Foreword

Explorations and insights into how humans think and reason have been of intense interest of researchers for centuries – in fact, they can be traced back to the origins of humanity. However, only in recent decades not only the computational modeling, but also simulation of intellectual capabilities of humans has become a reality. This was a direct consequence of the massive increase in computational power. It can also be credited to proliferation of hardware for inexpensive and easily searchable data storage.

Modeling and simulation of intellect can explore different approaches and can dwell on a variety of inspirations. The approaches presented in this volume are rooted in biology-inspired computing techniques. These techniques, based on efforts to understand and model the nature offer a wide range of insights, solutions and opportunities. They bridge the gap between the traditional, anthropocentric view of intellect with the modern computational metaphor that allows mimicking of intellect with computational models and tools.

The main thread of this publication is biologically-inspired intellect modeling and simulation in various fields, such as digital signal processing, image processing, robotics, systems biology, and their applications to areas of finances, business, management, defense, national security, medicine and new drug research. The book presents a wide spectrum of diverse approaches to the problems in these different areas. Altogether, the book reflects an interdisciplinary perspective of intellect modeling and simulation. It also tackles the issue of possible fusion of presented methods, as well as their computational efficiency, and their scalability.

The book consists of four sections with 22 chapters covering applied topics in image and signal processing, robotics and control (Sect. 1, 7 chapters), applications in biomedicine and environmental science (Sect. 2, 3 chapters), general concepts (Sect. 3, 9 chapters), and applications of these methods to learning (Sect. 4, 4 chapters).

Three papers of Sect. 1 discuss the biomedical image processing technique applied to specific disease recognition (inflammatory bowel disease), intelligent information characterization of biomedical images, and theoretical approaches to image compression and transmission. Three papers to follow cover distributed sensing, processing, communication and navigation of robots or unmanned vehicles. Adaptive linear programming applied to helicopter flying in an uncontrolled environment subject to various disturbances, and model uncertainties are also discussed.

Sect. 2 features two papers covering reasoning and detection methods based on uncertainty analysis, and specifically on classification and ranking with belief simplex technique in hip replacement treatment and diagnosis; and covers analysis of magnetocardiograms for detection of ischemic heart disease from measurements of magnetic field around the heart. The third paper is concerned with artificial neural networks for modeling of waste-gas and wastewater treatment.

Sect. 3 discusses general concepts of learning. It opens with the chapter on motivated learning, which makes use of the goals, rewards, advanced perception and motor skills to achieve desired cognitive properties. The chapter to follow introduces a constructive neural representation of a topological space in the brain's hippocampus. Discussion in the next chapters of intelligence augmentation in individual and teamwork and related cognitive models, and discovery of associations from vague spatial data bring another contribution to intellect analysis.

The two remaining chapters of this section cover an important aspect of feature selection and of their ranking in the classification process, and discuss how spiking neurons look for salient features in the person authentication task. Next, the modeling of intellect based on the concept of activity is presented from the coordination perspective. Finally, the chapter on information processing by chemical reaction-diffusion media postulates this approach for better solutions of fundamental artificial intelligence problems.

The final Sect. 4 addresses the concept of learning based on artificial and computational intelligence paradigms. Discussion of learning vector quantization for improved centering of fuzzy membership function is followed by the mathematical modeling and associated demonstrations of outlier detection in linear regression. The following chapter offers a survey of techniques dealing with unbalanced datasets in real-life applications. The closing chapter of the volume explores how complex-valued neural networks can learn to perform transformations and produce associative memories.

This interesting and ambitious book will assist researchers, users, developers and designers of the information and management systems. It will also offer a comprehensive overview of computational and artificial intelligence issues to graduate students and other learners, who want a gentle but rigorous introduction to the computational modeling and simulation of intellect.

I do hope that the readers will find this volume interesting and that it will contribute to the further development of research in the exciting area of natural computing.

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