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Preface

This volume contains the papers selected for presentation of the technical sessions and invited special session of the 2012 International Conference on Brain Informatics (BI 2012) organized by the Web Intelligence Consortium (WIC), IEEE Computational Intelligence Society Task Force on Brain Informatics (IEEE-CIS TF-BI), and University of Macau.

Brain Informatics 2012 was organized under the umbrella of the 2012 World Intelligence Congress (WIC 2012) in Macau, a special event of the Alan Turing Year (centenary of Alan Turing's birth), and it was held jointly with other four international conferences: Active Media Technology 2012 (AMT 2012), Methodologies for Intelligent Systems 2012 (ISMIS 2012), IEEE/WIC/ACM Web Intelligence 2012 (WI 2012), and IEEE/WIC/ACM Intelligent Agent Technology 2012 (IAT 2012). The WIC aims to facilitate interactions and exchange of ideas among researchers working on a variety of focused themes under intelligent informatics.

Brain informatics (BI) is an emerging interdisciplinary and multi-disciplinary research field that focuses on studying the mechanisms underlying the human information processing system (HIPS). BI investigates the essential functions of the brain, ranging from perception to thinking, and encompassing such areas as multi-perception, attention, memory, language, computation, heuristic search, reasoning, planning, decision making, problem solving, learning, discovery, and creativity.

This field goes along with the mainstreams of both medical science and information science. Medical research aims at the understanding of the structure and function of the human body: anatomy looks for structure behind a given function, and physiology studies a function achieved by interaction between components, which are analogous with geometry and algebra in mathematics. Brain research can be understood in the same framework, although methods for research were very much limited, compared with other medical fields. In the end of the last century, rapid progress in brain image and electrophysiological measurements changed such research environments and we can easily measure brain functions by combinations of imaging and signal processing. For example, functional MRI depicts the temporal change of activities in brains, which gives insights into cognitive function from the information on structure, and EEG topography gives information about brain structure from the measurements of brain signals. However, all the technologies introduced have limitations for understanding brain functions, due to one important missing point: the introduction of informatics. Since a brain is a highly advanced information processing device, higher brain function should be studied from the viewpoint of informatics. Brain informatics will give new insights into the deep understanding of the brain as an information processor. As computer science enriches geometry and algebra in mathematics, brain informatics is expected to enrich studies on neuroanatomy and neurophys-

iology, which is the basis of brain research. We believe that the person who introduced this perspective is Alan Turing, who proposed the Turing test as an examination of the intelligence of computing machinery.

One goal of BI research is to develop and demonstrate a systematic approach to an integrated understanding of the macroscopic- and microscopic-level working principles of the brain, by means of experimental, computational, and cognitive neuroscience studies, as well as by utilizing advanced Web intelligence (WI)-centric information technologies. Another goal is to promote new forms of collaborative and interdisciplinary work. New kinds of BI methods and global research communities will emerge, through infrastructure on the wisdom Web and knowledge grids that enable high-speed and distributed large-scale analysis and computations as well as radically new ways of data/knowledge sharing.

The series of Brain Informatics Conferences started with the First WICI International Workshop on Web Intelligence Meets Brain Informatics (WImBI 2006), held at Beijing, China, in 2006. The second, third, and fourth conferences, Brain Informatics 2009, 2010, and 2011 were held jointly with the International Conferences on Active Media Technology (AMT 2009, AMT 2010, and AMT 2011), respectively, in Beijing, China, Toronto, Canada, and Lanzhou, China.

The conferences provide a leading international forum to bring together researchers and practitioners who explore the interplay between studies of the human brain and research in computer science. On the one hand, studies of human brain models characterize the functions of the human brain based on the notions of information processing systems. WI-centric information technologies are applied to support brain science studies. For instance, the wisdom Web and knowledge grids enable high-speed, large-scale analysis, simulation, and computation as well as new ways of sharing research data and scientific discoveries. On the other hand, informatics-enabled brain studies, e.g., based on fMRI, EEG, and MEG, significantly broaden the spectrum of theories and models of brain science and offer new insights into the development of human-level intelligence on the wisdom Web and knowledge grids. Different fields are involved in this challenge: computer science, information technology, artificial intelligence, Web intelligence, cognitive science, neuroscience, medical science, life science, economics, data mining, data and knowledge engineering, intelligent agent technology, human–computer interaction, complex systems, and system science.

Here we would like to express our gratitude to all members of the Conference Committee for their support. BI 2012 had a very exciting program including keynote talks shared with the other four conference of the WIC 2012, technical sessions, special sessions, workshops, tutorials, and social programs. This would not have been possible without the generous dedication of the Program Committee members and the external reviewers who reviewed the papers submitted to BI 2012, our keynote speakers, Edward Feigenbaum of Stanford University, USA (1994 Turing Award Winner) and Jianhua Ma of Hosei University, Japan, and without the enthusiasm of the organizers of our two special sessions with invited papers: (1) Granular Computing for Brain Informatics organized by Duoqian Miao, Andrzej Skowron, Dominik Slezak, Guoyin Wang, JingTao Yao, and

Yiyu Yao; (2) Cognitive Architectures Meets Brain Informatics organized by Jian Yang and Peipeng Liang.

BI 2012 could not have taken place without the great team effort of the Organizing Committee, the support of the University of Macau, Hong Kong Baptist University, the International WIC Institute, Beijing University of Technology, China. Special thanks to Gong Zhiguo, Ryan Leang Hou U, Feng Wan, Juzhen Dong, Qin (Christine) Lv, Lars Schwabe, Daniel Tao, Jian Yang, and Shinichi Motomura for their supportive work. We are grateful to Springer *Lecture Notes in Computer Science* (LNCS/LNAI) for their generous support. We thank Alfred Hofmann and Anna Kramer of Springer for their help in coordinating the publication of this special volume in an emerging and interdisciplinary research field.

September 2012

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