary precision, which is why MLPs are said to be universal approximators. Hence MLPs are very useful in controlling non-linear dynamic systems. In the chapter written by Davoli and Maryni, MLPs are used to provide optimal admission control for bandwidth allocation in multiservice access multiplexers. Zerguine and Shafi study performance of an MLP-based decision feedback equalizer in non-linear channels. Ibnkahla investigates adaptive identification of nonlinear channels using natural gradient descent.

Hopfield-type neural networks (HNNs) have recurrent connections between neurons and minimize energy functions while the states of the neurons are updated. Because of this intriguing property, HNNs have been used in solving numerous optimization problems. Compared with other optimization approaches, HNNs are highly parallel and can be easily implemented with hardware. In this book, AboElFotoh applies the HNN in maximizing topology connectivity. Funabiki describes binary HNNs for combinatorial optimization problems in communication networks. Sharif, Chuah, and Hinton survey applications of neural networks for robust multiuser detection in direct-sequence code-division multiple-access systems. Wang, Li, Wan, and Soong employ a chaotic HNN for minimizing interference in cellular mobile communications by optimal channel assignment.

Evolutionary computation (EC) techniques, e.g., genetic algorithms (GA), are

motivated from natural processes in which individuals evolve and improve themselves for the purpose of survival. Part 2 of this book includes three chapters on applications of GA in various optimization problems in communications.

In particular, Leung proposes orthogonal genetic algorithms with applications to multimedia multicast routing. Gu and Chu solve QoS multicast routing problems using GA. Krishnamachari and Wicker investigate base station location optimization in cellular wireless networks using GA and other heuristic search algorithms. Werner, Bray, Allard, and Werner study the synthesis and design of communication antennas using GA.

Fuzzy logic (FL) was invented to mimic human's vague concepts and approximate reasoning. Neurofuzzy systems, also known as fuzzy neural networks, combine FL with adaptive weights found in neural networks and are also universal approximators, like MLPs. Part 3 of this book contains five chapters on applications of FL and neurofuzzy systems in communications.

Koliver, Farines, and Nahrstedt report their work on QoS adaptation based on FL. Lian, Liu, and Chiu discuss chaotic signal synchronization and secure communications using FL design methods. Lo, Chang, and Chen study FL and neurofuzzy channel assignment schemes for hierarchical cellular systems. Gil and Park describe a neurofuzzy mobility prediction system and its application to restoration of mobility databases. Yuang and Tien present a framework for transporting voice over wireless LAN using neurofuzzy control.

Support vector machines and kernel methods have recently enjoyed great success in many areas. Part 4 of this book consists of two chapters on applications of kernel methods in various communications problems. Kuh focuses on the theory and applications of a newly developed kernel algorithm called the least squares support vector machine. Chen investigates least bit error rate adaptive multiuser detection.

I would like to sincerely thank all authors who have spent time and effort to make important contributions to this book. My gratitude also goes to Professor Janusz Kacprzyk and Dr. Thomas Ditzinger for their most kind support and help for this book.

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