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Book review

D.B. Fogel, C.J. Robinson (Eds.), Computational Intelligence: The Experts Speak, Wiley InterScience, IEEE Press, 2003 (hardcover, 282 pp., ISBN 0-471-27454-2)

Computational intelligence, the other name of soft computing, is becoming more and more sophisticated and diverging rapidly these days, and it gets difficult to catch up with the state of the research in this field. In this sense, the 2002 IEEE World Congress on Computational Intelligence (WCCI 2002) was a remarkable milestone in the development of theory and applications of computational intelligence.

The book edited by Fogel and Robinson presents a significantly expanded version of several invited plenary and special lectures from the leading experts in the field of computational intelligence. If you realized the editors' capabilities and skills as leading researchers and writers, there is no doubt that this book could be beneficial to a broad audience of researchers and practitioners in computational intelligence.

The only thing that I am concerned about is the organization. It looks a little scattered and disordered at the first glance. I believe there must be the editors' intention to appeal to the readers by introducing diverse but self-contained topics independently. In this review, however, I dare to reorganize them to give you clearer introduction on the book with my point of view.

The book contains 18 chapters that can be categorized in terms of the main techniques and characteristics as the following table:

	Principle	Application
Intelligence	3, 4, 17	5, 9, 10
Evolutionary	13	1, 14, 15
Fuzzy Systems	11	2, 12
Neural Networks	6, 18	7, 8, 16

- *Principle of Intelligence*: Chapter 3 deals with the problem of intelligence estimation and presents the definitions and historical tests such as the Turing test associated with measuring intelligence. Using that basis Rogers et al. offer intelligence amplification as opposed to artificial intelligence as the real attainable goal of the computational intelligence community. Chapter 4 illustrates the optimistic view to formulate a meaningful understanding of brain function due to the significant advancement of neuroscience knowledge and computing technology. Watts addresses the reasons for this optimistic view in terms of neuroscience knowledge, computing technology and non-technical issues. Chapter 17 presents collectives to develop intelligent systems of self-interested agents with an associated performance criterion that rates the dynamic behavior of the overall system. The idea of collectives becomes promising especially as computing becomes ubiquitous in artificial systems. Wolpert gives some of the mathematical theory and tests underpinning the design problem of collectives.
- *Application of Intelligence*: Chapter 5 describes the Office of Naval Research's need for intelligent computation in the development of underwater sensors and points out the main advantages of computational intelligence in research applications and commercial markets as simplicity and performance. In Chapter 9, Fukuda and Kubota present several topics of motion planning and behavior acquisition of robots using intelligent techniques in unknown and dynamic environments from viewpoints of adaptation, learning, and evolution. They also introduce structured intelligence for building intelligent robots and discuss the communication between a partner robot and a human. Chapter 10 describes some examples that reach from application of fuzzy clustering and neural networks in traffic management via fuzzy linear programming in fleet management to approximate reasoning in in-house logistics.
- *Principle of Evolutionary Computation*: Chapter 13 introduces the role of evolutionary computation in the study of cognitive science. Evolutionary computation in cognitive science is used primarily to optimize parameters in cognitive models such as autonomous robots and symbolic models of language, and as a model of the evolutionary process itself. Wiles and Hallinan give some case studies such as the evolution of altruism, the evolution of language, and the interaction between learning and evolution.
- *Application of Evolutionary Computation*: In Chapter 1, Pollack et al. present a selection of their work on evolutionary robotics, each of which addresses a physical evolutionary substrate in one or more dimensions. They point out that both the morphology and control programs for robots arise directly through morphology and control-software coevolution. Chapter 14 introduces another interesting application of evolutionary computation, evolvable hardware (EHW), mainly with the achievements that Higuchi et al. have made such as a general-purpose EHW chip used in prosthetic hands, a data-compression EHW chip, an analog EHW chip

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for cellular phones, an EHW-based clock-timing architecture, and an evolvable optical system. In Chapter 15, Takagi introduces the humanized computational intelligence as one of several research directions for this technology, and presents four applications of interactive evolutionary computation in computer graphics, signal processing, control, and internet.

- *Principle of Fuzzy Systems*: Chapter 11 deals with the problem of iterative optimization, and presents two new convergence results for alternating optimization: global and local convergence properties. This result is not only for fuzzy systems, but it is categorized as such due to the authors' main area of research.
- *Application of Fuzzy Systems*: In Chapter 2, Keller et al. discuss their efforts to move toward the goal of efficient linguistic communication between a robot and humans. Chapter 12 develops a stability theorem for discrete-time fuzzy dynamic systems based on the piecewise-continuous Lyapunov function, and proposes a new constructive controller synthesis method for the fuzzy dynamic systems.
- *Principle of Neural Networks*: Chapter 6 presents optimal solutions to nonlinear dynamical systems in the setting of a neural space introduced by Figueiredo in 1990. In Chapter 18, Werbos reviews the chain rule for ordered derivatives, the original mathematical foundation for the use of backpropagation in five areas. Also, he reviews backpropagation for supervised learning, including vanilla backpropagation.
- *Application of Neural Networks*: Chapter 7 describes decompositional methods to extract rules from trained neural networks, and illustrates the steps of the algorithms in detail in two examples for bankruptcy prediction and for prediction of central processing unit performance. In Chapter 16, Szu presents space-variant unsupervised classifications by neural networks, and discusses of an application of unsupervised learning to multispectral breast imaging. Chapter 8 presents the challenges and opportunities of neural network control.

From the review of the whole chapters, it can be figured out that we still need more sound theory to integrate all the disciplines in computational intelligence, and the dominant applications of computational intelligence can be summarized as robotics, pattern classification and control. On the contrary, the applications are expanding widely and rapidly.

This book puts another important step into the final manifestation of computational intelligence, as the first book, Computational Intelligence: Imitating Life from the 1994 World Congress (WCCI 1994) edited by the same authors, opened the successful beginning of the field. I already look forward to seeing the next book that must be another breakthrough to the next step in computational intelligence.

Sung-Bae Cho
Department of Computer Science,
Yonsei University, 134 Shinchon-dong,
Sudaemoon-ku, Seoul 120-749, Republic of Korea

E-mail address: sbcho@cs.yonsei.ac.kr

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