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Volume 183

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Knowledge Management and Engineering with Decisional DNA

Springer

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Foreword

This is the first book on experience-based knowledge representation and knowledge management/engineering with Set of Experience Knowledge Structure (SOEKS) and Decisional DNA (DDNA). These two concepts were proposed about a decade ago by two very dear colleagues of mine: Dr. Cesar Sanin (The University of Newcastle, Newcastle, Australia) and Prof. Edward Szczerbicki (The University of Newcastle, Newcastle, Australia and The Gdansk University of Technology, Gdansk, Poland).

The main idea of Cesar and Edward was to replicate the natural DNA behaviour to be able to capture, integrate, store, and reuse experience in smart knowledge-based systems. This is more than needed in these days, where the success of technologies such as deep learning and automatic decision-making allows the development of increasingly robust and autonomous Artificial Intelligence (AI) applications for everyday life in all domains of private and public sectors. Nevertheless, these new developments raise important challenges in terms of human understanding of processes resulting from learning, explanations of decisions made (crucial issue when ethical or legal considerations are involved) and human–machine communication.

And this is where SOEKS and DDNA come to play. The very innovative knowledge structure defined by Cesar and Edward is the perfect tool for providing explainability when numerical approaches to AI fail and, additionally, it bridges the gap between numerical and symbolic approaches to AI. It also crosses the threshold into the recently revisited research field of Augmented *Intelligence*, which concentrates on human intelligence amplification rather than replacement.

This book provides a number of comprehensive real-life case studies with DDNA successful implementations, coming from a broad spectrum of domains, such as industrial safety, artificial vision, manufacturing in Industry 4.0 Cyber-Physical System (CPS) environment, medicine and health, product design, engineering innovation, and embedded Internet of Things systems. The presented implementations highlight the challenges and complexities of the development of smart knowledge-based systems in multidisciplinary environments.

I am sure that readers will take great advantage of this book and I hope that in future, the DDNA technology will venture into new domains, providing further amplification of natural intelligence and explanation mechanisms for complex decision-making processes based on AI.

November, 2019

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Preface

A desire to come to grips with knowledge management and to be able to engineer knowledge has become an area of interest both commercially and academically in recent years, primarily as a consequence of the technological revolution. Our ability as a society to manage our existing knowledge base has become the benchmark by which we are able to move forward and expand our knowledge horizons. Ability to manage complexities and dynamics of knowledge-based systems, ability to efficiently transform information into knowledge, can make the difference between the success and failure of a company in the competitive environment of global economy and knowledge-based semantic society. This is a new paradigm, which creates enormous challenges for system science researchers and practitioners in the new millennium. The purpose of this book is to address some of these challenges by proposing, developing, and implementing in number of domains, a unique experience-based knowledge structure (Set of Experience Knowledge Structure, SOEKS) and bio-inspired concept of Decisional DNA (DDNA).

We coined our pillar notions of SOEKS and DDNA a little over a decade ago. Our research motivation stems from the role of deoxyribonucleic acid (DNA) in storing and sharing information and knowledge. The idea behind our research is to develop an artificial system, an architecture that would support discovering, adding, storing, improving, and sharing information and knowledge among machines and organizations through experience. We propose a novel knowledge representation approach in which experiential knowledge is represented by SOEKS and is carried into the future by DDNA.

This book is a platform to share ideas. Our contributors, the authors of carefully selected and peer reviewed chapters, are academics, educators, and practitioners who are pursuing a course of study, research, and implementation of experience-based knowledge engineering using the DDNA technology. This book serves as a way for them to connect with others by sharing strategies, ideas, models, approaches that they have successfully implemented in their own environments and case studies. SOEKS and DDNA are frontier technologies, which have enormous potential to transfer global industries to fully evolved knowledge-based philosophy

as required by the imminent fourth industrial revolution and its new cognitive society set in the Internet of Things (IoT) and Cyber-Physical Systems (CPS).

This book is organized into seven chapters:

- Chapter 1 presents an overview of experience-based technologies Set of Experience Knowledge Structure (SOEKS or SOE for short) and Decisional DNA (DDNA),
- Chapter 2 discusses the role of SOE and DDNA in developing cognitive vision systems as part of Augmented Intelligence,
- Chapter 3 introduces DDNA-based manufacturing model developed to enhance Industry 4.0 and Cyber-Physical Systems (CPS),
- Chapter 4 offers insights into the Internet of Things (IoT) aware intelligent embedded systems based on DDNA knowledge representation,
- Chapter 5 enters into medical domain and proposes experience-based clinical support systems using SOE and DDNA,
- Chapter 6 advances concepts of experience-based product development for the 4th Industrial Revolution, Industry 4.0,
- Chapter 7 establishes SOE and DDNA-based environment for smart product innovation.

The above chapters represent a sample of an effort to provide guidelines to develop experience-based tools for smart processing of knowledge and information that is available to decision-makers acting in information and data-rich environments. The overall aim of this book is to provide useful, practical ideas, and perceptions related to the DDNA technology. It poses views and case studies to explore and solve the complexities and challenges of modern smart knowledge-based systems management issues. It also encourages its reader to become aware of the multifaceted interdisciplinary character of such issues. The premise of this book is that its reader will leave it with a heightened ability to think—in different ways—about developing, evaluating, and implementing smart experience-based knowledge engineering support to manage systems functioning in real-life environment.

It has been our pleasure to work with the contributors and reviewers of this book's chapters. This book would not have materialized without their very active collaboration. Our special thanks go to Prof. Lakhmi C. Jain, the Series Editor, for his vision and direction during the initial development phase of this book.

Gdansk, Poland — Edward Szczerbicki
Newcastle, Australia — Cesar Sanin

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About the Editors

Prof. Edward Szczerbicki has had very extensive experience in the area of intelligent system development over an uninterrupted 40-year period, 30 years of which he spent in the top systems research centres in the USA, UK, Germany, and Australia. In this area, he contributed to the understanding of information and knowledge engineering in systems operating in environments characterized by informational uncertainties and dynamics. He has published 300+ refereed papers, which attracted close to 2500 citations over the last ten years. His D.Sc. degree (1993) and the title of Professor (2006) were gained in the area of information science for his international published contributions. The research of Prof. Szczerbicki contributes significantly to the area of smart knowledge engineering and development of intelligent systems. His academic experience includes positions with the Gdansk University of Technology, Gdansk, Poland; Strathclyde University, Glasgow, Scotland; The University of Iowa, Iowa City, USA; University of California, Berkeley, USA; and The University of Newcastle, Newcastle, Australia.

Dr. Cesar Sanin counts with extensive experience in the development of knowledge engineering and intelligent technologies for the past 17 years. He gained studies in the Bachelor of Systems Engineering from EAFIT University, Colombia; Administrative Engineering from the National University of Colombia; and an IT Diploma at The University of Newcastle, Australia. Afterwards, he pursued a Ph.D. degree at the School of Engineering of The University of Newcastle and received his degree in the field of Knowledge Engineering and Intelligent Technologies (2007). Currently, he continues his work at The University of Newcastle as a co-director of the Knowledge Engineering Research Team—KERT, where he mainly contributes to the expansion and use of knowledge engineering, decision support systems, and intelligent systems for engineering and business.